IMPULSE®•G+/VG+ Series 5

Variable Frequency/Vector Crane Controls

Technical Manual

MAGNETEK
By Columbus McKinnon

VFD Firmware: 14305
Part Number: 144-80002 R4
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Parts of this product may be covered by one or more of the following patents: 7,190,146, 7,841,583, 8,401,814, 8,669,724, 8,686,670, and 3,017,333 (Canada).

PRODUCT SAFETY INFORMATION

Magnetek® offers a broad range of radio remote control products, control products and variable frequency drives (VFD), and industrial braking systems for material handling applications. This manual has been prepared by Magnetek to provide information and recommendations for the installation, use, operation and service of Magnetek's material handling products and systems (Magnetek Products). Anyone who uses, operates, maintains, services, installs or owns Magnetek Products should know, understand and follow the instructions and safety recommendations in this manual for Magnetek Products.

The recommendations in this manual do not take precedence over any of the following requirements relating to cranes, hoists lifting devices or other material handling equipment which use or include Magnetek Products:

- Instructions, manuals, and safety warnings of the manufacturers of the equipment where the Magnetek Products are used,
- Plant safety rules and procedures of the employers and the owners of the facilities where the Magnetek Products are being used,
- Regulations issued by the Occupational Health and Safety Administration (OSHA),
- Applicable local, state or federal codes, ordinances, standards and requirements, or
- Safety standards and practices for the industries in which Magnetek Products are used.

This manual does not include or address the specific instructions and safety warnings of these manufacturers or any of the other requirements listed above. It is the responsibility of the owners, users and operators of the Magnetek Products to know, understand and follow all of these requirements. It is the responsibility of the employer to make its employees aware of all of the above listed requirements and to make certain that all operators are properly trained. **No one should use Magnetek Products prior to becoming familiar with and being trained in these requirements and the instructions and safety recommendations for this manual.**

Product Warranty Information

Magnetek, hereafter referred to as Company, assumes no responsibility for improper programming of a VFD by untrained personnel. A VFD should only be programmed by a trained technician who has read and understands the contents of this manual. Improper programming of a VFD can lead to unexpected, undesirable, or unsafe operation or performance of the VFD. This may result in damage to equipment or personal injury. Company shall not be liable for economic loss, property damage, or other consequential damages or physical injury sustained by the purchaser or by any third party as a result of such programming. Company neither assumes nor authorizes any other person to assume for Company any other liability in connection with the sale or use of this product.

WARRANTY INFORMATION

For information on Magnetek's product warranties by product type, please visit www.cmco.com/magnetek.

⚠ WARNING

Improper programming of a VFD can lead to unexpected, undesirable, or unsafe operation or performance of the VFD.

DANGER, WARNING, CAUTION, and NOTE Statements

Read and understand this manual before installing, operating or servicing this product. Install the product according to this manual and local codes.

The following conventions indicate safety messages in this manual. Failure to heed these messages could cause fatal injury or damage products and related equipment and systems.

DANGERS, WARNINGS, and CAUTIONS

Throughout this document DANGER, WARNING, and CAUTION statements have been deliberately placed to highlight items critical to the protection of personnel and equipment.

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTE: *A NOTE statement is used to notify people of installation, operation, programming or maintenance information that is important, but not hazard-related.*

DANGER, WARNING, and CAUTION STATEMENTS SHOULD NEVER BE DISREGARDED.

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Table of Contents

1 Introduction

WARNING

Do not touch any circuitry components while the main AC power is on. In addition, wait until the red “CHARGE” LED is out before performing any service on that unit. It may take as long as 5 minutes for the charge on the main DC bus capacitors to drop to a safe level.

Do not check signals during operation.

Do not connect the main output terminals (U/T1, V/T2, W/T3) to the incoming, three-phase AC source.

Before executing a rotational Auto-Tuning, ensure that the motor is disconnected from the drive train and the electric brake is released. If the electric brake cannot be released, you must ensure that the brake is disengaged for the entire tuning process.

Read and understand this manual before installing, operating, or servicing this VFD. All warnings, cautions, and instructions must be followed. All activity must be performed by qualified personnel. The VFD must be installed according to this manual and local codes.

Do not connect or disconnect wiring while the power is on. Do not remove covers or touch circuit boards while the power is on. Do not remove or insert the keypad while power is on.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 VDC. To prevent electric shock, wait at least five minutes after all indicators are OFF and measure DC bus voltage to confirm safe level.

Do not perform a withstand voltage test on any part of the unit. This equipment uses sensitive devices and may be damaged by high voltage.

The VFD is suitable for circuits capable of delivering not more than 100,000 RMS symmetrical Amperes. Install adequate branch circuit short circuit protection per applicable codes. Failure to do so may result in equipment damage and/or personal injury.

Do not connect unapproved LC or RC interference suppression filters, capacitors, or overvoltage protection devices to the output of the VFD. These devices may generate peak currents that exceed VFD specifications.

1.1 How to Use This Manual

This manual provides technical information on IMPULSE®•G+/VG+ Series 5 VFD (variable frequency drive) parameter settings, functions, troubleshooting, and installation details. Use this manual to expand the functionality and to take advantage of higher performance features. This manual is available for download at www.cmco.com/magnetek.

The VFDs share a common power section and similar parameters. The parameters and performance differ because the VG+ includes a PG-X3 encoder feedback card allowing the VFD to perform Closed Loop Vector control of the motor. The G+ VFDs operate in V/f or Open Loop Vector control methods, appropriate for traverse or standard (mechanical load brake) hoist motions. The VG+ VFDs are typically applied to hoists without mechanical load brakes, and traverse motions where torque control or a wide speed control range is required.

Many parameter functions are common between the two VFD classes. The functions that differ by model or control method are noted in the parameter descriptions. ***Table 1-1*** below lists the available configurations by model.

Table 1-1: Configurations by Model

VFD Model	Control Method (A01-02)	Speed Control Range	Motion (A01-03)
G+	V/f (0)	40:1	Traverse (0) Standard Hoist (1) Braketronic (4)
G+	Open Loop Vector (2)	200:1	Traverse (0) Standard Hoist (1) Braketronic (4)
VG+	Closed Loop Vector (3)	1500:1	Traverse (0) NLB Hoist (2) Bucket (3) Braketronic (4) Static Stepless Simulation (7)

The instructions in the following chapters apply to most crane, hoist, and monorail applications. However, carefully evaluate each specific situation and ensure that the National Electric Code (NEC) codes or local wiring practices are followed.

These chapters explain how to install the VFD and, to some extent, the components that it interconnects. It explains how to: assess the environment, mount, and wire the VFD. It is important to develop a plan for mounting and wiring since each task has an effect on the other one. Wiring Practices is included to provide assistance and reference.

NOTE: *If the IMPULSE•G+/VG+ Series 5 is part of a Magnetek motor control panel, reference the control panel drawings and this technical manual, as needed.*

1.2 General Information

1.2.1 Assessing the System Requirements

It is important to know how the VFD will be utilized before installation. Please know the requirements for the following components:

- Speed control method(s) - i.e., stepped, stepless, infinitely variable
- Braking method(s) - coast to stop, decel to stop, NLB Hoist
- Power source voltage, number of phases, and kVA rating
- Power source location
- Wire size
- Grounding location and method
- Control wiring sources - i.e., cab, pendant, radio

1.2.2 Assessing the VFD Environment

When choosing a location for the IMPULSE•G+/VG+ Series 5, perform the following steps:

1. Ensure that a three-phase 200 to 240 VAC 50/60 Hz power supply is available for a 230 VAC-rated VFD, a three-phase 380 to 480 VAC 50/60 Hz power supply is available for a 460 VAC-rated VFD, and a 500 to 600 VAC 50/60 Hz power supply is available for a 575 VAC-rated VFD.
2. Ensure the encoder (if required) is compatible with +5 VDC or 12 VDC and has a quadrature signal.
3. If the RMS encoder current requirement is greater than 200 mA, provide an auxiliary power supply.
4. Ensure that VFD-to-motor wiring distance is less than 150 ft. unless appropriate reactors and/or filters are used.
5. Ensure that the VFD is protected or isolated from:
    - Ambient temperatures outside the range of +14°F to +140°F (-10°C to +60°C).
    - Rain or moisture
    - Corrosive gases or liquids
    - Direct sunlight
    - Severe mechanical vibration
6. Ensure that the VFD is housed in an appropriate environmentally rated (such as NEMA) enclosure.
7. For severe-duty applications (long lifts, for example), ensure that the VFD control system (including dynamic braking resistors) is adequately cooled, even if the ambient temperature limit is not exceeded. For more information, contact Magnetek.

1.2.3 Cybersecurity

This product is designed to connect and communicate information and data through a network interface. It is the sole responsibility of the user to provide and continuously guarantee a secure connection between the product and network. The user must establish and maintain the appropriate measures (such as, but not limited to, the installation of firewalls, the application of authentication measures, the encryption of data, the installation of anti-virus programs, etc.) to protect the product, the network, and its system and interface against all types of security breaches, unauthorized access, interference, intrusion, leakage, and/or theft of data or information. Magnetek and its affiliates are not responsible for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage, and/or theft of data or information.

1.3 Specifications

1.3.1 VFD Specifications

Table 1-2: VFD Capacity - Heavy Duty

230 VAC			460 VAC			575 VAC		
Model (G+/VG+ S5)	**Output Current (A)**	**Output Power** (HP [kW])**	**Model (G+/VG+ S5)**	**Output Current (A)**	**Output Power** (HP [kW])**	**Model (G+/VG+ S5)**	**Output Current (A)**	**Output Power** (HP [kW])**
2003	3.5	0.75 [0.55]	4001	1.8	0.75 [0.55]	5001	1.3	0.75 [0.55]
2005	5.0	1.0 [0.75]	4003	3.4	1.5 [1.1]	5002	2.4	1.5 [1.1]
2007	6.9	1.5 [1.1]	4004	4.8	2.0 [1.5]	5003	2.7	2.0 [1.5]
2008	8.0	2.0 [1.5]	4005	5.5	3.0 [2.2]	5004	3.9	3.0 [2.2]
2011	11	3.0 [2.2]	4007	7.2	4.0 [3.0]	5006	6.1	5.0 [3.7]
2014	14	4.0 [3.0]	4009	9.2	5.0 [3.7]	5009	9.0	7.5 [5.6]
2017	17.5	5.0 [3.7]	4014	14.8	7.5 [5.5]	5012	11	10 [7.5]
2025	25	7.5 [5.5]	4018	18	10 [7.5]	5017	17	15 [11]
2033	33	10 [7.5]	4024	24	15 [11]	5022	22	20 [15]
2047	47	15 [11]	4031	31	20 [15]	5027	27	25 [19]
2060	60	20 [15]	4039	39	25 [18.5]	5032	32	30 [22]
2075	75	25 [18]	4045	45	30 [22]	5041	41	40 [30]
2088	88	30 [22]	4060	60	40 [30]	5052	52	50 [37]
2115	115	40 [30]	4075	75	50 [37]	5062	62	60 [45]
2145	145	50 [37]	4091	91	60 [45]	5077	77	75 [56]
2180	180	60 [45]	4112	112	75 [55]	5099	99	100 [75]
2215	215	75 [55]	4150	150	100 [75]	5125	125	125 [93]
2283	283	100 [75]	4180	180	125 [90]	5172	172	150 [112]
2346	346	125 [90]	4216	216	150 [110]	5192	192	200 [149]
2415	415	150 [110]	4260	260	200 [150]	5242	242	250 [186]
			4304	304	250 [185]	5336	336	350 [261]
			4371	371	300 [220]	5382	382	400 [298]
			4414	414	350 [260]	5412	412	450 [335]
			4453*	453	400 [300]			
			4477	477	400 [300]			
			4515	515	450 [335]			
			4605	605	500 [370]			
			4720	720	600 [450]			
			4810	810	700 [525]			
			4930	930	800 [600]			
			41090	1090	900 [675]			

** The 4453 model is only available in Europe, instead of the 4477 model.*

***Output Power ratings are for reference only. The VFD should be sized based on the FLA rating of the motor.*

Table 1-3: VFD Specifications

Specification	Specification Value and Information for All Models
Global Certifications	UL, CSA, CE (with filters), RCM, RoHS - ***See Appendix B: Standards Compliance on page 407*** for details.
Crane Duty Classification	CMAA Crane Duty Class A - F (or equivalent)
Nominal input power supply	230 VAC Class: • AC: 200 to 240 VAC, 3-phase, 50/60 Hz • DC: 270 to 340 VDC 460 VAC Class: • AC: 380 to 480 VAC, 3-phase, 50/60 Hz • DC: 513 to 679 VDC 575 VAC Class: • AC: 500 to 600 VAC, 3-phase, 50/60 Hz • DC: 675 to 848 VDC
Overvoltage protection level	230 VAC Class: Stops when DC bus voltage exceeds approx. 410 VDC 460 VAC Class: Stops when DC bus voltage exceeds approx. 820 VDC 575 VAC Class: Stops when DC bus voltage exceeds approx. 1040 VDC
Undervoltage protection level	230 VAC Class: Stops when DC bus voltage falls below approx. 190 VDC 460 VAC Class: Stops when DC bus voltage falls below approx. 380 VDC 575 VAC Class: Stops when DC bus voltage falls below approx. 475 VDC
Allowable voltage fluctuation	+10% or -15% of nominal
Allowable input frequency fluctuation	±5% of nominal
Allowable control frequency fluctuation	±3 Hz of nominal
Short-Circuit Current Rating (SCCR)	The VFD is suitable for circuits capable of delivering a maximum of 100,000 RMS symmetrical Amps.
Control voltage	120 VAC (50/60 Hz) - optional interface card 24 VDC
Displacement Power Factor	0.98
VFD Efficiency	96% at half-speed; 98% at full-speed
Control methods	V/f, open loop vector, or closed loop vector; sine-wave, pulse-width modulated (PWM)
Maximum output voltage (VAC)	230 VAC Class: 3-phase 200 to 240 VAC (proportional to input voltage) 460 VAC Class: 3-phase 380 to 480 VAC (proportional to input voltage) 575 VAC Class: 3-phase 500 to 600 VAC (proportional to input voltage)
Output frequency (Hz)	0.00 to 300.00 Hz
Output speed control range	Closed Loop Vector: 1500:1; Open Loop Vector: 200:1; V/f: 40:1
Output frequency accuracy	Digital inputs: ± 0.01% of max frequency Analog inputs: ± 0.1% of max frequency, 10 bits/10 V
Frequency reference resolution	Digital: 0.01 Hz; Analog: 1/2048 of max frequency (11 bits and sign bit)
Output frequency resolution	0.001 Hz
Overload capacity	150% of VFD rated current for 1 minute, 175% for 5 seconds
Frequency reference sources	0–10 VDC; 0–20 mA; 4–20 mA; ±10 VDC; Serial (RS-485); Digital (Stepped)
Acceleration/deceleration times	0.00 to 60.00 seconds (standard); 0.0 to 600.0 seconds (optional)
Braking torque	150% or more with dynamic braking
DC Link Choke	Models 2088 to 2415, 4045 to 41090, 5032 to 5412 have a built-in DC link choke.
Internal Braking Transistor	Models 2003 to 2115, 4001 to 4150, 5001 to 5062 have an internal braking transistor (B1 and B2 terminals).

Specification	Specification Value and Information for All Models
Motor overload protection	UL recognized electronic thermal overload relay; field-programmable
Over Current protection level (OC)	200% of VFD rated current
Circuit protection	Ground Fault and Short Circuit detection on the VFD output
Safe Torque Off (STO)	SIL3, Category 3 PL e
Heatsink overtemperature	Thermostat trips at approximately 100°C (212°F)
Torque limit selection	Limiting of Forward, Reverse, and Regen torques; selectable from 0–300%
Stall prevention	Functions for accel, decel, at-speed, and constant power region
Other protection features	**VG+:** Speed deviation, overspeed, mechanical brake failure, output phase loss, failed-oscillator, encoder disconnect, roll-back detection, micro controller watchdog, internal braking transistor failure, torque output limit, motor overload, VFD over current, input phase loss. **G+:** Output phase loss, micro-controller watchdog, internal braking resistor failure, motor overload, VFD over current, input phase loss.
Chassis Design	Open Chassis (standard) UL Type 1 (optional finger-safe kits)
DC bus voltage indication	Charge LED is on until DC bus voltage drops below 50 VDC
Installation Location	VFD must be installed inside an enclosure, and requires protection from moisture, corrosive gases, and liquids
Keypad Battery	CR2016 rated at 3V. Estimated battery life of 5 years at 20°C (68°F).
Ambient operating temperature	-10° to 60°C (14° to 140°F)*
Storage temperature	-20°C to +70°C (-4°F to 158°F)
Humidity	95% relative; non-condensing
Conformal Coating	A G+ comes standard with conformal coating on the VFD circuit boards to meet IEC 60721-3-3, 3C2, 3S3 levels. A VG+ requires a special encoder option card, PG-X3.M, which has conformal coating.
Vibration	10 to 20 Hz at 9.8 m/s^2 (Models 2003 to 2415, 4001 to 4605, 5001 to 5412) 10 to 20 Hz at 5.9 m/s^2 (Models 4720 to 41090) 20 to 55 Hz at 5.9 m/s^2 (Models 2003 to 2180, 4001 to 4150, 5001 to 5077) 20 to 55 Hz at 2.0 m/s^2 (Models 2215 to 2415, 4180 to 41090, 5099 to 5412)
Seismic Standards	Capable of structurally and operationally withstanding the seismic response criteria as defined in the IBC, ASCE7, HCAI, and tested to AC-156. Contact Magnetek for information on the IBC/HCAI seismic mounting requirements.
Elevation	Up to 1,000 m without derate, and up to 4,000 m with derate. Derate 1% of the VFD output current for every 100 m above 1,000 m.
Atmospheric Pressure	0.61 atmosphere (8.9 psi/61.6 kPa) to 1.05 atmosphere (15.4 psi/106.4 kPa)
Orientation	Install the VFD vertically to maintain maximum cooling effects.

* *Maximum ambient temperature of 60°C at the VFD chassis with output current derate*

1.3.2 AC Reactor Specifications

Reactors are inductive components used for lowering harmonics on a power feed. They absorb power line disturbances that can damage variable frequency drives (VFDs), motors, and other sensitive equipment. Reactors can help mitigate nuisance power faults, reduce harmonic distortion, and minimize long wire lead effects.

A reactor is typically classified by an impedance of 3% or 5%, meaning that percentage of impedance is applied when the current flowing through the reactor is at the rated current of the device. Reactors by themselves don’t have a % impedance (%Z) value. Instead, %Z is derived from the current rating, line voltage, and frequency of the application. Note that a voltage drop will occur equal to the reactor impedance. Therefore, a 3% reactor will cause a voltage drop of 3%.

The following guidelines are recommendations to help determine input and output reactor requirements:

- The following tables are only a guideline. The size of the reactor is based on motor HP or kW.
- The Fundamental Amps rating is a typical load for the associated motor HP/kW, and is used to calculate the impedance (%Z) rating. The Maximum Amps rating is typically 1.5x the Fundamental rating.
- Install an input reactor if the power source is greater than 500 kVA.
- Install an output reactor if the distance between the VFD and the motor exceeds 150 feet (45.7 meters).
- Install an output reactor if a device, such as a power limit switch, is used to disconnect the motor from the VFD. Use a power limit switch early break circuit to fault the VFD.
- Install one output reactor per VFD for a multiple-VFD arrangement requiring reactor protection.
- For a multiple VFD arrangement, an input reactor for each VFD is recommended for optimal protection. However, if the VFDs are within two sizes of each other, a single input reactor can be used. The reactor must be sized for the sum of the motor ratings.
- Reactors are most commonly installed on the line side of the VFD, but can be installed on the load side between the VFD output and motor.

Table 1-4: 230 V Class AC Reactors (3%)

VFD Model Number	Reactor Part Number	Reactor Fundamental Amps	Reactor HP (kW)
2003	REA230-1	4	1 (0.75)
2005	REA230-1	4	1 (0.75)
2007	REA230-2	8	2 (1.5)
2008	REA230-2	8	2 (1.5)
2011	REA230-3	12	3 (2.2)
2014	REA230-3	12	3 (2.2)
2017	REA230-5	18	5 (3.7)
2025	REA230-7.5	25	7.5 (5.6)
2033	REA230-10	35	10 (7.5)
2047	REA230-15	45	15 (11)
2060	REA230-20	55	20 (15)
2075	REA230-25	80	25 (18.5)
2088	REA230-30	80	30 (22)
2115	REA230-40	100	40 (30)
2145	REA230-50	130	50 (37)
2180	REA230-60	160	60 (45)
2215	REA230-75	200	75 (56)
2283	REA230-100	250	100 (75)
2346	REA230-125	320	125 (93)
2415	REA230-150	400	150 (112)

Table 1-5: 460 V Class AC Reactors (3%)

VFD Model Number	Reactor Part Number	Reactor Fundamental Amps	Reactor HP (kW)
4001	REA460-1	2	1 (0.75)
4003	REA460-2	4	2 (1.5)
4004	REA460-2	4	2 (1.5)
4005	REA460-3	4	3 (2.2)
4007	REA460-5	8	5 (3.7)
4009	REA460-5	8	5 (3.7)
4014	REA460-7.5	12	7.5 (5.6)
4018	REA460-10	18	10 (7.5)
4024	REA460-15	25	15 (11)
4031	REA460-20	35	20 (15)
4039	REA460-25	35	25 (18.5)
4045	REA460-30	45	30 (22)
4060	REA460-40	55	40 (30)
4075	REA460-50	80	50 (37)
4091	REA460-60	80	60 (45)
4112	REA460-75	100	75 (56)
4150	REA460-100	130	100 (75)
4180	REA460-125	160	125 (93)
4216	REA460-150	200	150 (112)
4260	REA460-200	250	200 (150)
4304	REA460-250	320	250 (187)
4371	REA460-300	400	300 (224)
4414	REA460-400	500	400 (298)
4477/4453*	REA460-400	500	400 (298)
4515	REA460-500	600	500 (373)
4605	REA460-500	600	500 (373)
4720	REA460-600	750	600 (448)
4810	REA460-750	850	750 (560)
4930	REA460-850	1000	850 (634)
41090	REA460-900	1200	900 (671)

** The 4453 model is only available in Europe.*

Table 1-6: 575 V Class AC Reactors (3%)

VFD Model Number	Reactor Part Number	Reactor Fundamental Amps	Reactor HP (kW)
5001	REA575-1	2	1 (0.75)
5002	REA575-2	4	2 (1.5)
5003	REA575-2	4	2 (1.5)
5004	REA575-3	4	3 (2.2)
5006	REA575-5	8	5 (3.7)
5009	REA575-7.5	8	7.5 (5.6)
5012	REA575-10	12	10 (7.5)
5017	REA575-15	18	15 (11)
5022	REA575-20	25	20 (15)
5027	REA575-25	25	25 (19)
5032	REA575-30	35	30 (22)
5041	REA575-40	45	40 (30)
5052	REA575-50	55	50 (37)
5062	REA575-60	80	60 (45)
5077	REA575-75	80	75 (56)
5099	REA575-100	100	100 (75)
5125	REA575-125	130	125 (93)
5172	REA575-150	160	150 (112)
5192	REA575-200	200	200 (149)
5242	REA575-250	250	250 (187)
5336	REA575-350	320	350 (261)
5382	REA575-400	400	400 (298)
5412	REA575-400	400	400 (298)

1.3.3 Single-Phase Specifications

The VFD is capable of accepting a single-phase input and producing a three-phase output. In this condition, the VFD output capacity must be derated due to increased DC bus ripple caused by the single-phase input. Adding an AC reactor to the line side of the VFD will add impedance that helps reduce the DC bus ripple, and therefore the output capacity is not derated as much on many VFD models. Some models have the same derated output capacity whether an AC reactor is added or not, but it's still recommended to add an AC reactor as a reliability safeguard. The Amps ratings should be used for sizing a motor. The horsepower ratings are for reference only.

NOTE: *Input Phase Loss detection will need to be disabled (L08-05 = 0).*

Table 1-7: 230 V Class Single-Phase Specifications

VFD Model	No Reactor		With AC Reactor		
	Output Capacity				
	HP	Amps	HP	Amps	AC Reactor
2003	0.33	1.52	0.5	2.2	REA230-1
2005	0.5	2.2	0.75	3.2	REA230-1
2007	0.75	3.2	1	4.2	REA230-2
2008	1	4.2	1.5	6	REA230-2
2011	1.5	6	2	6.8	REA230-3
2014	2	6.8	3	9.6	REA230-3
2017	2	6.8	3	9.6	REA230-5
2025	2	6.8	5	15.2	REA230-7.5
2033	3	9.6	7.5	22	REA230-10
2047	3	9.6	7.5	22	REA230-15
2060	5	15.2	10	28	REA230-20
2075	7.5	22	10	28	REA230-25
2088	10	28	15	42	REA230-30
2115	10	28	10	28	REA230-40
2145	15	42	20	54	REA230-50
2180	20	54	25	68	REA230-60
2215	30	80	30	80	N/A
2283	30	80	40	104	REA230-100
2346	40	104	50	130	REA230-125
2415	50	130	60	154	REA230-150

Table 1-8: 460 V Class Single-Phase Specifications

VFD Model	No Reactor		With AC Reactor		
	Output Capacity				
	HP	Amps	HP	Amps	AC Reactor
4001	0.33	0.76	0.5	1.1	REA460-1
4003	0.75	1.6	1	2.1	REA460-2
4004	1	2.1	1.5	3	REA460-2
4005	1	2.1	2	3.4	REA460-3
4007	2	3.4	3	4.8	REA460-5
4009	2	3.4	3	4.8	REA460-5
4014	3	4.8	5	7.6	REA460-7.5
4018	3	4.8	5	7.6	REA460-10
4024	3	4.8	10	14	REA460-15
4031	5	7.6	10	14	REA460-20
4039	5	7.6	15	21	REA460-25
4045	10	14	10	14	REA460-30
4060	10	14	15	21	REA460-40
4075	15	21	15	21	REA460-50
4091	15	21	15	21	REA460-60
4112	25	34	25	34	REA460-75
4150	25	34	30	40	REA460-100
4180	50	65	50	65	REA460-125
4216	50	65	50	65	REA460-150
4260	50	65	60	77	REA460-200
4304	75	96	75	96	REA460-250
4371	100	124	100	124	REA460-300
4414	125	156	150	180	REA460-400
4477/4453*	125	156	150	180	REA460-400
4515	150	180	200	240	REA460-500
4605	150	180	200	240	REA460-500

** The 4453 model is only available in Europe.*

1.3.4 Terminal Board Specifications

IMPULSE•G+/VG+ Series 5 is designed to interface with user input and output devices through the integrated terminal board. This eliminates the need for an additional interface relay or isolation circuitry. The terminal board supports 24VDC digital inputs.

The terminal board has eight optically isolated input terminals which can be used to connect the user input device to the VFD. The eight terminals are multi-function and programmable.

The terminal board has four 250 VAC, 1.0 Amp relays for output devices. Three of them are programmable multi-function output terminals, and one is a fault output terminal.

A **120 VAC interface card** is available for support of 120 VAC 50/60 Hz digital inputs. The interface card plugs into the S1-S8 terminals of the 24 VDC terminal board.

NOTE: *The **S5-120VAC-CARD** complies with UL and CSA standards. The **S5-120VAC-CARD-UNCERT** is not UL, CSA, or CE certified. At time of order, please specify if compliance to a standard is required.*

Table 1-9: Terminal Board Ratings

Part Number	S1-S8	
	Voltage	Frequency
S5-120VAC-CARD S5-120VAC-CARD-UNCERT	120 VAC	50/60 Hz
S5-24VDC-TERM	24 VDC	-

NOTE: *The 120 VAC interface card (S5-120VAC-CARD and S5-120VAC-CARD-UNCERT) cannot be used without the 24 VDC terminal board (S5-24VDC-TERM).*

1.3.5 S4IO Option Card Specifications

The S4IO is an option card that plugs into the VFD to provide additional I/O capability in addition to the I/O included on the terminal board.

The S4IO has four optically isolated input terminals and four dry contact form A relays.

NOTE: *The S4IO does not comply with UL, CSA, or CE standards.*

Table 1-10: S4IO Ratings

Part Number	I1-I4		O1-O6	
	Voltage	Frequency	Voltage (max)	Current (max)
S4IO-120A60	120 VAC	50/60 Hz	250 VAC/30 VDC	1.0 A

2 Installation

WARNING

- When preparing to mount the IMPULSE•G+/VG+ Series 5 VFD, lift it by its base. Never lift the VFD by the front cover, as doing so may cause damage or personal injury.
- Mount the VFD on nonflammable material.
- The VFD generates heat. For the most effective cooling, mount it vertically. For more details, refer to the “Dimensions (Open-Chassis)” section in this chapter.
- Install a fan or other cooling device to keep the ambient temperature below 60°C (140°F).

Failure to observe these warnings may result in equipment damage.

This chapter explains the following:

- Environmental requirements
- System components
- VFD dimensions
- VFD installation
- VFD derating

2.1 Environmental Requirements

Be sure that the VFD is mounted in a location protected against the following conditions:

- -10°C to +60°C (+14°F to 140°F):
- Excessive cold and heat. Use only within the ambient temperature range.
- Direct sunlight (The VFD must be installed inside an enclosure)
- Rain, moisture
- High humidity
- Oil sprays, splashes
- Salt spray
- Dust or metallic particles in the air
- Corrosive gases (e.g. sulfurized gas or liquids)
- Radioactive environments
- Combustibles (e.g. thinner, solvents, etc.)
- Physical shock, vibration
- Magnetic noise (e.g. welding machines, power devices, etc.)

2.2 System Components

2.2.1 Standard Components

- Terminal Board (24VDC with Optional 120VAC Interface Card)
- Line Driver Encoder Option Card (PG-X3) - VG+ only

2.2.2 Optional Components

- Digital DC Input Option Card (DI-A3)
- Digital Output Option Card (DO-A3)
- Analog Output Option Card (AO-A3)
- Digital AC Input/Output Option Card (S4IO)
- Open Collector Encoder Option Card (PG-B3)
- EtherNet/IP Option Card (SI-EN3)
- EtherNet/IP (Dual-Port) Option Card (SI-EN3D)
- Modbus TCP/IP Option Card (SI-EM3)
- Modbus TCP/IP (Dual-Port) Option Card (SI-EM3D)
- PROFINET Option Card (SI-EP3)
- PROFIBUS-DP Option Card (SI-P3)
- UL Type 1 Finger-safe Covers (Ship-along only; Kit depends on VFD model)
- Panel-Mount Keypad Kit (S5-RMT-OPER-KIT)

2.2.3 As-Required Components

- AC reactor - line or load
- DC link choke
- External dynamic braking unit
- Internal or external category C3 EMC filter (***See Appendix B: Standards Compliance on page 407.***)

2.2.4 Required Control Components

- External dynamic braking resistor(s) or AC line regen system
- Motor (3-Phase AC Induction)
- User input device (pendant, joystick, PC, PLC, radio, etc.)
- External circuit protection devices (fuses or circuit breakers). ***See Section 3.2 on page 43.***
- R-C surge suppressors on contactor coils

2.3 Long-Term Storage and Capacitor Reforming

Powering up the VFD every six months is recommended. Over longer periods of time without power, the VFD's electrolytic DC bus capacitors require reformation, especially if stored in an area of high temperatures. Capacitor reforming is required if VFDs are stored without power for more than 2 to 3 years. This process can be avoided by powering up the VFD bi-annually for 30 to 60 minutes.

NOTE: *Bus cap reforming may not restore full VFD functionality after 2 to 3 years of storage without power.*

Variable frequency drives (VFD) contain large bus capacitors that have the potential to be reformed. However, printed circuit boards also contain electrolytic capacitors that may not function after several years without power. Magnetek recommends replacing the PCBs should the VFD's functionality not be restored after bus cap reforming. Contact Magnetek Field Service for assistance.

The electrical characteristics of aluminum electrolytic capacitors are dependent on temperature; the higher the ambient temperature, the faster the deterioration of the electrical characteristics (i.e., leakage current increase, capacitance drop, etc.). If an aluminum electrolytic capacitor is exposed to high temperatures such as direct sunlight, heating elements, etc., the life of the capacitor may be adversely affected. When capacitors are stored under humid conditions for long periods of time, the humidity will cause the lead wires and terminals to oxidize, which impairs their solderability. Therefore, aluminum electrolytic capacitors should be stored at room temperature, in a dry location and out of direct sunlight.

In the event that a capacitor has been stored in a high ambient environment for more than 2 or 3 years, a voltage treatment reformation process to electrolytic capacitors should be performed. When stored above room temperatures for long periods of time, the anode foil may react with the electrolyte, increasing the leakage current. After storage, the application of even normal voltages to these capacitors may result in higher than normal leakage currents. In most cases the leakage current levels will decrease in a short period of time as the normal chemical reaction within the capacitor occurs. However, in extreme cases, the amount of gas generated may cause the safety vent to open.

Capacitors, when used in VFDs that are stored for long periods of time, should be subjected to a voltage treatment/ reforming process as noted below, which will reform the dielectric and return the leakage current to the initial level.

2.3.1 Capacitor Reforming Procedure

1. Connect the VFD inputs L1 and L2 to a variac. It is also acceptable to use a three-phase variac or a variable DC power supply rated for the VFD's nominal DC bus voltage.
2. Make sure the variac voltage setting is turned down so that when input power is applied to the variac, the output of the variac will be at or near 0 volts.
3. Apply power to the variac, listening for abnormal sounds and watching for abnormal visual indications in the VFD. If the variac has an output current indication, make sure the current is near zero.
4. Slowly turn the variac up, increasing the output voltage to nominal rated input voltage over a time period of 2 to 3 minutes. In other words, ramp the voltage up at a rate of approximately 75 to 100 volts/minute for 230 VAC units, 150 to 200 volts/minute for 460 VAC units, and 225 to 300 volts/minute for 575 VAC.
5. Let the output voltage remain at rated voltage for 30 to 60 minutes while keeping close watch for abnormal signs within the VFD. While increasing the variac's output voltage, the current will momentarily increase as current is necessary to charge the capacitors.
6. Once 30 to 60 minutes elapse, remove power.

If any abnormal indications occur during this process, it is recommended that the process be repeated. If problems persist, the VFD should be replaced.

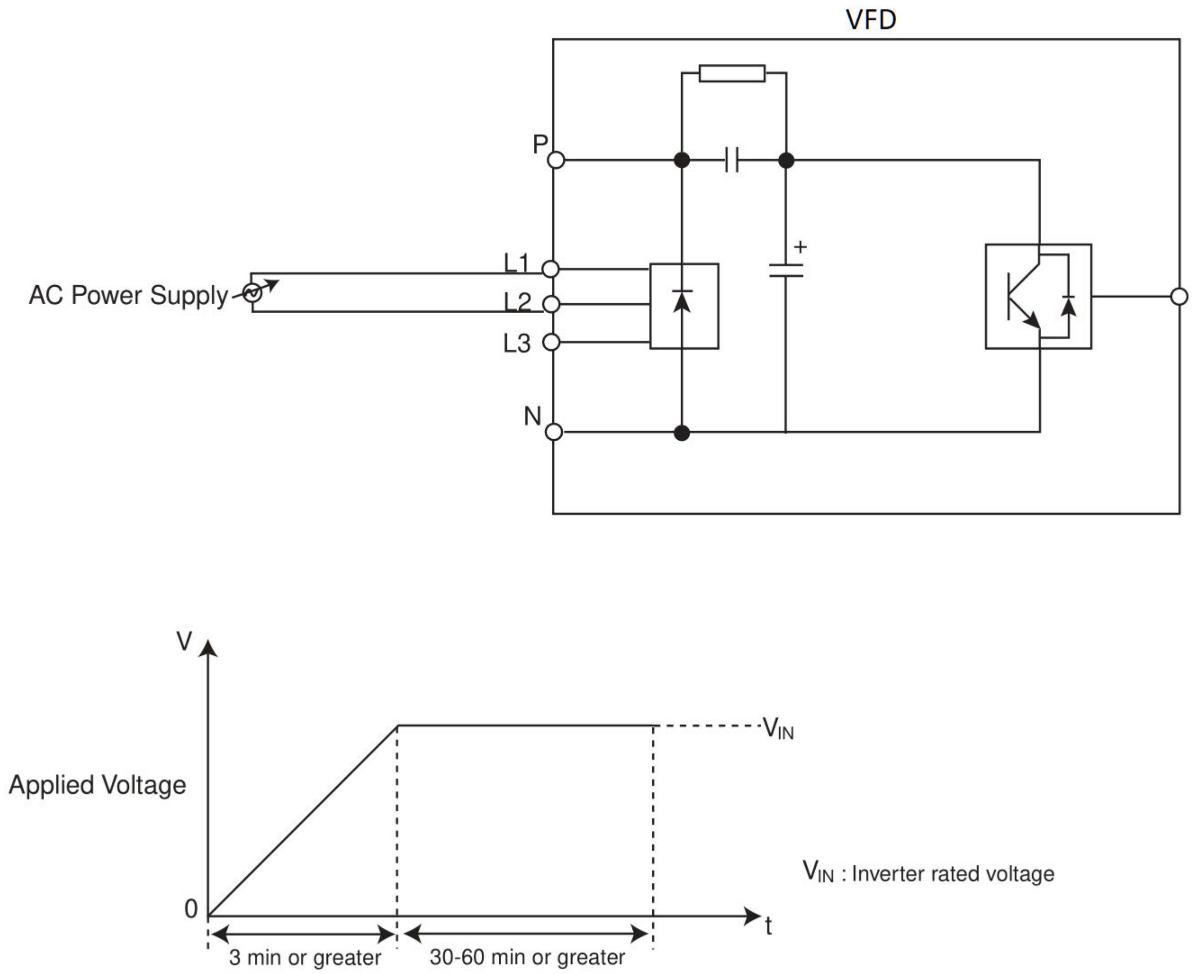


Figure 2-1: Capacitor Reform Diagrams

2.4 Installation Orientation

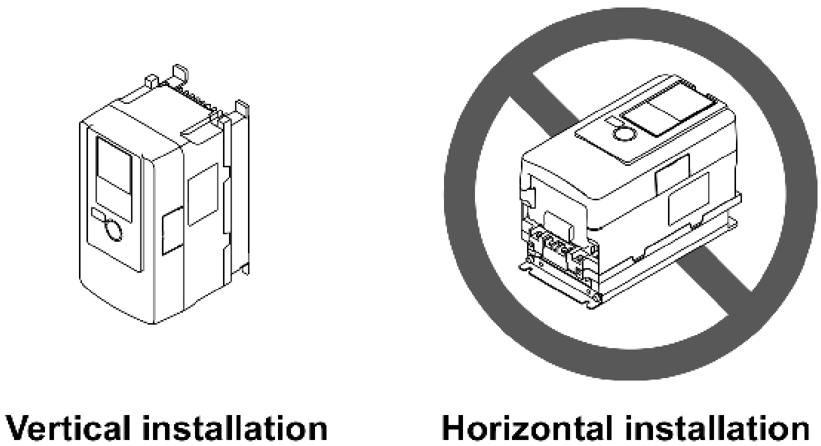


Figure 2-2: Acceptable Installation Orientation

2.5 Recommended Installation Clearances

The following two figures show the recommended minimum clearances when mounting the VFD in standard or side-by-side installations. If the recommended clearances can't be met, decreased airflow may reduce the life of the VFD. It is acceptable to have wireway above or below, and inside the recommended clearances, as long as air flow isn't restricted.

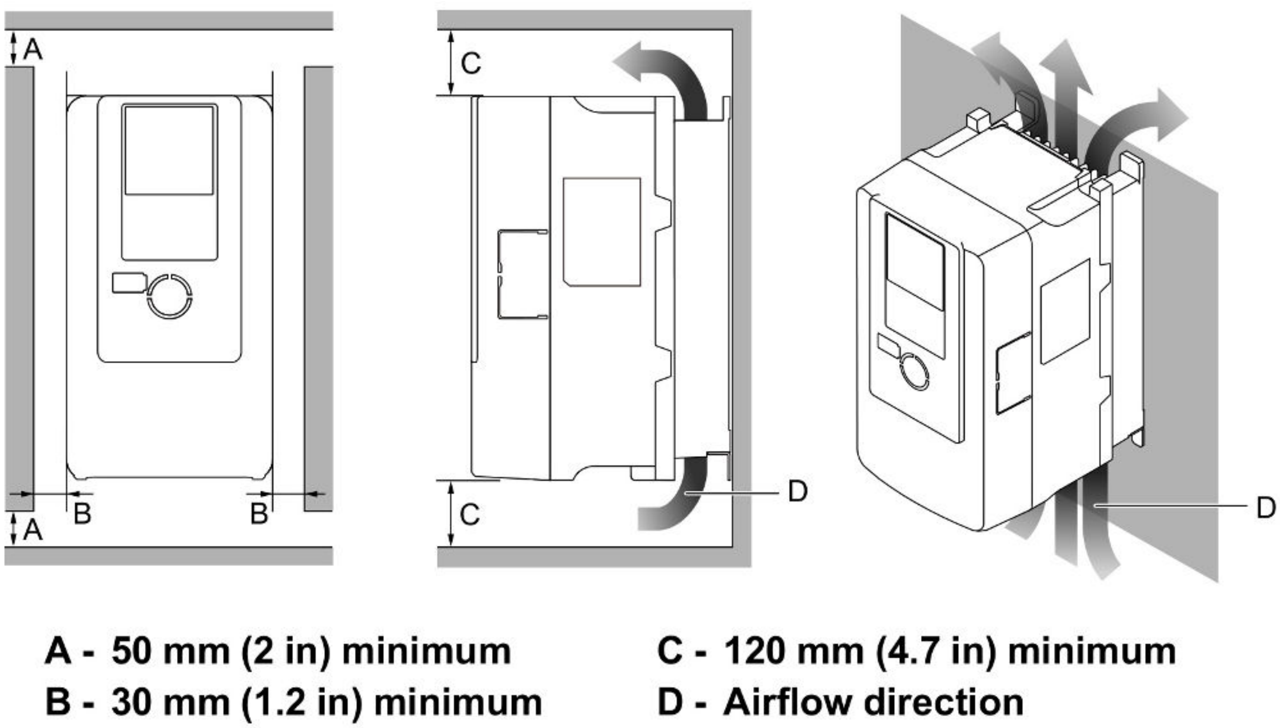


Figure 2-3: Installation Clearances

2.6 Optional Side-by-Side Installation

Models 2003 to 2075 and 4001 to 4039 can take advantage of Side-by-Side installation.

It is recommended to set parameter L08-35 = 1 when mounting VFDs in a side-by-side configuration. This provides a more conservative oL2 overload protection.

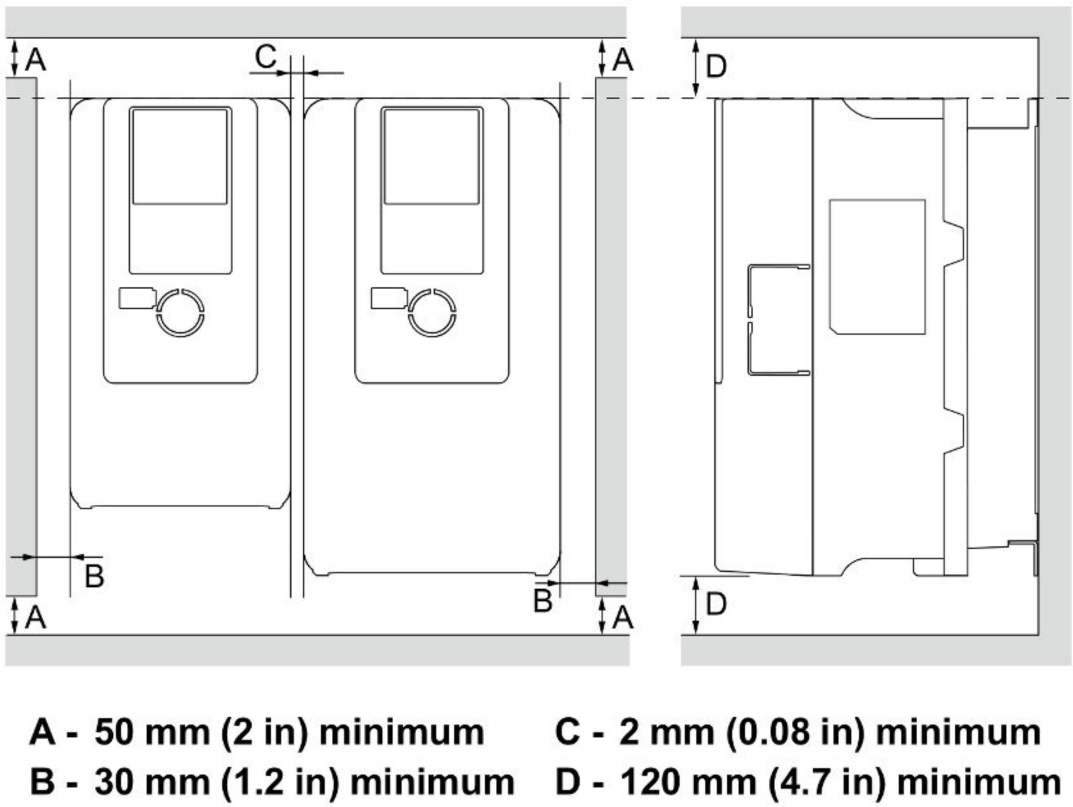


Figure 2-4: Side-by-Side Installation

2.7 VFD Derating

2.7.1 Temperature Derating

To ensure the maximum performance life, the VFD output current must be derated when it is installed in areas with high ambient temperature or if VFDs are mounted side-by-side in a cabinet. In order to ensure reliable VFD overload protection, set parameters L08-12 and L08-35 according to the installation conditions.

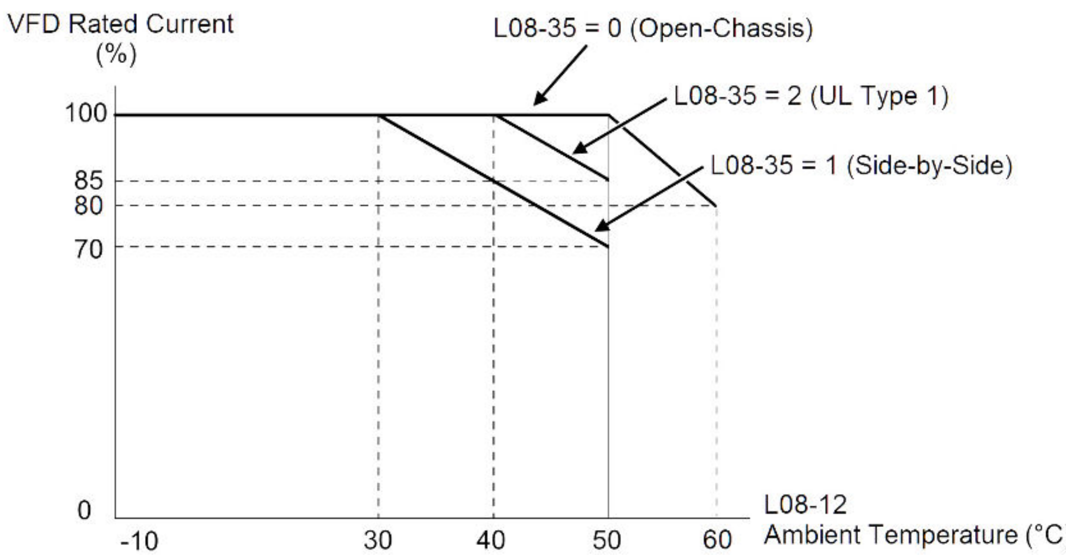


Figure 2-5: Ambient Temperature and Installation Method Derating

2.7.1.1 Open-Chassis Enclosure

An ambient temperature between -10°C to +50°C (14°F to 122°F) allows continuous and fully loaded operation without derating. For ambient temperatures up to 60°C (140°F), derate the output current to 80% of rated output current.

2.7.1.2 Side-by-Side Mounting

An ambient temperature between -10°C and 40°C (14°F to 104°F) allows continuous and fully loaded operation without derating. Operation between 40°C and 50°C (104°F to 122°F) requires output current derating.

2.7.2 Altitude Derating

The VFD output current must be derated when it is installed in altitudes above 1000 meters and up to a maximum of 4000 meters. Derate 1% for every 100 m above 1000 m.

2.8 Dimensions (Open-Chassis)

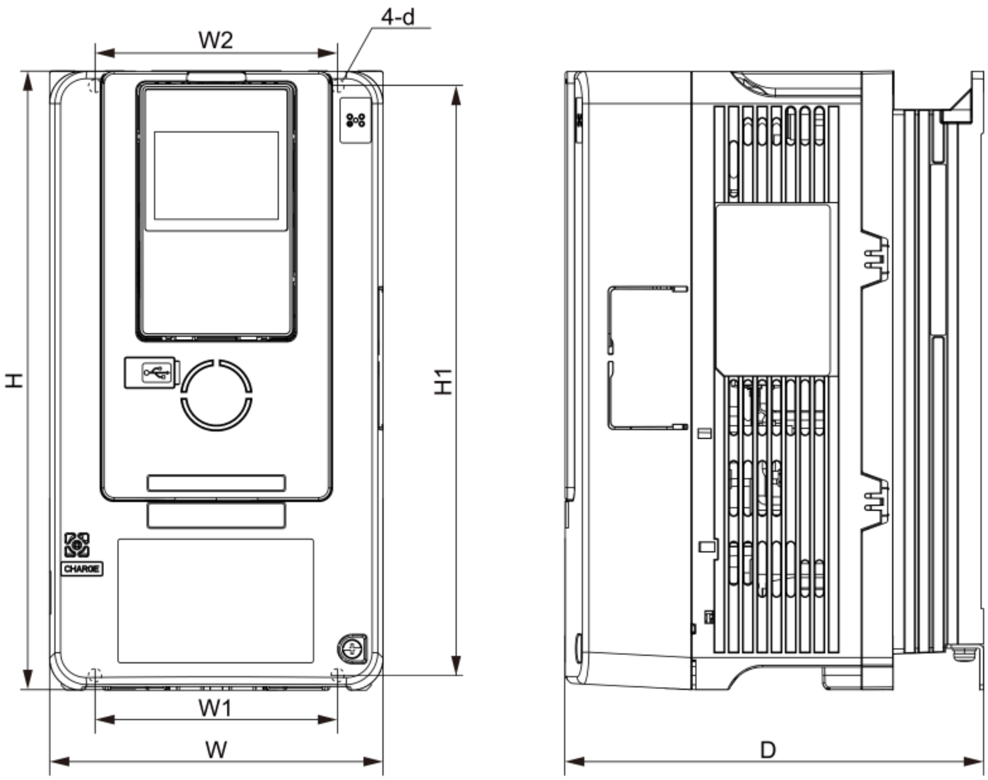


Figure 2-6: Frame 1 and 1.5

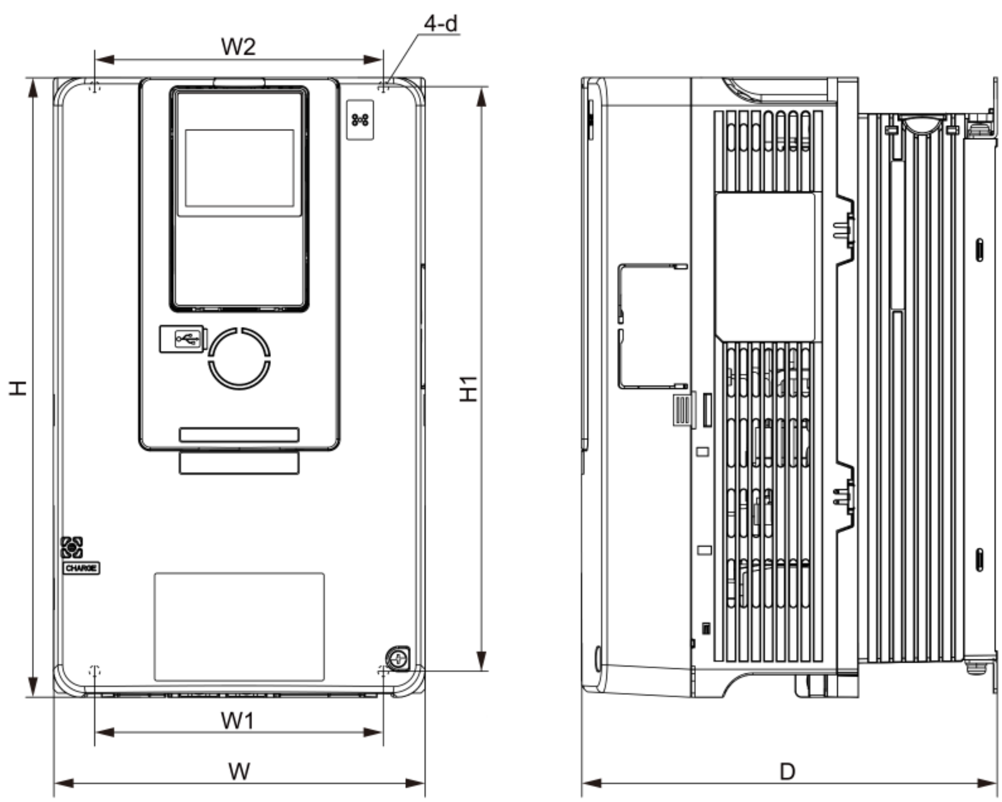


Figure 2-7: Frame 2

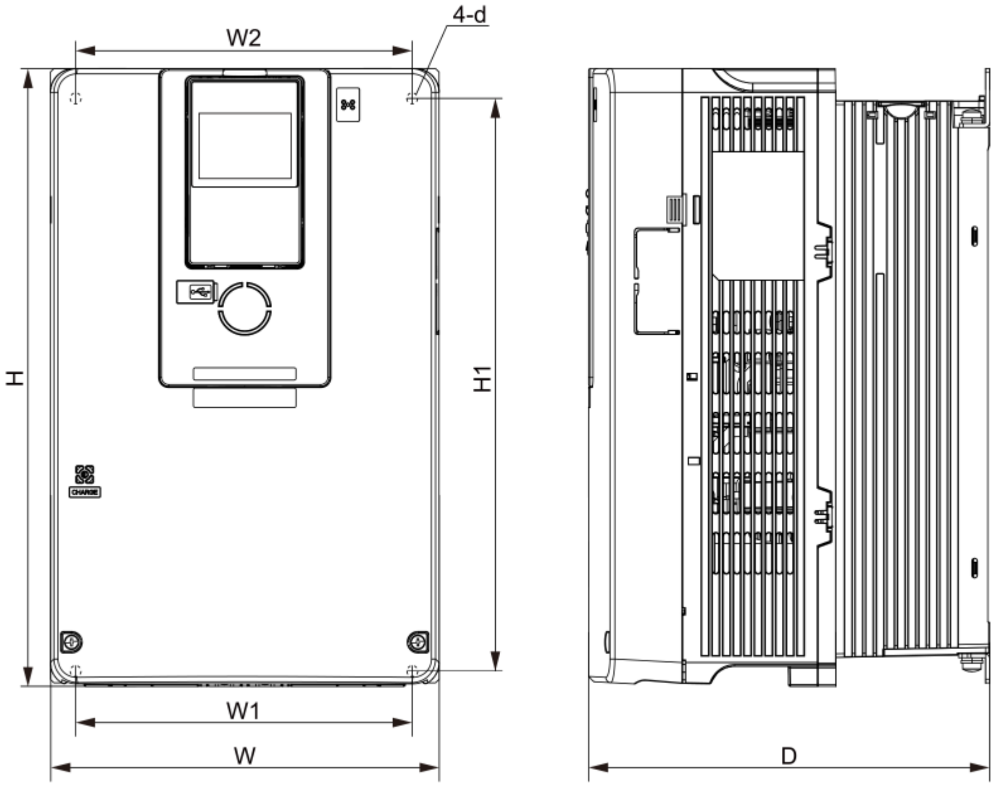


Figure 2-8: Frame 3 and 3.5

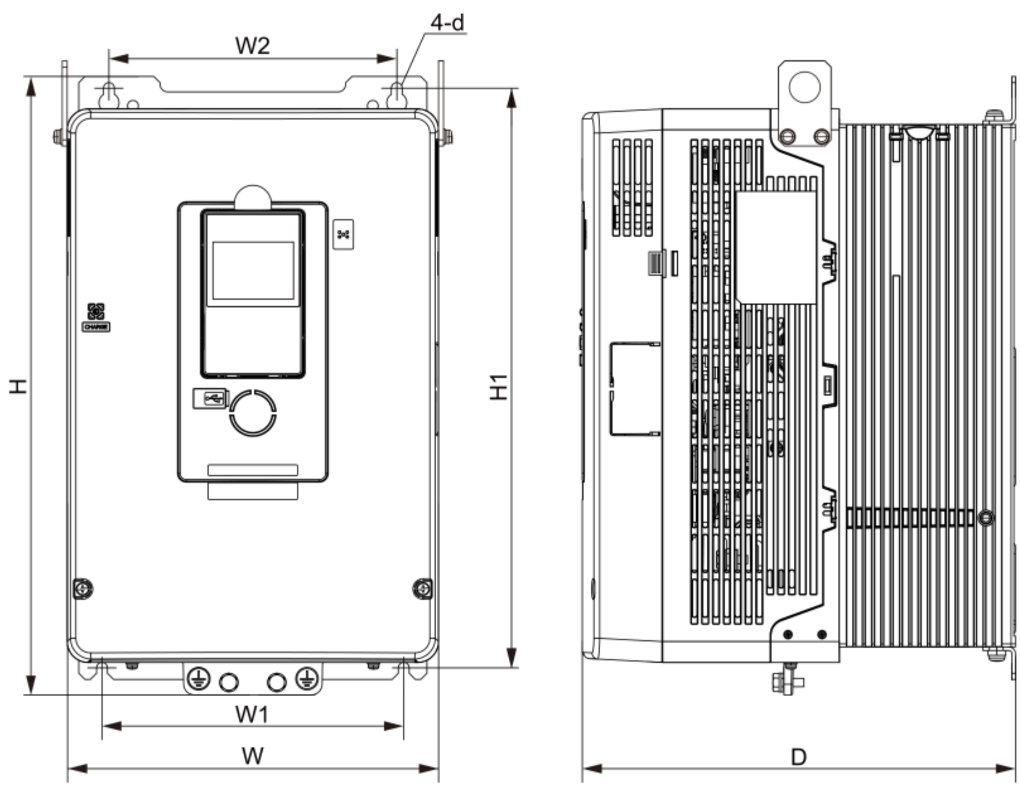


Figure 2-9: Frame 4

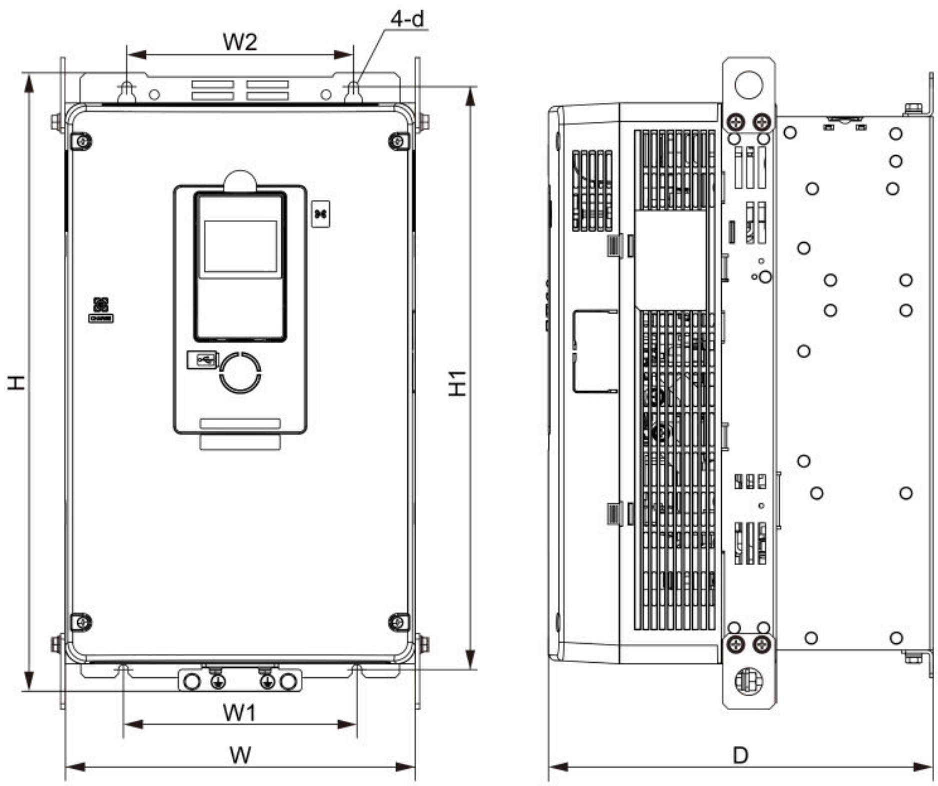


Figure 2-10: Frame 6

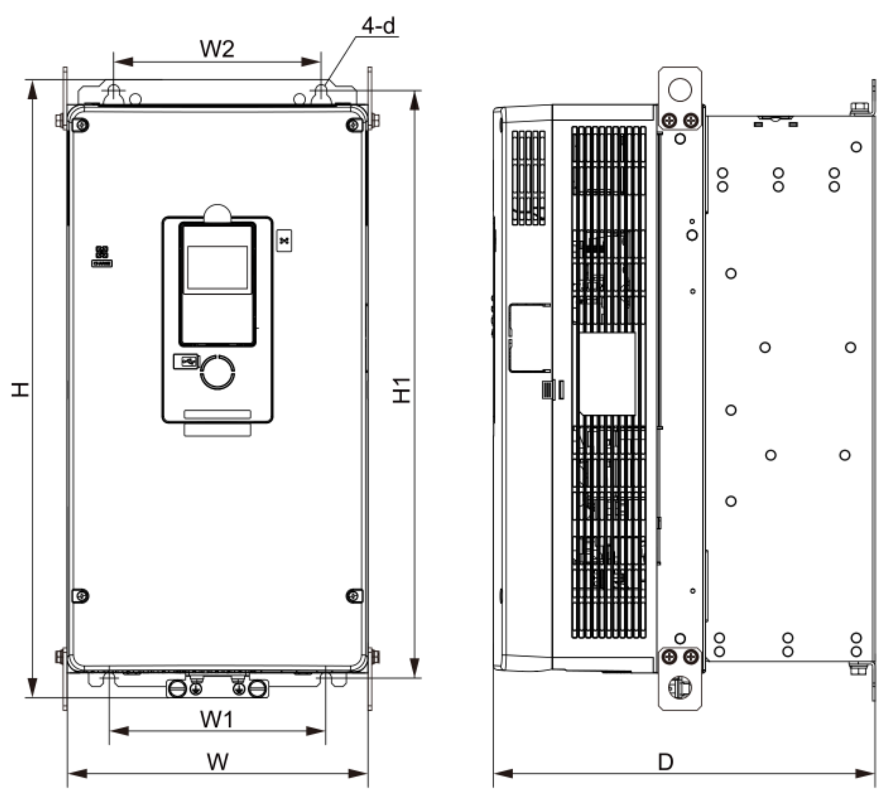


Figure 2-11: Frame 7

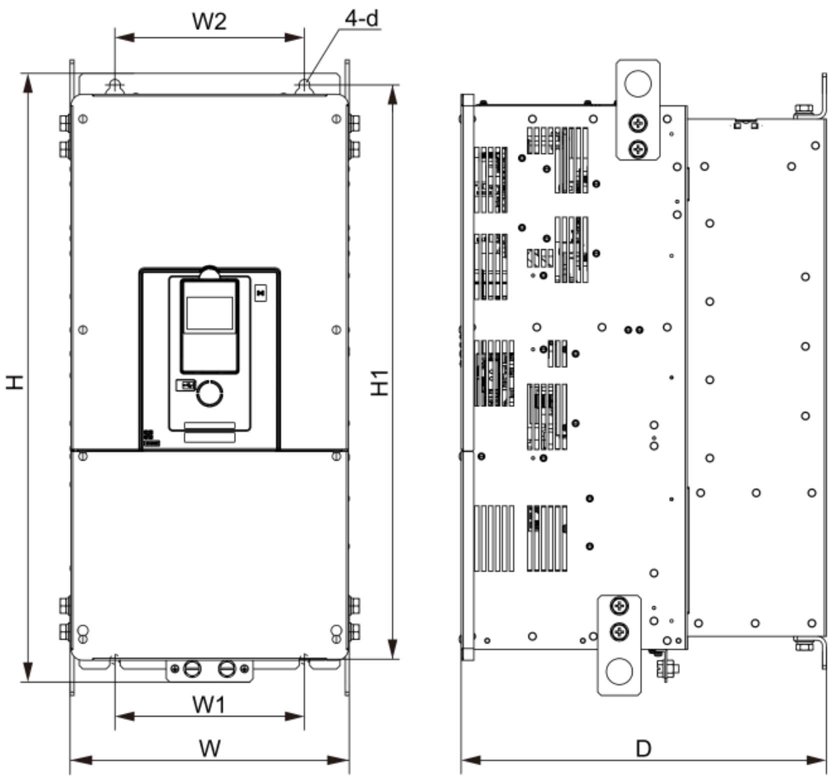


Figure 2-12: Frame 9

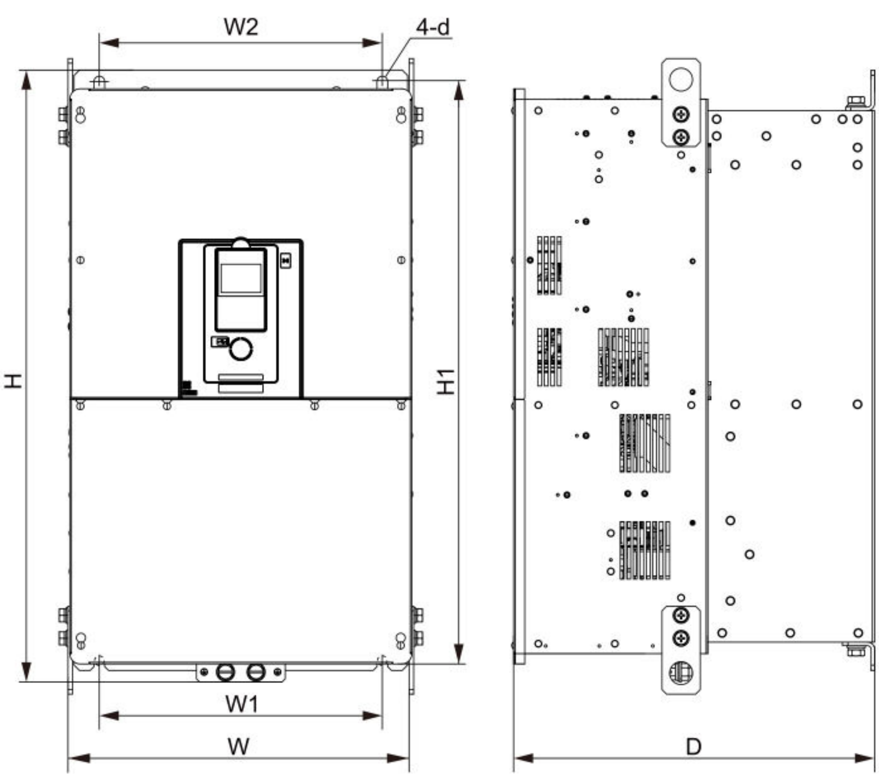


Figure 2-13: Frame 10

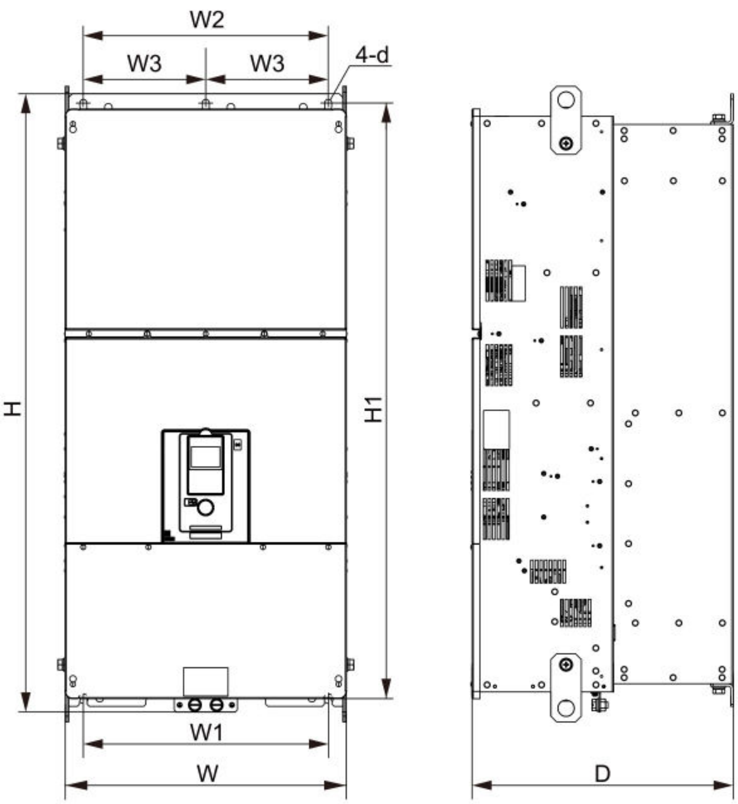


Figure 2-14: Frame 11

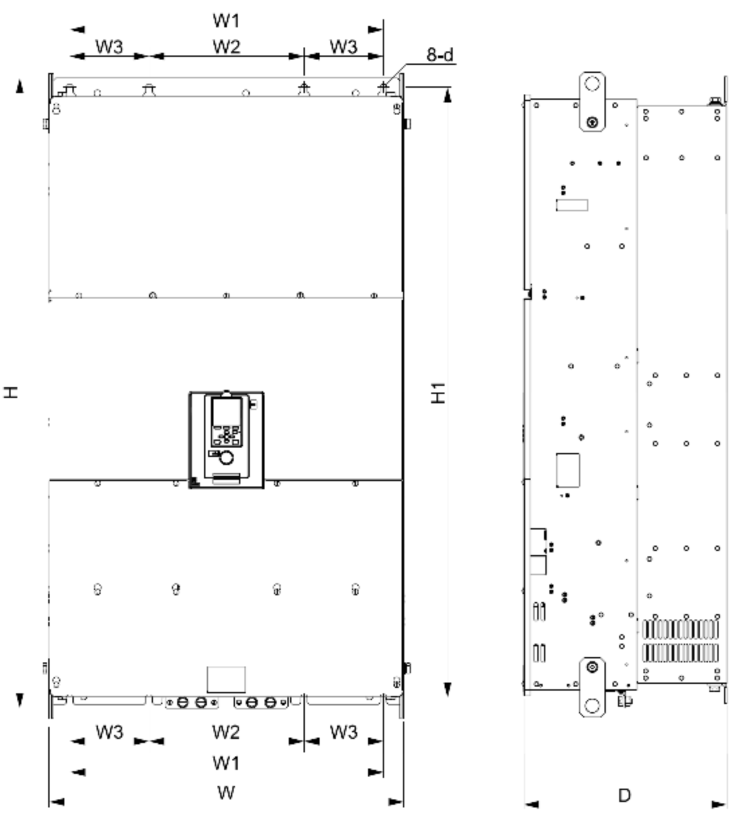


Figure 2-15: Frame 12

Table 2-1: Open-Chassis Dimensions – 230 V Class

Model	Figure	Dimensions - inches (mm)							Weight lbs (kg)	Heat Loss (W)*
		W	H	D	W1	W2	H1	d		
2003	2-6	5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	9.76 (248)	M5	7.7 (3.5)	54
2005		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	9.76 (248)	M5	7.7 (3.5)	63
2007		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	9.76 (248)	M5	7.7 (3.5)	76
2008		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	9.76 (248)	M5	7.7 (3.5)	87
2011		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	9.76 (248)	M5	7.7 (3.5)	111
2014		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	9.76 (248)	M5	8.4 (3.8)	129
2017		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	9.76 (248)	M5	8.4 (3.8)	161
2025		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	9.76 (248)	M5	9.3 (4.2)	248
2033		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	9.76 (248)	M5	9.3 (4.2)	271
2047	2-7	7.09 (180)	11.81 (300)	7.95 (202)	5.51 (140)	5.51 (140)	11.18 (284)	M5	13.2 (6.0)	379
2060	2-8	8.66 (220)	13.78 (350)	8.94 (227)	7.56 (192)	7.56 (192)	13.19 (335)	M6	18.7 (8.5)	518
2075		8.66 (220)	13.78 (350)	8.94 (227)	7.56 (192)	7.56 (192)	13.19 (335)	M6	21.0 (9.5)	657
2088	2-9	9.45 (240)	15.75 (400)	11.02 (280)	7.68 (195)	7.32 (186)	14.76 (375)	M6	39.7 (18.0)	718
2115	2-10	10.04 (255)	17.72 (450)	11.02 (280)	6.69 (170)	6.50 (165)	16.69 (424)	M6	46.3 (21.0)	892
2145	2-11	10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	20.31 (516)	M8	75.0 (34.0)	1095
2180		10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	20.31 (516)	M8	77.2 (35.0)	1305
2215	2-12	12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	25.94 (659)	M10	127.9 (58.0)	1650
2283		12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	25.94 (659)	M10	134.5 (61.0)	2145
2346	2-13	17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	29.80 (757)	M12	220.5 (100.0)	2560
2415		17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	29.80 (757)	M12	233.7 (106.0)	3003

* *Heat Loss is specified for fully loaded, continuous operation.*

NOTE: *Models with optional built-in EMC filter have the same physical dimensions, but have additional weight of around 2.2 lb (1 kg).*

Table 2-2: Open-Chassis Dimensions – 460 V Class

Model	Figure	Dimensions - inches (mm) W	H	D	W1	W2	W3	H1	d	Weight lbs (kg)	Heat Loss (W)*
4001	2-6	5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	7.5 (3.4)	53
4003		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	7.5 (3.4)	70
4004		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	7.5 (3.4)	83
4005		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.2 (3.6)	93
4007		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.2 (3.7)	98
4009		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.2 (3.7)	128
4014		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.8 (4.0)	205
4018		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.8 (4.0)	223
4024	2-7	7.09 (180)	11.81 (300)	7.95 (202)	5.51 (140)	5.51 (140)	-	11.18 (284)	M5	12.1 (5.5)	312
4031		7.09 (180)	11.81 (300)	7.95 (202)	5.51 (140)	5.51 (140)	-	11.18 (284)	M5	12.1 (5.5)	391
4039	2-8	8.66 (220)	13.78 (350)	8.94 (227)	7.56 (192)	7.56 (192)	-	13.19 (335)	M6	17.6 (8.0)	502
4045		8.66 (220)	13.78 (350)	9.69 (246)	7.56 (192)	7.56 (192)	-	13.19 (335)	M6	28.7 (13.0)	515
4060	2-9	9.45 (240)	15.75 (400)	11.02 (280)	7.68 (195)	7.32 (186)	-	14.76 (375)	M6	33.1 (15.0)	692
4075	2-10	10.04 (255)	17.72 (450)	11.02 (280)	6.69 (170)	6.50 (165)	-	16.69 (424)	M6	44.1 (20.0)	801
4091		10.04 (255)	17.72 (450)	11.02 (280)	6.69 (170)	6.50 (165)	-	16.69 (424)	M6	52.9 (24.0)	1016
4112	2-11	10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	-	20.31 (516)	M8	79.4 (36.0)	1256
4150		10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	-	20.31 (516)	M8	81.6 (37.0)	1760
4180	2-12	12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	-	25.94 (659)	M10	132.3 (60.0)	1878
4216		12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	-	25.94 (659)	M10	136.7 (62.0)	2022
4260		12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	-	25.94 (659)	M10	143.3 (65.0)	2753
4304	2-13	17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	-	29.80 (757)	M12	233.7 (106.0)	3342
4371		17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	-	29.80 (757)	M12	247.0 (112.0)	2989
4414	2-14	20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	436.5 (198.0)	3659
4453** / 4477		20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	436.5 (198.0)	4512
4515		20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	456.3 (207.0)	5485
4605		20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	451.9 (205.0)	5593
4720	2-15	29.92 (760)	53.84 (1367.5)	17.32 (440)	26.77 (680)	13.23 (336)	6.77 (172)	52.13 (1324)	M12	800.4 (363.0)	7814
4810		29.92 (760)	53.84 (1367.5)	17.32 (440)	26.77 (680)	13.23 (336)	6.77 (172)	52.13 (1324)	M12	800.4 (363.0)	8683
4930		29.92 (760)	53.84 (1367.5)	17.32 (440)	26.77 (680)	13.23 (336)	6.77 (172)	52.13 (1324)	M12	811.4 (368.0)	10398
41090		29.92 (760)	53.84 (1367.5)	17.32 (440)	26.77 (680)	13.23 (336)	6.77 (172)	52.13 (1324)	M12	811.4 (368.0)	11783

** Heat Loss is specified for fully loaded, continuous operation.*

*** The 4453 model is only available in Europe.*

NOTE: *Models with optional built-in EMC filter have the same physical dimensions, but have additional weight of around 2.2 lb (1 kg).*

Table 2-3: Open-Chassis Dimensions – 575 V Class

Model	Figure	Dimensions - inches (mm)								Weight lbs (kg)	Heat Loss (W)*
		W	H	D	W1	W2	W3	H1	d		
5001	2-6	5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.8 (4.0)	32
5002		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.8 (4.0)	40
5003		5.51 (140)	10.24 (260)	6.93 (176)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	8.8 (4.0)	43
5004		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	9.0 (4.1)	52
5006		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	9.0 (4.1)	71
5009		5.51 (140)	10.24 (260)	8.31 (211)	4.02 (102)	4.02 (102)	-	9.76 (248)	M5	9.0 (4.1)	101
5012	2-7	7.09 (180)	11.81 (300)	7.95 (202)	5.51 (140)	5.51 (140)	-	11.18 (284)	M5	12.1 (5.5)	116
5017		7.09 (180)	11.81 (300)	7.95 (202)	5.51 (140)	5.51 (140)	-	11.18 (284)	M5	12.1 (5.5)	180
5022	2-8	8.66 (220)	13.78 (350)	8.94 (227)	7.56 (192)	7.56 (192)	-	13.19 (335)	M6	17.6 (8.0)	241
5027		8.66 (220)	13.78 (350)	9.69 (246)	7.56 (192)	7.56 (192)	-	13.19 (335)	M6	17.6 (8.0)	318
5032	2-9	9.45 (240)	15.75 (400)	11.02 (280)	7.68 (195)	7.32 (186)	-	14.76 (375)	M6	35.3 (16.0)	370
5041		9.45 (240)	15.75 (400)	11.02 (280)	7.68 (195)	7.32 (186)	-	14.76 (375)	M6	35.3 (16.0)	522
5052	2-11	10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	-	20.31 (516)	M8	79.4 (36.0)	688
5062		10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	-	20.31 (516)	M8	81.6 (37.0)	812
5077		10.39 (264)	21.38 (543)	13.19 (335)	7.48 (190)	7.17 (182)	-	20.31 (516)	M8	81.6 (37.0)	998
5099	2-12	12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	-	25.94 (659)	M10	130.1 (59.0)	1558
5125		12.28 (312)	27.56 (700)	16.54 (420)	8.58 (218)	8.58 (218)	-	25.94 (659)	M10	130.1 (59.0)	1967
5172	2-13	17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	-	29.80 (757)	M12	235.9 (107.0)	2144
5192		17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	-	29.80 (757)	M12	235.9 (107.0)	2566
5242		17.32 (440)	31.50 (800)	18.58 (472)	14.57 (370)	14.57 (370)	-	29.80 (757)	M12	262.4 (119.0)	3540
5336	2-14	20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	448.0 (204.0)	4876
5382		20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	448.0 (204.0)	5581
5412		20.08 (510)	44.72 (1136)	18.90 (480)	17.72 (450)	17.72 (450)	8.86 (225)	43.03 (1093)	M12	448.0 (204.0)	6149

* *Heat Loss is specified for fully loaded, continuous operation.*

2.9 Remote Keypad Mounting Kit

The IMPULSE•G+/VG+ Series 5 keypad is removable and can be remotely mounted to a control panel door with a remote keypad mounting kit (P/N: S5-RMT-OPER-KIT). The mounting kit will maintain the seal rating of UL Type 1, 3R, 4, 4X, 12, IP55, and IP66 enclosures.

The kit includes the keypad bracket and overlay, mounting hardware, and a mounting template. An RJ45 cable is not included, but is required to connect the keypad to the VFD. The recommended RJ45 cable length is 50 ft (15 m) or less. After the keypad is removed from the VFD, a small plastic RJ45 connector also needs to be removed and can be stored in a holder to the left of the RJ45 port.

Installation requires a rectangular cutout and six drilled holes. Reference the Figures below for dimensions and assembly diagrams.

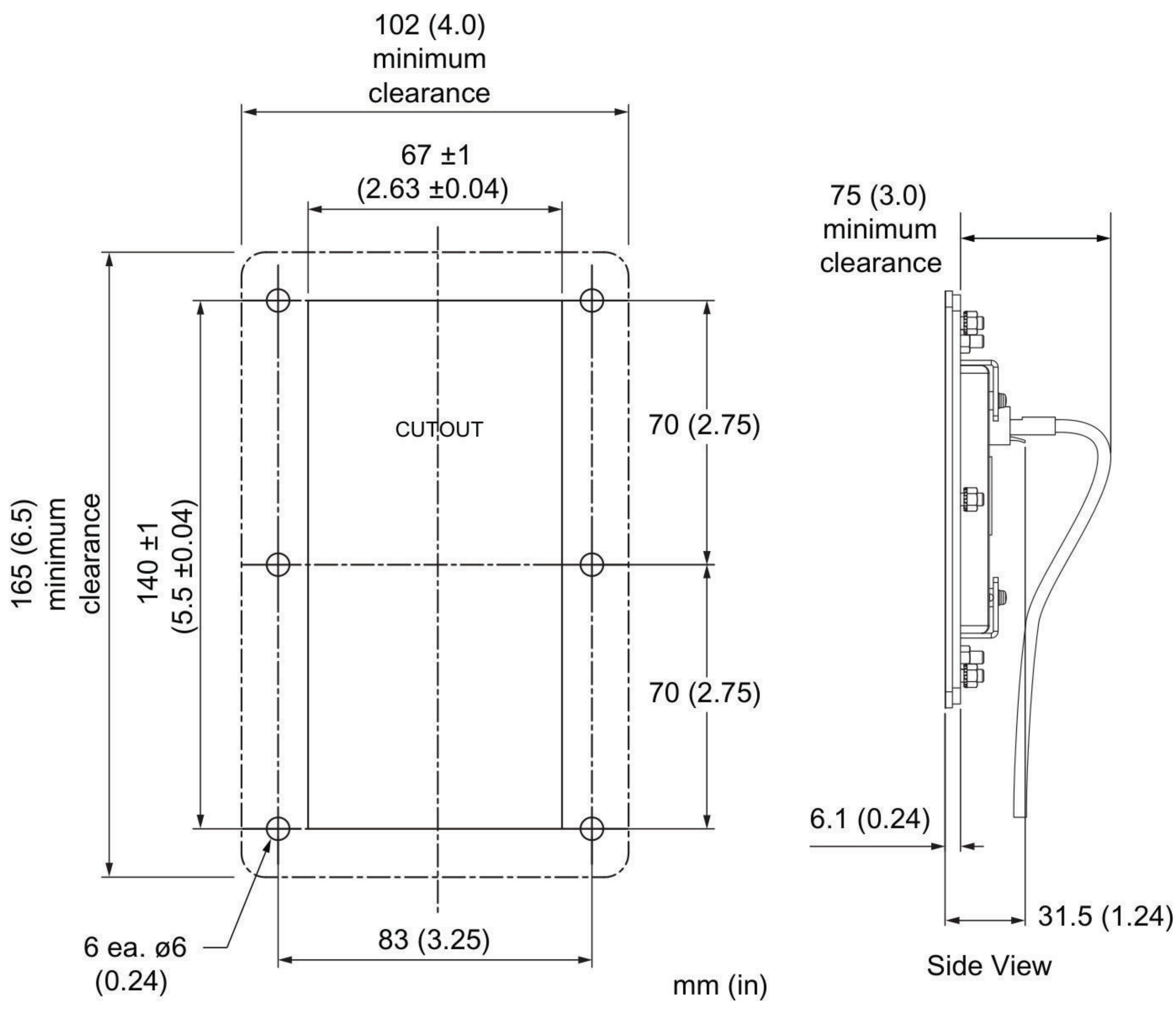


Figure 2-16: Cutout Dimensions

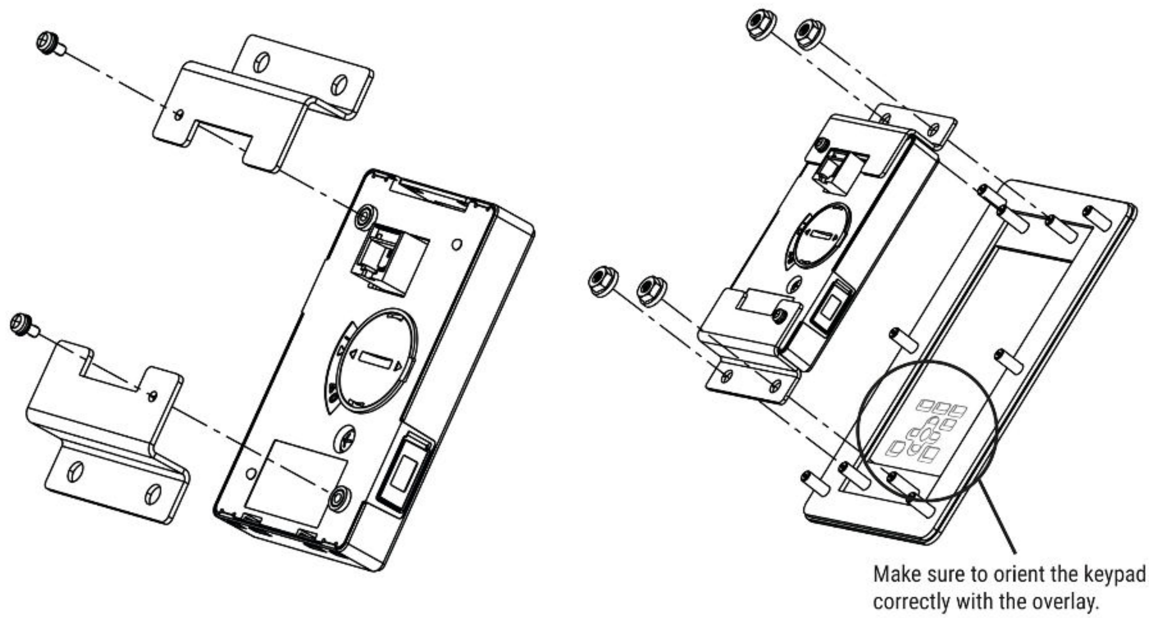


Figure 2-17: Bracket Assembly

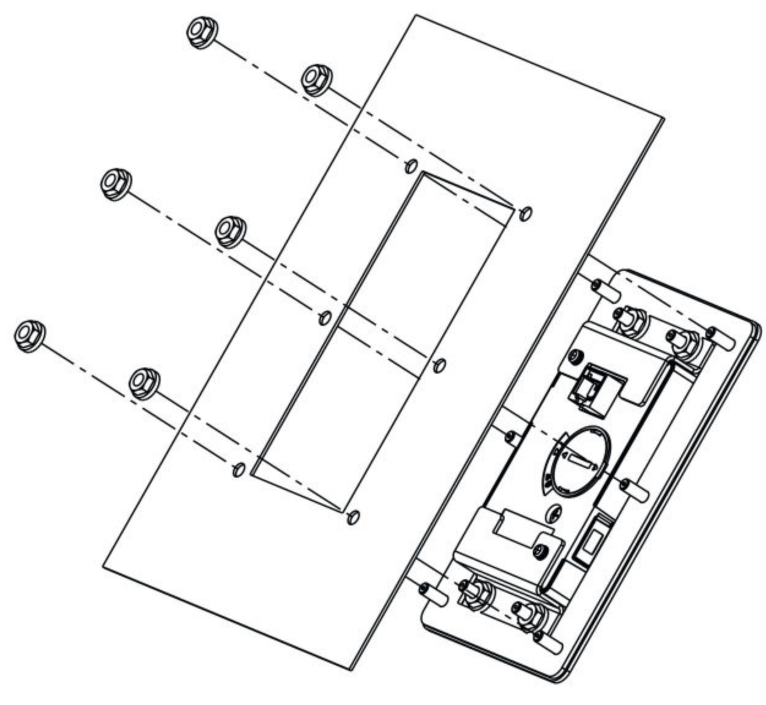


Figure 2-18: Assembly to the Enclosure

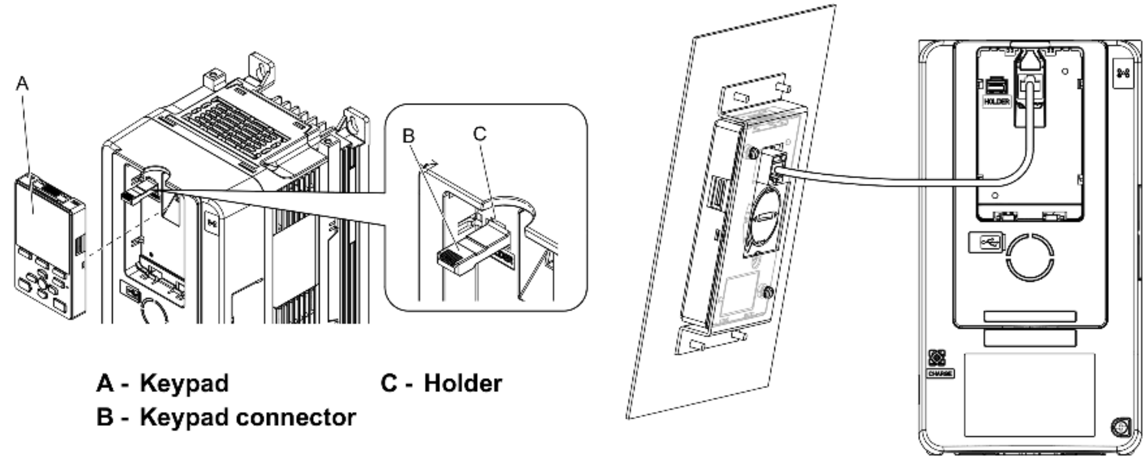


Figure 2-19: Remote Keypad to VFD Connection

3 Wiring

3.1 Wiring Practices

WARNING

Before you wire the VFD, review the following practices to help ensure that your system is wired properly.

- Recommended wire is to be rated for minimum 75°C, 600 VAC, vinyl sheathed.
- Ensure that the encoder wiring is less than 300 feet unless fiber optic cables are used.
- Ensure that the encoder wiring is isolated from the power wiring.
- Ensure that the encoder wiring shield is grounded only at the VFD end.
- Connect the incoming three-phase AC source to terminals R/L1, S/L2, T/L3.
- Connect the Motor leads to terminals U/T1, V/T2, W/T3.
- Install a line reactor between the output of the VFD in applications that require a disconnecting means between the VFD's output and motor. Use a "make before break" auxiliary contact with the disconnect means and the hardware baseblock of the VFD.
- Use hard contacts between the PLC output and the VFD interface board. If using a solid state output from a PLC (TRIAC) to a 120 VAC input card, use a 5KΩ, 5W resistor between the signal and X2.
- If the power source is 500 kVA or greater, or more than 10 times the VFD kVA rating, ensure there is at least 3% impedance between the power source and the VFD input. To accomplish this, a DC reactor can be installed between VFD terminals +1 and +2, or an AC line reactor can be used on the input of the VFD. Excessive peak currents could damage the input power supply circuit if there is not enough impedance.
- Comply with the Suggested Circuit Protection and Wire Size specifications in ***Section 3.2 on page 43***.
- Use time delay fuses, which are sized at 150% of VFD's continuous rated input current, for wiring protection.
- Use appropriate R-C or MOV type surge absorbers across the coil of all contactors and relays in the system. Failure to do so could result in noise-related, nuisance fault incidents.
- Use external dynamic braking resistors for all applications.
- Do not ground the VFD with any large-current machines.
- Before using any welding or high-current machines near the crane, disconnect all line and ground wiring.
- Do not let the wiring leads come in contact with the VFD enclosure.
- Do not connect power factor correction capacitors to the VFD input or output; use a sine wave filter.
- The VFD and motor must be hardwired together. Do not use sliding collector bars.
- If there is a user input device or interface board that is remote, use shielded cable between the VFD input terminals and the interface output terminals or user input device(s).
- Before turning on the VFD, check the output circuit (U/T1, V/T2 and W/T3) for possible short circuits and ground faults.
- Increase the wire size by one gauge for every 250 feet (76.2 meters) between the VFD and motor; suggested for center driven cranes, trolleys, and bridges (voltage drop is significant at low frequencies).

- When using more than one transformer for the VFD's power, properly phase each transformer.
- To reverse the direction of rotation, program b03-04 = 1 (exchange phases), or interchange any two motor leads (changing R/L1, S/L2, or T/L3 will not affect the shaft rotation direction) as well as encoder phasing (F01-02 = 1 or swap the A+ and A- wires).
- Use shielded cable for all low-level DC speed reference signals (0 to 10 VDC, 4 to 20 mA). Ground the shield only at the VFD side.
- Please observe National Electrical Code (NEC) guidelines when wiring electrical devices.
- IMPORTANT: All wire connections must have strain relief, and must not apply downward pressure to the terminals on the VFD.

NOTE: *Failure to observe these warnings may result in equipment damage.*

CAUTION

Do NOT connect external dynamic braking units to VFD braking resistor terminal “B2”. Connect positive external dynamic braking unit terminal(s) to terminal “+3” and negative external dynamic braking unit terminal(s) to terminal “-”. When terminal “+3” is unavailable, use terminal “B1”.

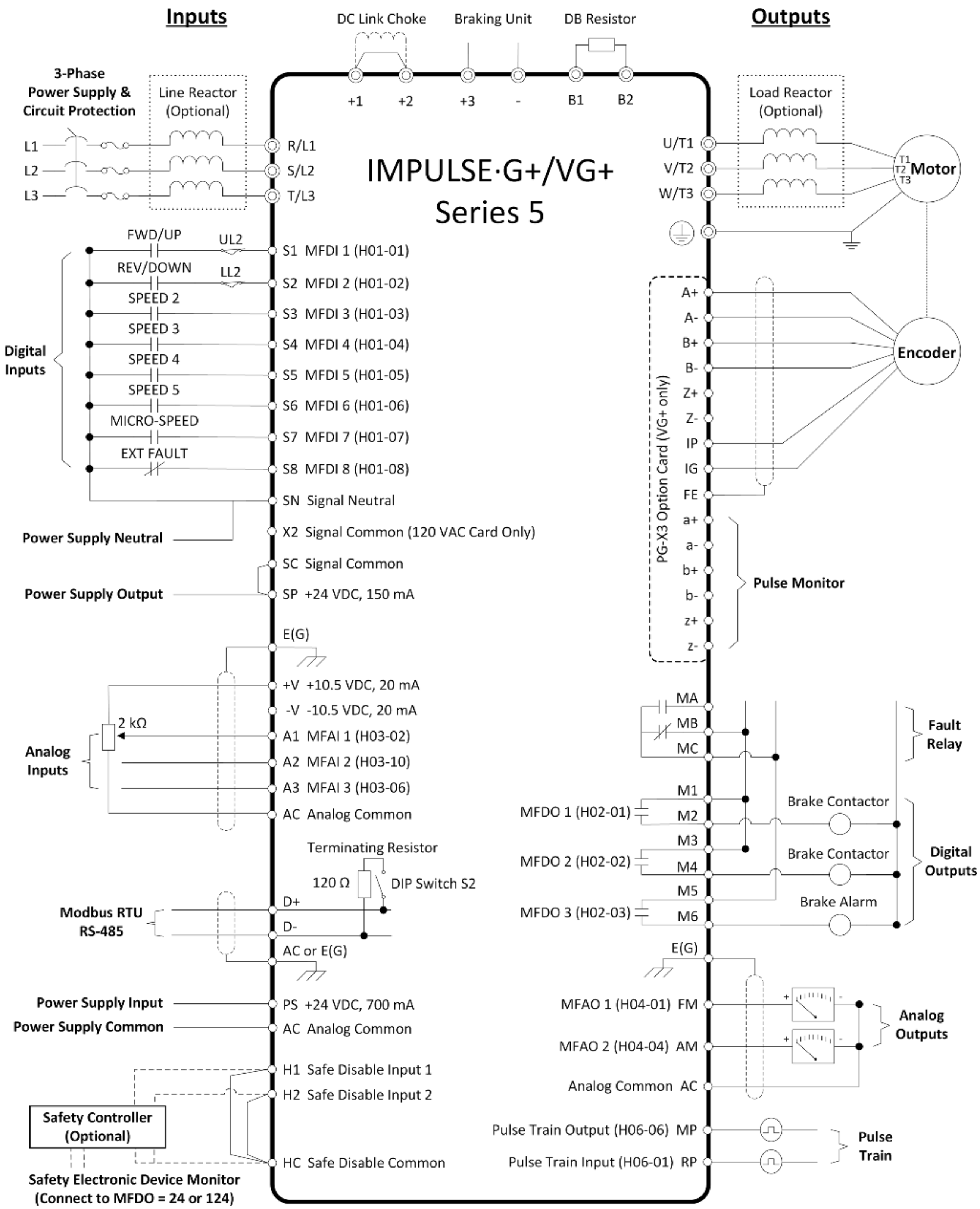


Figure 3-1: Typical Connection Diagram

3.2 Suggested Circuit Protection and Wire Size

In order to comply with most safety standards, circuit protective devices should be used between the incoming three-phase power supply and the VFD. These devices can be thermal, magnetic, or molded-case circuit breakers (MCCB); or “slow-blow” type time-delay fuses.

NOTE: *The following are recommendations based on the rated capacity of the VFD. Per NEC guidelines, circuit protection and wiring can be selected based on the capacity of the motor.*

CAUTION

The following guidelines are suggested values. Always conform to local electrical codes and wiring practices.

Table 3-1: Wire Size and Circuit Protection for 230 V Class

Model Number (G+/VG+ S5)	Recommended Maximum Circuit Protection				Recommended Wire Size (AWG)[1]			
	Continuous Input Amps (Heavy Duty)	Time Delay Input Fuse (Amps)[3]	Time Delay Input Fuse Class	Inverse Time Circuit Breaker (Amps)[3]	Power Circuit Wiring	Control Wiring[4]	Ground Copper[2] (Fuse)	Ground Copper[2] (Breaker)
2003	3.6	7	CC	15	14	26 to 16	14	14
2005	4.8	9	CC	15	14	26 to 16	14	14
2007	6.7	12	CC	20	14	26 to 16	14	12
2008	8.9	17.5	CC	25	14	26 to 16	12	10
2011	12.7	25	CC	35	14	26 to 16	10	10
2014	17	30	CC	45	14	26 to 16	10	10
2017	20.7	40	J	60	14 to 12	26 to 16	10	10
2025	30	60	J	80	12 to 10	26 to 16	10	8
2033	40.3	80	J	110	10 to 8	26 to 16	8	6
2047	58.2	110	J	150	8 to 4	26 to 16	6	6
2060	78.4	150	J	200	6 to 2	26 to 16	6	6
2075	96	175	J	250	4 to 2	26 to 16	6	4
2088	82	150	J	225	4 to 2	26 to 16	6	4
2115	111	200	J	300	2 to 1/0	26 to 16	6	4
2145	136	250	J	350	1/0 to 2/0	26 to 16	4	3
2180	164	300	J	450	1/0 to 3/0	26 to 16	4	2
2215	200	350	J	500	3/0 to 250	26 to 16	3	2
2283	271	500	J	700	250 to (2)2/0	26 to 16	2	1/0
2346	324	600	J	1000	(2)1/0 to 500	26 to 16	1	2/0
2415	394	700	J	1000	(3)1/0 to 450	26 to 16	1/0	2/0

1) NFPA 70 National Electric Code 2017. Section 430.122(a) and Table 310.15(b)(16), 75°C conductor, 60-minute, copper with 40°C ambient correction factor, for up to CMAA Class F duty cycle cranes and hoists.

2) NFPA 70 National Electric Code 2017. Table 250.122.

3) NFPA 70 National Electric Code 2017. Table 430.52 (selected based on VFD input Amps).

4) ***See Section 3.5*** *for stranded, solid, and dual wire specifications.*

Table 3-2: Wire Size and Circuit Protection for 460 V Class

Model Number (G+/VG+ S5)	Recommended Maximum Circuit Protection				Recommended Wire Size (AWG)[1]			
	Continuous Input Amps (Heavy Duty)	Time Delay Input Fuse (Amps)[3]	Time Delay Input Fuse Class	Inverse Time Circuit Breaker (Amps)[3]	Power Circuit Wiring	Control Wiring[4]	Ground Copper[2] (Fuse)	Ground Copper[2] (Breaker)
4001	1.6	2.8	CC	15	14	26 to 16	14	14
4003	2.1	4	CC	15	14	26 to 16	14	14
4004	3.9	7	CC	15	14	26 to 16	14	14
4005	5.5	10	CC	15	14	26 to 16	14	14
4007	7.4	15	CC	20	14	26 to 16	14	12
4009	9	17.5	CC	25	14	26 to 16	12	10
4014	13.1	25	CC	35	14	26 to 16	10	10
4018	17.5	35	J	45	14 to 12	26 to 16	10	10
4024	25.3	45	J	70	12 to 10	26 to 16	10	8
4031	34.1	60	J	90	10 to 8	26 to 16	10	8
4039	41.7	80	J	110	8 to 6	26 to 16	8	6
4045	35.6	70	J	90	8 to 6	26 to 16	8	8
4060	48.1	90	J	125	8 to 4	26 to 16	8	6
4075	59	110	J	150	4 to 2	26 to 16	6	6
4091	71.4	125	J	200	4 to 2	26 to 16	6	6
4112	86.9	175	J	225	4 to 1/0	26 to 16	6	4
4150	118	225	J	300	2 to 2/0	26 to 16	4	4
4180	141	250	J	400	1/0 to 3/0	26 to 16	4	3
4216	171	300	J	450	2/0 to 250	26 to 16	4	2
4260	232	450	J	600	(2)1/0 3/0 to 300	26 to 16	2	1
4304	289	600	J	800	(2)2/0 250 to 400	26 to 16	1	1/0
4371	346	650	J	1000	(2)2/0 to 400	26 to 16	1/0	2/0
4414	403	750	L	1200	(2)250 to (2)300 350 to 400	26 to 16	1/0	3/0
4453[5] / 4477	460	900	L	1200	(3)2/0 to (2)250	26 to 16	2/0	3/0
4515	516	1000	L	1600	(3)3/0 to 450	26 to 16	2/0	4/0
4605	573	1100	L	1600	(2)250 to 500	26 to 16	3/0	4/0
4720	686	1350	L	2000	(2)350 (3)350 to (3)400	26 to 16	4/0	250
4810	799	1400	L	2000	(2)350 (3)350 to (3)400	26 to 16	4/0	250
4930	912	1600	L	2500	(2)450 to (2)500 (3)500	26 to 16	4/0	350
41090	1024	1800	L	3000	(2)450 to (2)500 (3)500	26 to 16	250	400

1) NFPA 70 National Electric Code 2017. Section 430.122(a) and Table 310.15(b)(16), 75°C conductor, 60-minute, copper with 40°C ambient correction factor, for up to CMAA Class F duty cycle cranes and hoists.

2) NFPA 70 National Electric Code 2017. Table 250.122.

3) NFPA 70 National Electric Code 2017. Table 430.52 (selected based on VFD input Amps).

*4) **See Section 3.5** for stranded, solid, and dual wire specifications.*

5) The 4453 model is only available in Europe.

Table 3-3: Wire Size and Circuit Protection for 575 V Class

Model Number (G+/VG+ S5)	Recommended Maximum Circuit Protection				Recommended Wire Size (AWG)[1]			
	Continuous Input Amps (Heavy Duty)	Time Delay Input Fuse (Amps)[3]	Time Delay Input Fuse Class	Inverse Time Circuit Breaker (Amps)[3]	Power Circuit Wiring	Control Wiring[4]	Ground Copper[2] (Fuse)	Ground Copper[2] (Breaker)
5001	1.3	2.5	CC	15	14	26 to 16	14	14
5002	2.3	5	CC	15	14	26 to 16	14	14
5003	3.1	6	CC	15	14	26 to 16	14	14
5004	4.4	8	CC	15	14	26 to 16	14	14
5006	7.2	15	CC	20	14	26 to 16	14	12
5009	11	20	CC	30	14	26 to 16	12	10
5012	14	25	CC	35	14	26 to 16	10	10
5017	20	35	J	50	14 to 12	26 to 16	10	10
5022	27	50	J	70	14 to 10	26 to 16	10	8
5027	33	60	J	90	10 to 8	26 to 16	10	8
5032	29	60	J	80	10 to 8	26 to 16	10	8
5041	39	70	J	100	8 to 6	26 to 16	8	8
5052	47	90	J	125	8 to 6	26 to 16	8	6
5062	57	100	J	150	6 to 4	26 to 16	6	6
5077	71	125	J	200	4 to 2	26 to 16	6	6
5099	94	175	J	250	2 to 1/0	26 to 16	6	4
5125	116	225	J	300	2 to 2/0	26 to 16	4	4
5172	139	250	J	350	1/0 to 3/0	26 to 16	4	3
5192	185	350	J	500	2/0 to 4/0	26 to 16	3	2
5242	230	450	J	600	3/0 to 300	26 to 16	2	1
5336	321	600	J	1000	(2)1/0 350 to 500	26 to 16	1	2/0
5382	365	650	J	1000	(2)2/0 to 400	26 to 16	1/0	2/0
5412	410	750	L	1200	(2)250 350 to 450	26 to 16	1/0	3/0

1) NFPA 70 National Electric Code 2017. Section 430.122(a) and Table 310.15(b)(16), 75°C conductor, 60-minute, copper with 40°C ambient correction factor, for up to CMAA Class F duty cycle cranes and hoists.

2) NFPA 70 National Electric Code 2017. Table 250.122.

3) NFPA 70 National Electric Code 2017. Table 430.52 (selected based on VFD input Amps).

4) ***See Section 3.5*** *for stranded, solid, and dual wire specifications.*

Table 3-4: Wire Size Range and Tightening Torque for 230 V Class

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
2003	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2005	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2007	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2008	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
2011	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2014	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2017	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	12 - 8 (4.0 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
2025	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
2033	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
2047	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1, +2	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 6 (10 - 16)	M6	5.4 - 6 (47.8 - 53.1)
2060	R/L1, S/L2, T/L3	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	14 - 3 (2.5 - 25)	M6	5 - 5.5 (45 - 49)
	-, +1, +2	14 - 1/0 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
2075	R/L1, S/L2, T/L3	14 - 1/0 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	14 - 2 (2.5 - 35)	M6	5 - 5.5 (45 - 49)
	-, +1, +2	14 - 2/0 (2.5 - 70)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
2088	R/L1, S/L2, T/L3	6 - 1/0 (16 - 50)	M6	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	6 - 1/0 (16 - 50)	M6	8 - 9 (71 - 80)
	-, +1	2 - 2/0 (35 - 70)	M8	10 - 12 (89 - 107)
	B1, B2	14 - 4 (2.5 - 25)	M6	3 - 3.5 (27 - 31)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
2115	R/L1, S/L2, T/L3	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	-, +1	2 - 4/0 (35 - 95)	M8	10 - 12 (89 - 107)
	B1, B2	14 - 3 (2.5 - 25)	M6	3 - 3.5 (27 - 31)
	Ground	4 (25)	M6	5.4 - 6 (47.8 - 53.1)
2145	R/L1, S/L2, T/L3	2 - 250 (35 - 120)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1[*2,*3]	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	+3[*3]	4 - 2/0 (25 - 70)	M8	8 - 9 (71 - 80)
	Ground	4 - 1/0 (25 - 50)	M8	9 - 11 (79.7 - 97.4)
2180	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, -, +1, +1[*2,*3]	2 - 250 x 2P (35 - 120 x 2P)	M10	20 (177)
	+3[*3]	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	3 - 350 (25 - 185)	M10	18 - 23 (159 - 204)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
2215	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, +1	2 - 250 x 2P (35 - 120 x 2P)	M10	20 (177)
	+3	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	3 - 350 (25 - 185)	M10	18 - 23 (159 - 204)
2283	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, +1	2 - 250 x 2P (35 - 120 x 2P)	M10	20 (177)
	+3	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	2 - 350 (35 - 185)	M10	18 - 23 (159 - 204)
2346	R/L1, S/L2, T/L3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	-, +1	4/0 - 400 x 2P (95 - 185 x 2P)	M12	35 (310)
	+3	1/0 - 4/0 x 2P (50 - 95 x 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)
2415	R/L1, S/L2, T/L3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	-, +1	4/0 - 400 x 2P (95 - 185 x 2P)	M12	35 (310)
	+3	1/0 - 4/0 x 2P (50 - 95 x 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)

**1 For wire gauges larger than AWG 8, use a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf-in to 40 lbf-in).*

**2 Terminals - and +1 have two screws. The Wire Range is the wire gauge for one terminal.*

**3 A junction terminal is needed to connect a braking unit (CDBR) to terminals - and B1. Terminal +1 can be used instead of B1.*

Table 3-5: Wire Size Range and Tightening Torque for 460 V Class

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4001	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
4003	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
4004	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
4005	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4007	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
4009	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (2.5 - 10)	M4	1.2 - 1.5 (10.6 - 13.3)
4014	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	14 - 8 (4.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
4018	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	12 - 8 (4.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4024	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	-, +1, +2	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 6 (6.0 - 16)	M6	5.4 - 6 (47.8 - 53.1)
4031	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	-, +1, +2	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 6 (6.0 - 16)	M6	5.4 - 6 (47.8 - 53.1)
4039	R/L1, S/L2, T/L3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 4 (10 - 25)	M6	5.4 - 6 (47.8 - 53.1)
4045	R/L1, S/L2, T/L3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	-, +1	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 4 (10 - 25)	M6	5.4 - 6 (47.8 - 53.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4060	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1	14 - 2 (2.5 - 35)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
4075	R/L1, S/L2, T/L3	14 - 2 (2.5 - 35)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 2 (2.5 - 35)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1	14 - 1/0 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 6 (2.5 - 16)	M5	2.3 - 2.5 (19.8 - 22)*1
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
4091	R/L1, S/L2, T/L3	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	-, +1	2 - 4/0 (35 - 95)	M8	10 - 12 (89 - 107)
	B1, B2	14 - 3 (2.5 - 25)	M6	3 - 3.5 (27 - 31)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
4112	R/L1, S/L2, T/L3	2 - 250 (35 - 120)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1*2	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	B1, B2*3	4 - 2/0 (25 - 70)	M8	8 - 9 (71 - 80)
	Ground	4 - 1/0 (25 - 50)	M8	9 - 11 (79.7 - 97.4)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4150	R/L1, S/L2, T/L3	2 - 250 (35 - 120)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1*2	6 - 2/0 (16 - 70)	M6	8 - 9 (71 - 80)
	B1, B2*3	4 - 2/0 (25 - 70)	M8	8 - 9 (71 - 80)
	Ground	4 - 1/0 (25 - 50)	M8	9 - 11 (79.7 - 97.4)
4180	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, +1	2 - 250 x 2P (35 - 120 x 2P)	M10	20 (177)
	+3	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	4 - 350 (25 - 185)	M10	18 - 23 (159 - 204)
4216	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, +1	2 - 250 x 2P (35 - 120 - 2P)	M10	20 (177)
	+3	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	2 - 350 (35 - 185)	M10	18 - 23 (159 - 204)
4260	R/L1, S/L2, T/L3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	3 - 4/0 x 2P (25 - 95 x 2P)	M10	20 (177)
	-, +1	2 - 250 x 2P (35 - 120 x 2P)	M10	20 (177)
	+3	4 - 1/0 x 2P (25 - 50 x 2P)	M10	20 (177)
	Ground	2 - 350 (35 - 185)	M10	18 - 23 (159 - 204)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4304	R/L1, S/L2, T/L3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	-, +1	4/0 - 400 x 2P (95 - 185 x 2P)	M12	35 (310)
	+3	1 - 4/0 x 2P (50 - 95 x 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)
4371	R/L1, S/L2, T/L3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 2P (70 - 150 x 2P)	M12	35 (310)
	-, +1	4/0 - 400 x 2P (95 - 185 x 2P)	M12	35 (310)
	+3	1 - 4/0 x 2P (50 - 95 x 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)
4414	R/L1, S/L2, T/L3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	-, +1	3/0 - 400 x 4P (95 - 185 x 4P)	M12	35 (310)
	+3	2 - 4/0 x 4P (35 - 95 x 4P)	M12	35 (310)
	Ground	1/0 - 300 (50 - 150)	M12	32 - 40 (283 - 354)
4453[*4] / 4477	R/L1, S/L2, T/L3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	-, +1	3/0 - 400 x 4P (95 - 185 x 4P)	M12	35 (310)
	+3	2 - 4/0 x 4P (35 - 95 x 4P)	M12	35 (310)
	Ground	2/0 - 300 (70 - 150)	M12	32 - 40 (283 - 354)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4515	R/L1, S/L2, T/L3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	-, +1	3/0 - 400 x 4P (95 - 185 x 4P)	M12	35 (310)
	+3	2 - 4/0 x 4P (35 - 95 x 4P)	M12	35 (310)
	Ground	2/0 - 300 (70 - 150)	M12	32 - 40 (283 - 354)
4605	R/L1, S/L2, T/L3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 x 4P (70 - 150 x 4P)	M12	35 (310)
	-, +1	3/0 - 400 x 4P (95 - 185 x 4P)	M12	35 (310)
	+3	2 - 4/0 x 4P (35 - 95 x 4P)	M12	35 (310)
	Ground	2/0 - 300 (70 - 150)	M12	32 - 40 (283 - 354)
4720	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	2/0 - 300 × 4P x 2 (70 - 150 × 4P) x 2	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 4P x 2 (70 - 150 × 4P) x 2	M12	35 (310)
	-, +1	3/0 - 400 × 4P x 2 (95 - 185 × 4P) x 2	M12	35 (310)
	+3	1/0 - 300 × 4P x 2 (50 - 150 × 4P) x 2	M12	35 (310)
	Ground	3/0 - 250 (95 - 120)	M12	32 - 40 (283 - 354)
4810	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	3/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	U/T1, V/T2, W/T3	3/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	-, +1	3/0 - 300 × 4P x 2 (95 - 185 × 4P) x 2	M12	35 (310)
	+3	1/0 - 300 × 4P x 2 (50 - 150 × 4P) x 2	M12	35 (310)
	Ground	3/0 - 250 (95 - 120)	M12	32 - 40 (283 - 354)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
4930	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	4/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	U/T1, V/T2, W/T3	4/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	-, +1	250 - 300 × 4P x 2 (95 - 185 × 4P) x 2	M12	35 (310)
	+3	1/0 - 300 × 4P x 2 (50 - 150 × 4P) x 2	M12	35 (310)
	Ground	4/0 - 250 (95 - 120)	M12	32 - 40 (283 - 354)
41090	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	4/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	U/T1, V/T2, W/T3	4/0 - 300 × 4P x 2 (95 - 150 × 4P) x 2	M12	35 (310)
	-, +1	250 - 300 × 4P x 2 (95 - 185 × 4P) x 2	M12	35 (310)
	+3	2/0 - 300 × 4P x 2 (70 - 150 × 4P) x 2	M12	35 (310)
	Ground	4/0 - 250 (95 - 120)	M12	32 - 40 (283 - 354)

**1 For wire gauges larger than AWG 8, use a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf-in to 40 lbf-in).*

**2 Terminals - and +1 have two screws. The Wire Range is the wire gauge for one terminal.*

**3 A junction terminal is needed to connect a braking unit (CDBR) to terminals - and B1. Terminal +1 can be used instead of B1.*

**4 The 4453 model is only available in Europe.*

Table 3-6: Wire Size Range and Tightening Torque for 575 V Class

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5001	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
5002	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
5003	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
5004	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)[*1]
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5006	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	10 - 8 (6.0 - 10)	M5	2 - 2.5 (17.7 - 22.1)
5009	R/L1, S/L2, T/L3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 10 (2.5 - 6.0)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 6 (10 - 16)	M5	2 - 2.5 (17.7 - 22.1)
5012	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1, +2	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 6 (10 - 16)	M6	5.4 - 6 (47.8 - 53.1)
5017	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1, +2	14 - 1 (2.5 - 50)	M6	5 - 5.5 (45 - 49)
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	8 - 6 (10 - 16)	M6	5.4 - 6 (47.8 - 53.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5022	R/L1, S/L2, T/L3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
5027	R/L1, S/L2, T/L3	14 - 4 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 6 (2.5 - 16)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1, +2	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 8 (2.5 - 10)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
5032	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1	14 - 2 (2.5 - 35)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)
5041	R/L1, S/L2, T/L3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	U/T1, V/T2, W/T3	14 - 3 (2.5 - 25)	M5	2.3 - 2.5 (19.8 - 22)*1
	-, +1	14 - 2 (2.5 - 35)	M5	2.3 - 2.5 (19.8 - 22)*1
	B1, B2	14 - 6 (2.5 - 16)	M4	1.5 - 1.7 (13.5 - 15)
	Ground	6 - 4 (16 - 25)	M6	5.4 - 6 (47.8 - 53.1)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5052	R/L1, S/L2, T/L3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1[*2]	3 - 2/0 (25 - 70)	M6	8 - 9 (71 - 80)
	B1, B2	4 - 3/0 (25 - 95)	M8	8 - 9 (71 - 80)
	Ground	6 - 250 (16 - 120)	M8	9 - 11 (79.7 - 97.4)
5062	R/L1, S/L2, T/L3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1[*2]	3 - 2/0 (25 - 70)	M6	8 - 9 (71 - 80)
	B1, B2	4 - 3/0 (25 - 95)	M8	8 - 9 (71 - 80)
	Ground	6 - 250 (16 - 120)	M8	9 - 11 (79.7 - 97.4)
5077	R/L1, S/L2, T/L3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2 - 300 (35 - 150)	M10	12 - 14 (107 - 124)
	-, -, +1, +1[*2]	2 - 2/0 (35 - 70)	M6	8 - 9 (71 - 80)
	B1, B2	4 - 3/0 (25 - 95)	M8	8 - 9 (71 - 80)
	Ground	6 - 250 (16 - 120)	M8	9 - 11 (79.7 - 97.4)
5099	R/L1, S/L2, T/L3	1 - 4/0 × 2P (50 - 95 × 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	1 - 4/0 × 2P (50 - 95 × 2P)	M10	20 (177)
	-, +1	2/0 - 250 × 2P (70 - 120 × 2P)	M10	20 (177)
	+3	3 - 1/0 × 2P (25 - 50 × 2P)	M10	20 (177)
	Ground	3 - 300 (25 - 150)	M10	18 - 23 (159 - 204)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5125	R/L1, S/L2, T/L3	1/0 - 4/0 × 2P (50 - 95 × 2P)	M10	20 (177)
	U/T1, V/T2, W/T3	2/0 - 4/0 × 2P (70 - 95 × 2P)	M10	20 (177)
	-, +1	3/0 - 250 × 2P (95 - 120 × 2P)	M10	20 (177)
	+3	3 - 1/0 × 2P (25 - 50 × 2P)	M10	20 (177)
	Ground	3 - 300 (25 - 150)	M10	18 - 23 (159 - 204)
5172	R/L1, S/L2, T/L3	3/0 - 300 × 2P (95 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	1 - 400 × 2P (50 - 185 × 2P)	M12	35 (310)
	+3	3 - 300 × 2P (25 - 150 × 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)
5192	R/L1, S/L2, T/L3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	1 - 400 × 2P (50 - 185 × 2P)	M12	35 (310)
	+3	3 - 300 × 2P (25 - 150 × 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)
5242	R/L1, S/L2, T/L3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	3/0 - 400 × 2P (95 - 185 × 2P)	M12	35 (310)
	+3	1 - 4/0 × 2P (50 - 95 × 2P)	M12	35 (310)
	Ground	1 - 350 (50 - 185)	M12	32 - 40 (283 - 354)

Model	Terminal	Wire Range AWG (mm^2)	Screw Size	Tightening Torque N·m (lbf-in)
5336	R/L1, S/L2, T/L3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	3/0 - 400 × 2P (95 - 185 × 2P)	M12	35 (310)
	+3	2 - 4/0 × 2P (35 - 95 × 2P)	M12	35 (310)
	Ground	1 - 300 (50 - 150)	M12	32 - 40 (283 - 354)
5382	R/L1, S/L2, T/L3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	3/0 - 400 × 2P (95 - 185 × 2P)	M12	35 (310)
	+3	2 - 4/0 × 2P (35 - 95 × 2P)	M12	35 (310)
	Ground	1 - 300 (50 - 150)	M12	32 - 40 (283 - 354)
5412	R/L1, S/L2, T/L3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	U/T1, V/T2, W/T3	2/0 - 300 × 2P (70 - 150 × 2P)	M12	35 (310)
	-, +1	3/0 - 400 × 2P (95 - 185 × 2P)	M12	35 (310)
	+3	2 - 4/0 × 2P (35 - 95 × 2P)	M12	35 (310)
	Ground	1/0 - 300 (50 - 150)	M12	32 - 40 (283 - 354)

**1 For wire gauges larger than AWG 8, use a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf-in to 40 lbf-in).*

**2 Terminals - and +1 have two screws. The Wire Range is the wire gauge for one terminal.*

3.3 Power Circuit Wiring

To wire the power circuit for IMPULSE•G+/VG+ Series 5:

1. Run the power supply wires through an appropriate enclosure hole.
2. Connect the power supply wires to a circuit protection system. ***See Section 3.2 on page 43***.
3. Connect the power supply wires from the circuit protection to Terminals R/L1, S/L2, and T/L3. It is acceptable to connect single-phase or three-phase AC or DC to these terminals. A single-phase input may require the VFD to be oversized to compensate for the increased DC bus ripple. A DC input will simply pass through the input diodes. A DC input can also be connected directly to the DC bus at the +1 and - terminals.
4. From Terminals U/T1, V/T2, and W/T3, connect the power output wires to the motor. If a load reactor is used, connect these output wires to the reactor input instead; then connect the reactor output to the motor.

NOTE: *If a device that can interrupt power is installed between the VFD and the motor, install a reactor on the output side of the VFD.*

Table 3-7: Power Circuit Terminals

<table>
<tr><th>Terminal</th><th colspan="3">VFD Model</th><th rowspan="4">Function</th></tr>
<tr><th>230 V Class</th><th>2003 to 2075</th><th>2085 to 2115</th><th>2145 to 2415</th></tr>
<tr><th>460 V Class</th><th>4001 to 4039</th><th>4045 to 4150</th><th>4180 to 41090</th></tr>
<tr><th>575 V Class</th><th>5001 to 5027</th><th>5032 to 5077</th><th>5099 to 5412</th></tr>
<tr><td>R/L1</td><td colspan="3" rowspan="3">Main circuit power supply input (AC or DC)
NOTE: *6-pulse operation only*
NOTE: *Models 4720 to 41090 have the second set of main power inputs labeled as “R1/L11, S1/L21, T1/L31”*</td><td rowspan="3">Connects line power to the VFD</td></tr>
<tr><td>S/L2</td></tr>
<tr><td>T/L3</td></tr>
<tr><td>U/T1</td><td colspan="3" rowspan="3">VFD Output</td><td rowspan="3">Connects to the motor</td></tr>
<tr><td>V/T2</td></tr>
<tr><td>W/T3</td></tr>
<tr><td>B1</td><td colspan="2" rowspan="2">Braking Resistor</td><td rowspan="2">Not Available
(braking unit required)</td><td rowspan="2">Connects to a braking resistor</td></tr>
<tr><td>B2</td></tr>
<tr><td>+2</td><td>DC link choke (+1, +2)</td><td colspan="2">Not Available (DC link choke built-in)</td><td rowspan="4">For connecting:
• DC power supply
• Braking unit (CDBR)
• Regen unit
• DC link choke
NOTE: *Remove the jumper between +1 and +2 to connect a DC link choke.*</td></tr>
<tr><td>+1</td><td rowspan="2">DC power supply or regen unit (+1, -)
Braking unit (B1, -)</td><td rowspan="2">DC power supply or regen unit (+1, -)
Braking unit (B1, -)</td><td rowspan="3">DC power supply or regen unit (+1, -)
Braking unit (+3, -)</td></tr>
<tr><td>-</td></tr>
<tr><td>+3</td><td colspan="2">Not available. Use B1 instead.</td></tr>
<tr><td>⏚</td><td colspan="3">For 230 V class: 100Ω or less
For 460 V class: 10Ω or less
For 575 V class: 10Ω or less</td><td>Grounding terminal</td></tr>
</table>

3.3.1 Power Circuit Connection Diagrams

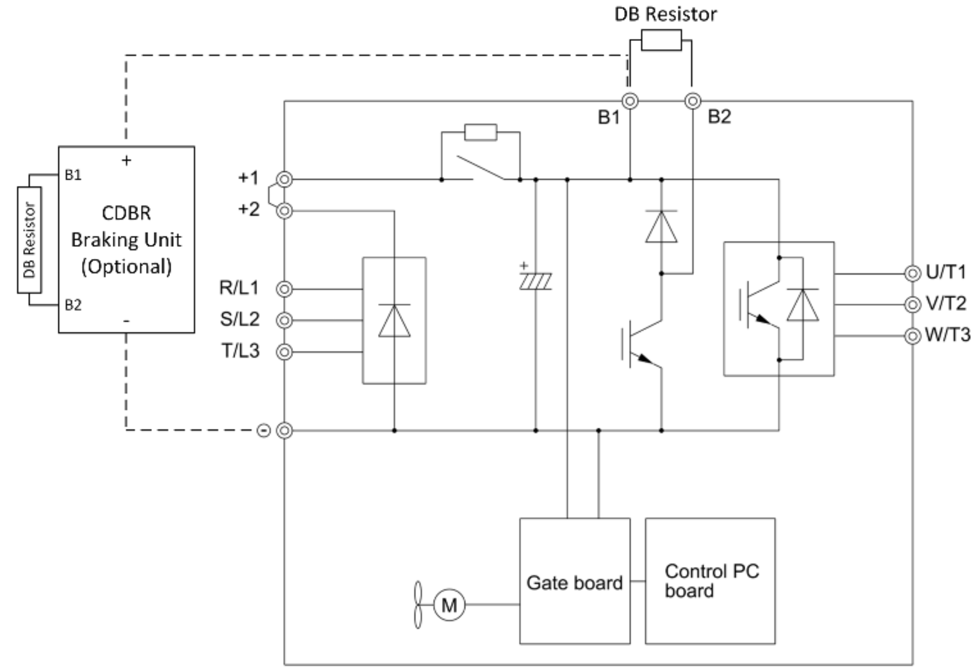


Figure 3-2: Power Circuit Connections (2003 to 2075, 4001 to 4039, 5001 to 5027)

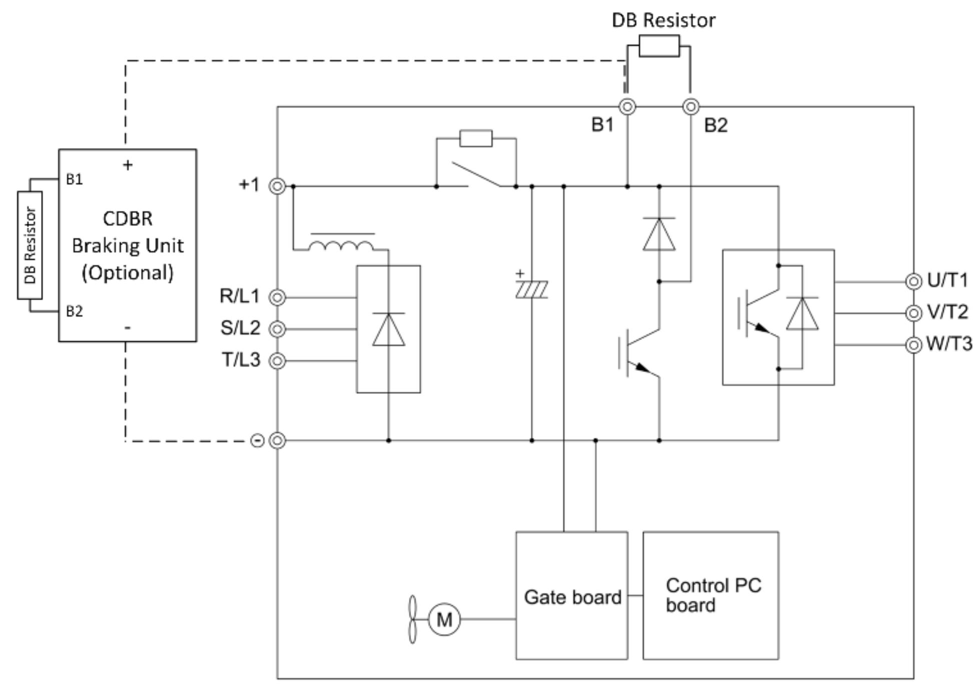


Figure 3-3: Power Circuit Connections (2088, 2115, 4045 to 4150, 5032 to 5077)

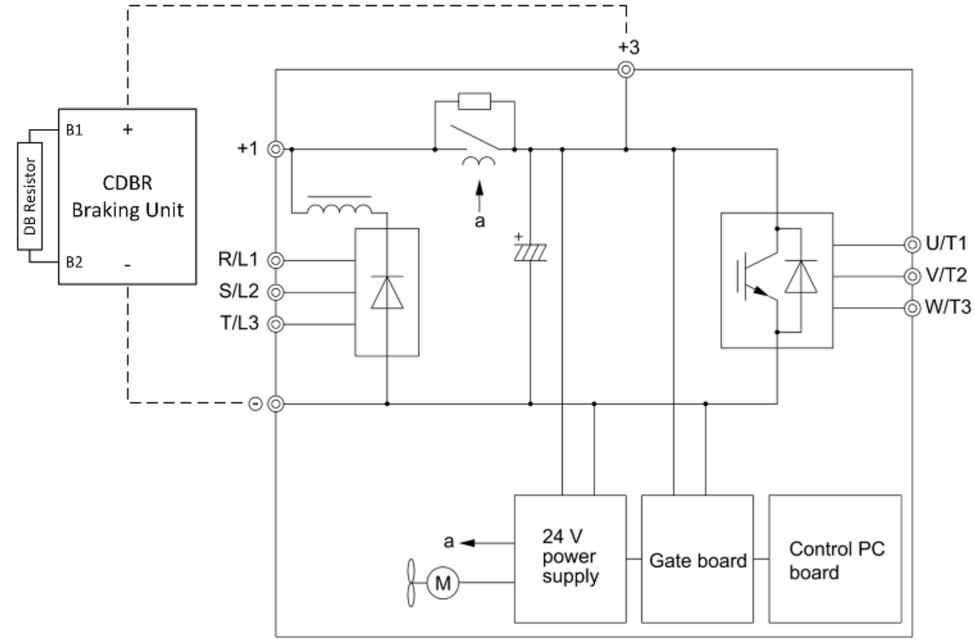


Figure 3-4: Power Circuit Connections (2145 to 2415, 4180 to 4371, 5099 to 5242)

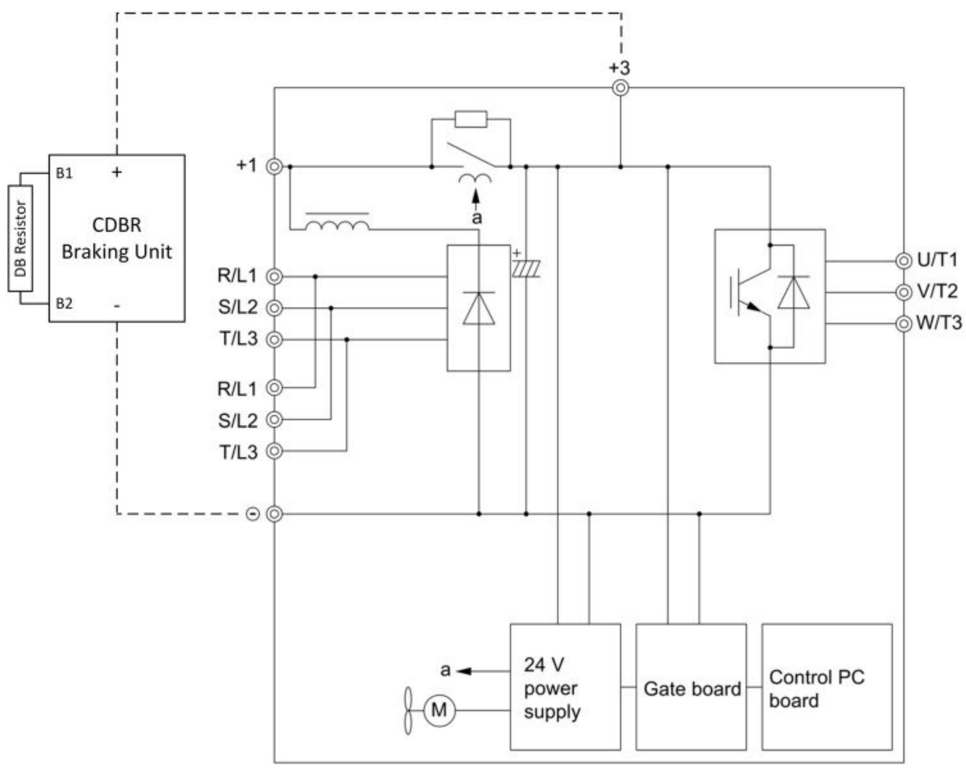


Figure 3-5: Power Circuit Connections (4414 to 41090*, 5336 to 5412)

NOTE: *Models 4720 to 41090 have the second set of main power inputs labeled as "R1/L11, S1/L21, T1/L31."*

3.3.2 Power Circuit Terminal Block Diagrams

Figure 3-6 through ***Figure 3-20*** show the main circuit terminal arrangements for the various VFD models.

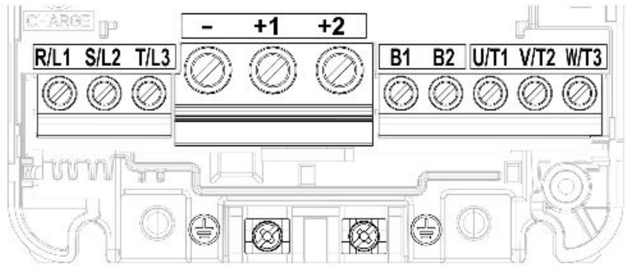


Figure 3-6: Main Circuit Terminal Block (2003 - 2033, 4001 - 4018, 5001 - 5009)

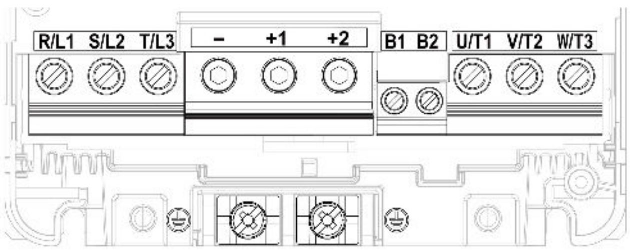


Figure 3-7: Main Circuit Terminal Block (2047, 4024, 4031, 5012, 5017)

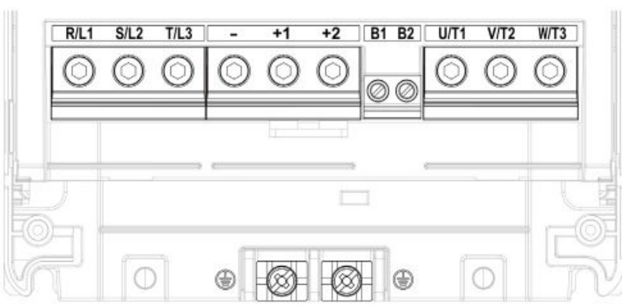


Figure 3-8: Main Circuit Terminal Block (2060, 2075)

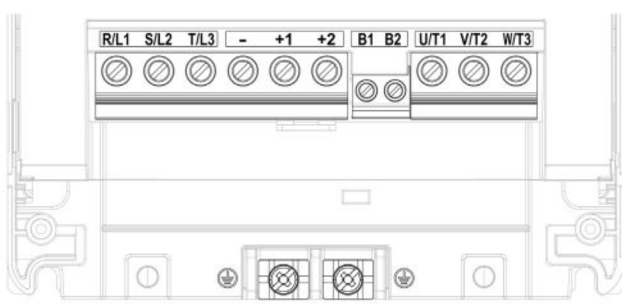


Figure 3-9: Main Circuit Terminal Block (4039, 5022, 5027)

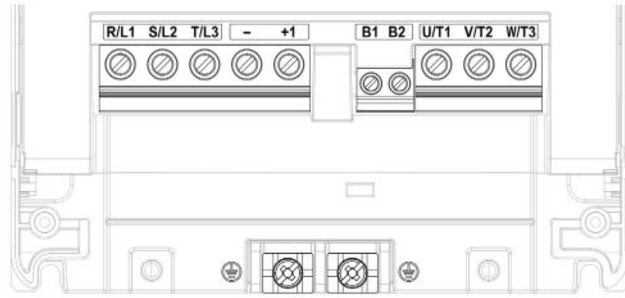


Figure 3-10: Main Circuit Terminal Block (4045)

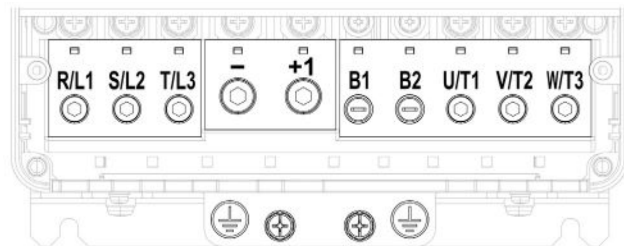


Figure 3-11: Main Circuit Terminal Block (2088)

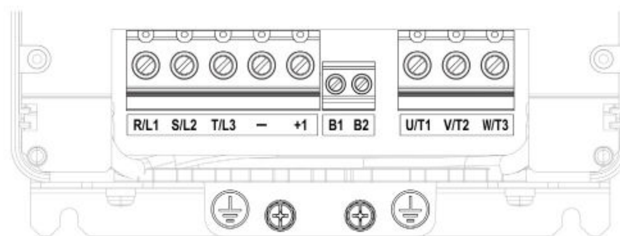


Figure 3-12: Main Circuit Terminal Block (4060, 5032, 5041)

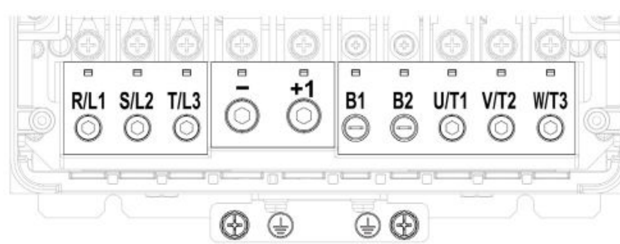


Figure 3-13: Main Circuit Terminal Block (2115, 4091)

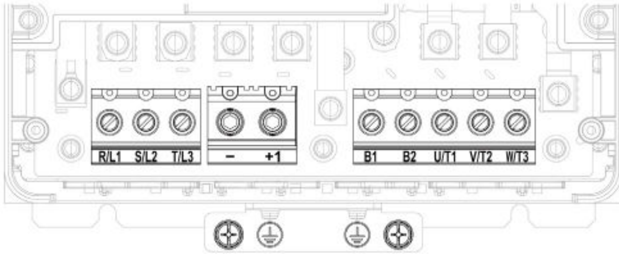


Figure 3-14: Main Circuit Terminal Block (4075)

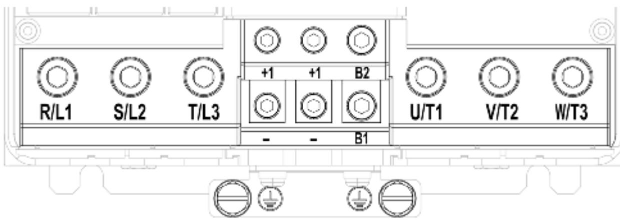


Figure 3-15: Main Circuit Terminal Block (4112, 4150, 5052, 5062)

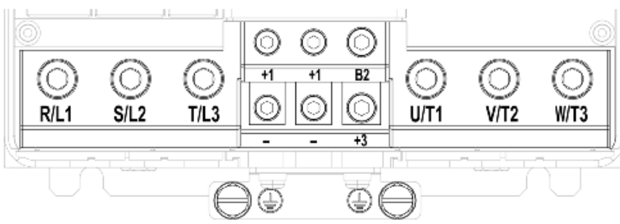


Figure 3-16: Main Circuit Terminal Block (2145, 2180, 5077)

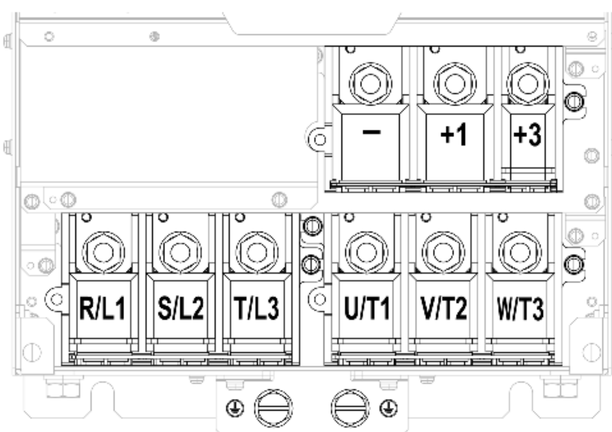


Figure 3-17: Main Circuit Terminal Block (2215, 2283, 4180 - 4260, 5099, 5125)

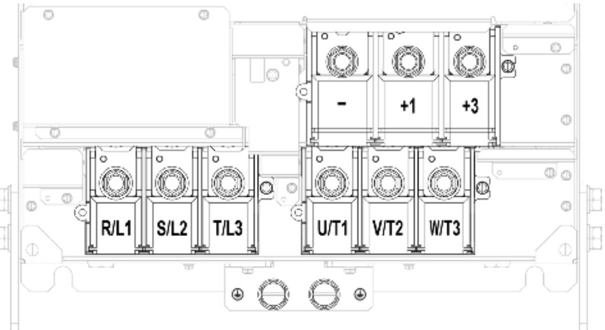


Figure 3-18: Main Circuit Terminal Block (2346, 2415, 4304, 4371, 5172 - 5242)

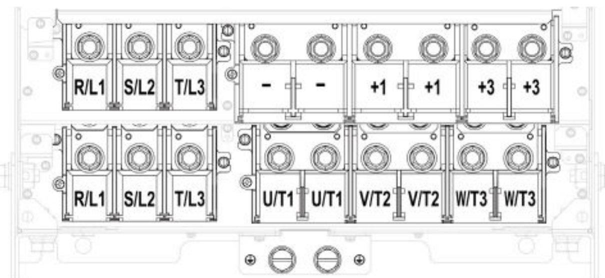


Figure 3-19: Main Circuit Terminal Block (4414 - 4605, 5336 - 5412)

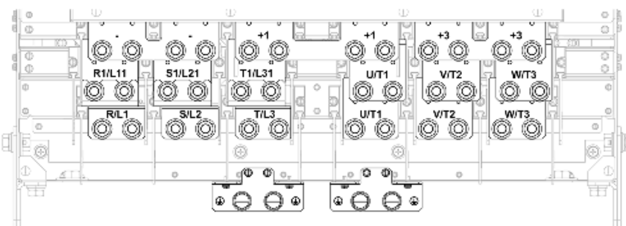


Figure 3-20: Main Circuit Terminal Block (4720 to 41090)

3.4 Grounding

Connect the VFD's ground terminal to a common grounding point on the control panel. Use ground wiring as specified in ***Section 3.2 on page 43***, and keep the length as short as possible.

- Ground Resistance:
  - For 230V class: 100Ω or less
  - For 460V class: 10Ω or less
  - For 575V class: 10Ω or less
- Never run the VFD ground wires in common with welding machines, or other high-current electrical equipment.
- When more than one VFD is used for the same system, ground each directly or daisy-chain to the ground pole. Do not loop the ground wires.

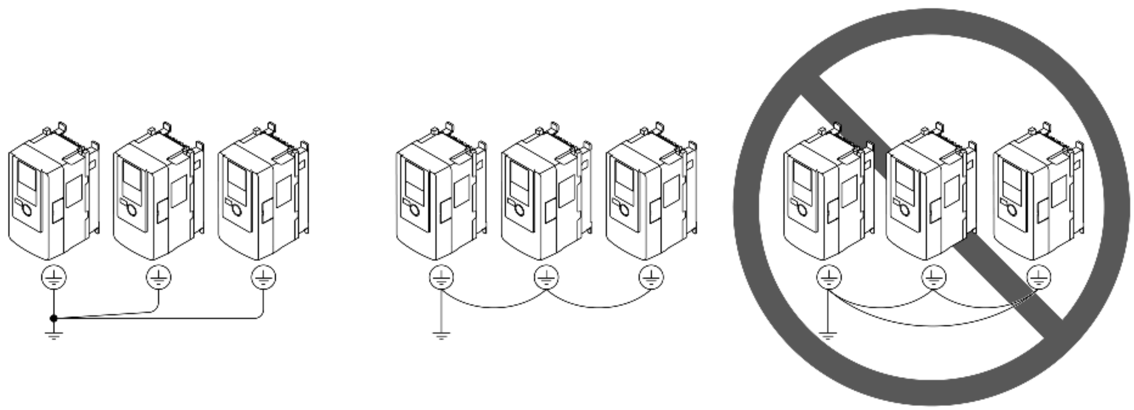


Figure 3-21: VFD Grounding

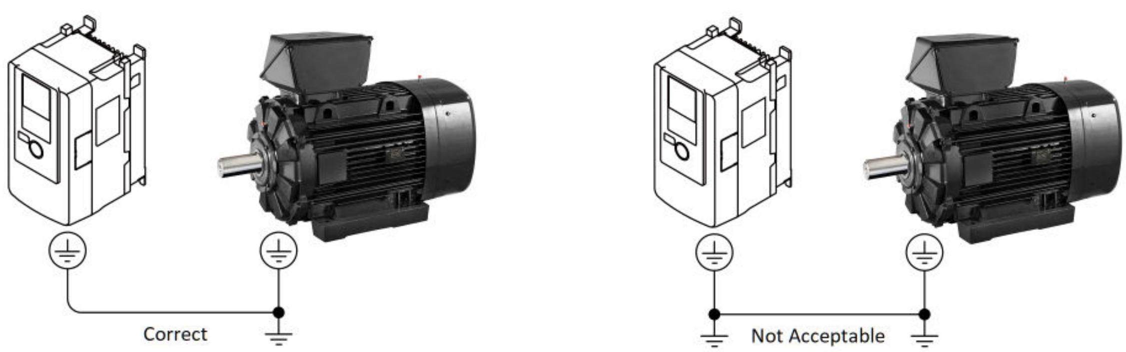


Figure 3-22: Motor Grounding

3.5 Terminal Board (24 VDC) & Interface Card (120 VAC)

Table 3-8: Terminal and Wire Specifications

Circuit Board	Screw Size	Tightening Torque lbf·in (N·m)	Wire Size AWG (mm^2)
24 VDC Terminal Board 120 VAC Interface Card	M3	4.4 to 5.3 (0.5 to 0.6)	Single Stranded: 26 to 16 (0.14 to 1.5) Single Solid: 26 to 16 (0.14 to 1.5) Dual Stranded: 26 to 18 (0.14 to 0.75) Dual Solid: 26 to 18 (0.14 to 0.75)

3.5.1 Terminal Board Diagram and Interface Card Installation

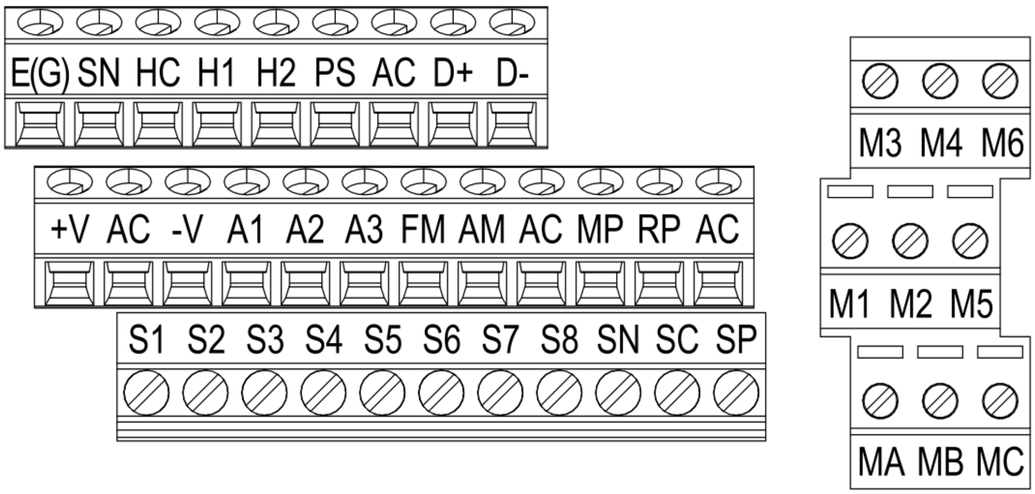


Figure 3-23: Terminal Board Diagram

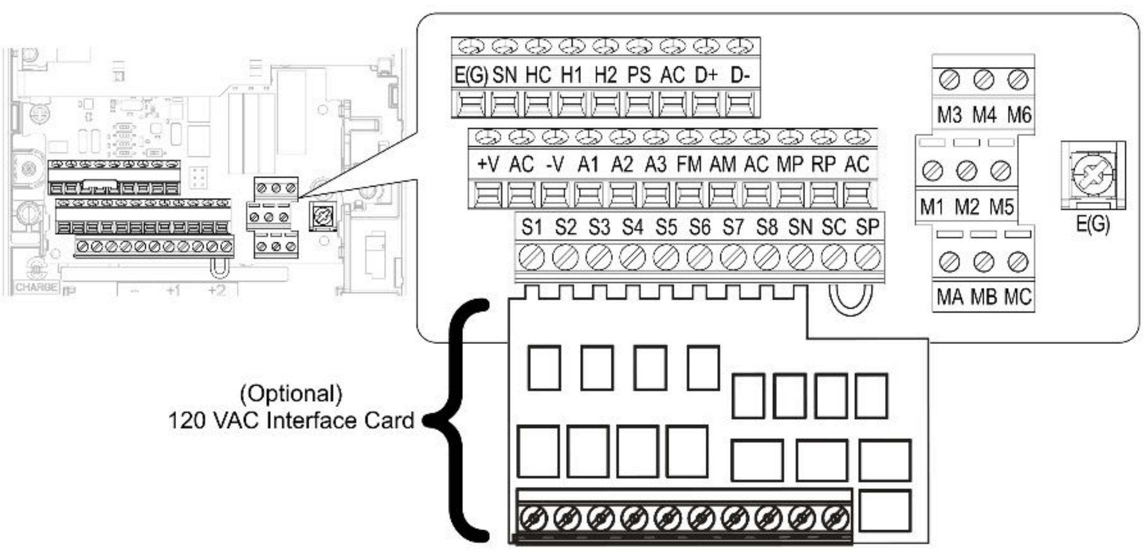
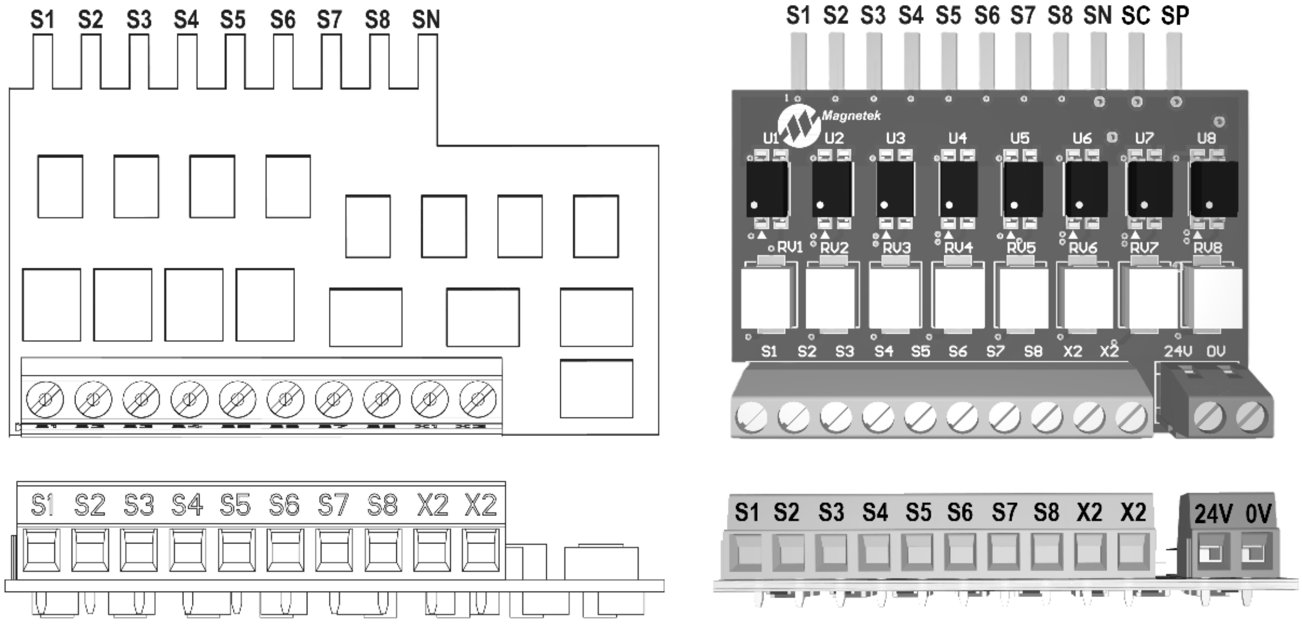


Figure 3-24: 24 VDC Terminal Board and Optional 120 VAC Interface Card

3.5.2 120 VAC Interface Card Diagrams

The 120 VAC interface card installs into the 24 VDC terminal board. There are two versions of the 120 VAC interface card. One is compliant with UL and CSA, and the other is not. By default, the VFD will include the 120 VAC card with no UL or CSA compliance. Applications requiring UL, CSA, or CE compliance must be specified at time of order.



(UL and CSA Certified) (Default - No Standards Compliance)

Figure 3-25: 120 VAC Interface Card Diagrams

3.5.3 DIP Switch and Jumper Functions

DIP Switches and Jumpers are described in this section, and the functions are shown in ***Table 3-9***.

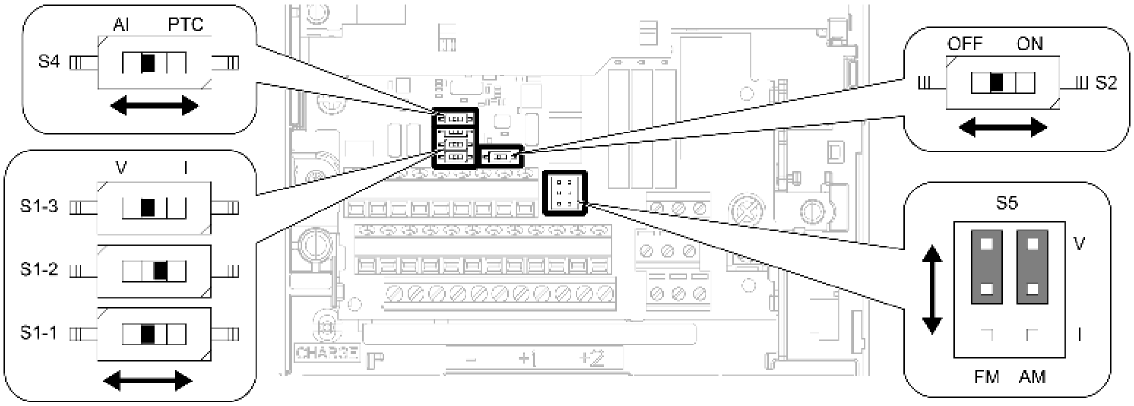


Figure 3-26: 24 VDC Terminal Board DIP Switches and Jumpers

Table 3-9: DIP Switches

Name	Function	Setting
S1-1	Analog Input A1 Signal Level	V: 0–10VDC or -10–10VDC (internal impedance: 20 kΩ) **(default)** I: 0–20mA or 4–20mA (internal impedance: 250 Ω)
S1-2	Analog Input A2 Signal Level	V: 0–10VDC or -10–10VDC (internal impedance: 20 kΩ) I: 0–20mA or 4–20mA (internal impedance: 250 Ω) **(default)**
S1-3	Analog Input A3 Signal Level	V: 0–10VDC or -10–10VDC (internal impedance: 20 kΩ) **(default)** I: 0–20mA or 4–20mA (internal impedance: 250 Ω)
S2	RS-485 Termination Resistor	OFF: No terminating resistance **(default)** ON: Terminating resistance of 120 Ω
S4	Analog Input A3 Select	AI: A3 is used as Analog Input 3 **(default)** PTC: A3 is used with a Positive Temperature Coefficient (PTC) thermistor
S5	Analog Output FM and AM Signal Level	V: 0–10VDC or -10–10VDC **(default)** I: 4–20mA

3.6 Control Circuit Wiring

The table below outlines the functions of the control circuit terminals.

NOTE: *The terminal SP power supply has a maximum capacity of 200 mA, but 150 mA is available for auxiliary devices.*

Terms:

- Multi-Function Digital Input (MFDI)
- Multi-Function Digital Output (MFDO)
- Multi-Function Analog Input (MFAI)
- Multi-Function Analog Output (MFAO)

Table 3-10: Control Circuit Terminals

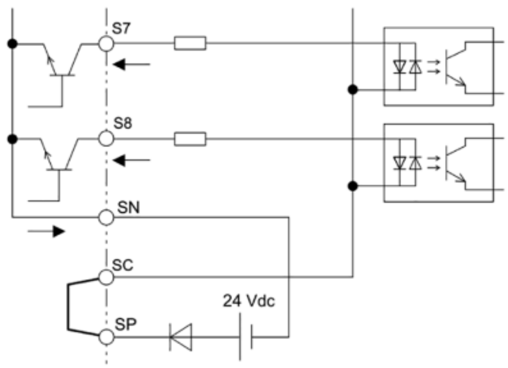
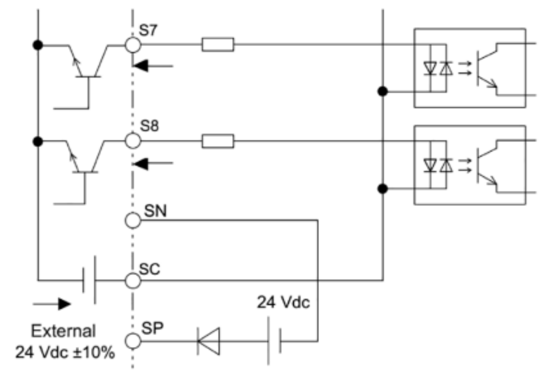
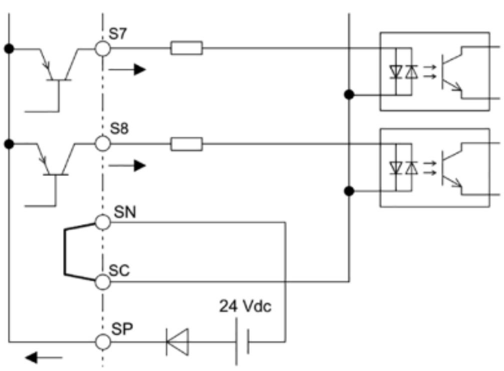
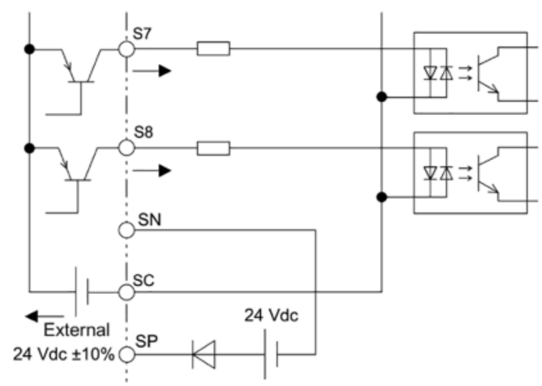
Type	Terminal	Function	Description	Signal Level
Digital Inputs	S1	MFDI 1	Multi-function digital inputs (H01-01 to H01-08)	Photo-coupler isolation 24 VDC; 6 mA per input 120 VAC, 12.5 mA per input (optional interface card)
	S2	MFDI 2		
	S3	MFDI 3		
	S4	MFDI 4		
	S5	MFDI 5		
	S6	MFDI 6		
	S7	MFDI 7		
	S8	MFDI 8		
	X2	Common	120 VAC interface card only	-
	SC	Common	Digital input common	-
	SN	Neutral	Power supply neutral	0 V
	SP	Power Supply	Power supply output	24 VDC, 150 mA (auxiliary)
Power Supply Output (S5-120VAC-CARD-UNCERT only)	24V	Power Supply	Power supply output	24 VDC, 150 mA (auxiliary)
	0V	Neutral	Power supply neutral	0 V
Analog Inputs	+V	MFAI Power Supply	Analog input positive supply	+10.5 VDC, 20 mA
	-V	MFAI Power Supply	Analog input negative supply	-10.5 VDC, 20 mA
	A1	MFAI 1	Multi-function analog input 1 (H03-02)	-10 to 10 VDC (impedance: 20kΩ) 0 to 10 VDC (impedance: 20kΩ) 0 to 20 mA (impedance: 250Ω) 4 to 20 mA (impedance: 250Ω)
	A2	MFAI 2	Multi-function analog input 2 (H03-10)	
	A3	MFAI 3	Multi-function analog input 3 (H03-06)	
	AC	Common	Analog signal common	0 V
	E(G)	Shield	Analog input & Modbus shield	-
Digital Outputs	M1	MFDO 1	Multi-function digital output 1 (H02-01)	Form A (N/O) Relay: 250 VAC, 1 A; 30 VDC, 1 A
	M2			
	M3	MFDO 2	Multi-function digital output 2 (H02-02)	Form A (N/O) Relay: 250 VAC, 1 A; 30 VDC, 1 A
	M4			
	M5	MFDO 3	Multi-function digital output 3 (H02-03)	Form A (N/O) Relay: 250 VAC, 1 A; 30 VDC, 1 A
	M6			
	MA	Fault Relays	MA-MC N/O; closed during fault MB-MC N/C; open during fault	Form C Relay: 250 VAC, 1 A; 30 VDC, 1 A
	MB			
	MC			
Analog Outputs	FM	MFAO 1	Multi-function analog output 1 (H04-01 to H04-03)	-10 to +10 VDC 0 to +10 VDC 4 to 20 mA
	AM	MFAO 2	Multi-function analog output 2 (H04-04 to H04-06)	
	AC	Common	Analog signal common	0 V

Type	Terminal	Function	Description	Signal Level
External Power Supply Input	PS	Power Supply Input	Supplies backup power to the control circuit and keypad	21.6 to 26.4 VDC, 700 mA
	AC	Common	Power supply common	0 V
Pulse I/O	RP	Pulse Train Input	Pulse input frequency (H06-01)	Frequency: 0 to 32 kHz Duty Cycle: 30 to 70% High Level: 3.5 to 13.2 VDC Low Level: 0 to 0.8 VDC Input Impedance: 3kΩ
	MP	Pulse Train Output	Pulse output frequency (H06-06)	32 kHz (max)
Modbus	D+	Communication (+)	RS-485 Modbus (H05 parameters)	115.2 kbps (max)
	D-	Communication (-)		
	AC	Common	Shield	0 V
Safe Disable	H1	Safe Disable Input 1	• One or both open: Motor Output Disabled • Both closed: normal operation • Off time of at least 2ms • Remove the factory-installed H1-H2-HC jumper to use Safe Disable.	24 VDC, 6 mA Internal Impedance: 4.7kΩ
	H2	Safe Disable Input 2		
	HC	Safe Disable Common		-

3.6.1 Sinking/Sourcing for Digital Inputs (24 VDC Only)

Use the wire jumper between terminals SC and SP or SC and SN to select Sink mode, Source mode, or to externally power the digital inputs. This function does not apply when using the 120 VAC interface card. There must be a jumper wire between terminals SC and SP when using the internal 24 VDC power supply.

Table 3-11: Sink/Source for Digital Inputs/External Power Supply Selection

Mode	VFD Internal Power Supply	External 24 VDC Power Supply
Sinking Mode	 **(Default)**	
Sourcing Mode		

3.6.2 Safe Disable and Safe Torque Off

The Safe Disable inputs provide a stop function in compliance with “Safe Torque Off” as defined in IEC/EN 61800-5-2. Safe Disable inputs have been designed to meet the requirements of the ISO/EN 13849-1, Category 3 PL e, IEC/EN 61508 (SIL3), and IEC/EN 62061 (SIL CL3).

Inputs/Outputs		Inputs: 2 (H1 and H2) ON: 18 to 28 VDC / OFF: -4 to +4 VDC Output: 1 MFDO safety monitor output for external device monitor (EDM)
Operation Time		Time from input open to VFD output stop is less than 3 ms.
Failure Probability	**Demand Rate Low**	PFD = $4.65E^{-6}$
	Demand Rate High/ Continuous	PFH = $1.11E^{-9}$
Performance Level		Performance Level (PL) e according to ISO/EN 13849-1.
HFT (Hardware Fault Tolerance)		N = 1
Type of Subsystem		Type B

DANGER

Sudden Movement Hazard. When you use the Safe Disable function in the safety system of a machine, do a full risk assessment for the system to make sure that all parts of the system comply with applicable safety standards. Incorrect application of the Safe Disable function can cause serious injury or death.

DANGER

Electrical Shock Hazard. You cannot depend on the Safe Disable function to prevent electrical shock. Disconnect all power to the VFD and wait for the time specified on the warning label before you remove covers. Check the VFD for dangerous voltages before servicing or repair work. If you do work on the VFD when it is energized and there is no cover over the electronic circuits, it can cause serious injury or death.

WARNING

Sudden Movement Hazard. Although the Safe Disable function is in operation, gravity or other external forces in the vertical axis can move the motor. Incorrect application of the Safe Disable function can cause serious injury or death.

WARNING

Sudden Movement Hazard. Do not use the VFD output signals to control external holding brakes or dynamic brakes for functional safety. Use a system that conforms to the functional safety requirements. Incorrect application of the Safe Disable function can cause serious injury or death. Systems that use the VFD output signals (including EDM) for safety are not safe because the VFD output signals are not safety components.

WARNING

Sudden Movement Hazard. Connect the Safe Disable inputs to the devices as specified by the safety requirements. If you connect the Safe Disable inputs incorrectly, it can cause serious injury or death.

WARNING

Sudden Movement Hazard. To use the Safe Disable inputs, remove the jumpers between terminals H1-HC and H2-HC. If the Safe Disable circuit does not work correctly, it can cause serious injury or death.

WARNING

Sudden Movement Hazard. When you clear the Safe Disable input, make sure that the Safe Disable Monitor output operates correctly as specified for the Safe Disable function. If the Safe Disable circuit does not operate correctly, it can cause serious injury or death.

WARNING

Sudden Movement Hazard. Regularly examine the Safe Disable input and all other safety features. A system that does not operate correctly can cause serious injury or death.

WARNING

Sudden Movement Hazard. Only let approved personnel who know about the VFD, technical manual, and safety standards wire, examine, and maintain the Safe Disable input. If personnel are not approved, it can cause serious injury or death.

WARNING

Sudden Movement Hazard. Only use the Safe Disable Monitor (MFDO = 24 or 124 for the EDM function) to monitor the Safe Disable status or to find a malfunction in the Safe Disable inputs. The monitor output is not a safety output. If you use the Safe Disable Monitor incorrectly, it can cause death or serious injury.

Safe Torque Off disables the VFD output for mechanical maintenance, E-stops, or redundancy safety monitor controller intervention. The feature provides safe removal of motor torque without removal of input power to the VFD. A Safe Disable Status Monitor for error detection in the safety circuit is also provided.

The Safe Disable circuit consists of two independent input channels (H1 and H2) that can block the output transistors and provide external device monitoring (EDM), using a digital output relay (H02-xx = 24 or 124), to monitor the status of the Safe Disable function. Remove the factory-installed H1-H2-HC jumper to use this function.

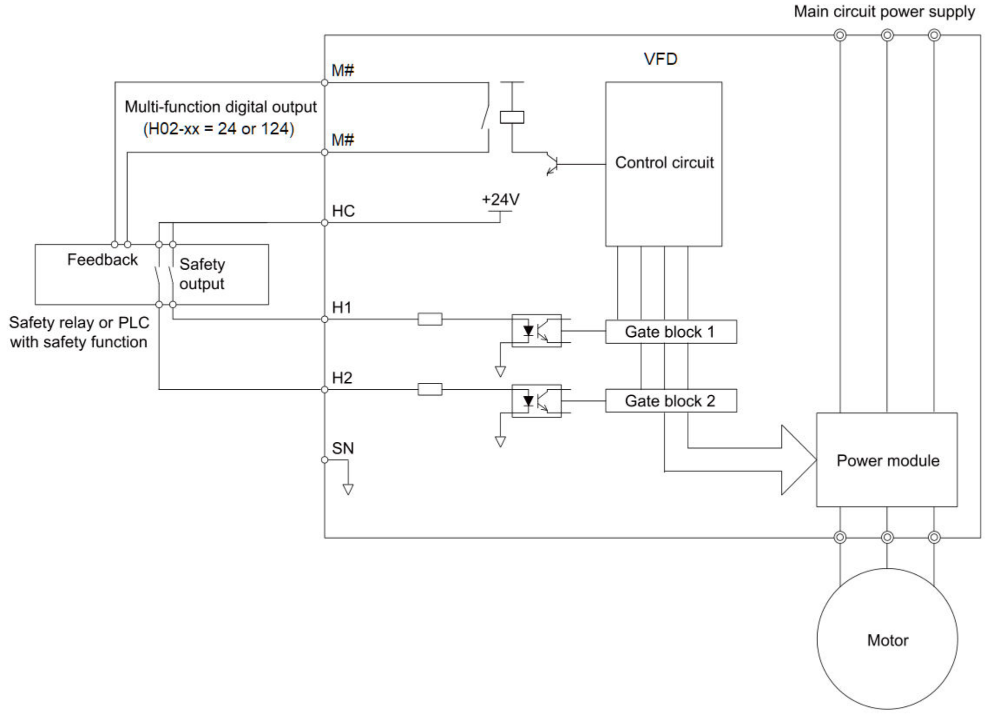


Figure 3-27: Safe Torque Off Block Diagram

The Figures below are wiring examples for using the internal 24 VDC power supply or an external 24 VDC power supply. The internal 24 VDC power supply capacity is 150 mA. The H1 and H2 inputs each require 24 VDC, 6 mA. Use only Sourcing Mode for the Safe Disable inputs.

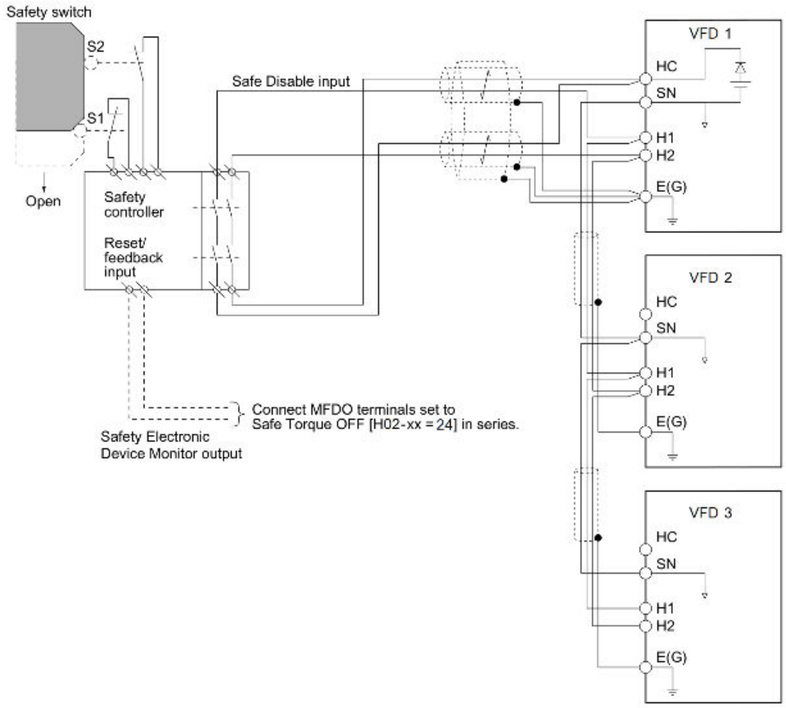


Figure 3-28: Safe Disable Example Using Internal Power Supply

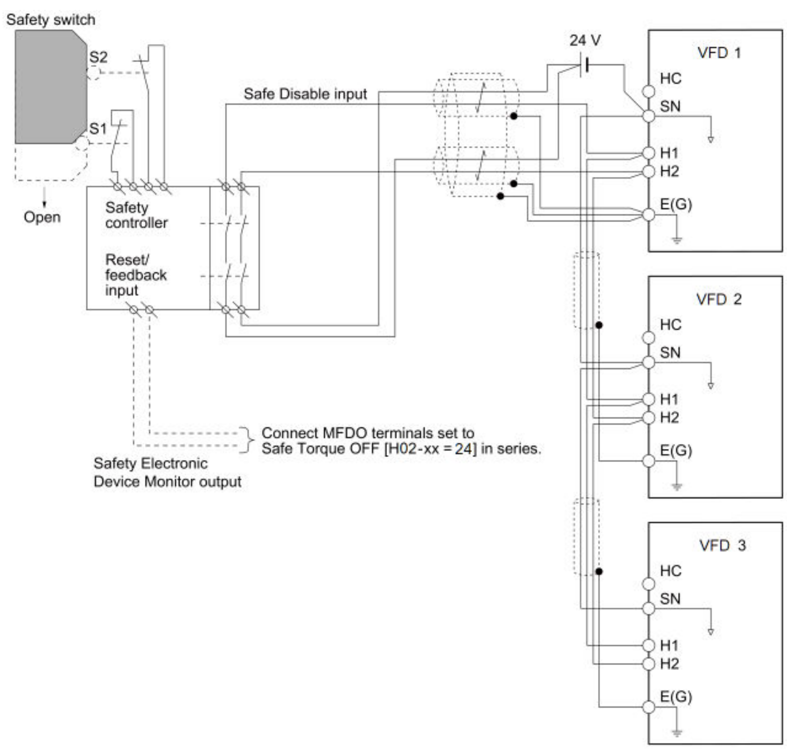


Figure 3-29: Safe Disable Example Using External Power Supply

3.7 Option Card Installation

There are three accessory slots for option cards that add encoder feedback, additional inputs, outputs, or industrial communication capabilities to the VFD. ***See Section 2.2.2 on page 23*** for a list of available option cards.

Option cards are installed under the cover of the VFD, and the three slots are ordered (CN5-C, CN5-B, CN5-A) from left to right. Only one option card of each type can be used at the same time, with the exception of the PG-X3 encoder card, which can be used twice.

CN5-C: Encoder cards only. Motor 1 must be attached to this port.

CN5-B: Expansion I/O cards. A second encoder card for Snap Shaft and Synchronization is allowed.

CN5-A: Industrial Communications cards only.

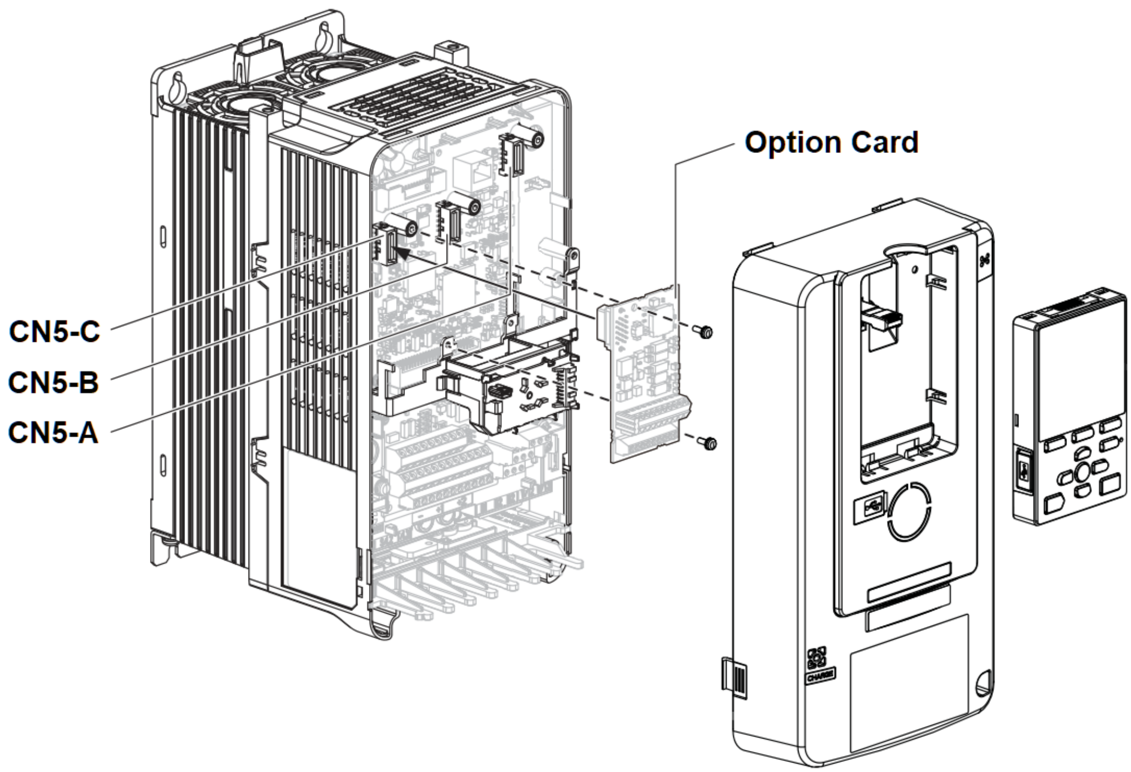


Figure 3-30: Option Card Installation

3.8 Encoder Circuit

A shaft-mounted encoder is required to provide speed and shaft position feedback to the IMPULSE•VG+ Series 5. Without an encoder, closed loop vector control cannot operate properly.

Before you wire the encoder circuit, refer to ***Table 3-12 on page 83*** and ***Table 3-13 on page 84***.

3.8.1 Encoder Circuit Specification and Wiring Procedure

Table 3-12: Encoder and PG-X3 Option Card Specifications

Power supply	+12 VDC (+5 VDC by CN3 jumper); max. 200 mA (consult factory if inrush currents exceed 200 mA), an auxiliary power supply is required
Output Type	Differential Quadrature (A+, A-, B+, and B- channels; Z is not used)
Compatible Types	Line Driver (TTL/RS422) Push-Pull (HTL) Open Collector (PNP or NPN) - Use the PG-B3 option card instead
Non-Compatible Types	Resolver Absolute (sine/cosine)
Maximum Input Frequency	300 kHz
Mounting method	Encoder must be direct-coupled to motor shaft, using a zero-backlash-type coupling.

To wire the encoder circuit (assuming the VFD cover and keypad are detached):

1. Direct-couple the encoder to the motor shaft, using a zero-backlash-type coupling.

NOTE: *Do not connect the encoder to the motor with roller chain or gear drive. If unable to direct-couple the encoder, use a timing belt to drive the encoder. Also, do not connect the encoder to the low-speed shaft of a speed reducer.*

2. Connect the encoder to the PG-X3 Encoder Option Card. ***See Figure 3-31 on page 84***.

NOTE: *Use twisted-pair, shielded cable 100 Ω impedance (Magnetek R-20/6, R-22/6, Belden 9730, or equivalent. Strip the encoder wires 0.25 in. (5.5 mm). Keep the wiring length less than 300 feet (for cable lengths greater than 300 feet, use fiber optic cable).*

3. Connect the shield to Terminal FE of the PG-X3 Option Card (on only one end of the shielded cable).
4. Whenever possible, the encoder cable should be a continuous run between the motor and VFD. If it cannot be a direct run, the splice should be in its own junction box and isolated from the power wires.

3.8.2 Encoder Wiring Diagram

Encoder 1: Install in option port CN5-C

Encoder 2: Install in option port CN5-B

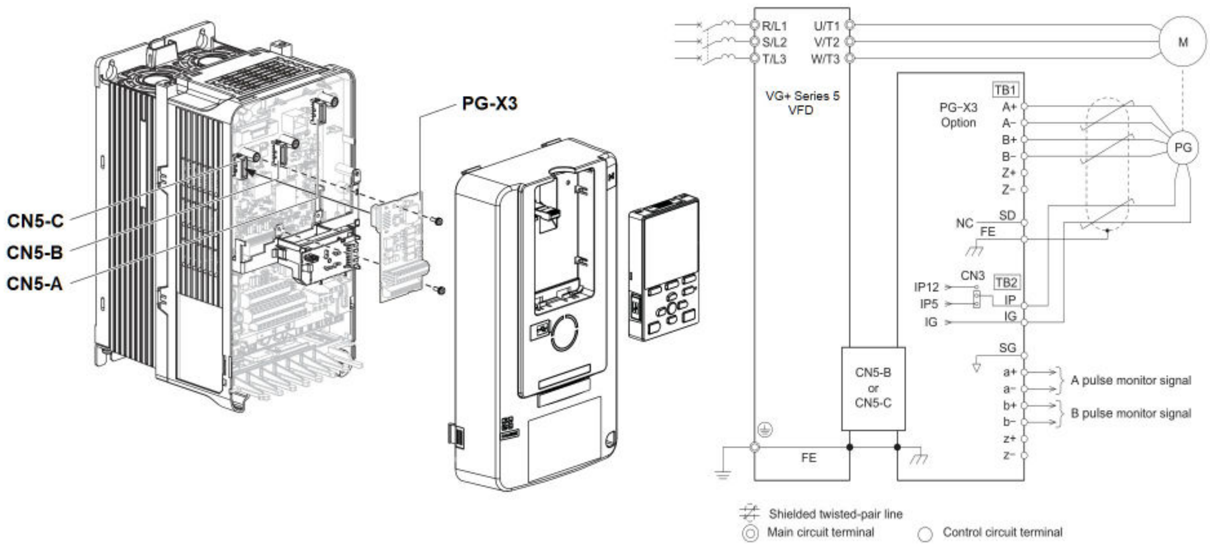


Figure 3-31: PG-X3 Encoder Card Wiring

Table 3-13: Encoder Wiring

Encoder Signal	Wire Color Example	PG-X3 Terminal
+5 or 12 VDC (select via CN3 jumper)	Red	IP
0V	Black	IG
A+	Blue	A+
A-	Gray	A-
B+	Green	B+
B-	Yellow	B-
Shield	-	FE

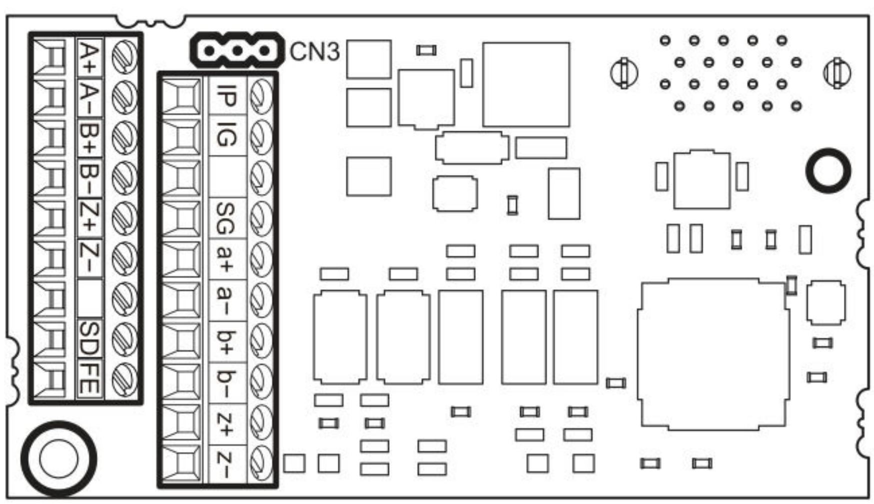


Figure 3-32: PG-X3 Encoder Card Terminals

4 Getting Started

4.1 Overview

With its easy-to-use keypad and X-Press Programming, the IMPULSE•G+/VG+ Series 5 makes it easy to get up and running quickly. In addition to explaining the keypad and X-Press Programming, this chapter explains how to navigate the menus and configure the VFD.

4.1.1 Checks Before Powering

After VFD installation and wiring are completed, verify:

- Correct connections.
- Correct input power supply (no voltage drop or imbalance, source kVA ≤ 500, unless a line reactor is used).
- No short circuit conditions.
- No loose screw terminals (check especially for loose wire clippings).
- Proper load conditions.

4.1.2 Precautions

- Only start the motor if motor shaft rotation is stopped.
- Even with small loading, never use a motor whose nameplate amperage exceeds the VFD rated current.

DANGER

Extreme caution should be used if braking method is set for Decelerate to stop. If deceleration time is too long, equipment could run into the end stop device, causing damage to equipment or injury to personnel.

4.2 Using the Keypad

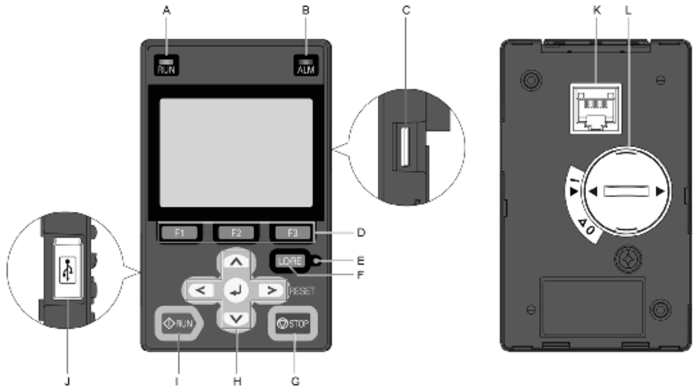
With five 16-character lines available, the keypad display makes it possible to monitor VFD operation, change parameter settings, and view fault codes. In addition, the parameter description is included on the top line of the display. The keypad enables you to:

- Program the various VFD parameters.
- Monitor the functions of the VFD.
- Read alpha-numeric fault-diagnostic indications.
- Operate the VFD using the keypad (local operation).

WARNING

Because of additional potential hazards when the VFD is operated locally, we advise you to avoid operating it this way. If the VFD is operated locally, be aware that the crane or hoist will move when the RUN button is pressed. Contact Magnetek with any questions.

4.2.1 Keypad LED and Button Functions



A	RUN	Lit while VFD is operating the motor; Flashing during a phantom stop.
B	ALM	Off during normal operation (no fault or alarm). Lit during a fault; Flashing during an alarm, oPE, or error.
C	Memory Card Slot	No function.
D	F1 F2 F3	Function keys with configurable functions.
E	LO/RE	Lit while the keypad is selected to run the VFD (LOCAL mode).
F	LO/RE	• Displays the phone number for the Magnetek Service department. • Switches VFD control between LOCAL and REMOTE mode.*2
G	STOP	Stops VFD operation. *1
H		• ENTER key for parameter values and settings. • Selects menu items to move between screens.
	<	• Moves the cursor to the left, or the previous screen.
	>	• Moves the cursor to the right, or the next screen. • Resets an active fault.
		• Scrolls up or down to show the next or previous item. • Increments or decrements parameter values.
I	RUN	Starts the VFD when in LOCAL mode.
J	USB Port	No function
K	RJ-45 Connector	The keypad connects to the VFD through this port.
L	Battery Cover	Access to the CR2016 battery which maintains the real time clock.

**1 The STOP key has highest priority and pressing it will stop the motor, even if a Run command is active from an external Run source.*

**2 The LO/RE key can only switch between LOCAL and REMOTE when the VFD is stopped. See parameter o02-01 = 1.*

4.3 Initialization Parameters (A)

There are a variety of parameters that determine how the VFD functions. These parameters are programmed into the VFD's software as measurable values or options - both of which will be referred to in this manual as settings. While some of these parameters are associated with one setting, others are tied to a number of possible settings.

Before shipping the VFD, Magnetek programmed initial settings so that most, if not all, of the crane system requirements are supported. However, if it is necessary to change the initial settings, Magnetek recommends that only qualified crane system technicians program the VFD. Security can be enabled by using the **Password** and **Access Level** features. For more information on these security features, ***see Section 4.3.3 on page 90***.

The VFD can be restricted to allow access to only certain parameters, called **User Parameters**. To select these parameters, ***see Section 4.3.3.10 on page 101***.

Two additional features are **Initialize Parameters** (A01-05) and **User Defaults** (o02-03). Both of these features are related and revert back to previously saved parameter settings. This is especially helpful when a number of programming changes were made, but the previous settings may still be needed. To program these features, ***see Section Table 4-10: on page 97*** and ***User Defaults (o02-03) on page 331***.

4.3.1 Parameter Menus

All parameters and settings are organized under several menus:

4.3.1.1 Monitors

VFD operation is enabled, and various live monitors can be viewed.

4.3.1.2 Parameters

Parameters are accessed, such as control method, motion, speed reference, and configuration of special functions. Parameter availability depends on the access level (A01-01).

4.3.1.3 User Custom Parameters

This is a section of up to 32 quick access parameters that are selected via the A02-01 to A02-32 parameters. If the access level is set to User Parameters (A01-01 = 1), the user will only have access to the user custom parameters.

4.3.1.4 Auto-Tuning

Automatically calculates and sets motor parameters to optimize VFD performance.

4.3.1.5 Modified Parameters

Only parameters that have been changed from the default settings are shown.

4.3.1.6 Parameter Backup/Restore

This allows for up to 4 sets of parameter backups to be stored on the keypad. Saved parameter sets can also be transferred to the VFD as long as the VFD type matches the parameter settings (e.g., same VFD model, firmware version, and control method).

4.3.1.7 Diagnostic Tools

This section contains a menu of various VFD specifications, including electrical ratings, firmware version, and serial number. An additional menu contains a time-stamped Fault Log of the last 10 faults.

4.3.1.8 Set Date/Time

The calendar date and time is selected and configured here. The time will be shown in the upper left corner of the keypad, and the date and time will be used for the Fault Log located in the Diagnostic Tools menu.

4.3.2 Menu Structure

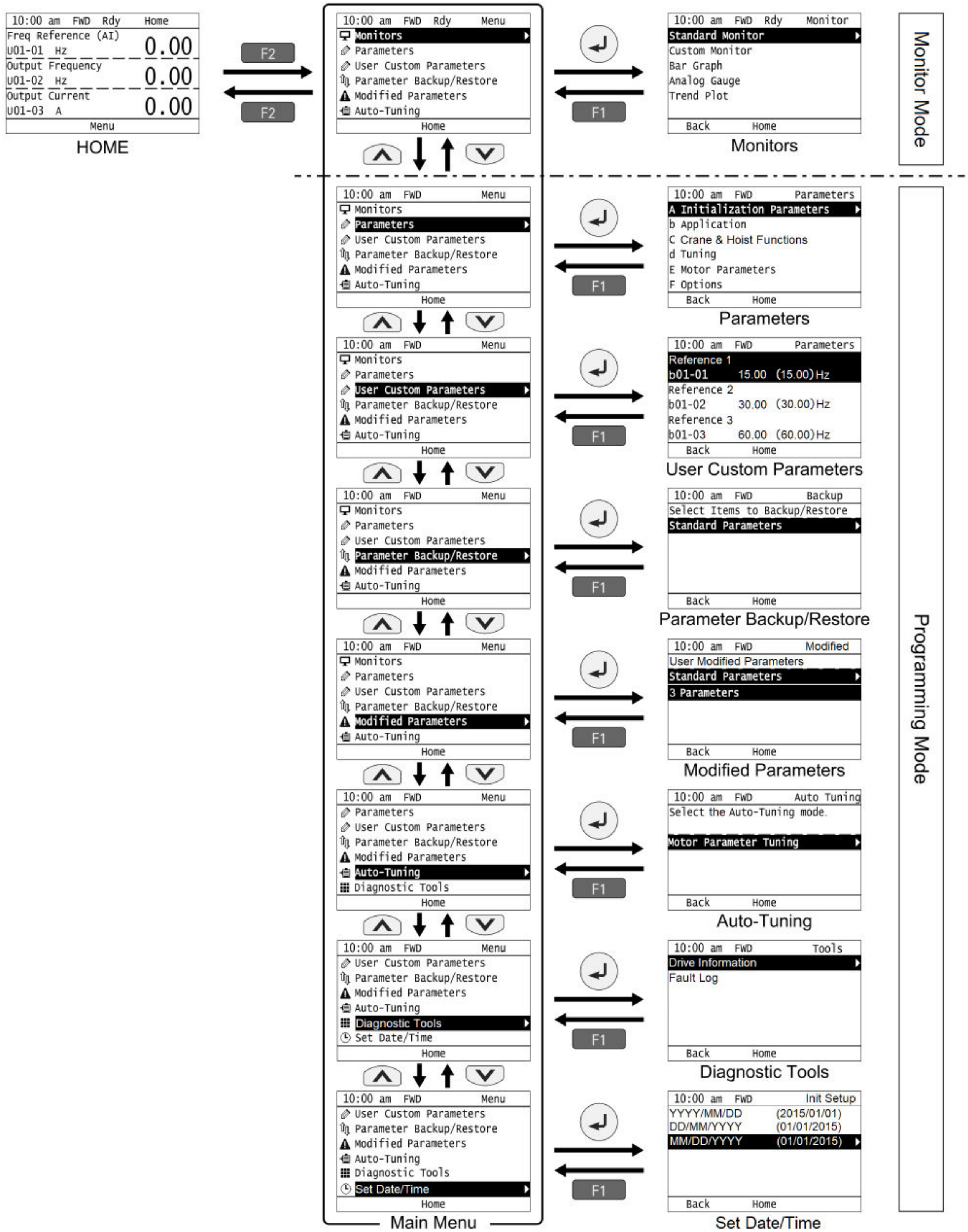
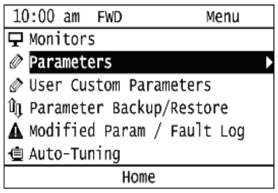


Figure 4-1: Menu Structure



Group	Function	
Monitor	U01	Operation Status
	U02	Fault Trace
	U03	Fault History
	U04	Maintenance
	U06	Control Status
	U07	Special Firmware
Initialize	A01	Initial Setup
	A02	User Parameters
Application	b01	Frequency References
	b02	Reference Limits
	b03	Operation Mode
	b05	Acceleration/Deceleration Times
	b08	Jump Frequencies / Offset Frequencies
	b09	Field Forcing
Crane & Hoist Functions	C01	Quick Stop / Reverse Plug Simulation
	C02	Micro-Speed
	C03	End of Travel Limits / Phantom Stop
	C03	Hook Height Measurement
	C03	Electronic Programmable Limit Switches (EPLS)
	C04	Load Share (Torque Following) / Load Float Alternate
	C05	Load Check
	C06	Ultra-Lift
	C07	Torque Limits / Anti-Shock
	C08	No Load Brake (NLB) Hoist
	C08	Brake Answerback / Dual Brake / Emergency Lift
	C09	Special Firmware (Synchronization / Bucket)
	C10	Load Weight Measurement / Load Summing
	C11	Snap Shaft Detection / Slack Cable Detection
	C12	Delay and Maintenance Timers and Counters
	C13	Inch Control / Index Control
	C14	Sway Control
	C15	Static Stepless Simulation
Tuning	d01	DC Injection
	d02	Slip Compensation
	d03	Torque Compensation
	d04	Automatic Speed Regulator (ASR) Tuning
	d05	Torque Control
	d08	Dwell
	d09	S-Curve Times
	d10	Duty Rating / Carrier Frequency
Motor	E01	V/f Pattern for Motor 1
	E02	Motor 1 Parameters
	E03	V/f Pattern for Motor 2
	E04	Motor 2 Parameters
	E07	Test Mode
Option Cards	F01	Encoder Feedback (PG-X3) Setup
	F04	Analog Output (AO-A3) Setup
	F05	Digital Output (DO-A3 or S4IO) Setup
	F06	Communication Setup
	F06	Profibus-DP (SI-P3) Setup
	F07	Ethernet (SI-EN3), ProfiNET (SI-EP3), Modbus TCP/IP (SI-EM3) Setup
Terminal	H01	Digital Inputs
	H02	Digital Outputs
	H03	Analog Inputs
	H04	Analog Outputs
	H05	Modbus RTU Communication
	H06	Pulse Train Input/Output
	H07	Virtual Inputs/Outputs
Protection	L01	Motor Protection
	L02	Power Loss Ride Through
	L03	Stall Prevention
	L04	Speed Detection
	L06	Torque Detection
	L08	Hardware Protection
	L09	Automatic Fault Reset / Fault Latch
Special Adjustment	n01	Hunting Prevention
	n02	Automatic Frequency Regulator (AFR)
Keypad	o01	Keypad Display
	o02	VFD Configuration
	o03	Maintenance Monitors
	o06	User Stored Data

4.3.3 Initial Setup Parameters (A01)

4.3.3.1 Parameter Access Level (A01-01)

The Parameter Access Level allows the “masking” of parameters according to user level.

Table 4-1: Parameter Access Level Settings

Setting	Description
0	**Operation Only** Access to only parameters A01-01, A01-06, and all U monitors.
1	**User Parameters** Access to only the parameters selected by A02-01 through A02-32.
2	**Advanced Level** Commonly used parameters can be viewed and edited (default).
3	**Expert Level** All parameters can be viewed and edited.

4.3.3.2 Control Method (A01-02)

A VG+ VFD is preconfigured to Closed Loop Vector and locked into that setting. A G+ VFD is preconfigured to V/f and may be changed to Open Loop Vector, but not Closed Loop Vector.

Table 4-2: Control Method Settings

Setting	Description	Model
0	**Volts-per-Hertz (V/f)** Use this mode for simple speed control and for multiple motor applications with low demands to dynamic response or speed accuracy. This control method is also used when the motor parameters are unknown and Auto-Tuning cannot be performed. The speed control range is 40:1.	G+
2	**Open Loop Vector (OLV)** Use this mode for applications that require precise speed control, quick torque response, and high torque at low speed without using a speed feedback signal from the motor. The speed control range is 200:1.	G+
3	**Closed Loop Vector (CLV)** Use this mode for applications that require precise speed control down to zero speed, quick torque response or precise torque control, and a speed feedback signal from the motor. The speed control range is up to 1500:1.	VG+

NOTE: *An Auto-Tune is recommended for all Closed Loop Vector and Open Loop Vector applications.* ***See Section 4.4 on page 103****.*

4.3.3.3 X-Press Programming

X-Press Programming automatically configures several commonly used parameters and features when Control Method (A01-02), Motion (A01-03), or Speed Reference (A01-04) are programmed. Many of these parameters are also added to the Custom User Parameters menu for fast parameter modification.

WARNING

When changing A01-03 or A01-04, some parameters will be overwritten by X-Press Programming. All parameter settings must be verified for proper operation.

4.3.3.4 Motion (A01-03)

Set this to match the application motion. See X-Press Programming (***Section 4.3.3.6 on page 93***) for details.

Table 4-3: Motion Settings

Setting		Notes	Model
0	Traverse		G+/VG+
1	Standard Hoist	G+ Default	G+
2	NLB Hoist	VG+ Default	VG+
3	Bucket		VG+
4	Braketronic		G+/VG+
7	Static Stepless Simulation		VG+

4.3.3.5 Speed Reference (A01-04)

This parameter will automatically define the input terminals for the selections listed below. See X-Press Programming (***See Section 4.3.3.6 on page 93***) for details.

Table 4-4: Speed Reference Settings

Setting	Description
0	**2-Speed Multi-Step** – Terminal S3 = 2nd speed.
1	**3-Speed Multi-Step** – Terminals S3 and S4 = speeds 2 and 3 respectively (default).
2	**5-Speed Multi-Step** – Terminals S3-S6 = speeds 2–5.
3	**2-Step Infinitely Variable** – Terminals S1 (Forward) and S2 (Reverse) use b01-01 and speed hold. Terminal S3 = Accelerate. Max Speed set via b01-21 or b01-22.
4	**3-Step Infinitely Variable** – Terminals S1 (Forward) and S2 (Reverse) use b01-01. Terminal S3 = Speed Hold. Terminal S4 = Accelerate. Max Speed set via b01-21 or b01-22.
5	**Uni-Polar Analog** – Terminals S1 (Forward) and S2 (Reverse). Terminal A1 = 0-10V. Terminal A2 = 4-20mA (when using Terminal A2, set H03-02 = 1F and H03-10 = 0).
6	**Bi-Polar Analog** – Terminal S1 = Run. Terminal A1 = direction and frequency -10 to +10VDC.

NOTE: *For Serial (RS-485) and Option Card (e.g., Ethernet/IP) Communications, see parameters b03-01 and b03-02 to set the Run and Speed Reference source.*

Table 4-5: X-Press Programming I/O Quick Reference

A01-04 =	0	1	2	3	4	5	6
Terminal S1	FWD	FWD	FWD	FWD	FWD	FWD	FWD
Terminal S2	REV	REV	REV	REV	REV	REV	REV
Terminal S3	Step 2	Step 2	Step 2	Accel	Hold	-	-
Terminal S4	-	Step 3	Step 3	-	Accel	-	-
Terminal S5	-	-	Step 4	-	-	-	-
Terminal S6	-	-	Step 5	-	-	-	-
Terminal S7	-	-	-	-	-	-	-
Terminal S8	-	-	-	-	-	-	-
Terminal A1	-	-	-	-	-	FREF	FREF
Terminal M1-M2	Brake	Brake	Brake	Brake	Brake	Brake	Brake
Terminal M3-M4	Brake (NLB Hoist only), otherwise unconfigured						
Terminal M5-M6	Fault Annunciate (NLB Hoist only), otherwise unconfigured						

4.3.3.6 Parameters Changed by X-Press Programming

Table 4-6: Traverse (A01-03 = 0)

Parameter	Description	A01-04 =						
		0	1	2	3	4	5	6
		2-Speed Multi-Step	3-Speed Multi-Step	5-Speed Multi-Step	2-Step Infinitely Variable	3-Step Infinitely Variable	Uni-Polar Analog	Bi-Polar Analog
b01-01	Speed 1	20.00	15.00	6.00	15.00	15.00	15.00	15.00
b01-02	Speed 2	60.00	30.00	15.00	30.00	30.00	30.00	30.00
b01-03	Speed 3	0.00	60.00	30.00	60.00	60.00	60.00	60.00
b01-04	Speed 4	0.00	0.00	45.00	0.00	0.00	0.00	0.00
b01-05	Speed 5	0.00	0.00	60.00	0.00	0.00	0.00	0.00
b01-17	Jog Reference	6.00	6.00	6.00	6.00	6.00	6.00	6.00
b02-01	Freq Ref Upper Limit	100.0	100.0	100.0	100.0	100.0	100.0	100.0
b03-01	Frequency Reference 1	0	0	0	5	5	1	1
b03-02	Run Command 1	1	1	1	1	1	1	1
b03-03	Stopping Method	0	0	0	0	0	0	0
b05-01	Acceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
b05-02	Deceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
C01-01	Quick Stop	0	0	0	0	0	0	0
C01-03	Reverse Plug	0	0	0	0	0	0	0
C03-09	LL2/UL2 Action	2	2	2	2	2	2	2
C08-10	Load Float Time	0	0	0	0	0	0	0
C13-12	Index Brake Control	0	0	0	0	0	0	0
C13-13	Bi-Polar Analog Index Deadzone	0.0	0.0	0.0	0.0	0.0	0.0	5.0
d05-04	Speed Limit	105	105	105	105	105	105	105
d09-01	S-Curve Time @ Start of Accel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-02	S-Curve Time @ End of Accel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-03	S-Curve Time @ Start of Decel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-04	S-Curve Time @ End of Decel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
E01-03	V/f Pattern	0	0	0	0	0	0	0
H01-01	Terminal S1	80	80	80	80	80	80	80
H01-02	Terminal S2	81	81	81	81	81	81	F
H01-03	Terminal S3	0	0	0	5	4	F	F
H01-04	Terminal S4	F	1	1	F	5	F	F
H01-05	Terminal S5	F	F	2	F	F	F	F
H01-06	Terminal S6	F	F	3	F	F	F	F
H01-07	Terminal S7	F	F	F	F	F	F	F
H01-08	Terminal S8	F	F	F	F	F	F	F
H02-01	Terminal M1-M2	0	0	0	0	0	0	0
H02-02	Terminal M3-M4	F	F	F	F	F	F	F
H02-03	Terminal M5-M6	F	F	F	F	F	F	F
H03-01	Terminal A1 Signal Level	0	0	0	0	0	0	1
H03-05	Terminal A3 Signal Level	0	0	0	0	0	0	0
H03-06	Terminal A3	1F	1F	1F	1F	1F	1F	1F

Table 4-7: Standard Hoist (A01-03 = 1)

Parameter	Description	A01-04 = 0 2-Speed Multi-Step	1 3-Speed Multi-Step	2 5-Speed Multi-Step	3 2-Step Infinitely Variable	4 3-Step Infinitely Variable	5 Uni-Polar Analog	6 Bi-Polar Analog
b01-01	Speed 1	20.00	15.00	6.00	15.00	15.00	15.00	15.00
b01-02	Speed 2	60.00	30.00	15.00	30.00	30.00	30.00	30.00
b01-03	Speed 3	0.00	60.00	30.00	60.00	60.00	60.00	60.00
b01-04	Speed 4	0.00	0.00	45.00	0.00	0.00	0.00	0.00
b01-05	Speed 5	0.00	0.00	60.00	0.00	0.00	0.00	0.00
b01-17	Jog Reference	6.00	6.00	6.00	6.00	6.00	6.00	6.00
b02-01	Freq Ref Upper Limit	100.0	100.0	100.0	100.0	100.0	100.0	100.0
b03-01	Frequency Reference 1	0	0	0	5	5	1	1
b03-02	Run Command 1	1	1	1	1	1	1	1
b03-03	Stopping Method	1	1	1	1	1	1	1
b05-01	Acceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
b05-02	Deceleration Time 1	3.0	3.0	3.0	3.0	3.0	3.0	3.0
C01-01	Quick Stop	0	0	0	0	0	0	0
C01-03	Reverse Plug	0	0	0	0	0	0	0
C03-09	LL2/UL2 Action	2	2	2	2	2	2	2
C08-10	Load Float Time	0	0	0	0	0	0	0
C13-12	Index Brake Control	0	0	0	0	0	0	0
C13-13	Bi-Polar Analog Index Deadzone	0.0	0.0	0.0	0.0	0.0	0.0	5.0
d05-04	Speed Limit	105	105	105	105	105	105	105
d09-01	S-Curve Time @ Start of Accel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-02	S-Curve Time @ End of Accel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-03	S-Curve Time @ Start of Decel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-04	S-Curve Time @ End of Decel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
E01-03	V/f Pattern	4	4	4	4	4	4	4
H01-01	Terminal S1	80	80	80	80	80	80	80
H01-02	Terminal S2	81	81	81	81	81	81	F
H01-03	Terminal S3	0	0	0	5	4	F	F
H01-04	Terminal S4	F	1	1	F	5	F	F
H01-05	Terminal S5	F	F	2	F	F	F	F
H01-06	Terminal S6	F	F	3	F	F	F	F
H01-07	Terminal S7	F	F	F	F	F	F	F
H01-08	Terminal S8	F	F	F	F	F	F	F
H02-01	Terminal M1-M2	0	0	0	0	0	0	0
H02-02	Terminal M3-M4	F	F	F	F	F	F	F
H02-03	Terminal M5-M6	F	F	F	F	F	F	F
H03-01	Terminal A1 Signal Level	0	0	0	0	0	0	1
H03-05	Terminal A3 Signal Level	0	0	0	0	0	0	0
H03-06	Terminal A3	1F	1F	1F	1F	1F	1F	1F

Table 4-8: NLB Hoist (A01-03 = 2)

Parameter	Description	A01-04 =						
		0	1	2	3	4	5	6
		2-Speed Multi-Step	3-Speed Multi-Step	5-Speed Multi-Step	2-Step Infinitely Variable	3-Step Infinitely Variable	Uni-Polar Analog	Bi-Polar Analog
b01-01	Speed 1	20.00	15.00	6.00	15.00	15.00	15.00	15.00
b01-02	Speed 2	60.00	30.00	15.00	30.00	30.00	30.00	30.00
b01-03	Speed 3	0.00	60.00	30.00	60.00	60.00	60.00	60.00
b01-04	Speed 4	0.00	0.00	45.00	0.00	0.00	0.00	0.00
b01-05	Speed 5	0.00	0.00	60.00	0.00	0.00	0.00	0.00
b01-17	Jog Reference	6.00	6.00	6.00	6.00	6.00	6.00	6.00
b02-01	Freq Ref Upper Limit	100.0	100.0	100.0	100.0	100.0	100.0	100.0
b03-01	Frequency Reference 1	0	0	0	5	5	1	1
b03-02	Run Command 1	1	1	1	1	1	1	1
b03-03	Stopping Method	6	6	6	6	6	6	6
b05-01	Acceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
b05-02	Deceleration Time 1	3.0	3.0	3.0	3.0	3.0	3.0	3.0
C01-01	Quick Stop	1	1	1	1	1	1	1
C01-03	Reverse Plug	1	1	1	1	1	1	1
C03-09	LL2/UL2 Action	2	2	2	2	2	2	2
C08-10	Load Float Time	10	10	10	10	10	10	10
C13-12	Index Brake Control	2	2	2	2	2	2	2
C13-13	Bi-Polar Analog Index Deadzone	0.0	0.0	0.0	0.0	0.0	0.0	5.0
d05-04	Speed Limit	105	105	105	105	105	105	105
d09-01	S-Curve Time @ Start of Accel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-02	S-Curve Time @ End of Accel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-03	S-Curve Time @ Start of Decel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d09-04	S-Curve Time @ End of Decel	0.50	0.50	0.50	0.50	0.50	0.50	0.50
E01-03	V/f Pattern	F	F	F	F	F	F	F
H01-01	Terminal S1	80	80	80	80	80	80	80
H01-02	Terminal S2	81	81	81	81	81	81	F
H01-03	Terminal S3	0	0	0	5	4	F	F
H01-04	Terminal S4	F	1	1	F	5	F	F
H01-05	Terminal S5	F	F	2	F	F	F	F
H01-06	Terminal S6	F	F	3	F	F	F	F
H01-07	Terminal S7	F	F	F	F	F	F	F
H01-08	Terminal S8	F	F	F	F	F	F	F
H02-01	Terminal M1-M2	0	0	0	0	0	0	0
H02-02	Terminal M3-M4	0	0	0	0	0	0	0
H02-03	Terminal M5-M6	40	40	40	40	40	40	40
H03-01	Terminal A1 Signal Level	0	0	0	0	0	0	1
H03-05	Terminal A3 Signal Level	0	0	0	0	0	0	0
H03-06	Terminal A3	1F	1F	1F	1F	1F	1F	1F

Table 4-9: Bucket (A01-03 = 3)

Parameter	Description	A01-04 = 0 2-Speed Multi-Step	1 3-Speed Multi-Step	2 5-Speed Multi-Step	3 2-Step Infinitely Variable	4 3-Step Infinitely Variable	5 Uni-Polar Analog	6 Bi-Polar Analog
b01-01	Speed 1	20.00	15.00	6.00	-	-	15.00	-
b01-02	Speed 2	60.00	30.00	15.00	-	-	30.00	-
b01-03	Speed 3	0.00	60.00	30.00	-	-	60.00	-
b01-04	Speed 4	0.00	0.00	45.00	-	-	0.00	-
b01-05	Speed 5	0.00	0.00	60.00	-	-	0.00	-
b01-17	Jog Reference	6.00	6.00	6.00	-	-	6.00	-
b02-01	Freq Ref Upper Limit	100.0	100.0	100.0	-	-	100.0	-
b03-01	Frequency Reference 1	0	0	0	-	-	1	-
b03-02	Run Command 1	1	1	1	-	-	1	-
b03-03	Stopping Method	6	6	6	-	-	6	-
b05-01	Acceleration Time 1	5.0	5.0	5.0	-	-	5.0	-
b05-02	Deceleration Time 1	3.0	3.0	3.0	-	-	3.0	-
C01-01	Quick Stop	1	1	1	-	-	1	-
C01-03	Reverse Plug	1	1	1	-	-	1	-
C03-09	LL2/UL2 Action	2	2	2	-	-	2	-
C08-10	Load Float Time	25	25	25	-	-	25	-
C13-12	Index Brake Control	2	2	2	-	-	2	-
C13-13	Bi-Polar Analog Index Deadzone	0.0	0.0	0.0	-	-	0.0	-
C09-51	Torque Reference 1	25	25	20	-	-	0	-
C09-52	Torque Reference 2	100	60	40	-	-	0	-
C09-53	Torque Reference 3	0	100	60	-	-	0	-
C09-54	Torque Reference 4	0	0	80	-	-	0	-
C09-55	Torque Reference 5	0	0	100	-	-	0	-
d05-04	Speed Limit	100	100	100	-	-	100	-
d09-01	S-Curve Time @ Start of Accel	0.50	0.50	0.50	-	-	0.50	-
d09-02	S-Curve Time @ End of Accel	0.50	0.50	0.50	-	-	0.50	-
d09-03	S-Curve Time @ Start of Decel	0.50	0.50	0.50	-	-	0.50	-
d09-04	S-Curve Time @ End of Decel	0.50	0.50	0.50	-	-	0.50	-
E01-03	V/f Pattern	F	F	F	-	-	F	-
H01-01	Terminal S1	80	80	80	-	-	80	-
H01-02	Terminal S2	81	81	81	-	-	81	-
H01-03	Terminal S3	0	0	0	-	-	F	-
H01-04	Terminal S4	F	1	1	-	-	F	-
H01-05	Terminal S5	F	F	2	-	-	F	-
H01-06	Terminal S6	F	F	3	-	-	F	-
H01-07	Terminal S7	F	F	F	-	-	F	-
H01-08	Terminal S8	F	F	F	-	-	F	-
H02-01	Terminal M1-M2	0	0	0	-	-	0	-
H02-02	Terminal M3-M4	0	0	0	-	-	0	-
H02-03	Terminal M5-M6	40	40	40	-	-	40	-

Table 4-10: Braketronic (A01-03 = 4)

Parameter	Description	A01-04 =						
		0	1	2	3	4	5	6
		2-Speed Multi-Step	3-Speed Multi-Step	5-Speed Multi-Step	2-Step Infinitely Variable	3-Step Infinitely Variable	Uni-Polar Analog	Bi-Polar Analog
b01-01	Speed 1	-	0.00	-	-	-	-	-
b01-02	Speed 2	-	60.00	-	-	-	-	-
b03-01	Frequency Reference 1	-	1	-	-	-	-	-
b03-10	Run Command at Power Up	-	1	-	-	-	-	-
b05-01	Acceleration Time 1	-	1.0	-	-	-	-	-
b05-02	Deceleration Time 1	-	1.0	-	-	-	-	-
d09-01	S-Curve Time @ Start of Accel	-	0.00	-	-	-	-	-
d09-02	S-Curve Time @ End of Accel	-	0.00	-	-	-	-	-
d09-03	S-Curve Time @ Start of Decel	-	0.00	-	-	-	-	-
d09-04	S-Curve Time @ End of Decel	-	0.00	-	-	-	-	-
H01-01	Terminal S1	-	80	-	-	-	-	-
H01-02	Terminal S2	-	F	-	-	-	-	-
H01-03	Terminal S3	-	2	-	-	-	-	-
H01-04	Terminal S4	-	3	-	-	-	-	-
H01-05	Terminal S5	-	65	-	-	-	-	-
H01-06	Terminal S6	-	15F	-	-	-	-	-
H01-07	Terminal S7	-	F	-	-	-	-	-
H01-08	Terminal S8	-	F	-	-	-	-	-
H02-01	Terminal M1-M2	-	F	-	-	-	-	-
H02-02	Terminal M3-M4	-	F	-	-	-	-	-
H02-03	Terminal M5-M6	-	F	-	-	-	-	-

NOTE: *These settings serve as a starting point for Braketronic and additional parameter changes will be required.* ***See Section 5.2.33 starting on page 198*** *for detailed Braketronic parameter tables and timing diagrams for foot pedal and radio controlled configurations.*

Table 4-11: Static Stepless Simulation (A01-03 = 7)

Parameter	Description	A01-04 = 0 2-Speed Multi-Step	1 3-Speed Multi-Step	2 5-Speed Multi-Step	3 2-Step Infinitely Variable	4 3-Step Infinitely Variable	5 Uni-Polar Analog	6 Bi-Polar Analog
b01-01	Speed 1	20.00	15.00	6.00	15.00	15.00	15.00	15.00
b01-02	Speed 2	60.00	30.00	15.00	30.00	30.00	30.00	30.00
b01-03	Speed 3	0.00	60.00	30.00	60.00	60.00	60.00	60.00
b01-04	Speed 4	0.00	0.00	45.00	0.00	0.00	0.00	0.00
b01-05	Speed 5	0.00	0.00	60.00	0.00	0.00	0.00	0.00
b01-17	Jog Reference	6.00	6.00	6.00	6.00	6.00	6.00	6.00
b02-01	Freq Ref Upper Limit	100.0	100.0	100.0	100.0	100.0	100.0	100.0
b03-01	Frequency Reference 1	0	0	0	5	5	1	1
b03-02	Run Command 1	1	1	1	1	1	1	1
b03-03	Stopping Method	1	1	1	1	1	1	1
b05-01	Acceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
b05-02	Deceleration Time 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
C01-01	Quick Stop	0	0	0	0	0	0	0
C01-03	Reverse Plug	0	0	0	0	0	0	0
C03-09	LL2/UL2 Action	1	1	1	1	1	1	1
C08-10	Load Float Time	0	0	0	0	0	0	0
C13-12	Index Brake Control	0	0	0	0	0	0	0
C13-13	Bi-Polar Analog Index Deadzone	0.0	0.0	0.0	0.0	0.0	0.0	5.0
C15-01	Torque Reference 1	25	25	20	0	0	0	0
C15-02	Torque Reference 2	100	60	40	0	0	0	0
C15-03	Torque Reference 3	0	100	60	0	0	0	0
C15-04	Torque Reference 4	0	0	80	0	0	0	0
C15-05	Torque Reference 5	0	0	100	0	0	0	0
d05-04	Speed Limit	100	100	100	100	100	100	100
d09-01	S-Curve Time @ Start of Accel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-02	S-Curve Time @ End of Accel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-03	S-Curve Time @ Start of Decel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
d09-04	S-Curve Time @ End of Decel	1.50	1.50	1.50	1.50	1.50	1.50	1.50
E01-03	V/f Pattern	0	0	0	0	0	0	0
H01-01	Terminal S1	80	80	80	80	80	80	80
H01-02	Terminal S2	81	81	81	81	81	81	F
H01-03	Terminal S3	0	0	0	5	4	F	F
H01-04	Terminal S4	F	1	1	F	5	F	F
H01-05	Terminal S5	F	F	2	F	F	F	F
H01-06	Terminal S6	F	F	3	F	F	F	F
H01-07	Terminal S7	F	F	F	F	F	F	F
H01-08	Terminal S8	F	F	F	F	F	F	F
H02-01	Terminal M1-M2	0	0	100	0	0	0	0
H02-02	Terminal M3-M4	9	9	9	9	9	9	9
H02-03	Terminal M5-M6	F	F	F	F	F	F	F

Parameter	Description	A01-04 =						
		0	1	2	3	4	5	6
		2-Speed Multi-Step	3-Speed Multi-Step	5-Speed Multi-Step	2-Step Infinitely Variable	3-Step Infinitely Variable	Uni-Polar Analog	Bi-Polar Analog
H03-01	Terminal A1 Signal Level	0	0	0	0	0	0	1
H03-05	Terminal A3 Signal Level	0	0	0	0	0	0	0
H03-06	Terminal A3	1F	1F	1F	1F	1F	1F	1F

4.3.3.7 Initialize Parameters (A01-05)

Use this parameter to reset the VFD to its factory default settings or transfer parameters.

Table 4-12: Initialize Settings

Setting	Description
0	**No Initialization** (factory default)
1110	**User Default** Resets parameters to the values saved by the user as User Settings. User Settings are stored when parameter o02-03 is set to “1: Set defaults”. ***NOTE:*** *User Initialization resets all parameters to a user-defined set of default values previously saved to the VFD. Set parameter o02-03 = 2 to clear the user-defined default values.*
2220	**Parameter Setting Reset** Resets most parameters back to default values. Some A01, F06, and F07 parameter settings will be retained.

4.3.3.8 Password (A01-06 and A01-07)

This parameter enables the user to set a password that inhibits the programming of the parameters. This function is used in conjunction with the access level parameter A01-01. To set the password, enter a password number in parameter A01-07 and press the ENTER key. If A01-06 is not the same as A01-07, A01-01 cannot be changed once A01-01 is set to 0 or 1. When A01-06 is the same as A01-07, A01-01 can be changed.

To create a password, when A01-06 is displayed, press the DOWN and STOP key simultaneously to reveal A01-07.

4.3.3.9 X-Press Programming Legacy Method (A01-13)

The IMPULSE Series 5 VFD method for X-Press Programming is different than that of the IMPULSE Series 4 VFD. This parameter allows the option to select the new or legacy method.

Table 4-13: X-Press Programming Legacy Method Settings

Setting	Description
0	**Disabled** (factory default) Triggering X-Press Programming with an A01-04 change will only update parameters if the default setting of the current motion (A01-04) is different than that of the new motion being set. Example: The default of b01-01 = 20.00 Hz when A01-04 = 0 (2-Speed). When A01-04 is changed to 1 (3-Speed), the b01-01 setting will change since the new default of b01-01 = 15.00 Hz. Adversely, since the default setting of H01-05 is F (Not Used) in both 2-Speed and 3-Speed, so that parameter will not be updated and will retain the existing value.
1	**Enabled** Use the legacy X-Press Programming method from the IMPULSE Series 4. In this method, triggering X-Press Programming with an A01-04 change, will cause all X-Press parameters to be overwritten to the settings in the X-Press Programming tables.

4.3.3.10 User Parameters (A02-01 through 32)

The user can select up to 32 parameters for quick-access programming. By setting the user access level to User Parameters (A01-01 = 1), only the parameters selected by the A02 parameters will be accessible to the user, located in the User Custom Parameters menu. For added security, a password can be set (A01-07) to prevent the user from changing the Access Level (A01-01).

The A02 group is pre-loaded with the settings listed in ***Table 4-14***, based on the setting of A01-03 (Motion).

Table 4-14: User Parameters

A01-03	0	1	2
Parameter	**Traverse**	**Standard Hoist**	**NLB Hoist**
A02-01	b01-01: Speed 1	b01-01: Speed 1	b01-01: Speed 1
A02-02	b01-02: Speed 2	b01-02: Speed 2	b01-02: Speed 2
A02-03	b01-03: Speed 3	b01-03: Speed 3	b01-03: Speed 3
A02-04	b01-04: Speed 4	b01-04: Speed 4	b01-04: Speed 4
A02-05	b01-05: Speed 5	b01-05: Speed 5	b01-05: Speed 5
A02-06	b01-20: Inf-Var Max Ref 1	b01-20: Inf-Var Max Ref 1	b01-20: Inf-Var Max Ref 1
A02-07	b01-21: Inf-Var Max Ref 2	b01-21: Inf-Var Max Ref 2	b01-21: Inf-Var Max Ref 2
A02-08	b03-04: Phase Order	b03-04: Phase Order	b03-04: Phase Order
A02-09	b05-01: Acceleration Time 1	b05-01: Acceleration Time 1	b05-01: Acceleration Time 1
A02-10	b05-02: Deceleration Time 1	b05-02: Deceleration Time 1	b05-02: Deceleration Time 1
A02-11	C01-03: Reverse Plug	C02-01: Micro-Speed Gain 1	C01-01: Quick Stop
A02-12	C01-04: Reverse Plug Decel	E01-03: V/f Pattern	C01-02: Quick Stop Time
A02-13	C02-01: Micro-Speed Gain 1	E02-01: Motor FLA	C02-01: Micro-Speed Gain 1
A02-14	C03-01: UL1 Speed	H01-05: Terminal S5	C03-01: UL1 Speed
A02-15	C03-04: LL1 Speed	H01-06: Terminal S6	C03-04: LL1 Speed
A02-16	d09-01: S-Curve Time 1	H01-07: Terminal S7	C08-03: Min Brake Release Trq
A02-17	d09-02: S-Curve Time 2	H01-08: Terminal S8	C08-10: Load Float Time
A02-18	d09-03: S-Curve Time 3	H02-03: Terminal M5-M6	C08-11: BE5 Brake Set Time
A02-19	d09-04: S-Curve Time 4	H03-02: Terminal A1	H01-05: Terminal S5
A02-20	E01-03: V/f Pattern	H03-03: Terminal A1 Gain	H01-06: Terminal S6
A02-21	E02-01: Motor FLA	-	H01-07: Terminal S7
A02-22	H01-05: Terminal S5	-	H01-08: Terminal S8
A02-23	H01-06: Terminal S6	-	H02-03: Terminal M5-M6
A02-24	H01-07: Terminal S7	-	H03-02: Terminal A1
A02-25	H01-08: Terminal S8	-	H03-03: Terminal A1 Gain
A02-26	H02-03: Terminal M5-M6	-	-
A02-27	H03-02: Terminal A1	-	-
A02-28	H03-03: Terminal A1 Gain	-	-
A02-29	-	-	-
A02-30	-	-	-
A02-31	-	-	-
A02-32	-	-	-

Table 4-15: User Parameters

A01-03	4	7
Parameter	**Braketronic**	**Static Stepless Simulation**
A02-01	b01-01: Speed 1	b01-02: Speed 2
A02-02	b01-15: Speed 15	b01-03: Speed 3
A02-03	b03-10: Run @ Power Up	b01-04: Speed 4
A02-04	b05-01: Acceleration Time 1	b01-05: Speed 5
A02-05	b05-02: Deceleration Time 1	b03-04: Phase Order
A02-06	b05-05: Switch Freq Accel	b05-01: Acceleration Time 1
A02-07	b05-06: Switch Freq Decel	b05-02: Deceleration Time 1
A02-08	b05-10: Switchover Freq	C02-01: Micro-Speed Gain 1
A02-09	b08-03: Dwell Ref @ Stop	F01-01: Encoder 1 PPR
A02-10	b08-04: Dwell @ Stop	F01-01: Encoder 1 Teeth
A02-11	H01-04: Terminal S4	H01-06: Terminal S6
A02-12	H01-05: Terminal S5	H01-07: Terminal S7
A02-13	H01-06: Terminal S6	H01-08: Terminal S8
A02-14	H03-03: Terminal A1 Gain	H02-03: Terminal M5-M6
A02-15	H03-04: Terminal A1 Bias	H04-02: Terminal FM Gain
A02-16	H03-10: Terminal A2	-
A02-17	H03-12: Terminal A2 Bias	-
A02-18	L02-01: Power Ride Thru	-
A02-19	L02-02: Power Loss Time	-
A02-20	L02-05: UV Level	-
A02-21	-	-
A02-22	-	-
A02-23	-	-
A02-24	-	-
A02-25	-	-
A02-26	-	-
A02-27	-	-
A02-28	-	-
A02-29	-	-
A02-30	-	-
A02-31	-	-
A02-32	-	-

4.4 Auto-Tuning

CAUTION

The brake output is not energized during Auto-Tune. The brake must be manually released before a rotational Auto-Tune and reengaged when complete. Ensure no load is on the hook, and it is near the floor.

The IMPULSE•G+/VG+ Series 5 can perform a calibration process with its automatic tuning function. The VFD prompts for motor information, and then runs a quick tuning process. Ideally, perform a rotational Auto-Tune with the motor uncoupled from the load. When the motor cannot be decoupled, perform a stationary Auto-Tune.

NOTE: *Contact Magnetek's service department if an Auto-Tune cannot be performed.*

Table 4-16: Auto-Tuning Parameter Settings

Display	Description	Default
Auto-Tuning Mode	Auto-Tuning Method	-
Rotational Auto-Tuning	*Rotational Auto-Tune*	
Stationary Auto-Tuning 1	*Non-Rotational Auto-Tune 1*	
Stationary Line-Line Resistance	*Non-Rotational Auto-Tune for Terminal Resistance*	
Motor Rated Power	Rated power shown on the motor nameplate (note: HP = kW/0.746)	Model dependent
Motor Rated Voltage	Rated voltage shown on the motor nameplate	Model dependent
Motor Rated Current	Rated full-load current (FLA) shown on the motor nameplate	Model dependent
Motor Base Frequency	Rated frequency shown on the motor nameplate	60.0 Hz
Number of Motor Poles	Number of motor poles shown on the motor nameplate	4
Motor Base Speed	Rated base speed, shown on the motor nameplate. This is the rotor speed, not the synchronous speed.	1750 RPM
Encoder Pulse Count (PPR)	Number of pulses per revolution for the encoder (VG+ only)	1024 PPR
Motor No-Load Current*	No-load current shown on the motor test report or motor nameplate.	-
Motor Rated Slip Frequency*	Rated slip shown on the motor test report or motor nameplate.	-
Motor Iron Loss	Iron loss to calculate the energy-saving coefficient.	-

** If the value is not known, leave at default.*

4.4.1 Rotational Auto-Tune

This is a rotational Auto-Tuning method for Open Loop Vector and Closed Loop Vector only, which allows for Auto-Tuning a motor that is unloaded and ideally decoupled from the gearbox. The brake must also be disengaged.

The instructions below will provide a step-by-step procedure to complete this Auto-Tune function:

1. In preparation for the Auto-Tune, the crane should be with minimal attachments. This Auto-Tuning method requires free rotation of the motor, so decoupling the motor from the load or gearbox is ideal.
2. Ensure the brake is disengaged.
3. Using the keypad, browse to the “Auto-Tuning” menu.
4. Choose “Rotational Auto Tuning” for the Tuning Mode.
5. Enter the nameplate motor characteristics until the “Tuning Start” screen is reached.
6. Press the green “RUN” key to start the Auto-Tune. It will take up to a few minutes to complete. During this time, the current will ramp up and down and a high pitched frequency may be audible coming from the motor; this is normal. The motor will then begin a rotational cycle, which will complete in one minute or less.
7. When the Auto-Tune has completed, the keypad display will display an “Auto-Tuning Successful” message. Press the F2 (Home) key to exit.

NOTE: *If the STOP key is depressed during tuning, auto-tuning is interrupted and the motor coasts to a stop. The data changed during tuning returns to its original values.*

4.4.2 Stationary Auto-Tune 1

This is a non-rotational Auto-Tuning method for Open Loop Vector and Closed Loop Vector only, which allows for Auto-Tuning without decoupling the motor.

This method will require a short movement of the crane subsequent to the non-rotational Auto-Tune process which allows the VFD to calibrate the Motor Rated Slip and No-Load Current.

The instructions below will provide a step-by-step procedure to complete this Auto-Tune function:

1. In preparation for the Auto-Tune, the crane should be unloaded with minimal hook attachments. For Traverse motion, ensure freedom of travel for Step #6.
2. Using the keypad, browse to the “Auto-Tuning” menu.
3. Choose “Stationary Auto-Tuning 1” for the Tuning Mode.
4. Enter the nameplate motor characteristics until the “Tuning Start” screen is reached. The last question will ask whether to calibrate the motor slip. It is recommended to select “Yes,” which will require a short run (Step #6).

   NOTE: *When prompted to enter the Motor Rated Slip, leave it at zero to enable the post Auto-Tune calibration of Slip and No-Load Current. Manually entering a Slip value will skip the calibration (steps 6 and 7).*

5. Press the green “RUN” key to start the Auto-Tune. It will take up to a few minutes to complete. During this time, the current will ramp up and down and a high pitched frequency may be audible coming from the motor; this is normal. When the Auto-Tune has completed, the keypad display will display an “Auto-Tuning Successful” message. Press the F2 (Home) key to exit.
6. Run the motor to at least 30% of the Rated Frequency. For example, if the Rated Frequency is 60 Hz, the motor must run to at least 18 Hz. In a hoisting motion, the motor must be run in the Up/Raising direction.
7. When the short run and adjustments have been completed, the motor will stop, and the keypad will display “Auto-Tune Complete”. The Auto-Tune is now complete and the VFD is ready for normal operation.

4.4.3 Stationary Line-to-Line Resistance Auto-Tune

This is a non-rotational Auto-Tuning method, which allows for Auto-Tuning without decoupling the motor.

This method is recommended for motors configured with the V/f control method when the Motor Rated Power and Current are known.

The instructions below will provide a step-by-step procedure to complete this Auto-Tune function:

1. In preparation for the Auto-Tune, the crane should be unloaded with minimal hook attachments.
2. Using the keypad, browse to the “Auto-Tuning” menu.
3. Choose “Stationary Line-Line Resistance” for the Tuning Mode.
4. Enter the nameplate motor characteristics for Motor Rated Power and Motor Rated Current until the “Tuning Start” screen is reached.
5. Press the green “RUN” key to start the Auto-Tune. It will take up to a few minutes to complete. During this time, the current will ramp up and down and a high pitched frequency may be audible coming from the motor; this is normal. When the Auto-Tune has completed, the keypad display will display an “Auto-Tuning Successful” message. Press the F2 (Home) key to exit.

5 Programming Advanced Features

5.1 Application Parameters (b)

The application parameters control the speed references, acceleration and deceleration characteristics, and reference sources. Application parameters included in this section are listed below:

- b01 Frequency References
- b02 Reference Limits
- b03 Operation Mode
- b05 Acceleration/Deceleration Times
- b08 Jump Frequencies
- b09 Field Forcing

5.1.1 Frequency References (b01)

Table 5-1: Frequency References Parameter Settings

Parameter	Display	Function	Range	Default
b01-01	Reference 1	Speed 1 frequency	0.00–E01-04 Hz	15.00*
b01-02	Reference 2	Speed 2 frequency	0.00–E01-04 Hz	30.00*
b01-03	Reference 3	Speed 3 frequency	0.00–E01-04 Hz	60.00*
b01-04	Reference 4	Speed 4 frequency	0.00–E01-04 Hz	0.00*
b01-05	Reference 5	Speed 5 frequency	0.00–E01-04 Hz	0.00*
b01-06	Reference 6	Speed 6 frequency	0.00–E01-04 Hz	0.00
b01-07	Reference 7	Speed 7 frequency	0.00–E01-04 Hz	0.00
b01-08	Reference 8	Speed 8 frequency	0.00–E01-04 Hz	0.00
b01-09	Reference 9	Speed 9 frequency	0.00–E01-04 Hz	0.00
b01-10	Reference 10	Speed 10 frequency	0.00–E01-04 Hz	0.00
b01-11	Reference 11	Speed 11 frequency	0.00–E01-04 Hz	0.00
b01-12	Reference 12	Speed 12 frequency	0.00–E01-04 Hz	0.00
b01-13	Reference 13	Speed 13 frequency	0.00–E01-04 Hz	0.00
b01-14	Reference 14	Speed 14 frequency	0.00–E01-04 Hz	0.00
b01-15	Reference 15	Speed 15 frequency	0.00–E01-04 Hz	0.00
b01-16	Reference 16	Speed 16 frequency	0.00–E01-04 Hz	0.00
b01-17	Jog Reference	Speed reference when Jog (MFDI = 15 or 16) or Inching (MFDI = 17 or 18) is enabled.	0.00–E01-04 Hz	6.00*
b01-20	Inf-Var Start Speed	Infinitely Variable starting speed	0.00–E01-04 Hz	6.00
b01-21	Inf-Var Max Reference 1	Infinitely Variable max speed reference 1	0.00–E01-04 Hz	60.00
b01-22	Inf-Var Max Reference 2	Infinitely Variable max speed reference 2. Enabled with the Multi-Step Speed Reference 2 MFDI.	0.00–E01-04 Hz	60.00

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

Table 5-2: Multi-Step Speed Processing by Multi-Function Digital Input (b01-01–b01-16)

Speed Reference	Forward/ Reverse Terminal S1 or S2	Multi-Step Speed 2 H01-XX = 0	Multi-Step Speed 3 H01-XX = 1	Multi-Step Speed 4 H01-XX = 2	Multi-Step Speed 5 H01-XX = 3	Jog/Inch H01-XX = 15, 16, 17, 18
STOP	Off	-	-	-	-	Off
b01-01 Reference 1	On	Off	Off	Off	Off	Off
b01-02 Reference 2	On	On	Off	Off	Off	Off
b01-03 Reference 3	On	On	On	Off	Off	Off
b01-04 Reference 4	On	On	On	On	Off	Off
b01-05 Reference 5	On	On	On	On	On	Off
b01-06 Reference 6	On	Off	On	Off	Off	Off
b01-07 Reference 7	On	Off	On	On	Off	Off
b01-08 Reference 8	On	Off	Off	On	Off	Off
b01-09 Reference 9	On	Off	On	On	On	Off
b01-10 Reference 10	On	Off	Off	On	On	Off
b01-11 Reference 11	On	Off	Off	Off	On	Off
b01-12 Reference 12	On	On	Off	Off	On	Off
b01-13 Reference 13	On	On	On	Off	On	Off
b01-14 Reference 14	On	Off	On	Off	On	Off
b01-15 Reference 15	On	On	Off	On	Off	Off
b01-16 Reference 16	On	On	Off	On	On	Off

5.1.2 Reference Limits (b02)

These parameters limit the frequency range as a percentage of maximum output frequency (E01-04). If the lower limit is below the DC injection start frequency (d01-01), then operation will continue at the current frequency reference.

An alternate upper limit frequency can be used during operation with a Multi-Function Digital Input (MFDI) set to 59 (Alternate Frequency Reference Upper Limit).

Table 5-3: Reference Limits Parameter Settings

Parameter	Display	Function	Range	Default
b02-01	Frequency Reference Upper Limit	Percentage of the maximum output frequency (as a percentage of E01-04), which determines the maximum frequency at which the VFD is able to run.	0.0–110.0%	100.0*
b02-02	Frequency Reference Lower Limit	Frequency reference lower limit as a percentage of maximum output frequency (E01-04).	0.0–110.0%	G+: 2.0 VG+: 0.0
b02-04	Alternate Frequency Upper Limit	Alternate maximum output frequency (as a percentage of E01-04), which is enabled by H01-xx or F03-xx = 59. It will decelerate using the b05-02 rate.	0.0–110.0%	0.0

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

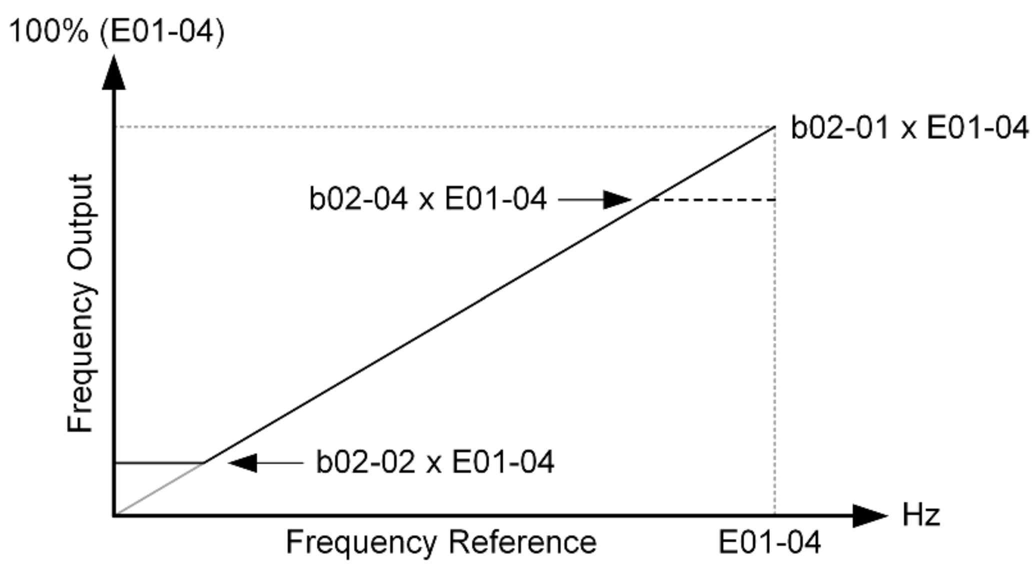


Figure 5-1: Frequency Upper and Lower Limits

5.1.3 Operation Mode (b03)

Determines the source from where the frequency reference and RUN command are generated.

Table 5-4: Run/Reference Source Parameter Settings

Parameter	Display	Function	Range	Default
b03-01	Frequency Reference Selection 1	Frequency Reference source.	0–5	0*
	0 Multi-Step Terminals	Multi-Step Terminals • Terminal Board / Interface Card • S4IO / DI-A3 Option Card		
	1 Analog Input	Analog Input (A1, A2, A3)		
	2 Serial Communication	RS-485 Serial Communications (D+, D-)		
	3 Option PCB - (Port CN5-A)	Communication Option Card (Port CN5-A) • EtherNet/IP, Modbus TCP/IP • PROFINET, PROFIBUS-DP		
	4 Pulse Input - (H06-01)	Pulse input via Terminal RP (H06-01)		
	5 Inf-Var Control	Infinitely Variable control		
b03-02	Run Command Selection 1	Run Command source.	0–3	1*
	0 Operator - Keypad	Keypad (Expert)		
	1 Terminals	Terminal Board / Interface Card		
	2 Serial Communication	RS-485 Serial Communications (D+, D-)		
	3 Option PCB - (Port CN5-A)	Communication Option Card (Port CN5-A) • EtherNet/IP, Modbus TCP/IP • PROFINET, PROFIBUS-DP		

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.1.4 Stopping Method (b03)

Selects the stopping method suitable for the application.

Table 5-5: Stopping Method Parameter Settings

Parameter	Display	Function	Range	Default
b03-03	Stopping Method Selection *0 Decel to Stop* *1 Coast to Stop* *4 Decel with Timer* *6 No Load Brake*	Determines the stopping method. (***Figure 5-2***) (***Figure 5-3***) (***Figure 5-4***) Traverse only See C08 parameter group (VG+ only).	0, 1, 4, 6	G+: 0* VG+: 6*

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.1.4.1 Decel to Stop (b03-03 = 0)

Upon removal of the FWD or REV run command, the motor decelerates at a rate determined by the time set in deceleration time 1 (b05-02) and DC injection braking is applied after the DC injection start frequency (d01-01) has been reached. If the deceleration time is set too short or the load inertia is too large, an overvoltage fault (oV) or deviation (dEv) may occur during deceleration. In this case, increase the deceleration time or verify the braking resistor is sized correctly.

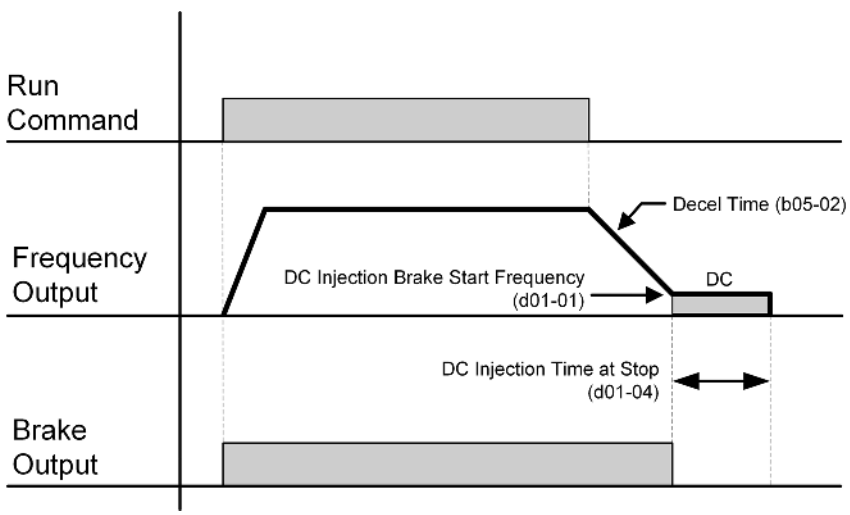


Figure 5-2: Decel to Stop

5.1.4.2 Coast to Stop (b03-03 = 1)

Upon removal of the FWD or REV run command, the motor starts to coast and the electric brake sets.

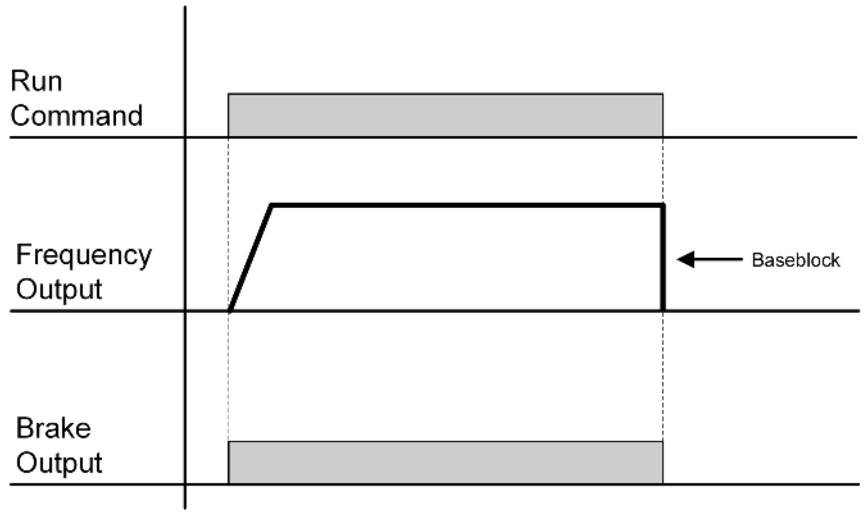


Figure 5-3: Coast to Stop

5.1.4.3 Decel with Timer (b03-03 = 4)

NOTE: *This option is only available in traverse motion.*

Upon run command removal, the motor decelerates to stop. The brake delays for a time interval (C12-02) before it is set. This option reduces brake wear for applications that involve frequent stopping and starting.

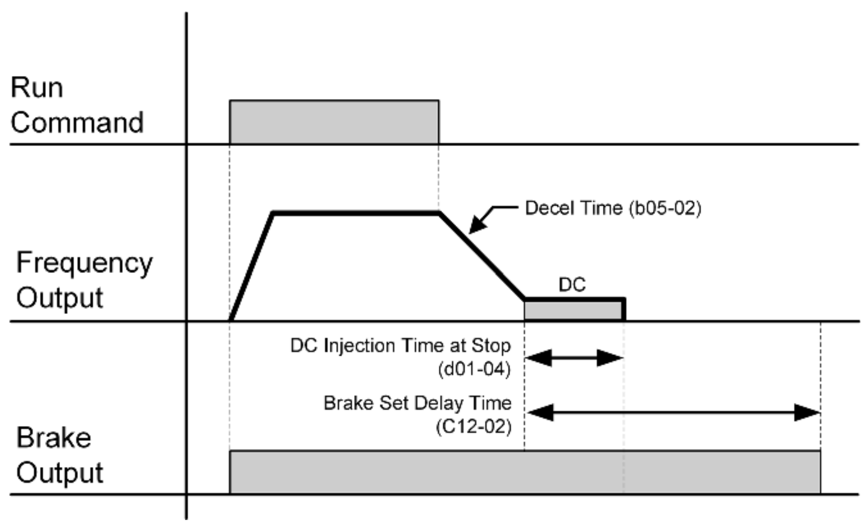


Figure 5-4: Decel w/Timer

5.1.5 Motor Rotation Change (b03)

This parameter allows you to change the motor direction without changing the motor leads.

Table 5-6: Motor Rotation Change Parameter Settings

Parameter	Display	Function	Range	Default
b03-04	Phase Order Selection *0 Standard* *1 Switch Phase Order*	Motor phase order Reverses the motor direction	0, 1	0

NOTE: *To reverse the direction of rotation, set b03-04 = 1, or swap any two motor leads (changing R/L1, S/L2, or T/L3 will not affect motor rotation direction) as well as encoder phasing (F01-02 = 1 or swap A+ and A- wires).*

5.1.6 Input Scan Time (b03)

Selects the microprocessor scan time for reading the status of the input control terminals. Set b03-06 = 0 when a quicker response is needed from the control circuit terminal.

Table 5-7: Input Scan Time Parameter Settings

Parameter	Display	Function	Range	Default
b03-06	Digital Input Reading *0 Single Scan* *1 Double Scan*	Selects the terminal scan time 0.5 ms 2 ms (better for noise immunity)	0, 1	1

5.1.7 Run Select (b03)

Determines additional RUN command options and the secondary source from where the frequency reference and RUN command are generated.

Table 5-8: Run Select Parameter Settings

Parameter	Display	Function	Range	Default
b03-08	Run Command Select in PRG Mode	Determines whether the VFD is allowed to run while inside the Programming menu.	0–2	0
	0 Disregard RUN while Programming	Run command not accepted while in Programming menu.		
	1 Accept RUN while Programming	Run command is accepted while in Programming menu.		
	2 Allow Programming Only at Stop	Prohibit entering Programming menu while running.		
b03-10	Run Command at Power Up	Determines how the VFD reacts if a run command is active when the VFD powers up. (Traverse only)	0, 1	0
	0 Disregard Existing RUN Command	A new Run command must be issued after power up.		
	1 Accept Existing RUN Command	Motor will start immediately after power up if a Run command is already enabled.		
b03-15	Frequency Reference Selection 2	Secondary Frequency Reference source, enabled by H01-0x = 1F.	0–5	0
	0 Multi-Step Terminals	Terminals • Terminal Board / Interface Card • S4IO / DI-A3 Option Card		
	1 Analog Input	Analog Input (A1, A2, A3)		
	2 Serial Communication	RS-485 Serial Communications (D+, D-)		
	3 Option PCB - (Port CN5-A)	Communication Option Card (Port CN5-A) • EtherNet/IP, Modbus TCP/IP • PROFINET, PROFIBUS-DP		
	4 Pulse Input (H06-01)	Pulse input via Terminal RP (H06-01)		
	5 Inf-Var Control	Infinitely Variable control		
b03-16	Run Command Selection 2	Secondary Run Command source, enabled by H01-0x = 1F.	0–3	1
	0 Operator - Keypad	Keypad (Expert)		
	1 Terminals	Terminal Board / Interface Card		
	2 Serial Communication	RS-485 Serial Communications (D+, D-)		
	3 Option PCB - (Port CN5-A)	Communication Option Card (Port CN5-A) • EtherNet/IP, Modbus TCP/IP • PROFINET, PROFIBUS-DP		
b03-35	Digital Input Deadband Time	Deadband time for the digital inputs to help prevent relay chattering malfunctions.	0.0–100.0 ms	0.0

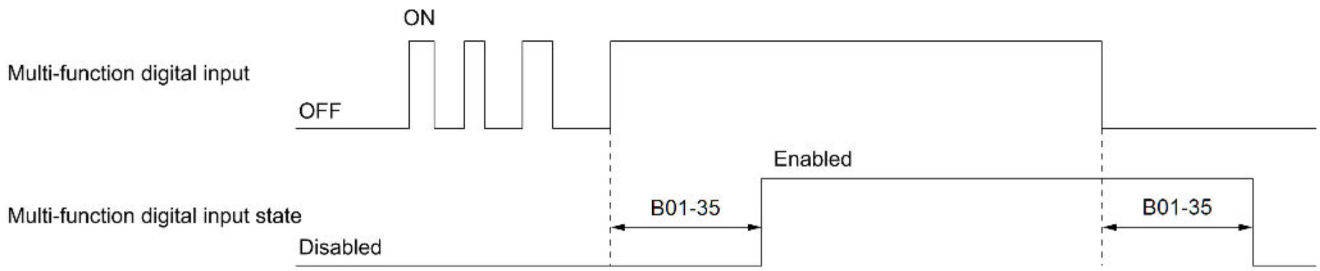


Figure 5-5: Digital Input Deadband Time (b03-35)

5.1.8 Acceleration/Deceleration Time (b05)

Acceleration time sets the time necessary for the output frequency to accelerate from 0 Hz to maximum output frequency (E01-04). Deceleration time sets the time necessary for the output frequency to decelerate from the maximum output frequency (E01-04) to 0 Hz.

NOTE: *The VFD will follow the lowest active deceleration time. For example, if Decel Time 1 (b05-02) is set to 2.0 seconds and UL2 Decel Time (C03-03) is set to 5.0 seconds, the VFD will use the 2.0 second decel time when a UL2 occurs.*

Table 5-9: Acceleration/Deceleration Time Parameter Settings

Parameter	Display	Function	Range	Default
b05-01	Acceleration Time 1	Acceleration time for normal operation.	0.00–60.00 sec	5.00*
b05-02	Deceleration Time 1	Deceleration time for normal operation.	0.00–60.00 sec	3.00*
b05-03	Acceleration Time 2	Acceleration time 2 enabled when H01-xx = 1A.	0.00–60.00 sec	10.00
b05-04	Deceleration Time 2	Deceleration time 2 enabled when H01-xx = 1A.	0.00–60.00 sec	10.00

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

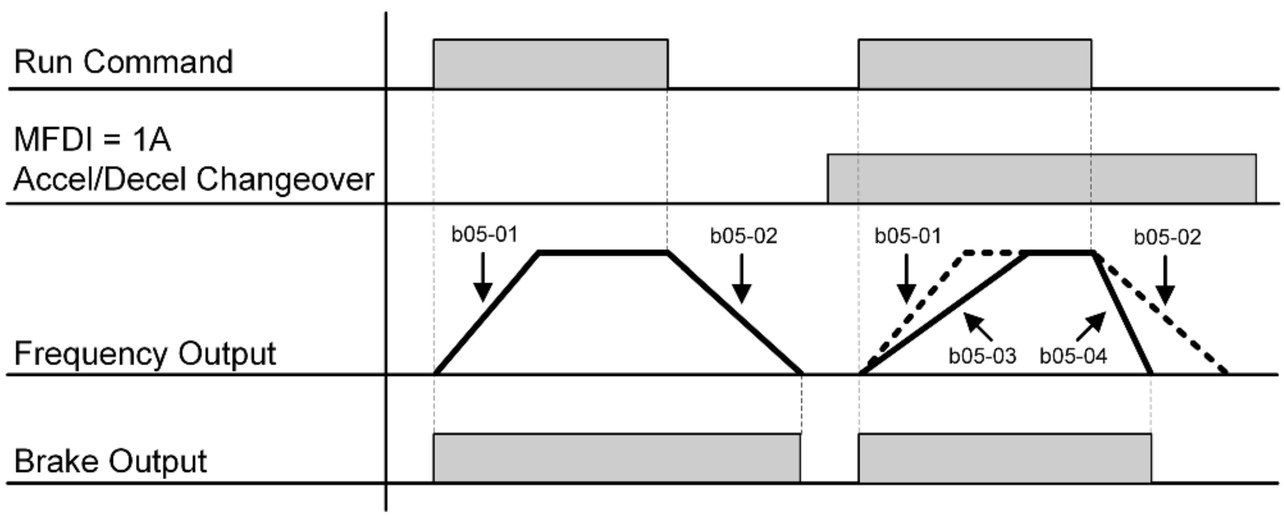


Figure 5-6: Acceleration and Deceleration Time and Changeover

NOTE: *Assume b03-03 = 0 (Decel to Stop).*

5.1.9 Accel/Decel Time Switching Frequency (b05)

Accel/Decel times can be changed automatically without using digital inputs. Alternatively, digital inputs can be used to enable additional accel and decel times. This has priority over automatic change of Accel/Decel.

Table 5-10: Accel/Decel Time Switching Frequency Parameter Settings

Parameter	Display	Function	Range	Default
b05-05	Switch Frequency Accel Time	Acceleration time at Switch Frequency (b05-10)	0.00–60.00 sec	2.00
b05-06	Switch Frequency Decel Time	Deceleration time at Switch Frequency (b05-10)	0.00–60.00 sec	2.00
b05-08	Fast Stop Time	Deceleration time for Fast Stop at external fault. ***See Section 5.6.1.1 on page 251.***	0.00–60.00 sec	0.50
b05-09	Accel/Decel Time Setting Units	Enables extended range of Acc/Dec Params: b05-01–b05-08, b05-12–b05-15	0, 1	0
	0 0.01s (0.00 to 60.00s)	Range = 0.00–60.00 seconds		
	1 0.1s (0.0 to 600.0s)	Range = 0.0–600.0 seconds		
b05-10	Accel/Decel Time Switchover Freq	Frequency to switch between acceleration/ deceleration time settings	0.0–300.0 Hz	0.0
b05-11	Switch Frequency Compare	Determines when Acceleration and Deceleration Time at b05-10 is enabled	0, 1	0
	0 Lower SW Freq	b05-05/b05-06 enabled if U01-02 < b05-10		
	1 Upper SW Freq	b05-05/b05-06 enabled if U01-02 > b05-10		
b05-12	Acceleration Time 3	Acceleration time 3 enabled by MFDI = 1B.	0.00–60.00 sec	3.00
b05-13	Deceleration Time 3	Deceleration time 3 enabled by MFDI = 1B.	0.00–60.00 sec	3.00
b05-14	Acceleration Time 4	Acceleration time 4 enabled by MFDI = 1C.	0.00–60.00 sec	3.00
b05-15	Deceleration Time 4	Deceleration time 4 enabled by MFDI = 1C.	0.00–60.00 sec	3.00
b05-16	Accel/Decel Rate Frequency	Starting frequency used to calculate acceleration and deceleration rates.	0.0–300.0 Hz	60.0

5.1.10 Jump Frequencies (b08)

Jump Frequencies sets a dead band to a specified frequency range. A motor or machine may resonate if a specific frequency is held, due to the natural frequency of the mechanical system. A frequency band jump will prevent certain frequencies from being held.

When a frequency reference is within the Jump frequency width, the frequency reference will change automatically.

The VFD will accelerate or decelerate the motor smoothly through the Jump frequency band until the frequency reference is not within it.

A setting of 0.0 disables the associated jump frequency.

Table 5-11: Jump Frequencies Parameter Settings

Parameter	Display	Function	Range	Default
b08-01	Jump Frequency 1	First of three jump frequencies	0.0–300.0 Hz	0.0
b08-02	Jump Frequency 2	Second of three jump frequencies	0.0–300.0 Hz	0.0
b08-03	Jump Frequency 3	Third of three jump frequencies	0.0–300.0 Hz	0.0
b08-04	Jump Frequency Width	Jump frequency reference bandwidth	0.0–20.0 Hz	1.0

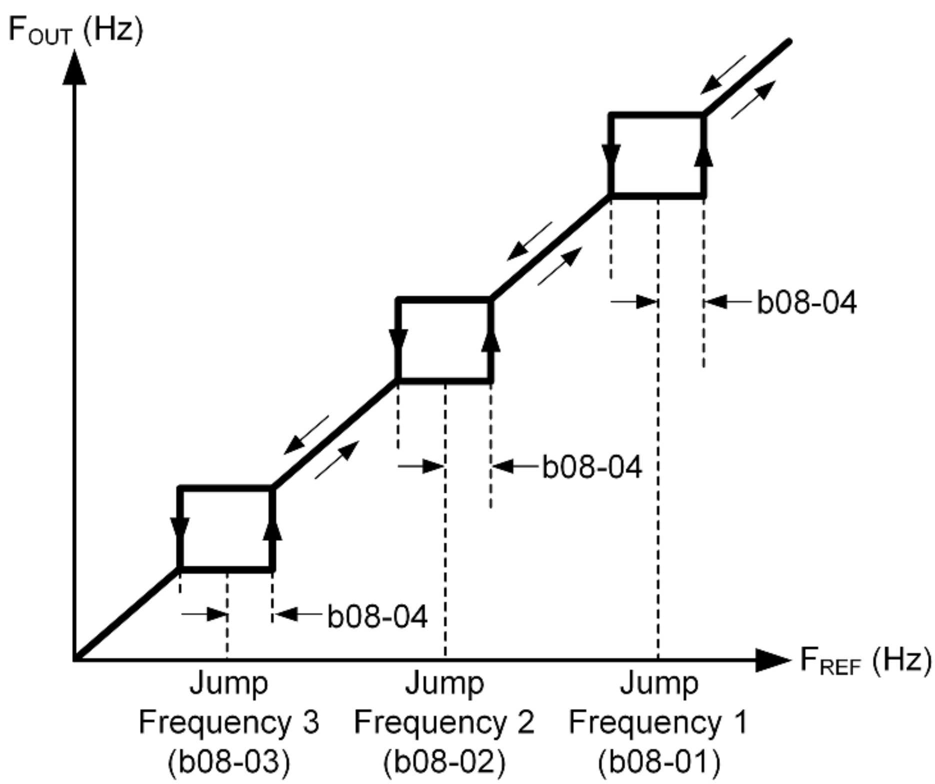


Figure 5-7: Jump Frequencies

5.1.11 Offset Frequencies (b08)

Offset Frequencies consists of three digital inputs to add or subtract an offset to/from the frequency reference and correct the speed. Each offset input is applied as a percentage of the Maximum Output Frequency (E01-04). When more than one offset is enabled at the same time, the offsets are added together.

Table 5-12: Offset Frequencies Parameter Settings

Parameter	Display	Function	Range	Default
b08-05	Offset Frequency 1	Enabled by MFDI H01-xx or F03-xx = 6C	-100.0–100.0%	0.0
b08-06	Offset Frequency 2	Enabled by MFDI H01-xx or F03-xx = 6D	-100.0–100.0%	0.0
b08-07	Offset Frequency 3	Enabled by MFDI H01-xx or F03-xx = 6E	-100.0–100.0%	0.0

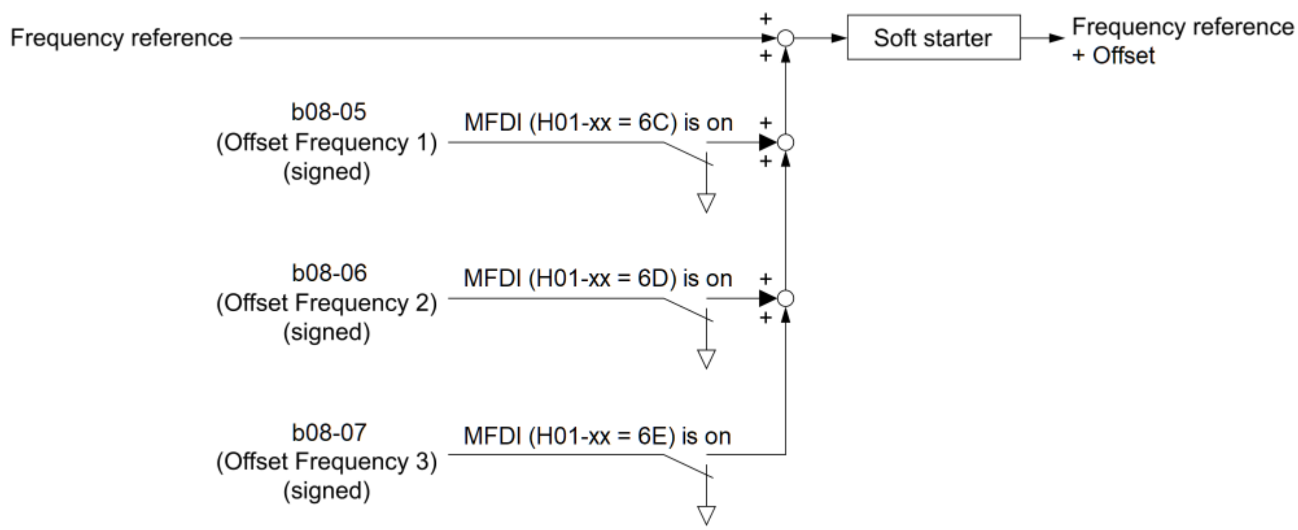


Figure 5-8: Offset Frequency Operation

5.1.12 Field Forcing (b09)

Field Forcing compensates the delaying influence of the motor time constant when changing the excitation current reference and improves motor responsiveness. It can also help develop motor excitation current. Field Forcing has no effect during DC Injection Braking.

Table 5-13: Field Forcing Parameter Settings

Parameter	Display	Function	Range	Default
b09-03	Field Forcing Selection *0 Disabled* *1 Enabled*	Enables or disables the Field Forcing Function	0, 1	0
b09-06	Field Forcing Limit	Maximum level at which the Field Forcing function can boost the excitation current reference. The value is set as a percentage of the motor no load current.	100–400%	200

5.2 Crane & Hoist Functions (C)

Table 5-14: Crane & Hoist Function Availability

Access Level (A01-01)	Advanced (2) or Expert (3)					
Motion (A01-03)	Traverse (0)			Standard Hoist (1)		NLB Hoist (2)
Function/Control Method (A01-02)	V/f (0)	OLV (2)	CLV (3)	V/f (0)	OLV (2)	CLV (3)
C01: Quick Stop	○	○	○	○	○	○
C01: Reverse Plug Simulation	○	○	○	×	×	○
C02: Micro-Speed	○	○	○	○	○	○
C03: End of Travel Limits	○	○	○	○	○	○
C03: Phantom Stop	○	○	○	○	○	○
C03: Hook Height Measurement	×	×	×	×	×	○
C03: EPLS	×	×	×	×	×	○
C04: Load Float Alternate	×	×	○	×	×	○
C04: Load Share (Torque Following)	×	×	○	×	×	○
C05: Load Check	×	×	×	×	○	○
C06: Ultra-Lift	×	×	×	○	○	○
C07: Torque Limit	×	○	○	×	○	○
C07: Anti-Shock	×	×	×	×	×	○
C08: Dual Brake	×	×	×	×	×	○
C08: No Load Brake (NLB) Hoist	×	×	×	×	×	○
C08: Brake Answerback	○	○	○	○	○	○
C08: Emergency Lift	×	×	×	×	×	○
C09: Synchronization	×	×	○	×	×	○
C10: Weight Measurement	×	×	×	○	○	○
C10: Load Summing	×	×	×	○	○	○
C11: Slack Cable Detection	×	×	×	×	×	○
C11: Snap Shaft Detection	×	×	○	×	×	○
C12: Brake Delay Timers	○	○	○	×	×	×
C12: On/Off Delay Timers	○	○	○	○	○	○
C12: Maintenance Timers and Counters	○	○	○	○	○	○
C13: Inch Control	○	○	○	○	○	○
C13: Index Control	×	×	○	×	×	○
C14: Sway Control	○	○	○	×	×	×
C15: Static Stepless Simulation	×	×	○	×	×	×

○*: Available*

×*: Not available*

5.2.1 Quick Stop (C01)

Quick Stop provides an automatic alternate deceleration time when the run command has been removed.

NOTE: *The Quick Stop Deceleration time differs from the normal deceleration time and is applied only when the RUN command is removed.*

Table 5-15: Quick Stop Parameter Settings

Parameter	Display	Function	Range	Default
C01-01	Quick Stop *0 Disabled* *1 Enabled*	Determines whether Quick Stop is enabled	0, 1	0*
C01-02	Quick Stop Time	Deceleration time during Quick Stop	0.0–25.5 sec	1.0

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

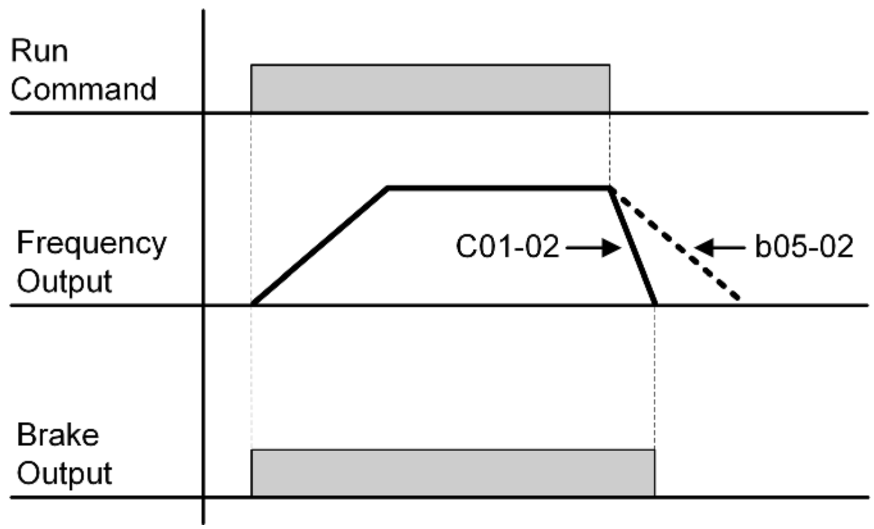


Figure 5-9: Quick Stop

5.2.2 Reverse Plug Simulation (C01)

Reverse Plug Simulation provides an automatic alternate deceleration time/acceleration time at a change direction command. The deceleration time and the acceleration time are set independently of the normal acceleration and deceleration times.

NOTE: *Reverse Plug Simulation is not available in Standard Hoist mode (A01-03 = 1).*

Table 5-16: Reverse Plug Simulation Parameter Settings

Parameter	Display	Function	Range	Default
C01-03	Reverse Plug *0 Disabled* *1 Enabled*	Determines whether Reverse Plug Simulation is enabled.	0, 1	0*
C01-04	Reverse Plug Deceleration Time	Deceleration time during Reverse Plug Simulation.	0.0–25.5 sec	2.0
C01-05	Reverse Plug Acceleration Time	Acceleration time during Reverse Plug Simulation. If set to 0.0, b05-01 is used. ***NOTE:*** Not available in NLB Hoist mode.	0.0–25.5 sec	0.0

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

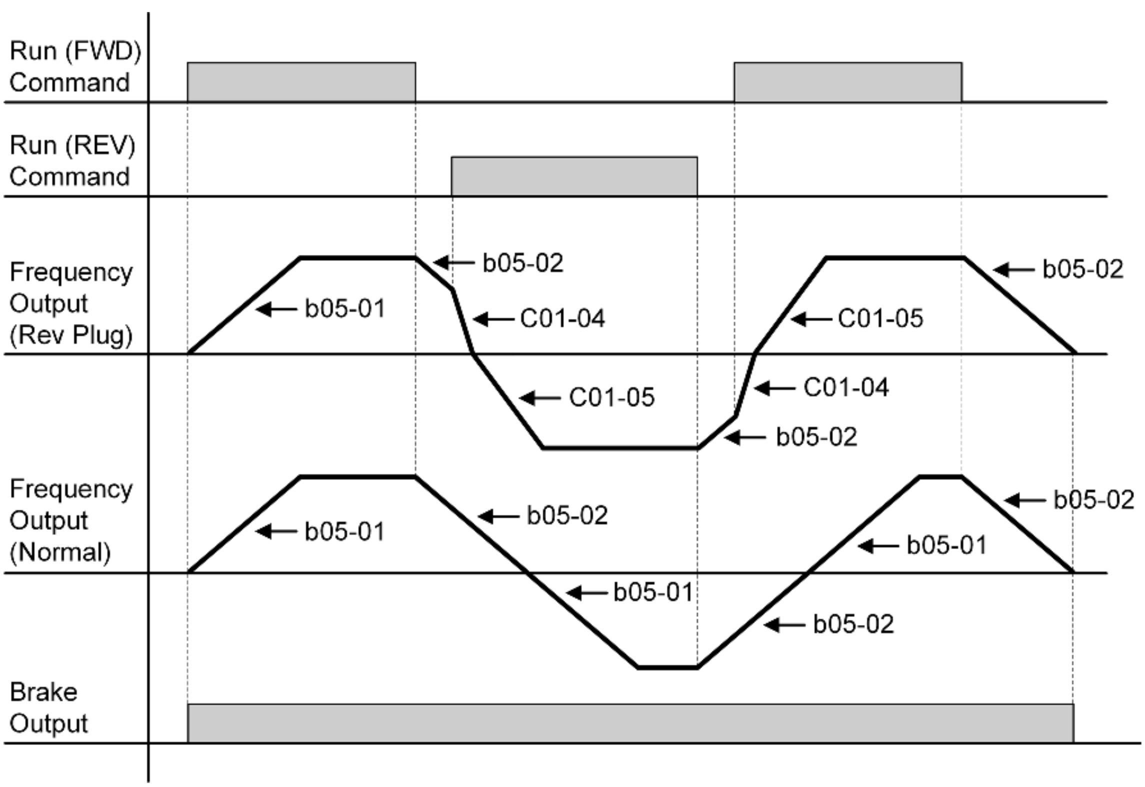


Figure 5-10: Reverse Plug Simulation

5.2.3 Micro-Speed (C02)

Micro-Speed provides a reduced speed range operation for precise positioning. Enabled by a Multi-Function Input, it multiplies the normal speed reference by the Micro-Speed Gain. Two Micro-Speed Gains are available and can be adjusted and enabled independently. Deceleration is by the b05-02 rate.

Table 5-17: Micro-Speed Parameter Settings

Parameter	Display	Function	Range	Default
C02-01	Micro-Speed Gain 1	The multiplier of the Analog or Digital Speed Reference to achieve slow-speed operation. Enabled by MFDI = E.	Hoist: 0.001–1.000 Traverse: 0.001–2.000	1.000
C02-02	Micro-Speed Gain 2	An alternate multiplier of the Analog or Digital Speed Reference to achieve slow-speed operation. Enabled by MFDI = 10.	Hoist: 0.001–1.000 Traverse: 0.001–2.000	1.000

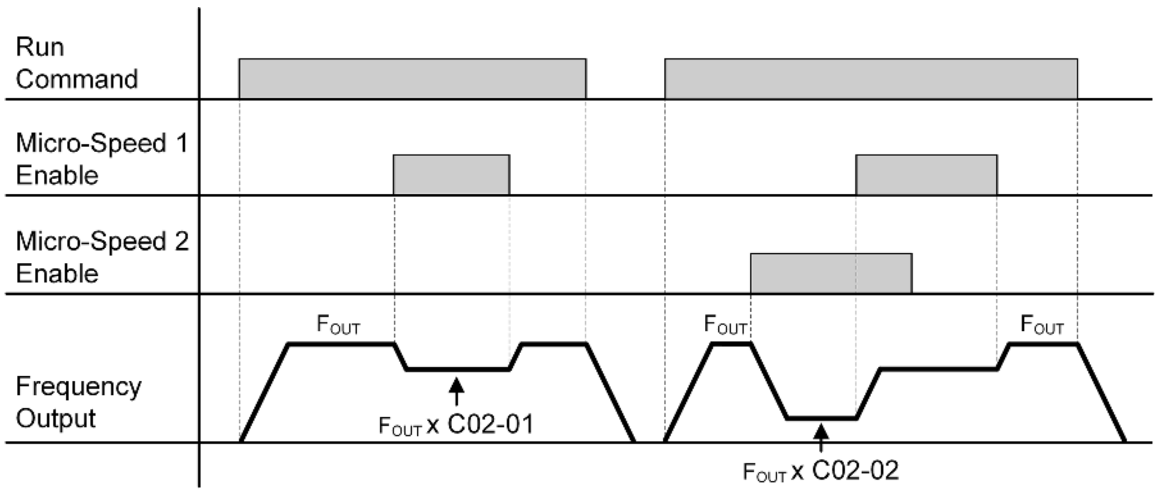


Figure 5-11: Micro-Speed Control

NOTE: *If both Micro-Speed 1 and Micro-Speed 2 are enabled, Micro-Speed 1 always takes higher priority.*

5.2.4 End of Travel Limits (C03)

End of Travel Limits can automatically slow and stop motion when a specified location is reached. Four types of limit inputs UL0/LL0: Warning, UL1/LL1: Slowdown, UL2/LL2: Stop, and UL3/LL3: Fault, limits are available in both travel directions. Travel limit inputs can be programmed to the H01 and F03 digital input parameters. The Warning (UL0/LL0) and Slowdown (UL1/LL1) limits can be configured as “Alarm Only” by setting their respective speed parameter to the max setting.

Table 5-18: End of Travel Limits Parameter Settings

Parameter	Display	Function	Range	Default
C03-01	UL1 Speed	Speed when UL1 is detected	0.00–E01-04 Hz	6.00
C03-02	UL0/UL1 Deceleration Time	Decel time when UL1 is detected	0.0–25.5 sec	1.0
C03-03	UL2 Deceleration Time	Decel time to STOP when UL2 is detected	0.0–25.5 sec	1.0
C03-04	LL1 Speed	Speed when LL1 is detected	0.00–E01-04 Hz	6.00
C03-05	LL0/LL1 Deceleration Time	Decel time when LL1 is detected	0.0–25.5 sec	1.0
C03-06	LL2 Deceleration Time	Decel time to STOP when LL2 is detected	0.0–25.5 sec	1.0
C03-07	UL0 Speed	Speed when UL0 is detected. Deceleration time is by C03-02.	0.00–E01-04 Hz	30.00
C03-08	LL0 Speed	Speed when LL0 is detected. Deceleration time is by C03-05.	0.00–E01-04 Hz	30.00
C03-09	LL2/UL2 Action *0 Decel to Stop* *1 Coast to Stop* *2 Use b03-03 Method*	Stopping method when UL2 or LL2 is detected. The faster stopping method between b03-03 and C03-09 will be used.	NLB: 1, 2 else: 0–2	2*
C03-10	LL3/UL3 Action	Upper Limit 3 (UL3) or Lower Limit 3 (LL3) stopping method for H01-xx = 11, 12, 111, or 112. Alarm only when VFD is not running. Deceleration time is by C03-11.	NLB: 1, 2, 4, 5 else: 0–5	1
	0 Decel to Stop	Decel to Stop with Fault		
	1 Coast to Stop	Coast to Stop with Fault		
	2 Use b03-03 Method	b03-03 to Stop with Fault		
	3 Decel to Stop, Alarm	Decel to Stop with Alarm. If UL3, Forward commands not allowed. If LL3, Reverse commands not allowed.		
	4 Coast to Stop, Alarm	Coast to Stop with Alarm. If UL3, Forward commands not allowed. If LL3, Reverse commands not allowed.		
	5 b03-03 to Stop, Alarm	b03-03 to Stop with Alarm. If UL3, Forward commands not allowed. If LL3, Reverse commands not allowed.		
C03-11	LL3/UL3 Deceleration Time	Decel time when UL3 or LL3 is detected.	0.0–25.5 sec	1.0

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.2.5 Phantom Stop (C03)

Phantom Stop allows quick identification of a faulted VFD while stopping other VFDs with Phantom Stop enabled. This feature is designed to stop the VFD operation using the stopping method selected in C03-12 when a Phantom Stop input (H01-xx = 5F or 15F) is active. The VFD will indicate a Phantom Stop by blinking the keypad RUN key LED, in sequence of two short bursts. A new run command is required to resume operation.

Table 5-19: Phantom Stop Parameter Settings

Parameter	Display	Function	Range	Default
C03-12	Phantom Stop Method	Stopping Method when H01-xx = 5F or 15F	NLB: 1–2 else: 0–2	1
	0 Decel to Stop	Deceleration by Fast Stop (b05-08)		
	1 Coast to Stop			
	2 Use b03-03 Method	Deceleration by b03-03 Setting		

5.2.6 Hook Height Measurement (C03)

Hook Height Measurement is a VG+ hoist feature that provides a monitor parameter (U01-50) and analog output proportional to the hook's position between a home position and a limit position. Hook height measurement can be used in conjunction with the Electronic Programmable Limit Switch function. ***See Figure 5-12 on page 126*** for Hook Height configuration. Setting C03-20 = 10 will home the hook height. This is an easy way to home the hook height via the keypad rather than needing a digital input.

NOTE: *Homing the hook height with a normally closed travel limit (C03-15 = 0, 1, or 4 and MFDI = 106, 107, or 111) requires Baseblock N.C. MFDI = 132. This prevents homing during a power down or power loss.*

Table 5-20: Hook Height Parameter Settings

Parameter	Display	Function	Range	Default
C03-14	Hook Height Revolutions Total	Number of motor revolutions from the top of travel (FWD) to the bottom of travel (REV).	0–65535 Rev	250
C03-15	Hook Height Home Position	Selects the hook height home position and how a homing command is triggered.	0–4	2
	0 Home = UL2	Motor Revolutions = 0 upon UL2.		
	1 Home = LL2	Motor Revolutions = C03-14 upon UL2.		
	2 Home MFDI Upper	Motor Revolutions is set to C03-29 when Hook Height Home is closed (H01-xx or F03-xx = 67).		
	3 Home MFDI Lower	Motor Revolutions is set to C03-14 when Hook Height Home is closed (H01-xx or F03-xx = 67).		
	4 Home = UL3	Motor Revolutions = 0 upon UL3.		
C03-16	Hook Height Analog Output	Hook height analog output signal. This selects whether a 0% or 100% analog output equates to the top or bottom.	0, 1	0
	0 0 Revs = 0% Analog Output	U01-50 = (U01-51 / C03-14) * 100%		
	1 0 Revs = 100% Analog Output	U01-50 = ((C03-14 - U01-51) / C03-14) * 100%		
C03-17	Hook Height Home Input Delay	Time delay, after receiving a hook height home input, before homing takes effect.	0.0–25.5 sec	0.1

NOTE: *Motor revolutions (U01-51) will not go negative. If 0 motor revolutions has been reached and the hoist continues in the Up (FWD) direction, the motor revolutions will remain at 0.*

Table 5-21: Monitor Values at Hook Height Home Position

		C03-16 = 0	C03-16 = 1
C03-15	**U01-51**	**U01-50**	**U01-50**
0	0	0%	100%
1	C03-14	100%	0%
2	0	0%	100%
3	C03-14	100%	0%
4	0	0%	100%

5.2.7 Electronic Programmable Limit Switches (C03)

Electronic Programmable Limit Switches (EPLS) is a closed loop hoist function that creates several upper and lower limit positions without the need for rotary limit switches. Instead, encoder feedback is utilized to track the position of the hoist based on motor revolutions. The limit positions are typically used as warning (UL0/LL0), slowdown (UL1, LL1), stop (UL2, LL2), and fault (UL3, LL3) points for the hoist. The resulting actions and speeds can be individually configured for each type of limit. The limits are organized into two groups, upper and lower. The upper limits will cause the hoist to slowdown or stop when traveling in the up direction, but it will be allowed to hoist down with no restrictions. Inversely, the lower limits will slow down or stop the hoist when traveling in the down direction, but it will be allowed to hoist up with no restrictions. A total of eight electronic limits (UL0, UL1, UL2, UL3, LL0, LL1, LL2, and LL3) can be configured. The top of travel is always considered 0 motor revolutions.

Use the steps below to walk through the setup process. ***See Figure 5-12 on page 126*** for a visual example.

Typical Setup Procedure

1. Move the hoist to the upmost position. This is typically at or just below the upper weighted limit. This point will become the position of zero motor revolutions.

NOTE: *The VFD cannot track a negative hook height position, so the zero point needs to be a location that the hoist will not travel above.*

2. The motor revolution monitor (U01-51) needs to be zeroed out in this position. A simple way to accomplish this is to first set C03-15 = 2 (Home at MFDI Upper) and C03-29 = 0 (Home Position Revolutions). Then set C03-20 = 10 (Trigger Hook Height Home). Alternatively, a digital input (for a button or toggle switch) can be programmed to H01-xx or F03-xx = 67 (Hook Height Home). Turn this input ON and then OFF. Either of these two methods will zero out the monitor. View monitor U01-51 (Motor Revolutions) to ensure it displays 0.
3. Lower the hook to the desired UL2 position. This needs to be low enough that the hoist can decelerate to a stop before reaching the weighted upper limit. Record the motor revolutions (U01-51) on a piece of paper.
4. Lower the hook to the desired UL1 position. This needs to be low enough that the hoist can decelerate from full speed to the UL1 speed before reaching UL2. Record the motor revolutions (U01-51) on a piece of paper.
5. Lower the hook to the desired LL1 position. This needs to be low enough that the hoist can decelerate from full speed to the LL1 speed before reaching LL2. Record the motor revolutions (U01-51) on a piece of paper.
6. Lower the hook to the desired LL2 position. Record the motor revolutions (U01-51) on a piece of paper.
7. Enable EPLS by setting C03-20 = 1.
8. Enter the recorded motor revolutions from Steps 3 to 6 into parameters C03-22, C03-23, C03-26, and C03-27.
9. Exit the parameter modification screen.
10. Verify EPLS functionality by running the hoist at full speed to the top and bottom of travel.

Optional Adjustments

1. Each EPLS position can be configured to trigger a specific action, speed, and deceleration time. See the C03-01 to C03-11 parameters to make these adjustments.
2. The hook height home position is the height at which the motor revolutions monitor (U01-51) is set to a predetermined value, typically zero. For example, the upper weighted limit (UL3) can be used to home the hook height and set it to zero. See parameter C03-15 for the various homing options.
3. A digital input can be configured to bypass the travel limits. If the weighted limit is used to home the hook height or the weighted limit needs to be tested, the bypass input is a convenient way to accomplish that. Set a digital input to H01-xx or F03-xx = 62 (Bypass Stop Travel Limits) to only bypass UL2 and LL2, or 63 (Bypass EPLS) to bypass all EPLS limits. ***See Section 5.2.8 on page 127*** for additional details.

Limitations

1. The VFD has no awareness of hoist movement while powered off. If for any reason the hoist slips or the brake is opened causing the hoist to move, the hook height position monitors will be incorrect when the VFD is powered back up. If this occurs, it is recommended to home the hook height.
2. It is not recommended to hit the e-stop while the hoist is in motion. In this condition, the VFD will quickly see a UV or UV1 (undervoltage) fault, and any movement of the hoist after that point will not get tracked, causing error in the hook height position tracking.

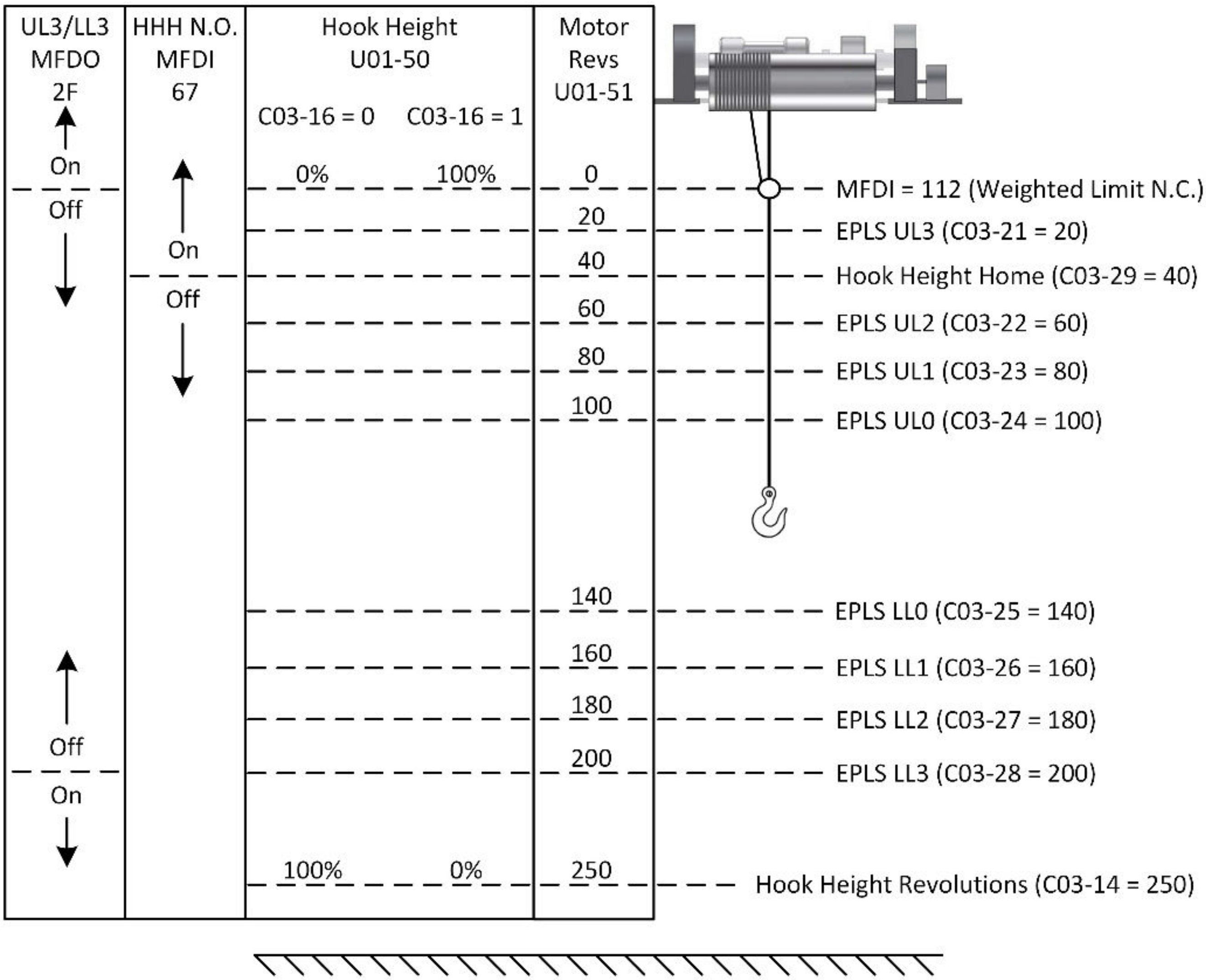
Table 5-22: Electronic Programmable Limit Switches Parameter Settings

Parameter	Display	Function	Range	Default
C03-20	Electronic Programmable Limits *0 Disabled* *1 Enabled* *2 Set UL3* *3 Set Upper Limits (UL2/UL1)* *4 Set Lower Limits (LL2/LL1)* *5 Set LL3* *10 Trigger Hook Height Home* *11 Set EPLS Rev Params to 0*	Enables or configures the EPLS function.	0–5, 10, 11	0
C03-21	UL3 Revolutions	Weighted Limit position	0–65535 Rev	0
C03-22	UL2 Revolutions	Upper Limit 2 position	0–65535 Rev	0
C03-23	UL1 Revolutions	Upper Limit 1 position	0–65535 Rev	0
C03-24	UL0 Revolutions	Upper Limit 0 position	0–65535 Rev	0
C03-25	LL0 Revolutions	Lower Limit 0 position	0–65535 Rev	0
C03-26	LL1 Revolutions	Lower Limit 1 position	0–65535 Rev	0
C03-27	LL2 Revolutions	Lower Limit 2 position	0–65535 Rev	0
C03-28	LL3 Revolutions	Ultimate Lower Limit position	0–65535 Rev	0
C03-29	Motor Revolutions at Home Pos	Home position	0–65535 Rev	0

NOTE: *A setting of 0 disables that specific limit.*

Table 5-23: Limit Switch Outputs (EPLS Only)

H02-0x or F05-0x =	Function
2B - Upper Limit 1	Output ON when keypad displays UL1
2C - Upper Limit 2	Output ON when keypad displays UL2
2D - Lower Limit 1	Output ON when keypad displays LL1
2E - Lower Limit 2	Output ON when keypad displays LL2
2F - Upper/Lower Limit 3	Output ON when keypad displays UL3 or LL3



Note 1: Hook Height Home input is triggered on the edge only.
Note 2: There is a 1 sec. delay at startup for N.C. inputs to engage. A Run command ends the delay.
Note 3: Motor revolutions do not go negative.

Figure 5-12: EPLS Parameter Layout

5.2.8 Upper/Lower Limit Bypass

Upper/Lower Limit Bypass allows for the following without the use of jumpers or re-programming parameters:

1. Ease of testing the Weighted Upper Limit Switch (UL3) or re-homing the Hook Height.
2. To allow changing of the wire ropes, i.e. spooling all the rope off of the hoist drum.

NOTE: *A momentary key-switch is recommended to operate this function and should only be accessible to maintenance personnel, not the crane operator. A functional description and usage procedure should be included in an administrative control program to avoid confusion and potentially have the End of Travel Limit switches left in a bypassed state during normal operation of the crane.*

Table 5-24: Limit Bypass MFDI

Functions Bypassed	F03-0x or H01-0x =	
	62	63
Upper Limit 1 N.C. (MFDI = 106)		
Upper Limit 2 N.C. (MFDI = 107)	×	
Lower Limit 1 N.C. (MFDI = 108)		
Lower Limit 2 N.C. (MFDI = 109)	×	
Lower Limit 3 N.C. (MFDI = 111)		
Upper Limit 3 N.C. (MFDI = 112)		
UL3 detected by EPLS (C03-21)		×
UL2 detected by EPLS (C03-22)	×	×
UL1 detected by EPLS (C03-23)		×
UL0 detected by EPLS (C03-24)		×
LL0 detected by EPLS (C03-25)		×
LL1 detected by EPLS (C03-26)		×
LL2 detected by EPLS (C03-27)	×	×
LL3 detected by EPLS (C03-28)		×

× = *Limit Bypass*

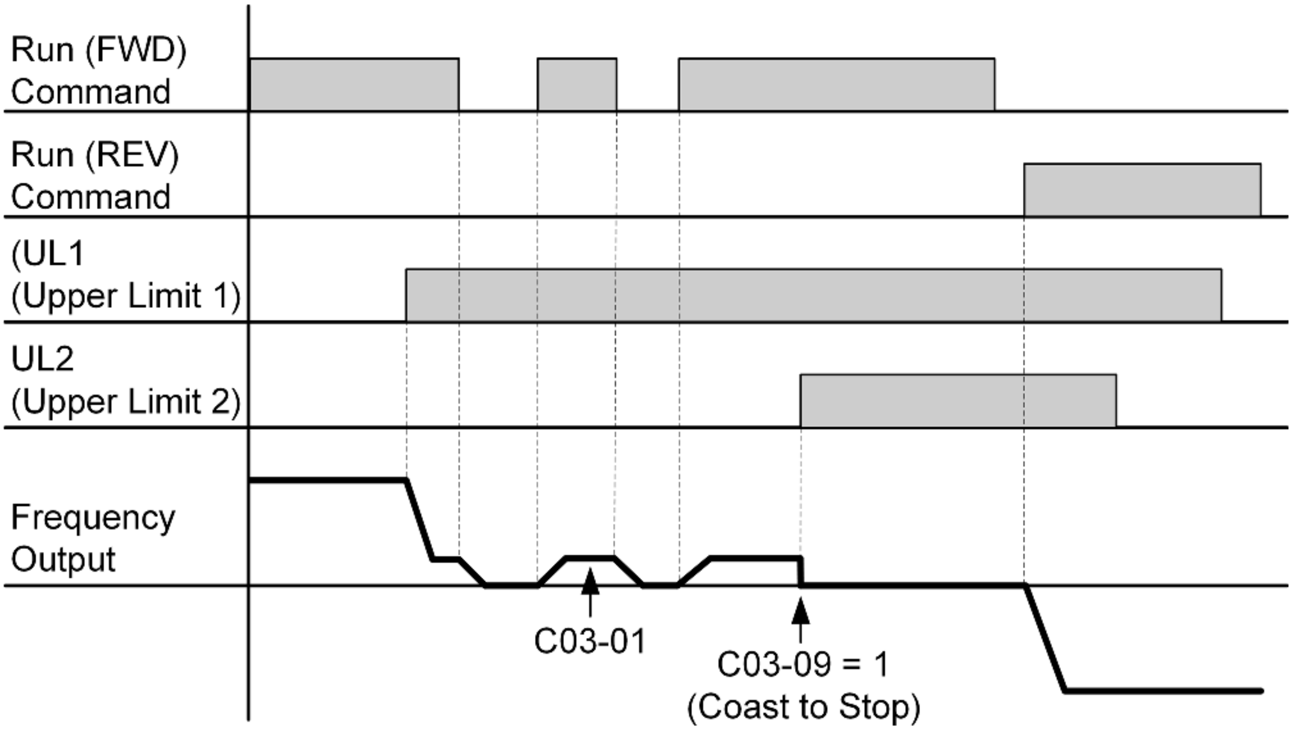


Figure 5-13: Upper Limits (UL1 / UL2)

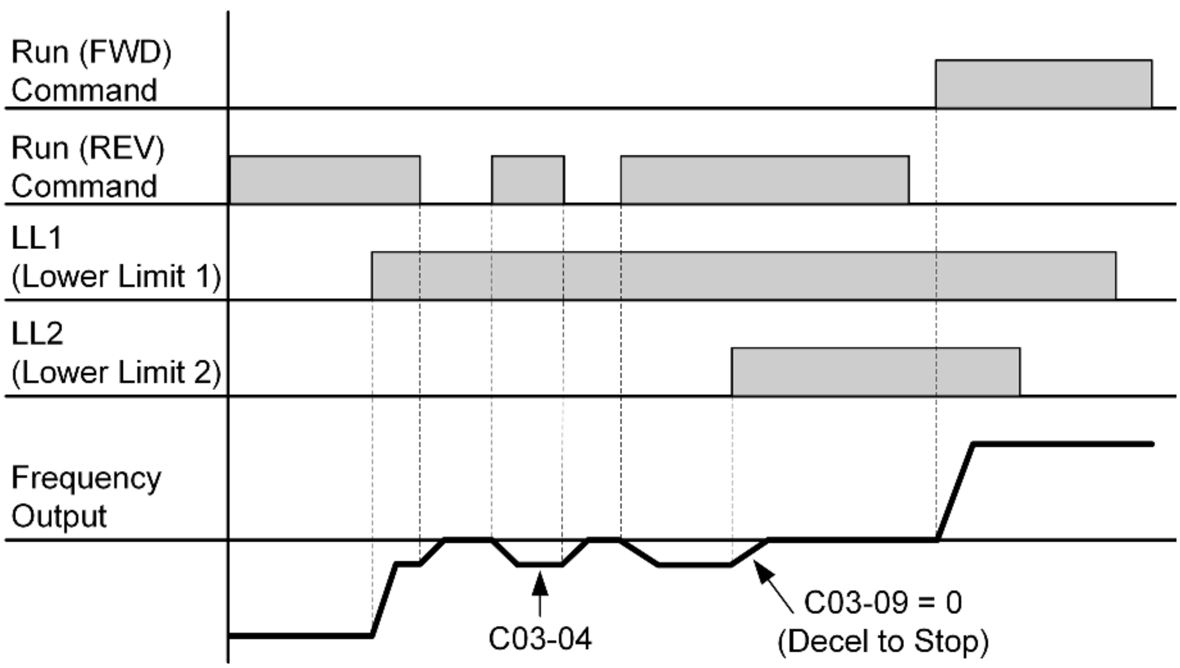


Figure 5-14: Lower Limits (LL1 / LL2)

5.2.9 Analog Input Programmable Limits (C03)

Analog Input Programmable Limits is a productivity and collision avoidance function that allows for up to two distance sensors with analog feedback (such as the LaserGuard 2 lasers) to be connected directly to analog inputs of the VFD. The VFD has a 24 VDC (150 mA) supply, for powering up to two sensors. This function will assign travel limits based on the analog feedback from the sensors. The LaserGuard 2 laser has 4-20 mA distance feedback, but this function will also work with lasers that have 0-10 VDC distance feedback.

NOTE: *When using a 4-20 mA sensor, consider enabling H03-19 (4-20 mA Feedback Loss Time). This will trigger a fault when the analog signal is less than 2 mA, indicating a loss of signal. The S1-1 (A1), S1-2 (A2), or S1-3 (A3) DIP switch for the analog input will need to be set to "I".*

Table 5-25: Analog Input Programmable Limits Parameters

Parameter	Display	Function	Range	Default
C03-40	Analog Input Programmable Limits	Function of the analog input programmable limits. The distance sensor is connected to the A1, A2, or A3 analog input and H03-02, H03-06, or H03-10 needs to be set to 35 (Travel Limits-Forward Sensor) or 36 (Travel Limits-Reverse Sensor).	0–5, 11	0
	0 Disabled			
	1 Enabled			
	2 Set UL3	Move the crane to the UL3 location. Set C03-40 = 2 to store that location to C03-41.		
	3 Set Upper Limits (UL2/UL1)	Move the crane to the UL2 location. Set C03-40 = 3 to store the UL2 location to C03-42 and +5% of that distance to C03-43.		
	4 Set Lower Limits (LL2/LL1)	Move the crane to the LL2 location. Set C03-40 = 4 to store the LL2 location to C03-47 and -5% of that distance to C03-46.		
	5 Set LL3	Move the crane to the LL3 location. Set C03-40 = 5 to store that location to C03-48.		
	11 Set MFAI Parameters to 0	Resets C03-41 to C03-48 = 0.		
C03-41	UL3 Analog Level	Upper Limit 3 analog input level.	0.0–100.0%	0.0
C03-42	UL2 Analog Level	Upper Limit 2 analog input level. Equivalent to a LaserGuard stop level.	0.0–100.0%	0.0
C03-43	UL1 Analog Level	Upper Limit 1 analog input level. Equivalent to a LaserGuard slowdown level.	0.0–100.0%	0.0
C03-44	UL0 Analog Level	Upper Limit 0 analog input level. Equivalent to a LaserGuard warning level.	0.0–100.0%	0.0
C03-45	LL0 Analog Level	Lower Limit 0 analog input level. Equivalent to a LaserGuard warning level.	0.0–100.0%	0.0
C03-46	LL1 Analog Level	Lower Limit 1 analog input level. Equivalent to a LaserGuard slowdown level.	0.0–100.0%	0.0
C03-47	LL2 Analog Level	Lower Limit 2 analog input level. Equivalent to a LaserGuard stop level.	0.0–100.0%	0.0
C03-48	LL3 Analog Level	Lower Limit 3 analog input level.	0.0–100.0%	0.0
C03-49	MFAI Hysteresis	Hysteresis around the analog input set points to prevent relay chattering.	0.0–10.0%	1.0

Parameter	Display	Function	Range	Default
C03-51	Rate Of Change Fault	An roC (Analog Rate Of Change) fault will occur if the analog input signal changes more than C03-51 percent over a 100ms period. This sudden feedback loss indicates that something has impeded the laser signal or the laser has diverted off the reflector. The roC detection is disabled if set to 0%.	0–20%	5
C03-52	Rate Of Change Fault Delay	Delay before triggering an roC fault. This allows the laser to leave the reflector for some amount of time before being considered a signal loss.	0.0–5.0 sec	0.5

5.2.10 Hook Height Set Points (C03)

Hook Height Set Points provides an indication of the hook height position using the configurable action of a digital output.

Table 5-26: Hook Height Set Points Parameters

Parameter	Display	Function	Range	Default
C03-60	Hook Height Point 1 Function *0 Above Set Point* *1 Below Set Point* *2 Between SP1 & SP2* *9 Set Current Position to SP*	Determines when the digital output (MFDO = 26) will close when Set Point 1 is reached. Selecting C03-60 = 9 serves as a setup function and will automatically program the current motor revolutions (U01-51) to C03-61.	0–2, 9	0
C03-61	Hook Height Point 1 Revolutions	Motor revolutions for Set Point 1 MFDO.	0–65535 Rev	0
C03-62	Hook Height Point 2 Function *0 Above Set Point* *1 Below Set Point* *2 Between SP1 & SP2* *9 Set Current Position to SP*	Determines when the digital output (MFDO = 27) will close when Set Point 2 is reached. Selecting C03-62 = 9 serves as a setup function and will automatically program the current motor revolutions (U01-51) to C03-63.	0–2, 9	1
C03-63	Hook Height Point 2 Revolutions	Motor revolutions for Set Point 2 MFDO.	0–65535 Rev	0
C03-64	Hook Height Point 3 Function *0 Above Set Point* *1 Below Set Point* *2 Between SP3 & SP4* *9 Set Current Position to SP*	Determines when the digital output (MFDO = 70) will close when Set Point 3 is reached. Selecting C03-64 = 9 serves as a setup function and will automatically program the current motor revolutions (U01-51) to C03-65.	0–2, 9	0
C03-65	Hook Height Point 3 Revolutions	Motor revolutions for Set Point 3 MFDO.	0-65535 Rev	0

Parameter	Display	Function	Range	Default
C03-66	Hook Height Point 4 Function *0 Above Set Point* *1 Below Set Point* *2 Between SP3 & SP4* *9 Set Current Position to SP*	Determines when the digital output (MFDO = 71) will close when Set Point 4 is reached. Selecting C03-66 = 9 serves as a setup function and will automatically program the current motor revolutions (U01-51) to C03-67.	0–2, 9	0
C03-67	Hook Height Point 4 Revolutions	Motor revolutions for Set Point 4 MFDO.	0-65535 Rev	0

5.2.11 Load Float Alternate (C04)

Load Float maintains the motor shaft at a stationary position with the brake still open. The Load Float Hold digital input (MFDI = 35) triggers an alternate Load Float time set in C04-01. During this time, the VFD will open the brake and hold the motor at a zero position. A FWD or REV run command takes priority over this function. The standard (automatic) Load Float time is set via the C08-10 parameter.

Table 5-27: Load Float Parameter Settings

Parameter	Display	Function	Range	Default
C04-01	Load Float MFDI Run Time	Maximum duration of Load Float time when MFDI = 35 is enabled.	0–65535 sec	10
C04-02	Load Float Gain	Gain for the control loop to hold the load from moving during load float	0–100	10*

** Dependent on VFD Model (≤ 30 HP: 10; > 30 HP: 20)*

5.2.12 Load Share / Torque Following (C04)

Load Share is a VG+ function (Hoist or Traverse) that allows one or more mechanically coupled motors to be connected in a Leader/Follower fashion where the Follower VFD will follow the torque reference of the Leader VFD. It can be configured in two ways, either as a dedicated Follower or as a Leader/Follower that can be switched with a digital input. When in Load Share, the follower motor is a torque helper to the lead motor. The Leader outputs the commanded torque via a ± 10 VDC analog signal into the Follower, which correlates directly to the direction and amount of torque the Follower should apply to its motor. This can be useful when two or more motors are driving a common load (i.e. single drum, gear box, etc.) and need to share the load. This will allow one VFD to handle the speed reference and speed regulation while the others simply help. This overcomes inherent problems with having more than one VFD trying to regulate speed on a common load.

Table 5-28: Load Share Parameter Settings

Parameter	Display	Function	Range	Default
C04-05	Load Share *0 Enabled by MFDI = 68* *1 Enabled Always*	Selects how Load Share is enabled. Increase F01-24 to 110% to prevent oS faults.	0, 1	0
C04-06	Load Share Fault Time	Time for the Load Share Follower VFD to give a Ready Signal before triggering a fault.	0.0–25.5 sec	1.5

NOTE: *The Limit Switch stopping method is not selectable in Load Sharing mode. If a Stop Limit is reached, the VFD output is turned off and the brake will set immediately. The Upper Limit 3 (UL3) input (H01-xx = 12 or 112) is always functional.*

5.2.12.1 Load Share Setup

A pair of wire interconnections is required between the Leader and Follower VFDs, in addition to the parameter settings below. Connect a wire between an analog output on the Leader to an analog input on the Follower. This passes the torque reference to be shared. Connect a digital output on the Leader to the Forward Run digital input (typically S1) on the Follower. This ensures the Leader and Follower always run and remain running together. Optionally, connect a wire between a digital output on the Follower and a digital input on the Leader, to ensure the Leader won't run by itself.

NOTE: *Applications with more than two Follower VFDs may have torque balancing challenges or oscillations during Load Float.*

1. **Leader** and **Follower** VFDs must be set to Closed Loop Vector (A01-02 = 3).
2. **Follower**: digital input H01-xx = 68 (Load Share Enable) <u>or</u> C04-05 = 1 (Enabled Always).
3. Wire Interconnection #1:
    - **Leader**: ±10 VDC <u>analog output</u> H04-01 or H04-04 = 109 (Torque Reference).
    - **Leader**: analog output gain H04-02 or H04-05 = 50%.
    - **Follower**: ±10 VDC <u>analog input</u> H03-02, H03-06, or H03-10 = 13 (Torque Reference).
    - **Follower**: analog input gain H03-03, H03-07, or H03-11 = 200%.
4. Wire Interconnection #2:
    - **Leader**: <u>digital output</u> H02-0x = 2A (During Frequency Output).
    - **Follower**: S1 <u>digital input</u> H01-01 = 80 (Forward Run).
5. Wire Interconnection #3 (OPTIONAL):
    - **Leader**: <u>digital input</u> H01-xx = 69 (Load Share Follower Ready) <u>or</u> C04-05 = 1 (Enabled Always).
    - **Follower**: <u>digital output</u> H02-0x = 0 (Brake Release).

5.2.13 Load Check (C05)

Load Check is a load-limiting feature which ensures the programmed load limit of the hoist is not exceeded. It prevents the lifting (and potential stall) of a load that is overweight. When an overload condition is detected, further lifting is restricted. The load may be lowered at a specified Load Check Alarm Speed (C05-08).

DANGER

Load Check is designed to limit loads less than or equal to the crane's rated capacity. Consult the factory and crane manufacturer before calibrating Load Check with a load heavier than the crane capacity.

5.2.13.1 Load Check Operation

Load Check is available for the Open Loop Vector and Closed Loop Vector control methods (A01-02 = 2 and 3). The motor torque (U01-09) is compared to values stored during the Load Check setup process. If they exceed the values for the active Load Check Zone, the motor will stop based on the LC Alarm Action (C05-02) and displays a Load Check alarm (LC).

NOTE: *The Load Check function will alter the acceleration time, depending on loading. It must be disabled when using two or more hoists to lift a single load.*

5.2.13.2 Load Check Setup

Load Check setup requires rated load to be suspended in the air and will quickly measure and calculate the torque required at each of the Load Check Zones. These values will automatically be stored in parameters C05-09 through C05-24.

The following steps are required to perform the Load Check setup process.

1. Verify that when the Master Switch is at full deflection (the highest speed point if stepped, or 10V if Analog), the Frequency Reference shown in U01-01 is equal to Motor Base Frequency E01-06 (typically 60Hz). For example, with a 3-Step speed reference, if b01-03 is set at 60Hz, then the frequency reference should be 60Hz when the Master Switch is pushed to full deflection. If the frequency reference doesn't reach Motor Base Frequency, set the following (depending on Speed Ref):
   - Multi-Step: b01-0x is 60 Hz
   - Infinitely Variable: b01-21 = 60 Hz
   - Analog: H03-03 = 100% and b02-01 = 100%
2. The motor should be rotationally Auto-Tuned.
3. Ensure b02-02 and E01-09 are at the desired values. If you change these, re-run Load Check setup.
4. Motor should be at normal operating temperature for the application (operate at or near rated capacity for at least 10 minutes) before performing the Load Check setup process.
5. Suspend the rated load just off of the ground (this allows for accurate measurements during calibration).
6. Set C05-01 = 8 (Setup).
7. Press and hold the Hoist (Up) run command and accelerate to full speed (60 Hz).

NOTE: *The Load Check setup process can be temporarily paused by lowering the load back down, keeping the load suspended, then pressing and holding the Hoist (Up) command button at full speed until the Load Check setup process is complete.*

8. When the Load Check setup process finishes, the VFD will decelerate the load to indicate the setup calibration is complete. For increased accuracy, the process can be repeated starting at Step #5 and instead set C05-01 = 9 (Setup - Optimize).

NOTE: *If an application requires Load Check to be bypassed, program an MFDI to 6A (Load Check Bypass).*

NOTE: *Upon completion of the Load Check setup process, the VFD will automatically set C05-01 = 1.*

NOTE: *If an error occurs during the Load Check setup, the load being lifted may have caused the torque to exceed 250%. Increase Holding Time and Testing Time, or decrease the load weight.*

5.2.13.3 Clearing a Load Check Alarm or Fault (LC)

A Load Check alarm/fault can be reset by pressing the F1 (RESET) key on the keypad.

Table 5-29: Load Check Parameter Settings

Parameter	Display	Function	Range	Default
C05-01	Load Check	Determines whether Load Check is enabled.	0, 1, 7–9	0
	0 Disabled	Disables Load Check		
	1 Hold & Measure	Enables Load Check (after Setup)		
	7 Clear LC Values	Reverts C05-09 through C05-24 to default		
	8 Setup	Setup Load Check		
	9 Setup - Optimize	Setup Load Check and average the new readings with the existing values. This method dials in the accuracy of the setup.		
C05-02	Load Check Detected Action	Action at Load Check alarm or fault	0, 2–5	5
	0 Alarm Only	Alarm will occur and can continue raising. Alarm will be reset when load is lowered.		
	2 Coast to Stop, Alarm	Allows lower only		
	3 Fault Stop	Fault contacts change state - requires reset		
	4 b03-03 to Stop, Alarm	Allows Lower only		
	5 b03-03 with LC Reset	Stopping method is b03-03. Allows Lower Only. Alarm will be reset when load is lowered.		
C05-03	Load Check Holding Time	Time to hold the output frequency allowing the output current/torque to stabilize.	0.00–2.55 sec	0.20
C05-04	Load Check Testing Time	Time (after the Holding Time) for comparing output torque to the LC Zone being tested.	0.00–2.55 sec	0.20
C05-05	Detection Margin at Acceleration	Margin for Load Check detection during acceleration. Setting 0 is the most sensitive.	0–50%	5
C05-07	Detection Margin at Speed Agree	Margin for Load Check detection at speed agree. A setting of 0 is the most sensitive.	0–50%	10
C05-08	Alarm Speed	Maximum lowering speed after an LC alarm.	0.0–30.0 Hz	6.0
C05-09	Load Check Level 01	Torque for Zone 01	0–250%	0
C05-10	Load Check Level 02	Torque for Zone 02	0–250%	0
C05-11	Load Check Level 03	Torque for Zone 03	0–250%	0
C05-12	Load Check Level 04	Torque for Zone 04	0–250%	0
C05-13	Load Check Level 05	Torque for Zone 05	0–250%	0
C05-14	Load Check Level 06	Torque for Zone 06	0–250%	0
C05-15	Load Check Level 07	Torque for Zone 07	0–250%	0
C05-16	Load Check Level 08	Torque for Zone 08	0–250%	0

Parameter	Display	Function	Range	Default
C05-17	Load Check Level 09	Torque for Zone 09	0–250%	0
C05-18	Load Check Level 10	Torque for Zone 10	0–250%	0
C05-19	Load Check Level 11	Torque for Zone 11	0–250%	0
C05-20	Load Check Level 12	Torque for Zone 12	0–250%	0
C05-21	Load Check Level 13	Torque for Zone 13	0–250%	0
C05-22	Load Check Level 14	Torque for Zone 14	0–250%	0
C05-23	Load Check Level 15	Torque for Zone 15	0–250%	0
C05-24	Load Check Level 16	Torque for Zone 16	0–250%	0
C05-26	Load Check Delay Time	Load Check delay time for transitions	0.00–2.55 sec	0.25
C05-27	Load Check REV to FWD Delay	Minimum delay when switching from REV to FWD. Used when the VFD cannot stop the load fast enough. Disabled when set to 0.	0.0–25.5 sec	0.0
C05-28	Load Check REV to FWD Frequency	Minimum frequency that will trigger C05-27	0.0–60.0 Hz	30.0

5.2.14 Ultra-Lift (C06)

Ultra-Lift is a hoist function that provides additional productivity by allowing a hoist to run above base speed when the load is less than 100% of the rated capacity. Ultra-Lift determines the torque required for the load, calculates the maximum safe speed, and automatically accelerates to this speed. The maximum speed cannot exceed the lesser value of the Maximum Forward Speed (C06-02), Maximum Reverse Speed (C06-03), and Maximum Frequency (E01-04).

NOTE: *Ultra-Lift is disabled for traverse motions. Maximum Frequency (E01-04) must be ≥ C06-02 & C06-03.*

WARNING

Motors and machinery must be capable of operating above base speed. Consult the motor/gearbox/hoist manufacturer before enabling the Ultra-Lift function. Failure to observe this warning may result in damage to equipment and possible injury or death to personnel.

5.2.14.1 Ultra-Lift in V/f and Open Loop Vector

Ultra-Lift can be enabled in Standard Hoist mode (A01-03 = 1). In the V/f control method, the Ultra-Lift function uses motor current to determine the maximum safe speed. When the OLV control method is selected, the Ultra-Lift function uses motor torque for its safe speed calculations. Ultra-Lift will not be enabled if the current or torque levels do not exceed C06-04 or C06-05 settings. Both C06-04 and C06-05 are a percentage of E02-01.

5.2.14.2 Ultra-Lift in Closed Loop Vector

Ultra-Lift can be enabled in NLB Hoist mode (A01-03 = 2). The Ultra-Lift function measures motor torque at base speed and accelerates to the maximum safe speed if the torque levels do not exceed C06-04 or C06-05 levels.

5.2.14.3 Adaptive Ultra-Lift

Adaptive Ultra-Lift can be enabled in NLB Hoist mode (A01-03 = 2). It continuously monitors motor torque when running above base speed to increase or decrease motor speed based on varying load conditions. Adaptive Ultra-Lift only functions in the up/raising direction.

Table 5-30: Ultra-Lift Parameter Settings

Parameter	Display	Function	Range	Default
C06-01	Ultra-Lift	Determines if Ultra-Lift is enabled.	0–4	0
	0 Disabled			
	1 Enabled Auto			
	2 Enabled by MFDI			
	3 Enabled Adaptive Auto	Closed Loop Vector NLB only		
	4 Enabled Adaptive by MFDI	Closed Loop Vector NLB only		
C06-02	Ultra-Lift Max Forward Speed	Maximum Ultra-Lift Forward Speed	0.1–300.0 Hz	60.0
C06-03	Ultra-Lift Max Reverse Speed	Maximum Ultra-Lift Reverse Speed	0.1–300.0 Hz	60.0
C06-04	Ultra-Lift Forward Torque	Output Current/Torque < C06-04 to enable Ultra-Lift Forward. Not used with Adaptive UL.	0–100%	50
C06-05	Ultra-Lift Reverse Torque	Output Current/Torque < C06-05 to enable Ultra-Lift Reverse. Not used with Adaptive UL.	0–100%	30

Parameter	Display	Function	Range	Default
C06-06	Ultra-Lift Enable Window	Frequency below Base Frequency (E01-06) to trigger Ultra-Lift.	0.1–10.0 Hz	0.5
C06-07	Ultra-Lift Delay Time	Delay time at Enabling Speed to allow the Current/Torque to stabilize before deciding if Ultra-Lift can be enabled. Not used with Adaptive Ultra-Lift.	0.0–25.5 sec	2.0
C06-08	Ultra-Lift Accel Multiplier	Greater than 1 increases acceleration time; less than 1 decreases acceleration time.	0.1–9.9	1.0
C06-10	Motor Torque QuickSet *0 Very Low Torque* *1 Low Torque* *2 Standard* *3 High Torque* *4 Very High Torque*	Available motor torque over base speed.	0–4	2
C06-15	Adaptive UL Torque FWD Offset	Adaptive UL torque measurement offset in the up direction to allow for deceleration.	0–100%	10
C06-16	Adaptive UL Torque REV Offset	Adaptive UL torque measurement offset in the down direction to allow for deceleration	0–100%	20

5.2.14.4 Ultra-Lift Setup

For Multi-Step or Infinitely Variable (A01-04 = 0 to 4):

1. Set C06-01 to enable Ultra-Lift. (1 = Enable Automatic, 2 = Enable by MFDI, 3 = Enable Adaptive Automatic, 4 = Enable Adaptive by MFDI.)
2. Set C06-02 and C06-03 to the desired Ultra-Lift maximum FWD/REV output frequency.
3. Set C06-04 and C06-05 to the current/torque that the motor must be under in order to enable Ultra-Lift.
4. Set C06-06 (Ultra-Lift Enable Window) to the desired frequency below Base Frequency (E01-06) to trigger Ultra-Lift.

   For example: If the motor base frequency (E01-06) is 60 Hz, and C06-06 = 0.5 Hz, then Ultra-Lift will be enabled at 59.5 Hz.
5. Ensure that the Maximum Frequency (E01-04) is increased above 60 Hz.

For Uni-Polar/Bi-Polar Analog (A01-04 = 5 or 6)

1. Follow steps 1-5 above.
2. Use the following formula to calculate the gain for the Frequency Reference analog input.

$$\begin{array}{c}\text{MFAI Gain}\\ \text{(H03-03, H03-07, H03-11)}\end{array} = \frac{\text{E01-06 x 100}}{\text{E01-04}}$$

5.2.15 Torque Limits (C07)

Torque Limits will limit the amount of torque the motor is capable of producing in Open and Closed Loop Vector control in each of the four quadrants. The VFD dynamically controls the torque output of the motor while running.

- *Forward Motoring (I)*
- *Forward Regenerating (II)*
- *Reverse Motoring (III)*
- *Reverse Regenerating (IV)*

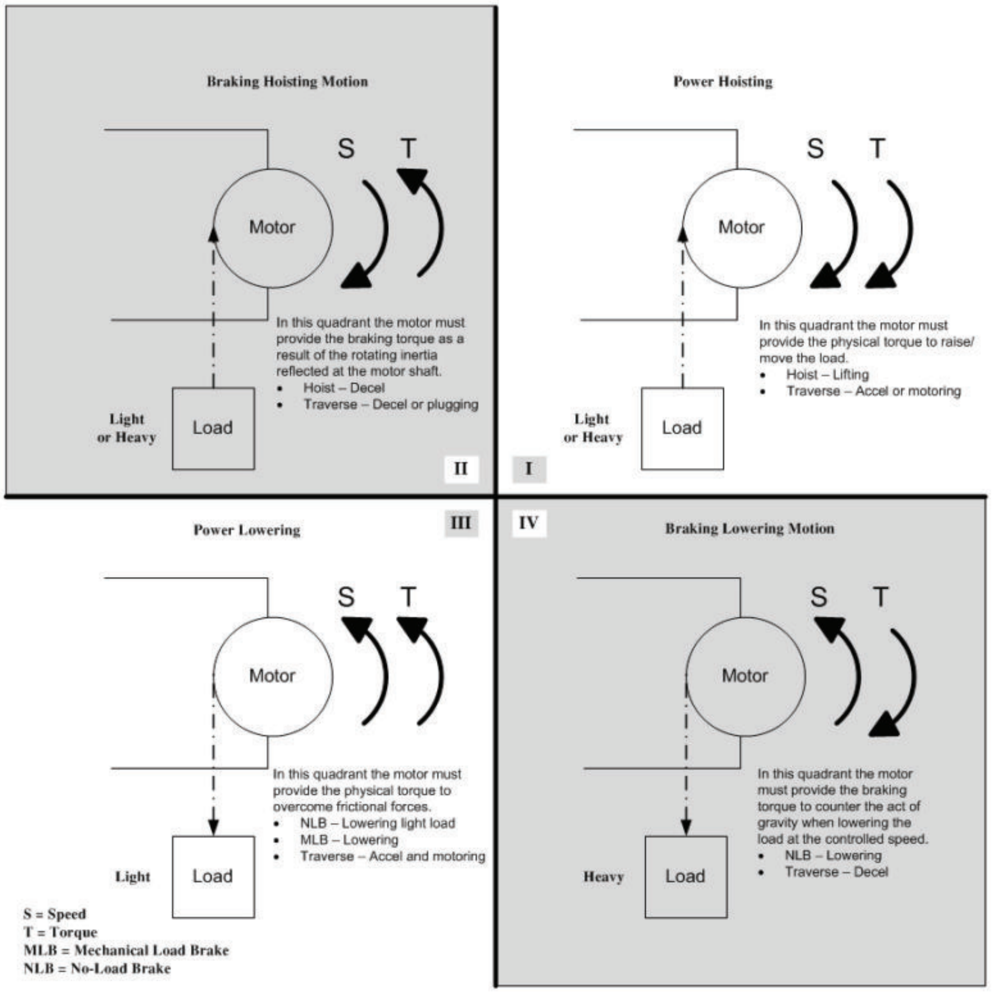


Table 5-31: Torque Limit Parameter Settings

Parameter	Display	Function	Range	Default
C07-01	Forward Torque Limit	Forward Motoring torque limit	0–300%	150
C07-02	Reverse Torque Limit	Reverse Motoring torque limit	0–300%	150
C07-03	Forward Regenerative Torque Limit	Forward Regenerative torque limit	0–300%	180
C07-04	Reverse Regenerative Torque Limit	Reverse Regenerative torque limit	0–300%	180
C07-05	Torque Limit Forward Gain	Torque Limit gain in FWD direction when MFDI = 14 is ON. Gain is applied to C07-01. If T-Lim by Analog Input is used, gain is applied to post-scaled/biased input.	0.50–1.50	1.25
C07-06	Torque Limit Reverse Gain	Torque Limit gain in REV direction when MFDI = 14 is ON. Gain is applied to C07-02. If T-Lim by Analog Input is used, gain is applied to post-scaled/biased input.	0.50–1.50	1.25
C07-07	Torque Limit Regenerative Gain	Torque Limit gain in RGN mode when MFDI = 14 is ON. Gain is applied to C07-03 and C07-04. If T-Lim by Analog Input is used, gain is applied to post-scaled/biased input.	0.50–1.50	1.25
C07-08	Torque Limit Integral Time	Integral time constant for the torque limit. (OLV only)	5–10000 ms	200
C07-09	Torque Limit during Accel/Decel *0 Proportional Only* *1 Proportional & Integral Control*	Torque Limit Method during Accel/Decel (OLV only) The torque limit uses proportional control during accel and decel, and switches to I control at constant speed. Use this setting when getting to the desired speed has priority over the torque limit. The torque limit will always use integral control. Use this when a highly accurate torque limit is required during speed changes. This setting may increase the acceleration time, or prevent the motor from reaching the frequency reference if the torque limit is reached first.	0, 1	0
C07-10	Torque Limit Process at Start *0 Disabled* *1 Enabled*	Adds a 64ms ramp-up time to the torque limits at the start of a run.	0, 1	1

5.2.16 Anti-Shock (C07)

Anti-Shock is a hoist feature on the IMPULSE•VG+ Series 5 VFD. The torque output of the hoist is continuously monitored, and when it increases above a threshold (torque delta C07-15 within the C07-16 time window), the hoist automatically decelerates (to the speed set at C07-17 with deceleration rate set at C07-18) and waits for the torque to stabilize before smoothly re-accelerating (per the b05-01 acceleration rate). Anti-Shock is designed to reduce crane structure fatigue.

Initial Setup and Adjustment

1. Choose an option to enable/disable Anti-Shock:
    a. C07-12 = 0 (Disabled) ensures Anti-Shock does not function.
    b. C07-12 = 1 (Enabled) allows Anti-Shock to run always.
    c. C07-12 = 2 (Enabled, Not in Micro-Speed) will block Anti-Shock when Micro-Speed is enabled.
    d. MFDI = 4B (Anti-Shock OFF), when enabled, will block Anti-Shock. This allows Anti-Shock to be enabled or disabled by a digital input.
2. Run the hoist, unloaded, in the UP direction. Note the value of U01-09 and enter that value into C07-23.

To make Anti-Shock less sensitive to light loads and more sensitive to heavy loads:

1. Increasing C07-15 (Torque Delta) to a higher percentage increases the torque spike magnitude that is required to trigger Anti-Shock.
2. Increasing C07-16 (Detection Time) to a higher time widens the window that a torque spike is looked for.

To make Anti-Shock more sensitive to light loads:

1. Decreasing C07-15 (Torque Delta) to a lower percentage lowers the torque increase magnitude that is required to trigger Anti-Shock.
2. Increasing C07-16 (Detection Time) to a higher time widens the window that a torque spike is looked for.

Troubleshooting

Anti-Shock is triggered when the load is already in the air:

Cause: This is caused by a torque increase due to acceleration, which falls within the parameter settings for triggering Anti-Shock.

Corrective Action:

1. Increasing C07-14 (Reaccelerate Delay) to a higher time delay.
2. Increasing C07-15 (Torque Delta) and decreasing C07-16 (Detection Time) will require a higher torque spike to occur in a shorter amount of time.

When Anti-Shock is triggered, the VFD faults with an oV (Overvoltage) or oC (Over Current):

Cause: By default, Anti-Shock is configured to decelerate very quickly when a torque spike is detected. The deceleration rate may cause a rapid increase in voltage or current, which may fault the VFD.

Corrective Action:

Increasing C07-18 (Smoothing Decel Time) will increase the time it takes for the motor to decelerate directly after the torque spike is detected. Resulting spikes in voltage and/or current will be reduced.

Table 5-32: Anti-Shock Parameter Settings

Parameter	Display	Function	Range	Default
C07-12	Anti-Shock	Enables or disables the Anti-Shock function.	0–2	0
	0 Disabled	Anti-Shock is disabled.		
	1 Enabled	Anti-Shock is enabled always.		
	2 Enabled, Not in Micro-Speed	Disables Anti-Shock if Micro-Speed is enabled.		
C07-13	Anti-Shock Enabling Frequency	Anti-Shock is disabled until the output frequency is above this setting.	0.0–60.0 Hz	6.0
C07-14	Anti-Shock Reaccelerate Delay	If the operator decelerates the hoist then re-accelerates, Anti-Shock Detection is disabled for this period of time.	0.00–2.55 sec	0.20
C07-15	Anti-Shock Torque Delta	Torque increase required to initiate the Anti-Shock sequence.	0–180%	10
C07-16	Anti-Shock Detection Time	Time window to detect torque delta (C07-15).	0.01–0.50 sec	0.30
C07-17	Anti-Shock Smoothing Frequency	When the torque increase is detected, the motor will decelerate to this frequency.	0.0–15.0 Hz	3.0
C07-18	Anti-Shock Smoothing Decel Time	Deceleration time once an Anti-Shock event has been detected. Increase this value in 0.1 sec increments if dEv faults are occurring.	0.00–2.55 sec	0.30
C07-20	Anti-Shock Smoothing Time	Time window to smooth out the torque.	0.00–0.50 sec	0.20
C07-22	Anti-Shock Alarm Display Time	When Anti-Shock is triggered, an alarm will display on the keypad screen for the selected duration of time.	0–30 sec	4
C07-23	Anti-Shock No Load Torque	Any torque values below this level are ignored. Best described as the torque level while hoisting with an empty hook (no load).	0–100%	20
C07-24	Anti-Shock Activation Torque	In order for Anti-Shock to be triggered, the torque increase is required to peak above this percentage.	0–180%	75
C07-25	Anti-Shock Detection Method	Anti-Shock detection method.	0–2	1
	0 Always Detect	Anti-Shock can be continuously detected.		
	1 Detect Once Per Lift	After Anti-Shock is detected once during a lift, it is disabled until the hoist is lowered.		
	2 Fault on Detect	Fault when Anti-Shock is detected.		

5.2.17 Traverse Torque Limiter (C07)

Traverse Torque Limiter is used in multi-VFD, closed-loop traverse applications to reduce skewing due to speed differences in the motors on each side of a bridge. This prevents one side of a bridge being at full forward torque, while the other side is at full regen torque, which can lead to skewing, dEv faults, or the motors simply not sharing the load sufficiently. When accelerating past the Limiter Freq (C07-41), this feature is enabled, and the ASR I time is reduced to zero to limit torque imbalance. Once the motor has reached its target speed, the regen torque limit is also reduced to zero. It will remain in this state until the speed reference is changed. When the speed reference is raised or lowered, regen torque limit is re-enabled to accel or decel the bridge as required.

Table 5-33: Traverse Torque Limiter Parameter Settings

Parameter	Display	Function	Range	Default
C07-40	Traverse Torque Limiter *0 Disabled* *1 Enabled*	ASR I time is forced to 0 when the output frequency is greater than the C07-41 speed window. When using this feature, it is suggested that the Overspeed Detect Level (F01-24) be increased to 110% to avoid overspeed faults.	0, 1	0
C07-41	Traverse Torque Limiter Window	Frequency window (+/-) size for Traverse Torque Limiter (C07-40) when at speed.	0.5–10.0 Hz	2.0

5.2.18 No Load Brake (NLB) Hoist (C08)

No Load Brake (NLB) Hoist mode is a VG+ feature that provides a start and stop sequence designed specifically for hoists without a mechanical load brake. This mode is enabled automatically when the Motion is set to NLB Hoist (A01-03 = 2). This will also automatically set the Stopping Method to No Load Brake (b03-03 = 6).

Start

The start sequence begins by building up torque in the motor to a predefined level within the C08-01 (BE2 Torque Build Up Time) timer. This level is determined by several factors which are defined below. During the C08-02 time, the VFD is monitoring current to motor. The current feedback equation must be satisfied within the time set in C08-02 (BE2 Torque Detection Time). If it is not, a BE2 (No Current) fault will be displayed on the keypad and the VFD will stop outputting voltage to the motor. The brake will remain closed.

Once the brake has been commanded to release, the VFD output remains in Load Float for the amount of time programmed into C08-04. During C08-04, the VFD waits for the brake to completely open and watches encoder feedback. If the amount of feedback is less than the setting in C08-05 (BE1 Rollback Pulse Count), then the VFD proceeds to the BE3 check. If it is not, a BE1 fault is displayed on the keypad and the sequence stops. For the BE3 check, if the brake opened mechanically, then the encoder feedback must be greater than or equal to the value programmed in C08-07 (BE3 Brake Release Pulse Count) within the time set in C08-06 (BE3 Brake Release Time). If it is not, then a BE3 fault is displayed. Once the VFD has completed the BE3 check, the No Load Brake start sequence is complete.

Stop

The stop sequence begins when the run command has been removed and the output frequency has decelerated to zero. Once at zero speed, the motor maintains a Load Float position for the duration of C08-10 (Load Float Time). During the Load Float time, run commands in either direction are accepted and will begin accelerating immediately in the commanded direction, thereby skipping the start sequence. The Load Float Timer is reset after each new run command. Once the Load Float Timer expires, the brake output command is removed (thereby closing the brake) and Load Float is maintained for the time set in C08-11 (BE5 Brake Set Time) to allow the brake to fully close. Once the Brake Delay Time has expired, the BE6 check is executed. The BE6 check monitors encoder feedback while the load is being transferred from the motor to the brake and compares it to C08-13 (BE6 Maximum Pulse Count). The encoder feedback must not exceed the number of counts in C08-13 within the C08-12 (BE6 Detection Time) time. If it does (meaning the load slipped through the brake), a BE6 alarm is displayed on the keypad and the VFD will keep Load Float active, with the brake closed, to maintain control of the load. Run commands will still be accepted with the exception of a reduced speed in the up direction set by C08-18 (BE5/BE6/BE8 Max Forward Speed). The VFD will remain in the BE6 alarm state after each run, allowing the operator to set down the load before turning off the crane for servicing.

Torque Proving

Factor 1: On the first run command after power up, or after any fault which causes the stop sequence to be skipped, the start sequence uses the value programmed to C08-16 (Initial Forward Brake Torque).

Factor 2: Once the system has completed a successful start and stop, a new Brake Release Torque value is used. This value is one that has been memorized and stored into memory during the stop sequence. It is equivalent to the amount of torque required for the motor to hold the load on the hook in Load Float with the brake released. Some benefits of stored Load Float torque for the next brake release are:

- Faster response to run commands when VFD is in Baseblock Status.
- Upon brake release, shaft rotation begins in the direction of the run command.

If the stored value is less than the programmed value in C08-03 (BE2 Minimum Brake Release Torque), C08-03 is used as the next brake release value. If the feature must be disabled, C08-03 will override C08-16 if it is a greater value.

Dual Brake Feature

The Dual Brake feature is designed for hoist systems with redundant holding brakes. One brake is controlled by an MFDO = 0, and the second brake is controlled by an MFDO = A. After Load Float expires and during the BE6 (Brake Slipping Check) time, one brake is left Open, while the VFD tests that the Closed brake is capable of holding the load. After the BE6 time expires, the second brake is closed.

This feature is only intended as a method to test each brake individually. A mechanical delay system may be required to prevent both brakes from closing simultaneously if power is lost.

NOTE: *All brake faults are annunciated by both the keypad and via a programmed digital output. Since the keypad is not visible by the operator, an external warning device must be used to ensure proper safety of personnel and equipment. Annunciating a brake fault can be accomplished by using one, or both, of the following methods: 1) An indicator or strobe light that is continuously “ON”, indicating proper operation. If the light should turn “OFF”, this indicates that the light bulb has either burned out, or there is a VFD or brake problem. Either scenario requires immediate corrective action. 2) The use of an indicating light wired to relay output terminals MC-MA, N.O. contact, or an audible warning device that will sound during a brake fault condition. An audible warning device can be wired directly to terminals MC-MA, provided that its ratings do not exceed the 1 Amp specification.*

If a brake fault is annunciated during a “Start” sequence, it is recommended that the crane be moved to a safe location with the load on the hook. The hoist should only be operated if absolutely necessary. In this type of alarm sequence, either the brake is seized or the VFD cannot develop enough torque in the motor in the time allotted. To troubleshoot the hoist, it will be necessary to monitor the keypad on the VFD and operate the hoist at the same time. Two people are recommended for this procedure. With one person operating the hoist and the other person monitoring the keypad, run the hoist. The keypad should display one of the following faults: BE1, BE2, BE3, or BE4. For corrective action, ***see Section 6.1 on page 345****.*

If a brake fault is annunciated after the hoist has come to a complete stop, and Load Float (C08-10) has timed out, it would indicate that the VFD has checked the brake and determined that the brake has insufficient torque available to hold the load. DO NOT TURN OFF POWER. This condition indicates that the brake has failed and the VFD / motor combination is suspending the load. If, during this condition, the hoist is operated in the “Raise” direction, it will only be allowed to run at a speed equal to or less than the “BE5/BE6/BE8 Max Forward Speed” setting in parameter C08-18 (6 Hz by default.) This is an additional indication that the brake has failed to open, or the load is slipping through the brake. It is recommended that the crane be moved to a safe location and the load lowered to the ground. Corrective action should be taken to repair the brake. The keypad will be displaying one of two alarms during this condition: BE5 or BE6. ***See Section 6.1 on page 345.***

WARNING

During a BE5, BE6, or BE8 alarm, DO NOT turn off power to the VFD until the load has been lowered to the ground and removed from the hoist. Otherwise this may result in loss of control of the load if the brake has failed in the open position or is unable to hold the load.

Table 5-34: No Load Brake Parameter Settings

Parameter	Display	Function	Range	Default
C08-01	BE2 Torque Build Up Time	Time (slope) for the Torque Compensation value to reach 300%.	0.00–2.55 sec	1.00
C08-02	BE2 Torque Detection Time	Time to look for current feedback before posting a BE2 alarm. ***NOTE:*** *To disable BE2 detection, set C08-02 = 0.00.* (Consult factory before disabling torque proving).	0.00–2.55 sec	1.00
C08-03	BE2 Minimum Brake Release Torque	Minimum brake release torque.	0–200%	10
C08-04	BE1 Rollback Time	Time for the brake to release and for brake feedback to be received from a Brake Answerback MFDI at start before posting a BE4 alarm. It is also the time when the amount of rollback is checked (BE1) and delay time before a BE0 occurs if Brake Answerback feedback is lost while running. In Traverse mode, this parameter only takes effect when a Brake Answerback MFDI is used.	0.00–2.55 sec	0.30
C08-05	BE1 Rollback Pulse Count	Detection counts for excessive rollback.	0–15000 pulses	200
C08-06	BE3 Brake Release Time	Time period when C08-07 is measured. See C08-08. ***NOTE:*** *To disable BE3 detection, set C08-06 = 0.00.*	0.00–2.55 sec	0.30
C08-07	BE3 Brake Release Pulse Count	Detection count for Encoder/Seized-Brake Alarm (BE3). It is the minimum encoder pulse count, during C08-06, below which triggers a BE3 alarm.	0–2000 pulses	10
C08-08	BE3 Reverse Torque Limit	For a LOWER command in the NLB Hoist mode only (A01-03 = 2). Torque limit for time of C08-06 to prevent driving through a brake that has failed closed with a load on the hook.	0–250%	25
C08-09	Zero Speed Level	Speed feedback at which Load Float activates.	0.0–5.0 Hz	1.0
C08-10	Load Float Time	Time period during which the motor is held stationary and the motor brake remains open. This time begins when the motor speed is below the Zero Speed Level (C08-09).	0–65535 sec	10*
C08-11	BE5 Brake Set Time	Time for the brake to set and also for brake feedback to be removed from the Brake Answerback digital input at stop before posting a BE5 Alarm. ***NOTE:*** *To disable BE5 detection, set C08-11 = 0.*	0.0–25.5 sec	0.7
C08-12	BE6 Detection Time	Time period during which the electric brake is set and tested for sustaining the load. ***NOTE:*** *To disable BE6 detection, set C08-12 = 0.0.*	0.0–25.5 sec	5.0
C08-13	BE6 Maximum Pulse Count	Total pulse counts must be less than C08-13, during C08-12, otherwise BE6 alarm.	0–2000 pulses	50
C08-14	Brake Set Hold Speed	Frequency the VFD outputs to push against the brake for BE2 torque proving at start and the frequency the VFD outputs until BE5 Brake Set Time (C08-11) time expires or the Brake Answerback MFDI is removed.	0.0–25.5%	G+: 2.0 VG+: 0.0

Parameter	Display	Function	Range	Default
C08-15	Load Float Extension Time	Load Float extension time enabled by MFDI=34 or 134.	0–65535 sec	10
C08-16	Initial Forward Brake Torque	Initial Forward Brake Release Torque for BE2 Detection. The percent of forward/up motor torque that must be reached within C08-02 time to release the brake at the start of a forward/up run.	10–300%	100
C08-17	Initial Reverse Brake Torque	Initial Reverse Brake Release Torque for BE2 Detection. The percent of reverse/down motor torque that must be reached within C08-02 time to release the brake at the start of a reverse/down run. (OLV only)	10–300%	30
C08-18	BE5/BE6/BE8 Max Forward Speed	Maximum up speed limit during a BE5, BE6, or BE8 alarm.	0.00–300.00 Hz	6.00
C08-19	BE5/BE6/BE8 Brake Slip Reset *0 Disabled* *1 Enabled*	Automatic retest and reset of BE5, BE6, and BE8 alarms. If enabled, VFD will always perform a BE5, BE6, and BE8 (if enabled) test after Load Float to determine if brake is operational and the alarm can be cleared. If disabled, the VFD will remain in an alarm state until power is cycled.	0, 1	0
C08-20	BE6 Torque Reference	Torque output during a BE6 check.	0–20%	0
C08-21	Minimum Magnetizing Current	Minimum magnetizing current before starting the BE2 check.	0–100%	5
C08-22	BE8 Brake Slip Detection *0 Disabled* *1 Enabled*	Continuous monitoring for a slipping brake. ***NOTE:*** *To enable BE8 detection, set C08-22 = 1.*	0, 1	0
C08-23	BE8 Detection Sensitivity	Adjusts the sensitivity of BE8 Slip Detection.	0.0–10.0 Hz	0.5
C08-24	Brake Test Torque	Motor runs in Forward direction when MFDI = 61 is enabled. Brake output relay is not energized, PGo and dEv detection are disabled. The measured brake torque is shown at U01-86.	50-200% Rated Torque FtLb	**
C08-25	Brake Test Complete Indication *0 Alarm* *1 Fault*	Determines whether an alarm or fault occurs if the Brake Test fails.	0, 1	1
C08-28	BE2 Brake Torque Check Time	Time during which the torque must be above C08-03 or C08-16 before releasing the brake. Increasing this time allows the load to stabilize and minimize erroneous BE2 faults. ***NOTE:*** *To disable BE2 detection, set C08-02 = 0.00.*	0.00–2.55 sec	0.05
C08-33	Dual Brake Test *0 Disabled* *1 Enabled*	Enabling this alternates the brake outputs after every run. MFDOs must be set to 0 and A or oPE28 will be displayed	0, 1	0
C08-34	DIR Fault Torque Level	Regen torque level required to trigger a DIR fault. This is used to detect an NLB hoist setup backwards (FWD is down). ***NOTE:*** *To disable DIR detection, set C08-34 = 0.*	0–100%	50

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

** $1.25\text{x}\,\frac{\text{E02-11x5252}}{\text{Motor RPM}}$

5.2.19 Emergency Lift (C08)

Emergency Lift (E-Lift) is a VG+ hoist feature that allows operation of the VFD in the event of a fault (PGo-1S/PGo-1H) that resulted from a defective encoder, encoder cable, or PG-X3 option card. The recommended use of this function is to set down the load and not to prolong normal operation. E-Lift can be enabled with C08-35 when the VFD is idle and not running.

When E-Lift is active, the VFD will switch to parameters for Motor 2, set in the E03 and E04 groups, and the VFD will operate in the Open Loop Vector (OLV) and NLB Hoist mode. This allows for some torque proving checks to remain operational. Furthermore, functions that depend on encoder feedback will be disabled. By default, E-Lift will remain operational for a maximum of 20 minutes (user-adjustable by C08-37), after which a fault will be generated.

DANGER

E-Lift allows temporary hoisting operations of motors equipped with an encoder in Closed Loop Vector control. It is designed to operate using the Open Loop Vector (OLV) control method. An oPE44 alarm will occur if E03-01 = 0 (V/f). Always follow the setup instructions, and use extreme caution when operating a hoist in E-Lift mode. Stop the hoist if undesired motion occurs and contact Magnetek for additional assistance.

5.2.19.1 Emergency Lift Setup

1. **Auto-Tune the motor:**

   Complete an Auto-Tune for the motor described in ***Section 4.4 on page 103***.

2. **Configure the E03 and E04 Parameter Groups for Motor 2:**

   When E-Lift is active, the Mode 2 parameters are used for voltage and frequency limits instead of the E01 group. The E03 and E04 paramater group should be configured as described in ***Table 5-82 on page 233***.

   NOTE: *The V/f control method (E03-01 = 0) cannot be used for E-Lift.*

3. **Configure the E-Lift Parameters:**

   The parameters listed in ***Table 5-35*** are used to configure the E-Lift function.

Table 5-35: Emergency Lift Parameter Settings

Parameter	Display	Function	Range	Default
C08-35	Emergency Lift *0 Disabled* *1 Enabled* *2 Enabled by MFDI*	Determines if and how the E-Lift function is enabled.	0–2	0
C08-36	Emergency Lift Maximum Speed	Maximum frequency when E-Lift is active.	0–150 Hz	30
C08-37	Emergency Lift Maximum Time	Maximum time that E-Lift can be active.	0–20 min	10

4. Conduct a Preliminary E-Lift Test:

   After all parameters have been configured in steps 2 and 3, the E-Lift function must be tested to ensure it can raise and lower a load properly. Conduct the following steps to verify the E-Lift function:

DANGER

If any undesired motions occur while E-Lift is active, immediately remove any RUN commands, turn off E-Lift, and contact Magnetek.

   a. Attach a test load to the hoist (rated capacity is recommended).
   b. Raise the load approximately one foot above the floor.
   c. Enable E-Lift by setting C08-35 = 1, or if an MFDI will be used, set C08-35 = 2 and turn on the physical input associated with E-Lift enable (H01-xx or F03-xx = 4A).
   d. The keypad will display “ELIFT (E-Lift Active)” to indicate that the feature is active.
   e. Perform a series of raise and lower commands and observe the test load.
   f. If setup was successful, turn off E-Lift (via C08-35 or MFDI) and return the hoist to normal operations.

5.2.20 Synchronization (C09)

Synchronization allows one or more motions to be synchronized to a Leader motor encoder signal. The Leader provides an encoder pulse reference to the Follower(s), and each Follower synchronizes its motor with the Leader's motor. The Follower monitors the pulse feedback from both the Leader encoder and its own encoder while also sending status I/O back to the Leader. The Follower will compensate for any position error by adjusting its motor speed, resulting in precise alignment between the Leader and Follower motors.

NOTE: *Synchronization is not part of the standard VFD firmware and must be purchased and unlocked. Contact Magnetek for information.*

Table 5-36: Synchronization Parameters

Parameter	Display	Function	Range	Default
C09-01	Synchronization Mode *0 Disabled* *1 Leader Only* *2 Follower (Always or by MFDI)*	Synchronization mode selection. Synchronization disabled. Leader only. Follower only or use an MFDI = 90 (Sync - Follower Mode) to switch between Leader and Follower mode.	0–2	0
C09-02	Leader Encoder PPR	Number of encoder PPR (pulses per revolution) from the Leader encoder. Copy the setting of F01-01 from the Leader VFD to this parameter.	0-60000 PPR	1024
C09-03	Leader Motor Poles	Number of Poles in the Leader Motor. Copy the setting of E02-04 from the Leader VFD to this parameter.	2-48	4
C09-04	Sync Ratio Numerator 1	Default sync ratio for the Follower. Used with C09-06. $Sync\ Ratio\ 1 = \frac{Sync\ Ratio\ Numerator\ 1\ (C09\text{-}04)}{Sync\ Ratio\ Denominator\ (C09\text{-}06)}$ ***NOTE:*** *Sync Ratio Numerator 1 is always active. If the ratio is programmed to something other than 1:1, the Follower speed will be scaled to this value.* ***EXAMPLE:*** *If C09-04 = 4 and C09-06 = 1, the ratio will be 4:1, or 4. With this ratio, every revolution of the Leader equals four (4) revolutions of the Follower.*	1-10000	1
C09-05	Sync Ratio Numerator 2	Alternate sync ratio for the Follower. Used with C09-06. $Sync\ Ratio\ 2 = \frac{Sync\ Ratio\ Numerator\ 2\ (C09\text{-}05)}{Sync\ Ratio\ Denominator\ (C09\text{-}06)}$ This ratio is selected by MFDI (H01-xx or F03-xx = 92). All motors must be stopped (Zero Speed) in order to switch ratios. A “CantSW - Motor Running” alarm will occur if trying to switch ratios while running. ***EXAMPLE:*** *If C09-05 = 250 and C09-06 = 1000, the ratio will be 1:4. With this ratio, every revolution of the Leader equals 0.25 revolutions of the Follower.*	1-10000	1
C09-06	Sync Ratio Denominator	Sync Denominator for C09-04 and C09-05.	1-10000	1
C09-07	Position P Gain	Position Proportional Gain. This increases the speed compensation based on the magnitude of the position error. Increasing this gain makes the Follower more responsive to position errors.	1-100	10

Parameter	Display	Function	Range	Default
C09-08	Position I Time	Position Integral Time. This adjusts the Follower's speed reference to compensate for any position error between the Leader and Follower over a given time period. Decreasing this time makes the Follower more responsive to position errors.	0.00-100.00 sec	0.10
C09-09	High Speed Resync Frequency	Frequency output during High Speed Resynchronization.	0.00-60.00 Hz	45.00
C09-10	High Speed Resync Revolutions	High Speed Resynchronization Level. When the Follower's Sync Error Revs (U07-04) is greater than this setting, the Follower will resynchronize its position with the Leader at high speed as set in C09-09. Disabled if set to 0.	0-1000 Rev	5
C09-12	Sync Error Detect Level	Synchronization Error Detection Level. Maximum allowable position error between the Leader and Follower before an "Out of Sync" alarm or fault occurs. When this level is exceeded, the Follower takes action according to C09-13. Use caution to not set this parameter to an unsafe level.	1-100 Rev	1
C09-13	Sync Error Action *0 None* *1 Alarm Only* *2 Fault*	Synchronization Error Action when the position error between the Leader and Follower exceeds C09-12. ***NOTE:*** *A setting of 0 or 1 should only be used for troubleshooting purposes.*	0-2	2
C09-14	Auto Resynchronization	Auto Resynchronization Selection. The Follower can accumulate or ignore position error when not running in Synchronization mode. When set to 1 or 2, the Follower will monitor the motor position of itself and the Leader. If position error develops, the Follower will correct the position error at the start of the next run.	0-2	0
	0 Disabled	Position error is held at zero when VFDs are operating independently and therefore will have to be manually resynchronized.		
	1 Enabled, Zero by UL2	Clear accumulated position error by running the motors to the Upper Limit 2 (UL2).		
	2 Enabled, Zero by MFDI	Clear the accumulated position error at any point by enabling MFDI (H01-xx or F03-xx = 91).		
C09-15	Switching Speed	The Leader motor must be running at or less than this speed to switch from a Leader to a Follower, or vice versa. If the user attempts to switch from a Follower to a Leader while above this speed, a "CantSW - Motor Running" fault will occur, and the motor will coast to stop and require a new run command. If the user attempts to switch from a Leader to a Follower, the same fault will be displayed and the motor will begin to coast to stop, but a new run command will not be required. The Follower's motor speed must be below this level before it will follow a speed reference other than the Leader.	0.0-10.0 Hz	0.5
C09-16	Advance/Retard Trim Rate	The Follower can advance or retard to the Leader's position, during a run, without accumulating position error. Every 40ms, the Leader will advance or retard this number of pulses. Applied by MFDI (H01-xx or F03-xx) = 93 (Sync - Advance) or 94 (Sync - Retard).	0-1000	20
C09-17	Store Position Error *0 Disabled* *1 Enabled*	Store Position Error to Memory. When enabled on the Follower, position error between the Leader and Follower is stored on power down and reinstated on power up.	0, 1	1

Parameter	Display	Function	Range	Default
C09-19	Run Follower Off Delay	The Run Follower MFDO (H02-xx or F05-xx = 51) will stay closed for this duration of time after the Leader begins Load Float. If the Load Float Time (C08-10) is shorter than C09-19, this delay will end early and follow the C08-10 time. This will allow the Follower to sync to the Leader's position while in Load Float. If this delay is too short, the Follower may become out of sync after every run. If C09-14 = 1 or 2, the Follower will sync to the Leader's position on every run.	0.0-10.0 Sec	0.5

5.2.20.1 Acceptable Synchronization Applications

- Speed Matching - Two (2) or more independent systems, such as independent hoists, bridges, or trolleys that are not mechanically linked or bound together.
- System needing to correct position alignment and not mechanically bound, i.e., through end truck wheels.
- Bridge applications where synchronized motors are driving opposite end trucks.

NOTE: *Synchronization does not compensate for or correct skewing.*

5.2.20.2 Non-Acceptable Synchronization Applications

- Load Sharing - Two (2) or more mechanically coupled systems or directly coupled motor shafts.
- Motor shafts coupled through gearing and wheels on the same runway.
- Bridge applications where synchronized motors are driving the same end truck.
- Hoists with a mechanical load brake or worm gearing (possible, but may have undesirable performance).

5.2.20.3 Synchronization Hardware Configuration

The Leader VFD requires one PG-X3 card. All Leader/Follower and Follower VFDs require two PG-X3 cards. Each VFD will output its motor position to the next VFD in the chain. The PG-X3 in slot CN5-C is used for motor feedback. The PG-X3 in slot CN5-B is used for the position reference from the upstream Leader or Follower VFD. For configurations with multiple Leaders, each Leader encoder must have the same PPR.

An expandable I/O option card (such as an S4IO) is typically required due to the number of inputs and outputs needed for Synchronization. In a typical Hoist motion, two digital outputs are used for brake control, and one is used for brake slipping indication. Synchronization requires outputs for “Run Follower(s)” and “Follower Ready”. Additional outputs may be needed for “Ultra-Lift”, “Overweight”, “Out of Sync” or other functions.

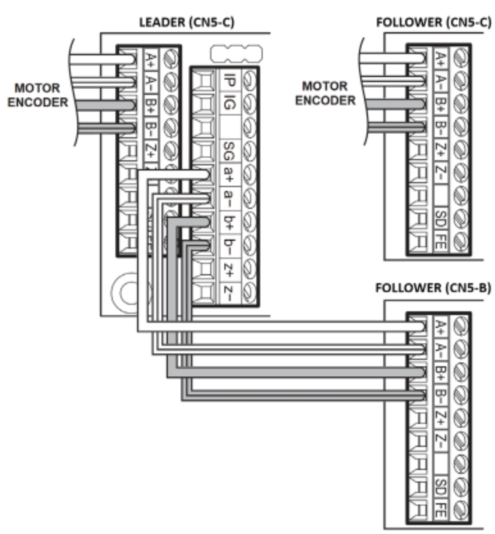


Figure 5-15: Leader-Follower Encoder Interlock Wiring

5.2.20.4 Independent Operation (e.g., A, B, Both)

It is common for a crane system to have the ability to run in Synchronization mode and also to run each motion individually. This will involve wiring/relay logic to allow a Leader to run without the Follower(s) and also for a Follower to run without the Leader.

When running the Leader independently, the Follower Ready input (H01-xx or F03-xx = 97) needs to be turned ON with external logic. When running in Follower mode, the Follower Ready input is not required.

When running a Follower in Synchronization, the run command input comes from the Run Follower output (H02-xx or F05-xx = 51) of the VFD upstream. In order to run a Follower independently, set Synchronization Mode C09-01 = 2 (Follower - Always or by MFDI) and an MFDI set to H01-xx or F03-xx = 90 (Sync - Follower Mode). This MFDI is turned ON when in Synchronization (Follower) mode, and OFF when in Independent/Leader mode.

If the user switches Sync modes while running (e.g., switched from independent to Synchronization mode via MFDI 90 “Follower Mode”), a “CantSW - Motor Running” fault will occur, requiring the run command to be cycled. The motor speed must be below C09-15 (Switching Speed) to switch Sync modes. This will allow the Follower Ready output to turn on.

If the Leader is capable of being powered down independently from the Follower, a PGo-2H fault will occur on the Follower if F01-16 ≠ 0 (Encoder 2 Detection) and the Follower is in Synchronization mode. To prevent this, use the C09-01 = 2 (Follower - Always or by MFDI) setting for the Follower(s). Enabling this input allows the Follower to run independently and won't be impacted by the power status of other VFDs.

5.2.20.5 Automatic Resynchronization

Automatic Resynchronization allows the Follower to track its position relative to the Leader. When both VFDs are running in Synchronization, there is no accumulation of position error, so alignment will be maintained. The Leader or Follower(s) can operate independently and later automatically resynchronize. This is accomplished by storing the position error while any motor is running independently. By default, the position error will be stored in memory while the VFD is powered down (see C09-17). When Synchronization is re-enabled, the Follower will run first to cancel the accumulated position error with the Leader. Once the position error has been zeroed out, the Follower will turn on the Follower Ready MFDO (H02-xx or F05-xx = 50) and the Leader will begin to run in Synchronization. The Follower will again track the pulse reference generated by the Leader.

NOTE: *During Synchronization, the oS (Overspeed) frequency is (E01-04 * F01-24) + (E01-04 / 15).*

NOTE: *While running in Synchronization, the Follower is allowed to cancel the accumulated position error at 4 Hz above the frequency reference. This allows the Follower motor to rotate up to four (4) Hz faster than the Leader in order to compensate for position error. During Automatic Resynchronization, the speed at which the Follower is allowed to cancel position error is limited to C09-09 (High Speed Resync Frequency) to allow for a faster resynchronization. It is good practice to manually align the hoists by eye to get them close to their respective positions and then let Automatic Resynchronization finish eliminating position error.*

If Automatic Resynchronization is enabled (C09-14 = 1 or 2), any position error is stored by the Follower. The position error will be naturally cleared by running the hoists in Synchronization and allowing the Follower to cancel the error, but the error can also be cleared depending on the Auto Synchronization mode:

1. **Auto Resynchronization & Zeroing with UL2 (C09-14 = 1):** The position error will be cleared by an Upper Limit 2 input (H01-xx or F03-xx = 107 or 109) and when the run command is removed. This acts as a “home” position for the Followers at which they will begin operation with no accumulated error.
2. **Auto Resynchronization & Zeroing by MFDI (C09-14 = 2):** A digital input set to Clear Sync Error (H01-xx or F03-xx = 91) on the Follower(s) will clear the accumulated error. This allows the VFDs to be set to any position (aligned with or offset from each other) and have the accumulated error cleared. The VFDs will then run at this set position while in Synchronization mode. If position error is not stored in memory during power down (C09-17 = 0), position error will always be zero upon power up.

5.2.20.6 Position Error Handling

Position error is the difference in motion between the Synchronized Leader and Follower(s). The Synchronization function tracks the amount of position error, and the Follower(s) will eliminate the error during operation.

NOTE: *The b02 parameters do not affect Synchronization speed references.*

When the Leader operates in the forward direction, monitor U07-03 (Sync Error Counts) of the Follower should display a positive value. If it does not, it may be necessary to reverse the channel A+ and A- wires of the Follower's PG-X3 in slot CN5-B.

If U07-03 (Sync Error Counts) on the Follower is positive, a run should rotate the motor in the proper direction and the Follower's U01-05 (Motor Speed) monitor should display a positive value. If the motor direction is incorrect, it may be necessary to reverse any two of the motor leads on the VFD. If the motor fails to rotate, or is unstable, it may be necessary to reverse the channel A+ and A- wires of the PG-X3 in slot CN5-C.

5.2.20.7 Electronic Gear Ratios

Electronic Gear Ratios is a feature available for a Follower. This allows the Follower to operate at a ratio of the Leader to accommodate differences in motor speeds through a gearbox. Two separate ratios may be used if the Follower is required to follow different Leaders. Encoders with PPRs (Pulses Per Revolution) that differ from the Follower can also be accommodated. See parameters C09-04 through C09-06 to configure the gear ratio numerator and denominators.

NOTE: *For applications with 3+ VFDs and multiple Leaders, their encoders must have identical PPR.*

5.2.20.8 Synchronization with Ultra-Lift

It is highly recommended that Ultra-Lift is configured to only run above base speed with no load. For proper Ultra-Lift operation, the Follower will provide a signal to the Leader when it is ready to run above base speed. When running the Leader independently, the Sync Ultra-Lift Enable MFDI (H02-xx or F05-xx = 53) must be ON in order to use Ultra-Lift, which may require external relay logic.

REQUIRED WIRING INTERLOCK: A digital output from the Follower set to H02-xx or F05-xx = 53 (Sync - OK for Ultra-Lift) is wired to a digital input of the Leader set to H01-xx or F03-xx = 98 (Sync - OK for Ultra-Lift).

NOTE: *C06-06 (Ultra-Lift Enable Window) may need to be increased on the Follower, if it won't successfully go into Ultra-Lift.*

5.2.20.9 Synchronization with Weight Measurement System

Weight Measurement System can be utilized along with Synchronization. It is required that the acceleration times match between the Leader and Follower(s). Weight Measurement should be calibrated on each hoist prior to configuring Synchronization.

NOTE: *Weight Measurement of a Follower may be less accurate due to the continuous position corrections to stay synchronized with the Leader. When the Follower slows down or speeds up its motor, the torque feedback will change, which correlates with a change in weight.*

5.2.20.10 Synchronization with Travel Limits

Slow Down (UL1/LL1) & Stop (UL2/LL2) limit inputs are ignored by the Follower(s) during Synchronization. The limits will be observed by the Leader, during which the Leader speed reference will decrease, and the Follower(s) will follow. Upper and Lower Limit 3 (UL3/LL3) is always active for the Leader and Follower.

When Automatic Resynchronization is used, the Follower Ready output will remain off until all position error is removed. If the Follower is in an Upper or Lower Limit (UL2/LL2), it may not be able to resynchronize in the appropriate direction. In this case, the Follower Ready signal will be turned on during Resynchronization thus causing the Leader and Follower to move simultaneously and additional position error may be accumulated without causing an “Out of Sync” fault. During automatic resynchronization, if the motor speed is greater than the slow down limit speed, the P and I limits will be limited to half the respective slow down limit speed.

5.2.20.11 Synchronization with Load Check

Load Check and Synchronization are not recommended to be used together. Load Check involves brief pauses and measurements at specific speed zones, which will cause the Leader and Follower(s) to maintain Synchronization. Load Check is also not intended for hoists that are lifting in tandem and require cumulative overload protection.

The recommended solution is to use the Weight Measurement System (C10) functions for synchronized tandem lift applications. These functions will perform weight measurements, without speed pauses, for more reliable overload protection.

5.2.20.12 Synchronization with Slack Cable

Slack Cable and Synchronization will not reliably function together due to how the Follower is matching its speed with the Leader.

5.2.20.13 Synchronization I/O Summary

The following list is a summary of the inputs, outputs, and monitors that are available for Synchronization. Some of these settings are required for proper operation and many are optional. Reference the “Control I/O Parameters (H)” section for more information specific to each setting.

Digital Inputs (H01-xx or F03-xx):

- **90** (Sync - Follower Mode) - Required on Follower in order to run independent.
- **91** (Sync - Clear Sync Error)
- **92** (Sync - Ratio Numerator 2)
- **93** (Sync - Advance)
- **94** (Sync - Retard)
- **97** (Sync - Follower Ready)
- **98** (Sync - Ultra-Lift)

Digital Outputs (H02-xx or F05-xx):

- **50** (Sync - Follower Ready) - Required on Follower
- **51** (Sync - Run Follower(s)) - Required on Leader
- **52** (Sync - Out of Sync)
- **53** (Sync - OK for Ultra-Lift)
- **152** (!Sync - Out of Sync)

Monitors (U07-xx):

- **U07-01** (Leader Reference)
- **U07-02** (Gear Ratio Ref)
- **U07-03** (Sync Error Counts)
- **U07-04** (Sync Error Revs)
- **U07-05** (Proportional Correct)
- **U07-06** (Integral Correction)

5.2.21 Bucket Control (C09)

Bucket Control is a function designed to control multi-line clamshell or grapple buckets that use separate Holding and Closing lines (or ropes).

Two VFDs work in tandem to control the Holding and Closing lines.

- Holding line: Leads the lifting and lowering of the bucket.
- Closing line: Controls the opening and closing of the bucket.
- Raising direction: VFDs operate in torque control mode, to share the load and keep the bucket closed.
- Lowering direction: VFDs operate in speed control mode to optimize productivity.

Although each VFD operates independently, the Bucket Control function provides integrated and versatile control without the need for a PLC.

NOTE: *Bucket Control is not part of the standard VFD firmware and must be purchased and unlocked. Contact Magnetek for information.*

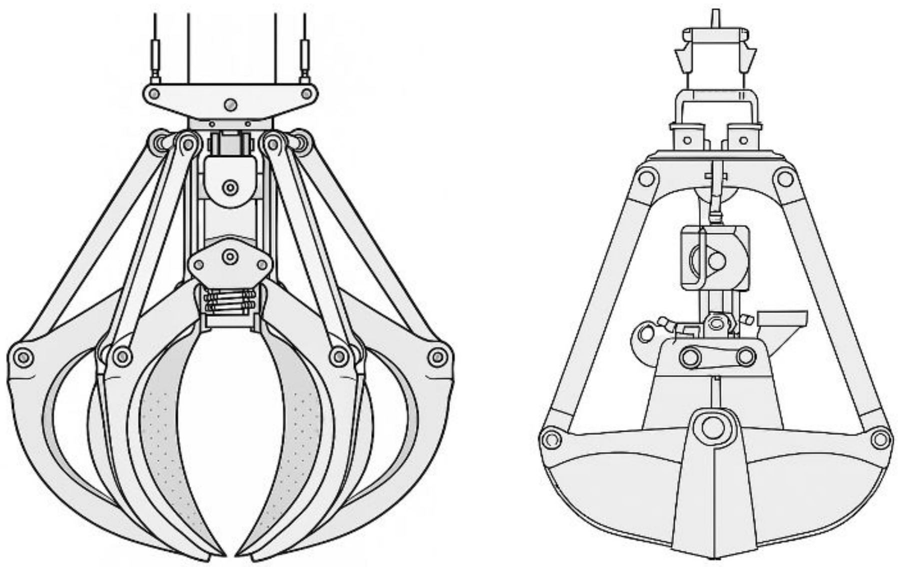


Figure 5-16: Typical Grapple and Clamshell Bucket

Table 5-37: Bucket Control Parameters

Parameter	Display	Function	Range	Default
C09-50	Bucket Control *0 Standard Bucket Controls* *1 Closer Motion* *2 Holder Motion*	Bucket Control mode selection. Use the “Standard Bucket Controls” setting for the Closer and Holder unless the Auto-Grab function is used. For Auto-Grab, set C09-50 = 1 for the Closer VFD and C09-50 = 2 for the Holder VFD. Auto-Grab requires a second PG-X3 encoder card on both VFDs.	0–2	0
C09-51	Torque Reference 1	Torque reference 1 when a digital multi-step torque reference is used.	0-250%	20*
C09-52	Torque Reference 2	Torque reference 2 when a digital multi-step torque reference is used.	0-250%	40*
C09-53	Torque Reference 3	Torque reference 3 when a digital multi-step torque reference is used.	0-250%	60*
C09-54	Torque Reference 4	Torque reference 4 when a digital multi-step torque reference is used.	0-250%	80*

Parameter	Display	Function	Range	Default
C09-55	Torque Reference 5	Torque reference 5 when a digital multi-step torque reference is used.	0–250%	100*
C09-56	Store Position Error *0 Disabled* *1 Enabled*	(Holder VFD only) Store the bucket position (U07-10, U07-11, U07-12) to memory. When enabled, position is stored on power-down and reinstated on power-up.	0, 1	1
C09-57	Bucket Open Revs	(Holder VFD only) Delta in motor revolutions between the Holder and Closer when the bucket is fully open. Enter the number displayed in U07-12 (system must be homed first) when the bucket is fully open. This will set 100% scaling for an analog output (H04-0x = 712) display.	-9999–9999 Rev	250
C09-58	Bucket Closed Threshold	(Holder VFD only) Threshold of a fully closed bucket (tolerance/hysteresis) for MFDO 3B that indicates whether the bucket is closed. For example, if the bucket is digging in a river and clamps on a log, the closed indicator may never turn on because the bucket starts to rise before it can fully close. Adjust this threshold in terms of motor revolutions to offset the closed position. This can also be used while digging (closer raising) and the operator wants to determine when to begin raising the holding line (slightly before the bucket is fully closed).	0–100 Rev	5
C09-59	Switching Speed	Switching level between speed and torque mode. This rarely needs to be modified.	0.0–10.0 Hz	1.0
C09-60	Variable Speed Limits *0 Disabled* *1 Enabled*	Sets a maximum motor speed for each torque step, using the associated Speed Reference (b01-xx) parameters. Optionally enable by MFDI = 5A.	0, 1	0
C09-61	Load Balancer *0 Disabled* *1 Enabled: Feedback MFAI = 20*	(Holder VFD only) Increase or decrease the frequency reference of the Holder to balance the load between the Holding and Closing lines.	0, 1	0
C09-62	Load Balancer Frequency Window	(Holder VFD only) Maximum frequency offset to balance the load with the Closer (lifting direction only).	5-20 Hz	5
C09-63	Load Balancer Torque Window	(Holder VFD only) Holder will begin adjusting its speed when the Closer torque feedback is above this level.	5–50%	10
C09-71	Auto-Grab Close Distance	Percentage of the Close distance this VFD is responsible for. The Sum between the Closer and Holder will typically equal 100%. Auto-Grab only applies to C09-50 = 1 or 2.	-50–150%	Closer: 90 Holder: 10
C09-72	Auto-Grab Speed	Output frequency during the Auto-Grab Process. When the correct operation of Auto-Grab has been verified, increase this value in both VFDs to increase cycle rate.	1.0–150.0 Hz	Closer: 20.0 Holder: 10.0
C09-73	Auto-Grab Torque Restore Time	Time to reset the torque reference after the bucket has closed. This restores the MFAI torque reference at a rate of 100% / C09-73 seconds.	0.1–5.0 sec	1.0

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.2.21.1 Typical Dual-Axis Master Switch Configuration

Available Speed References (A01-04):

- **Uni-Polar (0-10 V) Analog (Recommended):** Independent raise, lower, and proportional (stepless) analog speed and torque references.
- **2-Speed Multi-Step:** Independent raise, lower, 2nd speed/torque references.
- **3-Speed Multi-Step:** Independent raise, lower, 2nd, and 3rd speed/torque references.
- **5-Speed Multi-Step (Recommended):** Independent raise, lower, 2nd to 5th speed/torque references.
- ***NOTE:*** *Infinitely Variable and Bi-Polar Analog are not available.*

Typical Master Switch Details:

- The figure below displays the recommended master switch operation.
- Gates are NOT recommended and can restrict the operator's precision and timing control of the bucket.
- Detents are helpful for ensuring equal references to both VFDs during certain operations.
- A spring return-to-center is recommended.

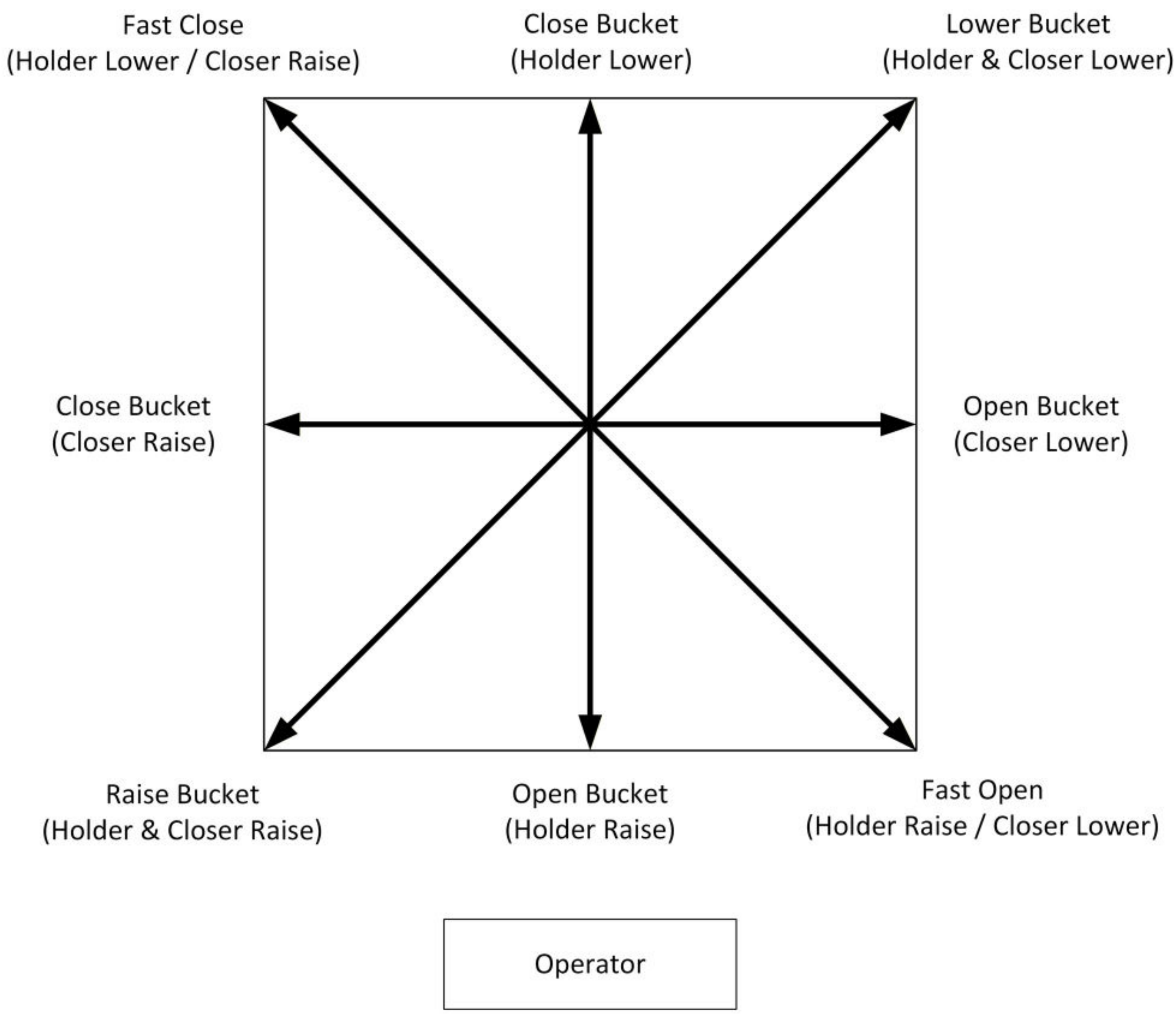


Figure 5-17: Typical Dual-Axis Master Switch Configuration

5.2.21.2 Bucket Control Initial Startup

Perform the following steps in numerical order:

1. De-couple the motor shafts from the gearbox and Auto-Tune both VFDs to their respective motors. After the Auto-Tune is complete, re-couple the motor shafts.
2. Verify both VFDs are programming as desired. Verify A01-03 = 3 (Bucket). Set A01-04 (Speed Reference) per the type of master switch being used. If desired, configure additional features, and their associated I/O, for the application (such as end of travel limits).
3. Verify proper operation of the master switch. Refer to the Master Switch Configuration section for a diagram of the typical control configuration. Verify that when raising, the VFD indicates forward motion on the keypad and that the reference is proportional to the deflection of the master switch. Verify that when lowering, reverse motion is displayed on the keypad and that the reference is proportional to the deflection of the master switch. ***NOTE:*** *U01-15, U01-16, or U01-17 (Terminals A1, A2, or A3) should have an equal reference from the master switch when using analog control.*
4. Verify that the electric brake is functioning properly and no alarms occur when a run command is given.
5. Reeve the hoists and attach the bucket or grapple.
6. Verify proper operation of all quadrants of the master switch.
7. With an empty bucket, configure the end of travel limits and verify that they function properly.
8. If required, perform a load test and ensure control is maintained in both directions.

5.2.21.3 Bucket Control Operation Notes

1. In the lowering direction (speed control), maximum speed is limited by E01-04 (Maximum Output Frequency). When using an analog master switch, speed is proportional to the master switch reference, and it is recommended to set H03-02 (Terminal A1 Gain) = 100%. This sets the percentage of E01-04 that the VFD will output when the master switch is given 100% reference in the down direction. When using a stepped master switch, each step is programmed to a preset speed reference, not to exceed E01-04.
2. In the raising direction (torque control), maximum speed is limited by d05-04 (Speed Limit) and by the amount of torque required to accelerate to the speed limit. For both analog and digital torque references, the torque output is ultimately limited by the C07-xx (Torque Limit) parameters.
3. After digging and the bucket is fully loaded, the closing hoist should not be able to reach the speed limit. If it does, or the holding lines are too slow to catch up, adjustments should be made. If using an analog torque reference, the analog gain should be lowered. If using digital torque references, adjust the torque steps (e.g., 5th point) so that the closing line will slow down. The closing line will then be able to speed up once the holding hoist starts to help lift the bucket.
4. The Holding line VFD should be programmed for approximately 5-10% less torque than the Closing line VFD. This allows the closing line to apply slightly more torque and ensure that the bucket remains closed. If it does not, for an analog torque reference, lower the torque on the holding hoist by a small percentage less than the closing hoist. For a digital torque reference, lower each torque reference step on the holding hoist by a small percentage less than the closing hoist. Generally, less than a 10% torque reference difference is required.
5. Acceleration times are ignored in the raising direction. The VFD will accelerate the motor to the programmed speed limit as fast as it can using its given torque reference. The b05-01 (Acceleration Time) parameter is used in the lowering direction. All possible deceleration times are in effect while stopping, depending on the deceleration time priority.
6. Quick Stop and other deceleration times should be set the same on both VFDs. Though, it may be desirable to set the Quick Stop time slightly longer on the holding VFD to ensure the bucket cinches tight when stopping.

5.2.21.4 Bucket Position and Status Indication

Bucket Position and Status Indication provide feedback to the operator to show the position of the bucket. When using this as a status indicator, the operator can see if the bucket is fully open (1 to 100%) or fully closed (0%). The Holder VFD can be programmed to provide an analog or digital output to indicate this information. Using this first requires that the bucket is homed at its closed position, via MFDI A0.

NOTE: *This function requires that the Holder VFD has a second PG-X3 encoder option card. The PG-X3 output on the Closer VFD is wired to the inputs of the second PG-X3 on the Holder VFD.*

Perform the following steps in numerical order:

1. On the Holder VFD, toggle MFDI A0 (Bucket - Set Closed Position) to reset the U07-xx counters.
2. Raise the Closer hoist briefly while monitoring U07-10 and ensure the value is positive. Repeat this for the Holder hoist.
3. Raise the Closer hoist briefly while monitoring U07-11 and ensure the value is positive. If one of the monitors shows positive while the other shows negative, swap the encoder A+ and A- wires on the middle PG-X3 option card or change the setting of parameter F01-12. Ensure that a forward run command results in a raising motion. Repeat this for the Holding hoist.
4. Close the bucket completely and ensure that there is no slack in any of the lines.
5. On the Holder VFD, toggle MFDI A0 (Bucket - Set Closed Position) to reset the counters and home the closed position.
6. Completely open the bucket using only the Closing hoist. Verify U07-12 shows a positive value.
7. On the Holder VFD, record the value shown in U07-12 and enter it into C09-57 (Bucket Open Revs).
8. If using an analog display module, set H04-0x = 712 (Bucket Delta Revs).
9. If using a digital display module, set H02-0x or F05-0x = 3B (Bucket Closed).
10. Verify proper wiring and operation of the analog and/or digital display device.

5.2.21.5 Variable Speed Limits

Variable Speed Limits (C09-60) are used to assign a speed limit to each torque step. Some applications may require more precise speed control while lifting a light load at slow speeds. Using this feature can prevent light loads from going to full speed.

NOTE: *When using this feature, it must be enabled on both VFDs.*

Configuring Variable Speed Limits (Multi-Step)

The b01-01 to b01-05 speed reference parameters act as speed limits for torque steps C09-51 to C09-55. When the speed limit has been reached, the torque reference may automatically get reduced to maintain the speed.

Configuring Variable Speed Limits (Analog)

A jumper wire is placed between the A1 and A3 terminals to link together the torque and speed references. Alternatively, set H03-20 = 2 (Terminal A1 to A3) to electronically bridge together A1 and A3 without a physical wire. Connect the analog signal from the master switch to the A1 terminal. The torque and speed reference will be proportional but can be offset by adjusting the H03-xx gain and bias parameters.

Example 1: The operator requires higher speed availability at lower master switch levels but wants a steady torque progression along the deflection range. Set a gain of 200% and a bias of 25% for the A1 analog input. As a result, a 25% master switch deflection will provide 25% torque and the speed of around 40 Hz.

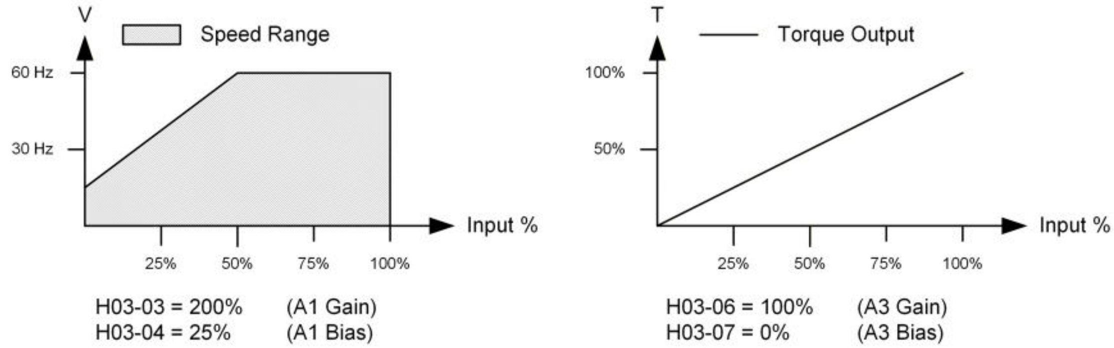


Figure 5-18: Variable Speed Limits Example 1

Example 2: The operator wants a lot of torque with little master switch deflection but wants a steady progression of speed along the deflection range. Set a gain of 200% to the A3 analog input. As a result, a 50% master switch deflection will provide 100% torque and the speed of around 30 Hz. Any further deflection will continue to provide 100% torque, and the speed will steadily increase up to the speed limit.

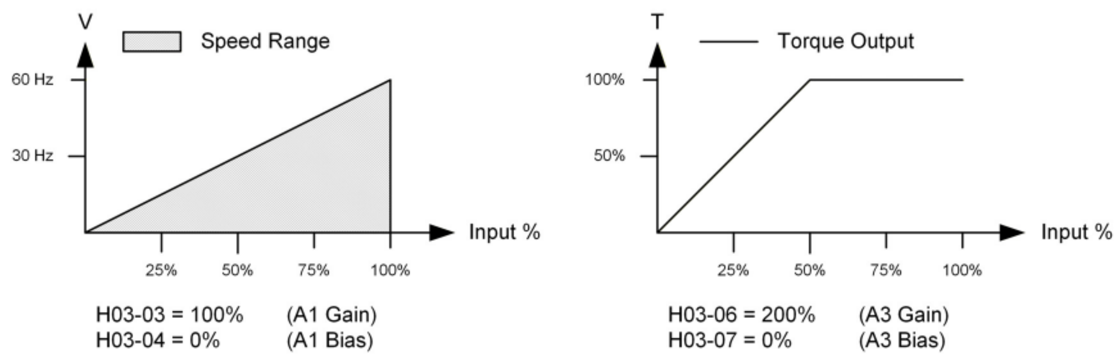


Figure 5-19: Variable Speed Limits Example 2

5.2.21.6 Load Balancer

Load Balancer (C09-61 to C09-63) is used to remove slack in the holding line when lifting at maximum speed. During a typical bucket lift, the Closer motor and Holder motor are both lifting the load at the same speed. Ideally the Closer will be running at a slightly higher torque reference than the Holder to maintain a closed bucket. With a heavy load, this is easy to accomplish. With light loads, the Closer may be able to lift the full load itself, and the Holder may have slack on the lines for the entire lift. Load Balancer equalizes the torque between the Holder and Closer so that even under a light load, both are doing some of the work.

To balance the torque, a torque reference analog output from the Closer VFD is interlocked to an analog input of the Holder VFD. The Holder VFD will adjust its output frequency to pull in or let out additional line to balance the load with the Closer. This will ensure that the bucket stays closed, and the load is shared.

This feature can allow the Holder VFD to automatically run above base speed. This is not considered Ultra-Lift and since the load will be low, control of the load is maintained.

Configuring Load Balancer with Torque Feedback

Load Balancer uses the torque reference from the Closer VFD to determine the speed required to take up the extra slack in the holding line. If the Closer VFD is outputting significantly more torque than the Holder VFD, it is assumed the Holder has fallen behind.

Holder VFD settings:

1. Analog Input (H03-xx) = 20 (Bucket Load Balancer Reference).
2. Set C09-61 = 1 (Enabled: Feedback MFAI = 20) to enable Load Balancer.
3. Set C09-62 (Load Balancer Speed Extension) to the desired speed window. This will allow the Holder to slow down or speed up, with respect to the Closer, to share the load.
4. Adjust C09-63 (Load Balancer Torque Window) to take up any slack in the holding line when lifting the bucket at full speed. The Holder VFD will start adjusting its speed when the Closer's torque level is higher than this setting (in the positive and negative torque polarity).
5. **Wire Interlock:** Wire an analog output from the Closer VFD to an analog input on the Holder VFD.

Closer VFD settings:

1. Analog Output (H04-xx or F04-xx) = 109 (Torque Reference).

5.2.21.7 Auto-Grab

Auto-Grab (C09-71 to C09-73) automates the closing and lifting of the bucket. It works best when digging into soft materials. The operator simply presses the Auto-Grab button (MFDI A2) and moves the master switch to the lower left corner (raise bucket). Auto-Grab will automatically close the bucket by lifting the closer and optionally lowering the holder. Once the bucket is closed, control is returned to the operator. Since the master switch is in the lower-left corner, this will result in the closed bucket lifting off the pile like a normal lift operation.

Example of an Auto-Grab operation:

1. Lower the bucket onto the pile, removing as much slack as possible from the lines.
2. Press the Auto-Grab button and move the master switch to lower-left corner (raise bucket).
3. The Closer and Holder will move their specified distances set in Auto-Grab Close Distance (C09-71), with respect to U07-12 (Bucket Delta Revs), at the Auto-Grab Speed (C09-72) to close the bucket.

NOTE: *The C09-72 speed is set low, by default, to not slam the bucket closed. This speed can be increased as desired.*

4. When the Closer and Holder are both stopped (and the bucket is closed), lifting torque will be restored at the rate specified in Auto-Grab Torque Restore Time (C09-73) until the torque output equals the torque reference, or the motor speed reaches speed agree (i.e. 60 Hz).

Since the VFDs are unaware of slack in the lines, it is the operator's responsibility to ensure that there is minimal slack in the lines before initiating the Auto-Grab function. Failure to do so may result in mechanical fatigue as slack is harshly taken out of the lines at high speed.

Example 1: Holder lowers slowly while digging

Closer VFD settings:

- C09-71 (Auto-Grab Close Distance) = 90%
- C09-72 (Auto-Grab Speed) = 60.0 Hz (Closer runs quickly to maximize production)

Holder VFD settings:

- C09-71 (Auto-Grab Close Distance) = 10%
- C09-72 (Auto-Grab Close Speed) = 10.0 Hz (Holder will slowly lower the bucket as it auto-grabs)

Example 2: Holder lifts slowly while digging

Closer VFD settings:

- C09-71 = 110% (Closer takes up more than 100% to compensate for the negative Holder distance)
- C09-72 = 60.0 Hz (Closer runs quickly to maximize production)

Holder VFD settings:

- C09-71 = -10% (Negative distance to open the bucket further)
- C09-72 = 10.0 Hz (Holder will slowly lift the bucket as it auto-grabs)

Note that, in both examples, the sum of C09-71 on the Holder and Closer equals 100%.

5.2.21.8 Hook Height Set Points

Hook Height Set Points (C03-60 to C03-63) allow an operator to easily store two location points, using a push button (MFDI 70 or 71), and alert them when they are above, below, or between these locations. This can be useful in applications such as underwater dredging or removing materials from inside of a ship where the operator may not be able to see the bucket as it approaches the loading point.

For example, as the operator lifts the bucket off the pile, a button is pressed to store the position of the bucket. On the next lowering, a digital output (MFDO 26 or 27) will close when the bucket is below the stored point. This will indicate that the bucket is near the pile. As the operator is lifting the bucket, another set point can be programmed, perhaps to avoid an obstacle.

NOTE: *Set points are retained in C03-61 and C03-63, even when the VFD is powered off.*

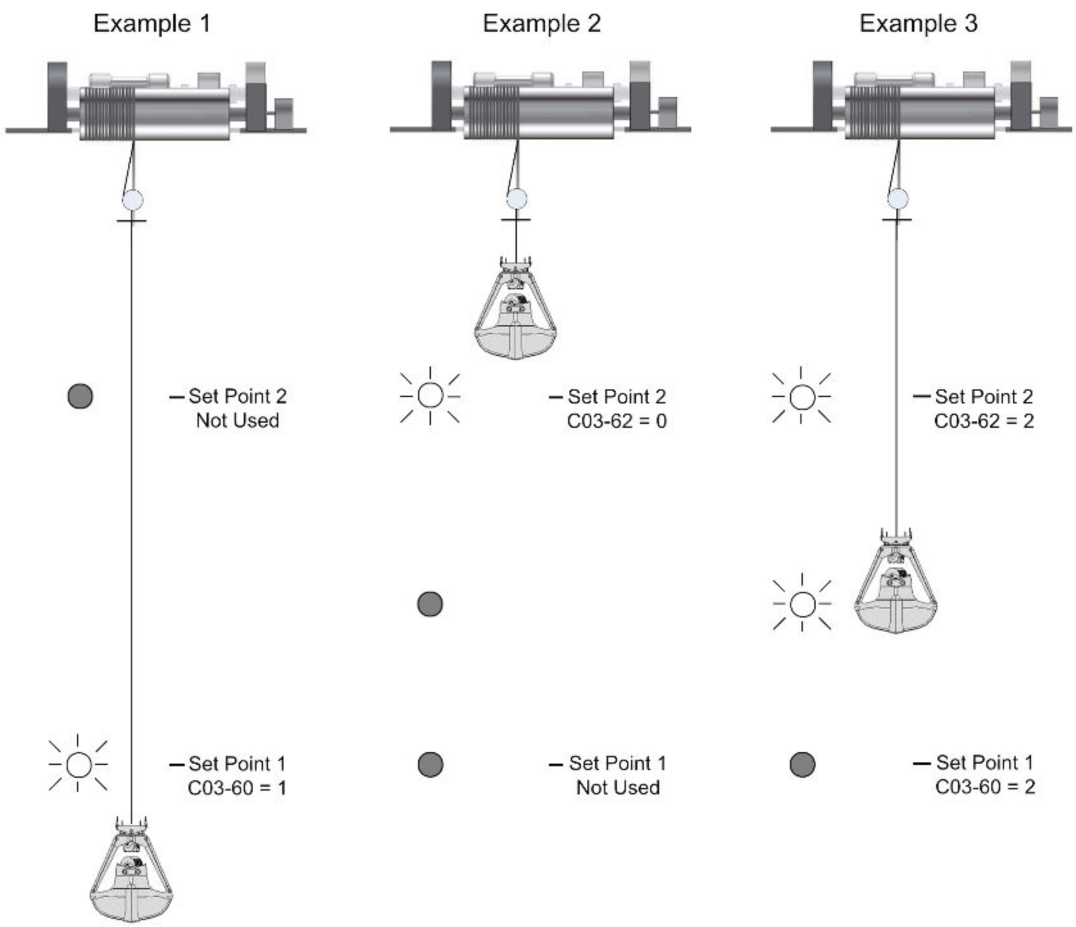


Figure 5-20: Hook Height Set Points Example

5.2.21.9 Bucket with Ultra-Lift

It is highly recommended that Ultra-Lift is configured to only run above base speed with a near-empty bucket. It is important to verify that the equipment design can run above motor base speed and that both hoists have enough motor torque available to run above base speed and maintain control of the load while lowering. For this reason, set the Ultra-Lift Reverse Torque (C06-05) such that Ultra-Lift is not enabled when there is a load present. Also, when using an analog speed reference, the analog input gain must be set properly. See the C06 parameter section for details on how to configure Ultra-Lift.

For Ultra-Lift to function properly in Bucket mode, d05-04 (Speed Limit) must be set according to the following equation: (E01-06 / E01-04) * 100 to limit the maximum speed in the raising direction. If this is not done, the VFD will always run at the Ultra-Lift speed in the up direction and will likely trigger an oS (Overspeed) fault.

NOTE: *Ultra-Lift works in the lowering direction only.*

REQUIRED WIRING INTERLOCK: For proper Ultra-Lift operation, the Closing and Holding VFDs will send a signal to each other when ready to run above base speed. On both VFDs, wire a digital output set to H02-xx or F05-xx = 3A (Ultra-Lift Ready) to a digital input on the other VFD set to H01-xx or F03-xx = A1 (Bucket - OK for Ultra-Lift).

5.2.21.10 Bucket with Anti-Shock

Anti-Shock and Bucket will not reliably function together due to torque control in the lifting direction.

5.2.21.11 Bucket with Slack Cable

Slack Cable and Bucket will not reliably function together due to how the Holding and Closing VFDs match speed and share the load.

5.2.21.12 Bucket Control I/O Summary

The following list is a summary of the inputs, outputs, and monitors that are available for Bucket Control. Some of these settings are required for proper operation and some are optional. Reference the “Control I/O Parameters (H)” section for more information specific to each setting.

Digital Inputs (H01-xx or F03-xx):

- **5A** (Variable Speed Limits)
- **70** (Hook Height SP1)
- **71** (Hook Height SP2)
- **A0** (Bucket - Set Closed Position)
- **A1** (Bucket - OK for Ultra-Lift)
- **A2** (Bucket - Grab)
- **A3** (Bucket - Switch to NLB)

Digital Outputs (H02-xx or F05-xx):

- **26** (Hook Height SetPoint 1)
- **27** (Hook Height SetPoint 2)
- **3A** (Ultra-Lift Ready)
- **3B** (Bucket Closed) - Holder VFD only

Analog Inputs (H03-xx):

- **20** (Bucket Load Balancer Reference) - Holder VFD only

Analog Outputs (H04-xx or F04-xx):

- **710** (Bucket Motor 1 Revs)
- **711** (Bucket Motor 2 Revs)
- **712** (Bucket Delta Revs)

Monitors (U07-xx):

- U07-10 (Bucket Motor 1 Revs)
- U07-11 (Bucket Motor 2 Revs)
- U07-12 (Bucket Delta Revs)

5.2.22 Weight Measurement System (C10)

Weight Measurement System (WMS) is a function used in hoisting applications to perform overload checks on an individual hoist or on a chain of multiple hoists. WMS contains two functions:

1. Weight Measurement
2. Load Summing

The VFD, in closed loop vector (CLV) mode, calculates a load weight based on motor torque or with a load cell that feeds an analog signal back to the VFD. In the V/f and open loop vector (OLV) modes, WMS is only available if using a load cell. The measured weight can be output as an analog signal to a scoreboard display, PLC HMI, or other type of display. Additionally, multiple hoists can be chained together, sum their measured weights, and detect an overload of the overall crane structure. WMS may be suitable as a load cell alternate when tight accuracy and precision is not required.

For Weight Measurement, the terms “Crane” and “Hoist” have specific meanings. “Hoist” refers to a single lifting motion controlled by a single VFD. “Crane” refers to a multitude of “Hoists” which are configured to sum together their weights.

WMS can be configured to be always enabled or to have the ability to turn on/off using a digital input. For the latter, set an MFDI (H01-xx or F01-xx) = 4D or 14D (Load Weight/Sum Enabled).

5.2.22.1 Weight Measurement

The Weight Measurement function measures the weight continuously during a lift by comparing against torque samples at a low speed and high speed (typically 6 Hz and 60 Hz). These measurements are taken during acceleration and steady speed. This allows the VFD to calculate the load weight regardless of how the hoist is operated, much like a load cell. Even with a constant load, motor torque varies depending on many factors such as acceleration, weight of ropes/reeving, motor temperature, gearbox temperature, and motor speed (i.e., gearbox losses). Since there are several data points, a setup process is required to properly calibrate the system.

When lowering the hoist, the previously measured weight will be held and will continue to be displayed. When the torque during Load Float is lower than a set level (C10-19), it indicates that the load has been set down, and the measured weight will be zeroed out.

5.2.22.2 Weight Measurement Limitations

Torque during acceleration varies depending on the rate of acceleration. For this reason, acceleration times cannot be changed once Weight Measurement has been enabled. Changing acceleration times will affect the measured weight and the setup process will need to be redone.

Weight is measured only while lifting the load. If weight is removed or added when the hoist is idle or lowering, the VFD will not be able to detect the change until the next lift.

Measured torque at very low speeds can be unreliable. For this reason, weight is not measured below C10-04 (6 Hz, by default). The correlation between motor torque and weight is most reliable in the constant torque region, up to Base Frequency (E01-06). Because of this, WMS will not function above base frequency in the constant power region (Ultra-Lift).

The wire rope weight is not factored into the weight calculation, so large hoists with very long lift distances will have a measured weight variance at the top of travel versus the bottom.

Accuracy is estimated to be +/- 5% of the hoist capacity but will vary with motor temperature. For example, for a 50 ton hoist, the measured weight will be within +/- 5,000 pounds across any lifted weight. Lifting a load closer to maximum capacity will have better accuracy than a light load. Also, a cold motor will read lower torque values than a hot motor which means that accuracy will be worse for motors that experience high temperature swings. Accuracy will be best when the motor is at the temperature WMS was setup at. For high accuracy, a load cell is recommended.

5.2.22.3 Load Summing

The rated lifting capacity of a crane may depend on many factors. Detecting an overload on a hoist with only one hook is fairly straightforward. Some cranes have multiple hoists on one bridge, each capable of lifting more than half of the bridge's total capacity. It's also possible that multiple cranes may lift a load in tandem that is beyond the capacity of the rails or structure. In these instances, it is desirable for each hoist to measure its load, sum all the loads together, and determine if the load sum exceeds the system capacity.

Load Summing is used in parallel with Weight Measurement and is implemented using a daisy chain setup, meaning each VFD accepts a Load Sum analog input from the previous VFD(s), adds its own measured weight, and then passes the total to the next VFD via analog output. If, at any point in the chain, the total weight is above the set threshold, the system will trigger an Overweight (OW) alarm or fault. An Overweight Warning point can also be configured as an indicator.

5.2.22.4 Hoist Weight vs. Crane Weight Sum

There are two weight values that Weight Measurement System (WMS) calculates. The Hoist Weight is the measured weight of the individual hoist. It can be monitored via U01-31 (Hoist Weight) and output as an analog signal MFAO 131 (Hoist Weight). The Crane Weight Sum is the Hoist Weight plus the Load Sum Chain weight analog input (MFAI 1A). The Crane Weight Sum can be monitored via U01-32 (Crane Weight Sum) and output as an analog signal MFAO 132 (Crane Weight Sum).

5.2.22.5 Overweight Detection

There are two weight measurements that each VFD may have awareness of. The first measurement is the weight of its own hoist, which is compared to the C10-30 and C10-31 hoist overweight detection levels. In a load summing configuration, each VFD should have a digital output configured for the overweight detected condition (MFDO = 15 “Overweight Detected”). This output should then be wired to a digital input on the other VFDs and configured as an external overweight (MFDI = 50 or 150 “External Overweight”). This ensures that one overloaded hoist will cause the other hoists to also stop. The second measurement is the summed weight that gets passed from one VFD to the next. Each VFD will measure its weight, add to the weight sum of the previous VFD(s) and then compare it to the C10-32 and C10-33 crane overweight detection levels. If a crane overweight is detected the overweight MFDO mentioned previously will close and cause all hoists to stop.

Table 5-38: Weight Measurement System Parameters

Parameter	Display	Function	Range	Default
C10-01	Load Weight Measurement	Weight Measurement selection using motor torque feedback or a load cell via analog input. Setup can be accomplished by manually setting the Feedback parameters or using an automated setup process (setting 3 or 6). After setup is complete, the Feedback settings can be fine-tuned for improved accuracy (settings 4, 5, 7-10).	0–11	0
	0 Disabled			
	1 Enabled - Motor Torque	Use motor torque for weight measurements.		
	2 Enabled - Load Cell	Use load cell analog input for weight measurements.		
	3 Setup using Torque Feedback	Begin automated setup process using motor torque.		
	4 Fine-tune Unloaded Torque	Fine-tune C10-11 to C10-14 (motor torque).		
	5 Fine-tune Loaded Torque	Fine-tune C10-15 to C10-18 (motor torque).		
	6 Setup using Load Cell Feedback	Begin automated setup process using a load cell.		
	7 Fine-tune Unloaded Load Cell	Fine-tune C10-11 to C10-14 (load cell).		
	8 Fine-tune Loaded Load Cell	Fine-tune C10-15 to C10-18 (load cell).		
	9 Fine-tune Mid Torque	Fine-tune C10-20 to C10-23 (motor torque).		
	10 Fine-tune Mid Load Cell	Fine-tune C10-20 to C10-23 (load cell).		
	11 Clear Feedback Values	Clear C10-11 to C10-18 and C10-20 to C10-23.		
	NOTE: *V/f and OLV only have access to the Load Cell selections.*			
C10-02	Hoist Display Conversion	Determines Load Weight Conversion for U01-31. Digits: 5th 4th 3rd 2nd 1st 0 0 0 0 0 The first through fourth digits equal 100% weight. The fifth digit sets the decimal point position as: 5th digit = 0: displayed as 0000 5th digit = 1: displayed as 000.0 **Example 1:** If 100% torque is equal to 200.0, set C10-02 = 12000. 100% of this reference is displayed as 200.0 and 60% of this reference is displayed as 120.0. **Example 2:** If 100% torque is equal to 65.00, set C10-02 = 26500. 100% of this reference is displayed as 65.00 and 60% of this reference is displayed as 39.00.	1-39999	11000

Parameter	Display	Function	Range	Default
C10-03	Hoist Display Units *0 Tons* *1 Pounds* *2 Kilograms* *3 Metric Tons* *4 Percent Load* *5 No Units*	Units displayed for the Hoist Weight (U01-31) monitor	0-5	4
C10-04	Minimum Test Frequency	Frequency at which weight measurements will begin. This is also the Steady Speed 1 calibration point.	0-20 Hz	6
C10-05	Steady Speed Settling Time	Delay after reaching steady speed before a weight measurement will be taken. The transition from acceleration to steady speed may cause a torque ripple, and this delay will ignore that ripple.	0.00-2.55 sec	0.50
C10-06	Acceleration Settling Time	Delay after starting to accelerate before a weight measurement will be taken. Acceleration may cause a torque spike, and this delay will ignore that spike.	0.00-2.55 sec	0.30
C10-11	Unloaded Feedback at SS 1	No Load Torque at Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-12	Unloaded Feedback at SS 2	No Load Torque at Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-13	Unloaded Feedback at Accel 1	No Load Torque during acceleration to Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-14	Unloaded Feedback at Accel 2	No Load Torque during acceleration to Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-15	Loaded Feedback at SS 1	Full Load Torque at Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-16	Loaded Feedback at SS 2	Full Load Torque at Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-17	Loaded Feedback at Accel 1	Full Load Torque during acceleration to Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-18	Loaded Feedback at Accel 2	Full Load Torque during acceleration to Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-19	Load Weight Reset Torque	If the torque during Load Float is below this level, the Hoist Weight monitor (U01-31) will zero out and MFDO 33 (Load Lifted) will open. ***NOTE:*** *Set this parameter higher if an empty hook requires above 10.0% torque during load float.*	0.0-200.0 %	10.0
C10-20	Mid Loaded Feedback at SS 1	Mid Load Torque at Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-21	Mid Loaded Feedback at SS 2	Mid Load Torque at Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-22	Mid Loaded Feedback at Accel 1	Mid Load Torque during acceleration to Steady Speed 1 (C10-04).	0.0-200.0 %	0.0
C10-23	Mid Loaded Feedback at Accel 2	Mid Load Torque during acceleration to Steady Speed 2 (E01-06).	0.0-200.0 %	0.0
C10-24	Mid Load Weight	Optional Mid Load Weight. See section 5.2.21.7.	0.0-200.0 %	0.0

Parameter	Display	Function	Range	Default
C10-28	Hoist Load During Setup Process	Hoist load during the setup process. Adjust this parameter if the load is not exactly 100% when running the Weight Measurement setup. The setup results will be extrapolated for 100% load.	60.0-200.0 %	100.0
C10-29	Hoist/Crane Capacity	When using Load Summing, this is the percent capacity of this hoist compared to the capacity sum of all hoists in the system.	0.0-200.0 %	0.0
C10-30	Hoist Overweight Warning	Overweight Pre-Alarm level for this hoist only. Set to 0% to disable this feature.	0-200 %	0
C10-31	Hoist Overweight	Overweight Detected level for this hoist only. The C10-35 action will be taken. Set to 0% to disable this feature.	0-200 %	0
C10-32	Crane Overweight Warning	Overweight Pre-Alarm level for all hoists in the Load Summing system. Set this to the same value for all hoists in the system. Set to 0% to disable this feature.	0-200 %	0
C10-33	Crane Overweight	Overweight Detected level for all hoists in the Load Summing system. The C10-35 action will be taken. Set this to the same value for all hoists in the system. Set to 0% to disable this feature.	0-200 %	0
C10-34	Overweight Detected Delay	Delay before detecting an Overweight condition and taking the C10-35 action. This delay does not apply to the Overweight Warning.	0.0-5.0 sec	0.0
C10-35	Overweight Detected Action *0 Alarm Only* *2 Coast to Stop, Alarm* *3 Fault Stop* *4 Use b03-03 - Lower Only* *5 Use b03-03 - Lower w/ Reset*	Action taken when an Overweight condition is detected. Settings 0-4 require the alarm/fault to be cleared with a Fault Reset MFDI or RESET key on the keypad. Setting 5 will automatically clear the alarm when Hoist Weight is below C10-30 and the Crane Sum Weight is below C10-32.	0, 2-5	5
C10-36	Overweight Alarm Speed	Maximum lowering speed during an Overweight Detected alarm. This is only in effect when C10-35 = 2, 4, or 5.	0.1-60.0 Hz	6.0
C10-37	Crane Display Conversion	Determines Load Sum Weight Conversion for U01-32. See C10-02 for how to set this parameter.	1-39999	11000
C10-38	Crane Display Units *0 Tons* *1 Pounds* *2 Kilograms* *3 Metric Tons* *4 Percent Load* *5 No Units*	Units displayed for the Load Sum Weight (U01-32) monitor.	0-5	4

Parameter	Display	Function	Range	Default
C10-39	Load Sum Analog Output Scale	Analog scaling for Load Summing. This is a gain applied to the Load Sum analog signal so that 100% load equals less than 10 VDC and therefore a weight over 100% can be passed on the chain. MFAO 132 (Load Sum Weight) is scaled (multiplied) by this percentage. MFAI 1A (Load Sum Chain) is inversely scaled (divided) by this percentage. ***NOTE:*** *All Hoists must be set to the same value. Changing this parameter is typically not required.*	50.0-100.0 %	66.7
C10-40	Spreader Weight 1	Spreader bar 1 weight. This value is subtracted from the Hoist's measured weight when MFDI 4E or 14E (Spreader 1) is ON. This only applies to MFAO 131 (Hoist Weight) and U01-31 (Hoist Weight) for this hoist. ***NOTE:*** *This setting ignores the decimal point position set via C10-02. For example, if C10-02 = 15000 (equaling a weight of 500.0) and C10-40 = 1000, enabling Spreader 1 will subtract 100.0 from the weight. The same applies to C10-41 and C10-42.*	0-9999	0
C10-41	Spreader Weight 2	Spreader bar 2 weight. This value is subtracted from the Hoist's measured weight when MFDI 4F or 14F (Spreader 2) is ON. This only applies to MFAO 131 (Hoist Weight) and U01-31 (Hoist Weight) for this hoist.	0-9999	0
C10-42	Spreader Weight 3	Spreader bar 3 weight. This value is subtracted from the Hoist's measured weight when Spreader 1 AND Spreader 2 MFDI are ON. This only applies to MFAO 131 (Hoist Weight) and U01-31 (Hoist Weight) for this hoist.	0-9999	0
C10-43	Alternate Crane OW Warning	When MFDI 51 or 151 (Alternate Hoist Overweight) is ON, this is the Overweight Warning level for all hoists in the Load Sum chain. Set the same for all hoists in the system.	0-200 %	0
C10-44	Alternate Crane OW	When MFDI 51 or 151 (Alternate Hoist Overweight) is ON, this is the Overweight Detected level for all hoists in the Load Summing system, and the C10-35 action will be taken. Set the same for all hoists in the system.	0-200 %	0
C10-45	Load Sum Chain FBL Detect *0 Disabled* *1 Enabled*	Load Sum Chain Feedback Loss Detection. When enabled, the Load Sum analog output signal is offset so that 0% load results in a 5% output. If the received Load Sum analog input signal is less than 3%, it is seen as a loss of signal and will trigger an AFbL-1 fault.	0, 1	0
C10-50	Taut Line Weight	Percent weight when the lines are considered taut	0-100%	15
C10-51	Load Lifted Revolutions	When Taut Line Weight (C10-50) is reached, MFDO 33 (Load Lifted) closes and will reopen after a lift of C10-51 motor revolutions. This is used by Intelli-Lift to search for an off-center load only during the initial lifting phase. Set to 0 to disable this feature. ***NOTE:*** *At 1800RPM and 60 FPM, 30 revs is 12 inches. Formula: Revs = (RPM/FPM)*Ft*	0-9999	20
C10-54	Steady Speed Filter Time	Filter applied during steady speed.	0.00-2.55 sec	2.00
C10-55	Acceleration Filter Time	Filter applied during acceleration.	0.00-2.55 sec	0.05
C10-56	Torque Feedback Filter Time	Filter applied to the torque feedback. Increasing this time can help with unstable weight measurements.	0.00-2.55 sec	0.02

5.2.22.6 Weight Measurement Setup (Manual)

The Weight Measurement setup consists of a calibration using a known load weight. The process involves lifting an empty hook and loaded hook to capture data points that correlate motor torque or load cell feedback with the actual weight. The steps below explain the setup process to take torque measurements and manually set the associated parameters. The setup process works best with 100% weight for the full load calibration steps, but setup can be completed with less weight (see Step 4).

1. Determine the desired acceleration time (b05-01, b05-03, b05-12, or b05-14). When Weight Measurement is enabled (C10-01 = 1 or 2), changes to the acceleration parameters will not be allowed.
2. Get the motor to normal operating temperature. On lightly used hoists, this will be a cold motor. On heavily used hoists, lift and lower a heavy load for a few minutes. This is to warm up the motor to provide a better setup.
3. Remove all loads from the hook, including any spreader bars or hook attachments.
4. Enable Weight Measurement by C10-01 = 1 (Motor Torque) or C10-02 = 2 (Load Cell).
5. Lift the empty hook off the ground and accelerate to the C10-04 speed (typically 6 Hz). While at that speed, record the value of U01-09 (Torque Reference). The chart below can be used.
6. From a stop, run the hoist up to full speed (typically 60 Hz). Record the value of U01-09 while at full speed. Stop the hoist and record the values shown at the U01-81 and U01-82 monitors.
7. Run the hoist from a stop to full speed two more times, and record the values shown at the U01-81 and U01-82 monitors after each run. Calculate the average of the three samples.
8. Attach the load (as selected in Step 4) to the hoist hook and lift it off the ground.
9. Repeat steps 5 through 7 with a full load.
10. Scale the Full Load values based on the test weight used during setup. For example, if the test weight was 80% of full load, multiply the values by 0.80 before entering them into C10-15 to C10-18.
11. Set the samples and averages into the indicated C10-xx parameters shown below.
12. See the C10-02 (Hoist Display Conversion) and C10-03 (Hoist Display Units) parameters to select the 100% weight value and units displayed at the U01-31 (Hoist Weight) monitor.
13. To enable overweight protection, set the desired level to C10-31 (Hoist Overweight).

Table 5-39: Weight Measurement Setup (Manual) Worksheet

Monitor	Operations	Sample (%)	Average (%)	Enter Into
U01-09	No Load at C10-04 (6 Hz)		n/a	C10-11
U01-09	No Load at E01-06 (60 Hz)		n/a	C10-12
U01-81	No Load Torque @ Accel 1	1. 2. 3.		C10-13
U01-82	No Load Torque @ Accel 2	1. 2. 3.		C10-14
U01-09	Full Load at C10-04 (6 Hz)		n/a	C10-15
U01-09	Full Load at E01-06 (60 Hz)		n/a	C10-16
U01-81	Full Load Torque @ Accel 1	1. 2. 3.		C10-17
U01-82	Full Load Torque @ Accel 2	1. 2. 3.		C10-18

NOTE: *If any of the above values are close to the Torque Limit setting of C07-01 (default of 150%), the Weight Measurement setup may not be reliable. Increase the Torque Limit and restart the setup.*

5.2.22.7 Weight Measurement Setup (Automated)

The automated Weight Measurement setup follows the same general steps as the manual setup, but the VFD will automatically measure and set the associated parameters. The VFD keypad will walk through the various required lifts. The operator will still need to adjust the hoist loads and operate the hoist as directed. The setup process works best with 100% weight for the full load calibration steps, but setup can be completed with less weight (see Step 4).

1. Determine the desired acceleration time (b05-01, b05-03, b05-12, or b05-14). When Weight Measurement is enabled (C10-01 = 1 or 2), changes to the acceleration parameters will not be allowed.
2. Get the motor to normal operating temperature. On lightly used hoists, this will be a cold motor. On heavily used hoists, lift and lower a heavy load for a few minutes. This is to warm up the motor to provide a better setup.
3. Remove all loads from the hook, including any spreader bars or hook attachments.
4. Set C10-28 (Hoist Load During Setup Process) to the percent of full load of the weight that will be used for the setup. For example, if the hoist is rated for 10 tons and the weight used for setup is 8 tons, set C10-28 = 80.0%. It is defaulted to 100.0%.
5. Select an automated Weight Measurement setup by C10-01 = 3 (Motor Torque) or C10-02 = 6 (Load Cell). The ALM light on the keypad will begin to blink. Press the Home key to initiate the setup process.
6. “Lift unloaded hook until it is suspended in the air”: Lift the empty hook off the ground then remove the run command.
7. “Run UP at Full Speed”: Perform a lift and accelerate up to full speed (e.g., 60 Hz). The lift will automatically end when complete.
8. Lower the hook to the ground and attach 100% rated load.
9. “Lift loaded hook until it is suspended in the air”: Lift the load off the ground and then remove the run command.

10. “Run UP at Full Speed”: Perform a lift and accelerate up to full speed (e.g., 60 Hz). The lift will automatically end when complete.
11. “Set load on ground”: Lower the load down to the ground. Setup is now complete.
12. See the C10-02 (Hoist Display Conversion) and C10-03 (Hoist Display Units) parameters to select the 100% weight value and units displayed at the U01-31 (Hoist Weight) monitor.
13. To enable overweight protection, set the desired level to C10-31 (Hoist Overweight).

5.2.22.8 Weight Measurement Fine-tuning (Optional)

After the Weight Measurement setup process is complete, it is recommended to lift a known weight and compare it with the VFD’s measured weight monitor (U01-31). Keep in mind, a load closer to the hoist capacity will have better accuracy. If the weight measurement accuracy isn't as good as expected, there are options for fine-tuning.

C10-01 contains options for fine-tuning the unloaded (C10-01 = 4 or 7) and fully loaded (C10-01 = 5 or 8) torque feedback parameters. After selecting one of these options, the ALM light on the keypad will blink, which indicates the fine-tuning process has started. Press the F2 key and follow the instructions on the display, which simply repeats some of the steps from the automated setup process and averages the results. If the new results are still not as accurate as desired, consider calibrating with a mid load weight. ***See 5.2.22.8 on page 172***.

5.2.22.9 Mid Load Weight (Optional)

A mid load weight calibration will add additional data points to the weight measurement calculation for increased accuracy. This consists of a lifting a weight that is ideally close to 50% capacity. First, set C10-24 (Mid Load Weight) to the percent load of the mid weight being used. For example, if the hoist capacity is 50 tons and the mid weight is 25 tons, enter 50.0% into C10-24. Next, a setup process is required for setting the C10-20 through C10-23 parameters. Follow a similar process as steps 6 through 8 in ***section 5.2.22.6 on page 170*** and instead use the table below.

Table 5-40: Mid Load Setup Worksheet

Monitor	Operations	Sample (%)	Average (%)	Enter Into
U01-09	No Load at C10-04 (6 Hz)		n/a	C10-20
U01-09	No Load at E01-06 (60 Hz)		n/a	C10-21
U01-81	No Load Torque @ Accel 1	1. 2. 3.		C10-22
U01-82	No Load Torque @ Accel 2	1. 2. 3.		C10-23

5.2.22.10 Load Summing Setup

The Load Summing setup involves parameter adjustments to set the ratio of the individual hoist capacity with the total crane capacity. In addition to the parameter adjustments, wire interconnects are required between each VFD to pass the analog signals for the summed weight.

1. Set up Weight Measurement as described in the previous sections.
2. **First VFD in the chain:** Set an MFAO (H04-xx or F04-xx) = 132 (Load Sum Weight).
3. **Other VFDs in the chain:** Set an MFAO (H04-xx or F04-xx) = 132 (Load Sum Weight) and an MFAI (H03-xx) = 1A (Load Sum Chain).
4. Connect the wire interconnections between each VFD, which correlate with the analog inputs and output settings of steps 2 and 3.

5. **All VFDs in the chain:** Determine the percent capacity of each hoist using the following formula and enter it into C10-29 (Hoist/Crane Capacity):

$$\text{C10-29} = \frac{\text{Hoist Capacity}}{\text{Crane Capacity}} \text{ x } 100\%$$

Example:

-	Crane	Hoist 1	Hoist 2	Hoist 3
Capacity	150 T	100 T	50 T	25 T
Hoist/Crane Capacity (C10-29)		66.7%	33.3%	16.7%

5.2.22.11 External Weight Display Setup

The measured weight of the individual hoist or the summed weight of the crane can be output to an external display or PLC. An analog output is used to output the measured weight as a 0-10 VDC or 4-20 mA signal. The display needs the ability to accept a 0-10 VDC or 4-20 mA signal analog and the ability to correlate 10 VDC or 20 mA with a specific weight. For example, if the VFD is outputting a 0-10 VDC analog signal that equals 0-50 tons, the display needs to be configured such that a 10 VDC input will display 50 tons.

To display the weight of the individual hoist, set an MFAO (H04-xx or F04-xx) = 131 (Hoist Weight).

To display the summed weight of the crane, set an MFAO on the last VFD in the chain to 132 (Load Sum Weight). Keep in mind that the analog output is scaled via parameter C10-39.

5.2.22.12 Weight Measurement System I/O Summary

The following list is a summary of the inputs, outputs, and monitors that are available for Weight Measurement and Load Summing. Reference the “Control I/O Parameters (H)” section for more information specific to each setting.

Digital Inputs (H01-xx or F03-xx):

- **4D and 14D** (Load Weight/Sum Enabled N.O and N.C.)
- **4E and 14E** (Spreader Weight 1 N.O and N.C.)
- **4F and 14F** (Spreader Weight 2 N.O and N.C.)
- **50 and 150** (External Overweight N.O and N.C.)
- **51 and 151** (Alternate Crane OW Levels N.O and N.C.)
- **52** (Overweight Bypass N.O.)

Digital Outputs (H02-xx or F05-xx):

- **15** (Overweight Detected)
- **16** (Overweight Warning)

Analog Inputs (H03-xx):

- **16** (Load Cell)
- **1A** (Load Sum Chain)

Analog Outputs (H04-xx or F04-xx):

- **131** (Hoist Weight)
- **132** (Crane Weight Sum)

Monitors (U01-xx):

- **U01-31** (Hoist Weight)
- **U01-32** (Crane Weight Sum)
- **U01-81** (WMS Torque @ Accel 1)
- **U01-82** (WMS Torque @ Accel 2)

5.2.23 Slack Cable Detection (C11)

Slack Cable Detection is a VG+ hoist function that monitors motor torque, while running at a steady speed, and detects when the torque suddenly dips below a set level (C11-03).

Slack Cable Detection is not executed, unless both of the following conditions are true:

- *The output frequency is at a steady speed between C11-04 and C11-06.*
- *The Slack Cable Detection delay time is between C11-05 and C11-07.*

Setup Procedure:

- *Lower the hoist without load at a constant speed that the hoist would normally run at during operation. Record the torque reference (U01-09). Repeat this several times to ensure an accurate reading.*
- *Set C11-03 = U01-09 - 2%.*
- *Enable Slack Cable Detection by setting C11-01 = 1 or 2.*
- *Select output action when Slack Cable is detected by defining C11-02.*

Table 5-41: Slack Cable Detection Parameter Settings

Parameter	Display	Function	Range	Default
C11-01	Slack Cable *0 Disabled* *1 Enabled* *2 Enabled by MFDI*	Determines whether Slack Cable Detection is enabled.	0–2	0
C11-02	Slack Cable Action	Action and allowable motion when Slack Cable is detected. RAISE command is permitted (MFDO = 28).	0–5	2
	0 No Action	Alarm Only		
	1 No Action, Lower at C03-04	Next LOWER command is at LL1 speed C03-04.		
	2 Limit Lower to C03-04	Decel (by C03-05) to LL1 Speed C03-04. LOWER limited to C03-04.		
	3 Decel to C03-05, Lower Blocked	Decel (by C03-05) to LL1 Speed C03-04. LOWER not allowed.		
	4 Decel to Stop, Lower at C03-04	Decel (by C03-06) to stop. LOWER limited to C03-04.		
	5 Decel to Stop, Lower Blocked	Decel (by C03-06) to stop. LOWER not allowed.		
C11-03	Slack Cable Detection Torque	Percentage of Output Torque below which Slack Cable Detection is activated-as long as the motor speed is between C11-04 and C11-06, and the delay time is between C11-05 and C11-07.	-50–100%	30
C11-04	Slack Cable Detection Speed 1	Frequency Output that is required for Slack Cable Detection to be activated. It corresponds to Slack Cable Delay Time 1 (C11-05).	0–E01-04 Hz	2
C11-05	Slack Cable Delay Time 1	Delay time before Slack Cable Detection can be activated. Corresponds to Slack Cable Detection Speed 1 (C11-04).	0.00–2.55 sec	0.50
C11-06	Slack Cable Detection Speed 2	Frequency Output below which Slack Cable Detection can be activated. It corresponds to Slack Cable Delay Time 2 (C11-07).	0–E01-04 Hz	60
C11-07	Slack Cable Delay Time 2	Delay time before Slack Cable Detection can be activated. It corresponds to Slack Cable Detection Speed 2 (C11-06).	0.00–2.55 sec	0.10

5.2.24 Snap Shaft Detection (C11)

Snap Shaft Detection is a VG+ feature designed to detect a broken or loose coupling by monitoring for a speed deviation between rotating shafts on a drive train. Ideally, mount one encoder on the motor, which drives the gearbox, and one encoder on the last rotating part of the drive train, usually near the drum if used for a hoist motion. It is required that a second brake be mounted on the drum shaft. The encoders are wired into two separate PG-X3 encoder option cards, with channel 1 (CN5-C) being the high speed shaft input and channel 2 (CN5-B) being the low speed shaft input. The VFD will use channel 1 for closed loop vector feedback. The VFD monitors and compares the speed of both encoders at all times (running and idle). A gear ratio is entered into parameters C11-12 and C11-13. In an example, if the gearbox ratio is 46.34 : 1, then you would program C11-12 to 4634 and C11-13 to 100. If the difference in speed is greater than the value in C11-10 for a period longer than the setting of C11-11, "Snap Shaft" is displayed on the keypad display and the VFD will perform the action defined by C11-09.

Monitor U01-30 (Snap Shaft Delta Speed) should be observed during operation to obtain the exact speed difference in RPM between the two shafts. The low speed shaft speed is normalized internally by multiplying the speed of the gear ratio. The value of C11-12 should be adjusted at start up such that U01-30 approaches zero.

Table 5-42: Snap Shaft Detection Parameter Settings

Parameter	Display	Function	Range	Default
C11-08	Snap Shaft *0 Disabled* *1 Enabled*	Determines if snap shaft detection is enabled.	0–2	0
	2 Auto-Detect Gear Ratio	Auto detect and set the values for Numerator (C11-12) and Denominator (C11-13). To use this feature: 1. Set C11-08 = 2. 2. Run VFD at minimum of half speed. 3. Wait for "PASS" to be displayed. 4. Validate C11-12 and C11-13.		
C11-09	Snap Shaft Action *0 Fault* *1 Alarm Only*	Action taken at Snap Shaft detection. A setting of 0 will set the brake and display a fault. With a setting of 1, the VFD will continue to run.	0, 1	0
C11-10	Snap Shaft Delta Speed	Difference in speeds of the two shafts normalized by the gear ratio.	0–900 RPM	30
C11-11	Snap Shaft Delay Time	Gear backlash time	0–2000 ms	250
C11-12	Snap Shaft Gear Ratio Numerator	Gear ratio numerator	1–65535	10000
C11-13	Snap Shaft Gear Ratio Denominator	Gear ratio denominator	1–65535	10000

5.2.25 Brake Delay Timers (C12)

Brake Delay Timers are used in Traverse applications to reduce the mechanical brake wear when positioning a load. This is a Traverse only function and b03-03 must be set to 4 (Decel With Timer).

Table 5-43: Brake Delay Timers Parameter Settings

Parameter	Display	Function	Range	Default
C12-01	Brake Set Delay @ Jog	Brake set delay time at Jog Control input.	0.0–100.0 sec	0.0
C12-02	Brake Set Delay @ Run	Brake set delay time at RUN input.	0.0–100.0 sec	0.0

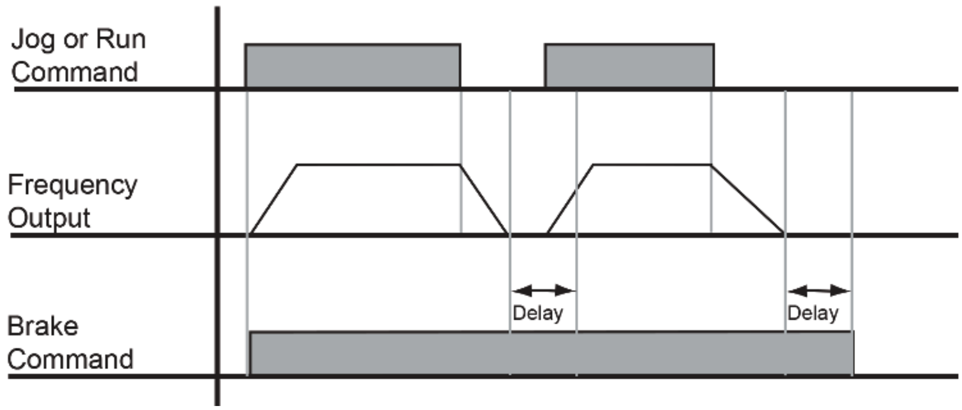


Figure 5-21: Brake Delay Timers

5.2.26 On/Off Delay Timers (C12)

- The timer function is enabled when the timer function MFDI (H01-0x = 43) and MFDO (H02-0x = 12) are both set.
- These serve as general purpose I/O. Chattering of sensors, switches, contactors, etc., can be prevented with a delay time.
- When the timer function input **ON** time is longer than the value set for **C12-03** (Timer ON-Delay Time), the timer function output turns **ON**.
- When the timer function input **OFF** time is longer than the value set for **C12-04** (Timer OFF-Delay Time), the timer function output turns **OFF**.

Table 5-44: On/Off Delay Timers Parameter Settings

Parameter	Display	Function	Range	Default
C12-03	Timer Function ON-Delay Time	Timer function On-Delay time.	0.0–3000.0 sec	0.0
C12-04	Timer Function OFF-Delay Time	Timer function Off-Delay time.	0.0–3000.0 sec	0.0

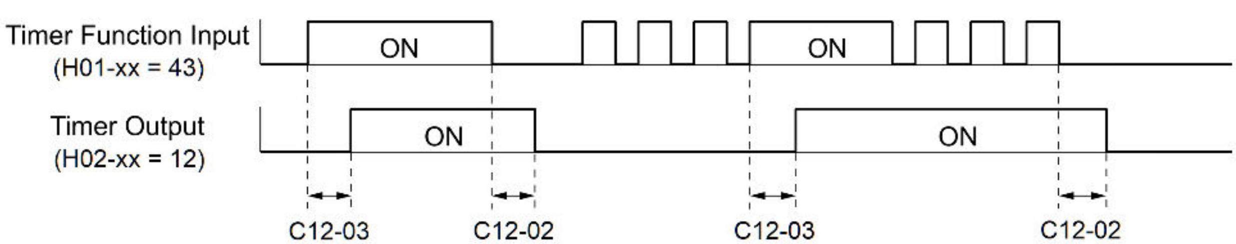


Figure 5-22: Timer Function Operation

5.2.27 Maintenance Timers and Counters (C12)

Maintenance Timers and Counters are based on various VFD run conditions and will alert an operator, for example, when the bearings need to be greased. It consists of a digital output (H02-0x = 37) that becomes active when the total running time has exceeded the amount of time (in hours) programmed in parameter C12-05 and the frequency reference will be multiplied by a gain (C12-06) to slow the motion down until the bearings have been greased. An alarm will be posted on the Keypad stating “Maintenance Required”. Once the bearings have been greased, the output and alarm message can be reset two ways. One method is through a digital input programmed for any of the timer and counter resets (H01-xx = 7C, 7D, or 7E) and the second method is by pressing the Mode/ Service (Local/Remote) button three consecutive times with no more than 2 seconds between presses. Press enter to reset the timer. A message will then appear on the keypad stating that the timer has been reset. The digital output will turn off at this time. When C12-05 = 0, the function is disabled.

Table 5-45: Maintenance Timers and Counters Parameter Settings

Parameter	Display	Function	Range	Default
C12-05	Maintenance Run Timer	Timer increments while VFD is outputting current. Maintenance Gain (C12-06) is enabled when the timer exceeds the C12-05 hours. Reset the timer by keypad or MFDI = 7C. View monitor U04-28 for remaining hours.	0–32000 Hrs	0
C12-06	Maintenance Alarm Speed Gain	Speed Reference Gain	0–100%	50
C12-07	Maintenance On Timer	Timer increments while VFD is powered up. Maintenance Gain (C12-06) is enabled when the timer exceeds C12-07 hours. Reset the timer by keypad or MFDI = 7D. View monitor U04-30 for remaining hours.	0–32000 Hrs	0
C12-08	Maintenance Brake Cycles	Counter increments each time the brake is commanded to open. Maintenance Gain (C12-06) is enabled when the brake cycle count exceeds 1,000x the C12-08 value. Reset the count by keypad or MFDI = 7E. View monitor U04-33 for remaining count. Example: To set counter to expire after 1,000,000 cycles, (1,000 x 1,000 = 1,000,000), so set C12-08 = 1,000	0–65000 kCycles	0

5.2.28 MFDO Delay Timers (C12)

MFDO Delay Timers provide a delay for activating and deactivating the multi-function digital output terminals.

Table 5-46: MFDO Delay Timers Parameter Settings

Parameter	Display	Function	Range	Default
C12-10	Terminal M1-M2 ON-Delay Time	Delay time to activate the M1-M2 output after the H02-01 function activates.	0–65000 ms	0
C12-11	Terminal M1-M2 OFF-Delay Time	Delay time to deactivate the M1-M2 output after the H02-01 function deactivates.	0–65000 ms	0
C12-12	Terminal M3-M4 ON-Delay Time	Delay time to activate the M3-M4 output after the H02-02 function activates.	0–65000 ms	0
C12-13	Terminal M3-M4 OFF-Delay Time	Delay time to deactivate the M3-M4 output after the H02-02 function deactivates.	0–65000 ms	0
C12-14	Terminal M5-M6 ON-Delay Time	Delay time to activate the M5-M6 output after the H02-03 function activates.	0–65000 ms	0
C12-15	Terminal M5-M6 OFF-Delay Time	Delay time to deactivate the M5-M6 output after the H02-03 function deactivates.	0–65000 ms	0

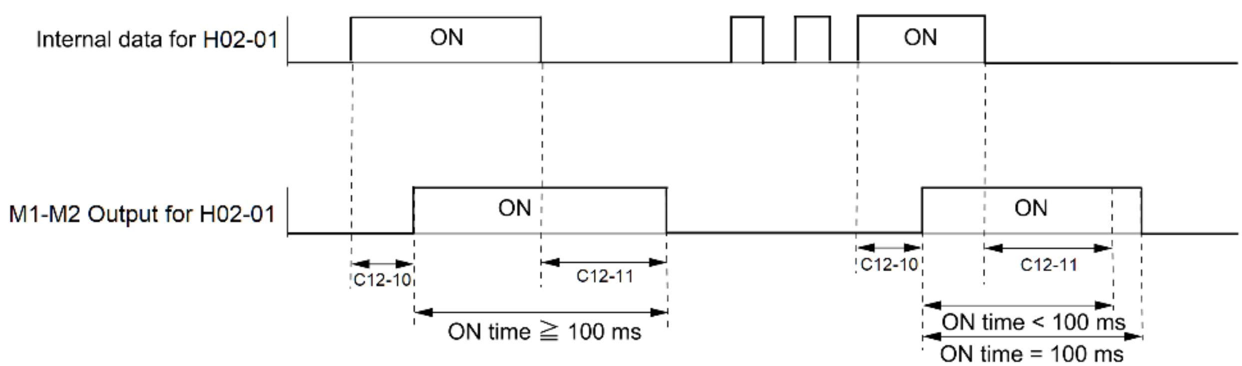


Figure 5-23: M1-M2 Delay Timer Example

5.2.29 Inch Control (C13)

Inch Control provides a repeatable run initiation with a specific run duration. It can be enabled by programming H01-xx or F03-xx = 17, 18, or 19 and enabling the associated digital inputs. The frequency reference used during Inch Control is determined by b01-17 (Jog Reference) and the acceleration and deceleration is determined by the b05-xx parameters (and d09-xx s-curves).

CAUTION

A directional run input is not needed to enable motion of the motor.

Table 5-47: Inch Control Parameter Settings

Parameter	Display	Function	Range	Default
C13-01	Inch Run Time	Inch Control run time. This run time does not include the deceleration time.	0.00–2.55 sec	1.00
C13-02	Inch Repeat Delay Time	Inch Control repeat delay time. The Inch Repeat function is enabled with a digital input (H01-xx or F03-xx = 19).	0.00–2.55 sec	1.00

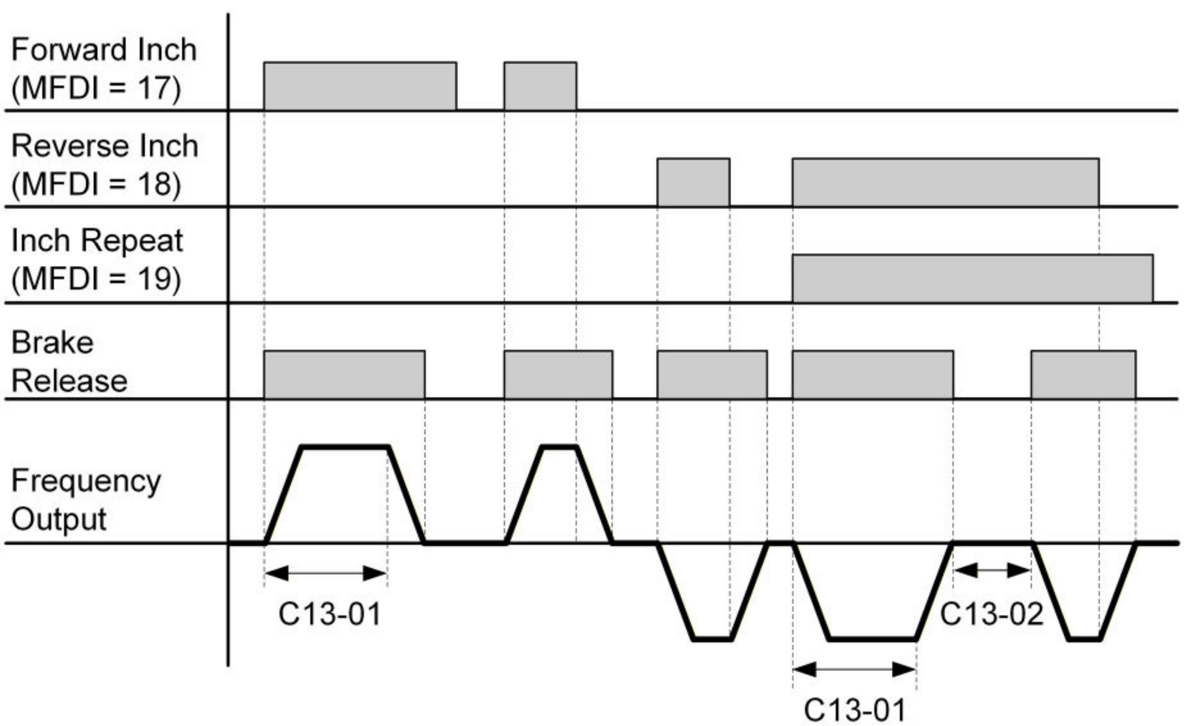


Figure 5-24: Inch Run and Inch Repeat

5.2.30 Index Control (C13)

Index Control is a VG+ feature that allows for precise movement of the motor each time a run command is applied. The Index function is enabled by a digital input (H01-xx = 60).

The total distance (Pulses or Ft) the motor will index is determined by the following equation:

$$\textbf{Total distance}\text{ (Pulses)} = [\textbf{F01-01}(^{\text{Pulse}}/_{\text{Rev}}) * \textbf{C13-04}\text{(Revs)}] + \textbf{C13-05}\text{(Pulses)}$$

$$\textbf{Travel distance}\text{ (ft)} = \frac{\left(\frac{\text{C13-05}}{\text{F01-01}}\right) + \text{C13-04}}{\left(\frac{\text{Motor RPM}}{\text{Hoist or Travel FPM}}\right)}$$

When Index is turned ON, it can be programmed to repeat as long as a Run command is ON and by setting the Index Repeat Delay (C13-06) greater than 0.00 seconds. The Index will repeat after the Index Repeat Delay (C13-06) time has expired. Once the motor completes the Index, the brake will either set or remain in Load Float depending on the braking sequence described below.

When an Index is complete, a digital output (H02-xx = 34) will turn ON until one of the following is true:

- another directional run input is received,
- the repeat delay time has expired and the movement is repeating, or
- the Index function is disabled.

<u>When Applied in Traverse (A01-03 = 0)</u>

When Index is turned ON, Index Brake Control (C13-12) controls the action of the brake. The following describes the brake control for each setting:

Open on Index Command (C13-12 = 0)

When Index is turned ON, the brake will release and hold the position in Load Float until a run command is applied. The brake will set and resume normal operation when the Index input is turned OFF.

Open on Run Command (C13-12 = 1)

When Index is turned ON, the brake will release after each run command is applied, then Index the motor. The brake will set after the Index or Index Repeat is complete, or the run command is removed.

Latch Open on Run Command (C13-12 = 2)

When Index is turned ON, the brake will release when a run command is applied, the Index will complete, and the motor will be held in Load Float. It will remain in Load Float until the next run command or the Index input is turned OFF. The brake will set when the Index input is turned OFF.

NOTE: *For best performance, enable Index after brake release. Not recommended for double A4 applications.*

<u>When Applied in NLB Hoist (A01-03 = 2)</u>

When Index Brake Control C13-12 = 2, the action of the brake is controlled by the NLB sequence. The Index function can be enabled at any time during operation.

At Stop

If Index is turned ON while the motor is stopped, the brake will release when a run command is applied. The Index will complete, and the motor will be held in Load Float. It will remain in Load Float until the next run command or the Index input is turned OFF. When Index is turned OFF, the brake will set according to the NLB stop sequence.

During Run

If the motor is in motion when Index is turned ON, the motor will decelerate to zero and hold the position in Load Float. After a Run command is applied, the Index will complete, and the motor will be held in Load Float. When Index is turned OFF, the brake will set according to the NLB stop sequence.

NOTE: *For best performance, enable Index after brake release. Not recommended for double A4 applications.*

Table 5-48: Index Control Parameter Settings

Parameter	Display	Function	Range	Default
C13-03	Index Frequency Reference	Frequency reference when an Index has been initiated.	0.01–60.00 Hz	1.00
C13-04	Index Motor Revolutions	Index motor revolutions (F01-01 ppr = 1 motor revolution)	0–65535 Revs	0
C13-05	Index Motor Pulses	Index fractional motor revolution. (1 pulse = 1 ppr of F01-01)	0–65535 Pulses	100
C13-06	Index Repeat Delay	Index Repeat Delay Time (Setting of 0.00 disables Index Repeat).	0.00–60.00 sec	0.00
C13-07	Index Complete Width	Index Complete Width (Quadrupled) for MFDO = 34. Upper Limit range is dependent on the following conditions: 32767 or (C13-04 *4 * encoder PPR + C13-05 -1), whichever is smaller. (1 pulse = 1 ppr of F01-01)	1–1000	10
C13-08	Index Load Float Gain	Index Zero Servo Gain.	0–100	10
C13-09	Index ASR Proportional Gain	Index ASR P Gain.	0.00–300.00	30.00
C13-10	Index ASR Integral Time	Index ASR Integral Time.	0.000–10.000 sec	0.200
C13-11	Index Accel/Decel Gain	Index Accel/Decel Rate Gain.	0.0–5.0	1.0
C13-12	Index Brake Control *0 Open on Index Command* *1 Open on Run Command* *2 Latch Open on Run Command*	Configures brake behavior when indexing. Brake will open on Index command and remain open until Index command is OFF. VFD is in Load Float between runs. Brake will open on Run command and close when the run is finished. Brake will open on Run command and remain open during Load Float until Index is turned off.	Traverse: 0–2 NLB: 0, 2	NLB: 2* else: 0*
C13-13	Bi-Polar Analog Index Deadzone	Deadzone width around the zero point of a Bi-Polar Analog input signal. This is intended to make the motor direction determination more accurate when using the Index Control function with a Bi-Polar Analog frequency reference.	0.0-20.0%	0.0*

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.2.31 Sway Control (C14)

Sway Control is a traverse motion function to greatly reduce the amount of unwanted swing when moving suspended loads. It works by point-mass theory such that a suspended load behaves as a pendulum. The algorithm predicts how the system will react to movement and reshapes the motor speed commands to prevent unwanted swing. A 90%-95% swing reduction is typical, but better results can be achieved. Less swing translates into increased productivity and a safer work environment.

Two elements are required for Sway Control to function optimally:

1. The (swing length) distance from the hoist drum center to the load's center of gravity (C.G.).
2. The speed of the traverse motion (crane bridge or trolley).

Hoist hook height feedback (from an encoder) boosts the sway control performance across any hook height, but it is not required. Programming a static hook height into the VFD at the common hoisting height will still provide improved performance. A dial can be added for the operator to fine tune the swing length.

Table 5-49: Sway Control Parameters

Parameter	Display	Function	Range	Default
C14-01	Sway Control *0 Disabled* *1 Enabled Always* *2 Enabled by MFDI*	Selects how Sway Control is enabled. When Enabled Always, if Main and Aux hook height MFAI (H03-xx = 1B and 1C) are configured, the larger of the two analog inputs is used for the hook height. When Enabled by MFDI, if only the Main Hoist MFDI (H01-xx or F03-xx =75) is configured and both the Main and Aux hook height MFAI are configured, the larger of the two analog inputs is used. If both a Main Hoist and Aux Hoist MFDI (H01-xx or F03-xx =75 and 76) are configured, those inputs will determine the hook height analog input that is used. ***NOTE:*** *The Sway Control MFDI <u>is</u> allowed to be enabled and disabled during a run.*	0–2	0
C14-02	Hook Height	**Hoist has hook height (encoder) feedback:** The Hoist VFD is configured to output a 0-10V signal that represents the percent hook height. The Sway Control function takes this percentage and multiplies it by C14-02 to determine the current Hook Height in feet. **Hoist does <u>not</u> have hook height feedback:** Without hoist hook height feedback, sway control will work best at this height. More sway will occur as the hook deviates from this height. Measure the distance from the drum to where the hook will be commonly lifted and enter that value into this parameter. A good starting point is 75% of the height from drum to floor.	0–300 Ft	25
C14-03	Drum to Weighted Limit Offset	Distance from the Drum to the Hook when the hook is lifted to its maximum height (usually UL3). This value does not change and is always added to the total Swing Length.	1–100 Ft	5

Parameter	Display	Function	Range	Default
C14-04	Center of Gravity Offset by MFDI	Size of each hook height increment for the additional center of gravity offset, enabled by MFDI (H01-xx or F03-xx = 77-7A).	0–10 Ft	1
C14-05	Center of Gravity Offset by MFAI	Additional hook height enabled by MFAI (H03-xx = 1D). The input voltage (not percent) is multiplied by this value to calculate the additional hook height.	0–10 Ft	1
C14-06	Acceleration Aggression	Aggression scale of Acceleration. 0.0 is the least aggressive (slower). 10.0 is the most aggressive (faster).	0.0–10.0	9.0
C14-07	Deceleration Aggression	Aggression scale of Deceleration. 0.0 is the least aggressive (slower). 10.0 is the most aggressive (faster).	0.0–10.0	9.0
C14-08	Sway Control Disabled In *0 None* *1 Micro-Speed* *2 Jog Commands* *3 Inching Commands* *4 All Of The Above*	Sway Control can be automatically disabled when the Micro-Speed, Jog, and/or Inching functions are enabled.	0–4	4
C14-09	Alternate Hook Height	Use alternate hook height, enabled by MFDI (H01-xx or F03-xx = 7B). Will override all other hook height settings. Motor must be stopped before switching.	0–300 Ft	20
C14-10	Sway Control Algorithm Gain	Gain on the Hook Height feedback to increase the responsiveness of the motion, resulting in increased swing. Lowering this gain will allow a faster deceleration, at the expense of more swing.	0–100%	100
C14-11	End at Zero Speed *0 Disabled* *1 Enabled*	When enabled, motion will stop, and the brake will close when the motor speed has reached zero. Minor sway may occur at low speeds. When disabled, brief and low speed movements may result in the brake actuating and the motor moving slightly to prevent sway.	0, 1	1
C14-12	Travel Limit Decel Method *0 Disable Sway Control* *1 Decel with Sway Control* *2 Quick Decel with Sway Control*	Sway Control response when a slowdown (LL1/UL1) travel limit is reached. A setting of 0 will use normal deceleration rates when a travel limit is reached, at the expense of sway occurring, but decelerating quickly. A setting of 1 will maintain sway control during the travel limit, at the expense of an elongated deceleration distance, though without sway. A setting of 2 is a combination of settings 0 and 1. The deceleration rate is scaled to approximately 50%, which allows some sway control to remain effective, while decelerating quicker.	0–2	0

Parameter	Display	Function	Range	Default
C14-13	Main/Aux Height Feedback *0 MFAI is 0% at Top* *1 MFAI is 100% at Top*	Determines the polarity of the analog input for Hoist Hook Height Feedback (MFAI = 1B or 1C).	0, 1	0
C14-14	SCS Enable Speed	When the motor speed is below this level, Sway Control is disabled, except if accelerating or decelerating through it.	0.0–20.0 Hz	0.0

5.2.31.1 Setting Up Sway Control

Sway Control functions best with an IMPULSE®•VG+ VFD on the Hoist. With this configuration, the hook height can be dynamically relayed from the Hoist to the Traverse (sway control) VFDs. For configurations without hoist hook height feedback, a static hook height is programmed into the sway control VFDs, and sway control will function best when the hook is at that height. More swing will occur as the hook deviates from that height.

Parameter Setup

1. Determine how Sway Control will be enabled. If the operator will always be using Sway Control, set C14-01 = 1 (Enabled Always). Alternatively, C14-01 can be set to 2 (Enabled by MFDI). This will allow the operator to enable Sway Control with a switch. The switch is wired to a digital input programmed to H01-xx or F03-xx = 75 (Sway Control Main Hoist) or 76 (Sway Control Aux Hoist).
2. Determine the desired Acceleration and Deceleration Aggressiveness. The Sway Control algorithm will typically extend the accel/decel times depending on the Swing Length. Enter the aggressiveness number into C14-06 and C14-07 (higher numbers cause quicker acceleration and deceleration).
3. If needed, determine how the Center of Gravity Offset will be applied. This is the distance from the Hook to the Center of Gravity of the load. This step is optional, but can further reduce load swing.
    a. Offset by MFDI - Enter the distance multiplier (in feet) into C14-04. Set up to four digital inputs to “CG Offset bit 1” to “CG Offset bit 4” (H01-xx = 77, 78, 79, 7A). The inputs will be used to generate a 4 bit number, 0 to 15 (***See Table 5-50 on page 185***). This value is then multiplied by the value in C14-04, usually 1 ft. For example, an input value of 5 will add 5 * 1 ft, or 5 feet to the swing length.
    b. Offset by MFAI - Enter the distance multiplier into C14-05. Set an analog input to H03-xx = 1D (Center of Gravity Offset). The Analog Input voltage is multiplied by C14-05 to determine the Center of Gravity adder. For example, if C14-05 is 2 ft, and the input voltage is 2 volts, the adder is 2 * 2 ft, or 4 feet.

Table 5-50: Center of Gravity Offset Input Logic

Value	CG Offset bit 4 (MFDI = 7A)	CG Offset bit 3 (MFDI = 79)	CG Offset bit 2 (MFDI = 78)	CG Offset bit 1 (MFDI = 77)
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

Setup without Hoist Hook Height Feedback

Hoist hook height feedback may not be known due to a lack of encoder on the Hoist VFD. In this configuration, a static hook height is programmed into the sway control VFDs, and sway control will function best when the hook is at that height. The following steps apply to the Sway Control VFDs.

1. Lift the hook to the height that will be commonly used when moving the load.
2. Measure the distance from the weighted upper limit block to the hook. Enter this value into C14-02 (Hook Height).
3. Measure the distance from the center of the drum to the weighted upper limit block. Enter this value into C14-03 (Drum to Weighted Limit Offset).

Setup with Hoist Hook Height Feedback (Recommended)

Setting up Sway Control with hook height feedback from the Hoist VFD allows for Sway Control to function at any height and allows lifting or lowering the load while moving without resulting swing. The following steps explain how to configure the Hook Height output of an IMPULSE®•VG+ Series 5 VFD controlling the hoist.

NOTE: *No changes are made to the Sway Control VFDs during these steps.*

1. Set C03-15 (Hook Height Home Position) to 2 (Home MFDI Upper). A Normally Open (N.O.) contact on the Weighted Limit Switch (UL3) or Upper Limit 2 (UL2) is used to home or zero out the hook height.
2. Set C03-16 (Hook Height Analog Output) to 0 (0 Revs = 0% Analog Output). This configures a 0 volt output when the hook is at the 0% home point and 10V when the hook is at 100% hook height.
3. Set an MFDI (H01-xx or F03-xx) to 67 (Hook Height Home). This terminal will close when the Limit switch opens. UL3 may require a relay, as some weighted limit switches only provide normally closed contacts.
4. Set parameter C03-14 (Hook Height Revolutions Total) to the total number of motor revolutions required for the entire lift.
   a. Start by raising the hoist up to the home point. Ensure that this action results in the system being homed (U01-50 will display 0%).

b. Lower the hook all the way to the lowest point of travel (usually the floor).

c. Transfer the number of motor revolutions from monitor U01-51 to parameter C03-14.

5. Use monitors U01-50 (Hook Height) and U01-51 (Motor Revolutions) to verify the setup.
6. Set H01-01 (Terminal FM Function) or H04-04 (Terminal AM Function) to 150 (Hook Height).
7. Set H01-02 (Terminal FM Gain) or H04-05 (Terminal AM Gain) to 100%.
8. Run a shielded wire from the Analog Output (Terminal AM or FM) on the Hoist VFD to an Analog Input on the Sway Control VFDs.

Swing Length Measurement

The Hoist VFD is now setup to output the hook height as an analog signal. An analog input on each of the Traverse VFDs is programmed to read this value into the Sway Control function. This value will be scaled to determine the exact height of the hook. The actual hook height needs to be measured and entered into C14-02. There are two methods to do this, outlined below.

Finding C14-02 and C14-03 by Manual Measurement

1. Raise the hook to the Home position (typically the UL3 weighted limit). U01-50 on the hoist VFD will read 0%.
2. Measure the distance from the center of the drum to the hook (it may be helpful to use a long rope and mark the position with a knot or marker to be measured later). This value is the Drum to Weighted Limit Offset (C14-03).
3. Lower the hook to the ground or lowest point. U01-50 on the hoist VFD will read 100%.
4. Measure the distance from the center of the drum to the hook.
5. Subtract the distance from Step 2 from the distance from Step 4. This is the difference in Hook Height between 0% and 100%. Enter this value into C14-02.
6. Confirm that U01-49 displays the value found in Step 2 when at Home, and the value found in Step 5 when at the ground. Ensure that a Center of Gravity Offset is not being applied.

Finding C14-02 and C14-03 by Swing Period

1. Remove all loads from the end of the hook (including slings). Lower the hook to its lowest point. U01-50 on the hoist VFD should show 100%.
2. With Sway Control disabled, move the bridge so that the hook is swinging back and forth a few feet. The amount of swing does not matter, so long as it is easy to count the number of complete swings.
3. With a stopwatch, time how long 10 complete swings take. Take this number and divide by 10. This is the swing period for the Low point. Record this number.
4. Raise the hook to its highest point (U01-50 on the hoist VFD should show 0%).
5. Move the bridge so that the hook is swinging back and forth a few feet.
6. Time how long 10 complete swings take. Take this number and divide by 10. This is the swing period for the Home point. Record this number.
7. Use ***Table 5-51 on page 187*** to find the Swing Length for the time determined in Step 6. If the recorded swing time is not shown, use the closest value. Enter this length into C14-03.
8. Use ***Table 5-51 on page 187*** to find the Swing Length for the time determined in Step 3. Subtract the value in C14-03 from this value. Enter this value into C14-02.
9. Confirm that U01-49 displays the value found in Step 7 when at the Home position, and the value found in Step 8 when at the ground. Ensure that a Center of Gravity Offset is not being applied.

Table 5-51: Swing Time to Swing Length Conversion Table

Swing Time (sec)	Swing Length (feet)
2	3
2.25	4
2.5	5
2.75	6
3	7
3.25	8
3.5	9
3.75	11
4	13
4.25	14
4.5	16
4.75	18
5	20
5.25	22
5.5	24
5.75	26
6	29
6.25	31
6.5	34
6.75	37
7	39
7.25	42
7.5	45
7.75	48
8	52
8.25	55
8.5	58
8.75	62
9	66
9.25	69
9.5	73
9.75	77
10	81
10.25	85
10.5	89
10.75	94
11	98
11.25	103
11.5	107
11.75	112
12	117
12.25	122
12.5	127
12.75	132
13	137
13.25	143
13.5	148
13.75	154
14	159
14.25	165
14.5	171
14.75	177
15	183
15.25	189
15.5	195
15.75	202
16	208
16.25	215
16.5	222
16.75	228
17	235
17.25	242
17.5	249
17.75	256
18	264
18.25	271
18.5	279
18.75	286
19	294
19.25	300

5.2.31.2 Sway Control Limitations

The Sway Control function is considered an open loop system which will not add additional swing but will also not remove any existing swing. Any external forces, such as wind, will not be accounted for and may cause a small amount of swing.

Sway Control is limited to a 300 foot swing length, meaning the combination of all swing length adders, such as Drum to UL3 Offset, Offset by MFDI and so on, cannot add up to more than that. If 300 feet is exceeded, a fault will be displayed on the keypad and movement will be halted until the calculated swing length is less than 300 feet and the fault is cleared.

5.2.31.3 Sway Control Estimated Acceleration/Deceleration Times

Table 5-52: Estimated Acceleration/Deceleration Times (0-60 Hz)

Swing Length (ft)	C14-06 (Accel) or C14-07 (Decel) Aggressiveness [Unitless]					
	0.0	2.0	4.0	6.0	8.0	10.0
5	12.1 sec	10.1 sec	8.1 sec	6.1 sec	4.1 sec	2.1 sec
10	12.7 sec	10.7 sec	8.7 sec	6.7 sec	4.7 sec	2.7 sec
20	13.4 sec	11.4 sec	9.4 sec	7.4 sec	5.4 sec	3.4 sec
40	14.5 sec	12.5 sec	10.5 sec	8.5 sec	6.5 sec	4.5 sec
60	15.2 sec	13.2 sec	11.2 sec	9.2 sec	7.2 sec	5.2 sec
80	15.9 sec	13.9 sec	11.9 sec	9.9 sec	7.9 sec	5.9 sec
100	16.5 sec	14.5 sec	12.5 sec	10.5 sec	8.5 sec	6.5 sec
120	17.0 sec	15.0 sec	13.0 sec	11.0 sec	9.0 sec	7.0 sec
140	17.5 sec	15.5 sec	13.5 sec	11.5 sec	9.5 sec	7.5 sec
160	18.0 sec	16.0 sec	14.0 sec	12.0 sec	10.0 sec	8.0 sec
180	18.4 sec	16.4 sec	14.4 sec	12.4 sec	10.4 sec	8.4 sec
200	18.8 sec	16.8 sec	14.8 sec	12.8 sec	10.8 sec	8.8 sec
220	19.2 sec	17.2 sec	15.2 sec	13.2 sec	11.2 sec	9.2 sec
240	19.6 sec	17.6 sec	15.6 sec	13.6 sec	11.6 sec	9.6 sec
260	19.9 sec	17.9 sec	15.9 sec	13.9 sec	11.9 sec	9.9 sec
280	20.3 sec	18.3 sec	16.3 sec	14.3 sec	12.3 sec	10.3 sec
300	20.6 sec	18.6 sec	16.6 sec	14.6 sec	12.6 sec	10.6 sec

5.2.31.4 Hoist Swing Length Diagram

Swing Length = (C14-02 x MFAI=1B per 0%-100%) + C14-03 + (C14-04 x MFDI[77-7A]) + (C14-05 x MFAI=1D per Volt)

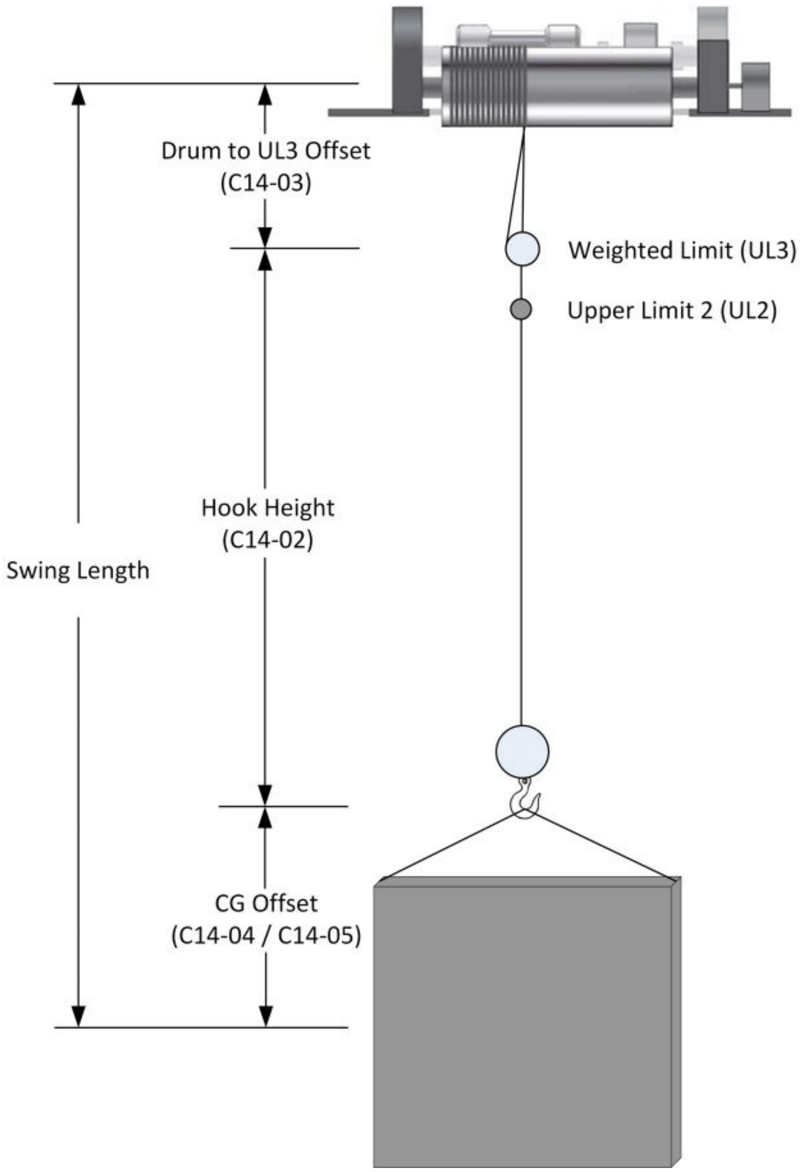


Figure 5-25: Hoist Swing Length Diagram

5.2.32 Static Stepless Simulation (C15)

Static Stepless Simulation provides a means to control an overhead bridge or trolley by allowing the operator to command a torque reference instead of a speed reference. This method is typically used in cab operated cranes, and when coupled with a Foot Brake, will approximate the accelerator and brake pedals on an automobile.

The VFD is configured to take a proportional command from the operator and develop the commanded amount of torque in the motor, which will in turn accelerate the motion. The more torque the operator commands, the quicker the motion will reach full speed. Once at full speed, the VFD will limit the motor speed to prevent overspeed (oS) faults.

The Foot Brake is operated in a similar fashion to that of an automobile where a master cylinder is operated by a foot pedal, which in turn transmits hydraulic pressure to engage the brake(s). The hydraulic pressure and braking torque developed by the master cylinder is proportional to the amount of force applied to the foot pedal. The same principal is true when using a Braketronic controller, except that the thruster braking torque is controlled electronically by a pedal-operated potentiometer.

Some features of this function are listed below and explained in detail throughout this section:

- This feature is usually applied to cab-operated cranes.
- Closed Loop Vector - Static Stepless Simulation.
- Foot Pedal Micro Switch Input - detects when the Foot Brake is being applied.
- Variable Torque Reverse Plugging - torque limited motor-assisted braking.
- Brake Stand Prevention - prevents driving into the brake to prevent additional wear and tear.
- Multi-Step Digital or Analog Torque References.
- Speed / Torque Limiting - programmable speed and torque limits (analog or digital).
- Responsive Control - minimal waiting for magnetic field decay in rotor prior to start.
- Easy Retrofit - compatible with most existing motors and Foot Brake systems.
- Full Control - start/stop speed is dependent on torque and independent of accel/decel times.

5.2.32.1 Control Methods for Foot Brake Operated Cranes

Table 5-53: Control Methods and Associated Stopping Methods

Control Method (A01-02)	A01-02 = 3 (Closed Loop Vector)	A01-02 = 0, 2, or 3 (V/f, OLV, or CLV)
Motion (A01-03)	A01-03 = 7 (Static Stepless)	A01-03 = 0 (Traverse)
Stopping Method (b03-03)	b03-03 = 1 (Coast to Stop)	b03-03 = 0 (Decel to Stop)
Brakes	Dynamic, Foot Brake, or Motor Brake(s) which generally become an Emergency/ parking brake	Motor Brake(s) are controlled by the VFD and are parking brakes that set when the motor reaches zero speed.
Master Switch Action	**Description of Control**	
Bridge Forward/Reverse - From stopped state, operator moves master switch fully ON.	Crane will accelerate at a rate proportional to the commanded torque reference, up to maximum speed. The torque reference is with respect to the deflection of the master switch.	Crane will accelerate to commanded speed. Each speed point is selectable or stepless. Acceleration time is selectable.
Neutral	Output to motor is off. Crane is coasting. An optional parking brake is commanded to set when zero speed is reached.	The crane will begin to decelerate down to zero speed following a selected deceleration time. Once zero speed is reached, a parking brake is commanded to set.
Reverse Plug (Direction Change)	Crane will begin to decelerate at a rate proportional to the deflection of the master switch and eventually change direction. A Foot Brake may be applied to assist with braking.	Crane will begin to decelerate according to an optional Reverse Plug deceleration time, eventually change direction, and accelerate in the opposite direction up to the commanded speed.
Foot Brake ON - Brake Stand Prevention (manual braking)	A Foot Brake can be used for all braking or to assist with dynamic braking. Brake stand prevention is optional since the motion is not following a programmed acceleration/ deceleration time. Restart is possible at any time, even if the crane is in motion.	Must use a micro switch from brake pedal or hydraulic pressure switch to signal the VFD to turn off to prevent pushing through the brake. Restarting is not possible until motion has completely stopped.
Bridge Forward/Reverse - From running/coasting state, operator moves master switch to half deflection.	The crane will accelerate from its present speed to maximum speed within the commanded torque settings. The rate at which it does so is with respect to the deflection of the master switch. Full on will yield full motor torque, half on will yield half motor torque (each detent is a programmable torque reference). ***NOTE:*** *Half deflection may be enough torque to keep the crane at a constant speed without applying full motor torque.*	The crane will accelerate or decelerate from the current speed to the commanded speed within the pre-programmed acceleration and deceleration times.

5.2.32.2 Controlling the Bridge/Trolley

Traversing with Torque Control

A master switch performs two separate functions in the control system. First, there is a set of contacts operated by a cam shaft. When the master switch is moved from the neutral position in either direction, the contacts close. This set of contacts issues the run command to the VFD. Second, the master switch provides a continuously variable voltage to the VFD, which internally correlates to a torque reference. The magnitude of the torque reference is proportional to the master switch position, which allows the crane operator to control the torque over the full range from minimum to maximum deflection.

Not only is the torque exerted at the motor shaft proportional to the master switch position, but it is regulated at that value as the crane accelerates or decelerates. As torque is applied to the motor, the crane begins to move in the commanded direction at the commanded amount of torque. As more torque is applied, the crane will accelerate or decelerate faster. The maximum speed is limited by parameter settings. Once the maximum speed is reached, the internal torque reference will automatically be reduced to prevent the crane from accelerating beyond the maximum speed setting, regardless of the master switch position. The amount of time for the crane to accelerate from zero speed to maximum speed is dependent on the torque reference given through the master switch. If a very slow speed and acceleration is required, then a very fine movement of the master switch in the desired direction will yield those results. This is helpful where a rapid acceleration would cause load swing.

Speed/Torque Mode Selection

The capability exists to switch from Static Stepless Simulation (SSS) mode into the V/f or Open Loop Vector speed control mode. This can be accomplished using the Motor 2 function. When Motor 2 is enabled (using an MFDI set to H01-xx or F03-xx = 44 or 144), the encoder is ignored and the VFD follows the speeds in the b01 parameter group, and the acceleration and deceleration times set in the b05 parameter group. The motor must be configured for running in Static Stepless Simulation (torque) mode, and for running in speed mode. Typically, a rotational auto-tune will be performed on the motor, which will calibrate torque mode. The E02 (Motor 1) and E04 (Motor 2) parameters should match. The E03 parameters are used to select the control method, stopping method, and V/f pattern that is used when the VFD is switched into speed mode (Motor 2).

Using Slowdown and Stop Limit Inputs

In Static Stepless Simulation, the VFD does not output current to the motor when the master switch is in the neutral position. This is unlike a traditional traverse motion, where the VFD will decelerate the motor to a stop. If a travel limit MFDI is turned on and the master switch is in the neutral position, the bridge will continue to coast. By default, the VFD will not output current to the motor without a run command from the operator. Enabling C15-14 will change this behavior, such that a UL1 or LL1 slowdown travel limit will initiate a run command and slow the motion to the slowdown speed set in C03-01 or C03-04. Once the UL1/LL1 speed is reached, the VFD will turn off again unless the operator issues a run command.

The Stop Limit inputs for UL2 and LL2 will not cause the VFD to decelerate. An MFDO set to 9 (SSS Parking Brake) may be used to control a stopping or parking brake. The SSS Parking Brake output will open in response to a UL2 or LL2 input, the Parking Brake feature activates, or any fault occurs.

Speed Control Functions Compatibility

In Static Stepless Simulation, the VFD is controlling the motor in Torque Control mode, but certain Speed Control functions remain functional. The Forward / Reverse Jog (MFDI = 15 and 16) and Forward / Reverse Inch (MFDI = 17 and 18) functions can be enabled when in SSS mode. These functions will be executed in Speed Control mode and allow for configurable slow movements, which may be desirable for fine positioning.

Variable Speed Limits

It may be beneficial to assign a speed limit to each torque step (C15-08 = 1). For a multi-step configuration, the b01-01 to b01-05 speed reference parameters act as speed limits for torque steps C15-01 to C15-05. When the speed limit has been reached, the torque reference may be reduced to maintain the speed. For a Bi-Polar or Uni-Polar configuration, a jumper wire is typically placed between the A1 and A3 terminals. The analog signal from the master switch is then wired to the A1 terminal. The torque and speed reference will be proportional and use the same input voltage but can be offset by adjusting the H03-xx gain and bias parameters.

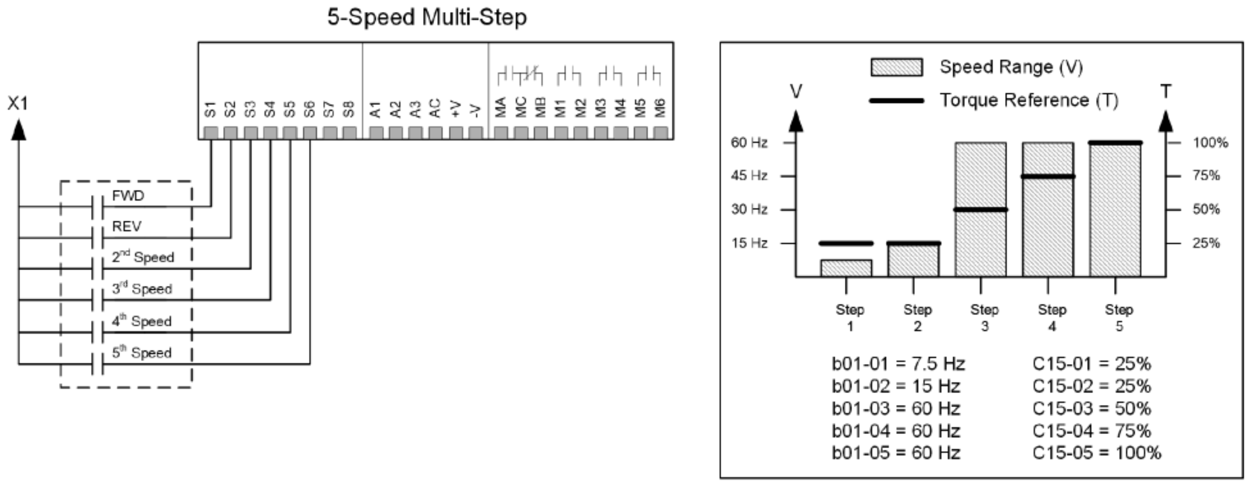


Figure 5-26: Digital Speed Limits Example

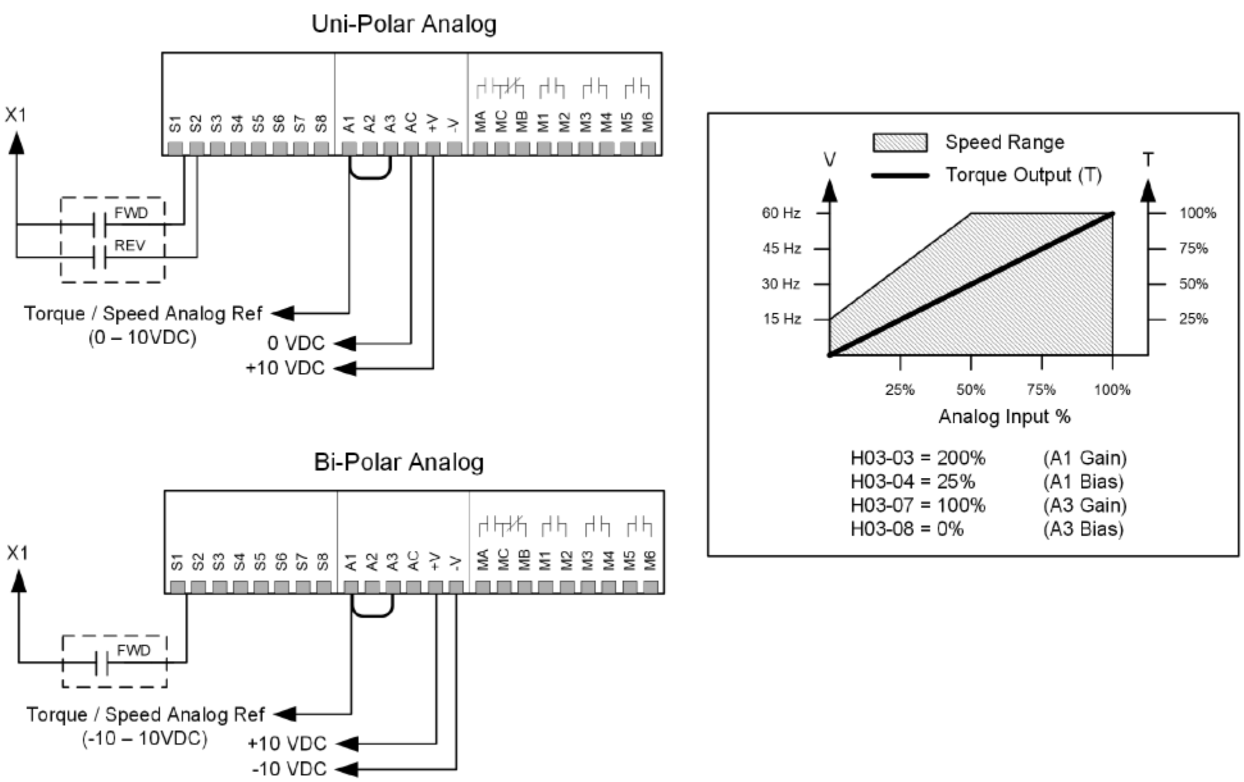


Figure 5-27: Analog Speed Limits Example

Stopping

Once the bridge or trolley is in motion and the operator has moved the master switch to the neutral position, the motion will coast and continue to do so until one or all of the following occur:

- Mechanical friction and wind resistance slow or stop motion over time
- The operator applies the brakes using the brake pedal
- The operator plugs the master switch to apply torque in the opposite direction of coasting motion

The following are possible scenarios when the Foot Brake is being applied:

Table 5-54: Foot Brake Actions

Crane Direction	Master Switch Torque Polarity	Torque Output to Motor	Keypad Display
Forward	Forward	Zero Torque Output	BRAKE STAND Foot Brake On
	Reverse	Reverse Plug (Follow Master Switch)	Normal Display
Reverse	Forward		
	Reverse	Zero Torque Output	BRAKE STAND Foot Brake On
Stopped (Zero Speed)	Forward		
	Reverse		

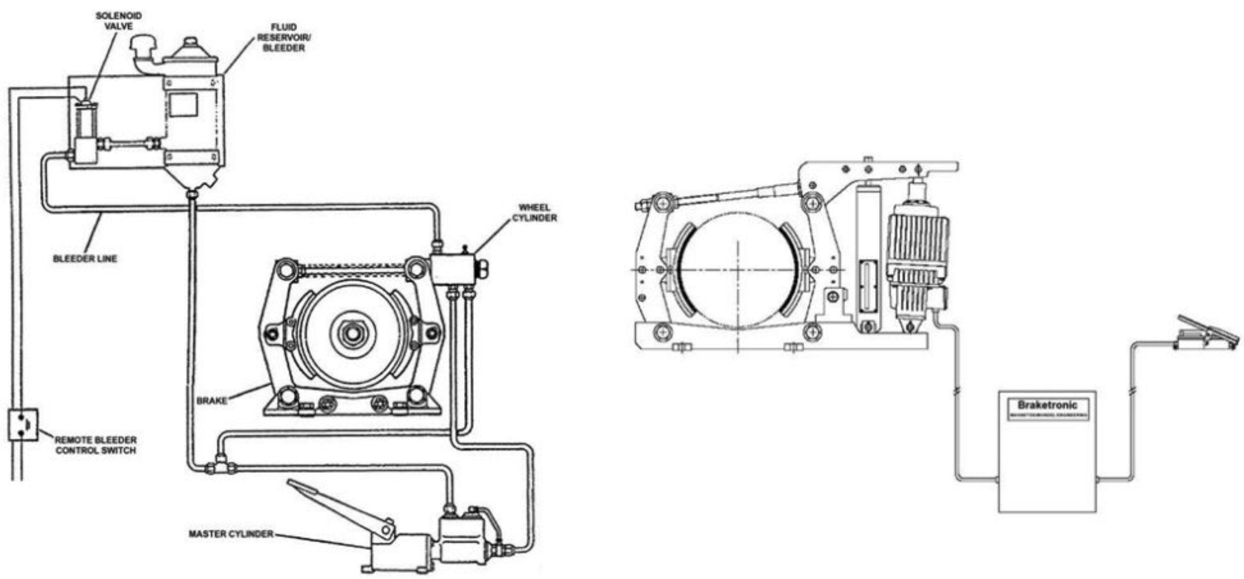


Figure 5-28: Typical Hydraulic Brake Circuit versus Braketronic System

Table 5-55: Static Stepless Simulation Parameters

Parameter	Display	Function	Range	Default
C15-01	Torque Reference 1	Torque Reference 1 for multi-step 1.	0–250%	20*
C15-02	Torque Reference 2	Torque Reference 2 for multi-step 2.	0–250%	40*
C15-03	Torque Reference 3	Torque Reference 3 for multi-step 3.	0–250%	60*
C15-04	Torque Reference 4	Torque Reference 4 for multi-step 4.	0–250%	80*
C15-05	Torque Reference 5	Torque Reference 5 for multi-step 5.	0–250%	100*
C15-07	Foot Brake Action	Action taken when the foot brake is applied. To use a foot brake, set an MFDI to H01-xx or F03-xx = 5D.	0–2	2
	0 Disabled	***NOTE:*** *There is a 500ms delay before any action is taken. This helps prevent nuisance faults if the brake pedal or master switch is bumped.*		
	1 Turn Output Off	Baseblock after foot brake input.		
	2 Brake Stand Prevention	Baseblock only if driving into the brake.		
C15-08	Variable Speed Limit *0 Disabled* *1 Enabled*	Sets a maximum motor speed for each torque step, using the associated Speed Reference (b01-xx) parameters.	0, 1	0
C15-10	Parking Brake Set Frequency	Frequency below which Parking Brake (MFDO = 9) will activate. This is also used by the Neutral Torque function (C15-12).	0.0–20.0 Hz	1.0
C15-11	Parking Brake Set Time	Time delay after the motor has decelerated below the C15-10 speed, without a run command active, before the Parking Brake will set. Once the brake is set, it will not reopen until a new run command is given.	0.0–6000.0 sec	1.0
C15-12	Neutral Torque Enable *0 Disabled* *1 Enabled*	Output a neutral torque (C15-13) until the motor speed is below C15-10 (Parking Brake Set Frequency).	0, 1	0
C15-13	Neutral Torque	When the motor speed (U01-05) is above C15-10, and the Run command is off, the VFD will apply this level of regen torque until the motor speed is below C15-10, a new run command is issued, or another action occurs (such as a fault).	0–200%	0
C15-14	Slowdown Limits Engage RUN Cmd *0 Disabled* *1 Enabled*	Energize the motor in response to a Slowdown limit (UL1 or LL1) input. **WARNING:** Take caution when enabling this parameter as it will run the motor even if a run command isn't active.	0, 1	0
C15-15	Run Extend Time	Extend the run, after the Run command is removed, to prevent the VFD from baseblocking during a reverse plug. This function is independent of Neutral Torque (C15-12). A setting of 0.0 disables this function.	0.0–5.0 sec	0.5

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.2.32.3 Setting Up Static Stepless Simulation

The following instructions will step through the setup of the basic features of Static Stepless Simulation (SSS). This feature requires a VG+ programmed for Closed Loop Vector control method (A01-02 = 3) and the Static Stepless Simulation motion (A01-03 = 7).

The first step is to choose a Speed Reference (A01-04) of either Analog or Digital control.

Analog Control

1. If only Torque Control is required and distinct speed steps are not required, a Uni-Polar or Bi-Polar speed reference (A01-04 = 5 or 6) is recommended and is commonly interfaced with a master switch (joystick).

NOTE: *A Uni-Polar signal is 0 to +10 VDC and a Bi-Polar signal is -10 to +10 VDC.*

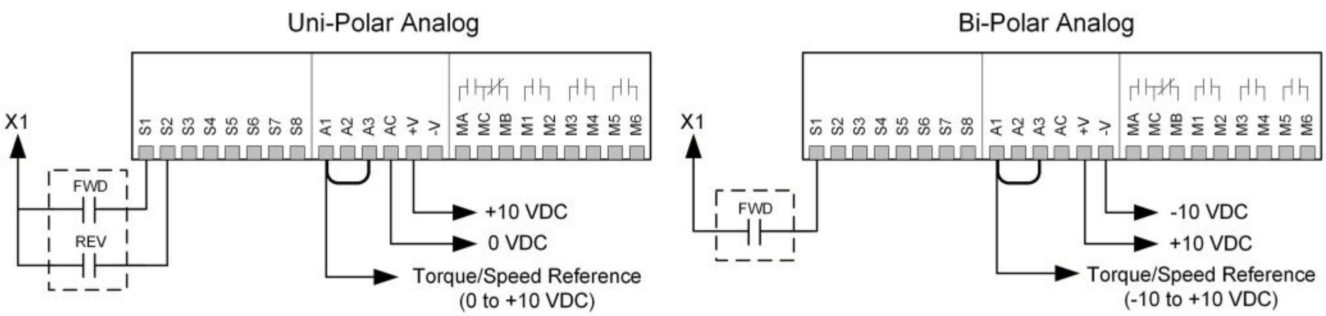


Figure 5-29: Analog Control Wiring Example

2. Variable Speed Limits can be enabled (C15-08 = 1) and applied using the following method:
   - Wire a jumper from A1 to A3. This will allow the VFD to output a torque and speed equally proportionate to the deflection of the master switch. Or, instead of a jumper wire, set H03-20 (MFAI Signal Bridge) = 2 (Terminal A1 to A3) to electrically bridge A1 and A3 together.
   - To configure a speed limit that is non-proportionate to the torque, the A1 gain (H03-03) and/or bias (H03-04) can be adjusted as needed.
3. To configure a Foot Brake input, wire the Foot Brake micro switch to a digital input (S1 - S8) and set the corresponding MFDI parameter to H01-xx or F03-xx = 5D (Brake Stand).
   - The default Foot Brake Action setting is C15-07 = 2 (Brake Stand Prevention). The VFD will baseblock when the Foot Brake is pressed, causing the crane to coast and decelerate. An opposite direction command (plug) is allowed to aide in stopping the crane.
   - If the Foot Brake Action is set to C15-07 = 1 (Turn Output Off), a directional run command will have no effect until the Foot Brake is released.

Digital Control

1. If Torque Control with specific speed steps is desired, the speed reference should be configured for 2-, 3-, or 5-Speed Multi-Step (A01-04 = 0, 1, or 2).

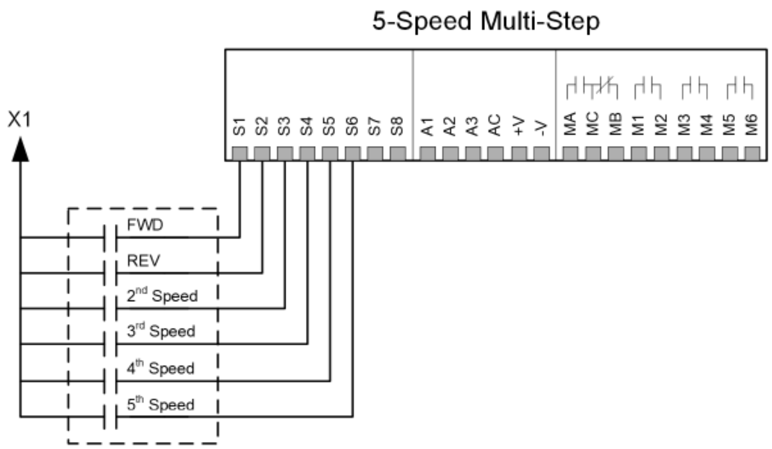


Figure 5-30: Digital Control Wiring Example

2. If a Multi-Step speed reference has been selected, the Torque References for each speed step can be configured in parameters C15-01 to C15-05.
   - **For example:** If C15-01 is set to 10%, then during 1st speed, only 10% torque will be applied to accelerate the motor (viewable via U01-09 monitor).
3. If a Multi-Step speed reference has been selected, Variable Speed Limits can also be enabled (C15-08 = 1). When enabled, each speed step will have a speed limit corresponding to its b01-0x parameter.
   - **For example:** To set the speed limit of 1st speed to 10.00 Hz, first set C15-08 = 1 (Enabled) and then set b01-01 = 10.00.
4. To configure a Foot Brake input, wire the Foot Brake micro-switch to a digital input (S1 - S8) and set the corresponding MFDI parameter to H01-xx or F03-xx = 5D (Brake Stand).
   - The default Foot Brake Action setting is C15-07 = 2 (Brake Stand Prevention). The VFD will baseblock when the Foot Brake is pressed, causing the crane to coast and decelerate. An opposite direction command (plug) is allowed to aide in stopping the crane.
   - If the Foot Brake Action parameter is set to C15-07 = 1 (Turn Output Off), a directional run command will have no effect until the Foot Brake is released.

5.2.33 Braketronic

Braketronic is a system that provides a means of varying the brake torque developed by thruster-released shoe and disc brakes. Single or multiple brakes may be operated from one Braketronic controller. The Braketronic controller contains a VFD, which is configured for the desired braking method.

Brake torque is achieved by either of the following methods:

- Operator-induced variable braking, typically with a foot pedal.
- Preset braking ramp, initiated by a radio, and controlled by the VFD.

5.2.33.1 Thruster Brake Actuation

Control of brake torque is achieved by adjusting the electrical supply voltage and frequency to the thruster pump motor. This varies the speed of the pump impeller and controls the “set” and “released” states of the brake, as follows:

- Brake torque is mechanically applied via a compression torque spring. The torque spring pulls on the brake lever, transmitting force through the brake linkage, and pressing the shoes against the wheel. The default (unenergized) mode of the brake is fully set.

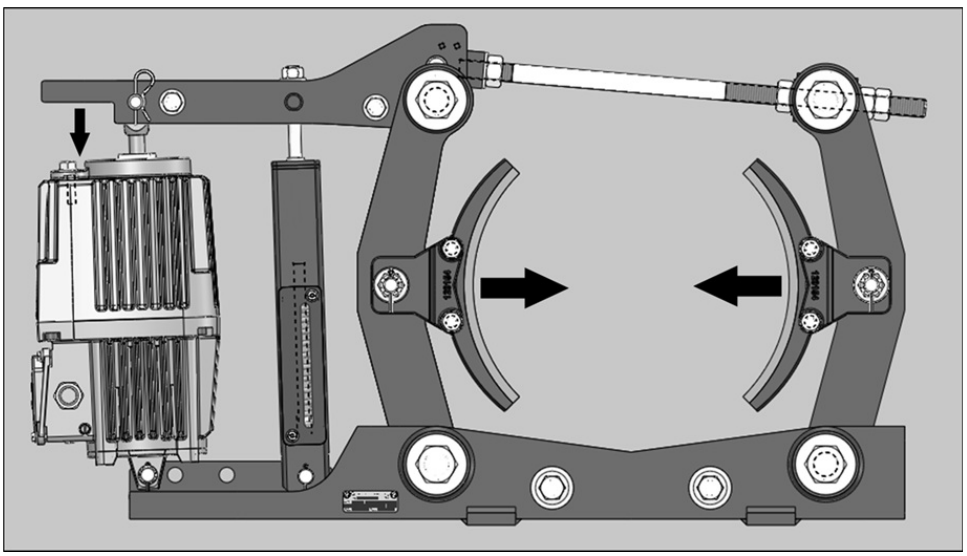


Figure 5-31: Brake Set

- When electric power is supplied to the thruster, it incrementally cancels the brake's ability to apply brake torque. As power increases, the thruster piston rod extends, which pushes the brake lever, and causes the brake linkage to develop a clearance between the shoes and the brake wheel/disc. The process to close the brake is the same procedure, but by decreasing the power to the thruster.

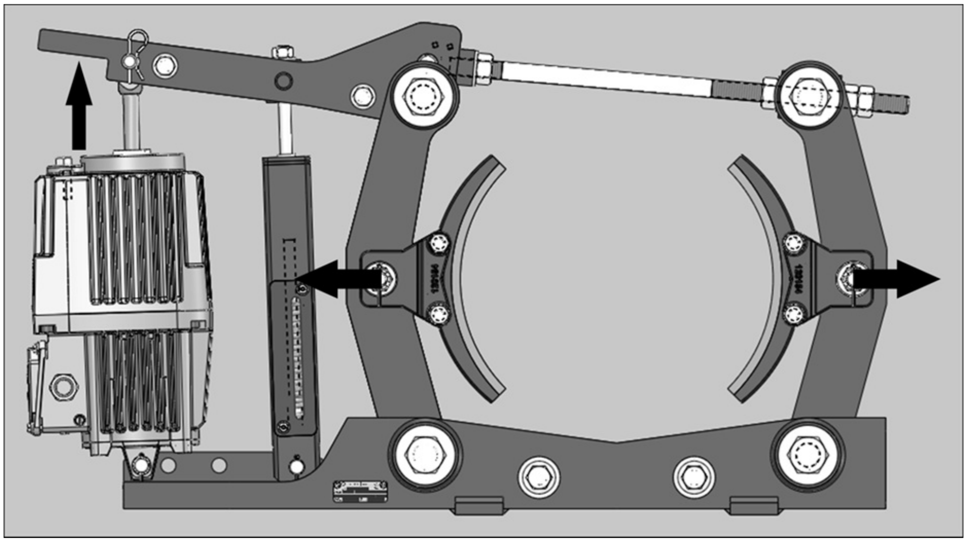


Figure 5-32: Brake Released

5.2.33.2 Braking by Brake Pedal Control

When using brake pedal control, the output voltage and frequency produced by the Braketronic controller will vary, depending upon the position of the pedal, as follows:

- When the Braketronic controller is powered on and the pedal is released (OFF), the controller supplies full rated voltage and frequency to the thruster motor to fully release the brake.
- When foot pressure is applied to the pedal, an internal switch trips as the pedal leaves the released (OFF) position. This switch causes the controller output to quickly move the shoes into a light “kiss” contact with the brake wheel/disc.
- As pressure on the pedal increases, a potentiometer adjusts the controller to produce a gradual increase in braking torque.
- When the pedal is fully depressed, maximum braking torque is produced.
- A small decrease in pedal pressure decreases the braking torque.
- When pressure on the foot pedal is completely removed, the internal switch resets to produce maximum controller output and quickly moves the shoes clear of the wheel/disc.

5.2.33.3 Braking by Wireless Control

Wireless radio control can be used to operate the Braketronic controller, typically by a “Brake Master Switch” on the radio transmitter. Braking characteristics are like those offered by a foot-operated brake pedal while allowing the operator better mobility. Operation is generally as follows:

- When the Braketronic controller is powered on and the Brake Master Switch is not operated, the controller supplies full rated voltage and frequency to the thruster motor to fully release the brake.
- Initial movement of the Brake Master Switch activates a primary relay. This causes the controller output to quickly move the shoes into a light “kiss” contact with the brake wheel/disc.
- Advancing the “Brake Master Switch” adjusts the controller to produce a gradual increase in braking torque.
- When the Brake Master Switch reaches full travel, maximum braking torque is produced.
- Gradually allowing the Brake Master Switch to return to its starting position gradually decreases the braking torque.
- When the Brake Master Switch returns to its starting position, the primary relay releases to produce maximum controller output and quickly moves the shoes clear of the wheel/disc.

5.2.33.4 Braking by Fixed Rate Ramp Control

Fixed rate ramp control is available as an alternative to variable rate braking. The controller will produce an output whose voltage and frequency emulate pedal operation, as follows:

- A switch or push button can initiate the braking sequence. When the “kiss” stage is reached, the controller output will decrease linearly to produce a ramp-controlled increase in braking torque. At the end of this ramp period, maximum braking torque is produced.
- Turning off the switch will increase the Braketronic output at a predetermined ramp rate. The frequency and voltage will ramp to maximum, and the brake will return to the fully released state.

5.2.33.5 Brake Pedal Types

The Industrial Duty foot pedal consists of a floor mounted, NEMA 4 rated, cast aluminum enclosure containing three switches and a potentiometer. The pedal drives the potentiometer via a gear set and the switches via independently adjustable cams.

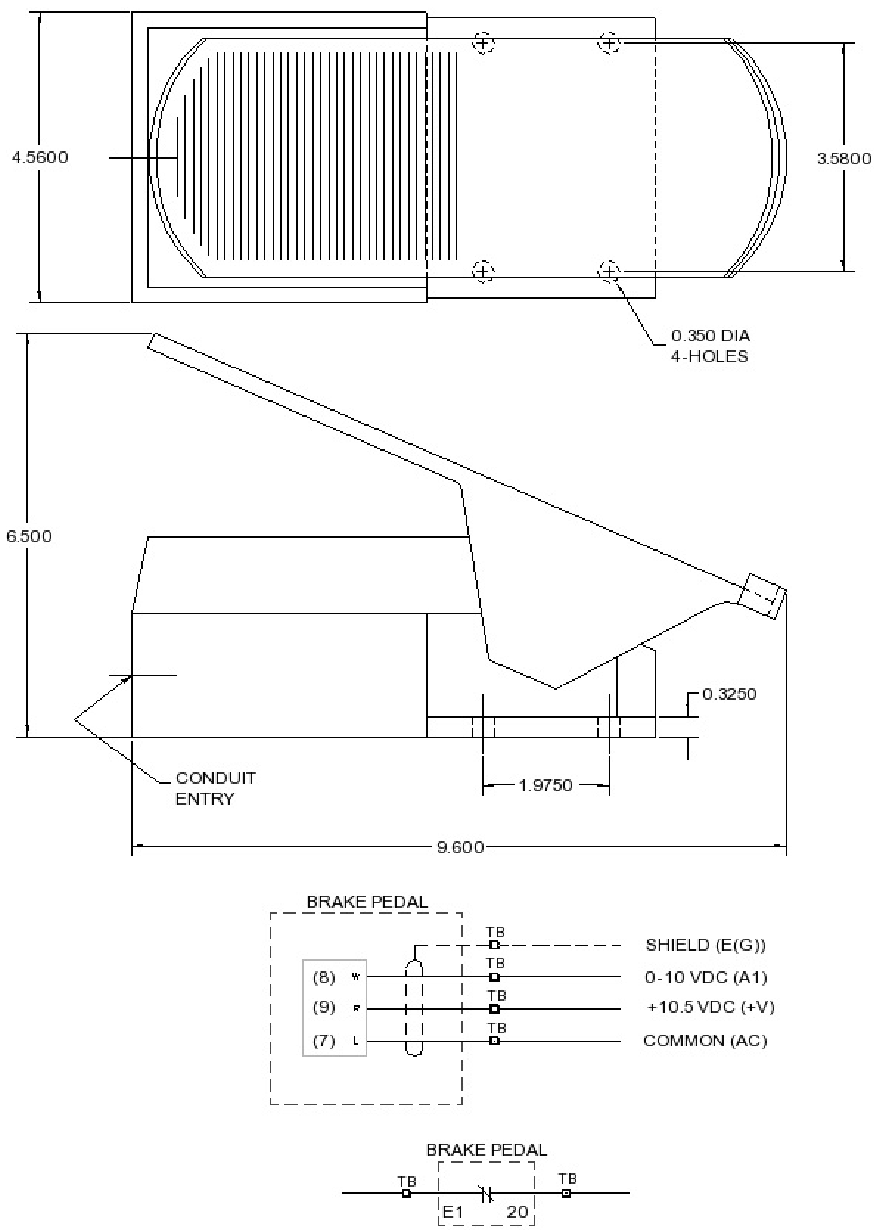


Figure 5-33: Industrial Duty Foot Pedal

The Mill Duty foot pedal consists of a more rugged floor mounted, NEMA 4 rated, cast aluminum enclosure containing a contact block and a gear-driven potentiometer. The pedal drives the potentiometer via a gear set and the switches via independently adjustable cams.

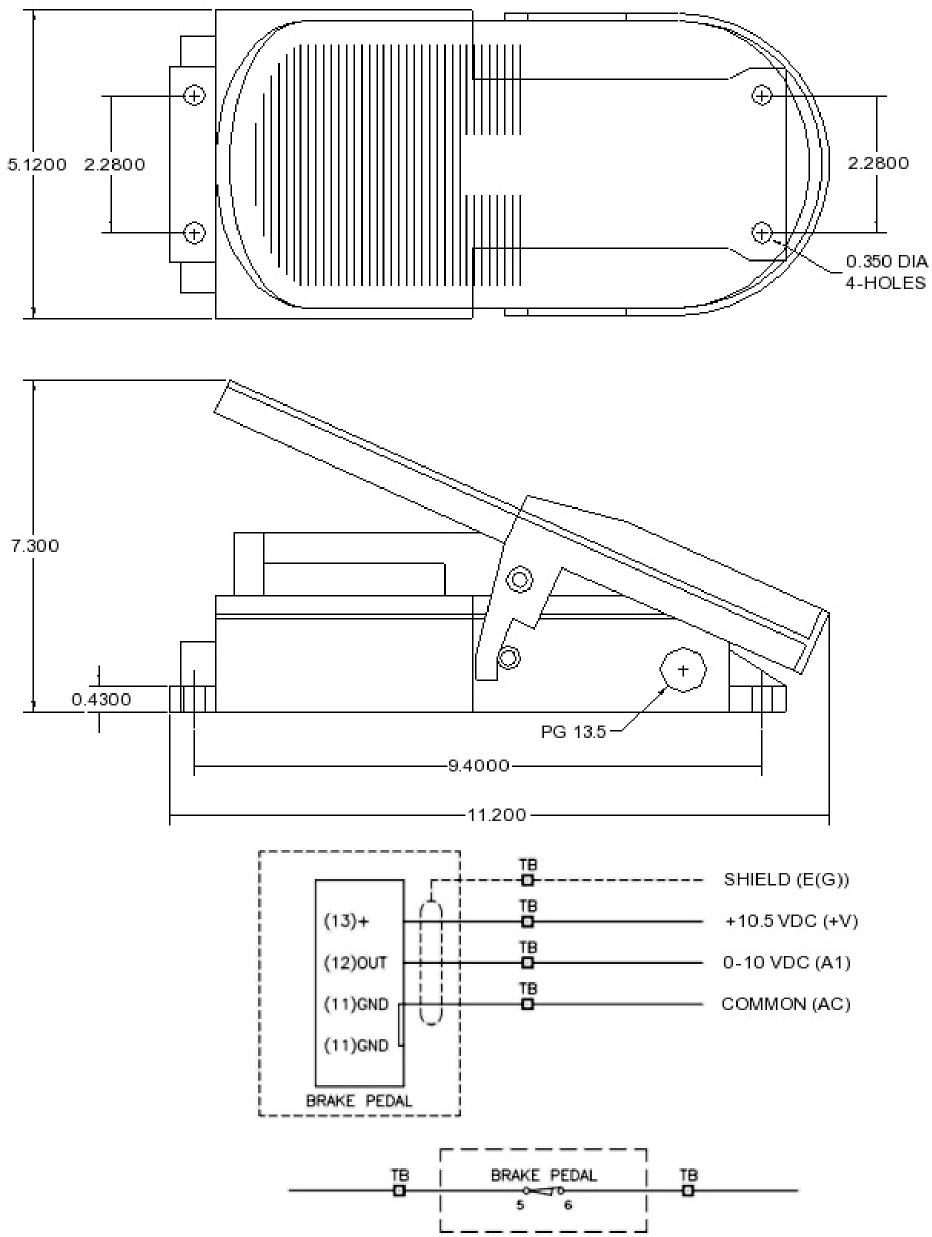


Figure 5-34: Mill Duty Foot Pedal

5.2.33.6 Typical Braketronic Parameters and Diagrams

Table 5-56: Foot Pedal Control Parameters

Parameter	Display	Setting	Setting Description
A01-03	Motion	4	Braketronic
A01-04	Speed Reference	1	3-Speed Multi-Step
b01-08	Reference 8	60.00 Hz	Brake fully released
b03-01	Frequency Reference Selection	1	Analog Input
b03-10	Run Command at Power Up	1	Release the brake immediately when power is turned on
b05-01	Acceleration Time	1.00 sec	Time for the brake to fully open
b05-02	Deceleration Time	1.00 sec	Time for the brake to fully close
d09-01	S-Curve Time @ Start of Accel	0.00 sec	S-curve at start of acceleration
d09-02	S-Curve Time @ End of Accel	0.00 sec	S-curve at end of acceleration
d09-03	S-Curve Time @ Start of Decel	0.00 sec	S-curve at start of deceleration
d09-04	S-Curve Time @ End of Decel	0.00 sec	S-curve at end of deceleration
E01-03	V/f Pattern	F	Custom V/f pattern
E01-05	Maximum Output Voltage	208.0 VAC	Set to thruster nameplate voltage
E01-06	Base Frequency	60.0 Hz	Frequency that correlates with maximum voltage
E01-13	Base Voltage	208.0 VAC	Set to thruster nameplate voltage
E02-01	Motor Full Load Amps	12.00 A	Set to total full load amps of all connected thrusters
H01-01	Terminal S1	80	Run command
H01-02	Terminal S2	F	Not Used
H01-03	Terminal S3	2	Multi-Step Speed Reference 4
H01-04	Terminal S4	F	Not Used
H01-05	Terminal S5	F	Not Used
H01-06	Terminal S6	15F	Phantom Stop (N.C.)
H03-02	Terminal A1 Function	0	Analog Frequency Reference 1
H03-03	Terminal A1 Gain	75.0%	Kiss Frequency as % of b01-08 (60 Hz * 75% = 45 Hz)
H03-04	Terminal A1 Bias	25.0%	Minimum thruster frequency (25.0% bias = ~20 Hz)
L02-01	Power Loss Ride Through	2	Provides sag protection and allows for a restart without fault
L02-05	Undervoltage Level	150 VDC	The VFD will run until the DC bus sags below this voltage

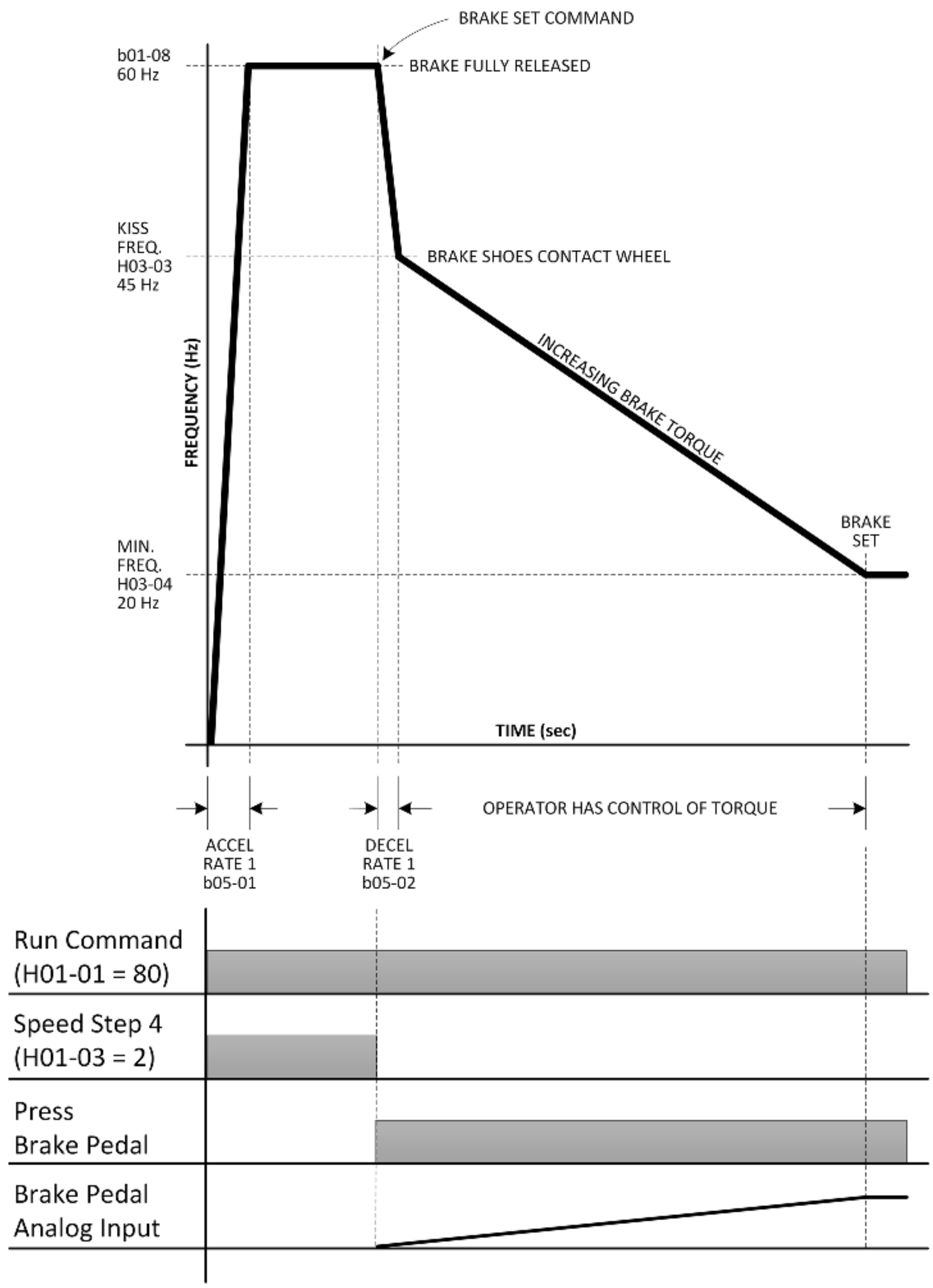


Figure 5-35: Foot Pedal Control Timing Diagram

Table 5-57: Radio Control Parameters

Parameter	Display	Setting	Setting Description
A01-03	Motion	4	Braketronic
A01-04	Speed Reference	1	3-Speed Multi-Step
b01-10	Reference 10	60.00 Hz	Brake fully released
b01-11	Reference 11	20.00 Hz	Brake fully depressed
b03-01	Frequency Reference Selection	0	Multi-Step Terminals
b03-10	Run Command at Power Up	1	Release the brake immediately when power is turned on
b05-01	Acceleration Time	1.00 sec	Time for the brake to fully open
b05-02	Deceleration Time	1.00 sec	Time for the brake to fully close
d08-03	Dwell Reference at Stop	45.0 Hz	Determines the kiss frequency
d08-04	Dwell Time at Stop	3.0 sec	Time to remain at the kiss frequency before closing the brake
d09-01	S-Curve Time @ Start of Accel	0.00 sec	S-curve at start of acceleration
d09-02	S-Curve Time @ End of Accel	0.00 sec	S-curve at end of acceleration
d09-03	S-Curve Time @ Start of Decel	0.00 sec	S-curve at start of deceleration
d09-04	S-Curve Time @ End of Decel	0.00 sec	S-curve at end of deceleration
E01-03	V/f Pattern	F	Custom V/f pattern
E01-05	Maximum Output Voltage	208.0 VAC	Set to thruster nameplate voltage
E01-06	Base Frequency	60.0 Hz	Frequency that correlates with maximum voltage
E01-13	Base Voltage	208.0 VAC	Set to thruster nameplate voltage
E02-01	Motor Full Load Amps	12.00 A	Set to total full load amps of all connected thrusters
H01-01	Terminal S1	80	Run command
H01-02	Terminal S2	F	Not Used
H01-03	Terminal S3	2	Multi-Step Speed Reference 4
H01-04	Terminal S4	3	Multi-Step Speed Reference 5
H01-06	Terminal S6	15F	Phantom Stop (N.C.)
L02-01	Power Loss Ride Through	2	Provides sag protection and allows for a restart without fault
L02-05	Undervoltage Level	150 VDC	The VFD will run until the DC bus sags below this voltage

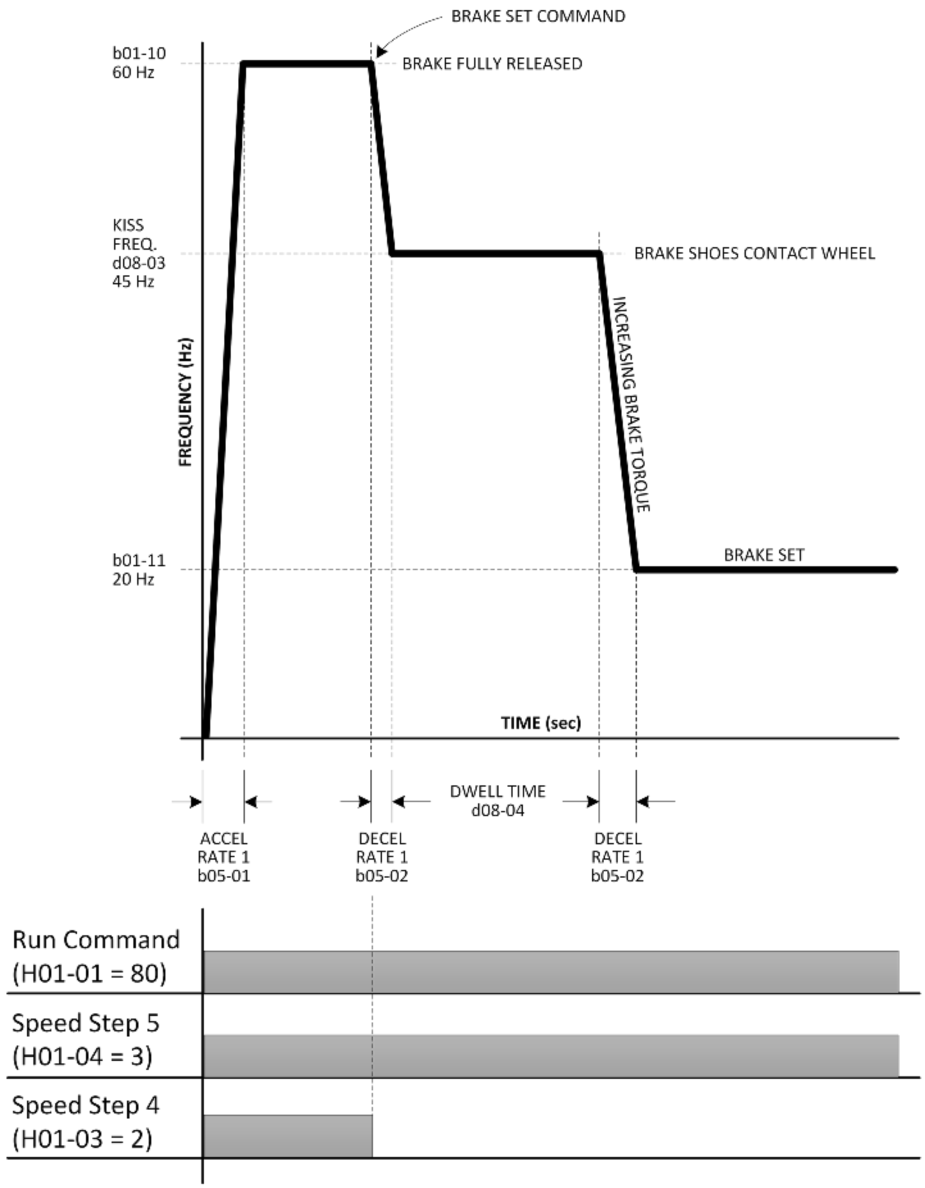


Figure 5-36: Radio Control Timing Diagram

Table 5-58: Selectable Foot Pedal or Radio Control Parameters

Parameter	Display	Setting	Setting Description
A01-03	Motion	4	Braketronic
A01-04	Speed Reference	1	3-Speed Multi-Step
b01-08	Reference 8	60.00 Hz	Brake fully released (Pedal)
b01-10	Reference 10	60.00 Hz	Brake fully released (Radio)
b01-11	Reference 11	20.00 Hz	Brake fully depressed (Radio)
b03-01	Frequency Reference Selection	1	Analog Input
b03-10	Run Command at Power Up	1	Release the brake immediately when power is turned on
b05-01	Acceleration Time	1.00 sec	Time for the brake to fully open
b05-02	Deceleration Time	1.00 sec	Time for the brake to fully close
d08-03	Dwell Reference at Stop	45.0 Hz	Determines the kiss frequency (Radio)
d08-04	Dwell Time at Stop	3.0 sec	Time to remain at the kiss frequency before closing the brake
d09-01	S-Curve Time @ Start of Accel	0.00 sec	S-curve at start of acceleration
d09-02	S-Curve Time @ End of Accel	0.00 sec	S-curve at end of acceleration
d09-03	S-Curve Time @ Start of Decel	0.00 sec	S-curve at start of deceleration
d09-04	S-Curve Time @ End of Decel	0.00 sec	S-curve at end of deceleration
E01-03	V/f Pattern	F	Custom V/f pattern
E01-05	Maximum Output Voltage	208.0 VAC	Set to thruster nameplate voltage
E01-06	Base Frequency	60.0 Hz	Frequency that correlates with maximum voltage
E01-13	Base Voltage	208.0 VAC	Set to thruster nameplate voltage
E02-01	Motor Full Load Amps	12.00 A	Set to total full load amps of all connected thrusters
H01-01	Terminal S1	80	Run command
H01-02	Terminal S2	F	Not Used
H01-03	Terminal S3	2	Multi-Step Speed Reference 4
H01-04	Terminal S4	3	Multi-Step Speed Reference 5
H01-05	Terminal S5	65	Dwell Enable
H01-06	Terminal S6	15F	Phantom Stop (N.C.)
H03-02	Terminal A1 Function	0	Analog Frequency Reference 1
H03-03	Terminal A1 Gain	75.0%	Kiss Frequency as % of b01-08 (60 Hz * 75% = 45 Hz)
H03-04	Terminal A1 Bias	25.0%	Minimum thruster frequency (25.0% bias = ~20 Hz)
L02-01	Power Loss Ride Through	2	Provides sag protection and allows for a restart without fault
L02-05	Undervoltage Level	150 VDC	The VFD will run until the DC bus sags below this voltage

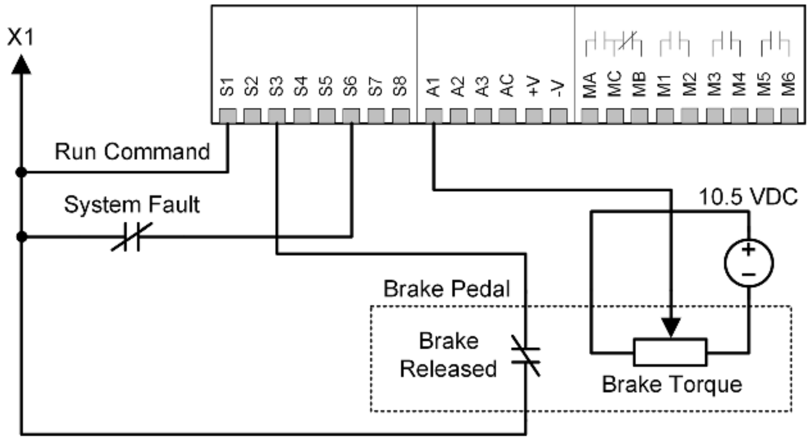


Figure 5-37: Foot Pedal Control Wiring Diagram

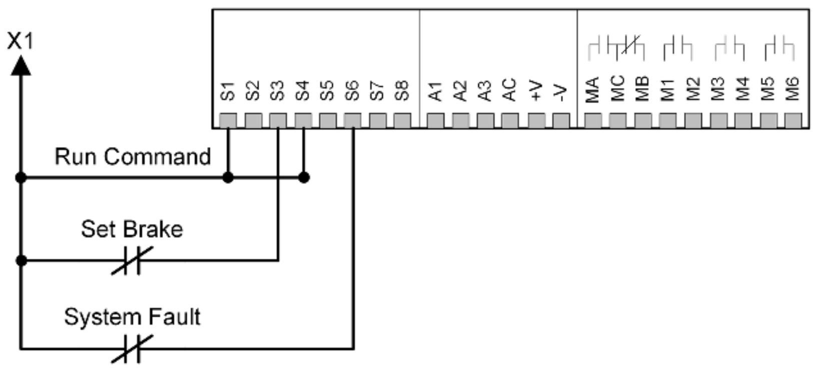


Figure 5-38: Radio Control Wiring Diagram

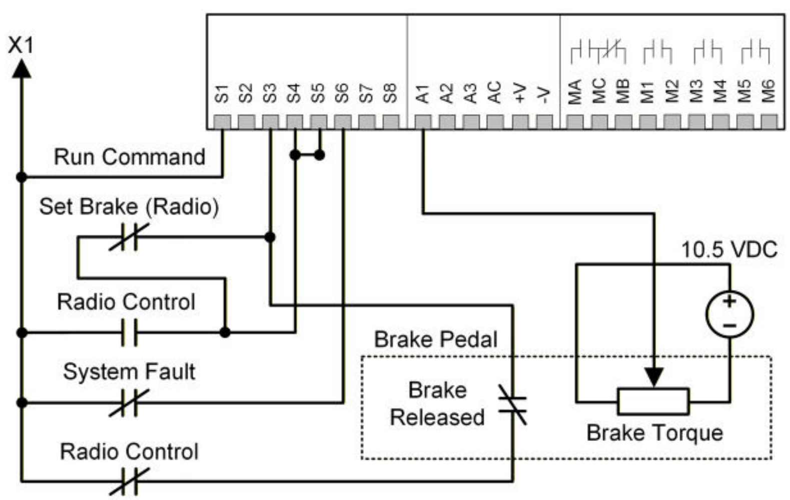


Figure 5-39: Selectable Foot Pedal or Radio Control Timing Diagram

Table 5-59: Table 5-x: Additional Parameters for Radio Control with Alternate Deceleration

Parameter	Display	Setting	Setting Description
b05-06	Switch Frequency Decel Time	3.00 sec	Deceleration time when b05-10 frequency is reached
b05-10	Switchover Frequency	45.0 Hz	Frequency to trigger the b05-06 deceleration time
b05-11	Switch Frequency Compare	0	Decelerate via b05-06 when U01-02 < b05-10

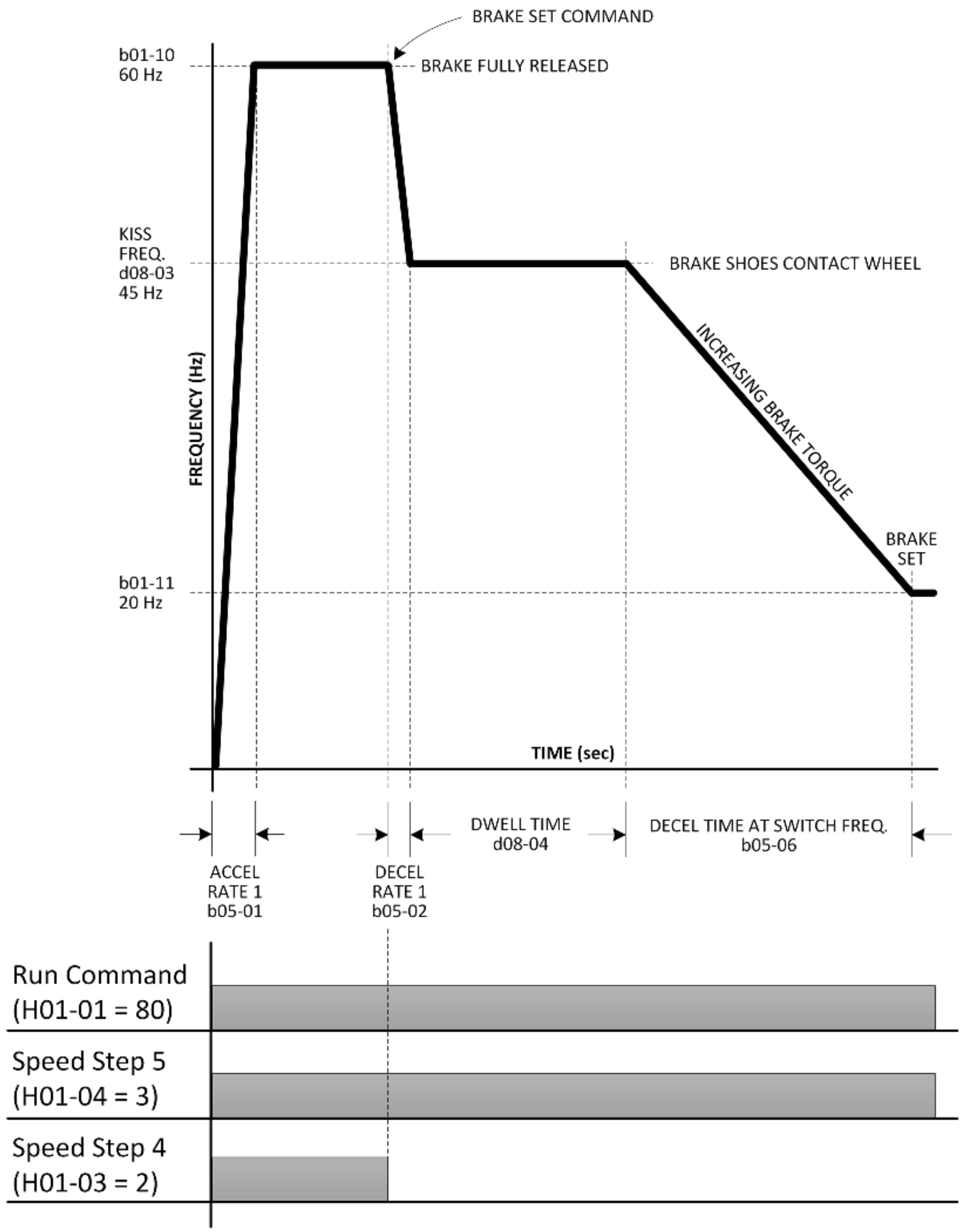


Figure 5-40: Radio Control with Alternate Deceleration Timing Diagram

5.3 Tuning Functions (d)

- d01 DC Injection
- d02 Slip Compensation
- d03 Torque Compensation
- d04 Automatic Speed Regulator (ASR) Tuning
- d05 Torque Control
- d08 Dwell
- d09 S-Curve Times
- d10 Duty Rating & Carrier Frequency

5.3.1 DC Injection (d01)

With decel to stop enabled (b03-03 = 0), upon removal of the run command, the motor will decelerate according to the Decel Time (b05-02), until output frequency reaches the DC Injection Braking Start Frequency (d01-01). Then the frequency output is turned off and DC injection current is applied to the motor. The effective DC injection time and current should be set to provide adequate stopping without excessive motor heating. The DC injection voltage is determined by the DC injection braking current and motor impedance.

Table 5-60: DC Injection Parameter Settings

Parameter	Display	Function	Range	Default
d01-01	DC Injection/Zero Speed Threshold	DC Injection Braking Frequency Start	0.0–10.0 Hz	0.5
d01-02*	DC Injection Braking Current	DC Injection Braking current as a percentage of the VFD rated current.	0–100%	50
d01-03	DC Inject Braking Time at Start	DC Injection Braking Time	0.00–10.00 sec	0.00
d01-04	DC Inject Braking Time at Stop	DC Injection Braking Time at Stop	0.00–10.00 sec	0.05
d01-08*	Magnetic Flux Compensation Value	Current injected at the start of DC Injection Braking as a percentage of motor no-load current (E02-03).	0–1000%	0

** Not available in the Closed Loop Vector control method (A01-02 = 3).*

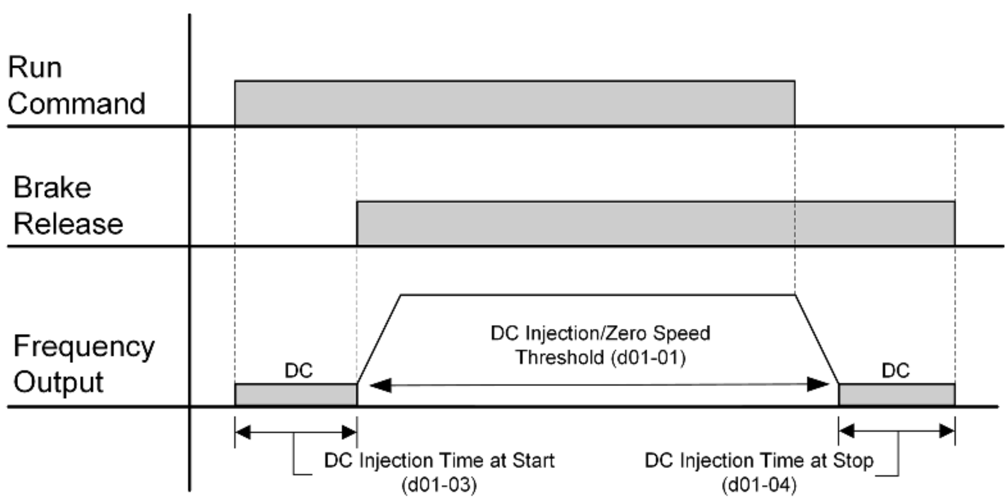


Figure 5-41: DC Injection Braking Sequence

5.3.2 Slip Compensation (d02)

As the load becomes larger, the motor speed is reduced and the motor slip increases. The Slip Compensation function keeps the motor speed constant under varying load conditions. Parameter d02-01 sets the slip compensation gain. When d02-01 = 1.0, the output frequency is increased by 1% of the E01-06 setting at rated current. A setting of d02-01 = 0.0 results in no slip compensation.

Table 5-61: Slip Compensation Parameter Settings

Parameter	Display	Function	Range	Default
d02-01	Slip Compensation Gain	Slip compensation multiplier.	0.0–2.5	V/f: 0.0 OLV: 1.0 CLV: 1.0
d02-02	Slip Compensation Delay Time	Adjusts the slip compensation function delay time (G+ only).	0–10000 ms	V/f: 2000 OLV: 200
d02-03	Slip Compensation Limit	Upper limit for the slip compensation as a percentage of motor rated slip E02-02 (G+ only).	0–250%	200
d02-04	Slip Compensation at Regen *0 Disabled* *1 Enabled Above 6Hz* *2 Enabled Above Defined Range*	Determines when Slip Compensation is enabled during regeneration (G+ only).	0–2	0
d02-05	Output Voltage Limit Selection *0 Disabled* *1 Enabled*	Automatically reduces motor flux when the output voltage saturates.	0, 1	0
d02-16	Vout Modulation Limit Start Lvl	Modulation factor that starts the output voltage limit operation when d02-05 = 1 (Enabled).	70.0–d02-17%	90.0
d02-17	Vout Modulation Limit Max Level	Modulation factor used with d02-18 for output voltage limit operation when d02-05 = 1 (Enabled).	85.0–100.0%	100.0
d02-18	Output Voltage Limit Level	Maximum voltage level drop width when d02-05 = 1 (Enabled).	50.0–100.0%	90.0
d02-21	Motor 2 Slip Compensation Gain	Slip Compensation gain for Motor 2.	0.0–2.5	V/f: 0.0 OLV: 1.0
d02-22	Motor 2 Slip Comp Delay Time	Slip Compensation delay time for Motor 2 when speed is unstable or response is too slow.	0–10000 ms	V/f: 2000 OLV: 200
d02-23	Motor 2 Slip Compensation Limit	Slip Compensation upper limit for Motor 2 as a percentage of rated slip.	0–250%	200
d02-24	Motor 2 Slip Comp during Regen *0 Disabled* *1 Enabled Above 6Hz* *2 Enabled Above Defined Range*	Slip Compensation during regenerative operation for Motor 2.	0–2	0

5.3.3 Torque Compensation (d03)

The motor torque requirement changes according to load conditions. Full-range automatic torque boost adjusts the voltage of the V/f pattern according to the required torque. The VFD automatically adjusts the voltage during constant-speed operation as well as during acceleration.

The required torque is calculated by the VFD. This ensures smooth operation and power savings.

Output voltage α Torque compensation gain x Required torque

When more torque is needed, increase the torque compensation gain in one-tenth (0.1) increments. Increase the setting when the wiring distance between the VFD and the motor is 100 feet (30.5 meters) or longer. If the motor generates excessive vibration or oscillates, decrease the torque compensation.

Increasing torque compensation gain increases motor torque, but an excessive increase may cause the following:

- VFD faults due to motor overexcitation, and/or
- Motor overheat or excessive vibration.

Increase the torque compensation time constant in 10 ms increments when the motor's output current is unstable. Decrease this value when speed response is slow.

Table 5-62: Torque Compensation Parameter Settings

Parameter	Display	Function	Range	Default
d03-01	Torque Compensation Gain	Gain for the automatic torque (voltage) boost function and helps to produce better starting torque.	0.00–2.50	1.00*
d03-02	Torque Compensation Delay Time	Torque compensation delay time.	0–60000 ms	V/f: 200 OLV: 20
d03-03	Torque Compensation @ FWD Start	Torque compensation at forward start as a percentage of motor torque.	0.0–200.0%	0.0**
d03-04	Torque Compensation @ REV Start	Torque compensation at reverse start as a percentage of motor torque.	-200.0–0.0%	0.0**
d03-05	Torque Compensation Time	Time constant for torque compensation at forward start and reverse start (d03-03 and d03-04).	0–200 ms	10**
d03-06	Motor 2 Torque Comp Delay Time	Torque compensation delay time 2.	0–10000 ms	150**
d03-07	Motor 2 Torque Compensation Gain	Torque Compensation gain for Motor 2.	0.00–2.50	1.00
d03-19	Torque Ripple Suppress Min Freq	Adjust this setting if there is slow oscillation at low speed.	0.0–10.0 Hz	0.1
d03-20	Voltage Compensation Adjust 1	Voltage Compensation 1 precision.	0–200 Hz	120
d03-21	Voltage Compensation Adjust 2	Voltage Compensation 2 precision.	0–10	5
d03-23	Current Control Gain	Current control gain.	0.50–2.50	1.00*

** Default setting is determined by A01-02 (Control Method).*

*** Only available in Open Loop Vector (A01-02 = 2).*

5.3.4 Automatic Speed Regulator (ASR) Tuning (d04)

The ASR controls the motor speed in the Closed Loop Vector control method and adjusts the output torque reference to minimize the difference between frequency reference and actual motor speed.

The figure below illustrates ASR functionality:

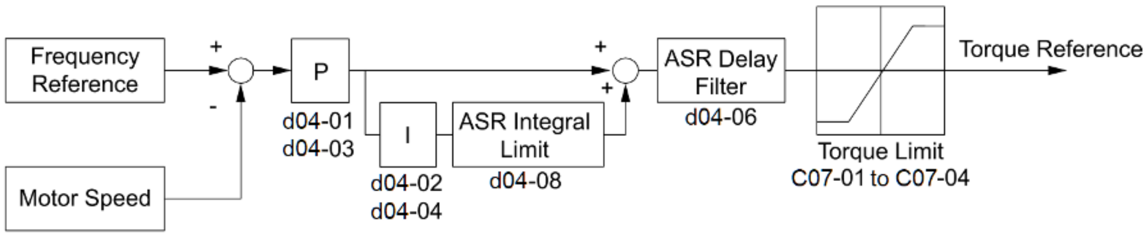


Figure 5-42: Speed Control Block Diagram for Closed Loop Vector

Perform Auto-Tuning and set all motor parameters correctly prior to adjusting ASR parameters.

Generally when tuning the ASR, optimize the ASR gain before adjusting the integral time settings. Always make adjustments with the load connected to the motor.

Parameters d04-03 and d04-04 define the ASR proportional gain an integral time at zero speed. The settings in d04-01 and d04-02 are used at speeds above the setting in d04-07. Parameter d04-07 is set by default to 0.0 so d04-01 and d04-02 are used by default over the entire speed range. However, changing d04-07 creates two levels of ASR control settings, as shown in ***Figure 5-43***.

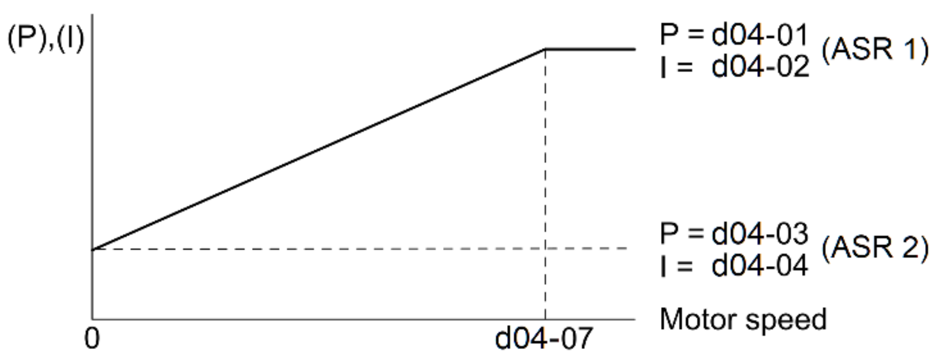


Figure 5-43: Low-speed and High-speed Gain Settings

The switching frequency (d04-07) can also be controlled with a digital input programmed to H01-xx = 37 (ASR Gain Select). When the digital input is OFF, the VFD uses the ASR gain level set by the pattern in ***Figure 5-43***. When the digital input is ON, d04-03 is used. The integral time set to d04-02 is used to change linearly between these settings, as shown in ***Figure 5-44***. The ASR gain enabled by a digital input overrides d04-07.

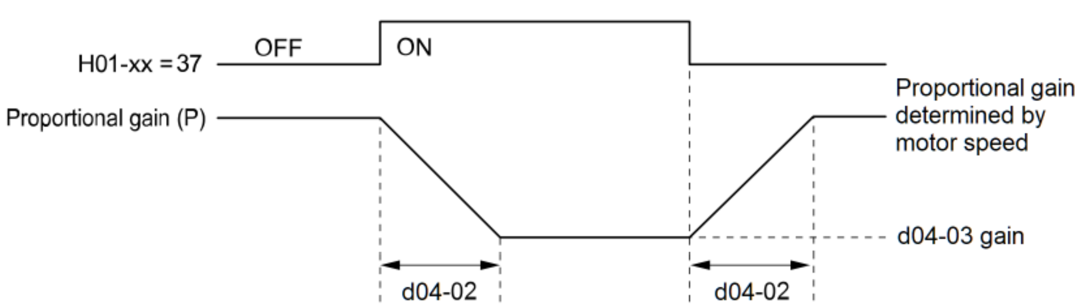


Figure 5-44: ASR Proportional Gain Switch

5.3.4.1 Adjusting the ASR Parameters in Closed Loop Vector

The VFD is preset to use ASR settings d04-01/d04-02 over the entire speed range in Closed Loop Vector. If required by the application, a second set of ASR parameters (d04-03/d04-04) can be activated at a specific motor speed or with a digital input.

Perform the following steps for adjusting ASR parameters:

1. Run the motor at zero speed and increase the ASR gain (d04-01) as much as possible without oscillation.
2. Run the motor at zero speed and decrease the ASR integral time (d04-02) as much as possible without oscillation.
3. Run at the normal operating speed. Check for over/undershoot when changing speed and for any oscillation.
4. If problems occur in step 3, increase the integral time and reduce the gain.

Alternatively, use different ASR settings for high and low speed. Set the values from step 1 and 2 to parameters d04-03 and d04-04, then set an ASR switching frequency in parameter d04-07. Run the motor at a speed higher than d04-07 and repeat step 3 while adjusting d04-01 and d04-02.

5.3.4.2 Solving Problems During ASR Setup

Use ***Table 5-63*** when making adjustments to ASR.

Table 5-63: ASR Setup Problems and Corrective Actions

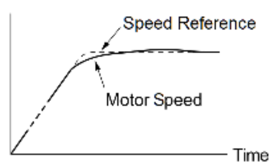
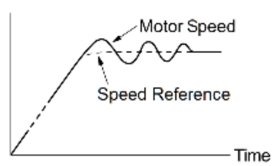
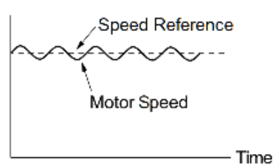
Problem		Possible Solutions
Slow response to speed changes		• Increase ASR P Gain (d04-01/d04-03). • Decrease ASR I Time (d04-02/d04-04).
Overshoot or undershoot at the end of acceleration or deceleration		• Decrease ASR P Gain (d04-01/d04-03). • Increase ASR I Time (d04-02/d04-04).
Vibration and oscillation occur at constant speed		• Decrease ASR P Gain (d04-01/d04-03). • Increase ASR I Time (d04-02/d04-04). • Increase ASR Delay Time (d04-06).
Oscillation at low speed and response is too slow at high speed (or vice versa)	-	• Use d04-01, d04-02, d04-03, and d04-04 to define optimal ASR settings for high and low speed. Use d04-07 to define a switching frequency.

Table 5-64: ASR Tuning Parameter Settings

Parameter	Display	Function	Range	Default
d04-01	ASR Proportional Gain 1	Proportional gain of the speed control loop.	0.00–300.00	20.00
d04-02	ASR Integral Time 1	Integral time of the speed control loop.	0.000–10.000 sec	0.500
d04-03	ASR Proportional Gain 2	Proportional gain 2 of the speed control loop.	0.00–300.00	20.00
d04-04	ASR Integral Time 2	Integral time 2 of the speed control loop.	0.000–10.000 sec	0.500
d04-06	ASR Delay Time	ASR Output Primary Delay Time.	0.000–0.500 sec	0.004
d04-07	ASR Gain Switchover Frequency	ASR Gain Switching Frequency.	0.0–150.0 Hz	0.0
d04-08	ASR Integral Limit	ASR Integral Limit.	0–400%	400
d04-17	Motor Inertia	Motor inertia for Motor 1.*	0.0001–600.0000 kgm^2	Depends on o02-04
d04-18	Load Inertia Ratio	Load inertia ratio for the motor inertia.	0.0–6000.0	1.0
d04-29	Speed Control Response *0 Standard* *1 High Performance 1*	Speed control responsiveness.	0, 1	0
d04-37	Motor 2 Inertia	Motor inertia for Motor 2.*	0.0001–600.0000 kgm^2	Depends on o02-04
d04-38	Motor 2 Load Inertia Ratio	Load inertia ratio for the Motor 2 inertia.	0.0–6000.0	1.0
d04-50	Notch Filter Frequency	Machine resonance frequency.	0–100 Hz	0
d04-51	Notch Filter Bandwidth	Notch width of the notch filter.	0.5–5.0	1.0

* *The range and decimal places are different for different models:*

2003 to 2017, 4001 to 4009, 5001 to 5006: 0.0001 to 6.0000 kgm^2
2025 to 2180, 4014 to 4091, 5009 to 5041: 0.001 to 60.000 kgm^2
2215 to 2415, 4112 to 41090, 5052 to 5412: 0.01 to 600.00 kgm^2

NOTE: *Mechanical backlash in an application can cause secondary current (I_2) reference variations in the motor's rotor. This condition can prevent the desired adjustment of ASR parameters. The output delay time constant is used to increase the stability of the system allowing a wider setting range of ASR parameters.*

5.3.5 Torque Control (d05)

Torque Control is a VG+ function to control the output torque of a motor. This function can be beneficial for certain applications, such as winches, cable reels, and load sharing of coupled motors, but it can be unsafe on others. Consult factory for application assistance. Typically, torque control should not be applied on a hoist due to the risk of losing control of the load, except for Load Share configurations.

Use one of these methods to enable Torque Control:

- Set d05-01 = 1 (Torque Control) - For Traverse Applications
- Enable MFDI H01-xx = 68 (Load Share) - For Hoist Applications with Coupled Motors

To switch between Torque Control and Speed Control:

- Enable MFDI H01-xx = 44 or 144 (Motor 2)

The Torque Reference sources are:

- Analog input as a 0-10V or +/-10V signal (Terminal A1, A2, or A3)
- Modbus command register 0x0004 (set b03-01 = 2)
- Communication option card (set b03-01 = 3 and F06-06 = 1)

Speed Control features that function when in Torque Control mode:

- Forward / Reverse Jog MFDI H01-xx = 15 and 16
- Forward / Reverse Inch MFDI H01-xx = 17 and 18

For additional torque control capabilities such as torque steps and variable speed limits, see the Static Stepless Simulation (C15) function.

Table 5-65: Torque Control Parameter Settings

Parameter	Display	Function	Range	Default
d05-01	Torque Control Selection	Selects between Speed or Torque Control.	0, 1**	0
	0 Speed Control	Speed Control enabled with torque limit.		
	1 Torque Control	Torque control enabled with speed limit.		
d05-02	Torque Reference Delay Time	Primary delay time for Torque Reference Input.	0–1000 ms	0
d05-03	Speed Limit Selection	Speed Limit Selection (***Figure 5-45 on page 216***)	1, 2	2
	1 Active Frequency Reference	Limit set by frequency reference source (b03-01).		
	2 d05-04 Setting	Limit set by d05-04.		
d05-04	Speed Limit	Speed Limit Value (% of E01-04)	-120–120%	105*
d05-05	Speed Limit Bias	Speed Limit Bias (% of E01-04)	0–120%	10
d05-06	Speed/Torque Changeover Time	Time delay when switching between Speed and Torque Control via MFDI = 68 (Load Share).	0–1000 ms	0
d05-08	Uni-directional Speed Limit Bias	Determines how speed limit bias is applied.	0, 1	1
	0 Disabled	Applied in the speed limit and opposite direction.		
	1 Enabled	Applied in the opposite direction only.		

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

*** Cannot set d05-01 = 1 for NLB Hoist; use Load Share MFDI (H01-xx = 68) instead.*

5.3.5.1 Speed/Torque Control Switching

Speed/Torque Control Switching is used in VG+ traverse applications and can be selected "on the fly" by using the digital input speed/torque control selection (H01-xx = 68).

Table 5-66: Speed/Torque Control Switch Parameters

Terminal	Parameter	Setting	Description
S1 - S8	H01-01–H01-08	68	Speed/torque control selection
A1/A2/A3	b03-01	1	Reference selection (terminals A1, A2, or A3)
A1/A2/A3	H03-06/H03-10	13	Torque reference/torque limit

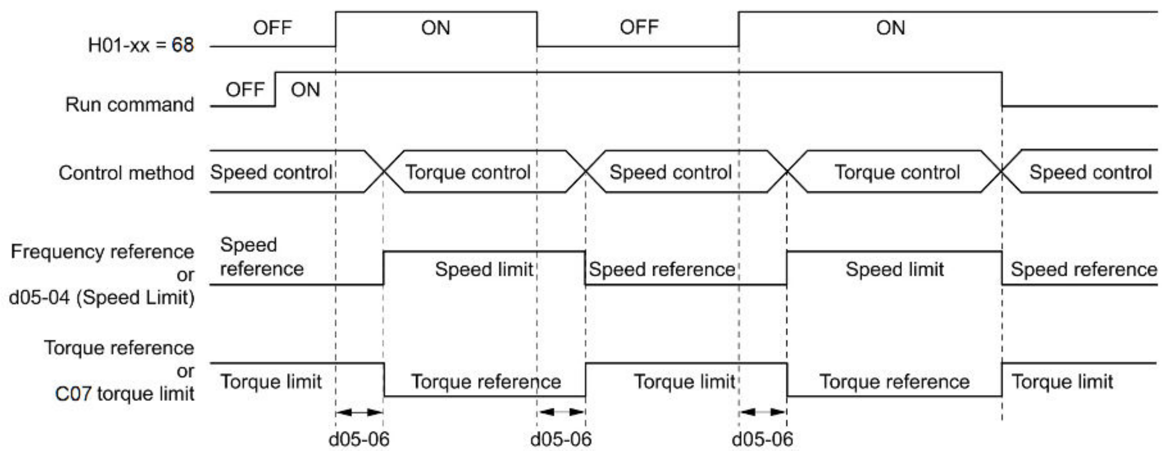


Figure 5-45: Speed/Torque Control Selection Timing Diagram

1. When the speed/torque control selection is OFF, speed control is activated.
   - Speed reference during speed control depends on the frequency reference selection (b03-01) setting. To use terminal A1, A2, or A3 as the frequency reference, set b03-01 = 1.
   - Torque limit during speed control is the smaller of the absolute value of a torque limit analog input, or the torque limit parameters (C07-01 to C07-04).
   - When the run command is removed during speed control, speed control is maintained as the motor decelerates to stop and the smaller of the absolute value of a torque limit analog input, or the torque limit parameters (C07-01 to C07-04) is used as the torque limit.
2. When the speed/torque control selection is ON, torque control is activated.
   - Speed limit during torque control is the b01-01 frequency reference when d05-03 = 1, and is the d05-04 speed limit value when d05-03 = 2, regardless of the frequency reference selection (b03-01) setting.
   - During torque control, the terminal A1, A2, or A3 analog input value becomes the torque reference.
3. When the run command is removed during torque control, operation changes to speed control automatically, and the motor decelerates to stop. The torque limit during deceleration becomes the values set in the torque limit parameters (C07-01 to C07-04).

5.3.6 Dwell (d08)

Dwell is used to temporarily hold the output frequency at a set reference for a set time. This function is automatically enabled when the respective d08 parameters are set. If desired, an MFDI (H01-xx = 65) can be used for enabling/disabling Dwell on demand.

Table 5-67: Dwell Function Parameter Settings

Parameter	Display	Function	Range	Default
d08-01	Dwell Reference at Start	Dwell frequency reference at start.	0.0–150.0 Hz	0.0
d08-02	Dwell Time at Start	Time duration for the Dwell function at start.	0.0–10.0 sec	0.0
d08-03	Dwell Reference at Stop	Dwell frequency reference at stop.	0.0–150.0 Hz	0.0
d08-04	Dwell Time at Stop	Time duration for the Dwell function at stop.	0.0–10.0 sec	0.0

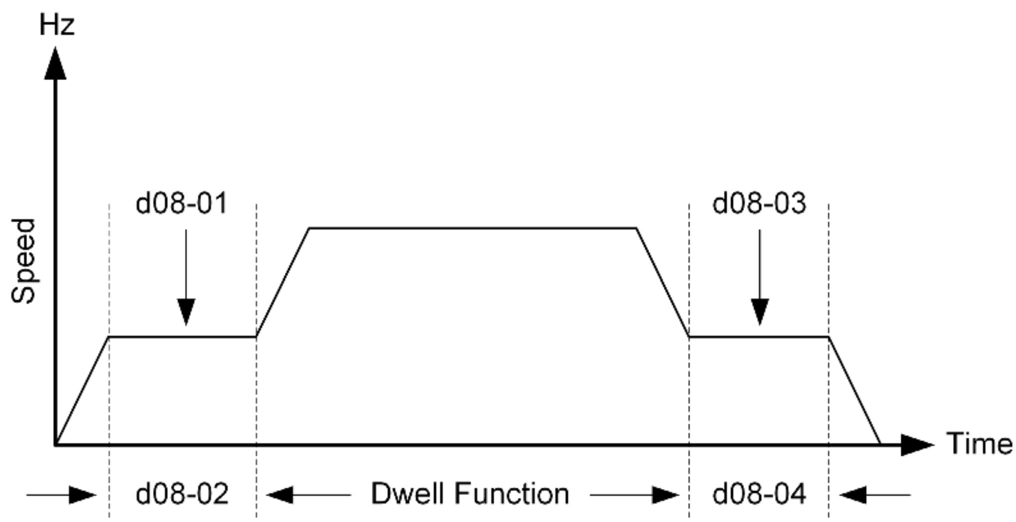


Figure 5-46: Dwell Function

5.3.7 S-Curve Times (d09)

S-Curve Times are used to reduce shock and provide smooth transitions during machine acceleration and deceleration. S-Curve characteristic time is the time from the output frequency to the set accel/decel time.

Table 5-68: S-Curve Times Parameter Settings

Parameter	Display	Function	Range	Default
d09-01	S-Curve Time @ Start of Accel	S-Curve at the beginning of the Accel time.	0.00–10.00 sec	0.50*
d09-02	S-Curve Time @ End of Accel	S-Curve at the end of the Accel time.	0.00–10.00 sec	0.50*
d09-03	S-Curve Time @ Start of Decel	S-Curve at the beginning of the Decel time.	0.00–10.00 sec	0.50*
d09-04	S-Curve Time @ End of Decel	S-Curve at the end of the Decel time.	0.00–10.00 sec	0.50*

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

Time to accelerate from the minimum frequency to the maximum frequency (total acceleration) is:

$$\text{Total Acceleration} = \text{b05-01} + \frac{\text{d09-01} + \text{d09-02}}{2}$$

Time to decelerate from the maximum frequency to the minimum frequency (total deceleration) is:

$$\text{Total Deceleration} = \text{b05-02} + \frac{\text{d09-03} + \text{d09-04}}{2}$$

CAUTION

Acceleration and deceleration times will be extended.

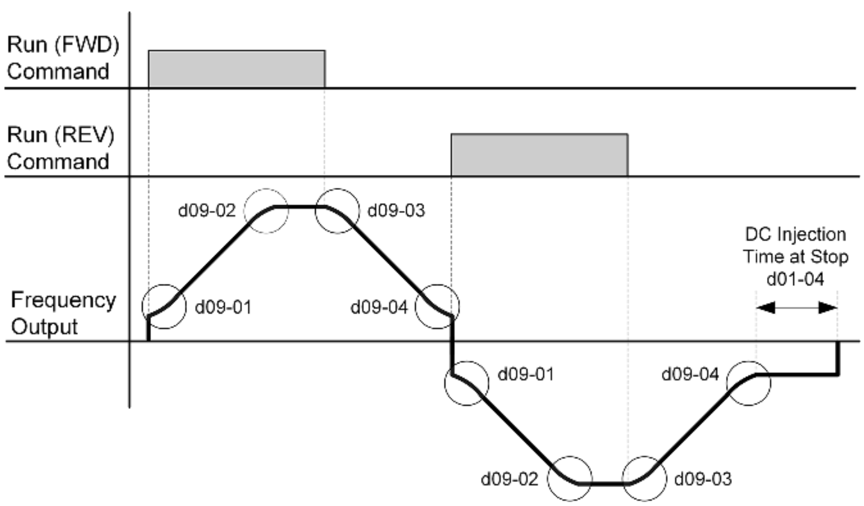


Figure 5-47: S-Curve Characteristic

5.3.8 Duty Rating & Carrier Frequency (d10)

Duty Rating & Carrier Frequency configures the VFD's output carrier frequency and overload level.

CAUTION

Consult Magnetek for VFD derating before modifying the d10 group parameters. Failure to do so may result in equipment damage.

Table 5-69: Duty Rating & Carrier Frequency Parameter Settings

Parameter	Display	Function	Range	Default
d10-01	Normal / Heavy Duty Selection	Duty rating, which determines the output and overload rating	0, 1	0
	0 Heavy Duty Rating	150% of rated current for 1 minute		
	1 Normal Duty Rating	120% of rated current for 1 minute		
d10-02	Carrier Frequency Selection	Carrier Frequency Selection	1–9, A, F	1
	1 2.0 kHz			
	2 5.0 kHz			
	3 8.0 kHz			
	4 10.0 kHz			
	5 12.5 kHz			
	6 15 kHz			
	7 Swing PWM1 (Audible Sound 1)			
	8 Swing PWM2 (Audible Sound 2)			
	9 Swing PWM3 (Audible Sound 3)			
	A Swing PWM4 (Audible Sound 4)			
	F User Defined	Determined by d10-03 through d10-05		
d10-03	Carrier Frequency Upper Limit	Carrier frequency upper limit.	1.0–15.0 kHz	2.0
d10-04	Carrier Frequency Lower Limit	Carrier frequency lower limit (V/f only).	1.0–15.0 kHz	2.0
d10-05	Carrier Freq Proportional Gain	Carrier Frequency Gain (V/f only).	0–99	0
d10-09	Carrier Freq at Rotational Tune	Carrier frequency while performing a rotational Auto-Tune.	0, 1	0
	0 5 kHz			
	1 Use d10-03			

5.4 Motor Parameters (E)

- E01 V/f Pattern for Motor 1
- E02 Motor 1 Parameters
- E03 V/f Pattern for Motor 2
- E04 Motor 2 Parameters
- E07 Test Mode

5.4.1 V/f Pattern for Motor 1 (E01)

WARNING

VFD input voltage (not motor voltage) must be set in E01-01 for the protective features of the VFD to function properly. Failure to do so may result in equipment damage and/or death or personal injury.

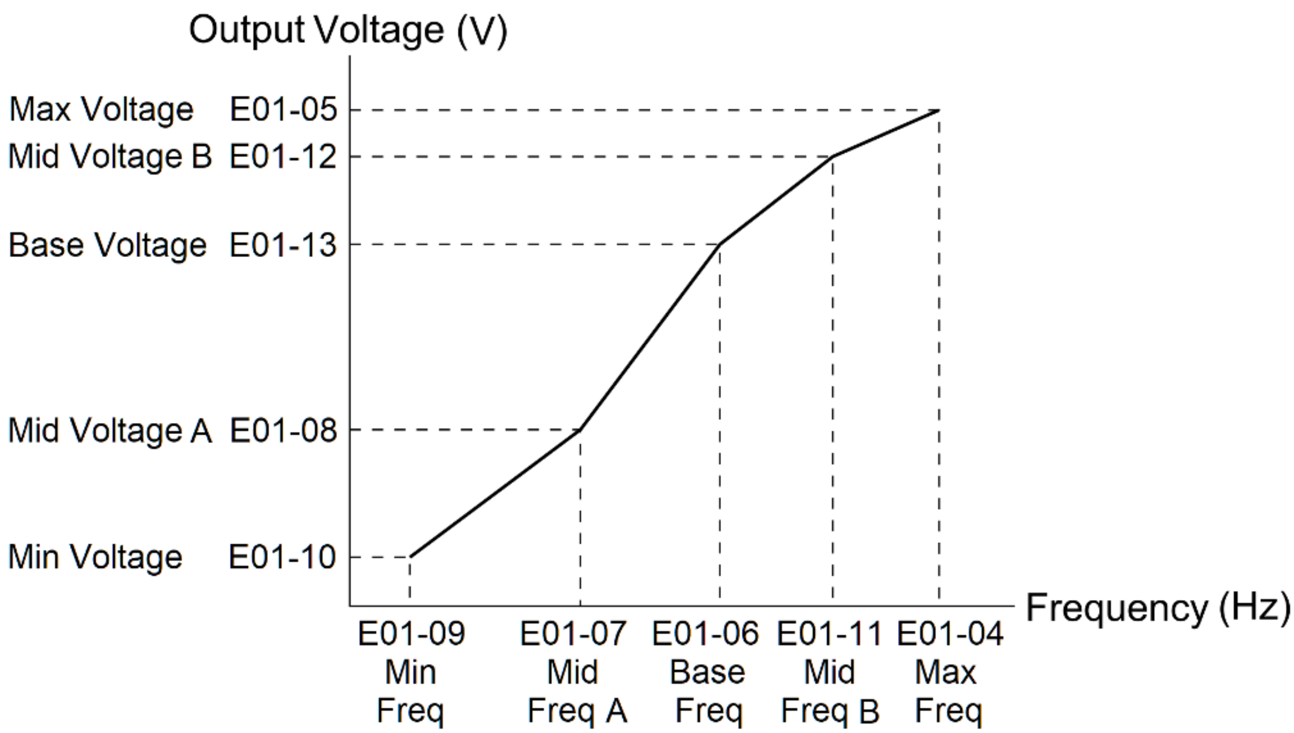


Figure 5-48: Output Voltage

An oPE10 error will occur if the following conditions are not met: E01-04 ≥ E01-11 ≥ E01-06 ≥ E01-07 ≥ E01-09

Table 5-70: DC Bus Regulation

VFD Voltage	Overvoltage Level		Braking Transistor	CDBR (External)
	Fault	Reset	Turn-On	Turn-On
230	410 VDC	400 VDC	394 VDC	380 VDC
460	820 VDC	800 VDC	788 VDC	760 VDC
575	1178 VDC	990 VDC	1132 VDC	950 VDC

Table 5-71: V/f Pattern for Motor 1 Parameter Settings

Parameter	Display	Function	Range	Default
E01-01	Input AC Supply Voltage	VFD input voltage used as the max and base voltage by preset V/f patterns (E01-03 = 0 to E). It also adjusts the levels of protective features (e.g., Overvoltage, braking transistor turn-on, stall prevention, etc).	230V: 155–255 VAC 460V: 310–510 VAC 575V: 446–733 VAC	240 480 575
E01-03	V/f Pattern Selection *0 60 Hz, Level 0* *1 60 Hz, Level 1* *2 60 Hz, Level 2* *3 60 Hz, Level 3* *4 60 Hz, Level 4* *5 60 Hz, Level 5* *6 60 Hz, Level 6* *7 50 Hz, Level 0* *8 50 Hz, Level 1* *9 50 Hz, Level 2* *A 50 Hz, Level 3* *B 50 Hz, Level 4* *C 50 Hz, Level 6* *D 75 Hz, Level 4* *E 90 Hz, Level 4* *F Custom V/f* *FF Custom w/o Limit*	V/f Pattern Selection Default for A01-03 = 0 (Traverse) Default for A01-03 = 1 (Std Hoist) Default for A01-03 = 2 (NLB Hoist), E01-04 through E01-13 define the V/f pattern. Custom with no lower limits on E01-xx.	V/f: 0–9, A–F, FF OLV: F, FF	0*
E01-04	Maximum Output Frequency	Maximum Output Frequency	20.0–300.0 Hz	60.0
E01-05	Maximum Output Voltage	Maximum Output Voltage Baseline ***NOTE:*** *After an Auto-Tune, E01-05 may get populated with a value lower than the motor rated voltage. This is expected. This setting is used as a voltage baseline and gets optimized to prevent voltage saturation. Additional compensations are added to ensure a rated voltage output.*	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on o02-04
E01-06	Base Frequency	Motor Base Frequency	0.0–300.0 Hz	60.0
E01-07	Mid Point A Frequency	Midpoint Output Frequency A	0.0–300.0 Hz	Depends on E01-03
E01-08	Mid Point A Voltage	Midpoint Output Voltage A	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E01-09	Minimum Output Frequency	Minimum Output Frequency	0.0–300.0 Hz	Depends on E01-03

Parameter	Display	Function	Range	Default
E01-10	Minimum Output Voltage	Minimum Output Voltage	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E01-11	Mid Point B Frequency	Midpoint Output Frequency B Disabled with a setting of 0.0.	0.0–300.0 Hz	0.0
E01-12	Mid Point B Voltage	Midpoint Output Voltage B Disabled with a setting of 0.0.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0
E01-13	Base Voltage	Motor Base Voltage Disabled with a setting of 0.0.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0

** Initial value is determined by X-Press Programming (**Section 4.3.3.6 on page 93**).*

NOTE: *In Closed Loop Vector, E01-03 is hidden, and the V/f pattern values are adjusted during an Auto-Tune.*

Table 5-72: Voltage/Frequency (V/f) Pattern Options (230 V Models: 2003 to 2017)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	**Hz**	**VAC**	**Hz**	**Hz**	**VAC**	**Hz**	**VAC**	**Hz**	**VAC**	**VAC**
0*	60.0	230.0	60.0	3.0	15.6	1.3	8.4	0.0	0.0	0.0
1	60.0	230.0	60.0	3.0	16.8	1.3	9.6	0.0	0.0	0.0
2	60.0	230.0	60.0	3.0	18.0	1.3	10.8	0.0	0.0	0.0
3	60.0	230.0	60.0	3.0	19.2	1.3	12.0	0.0	0.0	0.0
4*1	60.0	230.0	60.0	3.0	20.4	1.3	13.2	0.0	0.0	0.0
5	60.0	230.0	60.0	3.0	21.6	1.3	14.4	0.0	0.0	0.0
6	60.0	230.0	60.0	3.0	22.8	1.3	15.6	0.0	0.0	0.0
7	50.0	230.0	50.0	2.5	15.6	1.1	8.4	0.0	0.0	0.0
8	50.0	230.0	50.0	2.5	16.8	1.1	9.6	0.0	0.0	0.0
9*2	50.0	230.0	50.0	2.5	18.0	1.1	10.8	0.0	0.0	0.0
A	50.0	230.0	50.0	2.5	19.2	1.1	12.0	0.0	0.0	0.0
B*3	50.0	230.0	50.0	2.5	20.4	1.1	13.2	0.0	0.0	0.0
C	50.0	230.0	50.0	2.5	22.8	1.1	15.6	0.0	0.0	0.0
D	75.0	230.0	50.0	2.5	20.4	1.1	13.2	0.0	0.0	0.0
E	90.0	230.0	60.0	3.0	20.4	1.3	13.2	0.0	0.0	0.0
US (V/f) F & FF	60.0	230.0	60.0	3.0	20.4	1.3	13.2	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	200.0	50.0	2.5	15.0	1.3	9.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	230.0	60.0	3.0	14.4	0.5	2.9	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	200.0	50.0	3.0	14.4	0.5	3.0	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*
**1 Default for o02-09 = 1 (US) and Std Hoist*
**2 Default for o02-09 = 2 (Euro) and Traverse*
**3 Default for o02-09 = 2 (Euro) and Std Hoist*
**4 Default for E01-05 is 200.0 when o02-09 = 2 (Euro)*

Table 5-73: Voltage/Frequency (V/f) Pattern Options (230 V Models: 2025 to 2180)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	230.0	60.0	3.0	14.4	1.3	6.1	0.0	0.0	0.0
1	60.0	230.0	60.0	3.0	15.7	1.3	7.3	0.0	0.0	0.0
2	60.0	230.0	60.0	3.0	16.8	1.3	8.4	0.0	0.0	0.0
3	60.0	230.0	60.0	3.0	18.0	1.3	9.7	0.0	0.0	0.0
4*1	60.0	230.0	60.0	3.0	19.3	1.3	10.9	0.0	0.0	0.0
5	60.0	230.0	60.0	3.0	20.4	1.3	12.1	0.0	0.0	0.0
6	60.0	230.0	60.0	3.0	21.7	1.3	13.3	0.0	0.0	0.0
7	50.0	230.0	50.0	2.5	14.4	1.1	6.1	0.0	0.0	0.0
8	50.0	230.0	50.0	2.5	15.7	1.1	7.3	0.0	0.0	0.0
9*2	50.0	230.0	50.0	2.5	16.8	1.1	8.4	0.0	0.0	0.0
A	50.0	230.0	50.0	2.5	18.0	1.1	9.7	0.0	0.0	0.0
B*3	50.0	230.0	50.0	2.5	19.3	1.1	10.9	0.0	0.0	0.0
C	50.0	230.0	50.0	2.5	21.7	1.1	13.3	0.0	0.0	0.0
D	75.0	230.0	50.0	2.5	19.3	1.1	10.9	0.0	0.0	0.0
E	90.0	230.0	60.0	3.0	19.3	1.3	10.9	0.0	0.0	0.0
US (V/f) F & FF	60.0	230.0	60.0	3.0	16.1	1.3	8.1	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	200.0	50.0	2.5	14.0	1.3	7.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	230.0	60.0	3.0	12.7	0.5	2.3	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	200.0	50.0	3.0	13.2	0.5	2.4	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

**4 Default for E01-05 is 200.0 when o02-09 = 2 (Euro)*

Table 5-74: Voltage/Frequency (V/f) Pattern Options (230 V Models: 2215 to 2415)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	230.0	60.0	3.0	12.1	1.3	5.0	0.0	0.0	0.0
1	60.0	230.0	60.0	3.0	13.4	1.3	6.1	0.0	0.0	0.0
2	60.0	230.0	60.0	3.0	14.5	1.3	7.3	0.0	0.0	0.0
3	60.0	230.0	60.0	3.0	15.7	1.3	8.6	0.0	0.0	0.0
4*1	60.0	230.0	60.0	3.0	17.0	1.3	9.7	0.0	0.0	0.0
5	60.0	230.0	60.0	3.0	18.1	1.3	11.0	0.0	0.0	0.0
6	60.0	230.0	60.0	3.0	19.4	1.3	12.1	0.0	0.0	0.0
7	50.0	230.0	50.0	2.5	12.1	1.1	5.0	0.0	0.0	0.0
8	50.0	230.0	50.0	2.5	13.4	1.1	6.1	0.0	0.0	0.0
9*2	50.0	230.0	50.0	2.5	14.5	1.1	7.3	0.0	0.0	0.0
A	50.0	230.0	50.0	2.5	15.7	1.1	8.6	0.0	0.0	0.0
B*3	50.0	230.0	50.0	2.5	17.0	1.1	9.7	0.0	0.0	0.0
C	50.0	230.0	50.0	2.5	19.4	1.1	12.1	0.0	0.0	0.0
D	75.0	230.0	50.0	2.5	17.0	1.1	9.7	0.0	0.0	0.0
E	90.0	230.0	60.0	3.0	17.0	1.3	9.7	0.0	0.0	0.0
US (V/f) F & FF	60.0	230.0	60.0	3.0	13.8	1.3	6.9	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	200.0	50.0	2.5	12.0	1.3	6.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	230.0	60.0	3.0	12.7	0.5	2.3	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	200.0	50.0	3.0	13.2	0.5	2.4	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

**4 Default for E01-05 is 200.0 when o02-09 = 2 (Euro)*

Table 5-75: Voltage/Frequency (V/f) Pattern Options (460 V Models: 4001 to 4009)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	460.0	60.0	3.0	31.1	1.3	16.8	0.0	0.0	0.0
1	60.0	460.0	60.0	3.0	33.6	1.3	19.1	0.0	0.0	0.0
2	60.0	460.0	60.0	3.0	35.9	1.3	21.4	0.0	0.0	0.0
3	60.0	460.0	60.0	3.0	38.2	1.3	24.0	0.0	0.0	0.0
4*1	60.0	460.0	60.0	3.0	40.8	1.3	26.3	0.0	0.0	0.0
5	60.0	460.0	60.0	3.0	43.1	1.3	28.8	0.0	0.0	0.0
6	60.0	460.0	60.0	3.0	45.6	1.3	31.1	0.0	0.0	0.0
7	50.0	460.0	50.0	2.5	31.1	1.1	16.8	0.0	0.0	0.0
8	50.0	460.0	50.0	2.5	33.6	1.1	19.1	0.0	0.0	0.0
9*2	50.0	460.0	50.0	2.5	35.9	1.1	21.4	0.0	0.0	0.0
A	50.0	460.0	50.0	2.5	38.2	1.1	24.0	0.0	0.0	0.0
B*3	50.0	460.0	50.0	2.5	40.8	1.1	26.3	0.0	0.0	0.0
C	50.0	460.0	50.0	2.5	45.6	1.1	31.1	0.0	0.0	0.0
D	75.0	460.0	50.0	2.5	40.8	1.1	26.3	0.0	0.0	0.0
E	90.0	460.0	60.0	3.0	40.8	1.3	26.3	0.0	0.0	0.0
US (V/f) F & FF	60.0	460.0	60.0	3.0	40.8	1.3	26.4	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	400.0	50.0	2.5	30.0	1.3	18.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	460.0	60.0	3.0	28.8	0.5	5.8	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	400.0	50.0	2.5	28.8	0.5	6.0	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

**4 Default for E01-05 is 400.0 when o02-09 = 2 (Euro)*

Table 5-76: Voltage/Frequency (V/f) Pattern Options (460 V Models: 4014 to 4091)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	460.0	60.0	3.0	28.8	1.3	12.2	0.0	0.0	0.0
1	60.0	460.0	60.0	3.0	31.3	1.3	14.5	0.0	0.0	0.0
2	60.0	460.0	60.0	3.0	33.6	1.3	16.8	0.0	0.0	0.0
3	60.0	460.0	60.0	3.0	35.9	1.3	19.4	0.0	0.0	0.0
4*1	60.0	460.0	60.0	3.0	38.5	1.3	21.7	0.0	0.0	0.0
5	60.0	460.0	60.0	3.0	40.8	1.3	24.2	0.0	0.0	0.0
6	60.0	460.0	60.0	3.0	43.3	1.3	26.5	0.0	0.0	0.0
7	50.0	460.0	50.0	2.5	28.8	1.1	12.2	0.0	0.0	0.0
8	50.0	460.0	50.0	2.5	31.3	1.1	14.5	0.0	0.0	0.0
9*2	50.0	460.0	50.0	2.5	33.6	1.1	16.8	0.0	0.0	0.0
A	50.0	460.0	50.0	2.5	35.9	1.1	19.4	0.0	0.0	0.0
B*3	50.0	460.0	50.0	2.5	38.5	1.1	21.7	0.0	0.0	0.0
C	50.0	460.0	50.0	2.5	43.3	1.1	26.5	0.0	0.0	0.0
D	75.0	460.0	50.0	2.5	38.5	1.1	21.7	0.0	0.0	0.0
E	90.0	460.0	60.0	3.0	38.5	1.3	21.7	0.0	0.0	0.0
US (V/f) F & FF	60.0	460.0	60.0	3.0	32.2	1.3	16.2	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	400.0	50.0	2.5	28.0	1.3	14.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	460.0	60.0	3.0	25.4	0.5	4.6	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	400.0	50.0	2.5	26.4	0.5	4.8	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

**4 Default for E01-05 is 400.0 when o02-09 = 2 (Euro)*

Table 5-77: Voltage/Frequency (V/f) Pattern Options (460 V Models: 4112 to 41090)

	E01-04	E01-05*4	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	460.0	60.0	3.0	24.2	1.3	9.9	0.0	0.0	0.0
1	60.0	460.0	60.0	3.0	26.7	1.3	12.2	0.0	0.0	0.0
2	60.0	460.0	60.0	3.0	29.0	1.3	14.5	0.0	0.0	0.0
3	60.0	460.0	60.0	3.0	31.3	1.3	17.1	0.0	0.0	0.0
4*1	60.0	460.0	60.0	3.0	33.9	1.3	19.4	0.0	0.0	0.0
5	60.0	460.0	60.0	3.0	36.2	1.3	21.9	0.0	0.0	0.0
6	60.0	460.0	60.0	3.0	38.7	1.3	24.2	0.0	0.0	0.0
7	50.0	460.0	50.0	2.5	24.2	1.1	9.9	0.0	0.0	0.0
8	50.0	460.0	50.0	2.5	26.7	1.1	12.2	0.0	0.0	0.0
9*2	50.0	460.0	50.0	2.5	29.0	1.1	14.5	0.0	0.0	0.0
A	50.0	460.0	50.0	2.5	31.3	1.1	17.1	0.0	0.0	0.0
B*3	50.0	460.0	50.0	2.5	33.9	1.1	19.4	0.0	0.0	0.0
C	50.0	460.0	50.0	2.5	38.7	1.1	24.2	0.0	0.0	0.0
D	75.0	460.0	50.0	2.5	33.9	1.1	19.4	0.0	0.0	0.0
E	90.0	460.0	60.0	3.0	33.9	1.3	19.4	0.0	0.0	0.0
US (V/f) F & FF	60.0	460.0	60.0	3.0	27.6	1.3	13.8	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	400.0	50.0	2.5	24.0	1.3	12.0	0.0	0.0	0.0
US (OLV) F & FF	60.0	460.0	60.0	3.0	25.4	0.5	4.6	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	400.0	50.0	2.5	26.4	0.5	4.8	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

**4 Default for E01-05 is 400.0 when o02-09 = 2 (Euro)*

Table 5-78: Voltage/Frequency (V/f) Pattern Options (575 V Models: 5001 to 5006)

	E01-04	E01-05	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	**Hz**	**VAC**	**Hz**	**Hz**	**VAC**	**Hz**	**VAC**	**Hz**	**VAC**	**VAC**
0*	60.0	575.0	60.0	3.0	38.9	1.3	21.0	0.0	0.0	0.0
1	60.0	575.0	60.0	3.0	42.0	1.3	23.9	0.0	0.0	0.0
2	60.0	575.0	60.0	3.0	44.9	1.3	26.8	0.0	0.0	0.0
3	60.0	575.0	60.0	3.0	47.8	1.3	30.0	0.0	0.0	0.0
4*1	60.0	575.0	60.0	3.0	50.9	1.3	32.8	0.0	0.0	0.0
5	60.0	575.0	60.0	3.0	53.8	1.3	36.0	0.0	0.0	0.0
6	60.0	575.0	60.0	3.0	57.0	1.3	38.9	0.0	0.0	0.0
7	50.0	575.0	50.0	2.5	38.9	1.1	21.0	0.0	0.0	0.0
8	50.0	575.0	50.0	2.5	42.0	1.1	23.9	0.0	0.0	0.0
9*2	50.0	575.0	50.0	2.5	44.9	1.1	26.8	0.0	0.0	0.0
A	50.0	575.0	50.0	2.5	47.8	1.1	30.0	0.0	0.0	0.0
B*3	50.0	575.0	50.0	2.5	50.9	1.1	32.8	0.0	0.0	0.0
C	50.0	575.0	50.0	2.5	57.0	1.1	38.9	0.0	0.0	0.0
D	75.0	575.0	50.0	2.5	50.9	1.1	32.8	0.0	0.0	0.0
E	90.0	575.0	60.0	3.0	50.9	1.3	32.8	0.0	0.0	0.0
US (V/f) F & FF	60.0	575.0	60.0	3.0	43.2	1.3	25.9	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	575.0	50.0	2.5	43.2	1.3	25.9	0.0	0.0	0.0
US (OLV) F & FF	60.0	575.0	60.0	3.0	31.7	0.5	5.8	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	575.0	50.0	2.5	41.5	0.5	8.7	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

Table 5-79: Voltage/Frequency (V/f) Pattern Options (575 V Models: 5009 to 5062)

	E01-04	E01-05	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	Hz	VAC	Hz	Hz	VAC	Hz	VAC	Hz	VAC	VAC
0*	60.0	575.0	60.0	3.0	36.0	1.3	15.3	0.0	0.0	0.0
1	60.0	575.0	60.0	3.0	39.2	1.3	18.2	0.0	0.0	0.0
2	60.0	575.0	60.0	3.0	42.0	1.3	21.0	0.0	0.0	0.0
3	60.0	575.0	60.0	3.0	44.9	1.3	24.2	0.0	0.0	0.0
4*1	60.0	575.0	60.0	3.0	48.1	1.3	27.1	0.0	0.0	0.0
5	60.0	575.0	60.0	3.0	50.9	1.3	30.2	0.0	0.0	0.0
6	60.0	575.0	60.0	3.0	54.1	1.3	33.1	0.0	0.0	0.0
7	50.0	575.0	50.0	2.5	36.0	1.1	15.3	0.0	0.0	0.0
8	50.0	575.0	50.0	2.5	39.2	1.1	18.2	0.0	0.0	0.0
9*2	50.0	575.0	50.0	2.5	42.0	1.1	21.0	0.0	0.0	0.0
A	50.0	575.0	50.0	2.5	44.9	1.1	24.2	0.0	0.0	0.0
B*3	50.0	575.0	50.0	2.5	48.1	1.1	27.1	0.0	0.0	0.0
C	50.0	575.0	50.0	2.5	54.1	1.1	33.1	0.0	0.0	0.0
D	75.0	575.0	50.0	2.5	48.1	1.1	27.1	0.0	0.0	0.0
E	90.0	575.0	60.0	3.0	48.1	1.3	27.1	0.0	0.0	0.0
US (V/f) F & FF	60.0	575.0	60.0	3.0	40.3	1.3	20.2	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	575.0	50.0	2.5	40.3	1.3	20.2	0.0	0.0	0.0
US (OLV) F & FF	60.0	575.0	60.0	3.0	31.7	0.5	5.8	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	575.0	50.0	2.5	38.0	0.5	7.0	0.0	0.0	0.0

** Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

Table 5-80: Voltage/Frequency (V/f) Pattern Options (575 V Models: 5077 to 5412)

	E01-04	E01-05	E01-06	E01-07	E01-08	E01-09	E01-10	E01-11	E01-12	E01-13
E01-03	**Hz**	**VAC**	**Hz**	**Hz**	**VAC**	**Hz**	**VAC**	**Hz**	**VAC**	**VAC**
0*	60.0	575.0	60.0	3.0	30.2	1.3	12.4	0.0	0.0	0.0
1	60.0	575.0	60.0	3.0	33.4	1.3	15.3	0.0	0.0	0.0
2	60.0	575.0	60.0	3.0	36.3	1.3	18.2	0.0	0.0	0.0
3	60.0	575.0	60.0	3.0	39.2	1.3	21.3	0.0	0.0	0.0
4*1	60.0	575.0	60.0	3.0	42.3	1.3	24.2	0.0	0.0	0.0
5	60.0	575.0	60.0	3.0	45.2	1.3	27.4	0.0	0.0	0.0
6	60.0	575.0	60.0	3.0	48.4	1.3	30.2	0.0	0.0	0.0
7	50.0	575.0	50.0	2.5	30.2	1.1	12.4	0.0	0.0	0.0
8	50.0	575.0	50.0	2.5	33.4	1.1	15.3	0.0	0.0	0.0
9*2	50.0	575.0	50.0	2.5	36.3	1.1	18.2	0.0	0.0	0.0
A	50.0	575.0	50.0	2.5	39.2	1.1	21.3	0.0	0.0	0.0
B*3	50.0	575.0	50.0	2.5	42.3	1.1	24.2	0.0	0.0	0.0
C	50.0	575.0	50.0	2.5	48.4	1.1	30.2	0.0	0.0	0.0
D	75.0	575.0	50.0	2.5	42.3	1.1	24.2	0.0	0.0	0.0
E	90.0	575.0	60.0	3.0	42.3	1.3	24.2	0.0	0.0	0.0
US (V/f) F & FF	60.0	575.0	60.0	3.0	34.6	1.3	17.3	0.0	0.0	0.0
Euro (V/f) F & FF	50.0	575.0	50.0	2.5	34.6	1.3	17.3	0.0	0.0	0.0
US (OLV) F & FF	60.0	575.0	60.0	3.0	31.7	0.5	5.8	0.0	0.0	0.0
Euro (OLV) F & FF	50.0	575.0	50.0	2.5	38.0	0.5	7.0	0.0	0.0	0.0

* *Default for o02-09 = 1 (US) and Traverse*

**1 Default for o02-09 = 1 (US) and Std Hoist*

**2 Default for o02-09 = 2 (Euro) and Traverse*

**3 Default for o02-09 = 2 (Euro) and Std Hoist*

5.4.2 Motor 1 Parameters (E02)

The Motor Setup parameters define the motor characteristics. Normally, the default settings for E02 parameters are determined by VFD Model Selection (o02-04). In closed loop vector and open loop vector, the E02 parameters will be set automatically during auto-tuning. At minimum, the motor rated current should be entered into E02-01.

If rotational auto-tuning cannot be performed, E02-02 and E02-05 can be calculated using the motor's nameplate information or by performing non-rotational auto-tuning.

Motor rated slip frequency (E02-02) can be calculated by using the following equation:

$$f_s = f - \frac{(N * P)}{120}$$

Where... f_s: slip frequency (Hz)
f: rated frequency (Hz)
N: rated motor speed (rpm)
P: number of motor poles

Motor terminal resistance (E02-05) can be calculated by using the following equation:

$$r_t = r_p * \frac{273 + \left[\frac{(25°C + T_i)}{2}\right]}{273 + T_i}$$

Where... r_t: motor terminal resistance
r_p: Phase-to-Phase resistance at insulation class temperature
T_i: insulation class temperature (°C)

Table 5-81: Motor 1 Parameter Settings

Parameter	Display	Function	Range	Default
E02-01	Motor Rated Current (FLA)	Motor rated current	(10–200% VFD Rating) A	*
E02-02**	Motor Rated Slip	Motor rated slip frequency	0.000–20.000 Hz	*
E02-03**	Motor No-Load Current	Motor no-load current	0.00–(E02-01–0.01) A	*
E02-04	Motor Pole Count	Number of motor poles	2–48	4
E02-05**	Motor Line-to-Line Resistance	Line-to-line resistance of motor stator windings	0.000–65.000 Ω***	*
E02-06**	Motor Leakage Inductance	Leakage inductance as a percentage of motor rated voltage.	0.0–60.0%	19.6*
E02-07**	Motor Saturation Coefficient 1	Motor iron-core saturation coefficient at 50% magnetic flux.	0.00–0.50	0.50
E02-08**	Motor Saturation Coefficient 2	Motor iron-core saturation coefficient at 75% magnetic flux.	E02-07–0.75	0.75
E02-09**	Motor Mechanical Loss	Motor mechanical loss as a percentage of motor rated power (E02-11).	0.0–10.0%	0.0
E02-10**	Motor Iron Loss	Motor iron loss (V/f only).	0–65535 W	*
E02-11	Motor Rated Power	Motor rated power output	0.00–650.00 HP/kW***	*

** Initial value is determined by o02-04 (VFD Model Selection) and d10-01.*

*** This value is automatically set during auto tuning.*

**** For models 4720 to 41090, E02-05 has mΩ units and E02-11 has a range of 0.0-1340.5 HP/kW.*

5.4.3 V/f Pattern for Motor 2 (E03)

The Motor 2 function allows for a secondary motor to be enabled and controlled by the VFD. This motor may serve as a backup to the primary motor, for redundancy.

To enable Motor 2, configure an MFDI to H01-xx = 44 or 144 (Motor 2 Selection). An oPE02 alarm may occur if parameter changes are made while Motor 2 is enabled. Parameter changes are recommended to be made beforehand.

Table 5-82: Motor 2 Parameter Settings

Parameter	Display	Function	Range	Default
E03-01	Motor 2 Control Mode Selection *0 V/f Control* *2 Open Loop Vector*	Control method for Motor 2.	0, 2	2
E03-02	Motor 2 Stopping Method *0 Decel to Stop* *1 Coast to Stop*	Stopping method for Motor 2.	0, 1	1
E03-04	Motor 2 Maximum Output Frequency	Maximum output frequency for Motor 2. This setting is recommended to be the same as E01-04 (Motor 1 Maximum Output Frequency).	20.0–300.0 Hz	60.0
E03-05	Motor 2 Maximum Output Voltage	Maximum output voltage for Motor 2.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on o02-04
E03-06	Motor 2 Base Frequency	Base frequency for Motor 2.	0.0–300.0 Hz	60.0
E03-07	Motor 2 Mid Point A Frequency	Middle output frequency for Motor 2.	0.0–300.0 Hz	Depends on E01-03
E03-08	Motor 2 Mid Point A Voltage	Middle output voltage for Motor 2.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E03-09	Motor 2 Minimum Output Frequency	Minimum output frequency for Motor 2.	0.0–300.0 Hz	Depends on E01-03
E03-10	Motor 2 Minimum Output Voltage	Minimum output voltage for Motor 2.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E03-11	Motor 2 Mid Point B Frequency	Middle output frequency for constant output range of Motor 2. Disabled with a setting of 0.0.	0.0–300.0 Hz	0.0
E03-12	Motor 2 Mid Point B Voltage	Middle output voltage for constant output range of Motor 2. Disabled with a setting of 0.0.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0
E03-13	Motor 2 Base Voltage	Base voltage for constant output range of Motor 2.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0

5.4.4 Motor 2 Parameters (E04)

These parameters define the Motor 2 characteristics.

Table 5-83: Motor 2 Parameter Settings

Parameter	Display	Function	Range	Default
E04-01	Motor 2 Rated Current	Motor rated current	*	*
E04-02	Motor 2 Rated Slip	Motor rated slip frequency	0.000–20.000 Hz	*
E04-03	Motor 2 No-Load Current	Motor no-load current	0.00–(E04-01–0.01) A	*
E04-04	Motor 2 Motor Poles	Number of motor poles	2–48	4
E04-05	Motor 2 Line-to-Line Resistance	Line-to-line resistance of motor stator windings	0.000–65.000 Ω**	*
E04-06	Motor 2 Leakage Inductance	Leakage inductance as a percentage of motor rated voltage.	0.0–60.0%	19.6*
E04-07	Motor 2 Saturation Coefficient 1	Motor iron-core saturation coefficient at 50% magnetic flux.	0.00–0.50	0.50
E04-08	Motor 2 Saturation Coefficient 2	Motor iron-core saturation coefficient at 75% magnetic flux.	E04-07–0.75	0.75
E04-09	Motor 2 Mechanical Loss	Motor mechanical loss as a percentage of motor rated power (E02-11).	0.0–10.0%	0.0
E04-10	Motor 2 Iron Loss	Motor iron loss (V/f only).	0–65535 W	*
E04-11	Motor 2 Rated Power	Motor rated power output	0.00–650.00 HP/kW**	*

** Initial value is determined by o02-04 (VFD Model Selection) and d10-01.*

*** For models 4720 to 41090, E04-05 has mΩ units and E04-11 has a range of 0.0-1340.5 HP/kW.*

5.4.5 Test Mode (E07)

DANGER

Test Mode is designed to allow for temporary operation of motors equipped with an encoder in Closed Loop Vector control. The primary purpose of Test Mode is to determine if the encoder is faulty. Always follow the instructions listed below, and use extreme caution when operating in Test Mode. Stop operation if any undesired motion occurs and contact Magnetek for additional assistance.

Test Mode is an aid intended for troubleshooting Closed Loop Vector problems. The feature cannot be left on indefinitely and will generate a fault after being on for 10 minutes. At this time, the fault must be reset or power must be cycled.

When enabled, the Control Method in A01-02 is temporarily overridden to the setting of E03-01. All other functions for the new control method are not restricted. Certain programming may need to be done to clear any oPE conditions that occur as a result of the new Control Method. It is up to the user to determine if a special function may cause an unsafe condition during testing. Since this feature is typically used for No Load Brake type hoists, many of the inherent safety checks will become disabled. It may be desirable to disable functions such as Ultra-Lift, but leave Limit Switch functions enabled. The user will determine what functions are being used. If unsure, it is best to disable the function.

Table 5-84: Test Mode Parameter Settings

Parameter	Display	Function	Range	Default
E07-00	Test Mode *0 Disabled* *1 Enabled*	Test Mode Enable. Starts a 10 minute timer after which the VFD will not function until Test Mode is disabled. If power is cycled, Test Mode will become disabled.	0, 1	0
E07-01	Test Mode Control Mode Selection *0 V/f Control* *2 Open Loop Vector*	Control method for Test Mode.	0, 2	2
E07-02	Test Mode Stopping Method *0 Decel to Stop* *1 Coast to Stop*	Stopping method for Test Mode.	0, 1	1
E07-04	Test Mode Max Output Frequency	Maximum output frequency for Test Mode. This setting is recommended to be the same as E01-04 (Motor 1 Maximum Output Frequency).	20.0–300.0 Hz	60.0
E07-05	Test Mode Max Output Voltage	Maximum output voltage for Test Mode.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on o02-04
E07-06	Test Mode Base Frequency	Base frequency for Test Mode.	0.0–300.0 Hz	60.0
E07-07	Test Mode Mid Point A Frequency	Middle output frequency for Test Mode.	0.0–300.0 Hz	Depends on E01-03
E07-08	Test Mode Mid Point A Voltage	Middle output voltage for Test Mode.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E07-09	Test Mode Minimum Output Freq	Minimum output frequency for Test Mode.	0.0–300.0 Hz	Depends on E01-03
E07-10	Test Mode Minimum Output Voltage	Minimum output voltage for Test Mode.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	Depends on E01-03
E07-11	Test Mode Mid Point B Frequency	Middle output frequency for constant output range of Test Mode. Disabled with a setting of 0.0.	0.0–300.0 Hz	0.0
E07-12	Test Mode Mid Point B Voltage	Middle output voltage for constant output range of Test Mode. Disabled with a setting of 0.0.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0
E07-13	Test Mode Base Voltage	Base voltage for constant output range of Test Mode.	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	0.0

5.5 Option Card Parameters (F)

- F01 Encoder Feedback (PG-X3) Setup
- F03 Digital Input (DI-A3 or S4IO) Setup
- F04 Analog Output (AO-A3) Setup
- F05 Digital Output (DO-A3 or S4IO) Setup
- F06 Communication Setup and Profibus-DP (SI-P3) Setup
- F07 Ethernet/IP (SI-EN3), ProfiNET (SI-EP3), Modbus TCP/IP (SI-EM3) Setup

5.5.1 Encoder Feedback (PG-X3) Setup (F01)

Table 5-85: Encoder Feedback (PG-X3) Parameter Settings (VG+ Only)

Parameter	Display	Function	Range	Default
F01-01	Encoder 1 Pulse Count (PPR)	PPR for the encoder connected to the PG-X3 card seated in port CN5-C.	1–60000 ppr	1024
F01-02	Encoder 1 Rotation Selection *0 Pulse A Leads in FWD Direction* *1 Pulse B Leads in FWD Direction*	Changing this parameter has the same effect as swapping A+ and A- encoder wires.	0, 1	0
F01-03	Encoder 1 Pulse Monitor Scaling	Division ratio for the pulse monitor. $f_{\text{Pulse Input}} = f_{\text{Pulse Output}} * \frac{(1+n)}{m}$ Example: For a ratio of 1/32 between the PG card pulse input and output, set F01-03 = 032 (where n = 0 and m = 32).	1–132	1
F01-06	Encoder 1 PCB Disconnect Detect	Delay time for PGo-1H detection. A setting of 0 disables PGo-1H detection.	0–200 ms	15
F01-11	Encoder 2 Pulse Count (PPR)	PPR for the encoder connected to the PG-X3 card seated in port CN5-B.	1–60000 ppr	1024
F01-12	Encoder 2 Rotation Selection *0 Pulse A Leads in FWD Direction* *1 Pulse B Leads in FWD Direction*	Changing this parameter has the same effect as swapping A+ and A- encoder wires.	0, 1	0
F01-15	Encoder 2 Pulse Monitor Scaling	Division ratio for the pulse monitor of encoder 2. This uses the same scaling formula as F01-03.	1–132	1
F01-16	Encoder 2 PCB Disconnect Detect	Delay time for PGo-2H detection. A setting of 0 disables PGo-2H detection.	0–200 ms	15
F01-21	Encoder Signal Loss Detect Sel *0 Decel to Stop* *1 Coast to Stop* *2 Fast Stop* *3 Alarm Only* *4 No Alarm Display*	PGo-1S or PGo-2S fault stopping method. Decelerate to stop using the decel time in b05-02. Decelerate to stop using the decel time in b05-08.	Traverse: 0–4 NLB: 1	1

Parameter	Display	Function	Range	Default
F01-22	Encoder Open-Circuit Detect Time	PGo-1S disconnection detection time. A setting of 0 disables PGo-1S detection.	0.0–10.0 sec	2.0
F01-23	Overspeed Detection Selection	Overspeed (oS) fault stopping method.	Traverse: 0–3 NLB: 1	1
	0 Decel to Stop	Decelerate to stop using the decel time in b05-02.		
	1 Coast to Stop			
	2 Fast Stop	Decelerate to stop using the decel time in b05-08.		
	3 Alarm Only			
F01-24	Overspeed Detection Level	Overspeed detection level as a percentage of the maximum output frequency.	0–120%	105
F01-25	Overspeed Detection Delay Time	Time for an overspeed event to trigger a fault (oS).	0.0–2.0 sec	0.1
F01-26	Speed Deviation Detection Select	Stopping method at excessive speed deviation.	Traverse: 0–7 NLB: 5	5
	0 @SpdAgree-Decel	Stops by deceleration time 1 (b05-02).		
	1 @SpdAgree-Coast	Coast to stop.		
	2 @SpdAgree-F-Stop	Decelerates by Fast-Stop b05-08.		
	3 @SpdAgree-Alarm	dEv displayed, operation continues.		
	4 @Run-Decel	Stops by deceleration time 1 (b05-02).		
	5 @Run-Coast	Coast to stop.		
	6 @Run-Fast Stop	Decelerates by Fast-Stop (b05-08).		
	7 @Run-Alarm Only	dEv displayed, operation continues		
F01-27	Speed Deviation Detection Level	Speed deviation detection level as a percentage of the maximum output frequency.	0–50%	10
F01-28	Speed Deviation Detect Delay Time	Time for a speed deviation event to trigger a dEv fault.	0.0–10.0 sec	0.3

5.5.2 Digital Input (DI-A3 or S4IO) Setup (F03)

Selects the digital input functions for the DI-A3 or S4IO option cards.

These parameters can also be used for virtual inputs over Modbus using the 0x10A0 register. The recommended method is to set F03-01 = 2, which will enable use of the entire F03 parameter group. An option card can be used at the same time as Modbus and the inputs are OR'ed together.

Alternatively, the H01-40 to H01-55 can be used for virtual inputs over Modbus using the 0x15C0 register. These parameters are dedicated to Modbus and are not shared with option cards. The H01-40 to H01-55 parameters cannot be used at the same time as the F03-06 to F03-17 parameters.

Table 5-86: Digital Input (DI-A3 or S4IO) Parameter Settings

Parameter	Display	Function	Range	Default
F03-01	Digital Input Option	Provides additional programmable MFDI	0–2	0
	0 Disabled	No additional MFDI are enabled.		
	1 S4IO Allowed	F03-02 to F03-05 enabled for S4IO and Modbus (0x10A0).		
	2 All Inputs Allowed	F03-02 to F03-17 enabled for DI-A3 and Modbus (0x10A0).		

Parameter	Display	Terminal Designation		Range	Default
		DI-A3	S4IO		
F03-02*	Digital Input 1 Function	D0	I1	0–17B	F
F03-03*	Digital Input 2 Function	D1	I2	0–17B	F
F03-04*	Digital Input 3 Function	D2	I3	0–17B	F
F03-05*	Digital Input 4 Function	D3	I4	0–17B	F
F03-06*	Digital Input 5 Function	D4	-	0–17B	F
F03-07*	Digital Input 6 Function	D5	-	0–17B	F
F03-08*	Digital Input 7 Function	D6	-	0–17B	F
F03-09*	Digital Input 8 Function	D7	-	0–17B	F
F03-10*	Digital Input 9 Function	D8	-	0–17B	F
F03-11*	Digital Input 10 Function	D9	-	0–17B	F
F03-12*	Digital Input 11 Function	DA	-	0–17B	F
F03-13*	Digital Input 12 Function	DB	-	0–17B	F
F03-14*	Digital Input 13 Function	DC	-	0–17B	F
F03-15*	Digital Input 14 Function	DD	-	0–17B	F
F03-16*	Digital Input 15 Function	DE	-	0–17B	F
F03-17*	Digital Input 16 Function	DF	-	0–17B	F

* ***See Table 5-93 on page 246*** *for MFDI selections.*

5.5.3 Analog Output (AO-A3) Setup (F04)

Selects the analog output functions for the AO-A3 option card.

Table 5-87: Analog Output (AO-A3) Parameter Settings

Parameter	Display	Function	Range	Default
F04-01*	Terminal V1 Function Selection	Terminal V1 function	0–712	102
F04-02	Terminal V1 Gain	Terminal V1 gain	-999.9–999.9%	100.0
F04-03*	Terminal V2 Function Selection	Terminal V2 function	0–712	103
F04-04	Terminal V2 Gain	Terminal V1 gain	-999.9–999.9%	50.0
F04-05	Terminal V1 Bias	Terminal V1 bias	-999.9–999.9%	0.0
F04-06	Terminal V2 Bias	Terminal V2 bias	-999.9–999.9%	0.0
F04-07	Terminal V1 Signal Level *0 0 to 10 V* *1 -10 to 10 V*	Terminal V1 output signal	0, 1	0
F04-08	Terminal V2 Signal Level *0 0 to 10 V* *1 -10 to 10 V*	Terminal V2 output signal	0, 1	0

* ***See Table 5-109 on page 266*** *for MFAO selections.*

5.5.4 Digital Output (DO-A3 or S4IO) Setup (F05)

Selects the digital output functions for the DO-A3 and S4IO option cards.

Table 5-88: Digital Output (DO-A3 or S4IO) Parameter Settings

Parameter	Display	Terminal Designation		Range	Default
		DO-A3	S4IO		
F05-01*	Digital Output 1 Function	P1-PC	O1-O2	0–171	F
F05-02*	Digital Output 2 Function	P2-PC	O3-O2	0–171	F
F05-03*	Digital Output 3 Function	P3-PC	O4-O5	0–171	F
F05-04*	Digital Output 4 Function	P4-PC	O6-O5	0–171	F
F05-05*	Digital Output 5 Function	P5-PC	-	0–171	F
F05-06*	Digital Output 6 Function	P6-PC	-	0–171	F
F05-07*	Digital Output 7 Function	M1-M2	-	0–171	F
F05-08*	Digital Output 8 Function	M3-M4	-	0–171	F

* ***See Table 5-100 on page 255*** *for MFDO selections.*

5.5.5 Communication Setup (F06)

These parameters are used to set the basic communication settings and method of fault detection for the communication option cards.

Table 5-89: Communication Setup Parameter Settings

Parameter	Display	Function	Range	Default
F06-01	Communication Error Selection *0 Decel to Stop* *1 Coast to Stop* *2 Fast Stop (Use b05-08)* *3 Alarm Only* *4 Alarm (Run at b01-17)* *5 Decel to Stop, Alarm*	Action or stopping method when an Open Card Communication Error (bUS) is detected.	0–5	1
F06-02	Comm External Fault (EF0) Detect *0 Always Detected* *1 Detected During Run Only*	Condition at which an Option Card External Fault (EF0) is detected.	0, 1	0
F06-03	Comm External Fault (EF0) Select *0 Decel to Stop* *1 Coast to Stop* *2 Fast Stop (Use b05-08)* *3 Alarm Only*	Action or stopping method when an Option Card External Fault (EF0) is detected.	0–3	1
F06-06	Torque Reference/Limit by Comm *0 Disabled* *1 Enabled*	Torque Reference Limit Selection (VG+ only)	0, 1	0
F06-07	Multi-Step Ref @ NetRef/ ComRef *0 Disable Multi-Step References* *1 Enable Multi-Step References*	Selects how multi-step speed inputs are treated when the NetRef command is set. Multi-step reference disabled Multi-step reference enabled	0, 1	0
F06-08	Comm Parameter Reset @Initialize *0 No Reset - Parameters Retained* *1 Reset Back to Factory Default*	Determines whether communication-related parameters (F06-xx and F07-xx) are reset when the VFD is initialized using A01-05. Communication-related parameters (F06-xx and F07-xx) are not reset. Reset all communication-related parameters (F06-xx and F07-xx).	0, 1	0
F06-14	BUS Error Auto Reset *0 Disabled* *1 Enabled*	Automatic reset function for bUS error.	0, 1	0

Parameter	Display	Function	Range	Default
F06-15	Comm. Option Parameters Reload *0 Reload at Next Power Cycle* *1 Reload Now* *2 Cancel Reload Request*	Update method when an F06-xx or F07-xx parameter is changed.	0–2	0

5.5.6 Profibus-DP (SI-P3) Setup (F06)

Settings for the Profibus-DP communication option card SI-P3.

Table 5-90: Profibus-DP (SI-P3) Parameter Settings

Parameter	Display	Function	Range	Default
F06-30	PROFIBUS-DP Node Address	Node address	0–125	0
F06-31	PROFIBUS-DP Clear Mode Selection	Determines the operation when a “Clear Mode” command is received.	0, 1	0
	0 Reset	Resets VFD operation with a Clear mode command.		
	1 Hold Previous State	Maintains the previous operation state when Clear mode command is given.		
F06-32	PROFIBUS-DP Data Format Select *0 PPO Type* *1 Conventional* *2 PPO (bit0)* *3 PPO (Enter)* *4 Conventional (Enter)* *5 PPO (bit0, Enter)*	Data format used for Profibus-DP comms	0–5	0

5.5.7 Ethernet/IP (SI-EN3), ProfiNET (SI-EP3), Modbus TCP/IP (SI-EM3) Setup (F07)

Settings for Ethernet/IP (SI-EN3), ProfiNET (SI-EP3), and Modbus TCP/IP (SI-EM3) option cards.

Table 5-91: Ethernet/IP, ProfiNET, Modbus TCP/IP Parameter Settings

Parameter	Display	Function	Range	Default
F07-01	IP Address 1	IP Address 1	0–255	192
F07-02	IP Address 2	IP Address 2	0–255	168
F07-03	IP Address 3	IP Address 3	0–255	1
F07-04	IP Address 4	IP Address 4	0–255	20
F07-05	Subnet Mask 1	Subnet Mask 1	0–255	255
F07-06	Subnet Mask 2	Subnet Mask 2	0–255	255
F07-07	Subnet Mask 3	Subnet Mask 3	0–255	255
F07-08	Subnet Mask 4	Subnet Mask 4	0–255	0
F07-09	Gateway Address 1	Gateway Address 1	0–255	192
F07-10	Gateway Address 2	Gateway Address 2	0–255	168
F07-11	Gateway Address 3	Gateway Address 3	0–255	1
F07-12	Gateway Address 4	Gateway Address 4	0–255	1
F07-13	Address Mode at Startup *0 Static* *1 BOOTP* *2 DHCP*	How the IP Address is set at start up	0–2	2
F07-14	Duplex Mode Selection *0 Half/Half* *1 Auto/Auto* *2 Full/Full* *3 Half/Auto* *4 Half/Full* *5 Auto/Half* *6 Auto/Full* *7 Full/Half* *8 Full/Auto*	How the communication between host/client will be determined	0–8	1
F07-15	Communication Speed Selection *10 10/10 Mbps* *100 100/100 Mbps* *101 10/100 Mbps* *102 100/10 Mbps*	Communication speed	10, 100–102	10

Parameter	Display	Function	Range	Default
F07-16	Timeout Value	Time-out value for communication loss (bUS) detection. Two timers run in parallel and the quicker of the two times is used for bUS detection. A Message loss timeout is equal to 4 x RPI time or 100 ms (whichever is greater) plus F07-16. A Link loss timeout is 2.0 sec plus F07-16. A setting of 0.0 will disable bUS detection, which is highly discouraged. Consult Magnetek for assistance.	0.0–30.0 sec	0.5
F07-17	EtherNet/IP Speed Scaling Factor	Scaling factor for EtherNet/IP speed monitor	-15–15	0
F07-18	EtherNet/IP Current Scale Factor	Scaling factor for EtherNet/IP output current monitor	-15–15	0
F07-19	EtherNet/IP Torque Scale Factor	Scaling factor for EtherNet/IP torque monitor	-15–15	0
F07-20	EtherNet/IP Power Scaling Factor	Scaling factor for EtherNet/IP power monitor	-15–15	0
F07-21	EtherNet/IP Voltage Scale Factor	Scaling factor for EtherNet/IP voltage monitor	-15–15	0
F07-22	EtherNet/IP Time Scaling	Scaling factor for EtherNet/IP time monitor	-15–15	0
F07-23 to F07-32*	DOA116 (1 to 10)	Dynamic parameters that contain the Modbus addresses used for programmable registers in the output assembly 116. Data residing in bytes 20 to 39 of assembly 116 will be written to the respective Modbus registers identified by the addresses contained in these parameters. No data is written to the Modbus registers if the parameter setting is 0.	Modbus Address 0x- - - -	0
F07-33 to F07-42*	DIA166 (1 to 10)	Dynamic parameters that contain the Modbus addresses used for programmable registers in the input assembly 166. Data residing in the Modbus registers will be written to the respective assembly 166 bytes 20 to 39. The Modbus registers are identified by the addresses contained in these parameters. No data is written to the programmable registers if the parameter setting is 0.	Modbus Address 0x- - - -	0
F07-60	PZD1 Write (Control Word)	For Profibus, this sets the Modbus address for PZD1 (PPO output). PZD1 (PPO output) functions as the STW when F07-60 = 0 to 2.	Modbus Address 0x- - - -	0
F07-61	PZD2 Write (Frequency Reference)	For Profibus, this sets the Modbus address for PZD2 (PPO output). PZD2 (PPO output) functions as the HSW when F07-61 = 0 to 2.	Modbus Address 0x- - - -	0
F07-62 to F07-69	PZD3 to 10 Write	For Profibus, this sets the Modbus address for PZD3 to 10 (PPO output). A setting of 0, 1, or 2 will disable the PZD3 to 10 (PPO output) write operation to the Modbus register.	Modbus Address 0x- - - -	0
F07-70	PZD1 Read (Status Word)	For Profibus, this sets the Modbus address for PZD1 (PPO input). PZD1 (PPO input) functions as the ZSW when F07-70 = 0.	Modbus Address 0x- - - -	0

Parameter	Display	Function	Range	Default
F07-71	PZD2 Read (Output Frequency)	For Profibus, this sets the Modbus address for PZD2 (PPO input). PZD2 (PPO input) functions as the HIW when F07-71 = 0.	Modbus Address 0x- - - -	0
F07-71 to F07-79	PZD3 to 10 Read	For Profibus, this sets the Modbus address for PZD3 to 10 (PPO input). A setting of 0 will disable the PZD3 to 10 (PPO input) read operation from the Modbus register.	Modbus Address 0x- - - -	0

** The SI-EP3 ProfiNET option card is limited to F07-23 to F07-27 (DOA116 1 to 5) and F07-33 to F07-37 (DIA166 1 to 5).*

5.6 Control I/O Parameters (H)

- H01 Digital Inputs
- H02 Digital Outputs
- H03 Analog Inputs
- H04 Analog Outputs
- H05 Modbus Communication
- H06 Pulse Train Input/Output
- H07 Virtual Inputs/Outputs

5.6.1 Digital Inputs (H01)

The VFD has eight multi-function digital inputs for numerous functions. The following table lists the function selections for Terminals S1 to S8. An oPE03 error will occur if a function is programmed to more than one terminal at the same time.

Table 5-92: Digital Inputs Parameter Settings

Parameter	Display	Function	Range	Default
H01-01	Terminal S1 Function Selection	***See Table 5-93 on page 246***.	0–17B	80 (FWD)
H01-02	Terminal S2 Function Selection	***See Table 5-93 on page 246***.	0–17B	81 (REV)
H01-03	Terminal S3 Function Selection	***See Table 5-93 on page 246***.	0–17B	*
H01-04	Terminal S4 Function Selection	***See Table 5-93 on page 246***.	0–17B	*
H01-05	Terminal S5 Function Selection	***See Table 5-93 on page 246***.	0–17B	*
H01-06	Terminal S6 Function Selection	***See Table 5-93 on page 246***.	0–17B	*
H01-07	Terminal S7 Function Selection	***See Table 5-93 on page 246***.	0–17B	*
H01-08	Terminal S8 Function Selection	***See Table 5-93 on page 246***.	0–17B	*

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

Table 5-93: Multi-Function Digital Input (MFDI) Selections for H01-0x and F03-0x

NOTE: *Some settings have a normally open (N.O.) and normally closed (N.C.) option. The normally open option will be a setting below 100. The normally closed option is 100 above that.*

Setting	Display	Function
0	Multi-Step Speed Reference 2	**ON:** Multi-Step Speed Reference 2 enabled
1	Multi-Step Speed Reference 3	**ON:** Multi-Step Speed Reference 3 enabled
2	Multi-Step Speed Reference 4	**ON:** Multi-Step Speed Reference 4 enabled
3	Multi-Step Speed Reference 5	**ON:** Multi-Step Speed Reference 5 enabled
4	Infinitely Variable Hold	**ON:** Hold current speed 2nd Step of 3-Step Infinitely Variable
5	Infinitely Variable Accelerate	**ON:** Accelerate 2nd Step of 2-Step Infinitely Variable or 3rd Step of 3-Step Infinitely Variable
6	Upper Limit 1 (N.O.)	**ON:** Upper Limit 1 slow down limit reached. Keypad blinks “UL1” alarm.
7	Upper Limit 2 (N.O.)	**ON:** Upper Limit 2 stop limit reached. Keypad blinks “UL2” alarm.
8	Lower Limit 1 (N.O.)	**ON:** Lower Limit 1 slow down limit reached. Keypad blinks “LL1” alarm.
9	Lower Limit 2 (N.O.)	**ON:** Lower Limit 2 stop limit reached. Keypad blinks “LL2” alarm.
E	Micro-Speed Gain 1	**ON:** Micro-Speed Gain 1 (C02-01) enabled. Takes priority over Micro-Speed Gain 2.
F	Not Used	Digital input is disabled.
10	Micro-Speed Gain 2	**ON:** Micro-Speed Gain 2 (C02-02) enabled
11	Lower Limit 3 (N.O.)	**ON:** Lower Limit 3 fault limit reached. Keypad displays “LL3” fault. Uses C03-10 stopping method and requires fault reset.
12	Upper Limit 3 (N.O.)	**ON:** Upper Limit 3 fault limit reached. Keypad displays “UL3” fault. Uses C03-10 stopping method and requires fault reset.
13	Ultra-Lift Enable	**ON:** Ultra-Lift enabled This input is used when C06-01 = 2 or 4. Not available for Traverse motions.
14	Alternate Torque Limit Gain	**ON:** Torque Limit Gains (C07-05 to C07-07) added to C07-01 to C07-04. Typically used when load testing a hoist to lift an overload.
15	Forward Jog	**ON:** Forward Jog at b01-17 speed reference
16	Reverse Jog	**ON:** Reverse Jog at b01-17 speed reference
17	Forward Inch	**ON:** Forward Inch at b01-17 speed for duration C13-01 (Inch Run Time)
18	Reverse Inch	**ON:** Reverse Inch at b01-17 speed for duration C13-01 (Inch Run Time)
19	Inch Repeat	**ON:** Repeat the Forward/Reverse Inch after C13-02 (Inch Repeat Delay Time)
1A	Accel/Decel Time Selection 2	**ON:** Use Acceleration/Deceleration Time 2 (b05-03 and b05-04)
1B	Accel/Decel Time Selection 3	**ON:** Use Acceleration/Deceleration Time 3 (b05-12 and b05-13)
1C	Accel/Decel Time Selection 4	**ON:** Use Acceleration/Deceleration Time 4 (b05-14 and b05-15)
1F	Run/Reference Selection 2	**ON:** Frequency Reference 2 (b03-15) and Run Reference 2 (b03-16) enabled **OFF:** Frequency Reference 1 (b03-01) and Run Reference 1 (b03-02) enabled
20 – 2F	External Fault	External Fault selection (***See Table 5-94 on page 251***)
30	Programming Lockout	**OFF:** Parameter changes are prohibited
32	Baseblock Command (N.O.)	**ON:** External Baseblock signal. Keypad blinks “bb” alarm.
34	Load Float Extend for C08-15	**ON:** Load Float extended by C08-15 (Load Float Extension Time)
35	Load Float Hold	**ON:** Load Float initiated Requires a run command or that the VFD is already running.
36	Load Float Run for C04-01	**ON:** Load Float initiated for duration C04-01 (Load Float MFDI Run Time)
37	ASR Gain Select	**ON:** Uses ASR Proportional Gain 2 (d04-03) **OFF:** Uses ASR Proportional Gain 1 (d04-01)

Setting	Display	Function
38	Accel/Decel Ramp Hold	**ON:** Acceleration/deceleration is stopped, and frequency is held.
3A	Jog Reference Selection	**ON:** Frequency reference is changed to b01-17 (Jog Reference)
3B	Force Brake Open	**ON:** Brake relay will close to force the brake open. ***NOTE:*** *Traverse only. A BE9 fault will occur if this input is ON at power-up.*
3C	ASR Integral Reset	**ON:** Resets the ASR Integral value and use Proportional control.
3F	Fault Reset	**ON:** Resets all active faults
40	Fast Stop (N.O.)	**ON:** Begin deceleration using b05-08 (Fast Stop Time)
42	Snap Shaft Disable	**ON:** Snap Shaft Detection is disabled
43	Timer Function	**ON:** Timer Function started Used with C12-03 and C12-04 delay times and H02-xx = 12 (Timer Output).
44	Motor 2 Selection	**ON:** Motor 2 selected. Can be used to switch between Torque/Speed Control. **OFF:** Motor 1 selected
48	Fault Latch Reset	**ON:** Resets the latched fault when the input is toggled ON and then OFF.
4A	Emergency Lift Enable	**ON:** Emergency Lift enabled to allow hoisting during an encoder failure.
4B	Anti-Shock OFF	**ON:** Anti-Shock is disabled
4C	DC Injection Braking Command	**ON:** DC Injection Braking output (d01-01) enabled A run command will override DC Injection Braking. ***NOTE:*** *Cannot be used in tandem with MFDI = 55 (Drive Enable).*
4D	Load Weight/Sum Enabled	**ON:** Load Weight Measurement and Load Summing enabled.
4E	Spreader Weight 1	**ON:** Spreader Weight 1 (C10-40) is subtracted from the measured weight.
4F	Spreader Weight 2	**ON:** Spreader Weight 2 (C10-41) is subtracted from the measured weight. ***NOTE:*** *When MFDI 4E and 4F are both ON, Spreader Weight 3 (C10-42) is subtracted from the measured weight.*
50	External Overweight	**ON:** Triggers an Overweight fault/alarm per the C10-35 (Overweight Detected Action) setting.
51	Alternate Crane OW Levels	**ON:** Enables alternate overweight levels per the C10-43 (Alternate Crane OW Warning) and C10-44 (Alternate Crane OW) settings.
52	Overweight Bypass	**ON:** Bypasses all Overweight alarm conditions and allows normal operation.
53	Communications Test Mode	**ON:** Begin a loopback self-test of Modbus RS-485 communications A jumper wire between this input and terminal SN is required.
55	Drive Enable	**ON:** VFD is ready to run. **OFF:** VFD disabled and run commands ignored. Keypad blinks “dnE” alarm.
56	Klixon (N.O.)	**ON:** Klixon input indicating an overheated motor. Stopping method by L01-06 (Klixon Action). Keypad blinks “KLX” alarm.
58	Brake 1 Answerback	**ON:** Brake answerback feedback received. Used with BE0, BE4, BE5, and BE7 conditions (C08-04 and C08-11).
59	Alternate Freq Ref Upper Limit	**ON:** Frequency reference upper limit set to b02-04 (Alternate Frequency Upper Limit)
5A	Variable Speed Limits	**ON:** Enable the Variable Speed Limits function
5B	Brake Error Up Speed Limit	**ON:** Frequency reference upper limit set to C08-18 (BE5/BE6/BE8 Max Forward Speed)
5D	Brake Stand	**ON:** Footbrake is being applied. Action is taken according to C15-07.
5F	Phantom Stop (N.O.)	**ON:** Phantom Stop input stops motion via C03-12. RUN LED on keypad blinks.
60	Index Enable	**ON:** Index function enabled and uses C13-03 (Index Frequency Reference) A run command is required to initiate the Index.

Setting	Display	Function
61	Brake Test	**ON:** Initiate Brake Test. PG faults disabled and brake stays closed. Motor pushes against the brake up to C08-24 (Brake Test Torque). This function works best with single motor-brake configurations. A single VFD will not be able to reliably measure the torque of multiple brakes.
62	Bypass Stop Travel Limits	**ON:** Bypass Upper/Lower Limit 2 (UL2 and LL2) MFDI and EPLS travel limits.
63	Bypass EPLS	**ON:** Bypass all EPLS travel limits (including LL3/UL3).
64	Slack Cable Enable	**ON:** Slack Cable Detection is enabled.
65	Dwell Enable	**ON:** Dwell function enabled.
67	Hook Height Home (N.O.)	**ON:** Hook Height (U01-50) gets set to C03-29 (Motor Revolutions at Home Position) or C03-14 (Hook Height Revolutions Total) depending on the setting of C03-15 (Hook Height Home Position).
68	Load Share Enable	**ON:** Load Share (torque control) enabled
69	Load Share Follower Ready	**ON:** Load Share follower ready signal received. Loss of this signal while running will result in an FNR fault.
6A	Load Check Bypass	**ON:** Disables Load Check and clears any LC faults
6B	Brake 2 Answerback	**ON:** Brake answerback feedback received from Brake 2. Used with C08-33 (Dual Brake Test) and MFDO = A (Brake 2 Output)
6C	Add Offset Frequency 1	**ON:** Add b08-05 (Offset Frequency 1) to the frequency reference.
6D	Add Offset Frequency 2	**ON:** Add b08-06 (Offset Frequency 2) to the frequency reference.
6E	Add Offset Frequency 3	**ON:** Add b08-07 (Offset Frequency 3) to the frequency reference.
70	Hook Height SP1	**ON:** Store U01-51 position to C03-61 for SP1. MFDO functions per C03-60.
71	Hook Height SP2	**ON:** Store U01-51 position to C03-63 for SP2. MFDO functions per C03-62.
72	External Anti-Shock	**ON:** Anti-Shock Fault from another VFD. Anti-Shock (C07-12) must be enabled for this input to have an effect.
75	Sway Control Main Hoist	**ON:** Sway Control enabled with Main Hook Height Used when C14-01 = 2 (Enabled by MFDI) and the motor is stopped. Enabling or disabling this input is not recommended while the motor is running. Hook height determined by H03-xx = 20 (Main Hook Height) analog input.
76	Sway Control Aux Hoist	**ON:** Sway Control enabled with Aux Hook Height Used when C14-01 = 2 (Enabled by MFDI) and the motor is stopped. Enabling or disabling this input is not recommended while the motor is running. Hook height determined by H03-xx = 21 (Aux Hook Height) analog input.
77	Center of Gravity Offset (Bit 1)	**ON:** Sway Control Center of Gravity Offset binary Bit 1 enabled
78	Center of Gravity Offset (Bit 2)	**ON:** Sway Control Center of Gravity Offset binary Bit 2 enabled
79	Center of Gravity Offset (Bit 3)	**ON:** Sway Control Center of Gravity Offset binary Bit 3 enabled
7A	Center of Gravity Offset (Bit 4)	**ON:** Sway Control Center of Gravity Offset binary Bit 4 enabled
7B	Alternate Hook Height Offset	**ON:** Sway Control swing length forced to C14-09 setting. This MFDI is typically used for tandem-lift bridge applications.
7C	Reset Maintenance Run Timer	**ON:** Reset the maintenance run timer (U04-27 and U04-28)
7D	Reset Maintenance On Timer	**ON:** Reset the maintenance on-time timer (U04-29 and U04-30)
7E	Reset Maintenance Brake Counter	**ON:** Reset the maintenance brake cycles counter (U04-31 and U04-33)
7F	Reset Lift Counter	**ON:** Reset the lift counter (U04-35)
80	Run Forward	**ON:** Forward/Up run command
81	Run Reverse	**ON:** Reverse/Down run command
90	Sync - Follower Mode	**ON:** Sync Follower enabled **OFF:** Sync Leader enabled

Setting	Display	Function
91	Sync - Clear Sync Error	**ON:** Clears the Follower's sync error (U07-03). Used by the Auto Resync function when C09-14 = 2 (Enabled, Zero by MFDI).
92	Sync - Ratio Numerator 2	**ON:** Switches the Follower to Sync Ratio 2 as defined by C09-05. Motor must be stopped in order to switch Sync Ratios.
93	Sync - Advance	**ON:** During a run, the Follower will advance in position, relative to the Leader, at the rate defined by C09-16.
94	Sync - Retard	**ON:** During a run, the Follower will retard in position, relative to the Leader, at the rate defined by C09-16.
97	Sync - Follower Ready	**ON:** The Sync Follower has received a run command and returned a signal indicating it is ready to run.
98	Sync - OK for Ultra-Lift	**ON:** The Follower is indicating it is ready to proceed into Ultra-Lift.
A0	Bucket - Set Closed Position	**ON:** Set Bucket closed (zero) position and zero out U07-10, U07-11, and U07-12.
A1	Bucket - OK for Ultra-Lift	**ON:** Allows Bucket Holder/Closer to proceed into Ultra-Lift.
A2	Bucket - Grab	**ON:** Initiate Bucket Auto-Grab. See C09-71 to C09-73.
A3	Bucket - Switch to NLB	**ON:** Override Bucket Control and switch to NLB Hoist mode.
100	Multi-Step Speed Reference 2*	**OFF:** Multi-Step Speed Reference 2 enabled
101	Multi-Step Speed Reference 3*	**OFF:** Multi-Step Speed Reference 3 enabled
102	Multi-Step Speed Reference 4*	**OFF:** Multi-Step Speed Reference 4 enabled
103	Multi-Step Speed Reference 5*	**OFF:** Multi-Step Speed Reference 5 enabled
104	Infinitely Variable Hold*	**OFF:** Hold current speed 2nd Step of 3-Step Infinitely Variable
105	Infinitely Variable Accelerate*	**OFF:** Accelerate 2nd Step of 2-Step Infinitely Variable or 3rd Step of 3-Step Infinitely Variable
106	Upper Limit 1 (N.C.)	**OFF:** Upper Limit 1 slow down limit reached. Keypad blinks “UL1” alarm.
107	Upper Limit 2 (N.C.)	**OFF:** Upper Limit 2 stop limit reached. Keypad blinks “UL2” alarm.
108	Lower Limit 1 (N.C.)	**OFF:** Lower Limit 1 slow down limit reached. Keypad blinks “LL1” alarm.
109	Lower Limit 2 (N.C.)	**OFF:** Lower Limit 2 stop limit reached. Keypad blinks “LL2” alarm.
10A	Upper Limit 1 (N.C.)	**OFF:** Upper Limit 1 slow down limit reached. Keypad blinks “UL1” alarm.
10B	Upper Limit 2 (N.C.)	**OFF:** Upper Limit 2 stop limit reached. Keypad blinks “UL2” alarm.
10C	Lower Limit 1 (N.C.)	**OFF:** Lower Limit 1 slow down limit reached. Keypad blinks “LL1” alarm.
10D	Lower Limit 2 (N.C.)	**OFF:** Lower Limit 2 stop limit reached. Keypad blinks "LL2" alarm.
10E	Micro-Speed Gain 1	**OFF:** Micro-Speed Gain 1 (C02-01) enabled. Takes priority over Micro-Speed Gain 2.
110	Micro-Speed Gain 2	**OFF:** Micro-Speed Gain 2 (C02-02) enabled
111	Lower Limit 3 (N.C.)	**OFF:** Lower Limit 3 fault limit reached. Keypad displays “LL3” fault. Uses C03-10 stopping method and requires fault reset.
112	Upper Limit 3 (N.C.)	**OFF:** Upper Limit 3 fault limit reached. Keypad displays “UL3” fault. Uses C03-10 stopping method and requires fault reset.
113	Ultra-Lift Enable	**OFF:** Ultra-Lift enabled This input is used when C06-01 = 2 or 4. Not available for Traverse motions.
114	Alternate Torque Limit Gain	**OFF:** Torque Limit Gains (C07-05 to C07-07) added to C07-01 to C07-04. Typically used when load testing a hoist to lift an overload.
11A	Accel/Decel Time Selection 2	**OFF:** Use Acceleration/Deceleration Time 2 (b05-03 and b05-04)
11B	Accel/Decel Time Selection 3	**OFF:** Use Acceleration/Deceleration Time 3 (b05-12 and b05-13)
11C	Accel/Decel Time Selection 4	**OFF:** Use Acceleration/Deceleration Time 4 (b05-14 and b05-15)
11F	Run/Reference Selection 2	**OFF:** Frequency Reference 2 (b03-15) & Run Reference 2 (b03-16) enabled **ON:** Frequency Reference 1 (b03-01) & Run Reference 1 (b03-02) enabled

Setting	Display	Function
130	Programming Lockout	**ON:** Parameter changes are prohibited
132	Baseblock Command (N.C.)	**OFF:** External Baseblock signal. Keypad blinks BB alarm.
134	Load Float Extend for C08-15	**OFF:** Load Float extended by C08-15 (Load Float Extension Time)
137	ASR Gain Select	**OFF:** Uses ASR Proportional Gain 2 (d04-03) **ON:** Uses ASR Proportional Gain 1 (d04-01)
13A	Jog Reference Selection	**OFF:** Frequency reference is changed to b01-17 (Jog Reference)
13C	ASR Integral Reset	**OFF:** Resets the ASR Integral value and use Proportional control.
140	Fast Stop (N.C.)	**OFF:** Begin deceleration using b05-08 (Fast Stop Time)
143	Timer Function	**OFF:** Timer Function started Used with C12-03 and C12-04 delay times and H02-xx = 12 (Timer Output).
144	Motor 2 Selection	**OFF:** Motor 2 selected. Can be used to switch between Torque/Speed Control. **ON:** Motor 1 selected
14B	Anti-Shock OFF	**OFF:** Anti-Shock is disabled
14D	Load Weight/Sum Enabled (N.C.)	**OFF:** Load Weight Measurement and Load Summing enabled.
14E	Spreader Weight 1 (N.C.)	**OFF:** Spreader Weight 1 (C10-40) is subtracted from the measured weight.
14F	Spreader Weight 2 (N.C.)	**OFF:** Spreader Weight 2 (C10-41) is subtracted from the measured weight. ***NOTE:*** *When MFDI 4E and 4F are both OFF, Spreader Weight 3 (C10-42) is subtracted from the measured weight.*
150	External Overweight (N.C.)	**OFF:** Triggers an Overweight fault/alarm per the C10-35 (Overweight Detected Action) setting.
151	Alt. Crane OW Levels (N.C.)	**OFF:** Enables alternate overweight levels per the C10-43 (Alternate Crane OW Warning) and C10-44 (Alternate Crane OW) settings.
155	Drive Enable	**OFF:** VFD is ready to run. **ON:** VFD disabled and run commands ignored. Keypad blinks “dnE” alarm.
156	Klixon (N.C.)	**OFF:** Klixon input indicating an overheated motor. Stopping method by L01-06 (Klixon Action). Keypad blinks “KLX” alarm.
159	Alternate Freq Ref Upper Limit	**OFF:** Frequency reference upper limit set to b02-04 (Alternate Frequency Upper Limit)
15B	Brake Error Up Speed Limit	**OFF:** Frequency reference upper limit set to C08-18 (BE5/BE6/BE8 Max Forward Speed)
15D	Brake Stand	**OFF:** Footbrake is being applied. Action is taken according to C15-07.
15F	Phantom Stop (N.C.)	**OFF:** Phantom Stop stops motion via C03-12. RUN LED on keypad blinks.
164	Slack Cable Enable	**OFF:** Slack Cable Detection is enabled.
167	Hook Height Home (N.C.)	**OFF:** Hook Height (U01-50) set to C03-29 (Motor Revolutions at Home Position) or C03-14 (Hook Height Revolutions Total) depending on the setting of C03-15 (Hook Height Home Position).
16C	Add Offset Frequency 1	**OFF:** Add b08-05 (Offset Frequency 1) to the frequency reference.
16D	Add Offset Frequency 2	**OFF:** Add b08-06 (Offset Frequency 2) to the frequency reference.
16E	Add Offset Frequency 3	**OFF:** Add b08-07 (Offset Frequency 3) to the frequency reference.
175	Sway Control Main Hoist	**OFF:** Sway Control enabled with Main Hook Height Used when C14-01 = 2 (Enabled by MFDI) and the motor is stopped. Enabling or disabling this input is not recommended while the motor is running. Hook height determined by H03-xx = 20 (Main Hook Height) analog input.
176	Sway Control Aux Hoist	**OFF:** Sway Control enabled with Aux Hook Height Used when C14-01 = 2 (Enabled by MFDI) and the motor is stopped. Enabling or disabling this input is not recommended while the motor is running. Hook height determined by H03-xx = 21 (Aux Hook Height) analog input.
177	Center of Gravity Offset (Bit 1)	**OFF:** Sway Control Center of Gravity Offset binary Bit 1 enabled

Setting	Display	Function
178	Center of Gravity Offset (Bit 2)	**OFF:** Sway Control Center of Gravity Offset binary Bit 2 enabled
179	Center of Gravity Offset (Bit 3)	**OFF:** Sway Control Center of Gravity Offset binary Bit 3 enabled
17A	Center of Gravity Offset (Bit 4)	**OFF:** Sway Control Center of Gravity Offset binary Bit 4 enabled
17B	Alternate Hook Height Offset	**OFF:** Sway Control swing length forced to C14-09 setting. This MFDI is typically used for tandem-lift bridge applications.

* *Take caution when using these Normally Closed selections. Losing the input signal will enable the associated function and may cause undesired speed changes.*

5.6.1.1 Digital Inputs—External Fault

It is sometimes desirable to have at least one external fault input to the VFD. The table below shows the possible selections for external faults that can be assigned to a digital input (H01-xx or F03-xx).

Table 5-94: External Fault Selection

Input Type		Detection Method		External Fault Action				MFDI Setting
N.O.(1)	N.C.(1)	Always	During Run	Decel to Stop	Coast to Stop	Fast Stop (b05-08)	Alarm Only	
√		√		√				20
√		√			√			24
√		√				√		28
√		√					√	2C
√			√	√				22
√			√		√			26
√			√			√		2A
√			√				√	2E
	√	√		√				21
	√	√			√			25
	√	√				√		29
	√	√					√	2D
	√		√	√				23
	√		√		√			27
	√		√			√		2B
	√		√				√	2F

(1) N.O. = normally open contact; N.C. = normally closed contact

5.6.1.2 Digital Inputs—F1, F2, and F3 Keys

The F1, F2 and F3 keys on the keypad have the ability of being programmed with specific functions to imitate digital inputs. The table below displays the settings that are valid for these buttons.

- To operate a function assigned to the F1, F2, or F3 key, the keypad needs to be on the F Key screen and then the respective key is required to be pressed and held.
- To navigate to the F Key screen, start from the Home screen and then, press the LO/RE key three times.

Table 5-95: F1, F2 and F3 Key Function Parameter Settings

Parameter	Display	Function	Range	Default
H01-15	F1 Key Function	Function selection for F1 key	F–7F	F
H01-16	F2 Key Function	Function selection for F2 key	F–7F	F
H01-17	F3 Key Function	Function selection for F3 key	F–7F	F

Table 5-96: F1, F2, and F3 Key Functions

Display	Function	Instruction
F Not Used	Function key is disabled	-
61 Brake Test	Motor pushes against brake up to C08-24 (Brake Test Torque). PG faults are disabled during the test.	Hold down the F key to initiate the Brake Test.
62 Bypass Stop Travel Limits	Bypass Upper/Lower Limit 2 (UL2 and LL2) MFDI and EPLS travel limits.	Hold down the F key to initiate LL2/UL2 Bypass.
63 Bypass EPLS	Bypass all EPLS travel limits (including LL3/UL3).	Hold down the F key to initiate LL/UL Bypass.
67 Hook Height Home (N.O.)	Hook Height (U01-50) gets set to C03-29 (Motor Revolutions at Home Position) or C03-14 (Hook Height Revolutions Total) depending on C03-15 (Hook Height Home Position).	Press the F key once to perform Hook Height Home.
6A Load Check Bypass	Disables Load Check and clears any LC faults.	Hold down the F key to initiate the LC Bypass.
7C Reset Maintenance Run Timer	Resets U04-27 and U04-28 maintenance run timer.	Press the F key once to perform the timer reset.
7D Reset Maintenance On Timer	Resets U04-29 and U04-30 maintenance on timer.	Press the F key once to perform the timer reset.
7E Reset Maintenance Brake Counter	Resets U04-31 and U04-33 brake counter.	Press the F key once to perform the counter reset.
7F Reset Lift Counter	Resets U04-35 lift counter.	Press the F key once to perform the counter reset.
91 Sync - Clear Sync Error	Resets U07-03 and U07-04 Sync error counter.	Press the F key once to perform the error reset.
A0 Bucket - Set Closed Position	Resets the U07-10, U07-11, and U07-12 bucket position counters.	Press the F key once to perform the counter reset.

5.6.1.3 Digital Inputs—Secondary Functions

The parameters in this section allow the selection of a secondary function for the S1 to S8 digital input terminals. An oPE03 error will occur if a function is programmed to more than one terminal at the same time.

Table 5-97: Digital Inputs Secondary Functions Parameter Settings

Parameter	Display	Function	Range	Default
H01-21*	Terminal S1 Function Select 2	Secondary function for Terminal S1.	0–17B	F
H01-22*	Terminal S2 Function Select 2	Secondary function for Terminal S2.	0–17B	F
H01-23*	Terminal S3 Function Select 2	Secondary function for Terminal S3.	0–17B	F
H01-24*	Terminal S4 Function Select 2	Secondary function for Terminal S4.	0–17B	F
H01-25*	Terminal S5 Function Select 2	Secondary function for Terminal S5.	0–17B	F
H01-26*	Terminal S6 Function Select 2	Secondary function for Terminal S6.	0–17B	F
H01-27*	Terminal S7 Function Select 2	Secondary function for Terminal S7.	0–17B	F
H01-28*	Terminal S8 Function Select 2	Secondary function for Terminal S8.	0–17B	F

* ***See Table 5-93 on page 246*** *for MFDI selections.*

5.6.1.4 Digital Inputs—Modbus

The parameters in this section configure digital inputs using the serial Modbus protocol. Run commands cannot be programmed to these inputs, and they cannot be used at the same time as the DI-A3 option card.

Table 5-98: Modbus Digital Inputs Parameter Settings

Parameter	Display	Function	Range	Default
H01-40 to H01-55	Mbus Reg 15C0h bit0 to 15 Input Func	Input function for bit 0 to 15 of Modbus register 15C0 (Hex.).	0–98	F

5.6.2 Digital Outputs (H02)

The VFD has three built-in multi-function digital outputs for indicating various conditions. Digital output capabilities can be increased with the installation of an S4IO or DO-A3 option card.

Table 5-99: Digital Outputs Parameter Settings

Parameter	Display	Function	Range	Default
H02-01	Term M1-M2 Function Selection	Digital Output 1 Function (***See Table 5-100 on page 255***.)	0–171	0*
H02-02	Term M3-M4 Function Selection	Digital Output 2 Function (***See Table 5-100 on page 255***.)	0–171	F*
H02-03	Term M5-M6 Function Selection	Digital Output 3 Function (***See Table 5-100 on page 255***.)	0–171	F*
H02-07	Fault Relay State During Decel *0 Remain Open Until Baseblock* *1 Immediate Close (Legacy)*	When a fault occurs, this selects whether the MA-MB-MC fault relay immediately changes state or waits until deceleration is complete. If a brake is wired through the fault relay, this will prevent running through the brake if a fault has a deceleration action.	0, 1	0
H02-16	Fault Annunciate A	Selects the faults to annunciate when an MFDO is set to H02-xx = 40.	100–4FF	2E1
H02-17	Fault Annunciate B	Selects the faults to annunciate when an MFDO is set to H02-xx = 41.	100–4FF	100
H02-18	Fault Annunciate C	Selects the faults to annunciate when an MFDO is set to H02-xx = 42.	100–4FF	100
H02-19	Fault Annunciate D	Selects the faults to annunciate when an MFDO is set to H02-xx = 43.	100–4FF	100

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

Table 5-100: Multi-Function Digital Output (MFDO) Selections for H02-0x and F05-0x

Display	Function
*0 Brake Release**	**ON:** VFD is commanding the brake to be Open **OFF:** VFD is commanding the brake to be Closed
1 Zero Speed	**ON:** Motor Speed < d01-01 or E01-09 **OFF:** Motor Speed > d01-01 or E01-09
2 Speed Agree 1	**ON:** Output frequency (U01-02) is within frequency reference (U01-01) ± L04-02 **OFF:** Output frequency (U01-02) is not within frequency reference (U01-01) ± L04-02
3 User-Set Speed Agree 1	**ON:** Output frequency (U01-02) is within L04-01 ± L04-02 **OFF:** Output frequency (U01-02) is not within L04-01 ± L04-02
4 Frequency Detection 1	***See Frequency Detection on page 318***.
5 Frequency Detection 2	***See Frequency Detection on page 318***.
6 Drive Ready	**ON:** VFD is in a run-ready state **OFF:** VFD is not in a run-ready state
7 DC Bus Undervoltage	**ON:** DC Bus voltage falls below the L02-05 level **OFF:** DC Bus voltage is above L02-05
8 During Baseblock (N.O.)	**ON:** During Baseblock - No Voltage output **OFF:** VFD is not in a Baseblock state - Voltage Output
*9 SSS Parking Brake**	**ON:** Opens the brake. Used for Static Stepless Simulation. **OFF:** Closes the brake.
*A Brake 2 Release**	**ON:** VFD is commanding the secondary brake to be Open **OFF:**VFD is commanding the secondary brake to be Closed
B Torque Detection 1 (N.O.)	**ON:** Output current/torque exceeds L06-02 for longer than the time set in L06-03. **OFF:** Output current/torque does not exceed L06-02 for longer than the time set in L06-03.
C Anti-Shock	**ON:** Anti-Shock is enabled and a torque spike is detected. **OFF:** Normal operation
E Fault	**ON:** VFD is in a fault condition (excluding CPF00 and CPF01) **OFF:** Normal operation
*F Not Used**	No Function
10 Alarm	**ON:** VFD is in an alarm condition **OFF:** VFD is not in an alarm condition
11 Fault Reset Command Active	**ON:** Reset command is present **OFF:** Normal operation
12 Timer Output	**ON:** H01-xx or F03-xx = 43 is ON for longer than C12-03 time **OFF:** H01-xx or F03-xx = 43 is OFF
13 Speed Agree 2	**ON:** Output frequency (U01-02) is within the frequency reference (U01-01) ± L04-04 **OFF:** Output frequency (U01-02) is not within the frequency reference (U01-01) ± L04-04
14 User-Set Speed Agree 2	**ON:** Output frequency (U01-02) is within L04-03 ± L04-04 **OFF:** Output frequency (U01-02) is not within L04-03 ± L04-04
*15 Overweight Detected**	**ON:** Measured weight exceeded the Hoist or Crane Overweight level (C10-31 / C10-33), or if enabled, the Alternate Crane Overweight level (C10-44). **OFF:** Normal operation

Display	Function
*16 Overweight Warning**	**ON:** Measured weight exceeded the Hoist or Crane Overweight Warning level (C10-30 / C10-32), or if enabled, the Alternate Crane Overweight Warning level (C10-43). **OFF:** Normal operation
17 Torque Detection 2 (N.O.)	**ON:** Output current/torque exceeds L06-05 for longer than time L06-06 **OFF:** Output current/torque does not exceed L06-05 for longer than time L06-06
18 Torque Control Mode	**ON:** Torque control mode or Load Share is enabled. **OFF:** Not in torque control mode or Load Share.
19 During Fast Stop	**ON:** Fast stop is in process. **OFF:** Normal operation
*1A During Forward**	**ON:** During Forward/Up operation **OFF:** Running in Reverse/Down direction or baseblock
1B During Reverse	**ON:** During Reverse/Down operation **OFF:** Running in Forward/Up direction or baseblock
1C Ultra-Lift Active	**ON:** VFD is operating in Ultra-Lift **OFF:** VFD is not operating in Ultra-Lift
1D Braking Resistor Fault	**ON:** VFD detects a braking resistor or transistor failure. Available if L08-55 = 1 or 2. **OFF:** Normal operation
1F During Regeneration	**ON:** VFD is in a regenerative mode **OFF:** Normal operation
21 Motor Overload Alarm (oL1)	**ON:** VFD exceeds 90% of the motor overload detection level (oL1) **OFF:** Normal operation
22 Drive Overheat Pre-Alarm (oH)	**ON:** VFD heatsink temperature ≥ L08-02 **OFF:** Normal operation
23 During Torque Limit	**ON:** Torque (U01-09) is ≥ C07-01–C07-04. **OFF:** Normal operation
24 Safe Torque OFF	**ON:** Terminals H1 and H2 are OFF/OPEN (safety stop state) **OFF:** Terminal H1 or H2 is OFF/OPEN (safety circuit fault), or both are ON/CLOSED.
25 During Load Float	**ON:** VFD is in Load Float **OFF:** VFD is not in Load Float
26 Hook Height SetPoint 1	**ON:** Conditions of C03-60 and C03-61 met. **OFF:** Normal operation
27 Hook Height SetPoint 2	**ON:** Conditions of C03-62 and C03-63 met. **OFF:** Normal operation
28 Sway Control System Active	**ON:** Sway Control function is enabled **OFF:** Sway Control function is disabled
29 Run Command Input ON	**ON:** Forward or Reverse run command is ON **OFF:** Forward and Reverse run command is OFF
2A During Frequency Output	**ON:** Run command is active or the VFD is outputting voltage. **OFF:** Run command is off and the VFD is not outputting voltage.
2B EPLS Upper Limit 1	**ON:** UL1 is detected when using the EPLS function **OFF:** Normal operation

Display	Function
2C EPLS Upper Limit 2	**ON:** UL2 is detected when using the EPLS function **OFF:** Normal operation
2D EPLS Lower Limit 1	**ON:** LL1 is detected when using the EPLS function **OFF:** Normal operation
2E EPLS Lower Limit 2	**ON:** LL2 is detected when using the EPLS function **OFF:** Normal operation
2F EPLS Fault Stop	**ON:** UL3 or LL3 is detected when using the EPLS function **OFF:** Normal operation
30 Load Check Detected	**ON:** VFD has detected a Load Check fault **OFF:** Normal operation
31 Slack Cable Detected	**ON:** VFD has detected a Slack Cable **OFF:** Normal operation
*32 Snap Shaft Detected**	**ON:** VFD has detected a Snap Shaft **OFF:** Normal operation
*33 Load Lifted**	**ON:** Taut Line Weight (C10-50) has been reached, indicating the hoist lines are taut. **OFF:** Load is on the ground or Load Lifted Revolutions (C10-51) have occurred since this output turned ON.
*34 Index Complete**	**ON:** Index move is complete **OFF:** Normal operation or Index move is not complete
*35 Ready for F-Ref**	**ON:** C08-04 timer has expired or Brake Answerback is detected H01-xx or F03-xx = 58 **OFF:** Normal operation or VFD detected a BE1, BE2, BE4 alarm or is stopped.
37 Maintenance Notification	**ON:** Maintenance Timer U01-52 ≥ C12-05 **OFF:** Normal operation or the Maintenance Timer U01-52 < C12-05
*38 In Speed Limit During Trq Ctrl**	**ON:** Speed Limit has been reached while using Torque Control **OFF:** Speed Limit has not been reached when using Torque Control
39 Drive Enabled	**ON:** VFD disabled (H01-xx or F03-xx = 55 input is ON or 155 input is OFF) **OFF:** Normal operation
*3A Ultra-Lift Ready**	**ON:** All conditions for Ultra-Lift have been met. **OFF:** Ultra-Lift not ready.
*3B Bucket Closed**	**ON:** Bucket is closed (U07-12 < C09-58) **OFF:** Bucket is open
3F Klixon	**ON:** Klixon alarm is detected (H01-xx or F03-xx = 56 input is ON or 156 input is OFF) **OFF:** Normal operation
40 Fault Annunciate A (H02-16)	**ON:** The faults selected via H02-16 are active. **OFF:** Normal operation
41 Fault Annunciate B (H02-17)	**ON:** The faults selected via H02-17 are active. **OFF:** Normal operation
42 Fault Annunciate C (H02-18)	**ON:** The faults selected via H02-18 are active. **OFF:** Normal operation
43 Fault Annunciate D (H02-19)	**ON:** The faults selected via H02-19 are active. **OFF:** Normal operation

Display	Function
4D oH Pre-Alarm Reduction Limit	**ON:** oH pre-alarm time limit has passed. **OFF:** Normal operation
4E Braking Transistor Fault (rr)	**ON:** Braking transistor fault (rr) active. Not functional on models 2145 to 2415, 4180 to 41090, and 5077 to 5412. **OFF:** Normal operation
4F Braking Resistor Overheat (rH)	**ON:** Braking resistor overheat (rH) active. Not functional on models 2145 to 2415, 4180 to 41090, and 5077 to 5412. **OFF:** Normal operation
*50 Sync - Follower Ready**	**ON:** Follower has received a run command and is ready to run. **OFF:** Follower is not ready to run
*51 Sync - Run Follower**	**ON:** Leader sending a run command to the Follower. **OFF:** Leader is not sending a run command to the Follower.
52 Sync - Out of Sync	**ON:** Follower is out of Sync with the Leader, as defined by C09-12. **OFF:** Follower is synchronized with the Leader.
*53 Sync - OK for Ultra-Lift**	**ON:** Follower is ready to proceed into Ultra-Lift as defined by the C06-xx parameters. **OFF:** Follower is not ready for Ultra-Lift.
60 Internal Cooling Fan Failure	**ON:** Cooling fan failure is detected **OFF:** Normal operation
69 External Power 24V Supply	**ON:** External 24V power active at the PS-AC terminal. **OFF:** VFD not being supplied with external 24V power.
70 Hook Height SetPoint 3	**ON:** Conditions of C03-64 and C03-65 met. **OFF:** Normal operation
71 Hook Height SetPoint 4	**ON:** Conditions of C03-66 and C03-67 met. **OFF:** Normal operation
*101 through 171***	Inverse of settings 1 through 71

** This output does not have an inverse output*

*** Relay will open (turn off) when power is disconnected*

5.6.2.1 Digital Outputs—Alarm/Fault Annunciate

Fault Annunciate enables you to assign a set of eight fault/alarm outputs to Relay Outputs M1-M2, M3-M4, and M5-M6. M1-M2 is typically assigned to a brake output, but it could instead be used for fault annunciate. This function will also trigger the MA-MB-MC fault relay.

You may find it convenient to print the Fault Annunciate Worksheet in this section. By being able to write in the worksheet's boxes, you will find it easier to program the feature.

Programming **Fault Annunciate** requires that you determine two 4-digit binary numbers and then convert these to two 1-digit hexadecimal values. You enter the hexadecimal values when you program the VFD.

Setup Procedure:

1. Navigate to H02-01 (M1-M2), H02-02 (M3-M4), or H02-03 (M5-M6) and press ENTER until the value blinks.
2. Press the UP or DOWN key until H02-xx = 40, 41, 42, or 43 appears. These settings correlate with H02-16 through H02-19 respectively. Press the ENTER key to accept the selection.
3. From the worksheet in ***Table 5-102 on page 260***, select one of four fault output sets.
4. Determine which faults/alarms will trigger the fault output. To enable a fault/alarm, enter 1 in the box; otherwise, enter 0. Do this for each column in the set.
5. Using the Binary to Hexadecimal Conversion chart (***Table 5-103 on page 261***), determine the 1-digit hexadecimal value for each 4-digit binary number.
6. Navigate to H02-16 through H02-19, which correlates with the value that was set in Step 2. Program the hexadecimal value to this parameter. The first digit is the Set number and the next two digits are the hexadecimal numbers determined above.

Example:

Select a Set containing the alarm/fault(s) you want to trigger an output. You can only select from one set. If you want a relay output based on only LL1 and LL2, you would choose Set 1.

1. Set relay M5-M6 to H02-03 = 43 (Fault Annunciate D).
2. The first digit will be "1" since LL1 and LL2 are in Set 1.
3. For the second digit, use ***Table 5-103 on page 261*** to convert the left binary value "0 0 1 0" to Hex 2.
4. For the third digit, use ***Table 5-103 on page 261*** to convert the right binary value "1 0 0 0" to Hex 8.
5. Enter 128 into H02-19 (Fault Annunciate D).

Table 5-101: Fault/Alarm Annunciate Example

	First digit				Second digit			
	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0
Set 1	LL3	UL3	LL2	UL2	LL1	UL1	LL0	UL0
Binary Number	0	0	1	0	1	0	0	0

Table 5-102: Fault/Alarm Annunciate Worksheet

	First digit				Second digit			
	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0
Set 1	LL3	UL3	LL2	UL2	LL1	UL1	LL0	UL0
Binary Number								

	First digit				Second digit			
	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0
Set 2	BE8	BE6	BE5	BE4	BE3	BE2	BE1	ELFT
Binary Number								

	First digit				Second digit			
	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0
Set 3	SLC	SNAP	oS	LF	KLX	LC	dEv	AS1
Binary Number								

	First digit				Second digit			
	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0	1 or 0
Set 4	-	-	-	BE7	BE6	BE5	BE4	BE0
Binary Number								

Table 5-103: Binary to Hexadecimal Conversion

Binary Number	Hexadecimal Value	Binary Number	Hexadecimal Value
0000	0	1000	8
0001	1	1001	9
0010	2	1010	A
0011	3	1011	B
0100	4	1100	C
0101	5	1101	D
0110	6	1110	E
0111	7	1111	F

5.6.2.2 Digital Outputs—Modbus

The parameters in this section configure digital outputs using the serial Modbus protocol.

Table 5-104: Modbus Digital Outputs Parameter Settings

Parameter	Display	Function	Range	Default
H02-40 to H02-47	Mbus Reg 15E0h bit0 to 7 Output Func	Output function for bit 0 to 7 of Modbus register 15E0 (Hex.).	0–171	F

5.6.2.3 Digital Outputs—Secondary Functions

The parameters in this section allow the selection of a secondary function for the M1-M2, M3-M4, and M5-M6 digital output relays. Additional parameters are available for delay times and logical operation options for the secondary functions.

Table 5-105: Digital Outputs Secondary Functions Parameter Settings

Parameter	Display	Function	Range	Default
H02-60*	Term M1-M2 Secondary Function	Secondary function for the M1-M2 relay.	0–71	F
H02-61	Terminal M1-M2 Logical Operation *0 A=B=1* *1 A=1 or B=1* *2 A=0 or B=0* *3 A=B=0* *4 A=B* *5 A != B* *6 A=1 and B=0* *7 A=1 or B=0* *8 ON Always*	Secondary function logical operation for the M1-M2 relay in relation to H02-01.	0–8	0
H02-62	Terminal M1-M2 Delay Time	Delay time after applying the H02-61 logical operation results.	0.0–25.0 sec	0.1
H02-63*	Term M3-M4 Secondary Function	Secondary function for the M3-M4 relay.	0–71	F
H02-64	Terminal M3-M4 Logical Operation *0 A=B=1* *1 A=1 or B=1* *2 A=0 or B=0* *3 A=B=0* *4 A=B* *5 A != B* *6 A=1 and B=0* *7 A=1 or B=0* *8 ON Always*	Secondary function logical operation for the M3-M4 relay in relation to H02-02.	0–8	0
H02-65	Terminal M3-M4 Delay Time	Delay time after applying the H02-64 logical operation results.	0.0–25.0 sec	0.1
H02-66*	Term M5-M6 Secondary Function	Secondary function for the M5-M6 relay.	0–71	F
H02-67	Terminal M5-M6 Logical Operation *0 A=B=1* *1 A=1 or B=1* *2 A=0 or B=0* *3 A=B=0* *4 A=B* *5 A != B* *6 A=1 and B=0* *7 A=1 or B=0* *8 ON Always*	Secondary function logical operation for the M5-M6 relay in relation to H02-03.	0–8	0
H02-68	Terminal M5-M6 Delay Time	Delay time after applying the H02-67 logical operation results.	0.0–25.0 sec	0.1

* ***See Table 5-100 on page 255** for MFDO selections. The Inverse functions are not available.*

5.6.3 Analog Inputs (H03)

The VFD has three built-in analog inputs for the external input of references and limits.

Table 5-106: Analog Inputs Parameter Settings

Parameter	Display	Function	Range	Default
H03-01	Terminal A1 Signal Level Select *0 0 to 10 V* *1 -10 to 10 V* *2 4 to 20 mA* *3 0 to 20 mA* ***NOTE:*** *DIP switch S1-1 selects a current or voltage input signal.*	Terminal A1 analog input signal	0–3	0*
H03-02	Terminal A1 Function Selection	Function of Terminal A1 (***see Table 5-108 on page 265***)	0–36	0
H03-03	Terminal A1 Gain Setting	Gain multiplier for Terminal A1	-999.9–999.9%	100.0
H03-04	Terminal A1 Bias Setting	Bias multiplier for Terminal A1	-999.9–999.9%	0.0
H03-05	Terminal A3 Signal Level Select *0 0 to 10 V* *1 -10 to 10 V* *2 4 to 20 mA* *3 0 to 20 mA* ***NOTE:*** *DIP switch S1-3 selects a current or voltage input signal.*	Terminal A3 analog input signal	0–3	0*
H03-06	Terminal A3 Function Selection	Function of Terminal A3 (***see Table 5-108 on page 265***)	0–36	1F*
H03-07	Terminal A3 Gain Setting	Gain multiplier for Terminal A3	-999.9–999.9%	100.0
H03-08	Terminal A3 Bias Setting	Bias multiplier for Terminal A3	-999.9–999.9%	0.0
H03-09	Terminal A2 Signal Level Select *0 0 to 10 V* *1 -10 to 10 V* *2 4 to 20 mA* *3 0 to 20 mA* ***NOTE:*** *DIP switch S1-2 selects a current or voltage input signal.*	Terminal A2 analog input signal	0–3	2
H03-10	Terminal A2 Function Selection	Function of Terminal A2 (***see Table 5-108 on page 265***)	0–36	1F
H03-11	Terminal A2 Gain Setting	Gain multiplier for Terminal A2	-999.9–999.9%	100.0
H03-12	Terminal A2 Bias Setting	Bias multiplier for Terminal A2	-999.9–999.9%	0.0
H03-13	Analog Input Filter Time Constant	Analog input filter average time	0.00–2.00 sec	0.03
H03-19	4-20mA Feedback Loss Time	If a 4-20 mA analog input is less than 2 mA for this set time, an AFbL fault will occur. A setting of 0.0 disables this function.	0.0–2.0 sec	0.0

Parameter	Display	Function	Range	Default
H03-20	MFAI Signal Bridge *0 Disabled* *1 Terminal A1 to A2* *2 Terminal A1 to A3* *3 Terminal A1 to A2 & A3*	Bridges MFAI terminals A1, A2, and/or A3 electronically without needing physical wiring.	0–3	0

* *Initial value is determined by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

5.6.3.1 Analog Inputs—Modbus

The parameters in this section configure analog inputs using the serial Modbus protocol.

Table 5-107: Modbus Analog Inputs Parameter Settings

Parameter	Display	Function	Range	Default
H03-40	Mbus Reg 15C1h Input Function	Analog input function for Modbus register 15C1 (Hex.). ***See Table 5-108 on page 265*** for selections.	4–36	1F
H03-41	Mbus Reg 15C2h Input Function	Analog input function for Modbus register 15C2 (Hex.). ***See Table 5-108 on page 265*** for selections.	4–36	1F
H03-42	Mbus Reg 15C3h Input Function	Analog input function for Modbus register 15C3 (Hex.). ***See Table 5-108 on page 265*** for selections.	4–36	1F
H03-43	Mbus Reg Inputs Filter Time Constant	Delay filter time constant applied to the Modbus analog input register values.	0.00–2.00 sec	0.00

Table 5-108: Multi-Function Analog Input (MFAI) Selections for H03-02, -06, and -10

Setting	Display	Function
0	Analog Frequency Reference 1	Analog Frequency Reference 1 10V = E01-04 (maximum output frequency) Enabled when multi-step reference 2 and 3 inputs (MFDI = 0 and 1) are OFF.
1	Frequency Gain	Analog frequency reference is multiplied with the Frequency Gain.
2	Analog Frequency Reference 2	Analog Frequency Reference 2 10V = E01-04 (maximum output frequency) Enabled by the multi-step reference 2 input (MFDI = 0).
3	Analog Frequency Reference 3	Analog Frequency Reference 3 10V = E01-04 (maximum output frequency) Enabled by the multi-step reference 3 input (MFDI = 1).
4	Output Voltage Bias	The Output Voltage Bias boosts the output voltage of the V/f curve as a percentage of the maximum output voltage. Only available in V/f mode. 10V = E01-05 (motor rated voltage)
5	Accel/Decel Time Gain	10V = 100% acceleration and deceleration time
6	DC Injection Braking Current	10V = 100% VFD rated current
7	Torque Detection Level	Overtorque/undertorque level as a percentage of VFD rated current.
8	Stall Prevent Level During Run	Stall prevention level, during run. Only available in V/f mode.
9	Output Frequency Lower Limit	Output frequency lower limit as a percentage of the max output frequency. 10V = E01-04 (maximum output frequency)
D	Frequency Bias	Bias added to the frequency reference as a percentage of E01-04.
E	Motor Temperature (PTC Input)	Positive Temperature Coefficient (PTC) thermistor input. Set Terminal Board DIP switch S4 to “PTC.”
10	Forward Torque Limit*	Torque limit when motoring in the forward direction.
11	Reverse Torque Limit*	Torque limit when motoring in the reverse direction.
12	Regenerative Torque Limit*	Torque limit during regen.
13	Torque Reference / Torque Limit*	Torque reference when in Torque Control mode. Torque limit when in Speed Control mode.
14	Torque Compensation*	Torque compensation when using torque control.
15	General Torque Limit*	Reverse, Forward, or Regen torque limit.
16	Load Cell	Feedback from a load cell used for Weight Measurement System (WMS).
17	Load Share Follower Feedback*	Trigger an Fnr alarm/fault if U01-09, minus this feedback, is greater than 20% for C04-06 time.
1A	Load Sum Chain	Load Sum of the previous hoists in the chain. Each hoist measures its weight, adds it to Crane Load Sum, and passes an analog output to the next VFD.
1B	Main Hook Height	0 V = 0% of C14-02 added to swing length 10 V = 100% of C14-02 added to swing length
1C	Aux Hook Height	0 V = 0% of C14-02 added to swing length 10 V = 100% of C14-02 added to swing length
1D	Center of Gravity Offset	0 V = 0 * C14-05 added to swing length 1 V = C14-05 added to swing length 10 V = 10 * C14-05 added to swing length
1F	Not Used	Input is disabled
20	Bucket Load Balancer Reference*	Set this on the Bucket Holder VFD when using Load Balancer (C09-61).
35	Travel Limits-Forward Sensor	Travel Limit feedback for forward facing sensor.
36	Travel Limits-Reverse Sensor	Travel Limit feedback for reverse facing sensor.

** Not available for the V/f control method (A01-02 = 0).*

5.6.4 Analog Outputs (H04)

The VFD has two built-in analog outputs for condition monitoring. Analog output capabilities can be increased with the installation of an AO-A3 option card.

Table 5-109: Analog Outputs Parameter Settings

Parameter	Display	Function	Range	Default
H04-01	Terminal FM Analog Output Select *0 Not Used* *101 Frequency Reference* *102 Output Frequency* *103 Output Current* *105 Motor Speed* *106 Output Voltage Ref* *107 DC Bus Voltage* *108 Output Power* *109 Torque Reference* *115 Terminal A1 Level* *116 Terminal A2 Level* *117 Terminal A3 Level* *120 SFS Output Frequency* *130 SS Delta Speed* *131 Hoist Weight* *132 Crane Weight Sum* *149 Swing Length* *150 Hook Height* *151 Motor Revolution* *154 Input Pulse Monitor* *160 Encoder 1 Pulse Counter* *161 Encoder 2 Pulse Counter* *191 Output Voltage* *401 Cumulative Operation Time* *403 Cooling Fan Operation Time* *404 Cooling Fan Maintenance* *405 Capacitor Maintenance* *406 Precharge Relay Maintenance* *407 IGBT Maintenance* *408 Heatsink Temperature* *416 Motor oL1 Level* *417 Drive oL2 Level* *419 Modbus Frequency Ref (dec)* *420 Option Frequency Ref (dec)* *424 Number of Runs (Low)* *425 Number of Runs (High)*	Function for Terminal FM. Reference the U monitor group for output function descriptions.	0–712	102

Parameter	Display	Function	Range	Default
H04-01	*428 Run Time Remaining* *430 On Time Remaining* *433 Brake Cycles Remaining* *452 Torque Reference from Comm* *601 Iq Secondary Current* *602 Id Excitation Current* *603 ASR Input* *604 ASR Output* *605 Output Voltage Reference (Vq)* *606 Output Voltage Reference (Vd)* *607 q-Axis ACR Output* *608 d-Axis ACR Output* *621 Offset Frequency* *631 Torque Detect Monitor* *710 Bucket Motor 1 Revs* *711 Bucket Motor 2 Revs* *712 Bucket Delta Revs*		0–712	102
H04-02	Terminal FM Analog Output Gain	Gain multiplier for Terminal FM	-999.9–999.9%	100.0
H04-03	Terminal FM Analog Output Bias	Bias multiplier for Terminal FM	-999.9–999.9%	0.0
H04-04	Terminal AM Analog Output Select	Function for Terminal AM. Same selections as H04-01.	0–712	103
H04-05	Terminal AM Analog Output Gain	Gain multiplier for Terminal AM	-999.9–999.9%	50.0
H04-06	Terminal AM Analog Output Bias	Bias multiplier for Terminal AM	-999.9–999.9%	0.0
H04-07	Terminal FM Signal Level Select *0 0 to 10 VDC* *1 -10 to +10 VDC* *2 4 to 20 mA* ***NOTE:*** *Jumper switch S5 selects a current or voltage output signal.*	Output signal level of Terminal FM	0–2	0
H04-08	Terminal AM Signal Level Select *0 0 to 10 VDC* *1 -10 to +10 VDC* *2 4 to 20 mA* ***NOTE:*** *Jumper switch S5 selects a current or voltage output signal.*	Output signal level of Terminal AM	0–2	0
H04-20	Analog Power Monitor 100% Level	Level at 10 V when an analog output is set for 108 (U01-08: Output Power)	0.00–650.00* kW	0.00

* *The range is 0.0-1000.0 kW for the 4720 to 41090 models.*

5.6.5 Modbus RTU Communication (H05)

The VFD uses terminals D+ and D- to communicate the Modbus RTU (RS-485) protocol. Cycle power after changing any of these parameters.

NOTE: *The Modbus RS-422 (4-wire) protocol is not compatible.*

Table 5-110: Modbus Communication Parameter Settings

Parameter	Display	Function	Range	Default
H05-01	Drive Node Address	Serial communication address. If multiple VFDs are communicating on the same Modbus line, each VFD must have a unique H05-01 setting.	0–FF	1F
H05-02	Communication Speed Selection *0 1200 bps* *1 2400 bps* *2 4800 bps* *3 9600 bps* *4 19.2 kbps* *5 38.4 kbps* *6 57.6 kbps* *7 76.8 kbps* *8 115.2 kbps*	Baud rate	0–8	4
H05-03	Communication Parity Selection *0 No Parity* *1 Even Parity* *2 Odd Parity*	Parity type	0–2	0
H05-04	Communication Error Stop Method *0 Decel to Stop* *1 Coast to Stop* *2 Fast Stop (Use b05-08)* *3 Alarm Only*	Stopping method when a Modbus Communication Error (CE) occurs.	0–3	0
H05-05	Comm Fault Detection Selection *0 Disabled* *1 Enabled*	A Modbus Communication Error (CE) is detected if data is not received for the time set in H05-09.	0, 1	1
H05-06	Drive Transmit Wait Time	Time to wait to send a response message after a command message is received.	0–65 ms	5
H05-09	CE Detection Time	Time required to detect a Modbus Communications Error (CE) when communication stops. Adjustment may be needed when networking several VFDs. A setting of 0.0 will disable CE detection, which is highly discouraged. Consult factory for assistance.	0.0–10.0 sec	1.0

Parameter	Display	Function	Range	Default
H05-10	Modbus Register 0025H Unit Sel *0 0.1 V Units* *1 1 V Units*	Units for the output voltage monitor value in Modbus Register 0025H.	0, 1	0
H05-11	Comm ACCEPT Command Mode *0 ACCEPT Command Required* *1 ACCEPT Command Not Required*	Accept command requirement when writing a parameter via Modbus. An Enter command is also required to save changes to non-volatile memory. VFD requires an Accept command before accepting any parameter changes. Parameter changes are activated immediately without the Accept command.	0, 1	1
H05-13	RDSI Legacy Mode *0 Disabled* *1 Enabled*	Legacy support for Hetronic RDSI.	0, 1	0
H05-17	ENTER Command Response @CPU BUSY *0 Ignore Command (No ROM/RAM Write)* *1 Write to RAM Only*	Allows VFD to substitute a RAM enter with a ROM enter when under heavy CPU load.	0, 1	0
H05-18	Motor Speed Filter over Comms	Motor Speed Monitor Filter Time. Adds a filter to Motor Speed monitor (U01-05).	0–100 ms	0
H05-20	Communication Parameters Reload *0 Reload at Next Power Cycle* *1 Reload Now*	If changes are made to any H05-xx parameters, setting H05-20 = 1 will load them without needing to power cycle the VFD. When the load is complete, it will automatically revert H05-20 to 0.	0, 1	0
H05-25	Function 5A Register 1 Selection	Returns the contents of the specified Modbus register.	0000-FFFF	44 (U01-05)
H05-26	Function 5A Register 2 Selection	Returns the contents of the specified Modbus register.	0000-FFFF	45 (U01-06)
H05-27	Function 5A Register 3 Selection	Returns the contents of the specified Modbus register.	0000-FFFF	42 (U01-03)
H05-28	Function 5A Register 4 Selection	Returns the contents of the specified Modbus register.	0000-FFFF	49 (U01-10)

NOTE: *After initial communication, if the VFD is not communicated with for the time duration set at parameter H05-09, a Communication Error (CE) fault/alarm will occur.*

5.6.5.1 Modbus RTU—Specifications

The data that may be sent or received from the VFD consists of:

- Run Command
- Frequency Reference
- Fault and Alarm Contents
- VFD Status
- Parameter Settings

The following table illustrates whether the serial communication specifications are fixed or user selectable. If the specification is fixed, the fixed value is shown in the last column. If the specification is selectable, the range of allowed values is shown in the last column.

Specification	Range
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200 bps
Interface	RS-485 (2-wire)
Data Length	8 bits (fixed)
Parity	None, Even, or Odd
Stop Bit	1 bit (fixed)
Nodes	Maximum of 31 nodes

5.6.5.2 Modbus RTU—Wiring

This section explains the configuration and setup steps for Modbus RS-485 (2-wire) communications.

1. Connect the PLC to the D+ and D- RS-485 terminals on the VFD. A shielded cable is recommended, and the shield wire can be wired to the AC or E(G) terminal. Isolate the communications wiring from the main circuit wiring and other high-power wiring.

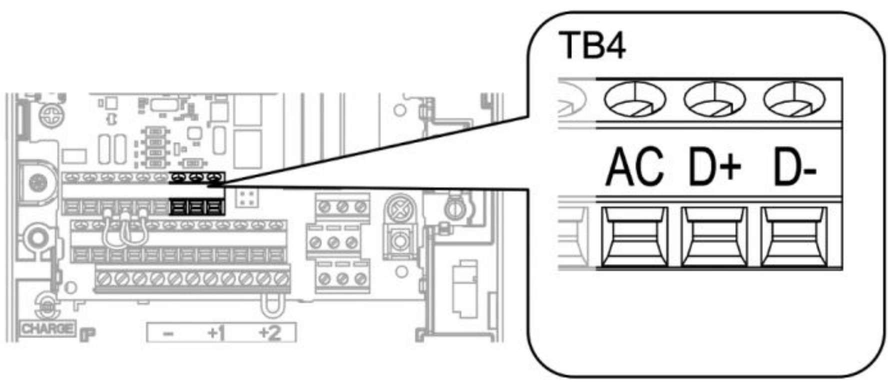


Figure 5-49: Modbus Cable Connection

2. Multiple VFDs can be connected to the same RS-485 Modbus network and chained together. The last VFD in the chain should have the termination resistor (S2 switch) turned on.

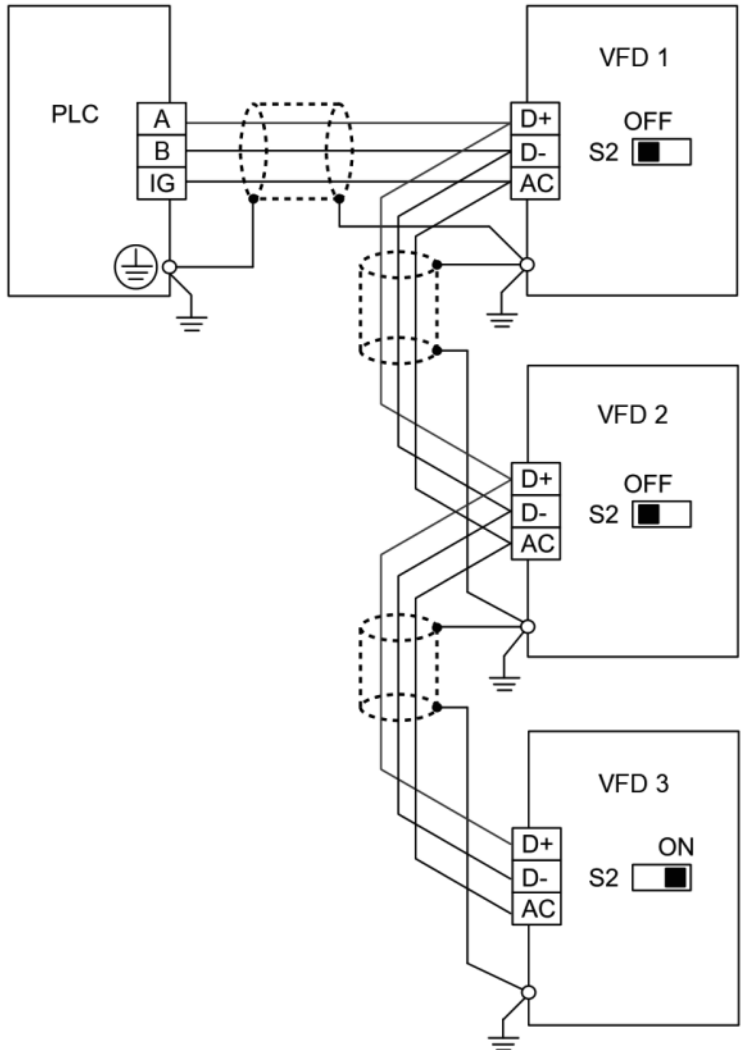


Figure 5-50: Wiring Diagram for Multiple VFDs

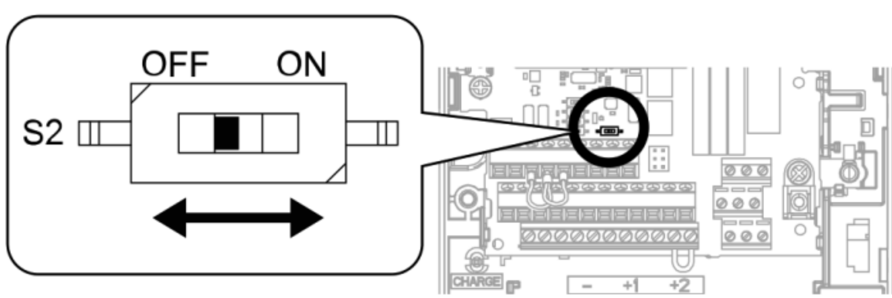


Figure 5-51: Termination Resistor

5.6.5.3 Modbus RTU—Configuration

Run and Frequency Reference Selection

The run/stop commands and frequency reference command can originate from serial communication, the digital operator, the external terminals, or an option board. The origin of the run command does not have to be the same as the origin for the frequency reference command.

Parameter b03-01 (Frequency Reference Source 1) allows you to set the origin of the frequency reference, and parameter b03-02 (Run Command Selection 1) sets the origin of the run commands. A second set of frequency and run sources can be configured to b03-15 and b03-16 and enabled with a digital input (H01-xx or F03-xx = 1F). This can be helpful if primary operation uses Modbus communication to control the VFD, and a backup radio or pendant is available and enabled with a toggle switch.

Parameter	Description	Setting Value
b03-01	Frequency Reference Selection 1	2 (Serial Communications)
b03-02	Run Command Selection 1	2 (Serial Communications)
b03-15	Frequency Reference Selection 2	2 (Serial Communications)
b03-16	Run Command Selection 2	2 (Serial Communications)

Serial Communication Setup

Configure the following parameters on each VFD to the desired settings. Cycle power to the VFD if any changes are made, or set H05-20 = 1 to implement the parameter changes without needing to cycle VFD power.

Parameter	Description	Notes
H05-01	Drive Node Address	Must be unique on each VFD
H05-02	Communication Speed Selection	Baud rate
H05-03	Communication Parity Selection	None, even, or odd parity
H05-04	Communication Error Stop Method	CE error stopping method
H05-05	Comm Fault Detection Selection	CE error enable/disable
H05-06	Drive Transmit Wait Time	Wait time for Modbus response
H05-09	CE Detection Time	Wait time for communication loss
H05-10	Modbus Register 0025H Unit Select	0.1 V or 1 V units
H05-11	Comm ACCEPT Command Mode	Modbus Accept command requirement

5.6.5.4 Modbus RTU—Message Format

Modbus Message Functions

There are five message functions available. The leader (PLC) specifies the function to be executed by the follower (VFD) according to the function code. The following table shows the types of function codes available, and the length (quantity) and contents of the message according to the function.

Function Code (Hex.)	Subfunction Code (Hex.)	Function Description	Command Message		Response Message	
			Min Data Length (byte)	Max Data Length (byte)	Min Data Length (byte)	Max Data Length (byte)
03	-	Read multiple registers	8	8	7	37
08	-	Loopback test	8	8	8	8
10	-	Write to multiple registers	11	41	8	8
5A	-	Write to multiple registers / Read the register indicated	11	41	17	17
67	010D	Read non-consecutive registers	10	248	10	248
	010E	Write to non-consecutive registers	14	250	8	8

Read Multiple Registers (0x03)

Function code 03 (Hex.) can read the contents of a maximum of 16 registers. The table below shows example messages of Node 2 VFD error contents, fault contents, and frequency references.

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)	Response Message (Fault)		Setting Data (Hex.)
0	Node Address		02	Node Address		02	Node Address		02
1	Function Code		03	Function Code		03	Function Code + 0x80		83
2	Starting No.	Upper	00	Data Qty		08	Error Code		03
3		Lower	20	First Register	Upper	00	CRC-16	Upper	F1
4	Data Qty	Upper	00		Lower	65		Lower	31
5		Lower	04	Next Register	Upper	00	-		
6	CRC-16	Upper	45		Lower	00	-		
7		Lower	F0	Next Register	Upper	00	-		
8	-				Lower	00	-		
9	-			Next Register	Upper	01	-		
10	-				Lower	F4	-		
11	-			CRC-16	Upper	AF	-		
12	-				Lower	82	-		

Loopback Test (0x08)

Function code 08 (Hex.) is used for checking signal transmission between leader and follower devices. The table below shows example messages of a loopback test on the Node 1 VFD.

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)
0	Node Address		01	Node Address		01
1	Function Code		08	Function Code		08
2	Test Code	Upper	00	Test Code	Upper	00
3		Lower	00		Lower	00
4	Data	Upper	A5	Data	Upper	A5
5		Lower	37		Lower	37
6	CRC-16	Upper	DA	CRC-16	Upper	DA
7		Lower	8D		Lower	8D

Write to Multiple Registers (0x10)

Function code 10 (Hex.) is for writing data to a maximum of 16 registers with one message. This process is similar to reading registers, in that the address of the first register to be written and the data quantity are set in the command message. The data to be written must be consecutive so that the register addresses are in order, starting from the specified address in the command message. The data order must be high byte then low byte. The table below shows an example message of sending a forward run command to Node 1 VFD with a 60.00 Hz frequency reference.

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)	Response Message (Fault)		Setting Data (Hex.)
0	Node Address		01	Node Address		01	Node Address		01
1	Function Code		10	Function Code		10	Function Code + 0x80		90
2	Starting No.	Upper	00	Starting No.	Upper	00	Error Code		02
3		Lower	01		Lower	01	CRC-16	Upper	CD
4	Data Qty	Upper	00	Data Qty	Upper	00		Lower	C1
5		Lower	02		Lower	02	-		
6	Number of Bytes		04	CRC-16	Upper	10	-		
7	First Data	Upper	00		Lower	08	-		
8		Lower	01	-			-		
9	Next Data	Upper	17	-			-		
10		Lower	70	-			-		
11	CRC-16	Upper	6D	-			-		
12		Lower	B7	-			-		

NOTE: *The number of bytes in the command message is the data quantity × 2, since there are two bytes of data per register.*

Write Multiple Registers / Read Register Indicated (0x5A)

Function code 5A (Hex.) is for writing to a maximum of 16 registers, and then read the contents of four holding registers at the same time. The four holding registers to be read are specified in H05-25 to H05-28 (Function 5A Register x Selection). The table below shows example messages when writing more than one holding register or when reading more than one command register. The following is used for register data:

- The Node 1 VFD is set for Forward run with a frequency reference of 60.00 Hz.
- H05-25 = 0x44: U01-05 (Motor Speed) = 60.00 Hz (6000 = 0x1770)
- H05-26 = 0x45: U01-06 (Output Voltage Reference) = 200.0 V (2000 = 0x07D0)
- H05-27 = 0x42: U01-03 (Output Current) = 50% of VFD rated current (100% = 8192, 50% = 4096 = 0x1000)
- H05-28 = 0x49: U01-10 (Input Terminal Status) = 0x00

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)	Response Message (Fault)		Setting Data (Hex.)
0	Node Address		01	Node Address		01	Node Address		01
1	Function Code		5A	Function Code		5A	Function Code + 0x80		DA
2	Starting No.	Upper	00	Register Status		0F	Register Status		0F
3		Lower	01	Data in H05-25	Upper	17	Data in H05-25	Upper	17
4	Data Qty	Upper	00		Lower	70		Lower	70
5		Lower	02	Data in H05-26	Upper	07	Data in H05-26	Upper	07
6	Number of Bytes		04		Lower	D0		Lower	D0
7	First Data	Upper	00	Data in H05-27	Upper	10	Data in H05-27	Upper	10
8		Lower	01		Lower	00		Lower	00
9	Next Data	Upper	17	Data in H05-28	Upper	00	Data in H05-28	Upper	00
10		Lower	70		Lower	00		Lower	00
11	CRC-16	Upper	4F	Starting No.	Upper	00	Error Codes		02
12		Lower	43		Lower	01	CRC-16	Upper	E9
13	-			Data Qty	Upper	00		Lower	6C
14	-				Lower	02	-		
15	-			CRC-16	Upper	AC	-		
16	-				Lower	D0	-		

NOTE: *The number of bytes in the command message is the data quantity × 2, since there are two bytes of data per register.*

Register Status	
bit 0	Data in register 1 selected with H05-25 *1 Successfully read the register* *0 Register read error*
bit 1	Data in register 2 selected with H05-26 *1 Successfully read the register* *0 Register read error*
bit 2	Data in register 3 selected with H05-27 *1 Successfully read the register* *0 Register read error*
bit 3	Data in register 4 selected with H05-28 *1 Successfully read the register* *0 Register read error*
bit 4 to 7	Not used

Read Non-Conservative Registers (0x67)

Function code 67 (Hex.) is used with subfunction code 010D (Hex.) to read data from a maximum of 120 registers. You must give the register number from which to read separately. The table below shows example messages when reading the frequency reference and torque limit from the Node 1 VFD.

The following is used for register data:

- The Node 1 VFD is set for Forward run with a frequency reference of 60.00 Hz.
- 0x24: U01-01 (Frequency Reference) = 60.00 Hz (6000 = 0x1770)
- 0x48: U01-09 (Torque Reference) = 100.0% (1000 = 0x03E8)

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)	Response Message (Fault)		Setting Data (Hex.)
0	Node Address		01	Node Address		01	Node Address		01
1	Function Code		67	Function Code		67	Function Code + 0x80		E7
2	Subfunction Code	Upper	01	Subfunction Code	Upper	01	Error Codes		02
3		Lower	0D		Lower	0D	CRC-16	Upper	EA
4	Data Qty	Upper	00	Number of Bytes	Upper	00		Lower	31
5		Lower	02		Lower	04	-		
6	Register 1	Upper	00	Register 1 Data	Upper	17	-		
7		Lower	24		Lower	70	-		
8	Register 2	Upper	00	Register 2 Data	Upper	03	-		
9		Lower	28		Lower	E8	-		
10	CRC-16	Upper	8B	CRC-16	Upper	47	-		
11		Lower	29		Lower	ED	-		

NOTE: *The number of bytes in the response message is the data quantity × 2, since there are two bytes of data per register.*

Write to Non-Conservative Registers (0x67)

Function code 67 (Hex.) is used with subfunction code 010E (Hex.) to write data to a maximum of 60 registers. You must give the register number to which to write separately. The table below shows example messages when writing the frequency reference and torque limit to the Node 1 VFD.

The following is used for register data:

- The Node 1 VFD is set for Forward run with a frequency reference of 60.00 Hz.
- 0x0002: Frequency Reference = 60.00 Hz (6000 = 0x1770)
- 0x0004: Torque Limit = 150.0% (1500 = 0x05DC)

Byte	Command Message		Setting Data (Hex.)	Response Message (Normal)		Setting Data (Hex.)	Response Message (Fault)		Setting Data (Hex.)
0	Node Address		01	Node Address		01	Node Address		01
1	Function Code		67	Function Code		67	Function Code + 0x80		E7
2	Subfunction Code	Upper	01	Subfunction Code	Upper	01	Error Codes		02
3		Lower	0E		Lower	0E	CRC-16	Upper	EA
4	Data Qty	Upper	00	Data Qty	Upper	00		Lower	31
5		Lower	02		Lower	02	-		
6	Number of Bytes	Upper	00	CRC-16	Upper	D5	-		
7		Lower	04		Lower	FC	-		
8	Register 1	Upper	00	-			-		
9		Lower	02	-			-		
10	Register 1 Data	Upper	17	-			-		
11		Lower	70	-			-		
12	Register 2	Upper	00	-			-		
13		Lower	04	-			-		
14	Register 2 Data	Upper	05	-			-		
15		Lower	DC	-			-		
16	CRC-16	Upper	55	-			-		
17		Lower	59	-			-		

NOTE: *The number of bytes in the command message is the data quantity × 2, since there are two bytes of data per register.*

Enter/Accept Command

When using Modbus communications to write parameters to the VFD, parameter H05-11 (Comm ACCEPT Command Mode) selects whether an Accept command is required for parameter changes to take effect. An Enter command is used to store the parameter changes to EEPROM, regardless of the H05-11 setting. This section contains information about how and when to use both commands.

There are two types of commands, shown in the table below.

Write 0 to register number 0900 to enable the Enter command. This saves the changes to EEPROM and automatically issues the Accept command. In other words, the Enter command immediately implements the changes on the VFD and saves them to non-volatile memory.

Write 0 to register number 0910 (Hex.) to enable the Accept command. This is only separately required when H05-11 = 0. When H05-11 = 0, a parameter write must be followed by an Accept command in order for the change to take effect on the VFD. When H05-11 = 1, the Accept command is automatically issued along with a parameter write. Regardless of the H05-11 setting, an Enter command is required to save the changes to non-volatile memory.

You can only write to these registers. If you read these registers, it will cause a Register Number Error (0x02). When command data or a broadcast message is written to the VFD, the Enter command is not necessary.

Register No. (Hex)	Description
0900	ENTER command. Writes the data to EEPROM and RAM at the same time. Required in order to save the parameter changes to non-volatile memory. If this step is skipped, the parameter changes will be lost when the VFD is powered off.
0910	ACCEPT command. Writes the data in RAM but does not write data to (non-volatile) EEPROM. Required when H05-11 = 1. An ENTER command is also required in order to save the changes to EEPROM.

NOTE: *EEPROM can be written a maximum of 100,000 times. Do not frequently execute the Enter command (0x0900) that is written to EEPROM.*

Error Check (CRC-16)

The error check function uses the CRC-16 method to detect transmission errors. Use the procedure in this section to calculate CRC-16.

Command Data

When the VFD receives data, it will make sure that there are no errors in the data. The procedure below is used to calculate the CRC-16, which the VFD will compare with the CRC-16 value in the message. If the CRC-16 values do not agree, the VFD will not execute a command message. The start value is FFFF (Hex.) and all 16 bits must be 1.

Use this procedure to calculate CRC-16:

1. The starting value is 0xFFFF.
2. Perform an XOR (exclusive OR) of 0xFFFF and the node address.
3. Move the result one column to the right. Do this shift until the overflow bit is 1.
4. When the overflow bit is 1, perform an XOR of the result from step 3 and 0xA001.
5. Repeat steps 3 and 4 until the 8th shift to the right.
6. After 8 shift operations, perform an XOR with the result and the next data in the message (function code, register address, data). Continue with steps 3 to 5 until the last data has been processed.
7. The result of the last right shift or XOR calculation is the CRC-16 checksum.

The table below shows an example CRC-16 calculation of the Node 1 VFD and function code 0x03. The calculated result of the CRC-16 is 0xD140.

Description	Calculation	Overflow	Description	Calculation	Overflow
Initial value (0xFFFF)	1111 1111 1111 1111		Function code 0x03	0000 0011	
Address 0x02	0000 0010		XOR with result	1000 0001 0011 1101	
XOR with initial value	1111 1111 1111 1101		Shift right #1	0100 0000 1001 1110	1
Shift right #1	0111 1111 1111 1110	1	XOR with 0xA001	1010 0000 0000 0001	
XOR with 0xA001	1010 0000 0000 0001		XOR result	1110 0000 1001 1111	
XOR result	1101 1111 1111 1111		Shift right #2	0111 0000 0100 1111	1
Shift right #2	0110 1111 1111 1111	1	XOR with 0xA001	1010 0000 0000 0001	
XOR with 0xA001	1010 0000 0000 0001		XOR result	1101 0000 0100 1110	
XOR result	1100 1111 1111 1110		Shift right #3	0110 1000 0010 0111	0
Shift right #3	0110 0111 1111 1111	0	Shift right #4	0011 0100 0001 0011	1
Shift right #4	0011 0011 1111 1111	1	XOR with 0xA001	1010 0000 0000 0001	
XOR with 0xA001	1010 0000 0000 0001		XOR result	1001 0100 0001 0010	
XOR result	1001 0011 11111 1110		Shift right #5	0100 1010 0000 1001	0
Shift right #5	0100 1001 1111 1111	0	Shift right #6	0010 0101 0000 0100	1
Shift right #6	0010 0100 1111 1111	1	XOR with 0xA001	1010 0000 0000 0001	
XOR with 0xA001	1010 0000 0000 0001		XOR result	1000 0101 0000 0101	
XOR result	1000 0100 1111 1110		Shift right #7	0100 0010 1000 0010	1
Shift right #7	0100 0010 0111 1111	0	XOR with 0xA001	1010 0000 0000 0001	
Shift right #8	0010 0001 0011 1111	1	XOR result	1110 0010 1000 0011	
XOR with 0xA001	1010 0000 0000 0001		Shift right #8	0111 0001 0100 0001	1
XOR result	1000 0001 0011 1110		XOR with A001	1010 0000 0000 0001	
Perform operations with next data (function code)			XOR result	1101 0001 0100 0000	
			CRC-16	1101 0001 0100 0000	
				D1 40 (Lower) (Upper)	
			Continue from here with next data.		

5.6.5.5 Modbus RTU—Registers

Command Data

The following registers are used to read and write command data. All “Not Used” registers and bits should be set to 0 and no data should be written to them. A minimum wait time of 5 ms is recommended between reads and writes.

Register (Hex.)	Description	
0000	Not Used	
0001	Run Command, MFDI Command	
	bit 0	1: Forward Run, 0: Stop
	bit 1	1: Reverse Run, 0: Stop
	bit 2	External Fault 1: EF0 (Option Card External Fault)
	bit 3	Fault Reset 1: Reset Command
	bit 4	Multi-Function Input 1 (ComRef) ***NOTE:*** *When the ComRef bit is switched ON, the frequency reference source changes to Modbus communications. When a communications option card is connected to the VFD, the frequency reference source gives it priority.*
	bit 5	Multi-Function Input 2 (ComCtrl) ***NOTE:*** *When the ComCtrl bit is switched ON, the run command source changes to Modbus communications. When a communications option card is connected to the VFD, the run command source gives it priority.*
	bit 6	Multi-Function Input 3
	bit 7	Multi-Function Input 4
	bit 8	Multi-Function Input 5
	bit 9	Multi-Function Input 6
	bit A	Multi-Function Input 7
	bit B	Multi-Function Input 8
	bit C-F	Not Used
0002	Frequency Reference	Unsigned (6000 = 60.00)
0003	Output Voltage Gain	Units: 0.1% Range: 20 (2.0%) to 2000 (200.0%), Default: 1000 (100.0%)
0004	Torque Reference/Torque Limit	0.1% signed (only used for torque control)
0005	Torque Compensation	0.1% signed (only used for torque control)
0006	Not Used	
0007	Analog Output (MFAO) 1	10 V/4000 Hex. Read only.
0008	Analog Output (MFAO) 2	10 V/4000 Hex. Read only.

Register (Hex.)	Description	
0009	MFDO Setting	
	bit 0	MFDO 1 (terminal M1-M2)
	bit 1	MFDO 2 (terminal M3-M4)
	bit 2	MFDO 3 (terminal M5-M6)
	bit 3-5	Not Used
	bit 6	1: bit 7 function is enabled
	bit 7	Fault Relay Output (terminal MA/MB-MC) 1: ON, 0: OFF
	bit 8-F	Not Used
000A	Pulse Train Output	Units: 1 Hz, Range: 0 to 32000
000B - 000E	Not Used	
000F	Command Selection	
	bit 0-1	Not Used
	bit 2	Torque Reference/Torque Limit Input 1: Enables the setting from Modbus
	bit 3	Torque Compensation Input 1: Enables the setting from Modbus
	bit 4-B	Not Used
	bit C	Terminal S5 Input of Broadcast Message
	bit D	Terminal S6 Input of Broadcast Message
	bit E	Terminal S7 Input of Broadcast Message
	bit F	Terminal S8 Input of Broadcast Message
0010 - 001A	Not Used	
001B	AO-A3 Analog Output 1	10 V/4000 Hex. Read only.
001C	AO-A3 Analog Output 2	10 V/4000 Hex. Read only.
001D	DO-A3 Digital Output	Binary
001E - 001F	Not Used	

Register (Hex.)	Description	
10A0	DI-A3/S4IO Digital Inputs	OR’ed with the physical option card input.
	bit 0	F03-02: Terminal D0 / I1
	bit 1	F03-03: Terminal D1 / I2
	bit 2	F03-04: Terminal D2 / I3
	bit 3	F03-05: Terminal D3 / I4
	bit 4	F03-06: Terminal D4
	bit 5	F03-07: Terminal D5
	bit 6	F03-08: Terminal D6
	bit 7	F03-09: Terminal D7
	bit 8	F03-10: Terminal D8
	bit 9	F03-11: Terminal D9
	bit A	F03-12: Terminal DA
	bit B	F03-13: Terminal DB
	bit C	F03-14: Terminal DC
	bit D	F03-15: Terminal DD
	bit E	F03-16: Terminal DE
	bit F	F03-17: Terminal DF
15C0	bit 0-F	Modbus Register 0x15C0 bit 0 to F Input Function When not setting a function to H01-40 to H01-55, set it to F (Not Used)
15C1	MFAI 1 (H03-40)	Range: -4095 to 4096
15C2	MFAI 2 (H03-41)	Range: -4095 to 4096
15C3	MFAI 3 (H03-42)	Range: -4095 to 4096
15E0	bit 0-7	Modbus Register 0x15E0 bit 0 to 7 Output Function (Read Only) When not setting a function to H02-40 to H02-47, set it to F (Not Used)
15DF	bit 0	Not Used
	bit 1	Baseblock Command 1: Enables baseblock command This is the same as H01-xx = 32 (Baseblock Command N.O.). This command is OR’ed with the MFDI terminals.
	bit 2	Baseblock Command (without message) 1: Enables baseblock command (No bb (Baseblock) alarm displayed) This is the same as H01-xx = 32 (Baseblock Command N.O.). This command is OR’ed with the MFDI terminals.
	bit 3	Coast to Stop Command 1: Enables Coast to Stop command The VFD output turns off and the motor coasts to stop at the bit 3 leading edge. To restart the VFD, set bit 3 to 0 and enter the Run command again.

Register (Hex.)	Description	
15DF	bit 4	Decel to Stop Command 1: Enables Decel to Stop command The VFD output turns off and the motor decels to stop at the bit 4 leading edge. To restart the VFD, set bit 4 to 0 and enter the Run command again.
	bit 5	Fast Stop Command 1: Enables Fast Stop command This is the same as H01-xx = 40 (Fast Stop N.O.). This command is OR'ed with the MFDI terminals.
	bit 6	Soft Start Input Reset 1: Enables Soft Start Input Reset When bit 6 is 1, the soft starter output will be 0. The VFD decelerates the motor in the selected deceleration time. When bit 6 is 0, the motor accelerates to the previous frequency reference.
	bit 7	Soft Start Output Reset 1: Enables Soft Start Output Reset When bit 7 is 1, the soft starter output will be 0. In Closed Loop Vector mode, the VFD decelerates the motor as specified by the torque limit. In V/f and Open Loop Vector modes, the VFD shuts off the output and the motor coasts. When bit 6 is 0, the motor accelerates to the previous frequency reference.
	bit 8	Accel/Decel Ramp Hold Command 1: Enables Accel/Decel Ramp Hold command This is the same as H01-xx = 38 (Accel/Decel Ramp Hold). This command is OR'ed with the MFDI terminals.
	bit 9	Jog Command 1: Enables Jog command This is the same as H01-xx = 3A (Jog Reference Selection). This command is OR'ed with the MFDI terminals.
	bit A	Forward Jog 1: Enables Forward Jog command This is the same as H01-xx = 15 (Forward Jog). This command is OR'ed with the MFDI terminals.
	bit B	Reverse Jog 1: Enables Reverse Jog command This is the same as H01-xx = 16 (Reverse Jog). This command is OR'ed with the MFDI terminals.
	bit C-F	Not Used
3004	Time Setting Range: 0000 to 2359 (decimal) Default: 0000 Set the hour/minute as HHMM. HH: 00 to 23 (decimal) MM: 00 to 59 (decimal)	Write only. Will not read the date/time from the keypad.

Register (Hex.)	Description	
3005	Year and Day Setting Range: 1600 to 9906 (decimal) Default: 1600 Set the year/day as YYDD. YY: 16 to 99 (decimal) DD: 00 to 06 (decimal) Sunday: 00 Monday: 01 Tuesday: 02 Wednesday: 03 Thursday: 04 Friday: 05 Saturday: 06	Write only. Will not read the date/time from the keypad.
3006	Date Setting Range: 0101 to 1231 (decimal) Default: 0101 Set the month/day as MMDD. MM: 01 to 12 (decimal) DD: 01 to 31 (decimal)	Write only. Will not read the date/time from the keypad.
3007	Set the Date Information Range: 0 to 8 (decimal) Default: 8 Sets 0x3004 to 0x3006 as date/time. Command Data: 1 Response Data: 0 (normal), 8 (fault)	

Monitor Data

The following registers are used to read monitor data. These registers are read-only. A minimum wait time of 5 ms is recommended between reads.

Register (Hex.)	Description	
0020	Drive Status 1	
	bit 0	During Run 1: During Run, 0: During Stop
	bit 1	During Reverse 1: During Reverse, 0: During Forward
	bit 2	Drive Ready 1: Ready, 0: Not Ready
	bit 3	Fault 1: Fault
	bit 4	Data Setting Error 1: oPExx Error
	bit 5	MFDO 1 (Terminal M1-M2) 1: ON, 0:OFF
	bit 6	MFDO 2 (Terminal M3-M4) 1: ON, 0:OFF
	bit 7	MFDO 3 (Terminal M5-M6) 1: ON, 0:OFF
	bit 8-B	Not Used
	bit C	SToF (Safe Torque Off Hardware) 1: Safe Disable input 1 (Terminal H1-HC) or Safe Disable input 2 (Terminal H2-HC) is OFF (open) and the other is ON (closed).
	bit D	STo (Safe Torque Off) 1: Both Safe Disable input 1 (Terminal H1-HC) and Safe Disable input 2 (Terminal H2-HC) are OFF (open).
	bit E	ComRef Status 1: Enabled
	bit F	ComCtrl Status 1: Enabled

Register (Hex.)	Description	
0021	Fault Description 1	
	bit 0	oC (Over Current), GF (Ground Fault)
	bit 1	ov (Overvoltage)
	bit 2	oL2 (Drive Overload)
	bit 3	oH1 (Heatsink Overheat)
	bit 4	rH (Braking Resistor Overheat), rr (Dynamic Braking Transistor Fault)
	bit 5-6	Not Used
	bit 7	EF0 (Option Card External Fault), EF1 to EF8 (External Fault)
	bit 8	CPFxx (Hardware Fault) and oFx (Option Card Faults)
	bit 9	oL1 (Motor Overload), oT1/oT2 (Overtorque 1 / 2), UT1/UT2 (Undertorque 1 / 2)
	bit A	PGo-xS / PGo-xH (Encoder Loss), oS (Overspeed), dEv (Speed Deviation)
	bit B	uV (Undervoltage)
	bit C	Uv1, Uv2, Uv3 (DC Bus / Control Power / Soft Charge Undervoltage)
	bit D	LF (Output Phase Loss), PF (Input Phase Loss)
	bit E	CE (Modbus Communication Error), bUS (Option Communication Error)
	bit F	oPr (Keypad Connection Fault)
0022	Fault Contents	
	bit 0	1: During data writing, during motor switching
	bit 1-2	Not Used
	bit 3	1: Upper/Lower Limit Fault
	bit 4	1: Data Integrity Fault
	bit 5	1: During EEPROM Fault
	bit 6	0: During EEPROM Writing 1: Change data only in RAM (Enabled when H05-17 = 1)
	bit 7-F	Not Used
0023	U01-01 (Frequency Reference)	Units: 0.01 Hz
0024	U01-02 (Output Frequency)	Units: 0.01 Hz
0025	U01-06 (Output Voltage Reference)	Use H05-10 to set the units
0026	U01-03 (Output Current)	Units: 0.1 A
0027	U01-08 (Output Power)	Units: 0.1 HP/kW
0028	U01-09 (Torque Reference)	Units: 0.1%

Register (Hex.)	Description	
0029	Fault Description 2	
	bit 0	Not Used
	bit 1	GF (Ground Fault)
	bit 2	PF (Input Phase Loss)
	bit 3	LF (Output Phase Loss)
	bit 4	rH (Braking Resistor Overheat)
	bit 5	Not Used
	bit 6	oH4 (Motor Overheat Fault - PTC Input)
	bit 7-F	Not Used
002A	Alarm Description 1	
	bit 0-1	Not Used
	bit 2	EF (FWD/REV Run Command Input Error)
	bit 3	bb (Baseblock)
	bit 4	oT1 (Overtorque 1)
	bit 5	oH (Heatsink Overheat)
	bit 6	ov (Overvoltage)
	bit 7	Uv (Undervoltage)
	bit 8	Fan (Internal Fan Fault)
	bit 9	CE (Modbus Communication Error)
	bit A	bUS (Option Communication Error)
	bit B	UT1 / UT2 (Undertorque 1 / 2)
	bit C	oH3 (Motor Overheat - PTC Input)
	bit D-E	Not Used
	bit F	CALL (Serial Comm Transmission Error)
002B	U01-10 (Input Terminal Status)	
	bit 0	1: Terminal S1 is ON
	bit 1	1: Terminal S2 is ON
	bit 2	1: Terminal S3 is ON
	bit 3	1: Terminal S4 is ON
	bit 4	1: Terminal S5 is ON
	bit 5	1: Terminal S6 is ON
	bit 6	1: Terminal S7 is ON
	bit 7	1: Terminal S8 is ON
	bit 8-F	Not Used

Register (Hex.)	Description	
002C	Drive Status 2	
	bit 0	1: During Run
	bit 1	1: During Zero Speed
	bit 2	1: During Speed Agree
	bit 3	1: During User-Defined Speed Agree
	bit 4	Frequency Detection 1 1: Output Frequency ≤ L04-01
	bit 5	Frequency Detection 2 1: Output Frequency ≥ L04-01
	bit 6	1: Drive Ready
	bit 7	1: During Undervoltage
	bit 8	1: During Baseblock
	bit 9	Frequency Reference Source 1: No Communication Option, 0: Communication Option
	bit A	Run Command Source 1: No Communication Option, 0: Communication Option
	bit B	1: During Overtorque/Undertorque 1 / 2 Detection
	bit C	1: Frequency Reference Loss
	bit D	1: During Fault Reset
	bit E	1: Fault Contact Output (MA/MB-MC)
	bit F	1: Modbus Communications Timeout
002D	U01-11 (Output Terminal Status)	
	bit 0	MFDO 1 (Terminal M1-M2) 1: ON, 0: OFF
	bit 1	MFDO 2 (Terminal M3-M4) 1: ON, 0: OFF
	bit 2	MFDO 3 (Terminal M5-M6) 1: ON, 0: OFF
	bit 3-6	Not Used
	bit 7	Fault Relay (Terminal MA/MB-MC) 1: ON, 0: OFF
	bit 8-F	Not Used
002E - 0030	Not Used	
0031	U01-07 (DC Bus Voltage)	Units: 1 V
0032	U01-09 (Torque Reference)	Units: 1%
0033	Not Used	
0034	Product Code 1	IMPULSE·G+/VG+ Series 5 = 0A ASCII (0x30 0x41)
0035	Product Code 2	IMPULSE·G+/VG+ Series 5 = 80 ASCII (0x38 0x30)
0036 - 003C	Not Used	

Register (Hex.)	Description	
003D	Communications Error Description	
	bit 0	CRC Error
	bit 1	Data Length Error
	bit 2	Not Used
	bit 3	Parity Error
	bit 4	Overrun Error
	bit 5	Framing Error
	bit 6	Timeout
	bit 7-F	Not Used
003E	Not Used	
003F	Output Frequency	Units: 0.01%
0040 - 004A	U01-01 to U01-11 (Monitors)	See Appendix A for Modbus address of associated Monitor.
004B	U01-12 (Drive Status)	
	bit 0	1: During Run
	bit 1	1: During Zero Speed
	bit 2	1: During Reverse
	bit 3	1: During Fault Reset
	bit 4	1: During Speed Agree
	bit 5	1: Drive Ready
	bit 6	1: Alarm
	bit 7	1: Fault
	bit 8	1: oPExx (Operation Error)
	bit 9	1: During Momentary Power Loss, 0: Power Recovery
	bit A	1: Motor 2 Selection
	bit B-D	Not Used
	bit E	ComRef Status / NetRef Status
	bit F	ComCtrl Status / NetCtrl Status
004C - 007E	U01-xx, U04-xx, U06-xx (Monitors)	See Appendix A for Modbus address of associated Monitor. U01-03 & U04-13: Output Current = Read Value / 8192 * VFD Rated Current
007F	Alarm Code	See Modbus RTU—Alarm Codes section for associated Alarm codes.
0080 - 0097	U02-xx, U03-xx (Monitors)	See Appendix A for Modbus address of associated Monitor. U02-05: Output Current = Read Value / 8192 * VFD Rated Current
0098 - 0099	U04-01 (Cumulative Oper Time)	Example: When U04-01 = 12345, 0x0098 = 1234 and 0x0099 = 5
009A - 009B	U04-03 (Cooling Fan Oper Time)	Example: When U04-03 = 12345, 0x009A = 1234 and 0x009B = 5
009C - 00AA	Not Used	
00AB	Drive Rated Current	Units: 2003 to 2033, 4001 to 4018, 5001 to 5012: 0.01 A 2047 to 2415, 4024 to 41090, 5017 to 5412: 0.1 A

Register (Hex.)	Description	
00AC	Not Used	
00AD	U01-05 (Motor Speed)	Units: 0.01%
00AE - 00AF	Not Used	
00B0	Option Card Connected to CN5-A	DI-A3 = 0x0001 DO-A3 = 0x0002 AO-A3 = 0x0004 PG-B3 = 0x0011 PG-X3 = 0x0012 S4IO = 0x0030 SI-EM3 = 0x1005 SI-EN3 = 0x1006 SI-EP3 = 0x1007 SI-P3 = 0x5350
00B1	Not Used	
00B2	Option Card Connected to CN5-B	Same Contents as 00B0
00B3	Option Card Connected to CN5-C	Same Contents as 00B0
00B4	Not Used	
00B5	Not Used	
00B6	U01-20 (SFS Output Frequency)	Units: 0.01%
00B7	Not Used	
00B8	Frequency Reference Monitor	Units: 0.01%
00B9 - 00BE	Not Used	
00BF	Operation Error Number	xx of oPExx is displayed.
00FB	Output Current	Units: 2003 to 2033, 4001 to 4018, 5001 to 5012: 0.01 A 2047 to 2415, 4024 to 4605, 5017 to 5412: 0.1 A 4720 to 41090: 1 A

U0x-xx Monitor Decimal Point Placement

The U0x-xx Monitors can be individually read over Modbus. See Appendix A for the Modbus register of each Monitor. The table below lists the Monitors that have specific decimal point placement.

Monitor	Description	Decimal Point Placement
U01-01	Frequency Reference	0.01 Hz
U01-02	Output Frequency	0.01 Hz
U01-03	Output Current	0.01 A: 2003 to 2033, 4001 to 4018, 5001 to 5012 models 0.1 A: 2047 to 2415, 4024 to 4605, 5017 to 5412 models 1 A: 4720 to 41090 models ***NOTE:*** *Reading this monitor requires a conversion to Amps.* Output Current = Read Value / 8192 * VFD Rated Current VFD Rated Current can be read from register 0x00AB. Alternate: 0x0026 (Output Current) does not require scaling.
U01-05	Motor Speed	0.01 Hz
U01-06	Output Voltage Reference	0.1 V
U01-07	DC Bus Voltage	1 V
U01-08	Output Power	0.01 HP/kW: 2003 to 2033, 4001 to 4018, 5001 to 5012 models 0.1 HP/kW: 2047 to 2415, 4024 to 41090, 5017 to 5412 models
U01-09	Torque Reference	0.1%
U01-15	Terminal A1 Level	0.1%
U01-16	Terminal A2 Level	0.1%
U01-17	Terminal A3 Level	0.1%
U01-20	SFS Output Frequency	0.01 Hz
U01-30	SS Delta Speed	1 RPM
U01-48	SCS - Revs to Stop	1 Rev
U01-49	Swing Length	1 Ft
U01-50	Hook Height	0.1%
U01-51	Motor Revolution	1 Rev
U01-53	Index Count	1 Rev
U01-54	Input Pulse Monitor	1 Hz
U01-60	Encoder 1 Pulse Counter	1 Pulse
U01-61	Encoder 2 Pulse Counter	1 Pulse
U01-62	Encoder 1 Frequency	0.01 kHz
U01-63	Encoder 2 Frequency	0.01 kHz
U01-69	LC Margin	0.1%
U01-86	Brake Test Torque	0.1 FtLb
U01-91	Output Voltage	0.1 V
U02-03	Frequency Reference @ Fault	0.01 Hz
U02-04	Output Frequency @ Fault	0.01 Hz

Monitor	Description	Decimal Point Placement
U02-05	Output Current @ Fault	0.01 A: 2003 to 2033, 4001 to 4018, 5001 to 5012 models 0.1 A: 2047 to 2415, 4024 to 4605, 5017 to 5412 models 1 A: 4720 to 41090 models ***NOTE:*** *Reading this monitor requires a conversion to Amps.* Output Current = Read Value / 8192 * VFD Rated Current VFD Rated Current can be read from register 0x00AB.
U02-06	Motor Speed @ Fault	0.01 Hz
U02-07	Output Voltage @ Fault	0.1 V
U02-08	DC Bus Voltage @ Fault	1 V
U02-09	Output Power @ Fault	0.1 HP/kW
U02-10	Torque Reference @ Fault	0.1%
U02-14	Elapsed Time @ Fault	1 Hr
U02-15	SFS Output @ Fault	0.01 Hz
U02-16	q-Axis Current @ Fault	0.1%
U02-17	d-Axis Current @ Fault	0.1%
U02-20	Heatsink Temperature @ Fault	1°C
U03-11 - U03-20	Elapsed Time @ X Fault	1 Hr
U04-01	Cumulative Operation Time	1 Hr
U04-03	Cooling Fan Operation Time	1 Hr
U04-04	Cooling Fan Maintenance	1%
U04-05	Capacitor Maintenance	1%
U04-06	Precharge Relay Maintenance	1%
U04-07	IGBT Maintenance	1%
U04-08	Heatsink Temperature	1°C
U04-10	kWh, Lower 4 Digits	1 kWh
U04-11	kWh, Upper 5 Digits	1 kWh
U04-13	Peak Hold Current	0.01 A: 2003 to 2033, 4001 to 4018, 5001 to 5012 models 0.1 A: 2047 to 2415, 4024 to 4605, 5017 to 5412 models 1 A: 4720 to 41090 models ***NOTE:*** *Reading this monitor requires a conversion to Amps.* Output Current = Read Value / 8192 * VFD Rated Current VFD Rated Current can be read from register 0x00AB.
U04-14	Peak Hold Output Frequency	0.01 Hz
U04-16	Motor oL1 Level	0.1%
U04-17	Drive oL2 Level	0.1%
U04-19	Modbus Frequency Reference	0.1%
U04-20	Option Frequency Reference	0.1%
U04-27	Run Time Elapsed	1 Hr

Monitor	Description	Decimal Point Placement
U04-28	Run Time Remaining	1 Hr
U04-29	On Time Elapsed	1 Hr
U04-30	On Time Remaining	1 Hr
U04-31	Brake Cycle Counts	1 Cycle
U04-33	Brake Cycles Remaining	1 Cycle
U04-52	Torque Reference from Comm	0.1%
U06-01	Iq Secondary Current	0.1%
U06-02	Id Excitation Current	0.1%
U06-03	ASR Input	0.01%
U06-04	ASR Output	0.01%
U06-05	Output Voltage Reference (Vq)	0.1 V
U06-06	Output Voltage Reference (Vd)	0.1 V
U06-07	q-Axis ACR Output	0.1%
U06-08	d-Axis ACR Output	0.1%
U06-31	Torque Detect Monitor	0.1%

5.6.5.6 Modbus RTU—Fault Codes

There following registers can be read to determine an active Fault. Alternatively, the Fault Monitors U02-01 (Current Fault), U02-01 (Previous Fault), and U03-01 to U03-10 (Fault Log) can be read and will contain the associated Fault code. See Appendix A for a complete list of Modbus addresses for Parameter and Monitors.

Code		Modbus			Fault	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
0	0x0000					
1	0x0001	0x00C0	bit 0	0x01	- -	- -
2	0x0002		bit 1	0x02	Uv1	DC Bus Undervoltage
3	0x0003		bit 2	0x04	Uv2	Control Power Undervoltage
4	0x0004		bit 3	0x08	Uv3	Soft Charge Answerback Fault
5	0x0005		bit 4	0x10	SC	Short Circuit/IGBT Failure
6	0x0006		bit 5	0x20	GF	Ground Fault
7	0x0007		bit 6	0x40	oC	Over Current
8	0x0008		bit 7	0x80	ov	Overvoltage
9	0x0009		bit 8	0x01	oH	Heatsink Overheat
10	0x000A		bit 9	0x02	oH1	Heatsink Overheat
11	0x000B		bit A	0x04	oL1	Motor Overload
12	0x000C		bit B	0x08	oL2	Drive Overload
13	0x000D		bit C	0x10	oT1	Overtorque Detection 1
14	0x000E		bit D	0x20	oT2	Overtorque Detection 2
15	0x000F		bit E	0x40	rr	Dynamic Braking Transistor Fault
16	0x0010		bit F	0x80	rH	Braking Resistor Overheat
17	0x0011	0x00C1	bit 0	0x01	EF3	External Fault (Terminal S3)
18	0x0012		bit 1	0x02	EF4	External Fault (Terminal S4)
19	0x0013		bit 2	0x04	EF5	External Fault (Terminal S5)
20	0x0014		bit 3	0x08	EF6	External Fault (Terminal S6)
21	0x0015		bit 4	0x10	EF7	External Fault (Terminal S7)
22	0x0016		bit 5	0x20	EF8	External Fault (Terminal S8)
23	0x0017		bit 6	0x40	FAn	Internal Fan Fault
24	0x0018		bit 7	0x80	oS	Overspeed
25	0x0019		bit 8	0x01	dEv	Speed Deviation
26	0x001A		bit 9	0x02	PGo-1S	Encoder (PG) Feedback Loss
27	0x001B		bit A	0x04	PF	Input Phase Loss
28	0x001C		bit B	0x08	LF	Output Phase Loss
29	0x001D		bit C	0x10	oH3	Motor Overheat (PTC Input)
30	0x001E		bit D	0x20	oPr	Keypad Connection Fault
31	0x001F		bit E	0x40	Err	EEPROM Write Error
32	0x0020		bit F	0x80	oH4	Motor Overheat Fault (PTC Input)

Code		Modbus			Fault	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
33	0x0021	0x00C2	bit 0	0x01	CE	Modbus Communication Error
34	0x0022		bit 1	0x02	bUS	Option Communication Error
35	0x0023		bit 2	0x04	- -	- -
36	0x0024		bit 3	0x08	- -	- -
37	0x0025		bit 4	0x10	- -	- -
38	0x0026		bit 5	0x20	- -	- -
39	0x0027		bit 6	0x40	EF0	Option Card External Fault
40	0x0028		bit 7	0x80	- -	- -
41	0x0029		bit 8	0x01	UT1	Undertorque Detection 1
42	0x002A		bit 9	0x02	UT2	Undertorque Detection 2
43	0x002B		bit A	0x04	- -	- -
44	0x002C		bit B	0x08	- -	- -
45	0x002D		bit C	0x10	- -	- -
46	0x002E		bit D	0x20	- -	- -
47	0x002F		bit E	0x40	- -	- -
48	0x0030		bit F	0x80	- -	- -
49	0x0031	0x00C3	bit 0	0x01	- -	- -
50	0x0032		bit 1	0x02	- -	- -
51	0x0033		bit 2	0x04	- -	- -
52	0x0034		bit 3	0x08	- -	- -
53	0x0035		bit 4	0x10	- -	- -
54	0x0036		bit 5	0x20	LF2	Output Current Imbalance
55	0x0037		bit 6	0x40	- -	- -
56	0x0038		bit 7	0x80	PGo-1H	Encoder (PG) Hardware Fault
57	0x0039		bit 8	0x01	- -	- -
58	0x003A		bit 9	0x02	- -	- -
59	0x003B		bit A	0x04	- -	- -
60	0x003C		bit B	0x08	PGo-2H	PGo Hardware Ch2
61	0x003D		bit C	0x10	PGo-2S	PGo Software Ch2
62	0x003E		bit D	0x20	- -	- -
63	0x003F		bit E	0x40	- -	- -
64	0x0040		bit F	0x80	- -	- -

Code		Modbus			Fault	
Dec	Hex	Register	bit	bitmask	Code	Text
65	0x0041	0x00C4	bit 0	0x01	- -	- -
66	0x0042		bit 1	0x02	EF1	External Fault (Terminal S1)
67	0x0043		bit 2	0x04	EF2	External Fault (Terminal S2)
68	0x0044		bit 3	0x08	- -	- -
69	0x0045		bit 4	0x10	- -	- -
70	0x0046		bit 5	0x20	CoF	Current Offset Fault
71	0x0047		bit 6	0x40	- -	- -
72	0x0048		bit 7	0x80	- -	- -
73	0x0049		bit 8	0x01	BE9	Brake Force ON At PowerUp
74	0x004A		bit 9	0x02	- -	- -
75	0x004B		bit A	0x04	- -	- -
76	0x004C		bit B	0x08	CantSW	Can’t Switch, Motor Running
77	0x004D		bit C	0x10	voF	Output Voltage Detection Fault
78	0x004E		bit D	0x20	rF	Braking Resistor Fault
79	0x004F		bit E	0x40	boL	BrakingTransistor Overload Fault
80	0x0050		bit F	0x80	- -	- -
81	0x0051	0x00C5	bit 0	0x01	- -	- -
82	0x0052		bit 1	0x02	- -	- -
83	0x0053		bit 2	0x04	- -	- -
84	0x0054		bit 3	0x08	- -	- -
85	0x0055		bit 4	0x10	DIR	Hoist Direction Fault
86	0x0056		bit 5	0x20	OW	Overweight - Hoist/Crane
87	0x0057		bit 6	0x40	AS1	Anti-Shock
88	0x0058		bit 7	0x80	E-LIFT	E-Lift Timeout
89	0x0059		bit 8	0x01	SNAP	Snapped Shaft
90	0x005A		bit 9	0x02	LC	Load Check
91	0x005B		bit A	0x04	- -	- -
92	0x005C		bit B	0x08	- -	- -
93	0x005D		bit C	0x10	- -	- -
94	0x005E		bit D	0x20	TSTEND	Test Mode Timer Expired
95	0x005F		bit E	0x40	BE3	Brake Release NG
96	0x0060		bit F	0x80	BE7	Brake Welded

Code		Modbus			Fault	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
97	0x0061	0x00C6	bit 0	0x01	BE4	Brake Ans At Start
98	0x0062		bit 1	0x02	BE0-2	Brake Ans Lost - 2
99	0x0063		bit 2	0x04	BE4-2	Brake Ans At Start - 2
100	0x0064		bit 3	0x08	BE5-2	Brake Ans At Stop - 2
101	0x0065		bit 4	0x10	BE6-2	Brake Slipping - 2
102	0x0066		bit 5	0x20	BE7-2	Brake Welded - 2
103	0x0067		bit 6	0x40	BE1	Rollback Detect
104	0x0068		bit 7	0x80	BE2	No Current
105	0x0069		bit 8	0x01	- -	- -
106	0x006A		bit 9	0x02	BE0	Brake Answerback Lost
107	0x006B		bit A	0x04	SCS	Swing Length Too Long
108	0x006C		bit B	0x08	Fnr	Follower Not Ready
109	0x006D		bit C	0x10	BE6	Brake Slipping
110	0x006E		bit D	0x20	BE8	Brake Slipping
111	0x006F		bit E	0x40	BE5	Brake Ans At Stop
112	0x0070		bit F	0x80	PLSDEV	Pulse Deviation Fault
113	0x0071	0x00C7	bit 0	0x01	UL3	Upper Limit 3
114	0x0072		bit 1	0x02	LL3	Lower Limit 3
115	0x0073		bit 2	0x04	FSd	Follower Speed Dev
116	0x0074		bit 3	0x08	ATL	Auto-Tune Travel Limit
117	0x0075		bit 4	0x10	roC-1	Analog Rate of Change - 1
118	0x0076		bit 5	0x20	AFbL-1	Analog Feedback Lost - 1
119	0x0077		bit 6	0x40	- -	- -
120	0x0078		bit 7	0x80	BRKTEST	Brake Slipped During Test
121	0x0079		bit 8	0x01	SYNC	Follower Out Of Sync
122	0x007A		bit 9	0x02	- -	- -
123	0x007B		bit A	0x04	roC-2	Analog Rate of Change - 2
124	0x007C		bit B	0x08	AFbL-2	Analog Feedback Lost - 2
125	0x007D		bit C	0x10	AFbL-3	Analog Feedback Lost - 3
126	0x007E		bit D	0x20	- -	- -
127	0x007F		bit E	0x40	- -	- -
128	0x0080		bit F	0x80	- -	- -

Code		Modbus			Fault	
Dec	Hex	Register	bit	bitmask	Code	Text
129	0x0081	0x00D0	bit 0	0x01	CPF00	Control Circuit Error
130	0x0082		bit 1	0x02	CPF01	Control Circuit Error
131	0x0083		bit 2	0x04	CPF02	A/D Conversion Error
132	0x0084		bit 3	0x08	CPF03	Control Board Connection Error
133	0x0085		bit 4	0x10	- -	- -
134	0x0086		bit 5	0x20	- -	- -
135	0x0087		bit 6	0x40	CPF06	EEPROM Memory Data Error
136	0x0088		bit 7	0x80	CPF07	Terminal Board Connection Error
137	0x0089		bit 8	0x01	CPF08	Terminal Board Connection Error
138	0x008A		bit 9	0x02	CPF09	EEPROM Error
139	0x008B		bit A	0x04	CPF10	ASIC Verify Error
140	0x008C		bit B	0x08	CPF11	RAM Fault
141	0x008D		bit C	0x10	CPF12	FLASH Memory Fault
142	0x008E		bit D	0x20	CPF13	Watchdog Circuit Exception
143	0x008F		bit E	0x40	CPF14	Control Circuit Fault
144	0x0090		bit F	0x80	- -	- -
145	0x0091	0x00D1	bit 0	0x01	CPF16	Clock Fault
146	0x0092		bit 1	0x02	CPF17	Timing Fault
147	0x0093		bit 2	0x04	CPF18	Control Circuit Fault
148	0x0094		bit 3	0x08	CPF19	Control Circuit Fault
149	0x0095		bit 4	0x10	CPF20	Control Circuit Error
150	0x0096		bit 5	0x20	CPF21	Control Circuit Error
151	0x0097		bit 6	0x40	CPF22	Hybrid IC Error
152	0x0098		bit 7	0x80	CPF23	Control Board Connection Error
153	0x0099		bit 8	0x01	CPF24	Drive Unit Signal Fault
154	0x009A		bit 9	0x02	- -	- -
155	0x009B		bit A	0x04	CPF26	BB Circuit Error
156	0x009C		bit B	0x08	CPF27	PWM Set Reg Error
157	0x009D		bit C	0x10	CPF28	PWM Pattern Error
158	0x009E		bit D	0x20	CPF29	On-Delay Error
159	0x009F		bit E	0x40	CPF30	BB On Error
160	0x00A0		bit F	0x80	CPF31	ASIC Code Error

Code		Modbus			Fault	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
161	0x00A1	0x00D2	bit 0	0x01	CPF32	ASIC Startup Error
162	0x00A2		bit 1	0x02	CPF33	Watch-dog Error
163	0x00A3		bit 2	0x04	CPF34	Power/Clock Eror
164	0x00A4		bit 3	0x08	CPF35	Ext A/D Conv Error
165	0x00A5		bit 4	0x10	CPF36	ASIC COM Error
166	0x00A6		bit 5	0x20	CPF37	ASIC COM Error
167	0x00A7		bit 6	0x40	CPF38	EEPROM Data Error
168	0x00A8		bit 7	0x80	CPF39	CPU-ASIC Communication Error
169	0x00A9		bit 8	0x01	- -	- -
170	0x00AA		bit 9	0x02	- -	- -
171	0x00AB		bit A	0x04	- -	- -
172	0x00AC		bit B	0x08	- -	- -
173	0x00AD		bit C	0x10	- -	- -
174	0x00AE		bit D	0x20	- -	- -
175	0x00AF		bit E	0x40	- -	- -
176	0x00B0		bit F	0x80	- -	- -
257	0x0101	oFA: 0x00D8 oFB: 0x00DC oFC: 0x00E1	bit 0	0x01	oFx00	Option Not Compatible with Port
258	0x0102		bit 1	0x02	oFx01	Option Fault/Connection Error
259	0x0103		bit 2	0x04	oFx02	Duplicate Options
260	0x0104		bit 3	0x08	oFx03	Diagnostic Error
261	0x0105		bit 4	0x10	oFx04	Flash Write Mode
262	0x0106		bit 5	0x20	oFx05	Option A/D Error
263	0x0107		bit 6	0x40	oFx06	Option Communication Error
264	0x0108		bit 7	0x80	- -	- -
265	0x0109		bit 8	0x01	- -	- -
266	0x010A		bit 9	0x02	- -	- -
267	0x010B		bit A	0x04	- -	- -
268	0x010C		bit B	0x08	- -	- -
269	0x010D		bit C	0x10	- -	- -
270	0x010E		bit D	0x20	- -	- -
271	0x010F		bit E	0x40	- -	- -
272	0x0110		bit F	0x80	- -	- -

Code		Modbus			Fault	
Dec	Hex	Register	bit	bitmask	Code	Text
273	0x0111	oFA: 0x00D9 oFB: 0x00DD oFC: 0x00E2	bit 0	0x01	oFx10	Option RAM Error
274	0x0112		bit 1	0x02	oFx11	Option Ope Mode Error
275	0x0113		bit 2	0x04	oFx12	Drive Receive CRC Error
276	0x0114		bit 3	0x08	oFx13	Drive Receive Frame Error
277	0x0115		bit 4	0x10	oFx14	Drive Receive Abort Error
278	0x0116		bit 5	0x20	oFx15	Option Receive CRC Error
279	0x0117		bit 6	0x40	oFx16	Option Receive Frame Error
280	0x0118		bit 7	0x80	oFx17	Option Receive Abort Error
281	0x0119		bit 8	0x01	- -	- -
282	0x011A		bit 9	0x02	- -	- -
283	0x011B		bit A	0x04	- -	- -
284	0x011C		bit B	0x08	- -	- -
285	0x011D		bit C	0x10	- -	- -
286	0x011E		bit D	0x20	- -	- -
287	0x011F		bit E	0x40	- -	- -
288	0x0120		bit F	0x80	- -	- -
305	0x0131	oFA: 0x00DB oFB: 0x00E0	bit 0	0x01	oFx30	COM ID Error
306	0x0132		bit 1	0x02	oFx31	Type Code Error
307	0x0133		bit 2	0x04	oFx32	SUM Check Error
308	0x0134		bit 3	0x08	oFx33	Option Receive Time Over
309	0x0135		bit 4	0x10	oFx34	Memobus Time Over
310	0x0136		bit 5	0x20	oFx35	Drive Receive Time Over 1
311	0x0137		bit 6	0x40	oFx36	CI Check Error
312	0x0138		bit 7	0x80	oFx37	Drive Receive Time Over 2
313	0x0139		bit 8	0x01	oFx38	Control Reference Error
314	0x013A		bit 9	0x02	oFx39	Drive Receive Time Over 3
315	0x013B		bit A	0x04	oFx40	Control Response Selection 1
316	0x013C		bit B	0x08	oFx41	Drive Receive Time Over 4
317	0x013D		bit C	0x10	oFx42	Control Response Selection 2
318	0x013E		bit D	0x20	oFx43	Drive Receive Time Over 5
319	0x013F		bit E	0x40	- -	- -
320	0x0140		bit F	0x80	- -	- -

Code		Modbus			Fault	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
337	0x0151	oFC: 0x00E4	bit 0	0x01	oFx50	Encoder Option A/D Conv Error
338	0x0152		bit 1	0x02	oFx51	Encoder Option Analog Circuit Error
339	0x0153		bit 2	0x04	oFx52	Encoder Option Comm Timeout
340	0x0154		bit 3	0x08	oFx53	Encoder Option Comm Data Fault
341	0x0155		bit 4	0x10	oFx54	Encoder Error
342	0x0156		bit 5	0x20	- -	- -
343	0x0157		bit 6	0x40	- -	- -
344	0x0158		bit 7	0x80	- -	- -
345	0x0159		bit 8	0x01	- -	- -
346	0x015A		bit 9	0x02	- -	- -
347	0x015B		bit A	0x04	- -	- -
348	0x015C		bit B	0x08	- -	- -
349	0x015D		bit C	0x10	- -	- -
350	0x015E		bit D	0x20	- -	- -
351	0x015F		bit E	0x40	- -	- -
352	0x0160		bit F	0x80	- -	- -
1025	0x0401	0x00EA	bit 0	0x01	TiM	Keypad Time Not Set
1026	0x0402		bit 1	0x02	bAT	Keypad Battery Low Voltage
1027	0x0403		bit 2	0x04	- -	- -
1028	0x0404		bit 3	0x08	- -	- -
1029	0x0405		bit 4	0x10	- -	- -
1030	0x0406		bit 5	0x20	- -	- -
1031	0x0407		bit 6	0x40	- -	- -
1032	0x0408		bit 7	0x80	- -	- -
1033	0x0409		bit 8	0x01	- -	- -
1034	0x040A		bit 9	0x02	- -	- -
1035	0x040B		bit A	0x04	- -	- -
1036	0x040C		bit B	0x08	- -	- -
1037	0x040D		bit C	0x10	- -	- -
1038	0x040E		bit D	0x20	- -	- -
1039	0x040F		bit E	0x40	SCF	Safety Circuit Fault
1040	0x0410		bit F	0x80	- -	- -

Code		Modbus			Fault	
Dec	Hex	Register	bit	bitmask	Code	Text
1041	0x0411	0x00EE	bit 0	0x01	- -	- -
1042	0x0412		bit 1	0x02	- -	- -
1043	0x0413		bit 2	0x04	FAn1	Drive Cooling Fan Fault
1044	0x0414		bit 3	0x08	- -	- -
1045	0x0415		bit 4	0x10	- -	- -
1046	0x0416		bit 5	0x20	- -	- -
1047	0x0417		bit 6	0x40	- -	- -
1048	0x0418		bit 7	0x80	- -	- -
1049	0x0419		bit 8	0x01	- -	- -
1050	0x041A		bit 9	0x02	- -	- -
1051	0x041B		bit A	0x04	- -	- -
1052	0x041C		bit B	0x08	- -	- -
1053	0x041D		bit C	0x10	- -	- -
1054	0x041E		bit D	0x20	- -	- -
1055	0x041F		bit E	0x40	- -	- -
1056	0x0420		bit F	0x80	- -	- -

5.6.5.7 Modbus RTU—Alarm Codes

There following registers can be read to determine an active Alarm. Alternatively, the Alarm Register (0x007F) can be read and will contain the active Alarm code.

Code		Modbus			Alarm	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
1	0x0001	0x00C8	bit 0	0x01	Uv	Undervoltage
2	0x0002		bit 1	0x02	ov	DC Bus Overvoltage
3	0x0003		bit 2	0x04	oH	Heatsink Overheat
4	0x0004		bit 3	0x08	- -	- -
5	0x0005		bit 4	0x10	- -	- -
6	0x0006		bit 5	0x20	- -	- -
7	0x0007		bit 6	0x40	EF	FWD/REV Run Command Input Error
8	0x0008		bit 7	0x80	bb	Baseblock
9	0x0009		bit 8	0x01	EF3	External Fault (Terminal S3)
10	0x000A		bit 9	0x02	EF4	External Fault (Terminal S4)
11	0x000B		bit A	0x04	EF5	External Fault (Terminal S5)
12	0x000C		bit B	0x08	EF6	External Fault (Terminal S6)
13	0x000D		bit C	0x10	EF7	External Fault (Terminal S7)
14	0x000E		bit D	0x20	EF8	External Fault (Terminal S8)
15	0x000F		bit E	0x40	Fan	Internal Fan Fault
16	0x0010		bit F	0x80	oS	Overspeed
17	0x0011	0x00C9	bit 0	0x01	dEv	Speed Deviation
18	0x0012		bit 1	0x02	PGo-1S	Encoder (PG) Feedback Loss
19	0x0013		bit 2	0x04	oPr	Keypad Disconnect
20	0x0014		bit 3	0x08	CE	Modbus Communication Error
21	0x0015		bit 4	0x10	bUS	Option Communication Error
22	0x0016		bit 5	0x20	CALL	Serial Comm Transmission Error
23	0x0017		bit 6	0x40	oL1	Motor Overloaded
24	0x0018		bit 7	0x80	oL2	Drive Overloaded
25	0x0019		bit 8	0x01	- -	- -
26	0x001A		bit 9	0x02	EF0	Option Card External Fault
27	0x001B		bit A	0x04	rUn	Motor Switch during Run
28	0x001C		bit B	0x08	- -	- -
29	0x001D		bit C	0x10	CALL	Serial Comm Transmission Error
30	0x001E		bit D	0x20	- -	- -
31	0x001F		bit E	0x40	- -	- -
32	0x0020		bit F	0x80	SE	Modbus Test Mode Error

Code		Modbus			Alarm	
Dec	Hex	Register	bit	bitmask	Code	Text
33	0x0021	0x00CA	bit 0	0x01	L24v	Loss of External Power 24 Supply
34	0x0022		bit 1	0x02	oH3	Motor Overheat (PTC Input)
35	0x0023		bit 2	0x04	- -	- -
36	0x0024		bit 3	0x08	- -	- -
37	0x0025		bit 4	0x10	- -	- -
38	0x0026		bit 5	0x20	- -	- -
39	0x0027		bit 6	0x40	- -	- -
40	0x0028		bit 7	0x80	- -	- -
41	0x0029		bit 8	0x01	CyPo	Cycle Power to Accept Changes
42	0x002A		bit 9	0x02	dnE	Drive Disabled
43	0x002B		bit A	0x04	PGo-1H	Encoder (PG) Hardware Fault
44	0x002C		bit B	0x08	- -	- -
45	0x002D		bit C	0x10	SLC	Slack Cable
46	0x002E		bit D	0x20	- -	- -
47	0x002F		bit E	0x40	KLX	Klixon
48	0x0030		bit F	0x80	- -	- -
49	0x0031	0x00CB	bit 0	0x01	- -	- -
50	0x0032		bit 1	0x02	- -	- -
51	0x0033		bit 2	0x04	- -	- -
52	0x0034		bit 3	0x08	HCA	High Current Alarm
53	0x0035		bit 4	0x10	LT-1	Cooling Fan Maintenance Time
54	0x0036		bit 5	0x20	LT-2	Capacitor Maintenance Time
55	0x0037		bit 6	0x40	- -	- -
56	0x0038		bit 7	0x80	- -	- -
57	0x0039		bit 8	0x01	EF1	External Fault (Terminal S1)
58	0x003A		bit 9	0x02	EF2	External Fault (Terminal S2)
59	0x003B		bit A	0x04	SToF	Safe Torque OFF Hardware
60	0x003C		bit B	0x08	STo	Safe Torque OFF
61	0x003D		bit C	0x10	- -	- -
62	0x003E		bit D	0x20	- -	- -
63	0x003F		bit E	0x40	- -	- -
64	0x0040		bit F	0x80	- -	- -

Code		Modbus			Alarm	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
65	0x0041	0x00CC	bit 0	0x01	voF	Output Voltage Detection Alarm
66	0x0042		bit 1	0x02	TrPC	IGBT Maintenance Time (90%)
67	0x0043		bit 2	0x04	LT-3	SoftChargeBypassRelay MainteTime
68	0x0044		bit 3	0x08	LT-4	IGBT Maintenance Time (50%)
69	0x0045		bit 4	0x10	boL	Braking Transistor Overload
70	0x0046		bit 5	0x20	SNAP	Snapped Shaft
71	0x0047		bit 6	0x40	PF	Input Phase Loss
72	0x0048		bit 7	0x80	- -	- -
73	0x0049		bit 8	0x01	LC	Load Check Error
74	0x004A		bit 9	0x02	- -	- -
75	0x004B		bit A	0x04	- -	- -
76	0x004C		bit B	0x08	- -	- -
77	0x004D		bit C	0x10	- -	- -
78	0x004E		bit D	0x20	CantSW	Can't Switch, Motor Running
79	0x004F		bit E	0x40	- -	- -
80	0x0050		bit F	0x80	BE0	Brake Ans Lost
81	0x0051	0x00CD	bit 0	0x01	BE4	Brake Answer 4
82	0x0052		bit 1	0x02	BE5	Brake Answer 5
83	0x0053		bit 2	0x04	BE6	Brake Stop Alarm
84	0x0054		bit 3	0x08	BE8	Brake Slipping
85	0x0055		bit 4	0x10	GF1	GF1 Error
86	0x0056		bit 5	0x20	SYNC	Sync Alarm
87	0x0057		bit 6	0x40	Fnr	Follower Not Ready
88	0x0058		bit 7	0x80	AS1	Anti-Shock
89	0x0059		bit 8	0x01	ELIFT	E-Lift Active
90	0x005A		bit 9	0x02	- -	- -
91	0x005B		bit A	0x04	PGo-2H	PGO-2-H
92	0x005C		bit B	0x08	PGo-2S	PGO-2-S
93	0x005D		bit C	0x10	BE0-2	Brake Ans Lost - 2
94	0x005E		bit D	0x20	BE4-2	Brake Ans At Start - 2
95	0x005F		bit E	0x40	BE5-2	Brake Ans At Stop - 2
96	0x0060		bit F	0x80	BE6-2	Brake Slipping - 2

Code		Modbus			Alarm	
Dec	**Hex**	**Register**	**bit**	**bitmask**	**Code**	**Text**
97	0x0061	0x00CE	bit 0	0x01	OW	Overweight - Hoist/Crane
98	0x0062		bit 1	0x02	OW-Pre	Overweight Warning - Hoist/Crane
99	0x0063		bit 2	0x04	- -	- -
100	0x0064		bit 3	0x08	LC Done	Load Check Setup Done
101	0x0065		bit 4	0x10	BRKTEST	Brake Slipped During Test
102	0x0066		bit 5	0x20	BRKTEST	Brake Test: PASSED
103	0x0067		bit 6	0x40	- -	- -
104	0x0068		bit 7	0x80	FbBrkSt	Footbrake Stand
105	0x0069		bit 8	0x01	UL3	Upper Limit 3
106	0x006A		bit 9	0x02	LL3	Lower Limit 3
107	0x006B		bit A	0x04	UL2	Upper Limit Stop
108	0x006C		bit B	0x08	LL2	Lower Limit Stop
109	0x006D		bit C	0x10	UL1	Upper Limit Slowdown
110	0x006E		bit D	0x20	LL1	Lower Limit Slowdown
111	0x006F		bit E	0x40	UL0	Upper Limit Warning
112	0x0070		bit F	0x80	LL0	Lower Limit Warning
113	0x0071	0x00CF	bit 0	0x01	MAINTRUN	Maintenance Run Time Elapsed
114	0x0072		bit 1	0x02	MAINTON	Maintenance On Time Elapsed
115	0x0073		bit 2	0x04	MAINTBRK	Maintenance Brake Cycles Elapsed
116	0x0074		bit 3	0x08	PASS	PASS: Gear Ratio Detected
117	0x0075		bit 4	0x10	roC-1	Analog Rate of Change - 1
118	0x0076		bit 5	0x20	roC-2	Analog Rate of Change - 2
119	0x0077		bit 6	0x40	- -	- -
120	0x0078		bit 7	0x80	- -	- -
121	0x0079		bit 8	0x01	- -	- -
122	0x007A		bit 9	0x02	- -	- -
123	0x007B		bit A	0x04	- -	- -
124	0x007C		bit B	0x08	- -	- -
125	0x007D		bit C	0x10	- -	- -
126	0x007E		bit D	0x20	- -	- -
127	0x007F		bit E	0x40	- -	- -
128	0x0080		bit F	0x80	- -	- -

Code		Modbus			Alarm	
Dec	Hex	Register	bit	bitmask	Code	Text
129	0x0081	0x00E5	bit 0	0x01	EP24v	External Power 24V Supply
130	0x0082		bit 1	0x02	- -	- -
131	0x0083		bit 2	0x04	WMS Setup	WMS Setup
132	0x0084		bit 3	0x08	- -	- -
133	0x0085		bit 4	0x10	bAT	Keypad Battery Low Voltage
134	0x0086		bit 5	0x20	- -	- -
135	0x0087		bit 6	0x40	- -	- -
136	0x0088		bit 7	0x80	- -	- -
137	0x0089		bit 8	0x01	TiM	Keypad Time Not Set
138	0x008A		bit 9	0x02	- -	- -
139	0x008B		bit A	0x04	TMA	Test Mode Active
140	0x008C		bit B	0x08	- -	- -
141	0x008D		bit C	0x10	- -	- -
142	0x008E		bit D	0x20	- -	- -
143	0x008F		bit E	0x40	- -	- -
144	0x0090		bit F	0x80	- -	- -

5.6.5.8 Modbus RTU—Communication Error Codes

The table below lists the Modbus communication error codes.

Error Code (Hex.)	Description	Cause
01	Function Code Error	The PLC set a function code that was not 0x03, 0x08, or 0x10
02	Register Number Error	1. The register in the command message does not exist. 2. A starting number that is not 0x0001 or 0x0002 was set when broadcasting.
03	Bit Count Error	1. Read or write data is greater than 16 bits. 2. The data read from non-consecutive registers contained more than 120 bytes. 3. The data written to non-consecutive registers contained more than 60 bytes. 4. In write mode, the number of bytes in the message is not the data x 2.
21	Data Setting Error	1. Control data or a parameter being written is outside of permitted range. 2. A parameter setting error occurred when writing a parameter.
22	Write Mode Error	1. A parameter write attempt occurred during a run. 2. During a CPF06 (EEPROM Error), a parameter besides these was written: • A01-01 (Access Level) • A01-02 (Control Method Selection) • A01-05 (Initialize Parameters) • A01-06 (Password) • E01-03 (V/f Pattern Selection) • o02-04 (Drive Model (KVA) Selection) 3. Read-only data was attempted to be written.
23	Undervoltage Write Error	A parameter write attempt occurred during a Uv (Undervoltage) condition.
24	Write Error During Parameter Processing	A parameter write attempt occurred during processing on the VFD.
25	Writing into EEPROM Disabled	Writing into EEPROM write is disabled, but EEPROM write was executed from Modbus communications. When this error occurs, the keypad shows a message, and the VFD continues operation.

5.6.5.9 Modbus RTU—No Response

A node VFD will ignore a command message from the PLC and will not send a response message in these conditions:

- When a communications error (overrun, framing, parity, CRC-16) is detected in the command message.
- When the node address in the command message and the node address for the VFD do not agree (Use H05-01 (Drive Node Address) to set the node address of the VFD).
- When the gap between two blocks (8-bit) of a message exceeds 24 bits.
- When the data length for the command message is invalid.

NOTE: *If a write is executed when the node address in the command message is 0x00, all of the node VFDs will execute the write command, but they will not send response messages.*

5.6.6 Pulse Train Input/Output (H06)

Pulse Input and Output provides speed control capabilities via the RP and MP terminals.

Table 5-111: Pulse Train Input/Output Parameter Settings

Parameter	Display	Function	Range	Default
H06-01	Terminal RP Pulse Train Function *0 Frequency Reference* *3 Speed Feedback (V/f Control)* *5 Follower Speed Feedback* *7 Main Hook Height* *8 Aux Hook Height*	Terminal RP pulse input Set b03-01 = 4 (Pulse Input) to enable RP. Pulse feedback for better speed control in V/f. Pulse feedback into the RP terminal coming from a Follower VFD.	0, 3, 5, 7, 8	0
H06-02	Terminal RP Frequency Scaling	Frequency of the terminal RP pulse train input when the H06-01 input is 100%.	100–32000 Hz	1440
H06-03	Terminal RP Function Gain	Gain applied to the RP function.	0.0–1000.0%	100.0
H06-04	Terminal RP Function Bias	Bias applied to the RP function.	-100.0–100.0%	0.0
H06-05	Terminal RP Filter Time	Input filter time constant	0.00–2.00 sec	0.10
H06-06	Terminal MP Monitor Selection *0 Not Used* *101 Frequency Reference* *102 Output Frequency* *105 Motor Speed* *120 SFS Output Frequency* *150 Hook Height*	Terminal MP pulse output monitor	0–150	102
H06-07	Terminal MP Frequency Scaling	Frequency of the terminal MP pulse train output when the H06-06 monitor is 100%.	0–32000 Hz	1440
H06-08	Terminal RP Minimum Frequency	Minimum frequency for the pulse train input to be detected. Enabled when H06-01 = 0.	0.1–1000.0 Hz	0.5
H06-09	Voltage Phase Sync MP Selection *0 Disabled* *1 Enabled*	Output the pulse synchronized with output voltage phase at terminal MP. Enabled when H06-06 = 102 (Output Frequency) and H06-07 = 0 Hz.	0, 1	0
H06-10	Pulse Difference Detect	When H06-01 = 5 (Follower Speed Feedback), the terminal RP pulse input is compared to the terminal MP pulse output. If the difference is greater than the percentage of H06-10, a Pulse Deviation fault will occur.	0.0–25.5%	5.0

5.6.7 Virtual Inputs/Outputs (H07)

Virtual inputs and outputs allow for the passing of information without the need for external wiring. This function performs the following:

- Inputs the result of the output from the MFDO terminal to the MFDI terminal without external wiring.
- Inputs the result of the output from the MFAO terminal to the MFAI terminal without external wiring.

Table 5-112: Virtual Inputs/Outputs Parameter Settings

Parameter	Display	Function	Range	Default
H07-00	Virtual MFIO Selection *0 Disabled* *1 Enabled*	Enable or disable the virtual I/O function.	0, 1	0
H07-01	Virtual Multi-Function Input 1	Virtual Input that is triggered by Virtual Output H07-10.	0–17B	F
H07-02	Virtual Multi-Function Input 2	Virtual Input that is triggered by Virtual Output H07-12.	0–17B	F
H07-03	Virtual Multi-Function Input 3	Virtual Input that is triggered by Virtual Output H07-14.	0–17B	F
H07-04	Virtual Multi-Function Input 4	Virtual Input that is triggered by Virtual Output H07-16.	0–17B	F
H07-10	Virtual Multi-Function Output 1	Function for virtual digital output 1.	0–171	F
H07-11	Virtual Output 1 Delay Time	Minimum ON time for virtual digital output 1.	0.0–25.0 sec	0.1
H07-12	Virtual Multi-Function Output 2	Function for virtual digital output 2.	0–171	F
H07-13	Virtual Output 2 Delay Time	Minimum ON time for virtual digital output 2.	0.0–25.0 sec	0.1
H07-14	Virtual Multi-Function Output 3	Function for virtual digital output 3.	0–171	F
H07-15	Virtual Output 3 Delay Time	Minimum ON time for virtual digital output 3.	0.0–25.0 sec	0.1
H07-16	Virtual Multi-Function Output 4	Function for virtual digital output 4.	0–171	F
H07-17	Virtual Output 4 Delay Time	Minimum ON time for virtual digital output 4.	0.0–25.0 sec	0.1
H07-30	Virtual Analog Input Selection	Function for virtual analog input.	0–36	1F
H07-31	Virtual Analog Input Gain	Gain for virtual analog input.	-999.9–999.9%	100.0
H07-32	Virtual Analog Input Bias	Bias for virtual analog input.	-999.9–999.9%	0.0
H07-40	Virtual Analog Out Signal Select *0 0 to 100% (Absolute Value)* *1 -100 to 100%* *2 0 to 100% (Lower Limit at 0)*	Signal level of the virtual analog output.	0–2	0
H07-41	Virtual Analog Output Function	Monitor to be output from the virtual analog output. Set the x-xx part of the U0x-xx monitor. For example, set H07-41 = 102 to monitor U01-02 (Output Frequency).	0–712	102
H07-42	Virtual Analog Output Filter Time	Time constant filter of the virtual analog output.	0.00–2.00 sec	0.00

5.7 Protection Parameters (L)

- L01 Motor Protection
- L02 Power Loss Ride Through
- L03 Stall Prevention
- L04 Speed Detection
- L06 Torque Detection
- L08 Hardware Protection
- L09 Automatic Fault Reset
- L09 Fault Latch

5.7.1 Motor Protection (L01)

The VFD has an electronic overload protection function (oL1) for protecting the motor from overheating. It bases the protection on time, output current, and output frequency. The electronic thermal overload function is UL-recognized, so an external thermal overload relay is not required for single motor operation.

L01-01 selects the motor overload curve used according to the type of motor applied.

L01-01 = 1 selects a motor with limited cooling capability below rated 60 Hz base speed when running at 100% load. The oL1 function derates the motor any time it is running below 60 Hz.

L01-01 = 2 selects a motor capable of cooling itself at any speed when running at 100% load. The oL1 function derates the motor when it is running at 10% of its rated speed or less.

L01-01 = 3 selects a motor capable of cooling itself at any speed when running at 100% load. The oL1 function derates the motor when it is running at 1% of its rated speed or less.

L01-01 = 6 selects a motor with limited cooling capability below rated 50 Hz base speed when running at 100% load. The oL1 function derates the motor any time it is running below 50 Hz.

If the VFD is connected to a single motor, the motor overload protection (L01-01) should be enabled.

Do not disable oL1 unless another means of motor thermal overload protection is provided. When an overload is detected, an oL1 fault occurs and shuts off the VFD output, thus preventing additional overheating of the motor. The motor temperature is continuously calculated while the VFD is powered up.

NOTE: *When operating several motors with one VFD, disable motor overload protection (L01-01 = 0) and install external overload protection, which can be a thermal overload relay on each motor or, if available, utilize the thermostats or thermocouples that are embedded in the motor windings. The VFD's Klixon and Thermistor features can assist with the latter.*

Table 5-113: Motor Protection Parameter Settings

Parameter	Display	Function	Range	Default
L01-01	Motor Overload (oL1) Protection	Motor type for oL1 overload protection.	0–3, 6	G+: 2 VG+: 3
	0 Disabled			
	1 Variable Torque	General purpose motor (60 Hz base frequency)		
	2 Constant Torque 10:1 Speed Range	Speed range for constant torque of 1:10		
	3 Constant Torque 100:1 Speed Range	Speed range for constant torque of 1:100		
	6 Variable Torque (50Hz)	General purpose motor (50 Hz base frequency)		
L01-02	Motor Overload Protection Time	Time for oL1 fault when motor current is ≥ 150% of the motor rated current.	0.1–5.0 min	1.0

Parameter	Display	Function	Range	Default
L01-03	Motor Thermistor oH Alarm Select	Operation when the motor temperature analog input (H03-02, H03-06, or H03-10 = E) exceeds the oH3 alarm/fault level. (1.17V)	0–3	3
	0 Decel to Stop			
	1 Coast to Stop			
	2 Fast Stop (Use b05-08)	Decel by b05-08		
	3 Alarm Only	oH3 Flashes		
L01-04	Motor Thermistor oH Fault Select	Operation when the motor temperature analog input (H03-02, H03-06, or H03-10 = E) exceeds the oH4 fault level. (2.34V)	0–2	1
	0 Decel to Stop			
	1 Coast to Stop			
	2 Fast Stop (Use b05-08)	Decel by b05-08		
L01-05	Motor Thermistor Filter Time	Motor temperature analog input filter time constant (H03-02, H03-06, or H03-10 = E)	0.00–10.00 sec	0.20
L01-06	Klixon Action *0 Decel to Stop* *1 Coast to Stop* *2 Use b03-03 Method* *4 Coast to Stop, Alarm* *5 b03-03 to Stop, Alarm*	The Klixon function is used with motors that have a Thermal Overload Switch. Klixons are usually embedded in the motor windings and change state when the motor reaches a certain temperature. When a digital input H01-xx or F03-xx = 56 (N.O.) or 156 (N.C.) is active, the VFD will use this stopping method and display a Klixon (KLX) alarm. The VFD will resume operation when the motor cools down and a new RUN command is issued. Option 0 is not available for hoist motions. Options 4 and 5 are only available for hoist motions and allow lowering.	0–2, 4, 5	2
L01-08	oL1 Current Level	Reference current for the Motor 1 oL1 detection. Except 0.00 A, you cannot set this value < 10% of VFD rated current. If set to 0.00, E02-01 is used for oL1 detection.	0.00–(150% VFD Rated Current)* A	0.00
L01-09	oL1 Current Level for Motor 2	Reference current for the Motor 2 oL1 detection. Except 0.00 A, you cannot set this value < 10% of VFD rated current. If set to 0.00, E04-01 is used for oL1 detection.	0.00–(150% VFD Rated Current)* A	0.00
L01-13	Motor Overload Memory Selection *0 Disabled* *1 Enabled*	Determines whether or not to hold the current value of the oL1 overload calculation when the power supply is interrupted.	0, 1	1

* *The decimal places are different for different models:*

0.01 A: 2003 to 2033, 4001 to 4018, 5001 to 5012

0.1 A: 2047 to 2415, 4024 to 41090, 5017 to 5412

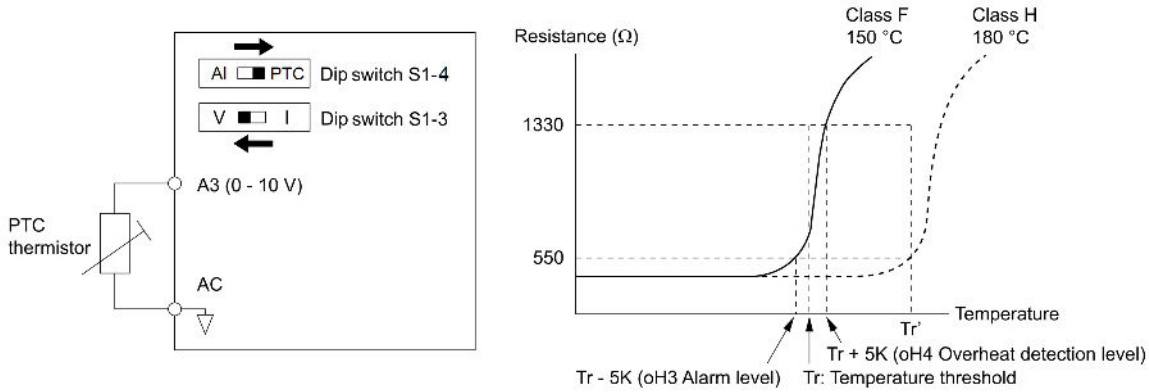


Figure 5-52: PTC Thermistor Configuration

5.7.2 Power Loss Ride Through (L02)

Table 5-114: Power Loss Ride Through Parameter Settings

Parameter	Display	Function	Range	Default
L02-01	Power Loss Ride Through *0 Disabled* *1 Enabled for L02-02 Time* *2 Enabled while CPU Power Active*	Power Loss Ride Through selection. UV1 fault if power loss is longer than 15 milliseconds. Uv1 fault if power loss is longer than L02-02. Recover as long as CPU has power. Uv1 is not detected.	0–2	0
L02-02	Power Loss Ride Through Time	Power Loss Ride thru time	0.0–25.5 sec	Depends on o02-04
L02-03	Minimum Baseblock Time	Output turn on delay after power resumes	0.1–5.0 sec	Depends on o02-04
L02-04	Powerloss V/f Recovery Ramp Time	Voltage recovery time after speed search is complete	0.0–5.0 sec	Depends on o02-04
L02-05	Undervoltage Detection Lvl (Uv1)	Under voltage fault detection level	230V: 150–210 VDC 460V: 300–420 VDC 575V: 431–604 VDC	190 380 500
L02-06	Kinetic Energy Backup Decel Time	Deceleration time during KEB operation down to a frequency of 0.	0.0–6000.0 sec	0.0
L02-07	Kinetic Energy Backup Accel Time	Acceleration time to return to the frequency reference before a power loss after canceling KEB operation.	0.0–6000.0 sec	0.0
L02-08	Frequency Gain at KEB Start	Output frequency reduction, as a percentage of E02-02 (Motor Rated Slip) before starting KEB operation.	0–300%	100
L02-09	KEB Minimum Frequency Level	Output frequency reduction, as a percentage of E02-02 (Motor Rated Slip) when KEB operation starts.	0–100%	20
L02-10	Minimum KEB Time	Minimum time to operate the KEB after a momentary power loss is detected.	0–25500 ms	50
L02-11	KEB DC Bus Voltage Setpoint	Target value that controls the DC bus voltage to a constant level when L02-29 = 2. For other L02-29 settings, this is the voltage level that completes KEB.	230V: 150–400 VDC 460V: 300–800 VDC 575V: 431–1015 VDC	E01-01 x 1.22
L02-29	Kinetic Energy Backup Method *0 Single Drive KEB Ride-Thru 1* *1 Single Drive KEB Ride-Thru 2* *2 System KEB Ride-Thru 1* *3 System KEB Ride-Thru 2*	KEB function operation mode.	0–3	0
L02-30	KEB Zero Speed Operation *0 Baseblock* *1 DC/SC Braking*	Operation when the output frequency decreases below d01-01 (DC Injection Threshold) during KEB deceleration when L02-01 = 3 to 5.	0,1	0
L02-31	KEB Start Voltage Offset Level	KEB start voltage offset.	230V: 0–100 VDC 460V: 0–200 VDC 575V: 0–287 VDC	0

5.7.3 Stall Prevention (L03)

Table 5-115: Stall Prevention Parameter Settings

Parameter	Display	Function	Range	Default
L03-01	Stall Prevention during Accel	Stall Prevention will function during acceleration. (G+ only)	0–3	1
	0 Disabled			
	1 Enabled	Acceleration is paused as long as the current is above the L03-02 setting.		
	2 Intelligent (Ignore Accel Ramp)	Accelerate in the shortest possible time without exceeding the L03-02 level.		
	3 Current Limit Acceleration	Acceleration rate is automatically adjusted when the output current exceeds L03-02.		
L03-02	Stall Prevent Level during Accel	Output current level that Stall Prevention during acceleration is activated. (G+ only)	0–150%	150
L03-03	Stall Prevent Limit during Accel	Stall Prevention lower limit during acceleration when operating in constant power range. Set as a percentage of VFD rated current. (V/f only)	0–100%	50
L03-05	Stall Prevention during RUN	Control for the stall prevention during run. (V/f only)	0–2	1
	0 Disabled	Runs at a set frequency. A heavy load may stall.		
	1 Deceleration Time 1	Use Decel Time 1 (b05-02)		
	2 Deceleration Time 2	Use Decel Time 2 (b05-04)		
L03-06	Stall Prevent Level during Run	Current level to trigger Stall Prevention during run. Depending on L03-23, the level is automatically reduced in the constant power range (speed beyond base speed). (G+ only) Enabled when L03-05 = 1 or 2.	30–150%	150
L03-11	Overvoltage Suppression Select *0 Disabled* *1 Enabled*	Enables or disables the overvoltage suppression function, which allows the VFD to change the output frequency as the load changes to prevent an oV fault.	0, 1	0
L03-17	DC Bus Regulation Level	DC bus voltage during overvoltage suppression and Stall Prevention during deceleration	230V: 150–400 VDC 460V: 300–800 VDC 575V: 431–1150 VDC	375 750 930
L03-20	DC Bus Voltage Adjustment Gain	Proportional gain for Stall Prevention and overvoltage suppression	0.00–5.00	V/f: 1.00 OLV: 0.30 CLV: 0.30
L03-21	OVSuppression Accel/ Decel P Gain	Proportional gain used to calculate the deceleration rate during oV suppression function and Stall Prevention during deceleration	0.10–10.00	1.0
L03-23	Stall P Reduction at Constant HP	Reduces the Stall Prevention during run level in the constant power range. (V/f only)	0, 1	0
	0 Use L03-06 for Entire Speed Range	Sets the Stall Prevention level that is used throughout the entire frequency range.		
	1 Automatic Reduction @ CHP Region	Automatic Stall Prevention level reduction in the constant output range. Lower limit is 40% of L03-06.		

Parameter	Display	Function	Range	Default
L03-24	Motor Accel Time @ Rated Torque	Time needed to accelerate the uncoupled motor at rated torque from stop to the maximum frequency.	0.001–10.000 sec	Depends on o02-04
L03-25	Load Inertia Ratio	Ratio between motor inertia and machine inertia.	0.1–1000.0	1.0
L03-26	Additional DC Bus Capacitors	Capacity for external main circuit capacitors. This parameter may be used with the KEB Ride Through.	0–65000 µF	0
L03-27	Stall Prevention Detection Time	Delay between reaching the Stall Prevention level and starting the Stall Prevention function. (V/f only)	0–5000 ms	50
L03-36	Current Suppression Gain @ Accel	Gain to suppress current and motor speed hunting during operation when L03-01 = 3. (G+ only)	0.0–100.0	V/f: 10.0 OLV: 20.0
L03-37	Current Limit P Gain @ Accel	P Gain to suppress current hunting during acceleration when L03-01 = 3. (G+ only)	0–100 ms	5
L03-38	Current Limit I Time @ Accel	I Time to suppress current hunting and overshooting if a stall occurs during acceleration when L03-01 = 3. (G+ only)	0.0–100.0	10.0
L03-39	Current Limit Filter Time @ Accel	Time constant to adjust the acceleration rate when L03-01 = 3. (G+ only)	1.0–1000.0 ms	100.0
L03-40	Current Limit S-Curve @ Acc/Dec *0 Disabled* *1 Enabled*	Use the best S-curve characteristic for current-limited acceleration when L03-01 = 3. (G+ only)	0, 1	0

5.7.4 Speed Detection (L04)

The IMPULSE•G+/VG+ Series 5 has three functions for detecting output frequency:

Speed Agree 1

- When enabled using MFDO “H02-xx = 2”, the contact closes when the output frequency (U01-02) is equal to the frequency reference (U01-01) plus or minus the speed agree detection width (L04-02).
  - *U01-02 = (U01-01 ± L04-02)*
- When enabled using MFDO “H02-xx = 3”, the contact closes when the output frequency (U01-02) is equal to the speed agree detection level (L04-01) plus or minus the speed agree detection width (L04-02).
  - *U01-02 = (L04-01 ± L04-02)*

Speed Agree 2

- When enabled using MFDO “H02-xx = 13”, the contact closes when the output frequency (U01-02) is equal to the frequency reference (U01-01) plus or minus the speed agree detection width (L04-04).
  - *U01-02 = (U01-01 ± L04-04)*
- When enabled using MFDO “H02-xx = 14”, the contact closes when output frequency (U01-02) is equal to the speed agree detection level (L04-03) plus or minus the speed agree detection width (L04-04).
  - *U01-02 = (L04-03 ± L04-04)*

Frequency Detection

When enabled using MFDO “H02-xx = 4 (Frequency Detection 1)”:

- Contact closes at start.
- Contact opens when accelerating: U01-02 ≥ (L04-01 + L04-02).
- Contact closes again when decelerating: U01-02 < L04-01.

When enabled using MFDO “H02-xx = 5 (Frequency Detection 2)”:

- Contact remains opens at start.
- Contact closes when accelerating: U01-02 ≥ L04-01.
- Contact opens again when decelerating: U01-02 < (L04-01 - L04-02).

NOTE: *If L04-01 or L04-03 is set below 5 Hz, the DC Injection Start Frequency (d01-01) and Speed Agree Widths (L04-02/L04-04) may need to be adjusted lower in order for the VFD to recognize runs properly.*

Table 5-116: Speed Agree Parameter Settings

Parameter	Display	Function	Range	Default
L04-01	Speed Agree Detection Level	Detection level for speed agree 1 and frequency detection. The detection level is effective during FWD and REV operation.	0.0–150.0 Hz	0.0
L04-02	Speed Agree Detection Width	Detection width for speed agree 1 and frequency detection functions.	0.0–20.0 Hz	2.0
L04-03	Speed Agree Detection Level (+/-)	Detection level for speed agree 2. The detection level is effective during FWD or REV operation, depending on the detection level (positive for FWD, negative for REV).	-150.0–150.0 Hz	0.0
L04-04	Speed Agree Detection Width (+/-)	Detection width for the speed agree 2 function.	0.0–20.0 Hz	2.0

Table 5-117: Frequency Detection Parameter Settings

Parameter	Display	Function	Range	Default
L04-05	Fref Loss Detection Selection	The VFD can detect a loss of an analog frequency reference from input A1, A2, or A3. Frequency reference loss is detected when the reference is less than 10% in 400 ms.	0, 1	0
	0 Stop	VFD stops when frequency reference is lost.		
	1 Run at (L04-06 x Last Reference)	VFD runs at a reduced speed when the frequency reference is lost.		
L04-06	Frequency Reference @Loss of Ref	Percentage of the frequency reference that the VFD should run at when the frequency reference is lost.	0.0–100.0%	80.0
L04-07	Speed Agree Detection Selection	Determines when frequency detection is active using parameters L04-01 to L04-04.	0, 1	0
	0 No Detection During Baseblock	No detection during baseblock.		
	1 Detection Always Enabled	Detection always enabled.		

5.7.5 Torque Detection (L06)

The torque detection function will trigger an alarm or fault when the motor load is above or below a set threshold. When an undertorque/overtorque condition is detected, it can trigger a digital output (H02-0x = B or 17).

Table 5-118: Torque Detection Parameter Settings

Parameter	Display	Function	Range	Default
L06-01	Torque Detection Selection 1	Activates overtorque/undertorque detection and selects whether detection generates an alarm or a fault	0–8	0
	0 Disabled			
	1 OT @ Speed Agree - Alarm			
	2 OT @ RUN - Alarm			
	3 OT @ Speed Agree - Fault			
	4 OT @ RUN - Fault			
	5 UT @ Speed Agree - Alarm			
	6 UT @ RUN - Alarm			
	7 UT @ Speed Agree - Fault			
	8 UT @ RUN - Fault			

Table 5-119: Torque Detection 1 (L06-01) Setting Descriptions

Settings	Description
0	Torque detection is disabled.
1	Overtorque detection is enabled whenever at speed agree (when VFD is not accelerating or decelerating). Continue running after detection (oT1 alarm).
2	Overtorque detection is enabled always. Continue running after detection (oT1 alarm).
3	Overtorque detection is enabled whenever at speed agree. Coast to a stop after detection (oT1 fault).
4	Overtorque detection is enabled always. Coast to a stop after detection (oT1 fault).
5	Undertorque detection is enabled whenever at speed agree (when VFD is not accelerating or decelerating). Continue running after detection (UT1 alarm).
6	Undertorque detection is enabled always. Continuing running after detection (UT1 alarm).
7	Undertorque detection is enabled whenever at speed agree. Coast to a stop after detection (UT1 fault).
8	Undertorque detection is enabled always. Coast to stop after detection (UT1 fault)

NOTE:

- *To detect overtorque/undertorque during acceleration or deceleration, set to “2” or “4” / “6” or “8”.*
- *To continue operation after overtorque/undertorque detection, set to “1” or “2” / “5” or “6” During detection, the keypad displays an “oT1/UT1” alarm (blinking).*
- *To stop the VFD after an overtorque/undertorque detection fault, set to “3” or “4” / “7” or “8”. During detection, the keypad displays an “oT1/UT1” fault.*

Table 5-120: Torque Detection Parameter Settings - continued

Parameter	Display	Function	Range	Default
L06-02	Torque Detection Level 1	Torque detection as a percentage of VFD rated current, during V/f control, and motor rated torque during vector control.	0–300%	150
L06-03	Torque Detection Time 1	Inserts a delay, between the time motor current (or torque) is above or below the torque detection level (L06-02) and when the torque detection function is enabled.	0.0–10.0 sec	0.1
L06-04	Torque Detection Selection 2 *0 Disabled* *1 OT @ Speed Agree - Alarm* *2 OT @ RUN - Alarm* *3 OT @ Speed Agree - Fault* *4 OT @ RUN - Fault* *5 UT @ Speed Agree - Alarm* *6 UT @ RUN - Alarm* *7 UT @ Speed Agree - Fault* *8 UT @ RUN - Fault*	Activates overtorque/undertorque detection, and selects whether detection generates an alarm or a fault.	0–8	0

Table 5-121: Torque Detection 2 (L06-04) Setting Descriptions

Settings	Description
0	Overtorque/undertorque detection is disabled.
1	Overtorque detection is enabled whenever at speed agree (when VFD is not accelerating or decelerating). Continue running after detection (oT2 alarm).
2	Overtorque detection is enabled always. Continue running after detection (oT2 alarm).
3	Overtorque detection is enabled whenever at speed agree. Coast to a stop after detection (oT2 fault).
4	Overtorque detection is enabled always. Coast to a stop after detection (oT2 fault).
5	Undertorque detection is enabled whenever at speed agree (when VFD is not accelerating or decelerating). Continue running after detection (UT2 alarm).
6	Undertorque detection is enabled always. Continuing running after detection (UT2 alarm).
7	Undertorque detection is enabled whenever at speed agree. Coast to a stop after detection (UT2 fault).
8	Undertorque detection is enabled always. Coast to stop after detection (UT2 fault).

Overtorque detection 2 functions the same as overtorque/undertorque detection 1 (L06-01), except that “oT2/UT2” is displayed on the keypad instead.

Table 5-122: Torque Detection Parameter Settings - continued

Parameter	Display	Function	Range	Default
L06-05	Torque Detection Level 2	Torque Detection 2 Level	0–300%	150
L06-06	Torque Detection Time 2	Torque Detection 2 Time	0.0–10.0 sec	0.1
L06-07	Torque Detection Filter Time	Time constant filter for the torque reference or output current used to detect overtorque/ undertorque.	0–1000 ms	0

5.7.6 Hardware Protection (L08)

The IMPULSE•G+/VG+ Series 5 has several built-in functions designed to protect the VFD and its components from damage.

Table 5-123: Hardware Protection Parameter Settings

Parameter	Display	Function	Range	Default
L08-02	Overheat Alarm Level	Heatsink temperature level for protection against overheat (oH). ***NOTE:*** *Heatsink temperature is measured by an NTC thermistor.*	50–150°C	105*
L08-03	Overheat Pre-Alarm Selection	Stopping method when heatsink overheat (oH) is detected	0–4	3
	0 Decel to Stop	Decel to stop using b05-02		
	1 Coast to Stop	Immediate stop		
	2 Fast Stop (Use b05-08)	Decel to stop using b05-08		
	3 Alarm Only	Operation continues and “oH Heatsink Overheat” is displayed on keypad		
	4 Operate at Reduced Speed (L08-19)	Continue operation at reduced speed L08-19.		
L08-05	Input Phase Loss Protection Sel *0 Disabled* *1 Enabled*	Input phase loss detection. Voltage ripple is measured on the DC bus and an input phase loss is detected if the DC bus fluctuates more than L08-06.	0, 1	1
L08-06	Input Phase Loss Detection Level	Input phase loss detection level. The VFD compares a high and low DC bus voltage measurement and compares it to this percentage.	0.0–50.0%	20.0*
L08-07	Output Phase Loss Protection Sel *0 Disabled* *1 Fault When One Phase is Lost* *2 Fault When Two Phases are Lost*	Output phase loss detection of one or two lost phases. Detection begins when output current is less than 5% of VFD rated current.	0–2	2
L08-08	Output Phase Loss Detection Lvl	Output current level above which is considered an output phase.	0.0–20.0%	5.0
L08-09	Output Ground Fault Detection *0 Disabled* *1 Enabled*	Ground fault detection. If there is high leakage current or a ground short circuit in one or two output phases, a Ground Fault is detected. If the ground path impedance is low, an oC, SC, or ov fault may be detected instead of GF.	0, 1	1
L08-10	Heatsink Fan Operation Selection *0 During Run w/ L08-11 Off-Delay* *1 Always On*	Operation of the heatsink cooling fan.	0, 1	0
L08-11	Heatsink Fan Off-Delay Time	When L08-10 = 0, the fan will run for this amount of time after the run command is removed.	0–300 sec	60
L08-12	Ambient Temperature Setting	Ambient temperature of the VFD installation area	-10–50°C	40

Parameter	Display	Function	Range	Default
L08-15	Drive oL2 @ Low Speed Protection *0 Disabled* *1 Enabled*	oL2 detection when output frequency ≤ 6 Hz. When enabled, the overload detection level is automatically decreased at low speeds. At zero speed, the oL2 level is derated by 50%.	0, 1	0**
L08-18	Software Current Limit Selection *0 Disabled* *1 Enabled*	When enabled, if the output current is at the software current limit, the VFD will decrease the output voltage to decrease output current.	0, 1	0
L08-19	Freq Reduction @ oH Pre-Alarm	Frequency reference reduction gain at overheat pre-alarm when L08-03 = 4.	0.1–0.9 Hz	0.8
L08-35	Installation Method Selection *0 Open Chassis* *1 Side-by-Side Mounting* *2 UL Type 1* *3 Finless*	VFD Installation Method	0–3	2*
L08-38	Carrier Frequency Reduction *0 Disabled* *1 Enabled Below 6 Hz* *2 Enabled for All Speeds*	Temporarily reduces the carrier frequency and temporarily increases the overload capability (oL2 detection) allowing the VFD to run through transient load peaks without faulting. Enabled below 6 Hz Carrier Frequency reduced when: < 6Hz & current > 100% of VFD rated current, returns to normal carrier frequency when output current falls below 88% of VFD rated current or frequency > 7Hz Enabled for the entire speed range Carrier Frequency reduced when: < 6Hz & current > 100% of VFD rated current or > 7Hz & current > 112% of VFD rated current	0–2	2
L08-40	Carrier Freq Reduction Off-Delay	Time that the VFD continues running with reduced carrier frequency after the carrier reduction condition is gone. Setting L08-40 = 0.00 disables the carrier frequency reduction time.	0.00–2.00 sec	0.50
L08-41	High Current Alarm Selection *0 Disabled* *1 Enabled*	Triggers a high current alarm (HCA) when the output current rises exceeds 150% of the VFD rated current.	0, 1	0
L08-55	Internal DB Transistor Protection *0 Disabled* *1 Enabled, DB Active During Run* *2 Enabled, DB Active Always*	Internal Braking Transistor Protection Disable when not using the internal braking transistor and instead using a CDBR. Enable when connecting a braking resistor to built-in braking transistor (B1 and B2 terminals). The braking transistor is functional even when the VFD is not running. May be used for common busing.	0–2	0*

** Initial value is determined by o02-04 (VFD Model Selection).*

*** Initial value is dependent on d10-02 (carrier frequency). 2kHz = 0, else 1*

5.7.7 Automatic Fault Reset (L09)

When a fault occurs during operation, it can be automatically reset when the run command is removed.

Table 5-124: Automatic Fault Reset Parameter Settings

Parameter	Display	Function	Range	Default
L09-01	Auto Fault Reset Attempts	Number of auto fault reset attempts. Reset attempt counter is returned to zero if no faults occur within a ten minute period.	0–10	3
L09-02	Fault Contact at Restart Select *0 Active Only when Not Restarting* *1 Always Active*	Fault contact status for faults set in L09-08 and L09-09 while the fault is active.	0, 1	0
L09-08*	Fault Reset Group 1	Automatic fault reset Group 1.	0000–FFFF	4201
L09-09*	Fault Reset Group 2	Automatic fault reset Group 2.	0000–FFFF	E000

* To program L09-08 or L09-09, refer to the example below and follow steps 1 through 4:

Table 5-125: Automatic Fault Reset Selections

	Digit 4				Digit 3				Digit 2				Digit 1			
Hex	4				2				0				1			
Binary	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	E	A			L	P	C		O	S	O	G	O	U	U	U
L09-08	F	S			F	F	O		H	C	V	F	C	V	V	V
	0	1					F		1					3	2	1
Hex	E				0				0				0			
Binary	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	B	B	B	O	O	O	L	C		E	E	E	E	E	E
L09-09	E	E	E	E	L	L	W	C	E		F	F	F	F	F	F
	1	2	3	4	1	2					8	7	6	5	4	3

1. Assign 1 to each fault code to enable the auto reset.
2. Assign 0 to each fault code to disable the auto reset.
3. Convert all Digits (1 to 4) from binary to hexadecimal ***(see Table 5-127 on page 325)***.
4. Program L09-08 or L09-09 to the hexadecimal number obtained in step 3.

Example:

Enable auto-reset for AS1, CoF, Uv1, BE1, BE2, and BE3 faults.

Table 5-126: Automatic Fault Reset Example (Default)

L09-08	Binary	Hex	L09-09	Binary	Hex
Digit 4	0100	4	Digit 4	1110	E
Digit 3	0010	2	Digit 3	0000	0
Digit 2	0000	0	Digit 2	0000	0
Digit 1	0001	1	Digit 1	0000	0

Table 5-127: Binary to Hexadecimal Conversion

Binary Number	Hexadecimal Value
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

5.7.8 Fault Latch (L09)

The Fault Latch function allows specific faults to become “latched” after the automatic fault reset attempts (L09-01) have maxed out. The Fault Reset digital input (H01-xx or F03-xx = 3F) will be blocked from resetting the fault. In the case of a power loss, the fault will remain latched when power is restored.

A latched fault can be cleared three ways:

1. The recommended method is to program an MFDI to 48 (Fault Latch Reset). This can be done before or after a fault is latched. The digital input must be toggled (ON and then OFF) in order for the fault to clear. Since this feature is intended for safety, a key switch is recom-mended. This can prevent a recurring fault from being con-tinuously cleared and ignored.
2. Clear the fault using the Monitor tool in the IMPULSE®•Link PC software.
3. Press the Reset key on the keypad.

Table 5-128: Fault Latch Parameter Settings

Parameter	Display	Function	Range	Default
L09-14	Fault Latch Select 1	Fault Latch Group 1	0000–FFFF	0000
L09-15	Fault Latch Select 2	Fault Latch Group 2	0000–FFFF	0000

NOTE: *To program parameters L09-14 and L09-15, refer to the Auto Fault Reset example. The same programming method applies here.*

Table 5-129: Fault Latch Programming

	Digit 4				Digit 3				Digit 2				Digit 1			
HEX	0				0				0				0			
Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L09-14				PGO1H	PGO2H	UL3	DEV	SNAP	BE8	BE7	BE6	BE5	BE4	BE3	BE2	BE1
HEX	0				0				0				0			
Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L09-15					EF8	EF7	EF6	EF5	OS	OV		LC	OL1	OL2	OT2	OT1

NOTE: *The BE_ selections also apply to Brake 2. For example, selecting BE7 in the table above will latch the BE7 and BE7-2 faults.*

5.8 Special Adjustment (n)

- n01 Hunting Prevention
- n02 Auto Frequency Regulator (AFR)

5.8.1 Hunting Prevention (n01)

Hunting Prevention is a feature available for the V/f control method only. Occasionally, resonance between the internal control system and the mechanical system causes instability. This is called hunting, and may cause a crane to vibrate at a lower speed (up to 30 Hz) and/or with a light load. The hunting prevention function monitors the motor flux and uses a special control circuit to “smooth out” any peaks in the output current wave form.

Table 5-130: Hunting Prevention Parameter Settings

Parameter	Display	Function	Range	Default
n01-01	Hunting Prevention Selection *0 Disabled* *1 Enabled (Normal)* *2 Enabled (High Carrier Frequency)*	Hunting Prevention. When response time is more important than reducing motor vibration, disable this function.	0–2	1
n01-02	Hunting Prevention Gain Setting	Hunting Prevention Gain. Increase this value if hunting is present while driving a light load. Decrease this value if the motor vibrates or stalls while driving a heavy load.	0.00–2.50	1.00
n01-03	Hunting Prevention Time Constant	Hunting Prevention Time Constant	0–500 ms	10
n01-05	Hunting Prevent Gain in Reverse	Reverse Hunting Prevention Gain	0.00–2.50	0.00
n01-08	Current Detection Method *0 2-Phases* *1 3-Phases*	Determines how to suppress motor vibration that is caused by leakage current. A setting of 1 may be beneficial when motor wiring distance is long.	0, 1	0
n01-13	DC Bus Stabilization Control *0 Disabled* *1 Enabled*	Oscillation suppression of the DC bus voltage. A setting of 1 may be beneficial if the DC bus voltage is not stable with light loads and oV faults occur.	0, 1	0
n01-14	DC Bus Stabilization Time	Responsiveness of the DC bus voltage oscillation suppression function. Enable by setting n01-13 = 1.	50.0–500.0 ms	100.0
n01-15	PWM Voltage Offset Calibration *0 No Calibration* *1 One Time Calibrate at Next Start* *2 Calibrate Every Time at Start*	Calibration method used to decrease torque/current ripple.	0–2	0
n01-16	Hunting Prevention High Fc Gain	Hunting prevention gain used when n01-01 = 2.	0.00–2.50	0.50
n01-17	Hunting Prevent High Fc Filter	Hunting prevention responsiveness when n01-01 = 2.	0–1000 ms	500
n01-20	Voltage Calibration Duration	Voltage calibration time at start.	10–500 ms	50

5.8.2 Automatic Frequency Regulator (n02)

The Automatic Frequency Regulator (AFR) is a speed feedback detection reduction function for Open Loop Vector that helps with speed stability during sudden load changes.

Table 5-131: Automatic Frequency Regulator Parameter Settings

Parameter	Display	Function	Range	Default
n02-01	Automatic Freq Regulator Gain	Gain of the AFR function as a magnification value. Increase this value if hunting or oscillation occurs with light loads. Decrease this value if torque is not sufficient with heavy loads or to make response time better.	0.00–10.00	1.00
n02-02	Automatic Freq Regulator Time 1	Time constant that sets the rate of change for the AFR function. Increase this value if hunting or oscillation occurs with light loads. Decrease this value if torque is not sufficient with heavy loads or to make response time better.	0–2000 ms	50
n02-03	Automatic Freq Regulator Time 2	Time constant that sets the speed difference of the AFR function. Increase this value if oV fault occur with heavy loads. Decrease this value to make response time better.	0–2000 ms	750
n02-06	OLV Stabilize Level *0 D03-02 = 10, N02-02 = 25* *1 D03-02 = 20, N02-02 = 50* *2 D03-02 = 30, N02-02 = 75* *3 D03-02 = 50, N02-02 = 125* *4 D03-02 = 60, N02-02 = 150* *5 D03-02 = 80, N02-02 = 200* *6 D03-02 = 100, N02-02 = 250* *7 D03-02 = 120, N02-02 = 300* *8 D03-02 = 140, N02-02 = 350* *9 D03-02 = 160, N02-02 = 400* *10 D03-02 = 200, N02-02 = 500* *11 D03-02 = 240, N02-02 = 600* *12 D03-02 = 200, N02-02 = 700* *13 D03-02 = 320, N02-02 = 800* *14 D03-02 = 360, N02-02 = 900* *15 Custom D03-02 and N02-02*	Used to stabilize torque in OLV applications.	0–15	0
n02-07	OLV NLB AFR Integral Time	ARF integral time during torque proving for NLB OLV applications.	0–2000 ms	5

5.9 Keypad and VFD Configuration (o)

- o01 Keypad Display
- o02 Keypad Operation
- o03 Maintenance Monitors
- o06 User Stored Data

5.9.1 Keypad Display (o01)

The home screen of the keypad can be configured to display various monitors. A maximum of three selected monitors will fit on each screen, and arrow keys can be used to navigate between screens.

Table 5-132: Keypad Display Parameter Settings

Parameter	Display	Function	Range	Default
o01-05	LCD Contrast Adjustment	Adjusts contrast of the keypad display	0–10	5
o01-24 to o01-35	Custom Monitor 1 to 12	Selects a maximum of 12 monitors to be displayed across the home screens. Example: 101 = U01-01 202 = U02-02	0, 101–648	o01-24: 101 o01-25: 102 o01-26: 103 o01-27: 109 o01-28: 110 o01-29: 111 o01-30: 115 o01-31: 116 o01-32: 117 o01-33: 202 o01-34: 204 o01-35: 205
o01-36	LCD Backlight Brightness	Intensity of the LCD keypad backlight.	1–5	4
o01-40	Home Screen Display Selection *0 Custom Monitor* *1 Bar Graph* *2 Analog Gauge* *3 Trend Plot*	Monitor display mode for the Home screen.	0–3	0
o01-41	1st Monitor Area Selection *0 +/- Area (-o01-42 ~ o01-42)* *1 + Area (0 ~ o01-42)*	Horizontal range used to display the monitor set in o01-24 (Custom Monitor 1) as a bar graph.	0, 1	0
o01-42	1st Monitor Area Setting	Horizontal axis value used to display the monitor set in o01-24 (Custom Monitor 1) as a bar graph.	0.0–100.0%	100.0
o01-43	2nd Monitor Area Selection *0 +/- Area (-o01-44 ~ o01-44)* *1 + Area (0 ~ o01-44)*	Horizontal range used to display the monitor set in o01-25 (Custom Monitor 2) as a bar graph.	0, 1	0

Parameter	Display	Function	Range	Default
o01-44	2nd Monitor Area Setting	Horizontal axis value used to display the monitor set in o01-25 (Custom Monitor 2) as a bar graph.	0.0–100.0%	100.0
o01-45	3rd Monitor Area Selection *0 +/- Area (-o01-46 ~ o01-46)* *1 + Area (0 ~ o01-46)*	Horizontal range used to display the monitor set in o01-26 (Custom Monitor 3) as a bar graph.	0, 1	0
o01-46	3rd Monitor Area Setting	Horizontal axis value used to display the monitor set in o01-26 (Custom Monitor 3) as a bar graph.	0.0–100.0%	100.0
o01-47	Trend Plot 1 Scale Minimum Value	Minimum value for the horizontal axis used to display the monitor set in o01-24 (Custom Monitor 1) as a trend plot.	-300.0–(o01-48 - 0.1)%	-100.0
o01-48	Trend Plot 1 Scale Maximum Value	Maximum value for the vertical axis used to display the monitor set in o01-24 (Custom Monitor 1) as a trend plot.	(o01-47 + 0.1)–300.0%	100.0
o01-49	Trend Plot 2 Scale Minimum Value	Minimum value for the horizontal axis used to display the monitor set in o01-25 (Custom Monitor 2) as a trend plot.	-300.0–(o01-50 - 0.1)%	-100.0
o01-50	Trend Plot 2 Scale Maximum Value	Maximum value for the vertical axis used to display the monitor set in o01-25 (Custom Monitor 2) as a trend plot.	(o01-49 + 0.1)–300.0%	100.0
o01-51	Trend Plot Time Scale Setting	Time scale (horizontal axis) to display the trend plot. When this setting is changed, the VFD automatically adjusts the data sampling time.	1–3600 sec	300
o01-55	Analog Gauge Area Selection *0 +/- Area (-o01-56 ~ o01-56)* *1 + Area (0 ~ o01-56)*	Range used to display the monitor set in o01-24 (Custom Monitor 1) as an analog gauge.	0, 1	1
o01-56	Analog Gauge Area Setting	Value used to display the monitor set in o01-24 (Custom Monitor 1) as an analog gauge.	0.0–100.0%	100.0

5.9.2 VFD Configuration (o02)

Table 5-133: VFD Configuration Parameter Settings

Parameter	Display	Function	Range	Default
o02-01	LO/RE Key Function Selection		0, 1	0
	0 Mode/Service	Pressing the LO/RE Key once displays: "Call Magnetek at 1-866-624-7378". Firmware Version (U01-14) VFD Specifications Pressing the LO/RE Key a second time: Control Method (A01-02) Motion (A01-03) Speed Reference (A01-04) Pressing the LO/RE Key a third time: F1/F2/F3 key assignments		
	1 Local/Remote	Pressing the LO/RE key switches operation between the keypad and the settings of b03-01 and b03-02. Local/Remote mode is not compatible with Run Reference 2 (H01-0x = 1F).		
o02-03	User Parameter Default Value	Store or clear a copy of the parameter settings.	0–2	0
	0 No Change			
	1 Set Defaults	Memorizes up to 150 modified parameters. User defaults can be restored by setting A01-05 = 1110.		
	2 Clear All	Clear user defaults.		

Parameter	Display	Function	Range	Default
o02-04	Drive Model (KVA) Selection	VFD model. *Default determined by VFD capacity. Use VFD nameplate.	62–DE	*
	62 2003 (GA80U2004)	2003-G+/VG+S5		
	63 2005 (GA80U2006)	2005-G+/VG+S5		
	64 2007 (GA80U2008)	2007-G+/VG+S5		
	65 2008 (GA80U2010)	2008-G+/VG+S5		
	66 2011 (GA80U2012)	2011-G+/VG+S5		
	67 2014 (GA80U2018)	2014-G+/VG+S5		
	68 2017 (GA80U2021)	2017-G+/VG+S5		
	6A 2025 (GA80U2030)	2025-G+/VG+S5		
	6B 2033 (GA80U2042)	2033-G+/VG+S5		
	6D 2047 (GA80U2056)	2047-G+/VG+S5		
	6E 2060 (GA80U2070)	2060-G+/VG+S5		
	6F 2075 (GA80U2082)	2075-G+/VG+S5		
	70 2088 (GA80U2110)	2088-G+/VG+S5		
	72 2115 (GA80U2138)	2115-G+/VG+S5		
	73 2145 (GA80U2169)	2145-G+/VG+S5		
	74 2180 (GA80U2211)	2180-G+/VG+S5		
	75 2215 (GA80U2257)	2215-G+/VG+S5		
	76 2283 (GA80U2313)	2283-G+/VG+S5		
	77 2346 (GA80U2360)	2346-G+/VG+S5		
	78 2415 (GA80U2415)	2415-G+/VG+S5		
	92 4001 (GA80U4002)	4001-G+/VG+S5		
	93 4003 (GA80U4004)	4003-G+/VG+S5		
	94 4004 (GA80U4005)	4004-G+/VG+S5		
	95 4005 (GA80U4007)	4005-G+/VG+S5		
	96 4007 (GA80U4009)	4007-G+/VG+S5		
	97 4009 (GA80U4012)	4009-G+/VG+S5		
	99 4014 (GA80U4018)	4014-G+/VG+S5		
	9A 4018 (GA80U4023)	4018-G+/VG+S5		
	9C 4024 (GA80U4031)	4024-G+/VG+S5		
	9D 4031 (GA80U4038)	4031-G+/VG+S5		
	9E 4039 (GA80U4044)	4039-G+/VG+S5		
	9F 4045 (GA80U4060)	4045-G+/VG+S5		
	A1 4060 (GA80U4075)	4060-G+/VG+S5		
	A2 4075 (GA80U4089)	4075-G+/VG+S5		
	A3 4091 (GA80U4103)	4091-G+/VG+S5		
	A4 4112 (GA80U4140)	4112-G+/VG+S5		
	A5 4150 (GA80U4168)	4150-G+/VG+S5		
	A6 4180 (GA80U4208)	4180-G+/VG+S5		
	A7 4216 (GA80U4250)	4216-G+/VG+S5		
	A8 4260 (GA80U4302)	4260-G+/VG+S5		

Parameter	Display	Function	Range	Default
o02-04	*A9 4304 (GA80U4371)*	4304-G+/VG+S5	62–DE	*
	AA 4371 (GA80U4414)	4371-G+/VG+S5		
	AC 4414 (GA80U4477)	4414-G+/VG+S5		
	AD 4477 (GA80U4568)	4477-G+/VG+S5 or 4453-G+/VG+S5		
	AE 4515 (GA80U4605)	4515-G+/VG+S5		
	AF 4605 (GA80U4720)	4605-G+/VG+S5		
	B0 4720 (GA80U4810)	4720-G+/VG+S5		
	B1 4810 (GA80U4810)	4810-G+/VG+S5		
	B2 4920 (GA80U4H11)	4920-G+/VG+S5		
	B3 41090 (GA80U4H12)	41090-G+/VG+S5		
	C2 5001 (GA80U5002)	5001-G+/VG+S5		
	C3 5002 (GA80U5003)	5002-G+/VG+S5		
	C4 5003 (GA80U5004)	5003-G+/VG+S5		
	C5 5004 (GA80U5006)	5004-G+/VG+S5		
	C7 5006 (GA80U5009)	5006-G+/VG+S5		
	C9 5009 (GA80U5011)	5009-G+/VG+S5		
	CA 5012 (GA80U5017)	5012-G+/VG+S5		
	CC 5017 (GA80U5022)	5017-G+/VG+S5		
	CD 5022 (GA80U5027)	5022-G+/VG+S5		
	CE 5027 (GA80U5032)	5027-G+/VG+S5		
	CF 5032 (GA80U5041)	5032-G+/VG+S5		
	D1 5041 (GA80U5052)	5041-G+/VG+S5		
	D2 5052 (GA80U5062)	5052-G+/VG+S5		
	D3 5062 (GA80U5077)	5062-G+/VG+S5		
	D4 5077 (GA80U5099)	5077-G+/VG+S5		
	D5 5099 (GA80U5125)	5099-G+/VG+S5		
	D6 5125 (GA80U5144)	5125-G+/VG+S5		
	D7 5172 (GA80U5192)	5172-G+/VG+S5		
	D9 5192 (GA80U5242)	5192-G+/VG+S5		
	DA 5242 (GA80U5289)	5242-G+/VG+S5		
	DB 5289 (GA80U5336)	5289-G+/VG+S5		
	DC 5336 (GA80U5382)	5336-G+/VG+S5		
	DD 5382 (GA80U5412)	5382-G+/VG+S5		
	DE 5412 (GA80U5472)	5412-G+/VG+S5		
o02-05	Home Mode Freq Ref Entry Mode	ENTER key is used when the frequency reference is set by the keypad. The keypad can simulate a motor operated potentiometer (M.O.P.).	0, 1	0
	0 ENTER Key Required	ENTER Key Required		
	1 Immediate / MOP-style	ENTER Key Not Required ***NOTE:*** *This feature cannot be used with infinitely variable speed control.*		

Parameter	Display	Function	Range	Default
o02-09	Region Code *1 American Spec* *2 European Spec*	VFD region. This presets the voltage and frequencies along with the motor power units that are common to the region.	1, 2	1
o02-10	Motor Power Units *0 HP* *1 kW*	Units for motor power.	0, 1	0
o02-23	External 24V Powerloss Detection *0 Disabled* *1 Enabled*	Display a (L24v) alarm if the backup external 24 VDC power supply is lost when the main circuit power supply is on.	0, 1	0
o02-24	LED Light Function Selection *0 Enable Status Ring & Keypad LED* *1 LED Status Ring Disable* *2 Keypad LED Light Disable*	Function of the LED status rings and keypad LED lights.	0–2	0
o02-26	Alarm Display at Ext. 24V Power *0 Disabled* *1 Enabled*	Display an (EP24v) alarm if the main supply power decreases below the UV level and an external 24 VDC is still active. This indicates that the control circuit is still live, but VFD operation is not possible.	0, 1	1

5.9.3 Maintenance Monitors (o03)

Table 5-134: Maintenance Monitors Parameter Settings

Parameter	Display	Function	Range	Default
o03-01	Elapsed Operating Time Setting	Initial operation time of the VFD in units of 10 hours. Cumulative time can be viewed using monitor Cumulative Operation Time (U04-01). A setting of 30 = 300 hours	0–9999 x 10 Hrs	0
o03-02	Elapsed Operating Time Selection	How the operation time monitor (U04-01) will keep track of the total operation time.	0, 1	1
	0 U04-01 Shows Total Power-up Time	Logs power-on time		
	1 U04-01 Shows Total RUN Time	Logs operation time when the VFD output is active.		
o03-03	Fan Operation Time Setting	Fan Operation Time monitor (U04-03) in units of 10 hours. A setting of 30 = 300 hours	0–9999 x 10 Hrs	0
o03-05	Capacitor Maintenance Setting	Maintenance Monitor for the capacitors. See U04-05 to check when the capacitors may need to be replaced.	0–150%	0
o03-07	Softcharge Relay Maintenance Set	Maintenance Monitor for the precharge relay. See U04-06 to check when the precharge relay may need to be replaced.	0–150%	0
o03-09	IGBT Maintenance Setting	Maintenance Monitor for the IGBTs. See U04-07 for IGBT replacement times.	0–150%	0
o03-11	Fault Trace/History Init (U02/U03)	Fault Trace (U02-xx) and Fault History (U03-xx) reset.	0, 1	0
	0 No Reset	Not cleared.		
	1 Reset	Resets the U02-xx and U03-xx fault history		
o03-12	kWh Monitor Initialization	Reset the monitor data (U04-10 and U04-11).	0, 1	0
	0 No Reset	Not cleared.		
	1 Reset	Resets the U04-10 and U04-11 power meter.		
o03-13	RUN Command Counter @ Initialize	Reset the run command counter monitors (U04-24 and U04-25).	0, 1	0
	0 No Reset	Not cleared.		
	1 Reset	Resets the U04-24 and U04-25 counters.		
o03-14	Clear OL/LC/OW Counter	Reset the Overload (OL), Load Check (LC), and Overweight (OW) fault counter (U01-73).	0, 1	0
	0 No Reset	Not cleared.		
	1 Reset	Resets the U01-73 counter.		
o03-22	Time Format	Time display format.	0–2	1
	0 24 Hour Clock			
	1 12 Hour Clock			
	2 12 Hour JP Clock			
o03-23	Date Format	Date display format.	0–2	2
	0 YYYY/MM/DD			
	1 DD/MM/YYYY			
	2 MM/DD/YYYY			

Parameter	Display	Function	Range	Default
o03-24	bAT Detection Selection *0 Disable* *1 Enable (Alarm Detected)* *2 Enable (Fault Detected)*	Operation when a low keypad battery alarm (bAT) or keypad time not set alarm (TiM) occurs.	0–2	0

5.9.4 User Stored Data (o06)

The parameters in the section can be used for data storage. The parameters and their settings have no effect on the performance of the VFD.

Table 5-135: User Stored Data Parameter Settings

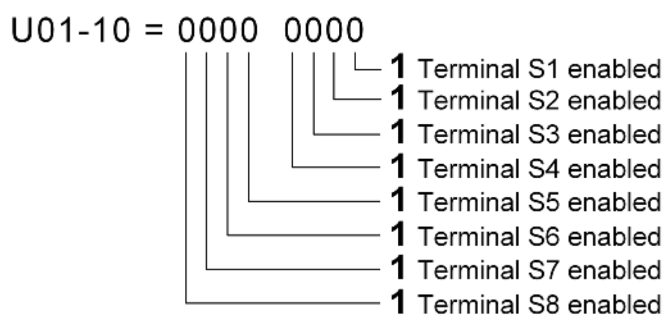
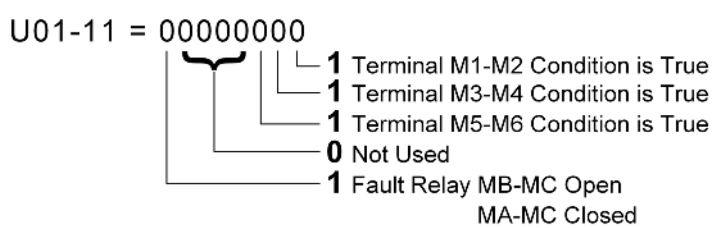
Parameter	Display	Function	Range	Default
o06-01 to o06-16	User Stored Data 0 to 15	User stored data Slot 0 to Slot 15.	0–65535	0

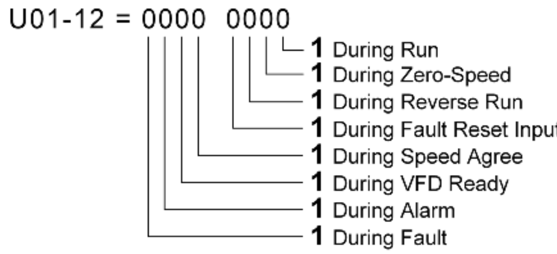
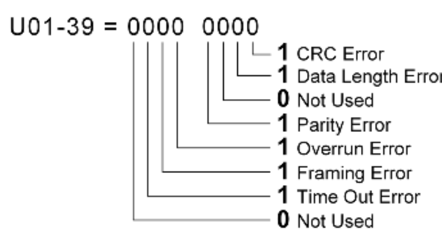
5.10 Monitors (U)

- U01 Operation Status
- U02 Fault Trace
- U03 Fault History
- U04 Maintenance
- U06 Control Status

5.10.1 Operation Status (U01)

Table 5-136: Operation Status Monitors

Monitor	Display	Function	Units
U01-01	Frequency Reference	Frequency Reference	Hz
U01-02	Output Frequency	Output Frequency	Hz
U01-03	Output Current	Output Current	A
U01-04	Control Method	Value of A01-02	-
U01-05	Motor Speed	Motor Speed	Hz
U01-06	Output Voltage Reference	Output Voltage (Reference)	VAC
U01-07	DC Bus Voltage	DC Bus Voltage (Measured)	VDC
U01-08	Output Power	Output Power (Calculated)	HP/kW
U01-09	Torque Reference	Torque Reference (Internal)	%
U01-10	Input Terminal Status	Input Terminal Status 	-
U01-11	Output Terminal Status	Output Terminal Status 	-

Monitor	Display	Function	Units
U01-12	Drive Status	Operation Status 	-
U01-14	Software Number Flash	Firmware version	-
U01-15	Terminal A1 Level	External Terminal A1 analog input level	%
U01-16	Terminal A2 Level	External Terminal A2 analog input level	%
U01-17	Terminal A3 Level	External Terminal A3 analog input level	%
U01-18	FM Output Level	Internal Terminal FM analog output level	%
U01-19	AM Output Level	Internal Terminal AM analog output level	%
U01-20	SFS Output Frequency	Output frequency after the soft starter, which includes acceleration and deceleration times, and s-curves.	Hz
U01-24	Option Card MFDO 8 Bits	Output from the option card S4IO - 8 bits.	-
U01-25	Option Card MFDI Lower 8 Bits	Inputs from the option card (DI-A3 or S4IO) lower 8 bits.	-
U01-26	Option Card MFDI Upper 8 Bits	Inputs from the option card (DI-A3 or S4IO) upper 8 bits.	-
U01-30	SS Delta Speed	Snap Shaft delta speed between Ch1 and Ch2 after gear ratio	RPM
U01-31	Hoist Weight	Measured hoist weight.	C10-03
U01-32	Crane Weight Sum	Measured crane load sum weight.	C10-38
U01-34	oPE Fault Parameter	Parameter that caused the oPExx error.	-
U01-39	MEMOBUS/Modbus Error Code	Contents of a Modbus error 	-
U01-48	SCS - Revs to Stop	Number of motor revolutions to stop from the current speed.	Revs
U01-49	Swing Length	Calculated pendulum swing length. Distance from the hoist drum to the load's center of gravity.	Ft
U01-50	Hook Height	Percentage of hook height. Displays 0% until the system is homed.	%
U01-51	Motor Revolution	Number of revolutions with respect to Home position.	Revs
U01-53	Index Count	Number of motor revolutions the shaft has moved since the beginning of a new Index command.	Revs
U01-54	Input Pulse Monitor	Frequency of pulse train input terminal RP.	Hz
U01-60	Encoder 1 Pulse Counter	Raw PG Channel 1 pulse count 4 pulses = 1 ppr of F01-01	Pulses

Monitor	Display	Function	Units
U01-61	Encoder 2 Pulse Counter	Raw PG Channel 2 pulse count 4 pulses = 1 ppr of F01-11	Pulses
U01-68	Load Check Zone	Load Check zone the VFD was in when an LC fault occurred.	-
U01-69	Load Check Margin	How close the current/torque levels are to the target value for each of the Load Check zones. Values less than zero will cause an LC detection or an LC fault to occur. If the LC fault occurs, the value is the amount the level was below the Load Check zone setting.	%
U01-73	OL/LC Count	Count of oL1, oL2, and LC faults. Counter cleared by o03-14.	-
U01-81	WMS Torque @ Accel 1	Torque of acceleration point 1 during Weight Measurement setup.	%
U01-82	WMS Torque @ Accel 2	Torque of acceleration point 2 during Weight Measurement setup.	%
U01-86	Brake Test Torque	Brake Test breakaway torque	FtLb
U01-91	Output Voltage	Internal output voltage reference (pre AVR).	VAC

5.10.2 Fault Trace (U02)

Table 5-137: Fault Trace Monitors

Monitor	Display	Function	Units
U02-01	Current Fault	Most current fault detected before being reset	-
U02-02	Previous Fault	Most recent fault after being reset	-
U02-03	Frequency Reference @ Fault	Frequency reference when the fault was detected	Hz
U02-04	Output Frequency @ Fault	Output frequency when the fault was detected	Hz
U02-05	Output Current @ Fault	Output current when the fault was detected	A
U02-06	Motor Speed @ Fault	Motor Speed when the fault was detected	Hz
U02-07	Output Voltage @ Fault	Output voltage when the fault was detected	VAC
U02-08	DC Bus Voltage @ Fault	DC Bus voltage when the fault was detected	VDC
U02-09	Output Power @ Fault	Output power when the fault was detected	HP/kW
U02-10	Torque Reference @ Fault	Torque reference when the fault was detected	%
U02-11	Input Terminal Status @ Fault	Input terminal status (U01-10) when the fault was detected	-
U02-12	Output Terminal Status @ Fault	Output terminal status (U01-11) when the fault was detected	-
U02-13	Operation Status @ Fault	Drive Status (U01-12) when the fault was detected	-
U02-14	Elapsed Time @ Fault	Elapsed time when the fault was detected	Hrs
U02-15	SFS Output @ Fault	Output frequency after the soft starter when the fault was detected	Hz
U02-16	q-Axis Current @ Fault	Q-axis current for the motor when the fault was detected	%
U02-17	d-Axis Current @ Fault	D-axis current for the motor when the fault was detected	%
U02-20	Heatsink Temperature @ Fault	Temperature of the heatsink when the fault was detected	°C

5.10.3 Fault History (U03)

Table 5-138: Fault History Monitors

Monitor	Display	Function	Units
U03-01	1st Most Recent Fault	First most recent fault	-
U03-02	2nd Most Recent Fault	Second most recent fault	-
U03-03	3rd Most Recent Fault	Third most recent faults	-
U03-04	4th Most Recent Fault	Fourth most recent fault	-
U03-05	5th Most Recent Fault	Fifth most recent fault	-
U03-06	6th Most Recent Fault	Sixth most recent fault	-
U03-07	7th Most Recent Fault	Seventh most recent fault	-
U03-08	8th Most Recent Fault	Eighth most recent fault	-
U03-09	9th Most Recent Fault	Ninth most recent fault	-
U03-10	10th Most Recent Fault	Tenth most recent fault	-
U03-11	Elapsed Time @ 1st Fault	Elapsed time of the first most recent fault	Hrs
U03-12	Elapsed Time @ 2nd Fault	Elapsed time of the second most recent fault	Hrs
U03-13	Elapsed Time @ 3rd Fault	Elapsed time of the third most recent fault	Hrs
U03-14	Elapsed Time @ 4th Fault	Elapsed time of the fourth most recent fault	Hrs
U03-15	Elapsed Time @ 5th Fault	Elapsed time of the fifth most recent fault	Hrs
U03-16	Elapsed Time @ 6th Fault	Elapsed time of the sixth most recent fault	Hrs
U03-17	Elapsed Time @ 7th Fault	Elapsed time of the seventh most recent fault	Hrs
U03-18	Elapsed Time @ 8th Fault	Elapsed time of the eighth most recent fault	Hrs
U03-19	Elapsed Time @ 9th Fault	Elapsed time of the ninth most recent fault	Hrs
U03-20	Elapsed Time @ 10th Fault	Elapsed time of the tenth most recent fault	Hrs

5.10.4 Maintenance (U04)

Table 5-139: Maintenance Monitors

Monitor	Display	Function	Units
U04-01	Cumulative Operation Time	Cumulative operation time of the VFD. Reset with o03-01. Use parameter o03-02 to determine if the operation time should start as soon as the power is switched on or only while the Run command is present. After the count reaches 99999, it will reset to 0 and start counting again.	Hrs
U04-03	Cooling Fan Operation Time	Cumulative operation time of the cooling fan. Reset with o03-03. After the count reaches 99999, it will reset to 0 and start counting again.	Hrs
U04-04	Cooling Fan Maintenance	Main cooling fan usage time as a percentage of its expected performance life. Reset with o03-03.	%
U04-05	Capacitor Maintenance	Main circuit capacitor usage time as a percentage of their expected performance life. Reset with o03-05.	%
U04-06	Precharge Relay Maintenance	Soft charge bypass relay maintenance time as a percentage of its estimated performance life. Reset with o03-07.	%
U04-07	IGBT Maintenance	IGBT usage time as a percentage of the expected performance life. Reset with o03-09.	%
U04-08	Heatsink Temperature	Heatsink temperature.	°C
U04-09	LED Check	Lights all LED segments to verify the display is working properly.	-

Monitor	Display	Function	Units
U04-10	kWh, Lower 4 Digits	VFD output power. The value is a 9 digit number displayed across two monitors, U04-10 and U04-11.	kWH
U04-11	kWh, Upper 5 Digits	-	MWH
U04-13	Peak Hold Current	Highest current value that occurred during run.	A
U04-14	Peak Hold Output Frequency	Output frequency when the value shown in U04-13 occurred.	Hz
U04-16	Motor oL1 Level	Motor overload detection accumulator. 100% is equal to the oL1 detection level. Accumulator is reset when power is cycled.	%
U04-17	Drive oL2 Level	100% = oL2 detection level	%
U04-18	Reference Source	Source for the frequency reference as XY-nn. X: Run/Reference Selection (H01-xx = 1F) • 1: b03-01 (Frequency Reference Selection 1) • 2: b03-15 (Frequency Reference Selection 2) Y-nn: Frequency reference source • 0-01: Keypad • 1-00: Analog (unassigned) • 1-01: Analog terminal A1 • 1-02: Analog terminal A2 • 1-03: Analog terminal A3 • 2-02 to 2-17: Multi-Step Reference 2 to 16, Jog Reference • 3-01: Modbus communications • 4-01: Communication option card • 5-01: Pulse train input	-
U04-19	Modbus Frequency Reference	Frequency reference provided by Modbus (decimal).	%
U04-20	Option Frequency Reference	Frequency reference input by an option card (decimal).	%
U04-21	Run Command Source	Source for the Run command as XY-nn. See U04-18.	-
U04-22	Modbus Command Data	Data sent by Modbus register 0001H as a four-digit hexadecimal number.	-
U04-23	Option Command Data	Data sent by an option card as a four-digit hexadecimal number.	-
U04-24	Number of Runs (Low)	Lower 4 digits of the VFD run counter. The run counter appears as an 8-digit number. Counter reset by o03-13.	-
U04-25	Number of Runs (High)	Upper 4 digits of the VFD run counter. The run counter appears as an 8-digit number. Counter reset by o03-13.	-
U04-26	OL/LC/OW Count	Counter of oL1, oL2, and LC faults. Counter reset by o03-14.	-
U04-27	Run Time Elapsed	Run time hours since last timer reset. Set using C12-05. Reset using MFDI = 7C.	Hrs
U04-28	Run Time Remaining	C12-05 - U04-27	Hrs
U04-29	On Time Elapsed	On time hours since last timer reset. Set using C12-07. Reset using MFDI = 7D.	Hrs
U04-30	On Time Remaining	C12-07 - U04-29	Hrs
U04-31	Brake Cycle Counts	Brake cycle count since last reset. Set using C12-08. Reset using MFDI = 7E.	-
U04-33	Brake Cycles Remaining	C12-08 - U04-31	-
U04-35	Lift Counter	Lift counter. Reset using MFDI = 7F.	-
U04-49	Password Challenge	Challenge code for temporary Factory password.	-
U04-52	Torque Reference from Comm	Torque reference received from a communication option card or from Modbus communications as a decimal number.	%

5.10.5 Control Status (U06)

Table 5-140: Control Status Monitors

Monitor	Display	Function	Units
U06-01	Iq Secondary Current	Motor secondary current (Iq) as a percentage of motor rated secondary current.	%
U06-02	Id Excitation Current	Motor excitation current (Id) as a percentage of motor rated secondary current.	%
U06-03	ASR Input	ASR input as a percentage of maximum frequency.	%
U06-04	ASR Output	ASR output as a percentage of motor rated secondary current.	%
U06-05	Output Voltage Reference (Vq)	Output voltage reference (Vq) for the q-axis.	VAC
U06-06	Output Voltage Reference (Vd)	Output voltage reference (Vd) for the d-axis.	VAC
U06-07	q-Axis ACR Output	ACR output relative to motor secondary current (q-axis).	%
U06-08	d-Axis ACR Output	ACR output relative to motor secondary current (d-axis).	%
U06-21	Offset Frequency	Total value of b08-05 to b08-07 (Offset Frequency 1 to 3) with Add Offset Frequency 1 to 3 (H01-xx = 6C to 6E).	%
U06-31	Torque Detect Monitor	Torque reference or output current after applying the filter set to L06-07 (Torque Detection Filter Time).	%
U06-36	Comm Errors-Host	Number of inter-CPU communication errors. When the VFD is powered off, this value resets to 0.	-
U06-37	Comm Errors-Sensor	Number of inter-CPU communication errors. When the VFD is powered off, this value resets to 0.	-
U06-48	ASIC Comm Errors	Number of inter-ASIC communication errors. When the VFD is powered off, this value resets to 0.	-
U06-80	Option IP Address 1	Assigned local IP address (1st octet).	-
U06-81	Option IP Address 2	Assigned local IP address (2nd octet).	-
U06-82	Option IP Address 3	Assigned local IP address (3rd octet).	-
U06-83	Option IP Address 4	Assigned local IP address (4th octet).	-
U06-84	Option Subnet 1	Assigned subnet mask (1st octet).	-
U06-85	Option Subnet 2	Assigned subnet mask (2nd octet).	-
U06-86	Option Subnet 3	Assigned subnet mask (3rd octet).	-
U06-87	Option Subnet 4	Assigned subnet mask (4th octet).	-
U06-88	Option Gateway 1	Assigned Gateway address (1st octet).	-
U06-89	Option Gateway 2	Assigned Gateway address (2nd octet).	-
U06-90	Option Gateway 3	Assigned Gateway address (3rd octet).	-
U06-91	Option Gateway 4	Assigned Gateway address (4th octet).	-
U06-92	Online Speed	Assigned communications speed of Port 1. (10: 10 Mbps or 100: 100 Mbps)	-
U06-93	Online Duplex	Assigned duplex setting of Port 1. (0: Half/Half or 1: Full/Full)	-
U06-94	OPT SPARE 1	Assigned communications speed of Port 2. (10: 10 Mbps or 100: 100 Mbps). Only available for dual-port communication option cards.	-
U06-95	OPT SPARE 2	Assigned duplex setting of Port 2. (0: Half/Half or 1: Full/Full) Only available for dual-port communication option cards.	-

Monitor	Display	Function	Units
U06-96	OPT SPARE 3	Rapid Spanning Tree Protocol (RSTP) status of Port 1 and Port 2. RSTP is only available for dual-port communication option cards and allows for enabling a ring protocol. It can only be enabled from the option card webpage. **First Digit (Port 1 Role):** 0 = Unknown, 2 = Root, 3 = Designated, 4 = Alternate, 5 = Backup, 6 = Disabled, 9 = RSTP Disabled **Second Digit (Port 1 State):** 0 = Discarding, 1 = Learning, 2 = Forwarding **Third Digit (Port 2 Role):** 0 = Unknown, 2 = Root, 3 = Designated, 4 = Alternate, 5 = Backup, 6 = Disabled, 9 = RSTP Disabled **Fourth Digit (Port 2 State):** 0 = Discarding, 1 = Learning, 2 = Forwarding	-
U06-97	OPT SPARE 4	Firmware version of the communications option card. The first three digits refer to the firmware version. The fourth digit is the subversion. For example, an Ethernet/IP option card with firmware version VST904107 will display 1071 at this monitor.	-
U06-98	First Fault	Most recent communications fault. 0 = No fault. 3 = EF0 fault. 1100 = No network link. 1101 = Node timer (RPI) timed out. 1102 = Duplicate IP address. 1103 = MAC Address invalid.	-
U06-99	Current Fault	Currently active communications fault. 0 = No fault. 3 = EF0 fault. 1100 = No network link. 1101 = Node timer (RPI) timed out. 1102 = Duplicate IP address. 1103 = MAC Address invalid.	-

5.10.6 Special Firmware (U07)

Table 5-141: Special Firmware Monitors

Monitor	Display	Function	Units
U07-01	Leader Reference	Speed reference from the Synchronization Leader prior to gear ratio adjustments (C09-04 to C09-06).	Hz
U07-02	Gear Ratio Reference	Gear ratio reference of the Synchronization Leader after factoring in the gear ratio parameters (C09-04 to C09-06).	Hz
U07-03	Sync Error Counts	Synchronization encoder pulse differential between the Follower and Leader. Typically used with the Auto Resynchronization function.	Pulses
U07-04	Sync Error Revs	Synchronization motor revolutions differential between the Follower and Leader. Typically used with the Auto Resynchronization function.	Revs
U07-05	Proportional Correct	Synchronization frequency adjustment to the Follower based on the C09-07 setting.	Hz
U07-06	Integral Correction	Synchronization frequency adjustment to the Follower based on the C09-08 setting.	Hz
U07-10	Bucket Motor 1 Revs	Bucket Control position of the Holder motor. Zero out using MFDI A0 (Bucket - Set Closed Position).	Revs
U07-11	Bucket Motor 2 Revs	Bucket Control position of the Closer motor. Zero out using MFDI A0 (Bucket - Set Closed Position).	Revs
U07-12	Bucket Delta Revs	Difference between U07-10 and U07-11 to indicate how opened/ closed the bucket is. Set the closed position (zero) using MFDI A0 (Bucket - Set Closed Position).	Revs

6 Troubleshooting

6.1 Troubleshooting the VFD

In this troubleshooting section, “Check,” means investigating whether an item is functioning and in an acceptable physical condition, and then taking corrective action (adjusting, fixing, replacing, etc.) as necessary. In the “Corrective Action” column, you may not have to perform all of the steps to correct the problem.

Alarms and Faults are described as follows:

- **Fault:** Brake is set, operation indicator lights flash, fault code is displayed on keypad, and fault relay MB-MC is activated. The reset key must be pressed, a digital input set for fault reset is enabled, or VFD power is cycled in order to continue operation.
- **Alarm or Error:** Brake may not set, operation is conditionally allowed to continue, alarm or error code is displayed on the keypad and ALM LED flashes, fault relay is not activated.

Visit Magnetek’s YouTube channel for a playlist of troubleshooting videos. Each video is specific to troubleshooting a specific fault or alarm. Additional videos walk through basic VFD navigation and the setup of certain features.

https://youtube.com/playlist?list=PLszDgq8G1Y2DO8kCRy3yS8zK1AXQrHi-2&si=cAMLYrQgWpgD1e8E

Figure 6-1: Series 5 YouTube Playlist

6.1.1 Maintenance and Inspection

This section describes basic maintenance and inspection procedures for the VFD.

Table 6-1: Maintenance and Inspection

Component	Check	Corrective Action
External terminals, connectors, mounting screws, etc.	Loose screws or connectors	Securely tighten.
Heatsink	Build-up of dust and dirt	Blow with dry, compressed air (57-86 psi).
Printed Circuit Board (PCB)	Accumulation of conductive dust or oil	Blow with dry, compressed air (57-86 psi). If dust and oil cannot be removed, replace the board.
Cooling Fan	Abnormal noise and vibration	Clean or replace the fan.
Power Components	Accumulation of dust or dirt	Blow with dry, compressed air (57-86 psi).

Table 6-2: Motor Related Issues

Symptom	Corrective Action
Analog frequency reference is not stable. (drifting)	1. Stabilize the analog source. 2. Increase H03-13. 3. Increase b05-01 or b05-02.
No motor rotation.	1. Verify that power is on (Charge LED). 2. Verify that the keypad display is not showing a fault. 3. Verify that the run command is input to the VFD (U01-10). 4. Check if motor is stalled due to excessive load.
Motor rotation is in the wrong direction.	1. Verify FWD/REV or UP/DN is correct at the interface card. 2. Match wiring to the phase order of motor leads T1, T2, T3. 3. Change motor rotation (b03-04).
Motor rotates, but at minimum speed only.	1. Check wiring of speed inputs. 2. Verify speed reference setting (A01-04). 3. Verify reference and run source settings (b03-01, -02). 4. Verify encoder direction (VG+).
Motor RPM too high or too low.	1. Compare motor nameplate with E02 parameters. 2. Check maximum frequency setting (E01-04). 3. Check minimum frequency setting (E01-09).

Table 6-3: VFD Faults and Alarms

Display	Description	Corrective Action	Fault	Alarm
AFbL-1 Analog Feedback Lost - 1	**Analog Feedback Lost 1 Fault.** The 4-20mA analog input signal at Terminal A1 is less than 2mA for the time set at H03-19 or if C10-45 = 1 (Enabled) and the Load Sum analog input signal is less than 3%.	1. Check the terminal A1 wiring. 2. Verify proper setting of H03-19. 3. Verify proper setting of C10-45.	X	
AFbL-2 Analog Feedback Lost - 2	**Analog Feedback Lost 2 Fault.** The 4-20mA analog input signal at Terminal A2 is less than 2mA for the time set at H03-19.	1. Check the terminal A2 wiring. 2. Verify proper setting of H03-19.	X	
AFbL-3 Analog Feedback Lost - 3	**Analog Feedback Lost 3 Fault.** The 4-20mA analog input signal at Terminal A3 is less than 2mA for the time set at H03-19.	1. Check the terminal A3 wiring. 2. Verify properly setting of H03-19.	X	
AS1 Anti-Shock 1	**Anti-Shock Indicator.** When Anti-Shock is triggered, the fault or alarm will be displayed on the keypad for the duration of time set via C07-22.	1. No action is required.	X	X
bAT Keypad Battery Low Voltage	**Keypad Battery Low Voltage Fault or Alarm.** The keypad battery voltage is low.	1. Replace the CR2016 battery inside the keypad. 2. Use o03-24 to adjust bAT detection.	X	X
bb Baseblock	**External Baseblock.** The baseblock signal is the result of a digital input. The baseblock indicates that the VFD's output has been disabled. The motor will begin coasting when the baseblock input is received while running. If a RUN command is still present when the bb alarm is cleared, the VFD will continue operation at the currently commanded frequency.	1. Check H01-01 through H01-08 for proper programming. 2. Check input status (U01-10).		X

Display	Description	Corrective Action	Fault	Alarm
BE0 Brake Answerback Lost	**Brake Answerback Lost During Run.** While running, the digital input for brake answerback (H01-0x = 58) is lost for longer than the C08-04 detection time.	1. Check brake answerback circuit. 2. Increase the value of C08-04.	X	X
BE0-2 Brake 2 Answerback Lost	**Brake 2 Answerback Lost During Run.** While running, the digital input for brake answerback 2 (H01-0x = 6B) is lost for longer than the C08-04 detection time.	1. Check brake 2 answerback circuit. 2. Increase the value of C08-04.	X	X
BE1 Rollback Detect	**Torque Proving Fault.** The BE1 fault indicates that the VFD has released the brake, but encoder pulses are detected before the motor is commanded to accelerate. A BE1 fault will occur if the pulses received during the BE1 detection time (C08-04) are greater then the expected number of pulses (C08-05).	1. Enable Field Forcing (b09-03 = 1). 2. Extend C08-01 to 1.5 sec. 3. Verify Auto-Tune was successful. 4. ***See Section 6.2 on page 362***.	X	
BE2 No Current	**Torque Proving Fault.** Before the brake is released, the VFD's torque did not reach Initial Brake Torque level (C08-16) within the BE2 Torque Detection Time (C08-02).	1. Ensure the motor has been Auto-Tuned successfully. 2. Verify the brake is closed. 3. If a power limit switch is used, ensure the switch is closed. 4. Decrease the value of C08-02 to no less than 0.5 seconds. 5. Decrease the value of C04-02 to no less than 5. 6. Decrease the value of C08-16 to no less than 50.	X	
BE3 Brake Release NG	**Brake Release Fault.** The BE3 fault indicates that the VFD has released the brake and commanded the VFD to run, but it has not detected the expected encoder feedback. A BE3 fault will occur if the pulses received during the BE3 detection time (C08-06) are less than the expected number of pulses (C08-07).	1. Enable Field Forcing (B09-03 = 1). 2. Extend C08-01 to 1.5 sec. 3. Verify Auto-Tune was successful. 4. ***See Section 6.2 on page 362***.	X	
BE4 Brake Ans At Start	**Brake Answerback, Brake not Released Fault.** At Start, a Brake Answerback input is not received within predetermined time (C08-04) after the brake release command is issued. This means the brake has not mechanically released.	1. Check brake answerback circuit. 2. Increase the value of C08-04. 3. Check input status (U01-10).	X	
BE4-2 Brake Ans At Start - 2	**Brake 2 Answerback, Brake not Released Fault.** At Start, a Brake 2 Answerback input is not received within predetermined time (C08-04) after the brake release command is issued. This means the brake has not mechanically released.	1. Check brake 2 answerback circuit. 2. Increase the value of C08-04. 3. Check input status (U01-10).	X	
BE5 Brake Ans At Stop	**Brake Answerback At Stop.** At Stop, Brake Answerback signal is not removed within predetermined time (C08-11) after brake release command is removed—brake not closed.	1. Check brake answerback circuit. 2. Increase the C08-11 time.	X	X
BE5-2 Brake Ans At Stop - 2	**Brake 2 Answerback at Stop.** At Stop, Brake 2 Answerback signal is not removed within predetermined time (C08-11) after brake release command is removed—brake not closed.	1. Check brake 2 answerback circuit. 2. Increase the C08-11 time.	X	X

Display	Description	Corrective Action	Fault	Alarm
BE6 Brake Slipping	**Brake Proving Alarm.** The VFD has commanded the brake to set but detected excessive encoder feedback. This occurs if the number of pulses received during BE6 Detection Time (C08-12) is greater than the BE6 Maximum Pulse Count (C08-13).	1. Check the brake. 2. ***See Section 6.2 on page 362***.	X*	X
BE6-2 Brake Slipping - 2	**Brake 2 Slipping Alarm.** Load slipping while Brake 2 is closed.	1. Check the brake. 2. ***See Section 6.2 on page 362***.	X*	X
BE7 Brake Welded	**Brake Answerback Fault.** Brake Answerback for Brake 1 is on at power-up, which indicates a brake that is stuck open.	1. Check if brake is closed. 2. Check brake answerback circuit.	X	
BE7-2 Brake Welded - 2	**Brake 2 Answerback Fault.** Brake Answerback for Brake 2 is on at power-up, which indicates a brake that is stuck open.	1. Check if brake is closed. 2. Check brake answerback circuitry.	X	
BE8 Brake Slipping	**Brake Slipping Alarm.** The VFD has detected excessive encoder feedback while not running. This occurs if the encoder frequency exceeds C08-23; Load Float will be enabled, and the brake will remain closed.	1. Check the brake. 2. Check C08-23 for proper programming. 3. ***See Section 6.2 on page 362***.	X*	X
BE9 Brake Force ON At PowerUp	**Brake Force MFDI ON at Powerup.** The MFDI (7B) to force open the brake was on at VFD powerup.	1. Turn the 7B MFDI off and clear the fault.	X	
boL Braking Transistor Overload	**Braking Transistor Overload.** The braking transistor reached its overload level.	1. The wrong braking resistor is installed. 2. Select the correct braking resistor. 3. Install an external braking module.	X	X
BRKTEST Brake Slipped During Test	**Brake Test Failed.** The motor didn't develop enough torque or the brake slipped while building torque to the C08-24 level. Resulting fault or alarm is selected via C08-25.	1. Check C08-24 torque setting. 2. Ensure the brake is closed during the test. 3. Repair the brake if insufficient braking torque is confirmed.	X	X
BRKTEST Brake Test: Passed	**Brake Test Passed.** The brake test has lasted 10 seconds without detected brake slippage.	1. No action is required.		X
bUS Option Communication Error	**Option Card Communication Error.** Communication to the option card was lost.	1. Check all connections between the PLC and VFD.	X	X
CALL Serial Comm Transmission Error	**Serial Communication Transmission Error.** Control data is not received correctly after power supply is turned ON for 2 sec.	1. Check serial device connections. 2. Ensure VFD is properly programmed for serial communication.		X

Display	Description	Corrective Action	Fault	Alarm
CantSW Motor Running	**Can't Switch - Motor Running.** Trying to enable or disable the Run/Reference Selection 2 MFDI (H01-xx or F03-xx = 1F), while the motor is still running. If in Synchronization (C09) mode, attempting to switch between Leader and Follower mode or Gear Ratio 1 and 2, while in motion.	1. Allow the motor to come to a stop before enabling or disabling the Run/Reference Selection 2 MFDI. 2. Sync: Do not switch between Leader and Follower mode or between Gear Ratio 1 and 2, while in motion. 3. Sync: Increase C09-15 to allow switching Sync modes at higher speeds or if instability occurs while switching at low speeds.	X	X
CE Modbus Communication Error	**Communication Error.** Serial communications disruption. Fault or alarm defined by H05-04.	1. Check serial connections. 2. Check H05-01 through H05-05 for proper programming.	X	X
CoF Current Offset	**Current Offset Fault.** The VFD automatically adjusts the current offset, the calculated value exceeded the allowable setting range.	1. Press reset. 2. Check brake. 3. Check brake contact.	X	
CPF00 CPF01 Control Circuit Error	**Control Circuit Error.** There is a self-diagnostic error in the control circuit, or the connector on the keypad is damaged.	1. Cycle power to the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board. 3. Replace the keypad if it is damaged.	X	
CPF02 A/D Conversion Error	**A/D Conversion Error.** An A/D conversion error or control circuit error occurred. The control circuit is damaged.	1. Cycle power to the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	

Display	Description	Corrective Action	Fault	Alarm
CPF03 Control Board Connection Error	**Control Board Connection Error.** Connection error between the control board and the VFD. Can be caused by a connection error, or the VFD failing to operate properly due to noise interference.	**Connection Error:** 1. Turn off the power and check the connection between the control board and the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board. **Noise Interference:** 1. Check the various options available to minimize the effects of noise. 2. Counteract noise in the control circuit, main circuit, and ground wiring. 3. Use only recommended cables or other shielded line. Ground the shield on the controller side or the VFD input power side. 4. Ensure that other equipment such as switches or relays do not cause noise. Use surge suppressors if required. 5. Separate all communication wiring from VFD power lines. Install an EMC noise filter to the VFD power supply input.	X	
CPF06 EEPROM Memory Data Error	**EEPROM Memory Data Error.** An Error in the data saved to EEPROM. Can be caused by an error in the EEPROM control circuit, or the power supply being switched off while parameters are being saved to the VFD. This error occurs if the terminal board isn't making a good connection with the control board, perhaps due to a bent pin in the connector.	1. Turn off the power and check the connection between the control board and the terminal board. 2. If the problem continues, replace the terminal board, control board, or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	
CPF07 CPF08 Terminal Board Connection Error	**Terminal Board Connection Error.** There is a fault connection between the terminal board and the control board.	1. Turn off the power and reconnect the terminal board. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	
CPF09– CPF21 Control Circuit Error	**Control Circuit Error.** These errors indicate that a hardware problem has been detected with the Control Board. If a power cycle doesn't clear the error, typically it means that the Control Board is damaged and needs to be replaced.	1. Cycle power to the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	

Display	Description	Corrective Action	Fault	Alarm
CPF22 Hybrid IC Error	**Hybrid IC Failure.** Hybrid IC failure on the power board.	1. Cycle power to the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	
CPF23 Control Board Connection Error	**Control Board Connection Error.** Connection error between the control board and the VFD. The hardware is damaged.	1. Turn off the power and check the connection between the control board and the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	
CPF24 Drive Unit Signal Fault	**VFD Unit Signal Fault.** The VFD capacity cannot be detected correctly (VFD capacity is checked when powered up). The hardware is damaged.	1. Turn off the power and check the connection between the control board and the VFD. 2. If the problem continues, replace the control board or the entire VFD. Contact Magnetek for instructions on replacing the control board.	X	
CPF26– CPF39	**Control Circuit Error.** These errors indicate that a hardware problem has been detected with the Control Board. If a power cycle doesn't clear the error, typically it means that the Control Board is damaged and needs to be replaced.	1. Cycle power to the VFD. 2. Ensure that the terminal board is seated properly. 3. Replace control board and/or terminal board.	X	
CrST Cannot Reset	**Cannot Reset Alarm.** A fault reset command was received while a run command was active.	1. Remove the run command and then retry the fault reset.		X
dEv Speed Deviation	**Speed Deviation.** Occurs when the deviation of the speed reference and speed feedback exceeds the regulation level, F01-27 for the time F01-28. Alarm or fault defined by F01-26.	1. ***See Section 6.2 on page 362***.	X	X
DIR Hoist Direction Fault	**Direction Fault.** Occurs when the VFD detects that a hoist is configured backwards such that the FWD direction is DOWN motion.	1. Verify FWD is shown on the keypad when moving in the UP direction. Change b03-04 if REV is shown when going UP. 2. If correct travel direction has been verified, set C08-34 = 0 to disable DIR detection.	X	
dnE Drive Disabled	**Drive Disabled Alarm.** An MFDI set for H01-xx or F03-xx = 55 (Drive Enable) was turned off while a run command was active.	1. Check the state of the Drive Enable MFDI.		X
EF External Fault	**External Fault.** Both FORWARD/UP and REVERSE/DOWN commands are input at same time for 500 msec or longer. The 500 msec delay time is not adjustable.	1. Check control input wiring. 2. Check the sequence of operation.		X
EF0 Option Card External Fault	**External fault input from communication option card.** Alarm or fault defined by F06-03.	1. Check communication option card connection and signals. 2. Check the commands sent from the PLC.	X	X

Display	Description	Corrective Action	Fault	Alarm
EF1 External Fault 1	**External fault occurs on Terminal S1.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-01 setting. 2. Check the conditions for input terminal S1.	X	X
EF2 External Fault 2	**External fault occurs on Terminal S2.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-02 setting. 2. Check the conditions for input terminal S2.	X	X
EF3 External Fault 3	**External fault occurs on Terminal S3.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-03 setting. 2. Check the conditions for input terminal S3.	X	X
EF4 External Fault 4	**External fault occurs on Terminal S4.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-04 setting. 2. Check the conditions for input terminal S4.	X	X
EF5 External Fault 5	**External fault occurs on Terminal S5.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-05 setting. 2. Check the conditions for input terminal S5.	X	X
EF6 External Fault 6	**External fault occurs on Terminal S6.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-06 setting. 2. Check the conditions for input terminal S6.	X	X
EF7 External Fault 7	**External fault occurs on Terminal S7.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-07 setting. 2. Check the conditions for input terminal S7.	X	X
EF8 External Fault 8	**External fault occurs on Terminal S8.** Alarm or fault defined by the External Fault Selection table (***Table 5-94 on page 251***).	1. Check H01-08 setting. 2. Check the conditions for input terminal S8.	X	X
EP24v External Power 24V Supply	**External 24 VDC Power Supply Alarm.** Voltage of the main circuit power supply has been lost, and a 24 VDC power supply is supplying power to the VFD.	1. No action may be needed. 2. Turn on the main circuit power supply to clear the alarm. 3. See o02-26 for EP24v detection.		X
E-LIFT E-Lift Active E-Lift Timeout	**Emergency Lift Active/Timeout.** The E-Lift timer has started (alarm) or expired (fault) per the C08-37 time.	1. No action may be needed. 2. Re-enable E-Lift if more time is needed.	X	X
Err EEPROM Write Error	**EEPROM Read/Write Fault.** EEPROM internal data did not match when initializing the parameter.	1. Cycle Power. 2. User initialize (A01-05=1110). 3. Replace Control board.	X	
FAn Internal Fan	**Internal Fan Fault.** Internal circulation fan has malfunctioned.	1. Cycle power to the VFD. 2. Check for fan operation. 3. Verify the fan elapsed time with U04-03 and fan maintenance timer with U04-04. 4. Replace circulation fan.	X	X
FAn1 Cooling Fan	**Cooling Fan Fault.** Internal cooling fan has malfunctioned.	1. Cycle power to the VFD. 2. Check for fan operation. 3. Verify the fan elapsed time with U04-03 and fan maintenance timer with U04-04. 4. Replace cooling fan.	X	

Display	Description	Corrective Action	Fault	Alarm
FbBrkSt Footbrake Stand	**Footbrake Stand Alarm.** The footbrake is being applied.	1. No action may be needed. When the crane is stopped, the keypad will indicate that the footbrake is being applied. 2. Operator is stepping on the brake and attempting to drive through it. 3. Verify the correct setting of C15-07.		X
Fnr Follower Not Ready	**Follower Not Ready.** The Load Share or Synchronization Follower Ready signal has been lost.	1. Check for loose/broken wires. 2. Check digital input settings.	X	X
FSd Follower Speed Deviation	**Follower Speed Deviation Fault.** The Leader has detected that the Follower is running at a different speed, based on pulse train feedback from the Follower.	1. Check speed parameters on the Follower. 2. Check I/O interlocks between the Leader and Follower.	X	
GF Ground Fault	**Ground Fault.** During operation, the VFD sums the currents of all three motor phases. Ideally, the sum should always equal zero. If the sum is greater than 50% of the VFD rated output current, a GF occurs.	1. Disconnect motor from VFD and check it for shorts using a megger. 2. Ensure that R/C Surge Suppressors are used across all brake contactor coils.	X	
HCA High Current	**High Current Alarm.** VFD current exceeded over current warning level (150% of the rated current).	1. Reduce the load. 2. Check the motor capacity.		X
KLX Klixon	**Klixon Circuit Alarm.** Input by MFDI H01-0x = 56 or 57.	1. Check Motor for Overtemp. 2. Check Klixon Circuit.		X
L24v Loss of External 24V Supply	**Loss of External 24 VDC Power Supply Alarm.** The external 24 VDC power supply voltage has been lost.	1. Check the condition of the external 24 VDC supply. 2. See o02-23 for L24v detection.		X
LC Load Check	**Load Check Fault or Alarm.** Load is greater than specified amount. Alarm or fault defined by C05-02.	1. Reduce Load. 2. Check Load Check sequence setup (C05-xx).	X	X
LC Done Load Check Done	**Load Check Done Alarm.** This alarm is displayed after the LC setup process is done. The alarm will clear when the Down command is pressed and complete the LC setup process.	1. No action is required.		X
LF Output Phase Loss	**Output Phase Loss Fault.** An open phase occurred at the VFD output. See parameters L08-07 and L08-08.	1. Check for broken motor output wires. 2. Check for open motor winding. 3. Check for loose terminals	X	
LF2 Output Current Imbalance	**Output Current Imbalance Fault.** One or more of the phases in the output current are lost.	1. Check for faulty wiring or poor/loose connections on the output side of the VFD. 2. Correct the wiring. 3. Measure the line-to-line resistance for each motor phase. Ensure they match. 4. Replace the motor.	X	

Display	Description	Corrective Action	Fault	Alarm
LL0 Lower Limit Warning	**Lower Limit 0—WARNING Indicator.** Lower Limit 0—WARNING switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
LL1 Lower Limit Slowdown	**Lower Limit 1—SLOWDOWN Indicator.** Lower Limit 1—SLOWDOWN switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
LL2 Lower Limit Stop	**Lower Limit 2—STOP Indicator.** Lower Limit 2—STOP switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
LL3 Lower Limit 3	**Lower Limit 3—FAULT Indicator.** Lower Limit 3—FAULT switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position. 3. Check the MFDI status (U01-10).	X	X
LT-1 Cooling Fan Maintenance Time	**Cooling Fan Maintenance Time Alarm.** The cooling fan is at 90% of expected service life.	1. Replace the cooling fan. 2. Reset by o03-03 = 0.		X
LT-2 Capacitor Maintenance Time	**Capacitor Maintenance Time Alarm.** The DC bus capacitors are at 90% of expected service life.	1. Contact Magnetek for servicing information. 2. Reset by o03-05 = 0.		X
LT-3 Soft Charge Maintenance Time	**Soft Charge Maintenance Time Alarm.** The pre charge relay is at 90% of expected service life.	1. Contact Magnetek for servicing information. 2. Reset by o03-07 = 0.		X
LT-4 IGBT Maintenance Time (50%)	**IGBT Maintenance Time Alarm.** The IGBTs are at 50% of expected service life.	1. No action may be needed. 2. Contact Magnetek for servicing information. 3. Reset by o03-09 = 0.		X
MAINTBRK Maintenance Brake Cycles Elapsed	**Maintenance Brake Cycles Alarm.** Brake cycle count has exceeded the maintenance brake cycles (C12-08).	1. Reset by H01-0x = 7E.		X
MAINTON Maintenance On Time Elapsed	**Maintenance On Time Alarm.** On time has exceeded the maintenance on time hours (C12-07).	1. Reset by H01-0x = 7D.		X
MAINTRUN Maintenance Run Time Elapsed	**Maintenance Run Time Alarm.** Running time has exceeded the maintenance run time hours (C12-05).	1. Reset by H01-0x = 7C.		X
oC Over Current	**Over Current Fault.** Output current exceeds 200% of VFD rated output current.	1. Check for a phase-to-phase short in the motor or wiring using a megger. 2. Extend the acceleration/ deceleration time. 3. Check torque limit setting. 4. ***See Section 6.2 on page 362***.	X	

Display	Description	Corrective Action	Fault	Alarm
oH Heatsink Overheat	**Overheat Pre-Alarm.** Heatsink is overheating. The temperature of the VFD heatsink exceeded the setting in L08-02.	1. The VFD cooling fan has stopped. 2. Reduce the ambient temperature.	X	X
oH1 Heatsink Overheat	**Overheat Fault.** There are two situations that result in an overheat fault. The first occurs when the measured heat sink exceeded 105°C. The second is a result of a fault in the internal 24 VDC cooling fan.	1. Ensure the heat sink cooling fans are functioning. 2. Ensure the heat sink is free from dirt and debris. 3. Ensure the VFD's ambient temperature is within specification. 4. Replace the 24 VDC fan. 5. Replace the heat sink thermistor(s).	X	
oH3 Motor Overheat 1	**Motor Overheating 1.** Thermistor analog input detected motor overheating. See L01-03.	1. Check Motor FLA setting (E02-01). 2. Increase cycle time or reduce the load.	X	X
oH4 Motor Overheat 2	**Motor Overheating 2.** Thermistor analog input detected motor overheating. See L01-04.		X	
oL1 Motor Overload	**Motor Overload Fault.** VFD output exceeded the motor overload level.	1. Check Motor FLA setting (E02-01). 2. Reduce the load.	X	
oL2 Drive Overload	**VFD Overload Fault or Alarm.** VFD output exceeded the overload level.	1. Reduce the load. 2. Extend the acceleration time.	X	X
oPr Keypad Disconnect	**Keypad Disconnected.** The keypad is removed while the VFD is running, and the run command was initiated via the keypad RUN key.	1. Secure the keypad.	X	X
oS Overspeed	**Overspeed.** The motor has exceeded the programmed detection level and time. This is typically caused by an overshoot condition due to an over-responsive ASR loop. If the VFD is configured for torque control mode, and no load is present, an overspeed fault can occur. Alarm or fault defined by F01-23.	1. Check the Automatic Speed Regulator (d04) parameters. 2. Check setting of F01-24, F01-25. 3. Verify proper encoder PPR setting, F01-01.	X	X
oT1 Overtorque Detection 1	**Overtorque Detection Level 1.** Defined by L06-02. Alarm or fault defined by L06-01.	1. Check for proper programming for L06-02 and L06-03.	X	X
oT2 Overtorque Detection 2	**Overtorque Detection Level 2.** Defined by L06-05. Alarm or fault defined by L06-04.	1. Check for proper programming for L06-05 and L06-06.	X	X
ov DC Bus Overvolt	**Overvoltage Fault.** The main circuit DC voltage exceeded the overvoltage level while the VFD is outputting current.	1. Extend the deceleration time. 2. Check CDBR operation. 3. Check the braking resistor. 4. Check the line voltage.	X	
ov DC Bus Overvolt	**Overvoltage Alarm.** Main circuit DC voltage rises above the detection level while not running.	1. Check the line voltage.		X
ovEr Too Many Parameters Changed	**Too Many Parameters Changed Alarm.** Modified parameters list has exceeded 150.	1. Reduce the amount of modified parameters.		X

Display	Description	Corrective Action	Fault	Alarm
OW Overweight - Hoist/ Crane	**Overweight Detected on Hoist/Crane.** Crane or hoist has exceeded lifting capacity set in C10-31 or C10-33. Action taken per the C10-35 setting.	1. Reduce the weight lifted by the hoist.	X	X
OW-Pre Overweight Warning - Hoist/Crane	**Overweight Warning on Hoist/Crane.** Crane or hoist has exceeded lifting warning level set in C10-30 or C10-32. No action will be taken since this is a warning only.	1. No action needed.		X
PF Input Phase Loss	**Input Phase Loss Fault.** VFD input power supply has one or more open phases. See parameters L08-05 and L08-06.	1. Check the line voltage and fuses. 2. Remove power. 3. Tighten input terminals.	X	
PGo-1S PGo-1H PG Open Ch1	**Encoder Channel 1 Fault or Alarm.** PGo-1S, software detected signal loss. PGo-1H, hardware detected signal loss. Alarm or fault defined by F01-21.	1. Check for proper direction of encoder feedback. 2. ***See Section 6.2 on page 362***.	X	X
PGo-2S PGo-2H PG Open Ch2	**Encoder Channel 2 Fault or Alarm.** PGo-2S, software detected signal loss. PGo-2H, hardware detected signal loss. Alarm or fault defined by F01-21.	1. Check for proper direction of encoder feedback. 2. ***See Section 6.2 on page 362***.	X	X
PLSDEV Pulse Deviation	**Pulse Deviation Fault.** The pulse input into terminal RP compared to the pulse output from terminal MP is greater than the percentage programmed into H06-09.	1. During operation, verify that there is an incoming pulse signal on the RP terminal, viewable at U01-54. 2. Increase the deviation margin percentage in H06-09.	X	
rF Braking Resistor Fault	**Braking Resistor Fault.** The resistance of the braking resistor is too low, or the proper braking resistor has not been installed.	1. Verify correct braking resistor.	X	
rH Braking Resistor Overheat	**Braking Resistor Overheat Fault.** Deceleration time is too short and excessive regenerative energy is flowing back into the VFD.	1. Verify correct braking resistor.	X	
roC-1 Analog Rate of Change - 1	**Analog Rate of Change 1.** The analog input signal for Forward Sensor (MFAI = 35) changed more than C03-51 percent over a 100ms period. Alarm when not running.	1. Check the wiring of the device connected to the analog input. 2. Verify setting of C03-51.	X	X
roC-2 Analog Rate of Change - 2	**Analog Rate of Change 2.** The analog input signal for Reverse Sensor (MFAI = 36) changed more than C03-51 percent over a 100ms period. Alarm when not running.	1. Check the wiring of the device connected to the analog input. 2. Verify setting of C03-51.	X	X
rr Dynamic Braking Transistor	**Braking Transistor Fault.** Internal Braking transistor failed.	1. Verify that the external braking resistor is connected to the B1 and B2 terminals. 2. Confirm that the proper resistor is installed. 3. Check for a short circuit across the braking resistor.	X	
rUn Motor Switch During Run	**Motor Switch During Run Alarm.** The digit input for Motor 2 (MFDI = 44) or Run/Reference Select (MFDI = 1F) changed state while the motor was running.	1. Allow the motor to stop before changing the state of Motor 2 or the Run/Reference Select.		X

Display	Description	Corrective Action	Fault	Alarm
SC Short Circuit/IGBT Failure	**Short Circuit Fault.** The VFD has detected an output short circuit condition or a failed IGBT.	1. Disconnect the motor. 2. Check for a short circuit in the motor or wiring via a megger.	X	
SCF Safety Circuit Fault	**Safety Circuit Fault.** The safety circuit has failed or malfunctioned.	1. Cycle power to the VFD. 2. Replace the terminal board or control board.	X	
SCS Swing Length Too Long	**Swing Length Too Long Fault.** The swing length input for Sway Control is greater than 300 feet.	1. Check if any C14 settings allow for a swing length over 300 feet. 2. Check the Hook Height MFAI gain.	X	
SE Modbus Test Mode Error	**Modbus Test Mode Alarm.** A Modbus self-diagnostics test (MFDI = 53) was initiated during a run.	1. Allow the motor to come to a stop before running the self-diagnostics test.		X
SLC Slack Cable Detection	**Slack Cable Alarm.** A hoist slack cable condition occurred.	1. May not require corrective action. 2. Check setting of Slack Cable Detection (C11-xx).		X
SNAP Snapped Shaft	**Snapped Shaft Fault or Alarm.** A drive train discontinuity has been detected. Alarm or fault defined by C11-09.	1. Check the motor coupling. 2. Check for loose encoder(s). 3. Check for broken shaft.	X	X
STo or SToF Safe Torque OFF	**Safe Torque Off Alarm.** The flashing Safe Torque Off signal is a result of either of the Safe Disable inputs being open. The motor will begin coasting when the Safe Disable circuit is open, and the brake relay digital output will open.	1. Check signal status at the input terminals H1 and H2. 2. Check the Sink/Source Selection for the digital inputs. 3. If the Safe Disable function is not utilized, verify that H1 and H2 jumpers are installed. 4. Replace either the control board or the entire VFD.		X
SYNC Follower Out of Sync	**Follower Out of Sync with Leader.** The Sync position error between the Leader and Follower(s) exceeded the allowable amount set by C09-12.	1. Check for proper encoder feedback from Leader & Follower(s). Run all VFDs individually to check proper functionality. 2. Check for physical obstruction of the Follower motion. (e.g., brake, load hang up) 3. Ensure that the load is not too heavy. 4. Decrease acceleration/ deceleration time(s) on Leader (b05-01 and b05-02). 5. The maximum speed of the Leader (E01-04) should be set to at least 4 Hz less than the Follower(s) to allow for correction of position error.	X	X

Display	Description	Corrective Action	Fault	Alarm
TiM Keypad Time Not Set	**Keypad Time Not Set Fault or Alarm.** There is a battery in the keypad, but the date and time are not set.	1. Use the “Set Date/Time” menu to set the date and time. 2. Use o03-24 to adjust TiM detection.	X	X
TMA Test Mode Active	**Test Mode Active Indicator.** The Test Mode function has been activated by E07-00. A 10 minute timer will start. After the timer elapsed, a TSTEND fault will occur and Test Mode will be disabled.	1. May not require corrective action. 2. See E07-00.		X
TrPC IGBT Maintenance Time (90%)	**IGBT Maintenance Time Alarm.** The IGBTs are at 90% of expected service life.	1. Contact Magnetek for servicing information. 2. Set o03-09 = 0 to reset the IGBT operation time.		X
TSTEND Test Mode Timer Expired	**Test Mode Fault.** Exceeded the 10 minute time limit.	1. Ensure the test mode MFDI is OFF. 2. Reset the fault. 3. Ensure that test mode is not used for normal operation.	X	
UL0 Upper Limit Warning	**Upper Limit 0—WARNING Indicator.** Upper Limit 0—WARNING switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
UL1 Upper Limit Slowdown	**Upper Limit 1—SLOWDOWN Indicator.** Upper Limit 1—SLOWDOWN switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
UL2 Upper Limit Stop	**Upper Limit 2—STOP Indicator.** Upper Limit 2—STOP switch status has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position.		X
UL3 Upper Limit 3	**Upper Limit 3—FAULT Indicator.** Upper Limit 3—FAULT (typically weighted limit) switch has changed.	1. May not require corrective action. 2. Check the Limit Switch condition and position. 3. Check the MFDI status (U01-10).	X	X
UT1 Undertorque Detection 1	**Undertorque Detection 1.** The current is less than L06-02 for more than L06-03. Alarm or fault defined by L06-01.	1. Check L06 parameters. 2. Check motor coupling.	X	X
UT2 Undertorque Detection 2	**Undertorque Detection 2.** The current is less than L06-05 for more than L06-06. Alarm or fault defined by L06-04.	1. Check L06 parameters. 2. Check motor coupling.	X	X
Uv Undervoltage	**Undervoltage Alarm.** DC bus voltage drops below undervoltage level for more than 2 seconds while not running.	1. Check power wiring. 2. Replace any bad branch fuses. 3. Check collector system.		X
Uv1 DC Bus Undervoltage	**Undervoltage 1 Fault.** DC bus voltage drops below undervoltage level for more than 2 seconds during RUN command.	1. Check power wiring. 2. Correct the line voltage. 3. Check collector system.	X	

Display	Description	Corrective Action	Fault	Alarm
Uv2 Control Power Undervoltage	**Undervoltage 2 Fault.** The VFD detected a loss of the 24V logic power supply voltage.	1. Check power wiring. 2. Correct the line voltage. 3. Check collector system.	X	
Uv3 Soft Charge Answerback	**Soft Charge Fault.** The pre-charge contactor opened during operation.	1. Check power wiring. 2. Correct the line voltage. 3. Check collector system. 4. Wait 30-45 seconds before restarting VFD.	X	
voF Output Voltage Detection	**Output Voltage Detection Fault or Alarm.** Problem detected with the voltage on the output side of the VFD.	1. Replace the VFD.	X	X
WMS Setup Weight Measurement Setup	**Weight Measurement Setup Initiated.** The automated Weight Measurement setup has been initiated. See the VFD’s keypad for instructions.	1. No action needed.		X

* These faults only occur when latched.

Table 6-4: Operation Error Table

Display	Description	Corrective Action
oPE01	**VFD Capacity Setting Error.** VFD model setting is incorrect.	1. Check that o02-04 matches the VFD model.
oPE02	**Setting Out of Range Error.** Parameter setting is out of range.	1. With the fault displayed on the keypad, press the ENTER key to reveal the “Out of Range” parameter via the U01-34 monitor. 2. Verify that E02-03 is < E02-01. 3. Verify E01-05 is within range. 4. Compare modified parameters with defaults. 5. Cycle Power.
oPE03	**Digital Input Setting Error.** Multiple digital inputs are set to the same value, besides for F (Not Used).	1. Check the settings for H01-xx and F03-xx and, verify that the same setting is not used twice.
oPE05	**Frequency Reference Source Selection Error.** A frequency reference is assigned to an option card that is not connected.	1. Cycle power. 2. Ensure that the option card is seated properly into the option card slot. 3. Replace option card.
oPE06	**Missing PG Card Error.** A closed loop control method was selected, and the required encoder feedback option card (PG-X3 or PG-B3) is not installed.	1. Install the required encoder option card. 2. Remove power and reset the option card.
oPE07	**Analog Input Setting Error.** H03-02, H03-06, and/or H03-10 multi-function analog input settings are set to the same value.	1. Check the function selections.
oPE08	**Parameter Selection Error.** A parameter has been changed that is not available in the present control method.	1. Undo the last parameter change (if known). 2. Scroll through modified parameters for obvious setting errors. 3. Perform a user initialize (A01-05=1110). **CAUTION: All settings will be restored to the factory defaults.**
oPE10	**V/f Parameter Setting Error.** The V/f pattern parameters do not satisfy these conditions: • For Motor 1: E01-09 ≤ E01-07 < E01-06 ≤ E01-11 ≤ E01-04 • For Motor 2: E03-09 ≤ E03-07 < E03-06 ≤ E03-11 ≤ E03-04	1. Check parameters E01-04 to E01-11.
oPE11	**Carrier Frequency Parameter Error.** These parameters are set at the same time: • d10-05 > 6 • d10-04 > d10-03 ***NOTE:*** *d10-04 is disabled when d10-05 > 7, and the carrier frequency becomes d10-03.*	1. Check parameters d10-02 to d10-05.

Display	Description	Corrective Action
oPE13	**Pulse Monitor Selection Error.** H06-06 = 101, 102, 105, or 116 (Terminal MP Monitor Selection = Frequency Reference, Output Frequency, Motor Speed, or SFS Output Frequency) has not been set when H06-07 = 0 (Terminal MP Frequency Scaling = 0 Hz).	1. Check parameters H06-06 and H06-07.
oPE33	**Digital Output Selection Error.** The H02-60, H02-63, and H02-66 (MFDO secondary functions) can't be used if their primary counterparts (H02-01, H02-02, or H02-03) are set to an inverse function.	1. Check the H02-xx MFDO settings.
oPE40	**Hook Height N.C. MFDI Setting Error.** Hook Height Home is set to UL2 N.C., LL2 N.C., or UL3 N.C., but no MFDI is programmed for Baseblock N.C.	1. Check C03-14 setting. 2. Set an MFDI for Baseblock N.C. (H01-xx or F03-xx = 132).
oPE41	**Dual Brake MFDO Error.** MFDO programmed to A, but another not programmed to 0. Must have 0 and A programmed.	1. Check MFDO settings (H02-xx = 0 and H02-xx = A). 2. Set C08-33 to Disabled.
oPE42	**E-Lift and Motor 2 MFDI Error.** The E-Lift and Motor 2 MFDIs are both set concurrently.	1. Check that multiple MFDIs are not set to 44 or 144 (Motor 2 Selection) and 4A (Emergency Lift Enable) at the same time.
oPE43	**Bi-Polar Speed Incompatibility Error.** A selected feature is incompatible with the Bi-Polar Analog speed reference.	1. Select a different A01-04 (Speed Reference). 2. Check Modified Parameter list to determine which feature triggered the error.
oPE44	**E-Lift and E03-01 = V/f Error.** The E-Lift function cannot use the V/f control method.	1. Set E03-02 = 2 (Open Loop Vector).
oPE45	**Second PG Required.** The Synchronization function was enabled for a Follower VFD, and it is missing a second PG-X3/PG-B3 encoder option card.	1. Install a PG-X3 or PG-B3 encoder option card into the CN5-B slot.

6.2 Troubleshooting Encoder and Brake Faults and Alarms

The faults and alarms in this section may involve the encoder feedback or motor brake system. During system startup, these faults and alarms are often caused by parameters that need to be adjusted. However, if the system has been running for some time, this usually indicates a problem with the physical system and adjusting the parameters should only be done after the physical system has been inspected.

6.2.1 dEv–Speed Deviation Fault

Definition

A Speed Deviation fault means that the VFD output is not able to follow the commanded speed reference. This is possible if there is not enough torque available to follow the internal speed reference. Therefore, speed deviations may occur when the VFD is at its programmed torque limit. In addition, if the VFD receives erratic, or missing, encoder pulses, speed deviations are also possible. If the initial VFD tuning and start-up of the system was successfully completed and the crane has been in operation without any faults, then the occurrence of this fault most likely indicates that something mechanical with the system has changed or VFD parameters were changed (i.e., failed encoder, load snag, crane overload, change in acceleration or deceleration times, etc.).

Corrective Action

1. Do **NOT** continue to operate the hoist.

NOTE: *Continued attempts to operate the hoist with speed deviation faults can result in loss of control of the load.*

2. As a precaution, the Load Float Time (C08-10) should be set to zero until the source of the speed deviation fault has been determined and corrected.
3. Verify if the load has snagged or if there is a load on the hook that exceeds capacity.
4. Check the alignment of the encoder pulse wheel and sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose, the VFD may get erratic pulse signals or no signals at all causing a Speed Deviation or PGo fault. Make repairs before attempting to operate the hoist.
5. The encoder cable should be checked for damage.
   - Each of the encoder wires should be checked for continuity, and visually checked for damage.
   - The wires should be checked for shorts between any two wires, including the shield or ground.
6. If the encoder feedback system checks out mechanically and electrically, then check for something in the mechanical system that might be resisting normal operation. One example may be the brake is not opening fully and drag is preventing the system from operating at commanded speed.
7. If the encoder feedback system checks out and no other mechanical problems can be found, then something must have changed in the control system.
   - Check if the accel or decel times have been changed (b05-01, b05-02, C01-02, C01-04, or C01-05).
   - Check if a function that provides an alternate acceleration or deceleration rate has been enabled or changed (Quick Stop, Reverse Plug Simulation, Accel/Decel Time 2).

   If one of these times is too short, causing a torque limit, then the times should be extended.
8. If none of the above steps has identified a valid problem(s), only then should the speed deviation detection levels be adjusted.

NOTE: *The reaction time necessary to stop a load is limited to the lift of the hoist and the response time of the hoist brakes. It is desirable to have as fast a fault reaction time as possible without causing nuisance faults.*

9. Increase Encoder Speed Deviation Level to no more than 30% (F01-27).
10. After the corrective action has been taken and the fault no longer occurs, set the Load Float Time (C08-10) back to its initial value.

6.2.2 PGo-XS/PGo-XH–Pulse Generator Signal Fault

Definition

A Pulse Generator Signal fault indicates that the VFD has detected a problem with encoder feedback. This fault will typically occur if the VFD doesn't receive any encoder feedback pulses while it is commanded to run or encoder wiring has a discontinuity.

NOTE: *The "X" in PGo-XS and PGo-XH depicts either a "1" if the PG-X3 is seated in connector CN5-C, or a "2" if the PG-X3 is seated in connector CN5-B.*

Corrective Action

1. Do **NOT** continue to operate the hoist in the event of a PGo-XH fault or repeated PGo-XS faults.

NOTE: *Continued attempts to operate the hoist with PGo faults can result in loss of control of the load.*

2. As a precaution, the Load Float Time (C08-10), should be set to zero until the source of the PGo Fault has been determined and corrected. Disable PGo hardware detection with F01-06 or F01-16 = 0.
3. Check the alignment of the encoder pulse wheel and sensor head, the encoder shaft coupling, or check for a failed encoder sensor head. If one of these conditions exists the VFD may get erratic pulse signals or no signal at all causing a Speed Deviation or PGo fault. Make repairs before attempting to operate the hoist.
4. If the encoder appears to have no mechanical problems, the encoder cable should be checked for damage.
   - Each of the encoder wires should be checked for continuity.
   - The wires should be checked for shorts between any two wires.
   - The wires should be checked for shorts to the shield or ground.
   - Visually inspect the cable for damage that may be causing intermittent problems.
5. If the encoder feedback system checks out, then check for physical obstruction to motor rotation such as the brake failing to open.
6. After corrective action has been taken and the fault no longer occurs, set the Load Float Time (C08-10) back to its initial value.

6.2.3 BE1–Rollback Fault

Definition

A BE1 fault indicates that the VFD has released the brake, but rotated backwards, rather than accelerating in the expected up direction. This is typically caused by the motor having insufficient torque to accelerate the load. A BE1 fault will occur if the pulses received during the BE1 Rollback Time (C08-04) are greater than the BE1 Rollback Pulse Count (C08-05).

Correction Action

1. Verify that an Auto-Tune was successful. Accurate “No Load Current” and “Slip” values are essential for motor performance, especially near full load.
2. Check the encoder cable for damage and proper grounding. Replace it if a problem is found.
   - Each of the encoder signals should be checked for excessive noise.
   - The shielded encoder cable should be properly grounded.
   - Visually inspect the cable for damage that may be causing intermittent problems.
3. Check the alignment of the encoder pulse wheel and sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose, the VFD may get erratic pulse signals and cause a BE1 fault. Make repairs before attempting to operate the hoist.
4. If none of the steps corrected the problem, only then should the BE1 detection parameters be adjusted.
5. Enable Field Forcing (b09-03 = 1). This can help boost excitation current at start.
6. Extend C08-01 (BE2 Torque Build Up Time) to 1.5 seconds. This gives the motor more time to build torque prior to the brake opening.
7. As a last resort, increase the Rollback Pulse Count (C08-05), but it should remain as close to 200 pulses as possible.

NOTE: *It is desirable to have as fast a fault reaction time as possible without causing nuisance faults.*

6.2.4 BE2–Torque Proving Fault

Definition

A BE2 fault indicates that the VFD was unable to develop sufficient torque before releasing the brake, typically because the brake is slipping. A BE2 fault occurs when the torque (U01-09) is less than the Initial Forward Brake Release Torque (C08-16) during the current feedback timer (C08-02) at start.

NOTE: *This fault typically indicates a failing brake. Power should NOT be removed after a BE2 occurs, and the load should be moved to a safe location and lowered before proceeding with any corrective action.*

Corrective Action

1. Check the brake for proper operation and adjustment. If the brake does not set, is improperly adjusted or is excessively worn, it may not be able to hold the load. This can cause encoder pulses to be received while torque is building up in the motor, against the brake.
2. Check the encoder cable for damage or improper grounding. Replace it if a problem is found.
   - Each of the encoder signals should be checked for excessive noise.
   - The shielded encoder cable should be properly grounded.
   - Visually inspect the cable for damage that may be causing intermittent problems.
3. Check the alignment of the encoder pulse wheel and sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose, the VFD may get erratic pulse signals and cause a BE2 fault. Make repairs before attempting to operate the hoist.

4. Perform a Brake Torque test to verify the torque matches brake specifications.
5. If none of the above steps has identified a problem(s), the brake may need to be replaced.

NOTE: *The Current Feedback Timer (C08-02) should be set as low as possible without causing nuisance faults.*

6.2.5 BE3–Brake Release Fault

Definition

The BE3 fault indicates that the VFD has released the brake and commanded the VFD to run, but has not detected the expected encoder feedback. A BE3 fault will occur if the pulses received during the BE3 detection time (C08-06) are less than the expected number of pulses (C08-07).

NOTE: *Depending on the condition of the crane and control system, the load may drift during the BE3 detection time until the brake is again set. If giving a run command, the BE3 fault should be detected before a PGo fault would be detected.*

Corrective Action

1. Check the brake for proper operation. If the brake does not open the VFD will not see the proper number of encoder pulses returned and will post this fault.
2. Check the alignment of the encoder pulse wheel with the sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose the VFD will get erratic pulse signals or no signals at all possibly causing a BE3 fault. Make repairs before attempting to operate the hoist.
3. If the encoder appears to have no mechanical problems, the encoder cable should be checked for damage and replaced if a problem is found.
   - Each of the encoder wires should be checked for continuity.
   - The wires should be checked for shorts between any two wires.
   - The wires should be checked for shorts to the shield or ground.
   - Visually inspect the cable for damage that may be causing intermittent problems.
4. If none of the above steps has identified a valid problem(s), only then should the BE3 detection parameters be adjusted.

NOTE: *It is desirable to have as fast a fault reaction time as possible without causing nuisance faults.*

5. Ensure that C08-04 is equal to the brake’s mechanical delay time.
6. Increase the value of C08-06 to no more than 1 second.
7. Decrease the value of C08-07 to no less than 10 pulses.

6.2.6 BE6–Brake Proving Alarm

Definition

The BE6 alarm indicates that the VFD has commanded the brake to set but it has detected more encoder pulse feedback than expected. A BE6 alarm will occur if the number of pulses received during the BE6 detection time (C08-12) is greater than the expected number of pulses (C08-13). The VFD will initiate Load Float for the duration of the BE6 alarm.

NOTE: *This alarm typically indicates a failed brake. Power should NOT be removed while this alarm is active and the load should be moved to a safe location and lowered before proceeding with any corrective action.*

NOTE: *The BE6-Brake Proving Alarm is re-verified during every brake set, including brake sets that occur after the BE6 alarm is posted. The BE6 alarm will turn off if a successful brake check occurs after an initial BE6 alarm condition is posted based on the setting of C08-19.*

Corrective Action

1. Check the brake for proper operation and adjustment. If the brake does not set, is improperly adjusted or is excessively worn, it may not be able to hold the load. This will allow the encoder pulses received during the detection time to exceed the set point.
2. Check the encoder cable for damage and proper grounding. Replace it if a problem is found.
    - Each of the encoder signals should be checked for excessive noise.
    - The shielded encoder cable should be properly grounded.
    - Visually inspect the cable for damage that may be causing intermittent problems.
3. Check the alignment of the encoder pulse wheel with the sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose the VFD may get erratic pulse signals possibly causing a BE6 alarm. Repairs to the encoder wheel or shaft coupling should be made immediately before again attempting to operate the hoist.
4. If none of the above steps has identified a valid problem(s), only then should the BE6 detection parameters be adjusted.

NOTE: *It is desirable to have as fast an alarm reaction time as possible without causing nuisance alarms.*

5. Ensure that C08-11 is equal to the brake’s mechanical delay time.
6. Increase the value of C08-13.

6.2.7 BE8–Brake Slipping Alarm

Definition

A BE8 alarm indicates that the VFD has detected that the brake is slipping after the brake is set. A BE8 alarm will occur if the load is moving greater than the BE8 Detection Sensitivity (C08-23) when the brake is set. When this occurs, the VFD will go into load float while the brake is set.

NOTE: *This alarm typically indicates a failed brake. Power should NOT be removed while this alarm is active and the load should be moved to a safe location and lowered before proceeding with any corrective action.*

Corrective Action

1. Check the brake for proper operation and adjustment. If the brake does not set, is improperly adjusted or is excessively worn, it may not be able to hold the load and encoder pulses will be received.
2. Check the encoder cable for damage and proper grounding. Replace it if a problem is found.
   - Each of the encoder signals should be checked for excessive noise.
   - The shielded encoder cable should be properly grounded.
   - Visually inspect the cable for damage.
3. Check the alignment of the encoder pulse wheel and sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose the VFD may get erratic pulse signals and cause a BE8 alarm. Make repairs before attempting to operate the hoist.
4. If none of the above steps has identified a valid problem(s), the brake may need to be replaced.

NOTE: *It is desirable to have as fast an alarm reaction time as possible without causing nuisance alarms.*

6.2.8 oC–Over Current Fault

Definition

An over current fault is caused if the output current exceeds 200% of the VFD rated output current. This fault can be caused by short circuits in the wiring or in the motor, or caused by parameters that are not adjusted properly. Another cause of this fault could be erratic or no encoder feedback. In the last instance, the VFD is trying to command the motor to hold a position, but due to the encoder problem, is unable to find the correct position. This would cause the VFD to increase current output to the motor in an attempt to correct the position.

Corrective Action

1. Check the motor wiring and the motor itself for a short between phases.
2. Check the alignment of the encoder pulse wheel and sensor head, or the encoder shaft coupling. If the pulse wheel is misaligned or the shaft coupling is loose the VFD may get erratic pulse signals or no signals at all. Make repairs before attempting to operate the hoist.
3. If the encoder has no mechanical problems, the encoder cable should be checked for damage.
   - Each of the encoder wires should be checked for continuity.
   - The wires should be checked for shorts between any two wires.
   - The shield should be checked for proper grounding.
   - The wires should be checked for shorts to the shield or ground.
   - Visually inspect the cable for damage.
4. If none of the above steps has identified a valid problem(s), check the torque limit parameters (C07-01 to C07-04). If these parameters have been changed to allow a higher torque value, it could cause oC faults.

NOTE: *Changing these parameters may cause dEv or oL faults. Only a trained technician should make modifications. It is desirable to have a fast fault reaction time without causing nuisance faults.*

6.3 Auto-Tune Errors

The following are errors that can occure during an Auto-Tune. If any of these errors are detected, the keypad will display the error text and the motor will coast to stop, if running. No fault or alarm output is triggered.

Table 6-5: Auto-Tune Errors and Corrective Actions

<table>
<tr><th>Display</th><th>Description</th><th>Corrective Action</th></tr>
<tr><td>ATL</td><td>Auto-Tune Travel Limit Error. A travel limit was encountered during an Auto-Tune.</td><td>• Decouple the motor and retry the Auto-Tune.
• Move the crane to a safer location and retry.</td></tr>
<tr><td>Er-01</td><td>Motor Data Error. The combination of motor rated power, motor no-load current, and motor rated current do not match. Or the combination of motor base frequency and motor base speed do not match. Motor nameplate data may have been entered incorrectly.</td><td>• Check motor nameplate data.
• Retry the Auto-Tune and enter the nameplate data correctly.</td></tr>
<tr><td>Er-02</td><td>Alarm. An alarm condition occurred during an Auto-Tune. This typically occurs during a Rotational Auto-Tune and at the beginning of the segment that runs the motor.</td><td>• Check that the motor nameplate data was entered correctly.
• If a digital input is programmed for Run/ Reference Select (MFDI = 1F), it is recommended that Run/Reference 1 is active, meaning that input is turned off.
• Disconnect the motor from the load.</td></tr>
<tr><td>Er-03</td><td>STOP Key Input. The stop key is pressed during the Auto-Tune and it did not complete.</td><td>• Retry the Auto-Tune.</td></tr>
<tr><td>Er-04</td><td>Line-to-Line Resistance Error. The Auto-Tune did not complete in the expected length of time. Motor nameplate data may have been entered incorrectly.</td><td rowspan="3">• Check motor nameplate data.
• Check motor wiring.
• Disconnect the motor from the load.
• Ensure the brake is manually released.
• Retry the Auto-Tune and enter the nameplate data correctly.</td></tr>
<tr><td>Er-05</td><td>No-load Current Error. The Auto-Tune did not complete in the expected length of time. Motor nameplate data may have been entered incorrectly or the motor is loaded too heavily and the Motor No-Load Current was not measured accurately.</td></tr>
<tr><td>Er-08</td><td>Rated Slip Error. The Auto-Tune did not complete in the expected length of time. Motor nameplate data may have been entered incorrectly or the motor is loaded too heavily and the Motor Slip was not measured accurately.</td></tr>
<tr><td>Er-09</td><td>Acceleration Error. The motor was not able to accelerate in the expected time. The motor may be loaded too heavily or a torque limit was reaching while accelerating.</td><td>• Increase b05-01 (acceleration time).
• Increase C07-01 and/or C07-02 motoring torque limits.
• Disconnect the motor from the load.</td></tr>
<tr><td>Er-10</td><td>Motor Direction Error. The motor began to rotate in the incorrect direction during the Auto-Tune. This is typically caused by an issue with the encoder wiring.</td><td>• Check the wiring of the encoder.
• Check the motor speed monitor U01-05 while manually turning the motor forward. If a negative number is displayed, change the setting of parameter F01-02.
• Ensure the motor is unloaded, the brake is manually opened, and retry the Auto-Tune.</td></tr>
<tr><td>Er-11</td><td>Motor Speed Error. The motor speed or torque reference was over 100% during the Auto-Tune.</td><td>• Increase b05-01 (acceleration time).
• Disconnect the motor from the load.</td></tr>
</table>

Display	Description	Corrective Action
Er-12	**Current Detection Error.** The output current during the Auto-Tune exceeded the rating of the VFD. Or the output current was too low, which may indicate an input phase loss or a completely disconnected motor.	• Ensure the brake is manually released. • Check that the motor is connected and the wiring is free of short circuits or loose connections.
Er-13	**Leakage Inductance Error.** The Auto-Tune did not complete in the expected length of time. Motor nameplate data may have been entered incorrectly or the motor is loaded too heavily and the Motor Leakage Inductance was not measured accurately.	• Check motor nameplate data. • Check motor wiring. • Disconnect the motor from the load. • Ensure the brake is manually released. • Retry the Auto-Tune and enter the nameplate data correctly.
End 1	**Excess Rated Voltage Setting.** The torque reference was more than 20% during Auto-Tune or the no-load current after Auto-Tune is more than 80%.	• Check the motor nameplate data. • Disconnect the motor from the load. • This error can occur if the motor is less than 50% of the VFD size. Auto-Tune parameters may need to be entered manually.
End 2	**Motor Iron Core Saturation Coefficient Error.** The Auto-Tune calculated an invalid Motor Iron Core Saturation Coefficient value. Motor nameplate data may have been entered incorrectly or the motor is loaded too heavily.	• Retry the Auto-Tune and enter the nameplate data correctly. • Check motor wiring. • Disconnect the motor from the load.
End 3	**Rated Current Setting Error.** The Motor Rated Current may have been entered incorrectly.	• Check Motor FLA setting (E02-01). • Retry the Auto-Tune and enter the nameplate data correctly.
End 4	**Adjusted Slip Calculation Error.** The Auto-Tune calculated an invalid Motor Slip value. Motor nameplate data may have been entered incorrectly or the motor is loaded too heavily.	• Retry the Auto-Tune and enter the nameplate data correctly. • If this error occurred during a Rotational Auto-Tune, try a Stationary Auto-Tune 1 instead.
End 5	**Resistance Tuning Error.** The Auto-Tune calculated an invalid Line-to-Line Resistance value.	• Retry the Auto-Tune and enter the nameplate data correctly. • Check the motor wiring for damage or loose connections.
End 6	**Leakage Inductance Error.** The Auto-Tune calculated an invalid Leakage Inductance value. Motor nameplate data may have been entered incorrectly.	• Retry the Auto-Tune and enter the nameplate data correctly.
End 7	**No-Load Current Error.** The entered Motor No-Load Current value was outside the allowable range, or Auto-Tuning results were less than 5% of the Motor Rated Current.	• Check the motor wiring for damage or loose connections. • Retry the Auto-Tune and enter the nameplate data correctly.

6.4 Option Card Faults

Check the following items first when an option card fault occurs on the VFD:

- Communication cable connections.
- Make sure the option card is properly installed to the VFD.
- Did a momentary power loss interrupt communications?

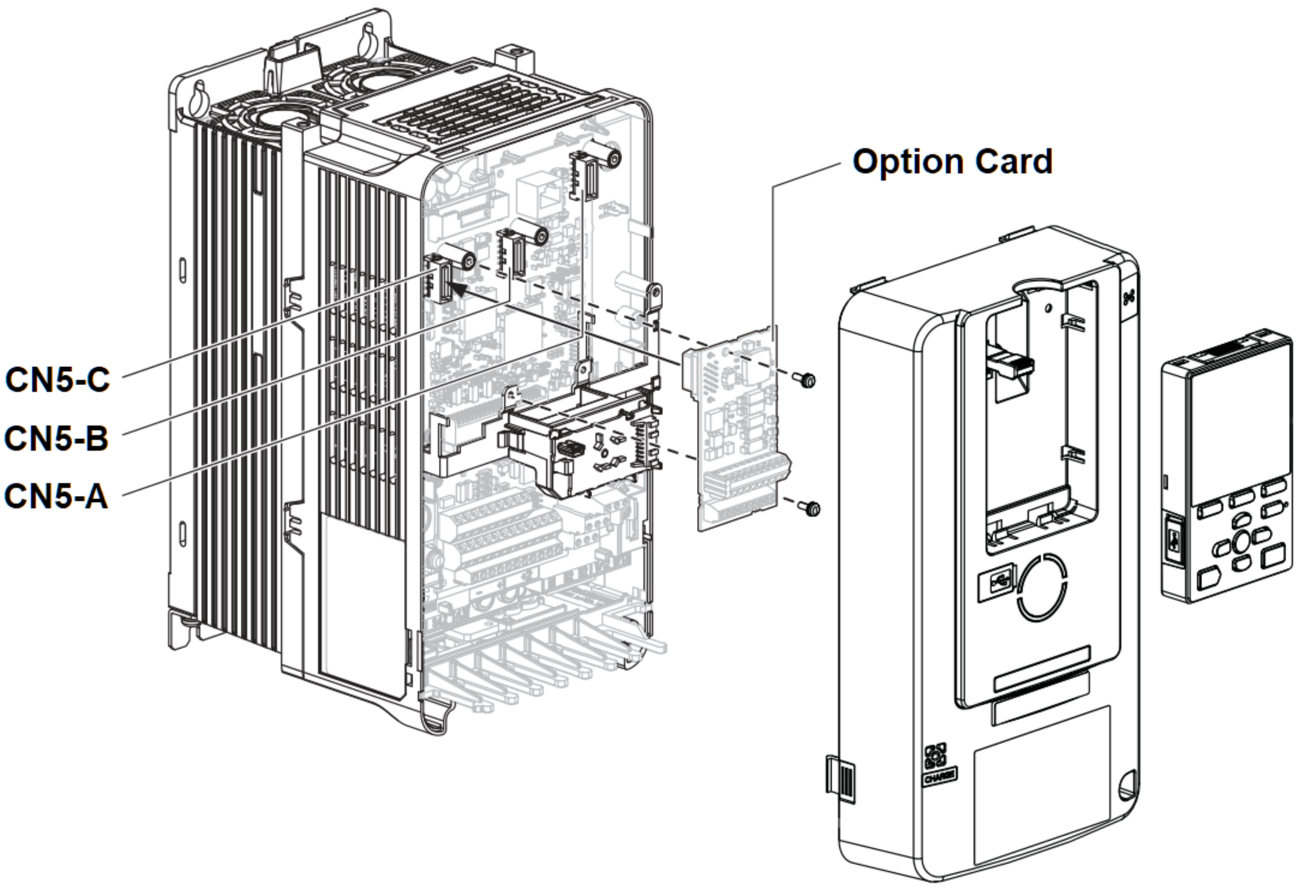


Figure 6-1: Option Card Ports

Table 6-6: Fault Codes for Option Cards

Display	Card	Description	Cause	Possible Solution
oFA00	SI- AO-A3 DI-A3 DO-A3 S4IO	**Option Error (CN5-A).** Option Card Connection Error at Port CN5-A.	• The option card in port CN5-A is incompatible. • A PG- option card is connected to port CN5-A.	• Confirm that the VFD supports the option card. • PG option cards are supported in ports CN5-B and CN5-C only. • SI- option cards are supported in port CN5-A only.
oFA01	SI- AO-A3 DI-A3 DO-A3 S4IO	**Option Fault (CN5-A).** Option Card at Port CN5-A is not properly connected or is faulty.	• The option card in port CN5-A was changed during run.	• Turn the power off and check the connectors between the VFD and the option.
oFB00	AO-A3 DO-A3 S4IO	**Option Error (CN5-B).** Option Card Connection Error at Port CN5-B.	• The option card in port CN5-B is incompatible. • A communication option card is in port CN5-B.	• Confirm that the VFD supports the option card. • Communication option cards must be in port CN5-A and there cannot be more than one.
oFB01	AO-A3 DO-A3 S4IO	**Option Fault (CN5-B).** Option Card at Port CN5-B is not properly connected or is faulty.	• The option card in port CN5-B was changed during run.	• Turn the power off and check the connectors between the VFD and the option.
oFB02	AO-A3 DO-A3 S4IO	**Option Fault (CN5-B).** Two of the same option cards are connected simultaneously.	• Duplicate type of option card is connected to ports CN5-A, CN5-B, and CN5-C.	• DI-A3/SI-: Can only be connected to port CN5-A. • AO-A3/DO-A3: Cannot be connected at the same time.
oFC00	AO-A3 DO-A3 S4IO	**Option Error (CN5-C).** Option Card Connection Error at Port CN5-C.	• The option card in port CN5-C is incompatible. • A communication option card is in port CN5-C.	• Confirm that the VFD supports the option card. • Communication option cards must be in port CN5-A and there cannot be more than one.
oFC01	AO-A3 DO-A3 S4IO	**Option Fault (CN5-C).** Option Card at Port CN5-C is not properly connected or is faulty.	• The option card in port CN5-C was changed during run.	• Turn off the power and check the connectors between the VFD and the option.
oFC02	AO-A3 DO-A3 S4IO	**Option Fault (CN5-C).** Two of the same option cards are connected simultaneously.	• Duplicate type of option card is connected to ports CN5-A, CN5-B, and CN5-C.	• DI-A3/SI-: Can only be connected to port CN5-A. • AO-A3/DO-A3: Cannot be connected at the same time.
oFA03 to oFA17	SI- AO-A3 DI-A3 DO-A3 S4IO	**Option Fault (CN5-A).** Option Card Fault at Option Port CN5-A.	• Option card or hardware is damaged.	• Cycle power to the VFD. • Re-seat option card, and if the problem continues, replace it.
oFA30 to oFA43	SI-	**Option Fault (CN5-A).** Communication Card Fault at Option Port CN5-A.	• Option card or hardware is damaged.	• Cycle power to the VFD. • Re-seat option card, and if the problem continues, replace it.
oFB03 to oFB17	AO-A3 DO-A3 S4IO	**Option Fault (CN5-B).** Option Card Fault at Option Port CN5-B.	• Option card or hardware is damaged.	• Cycle power to the VFD. • Re-seat option card, and if the problem continues, replace it.
oFC03 to oFC17	AO-A3 DO-A3 S4IO	**Option Fault (CN5-C).** Option Card Fault at Option Port CN5-C.	• Option card or hardware is damaged.	• Cycle power to the VFD. • Re-seat option card, and if the problem continues, replace it.

6.5 Copy Function Errors

The table below lists the messages and errors that may appear when using the Copy function.

When executing the tasks offered by the Copy function, the keypad will indicate the task being performed. When an error occurs, a code appears on the keypad to indicate the error. Note that errors related to the Copy function do not trigger the fault relay. To clear an error, simply press any key on the keypad and the error display will disappear.

NOTE:

1. *Whenever using the copy function, the VFD should be fully stopped.*
2. *The VFD will not accept a Run command while the Copy function is being executed.*
3. *Parameters can only be saved to a VFD when the model, control method, and firmware version match.*

Table 6-7: Copy Function Error Displays

Display	Description	Corrective Action
CPyE	**Error Writing Data.** Failed writing parameters.	Attempt to write parameters again.
CSEr	**Control Mode Mismatch.** The keypad is broken.	Replace the keypad.
dFPS	**VFD Model Mismatch.** The parameters being restored to the VFD are different than those in the backup.	Examine the VFD model being backed up along with the destination VFD model.
iFEr	**Keypad Communication Error.** • A communication error occurred between the VFD and the keypad. • A non-compatible cable is being used to connect the keypad and the VFD.	• Check the cable connection.
ndAT	**Model, Voltage Class, Capacity Mismatch.** • The VFD from which the parameters were copied and the VFD to which the parameters will be written have different electrical specifications, capacities, are set to different control methods, or are different models. • The device being used to write the parameters is blank and does not have any parameters saved on it.	• Make sure model numbers and specifications are the same for both VFDs. • Make sure all connections are correct, and copy the parameter settings onto the keypad.
vAEr	**Voltage Class, Capacity Mismatch.** The VFD from which the parameters were copied and the VFD on which the Verify mode is being performed have different electrical specifications or are a different capacity.	Make sure electrical specifications and capacities are the same for both VFDs.
vFyE	**Parameter Settings Mismatch.** Indicates that parameter settings that have been Read and loaded onto the keypad are different.	Restore or backup the parameters again.

6.6 Power Section Check

WARNING

Do NOT touch any circuit components while main power is on or immediately after main power is turned off. You must wait until the red “CHARGE” lamp is extinguished, which may take up to 10 minutes for the DC bus voltage to drop to a safe level. Failure to adhere to this warning could result in serious injury.

To perform a power section check, remove the VFD’s main and control wiring from the terminal strips. Obtain reading as specified in the table below, and ensure that the reading falls within the normal reading range.

Table 6-8: Analog Ohmmeter (R x 1 Scale) or Digital Multimeter (Diode Test)

Device	VFD Terminal		Normal Reading (Analog Meter)	Normal Reading (Digital Meter)
	Positive Lead	Negative Lead		
Input Rectifier Bridge	L1	+	7–100 Ω	0.299 ~ 0.675 VDC
	L2	+		
	L3	+		
	-	L1		
	-	L2		
	-	L3		
	L1	-	Infinite Ω	OL Displayed
	L2	-		
	L3	-		
	+	L1		
	+	L2		
	+	L3		
Bus Capacitors	+	-	Observe gradually increasing resistance	Observe gradually increasing voltage to OL
Output Transistors	T1	+	7–100 Ω	0.299 ~ 0.675 VDC
	T2	+		
	T3	+		
	-	T1		
	-	T2		
	-	T3		
	T1	-	Infinite Ω	OL Displayed
	T2	-		
	T3	-		
	+	T1		
	+	T2		
	+	T3		
Braking Diode	B2	B1	10 Ω	0.299 ~ 0.675 VDC
	B1	B2	Infinite Ω	OL Displayed
	B2	-	Infinite Ω	OL Displayed
	-	B2	Infinite Ω	0.299 ~ 0.675 VDC

NOTE: *“+” could be any one of three (+) terminals which are labeled as ⊕1, ⊕2, and ⊕3.*

6.7 Terminal Board (24 VDC) Replacement Procedure

WARNING

Do NOT touch any circuit components while AC main power is on or immediately after the main AC power is disconnected from the VFD. You must wait until the red “CHARGE” lamp is extinguished. It may take as long as 10 minutes for the charge on the main DC bus capacitors to drop to a safe level. Failure to adhere to this warning could result in serious injury.

NOTE: *When handling circuit boards always use electrostatic discharge protection. Keep the boards in the ESD bag as long as you can. Do not lay the board on any surfaces without ESD protection. When handling, always hold the board from the edges and do not touch the components. Installation should be performed only by qualified personnel who are familiar with this type of equipment and the hazards involved.*

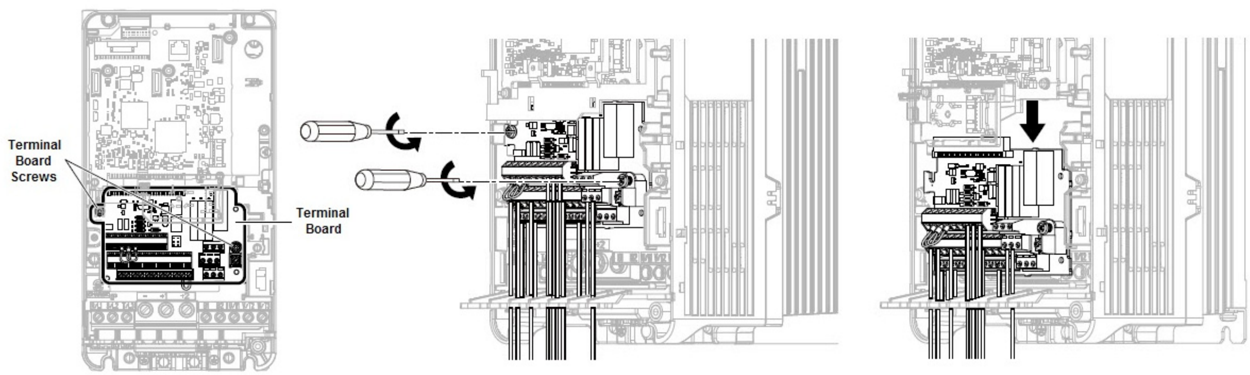


Figure 6-2: Terminal Board Removal

Removal Process

The following process explains how to remove the 24 VDC terminal board from the VFD. Installing the new terminal board consists of the same steps, but in reverse. No additional programming is required before or after the new terminal board is installed.

1. Remove the keypad and front cover(s) to access the terminal board.
2. Loosen the two screws securing the terminal board.
3. Slide the terminal board in a downward direction to detach itself from the control board.

Appendix A: Parameter Listing

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
A01-01	Access Level Selection	2	0–3	-	0101	***Page 90***
A01-02	Control Method Selection	G+: 0 VG+: 3	0, 2, 3	-	0102	***Page 90***
A01-03	Motion	G+: 1 VG+: 2	0–4, 7	-	1600	***Page 91***
A01-04	Speed Reference	1*	0–6	-	1601	***Page 91***
A01-05	Initialize Parameters	0	0, 1110, 2220	-	0103	***Page 97***
A01-06	Password	-	-	-	0104	***Page 99***
A01-07	Password Setting	-	-	-	0105	***Page 99***
A01-13	X-Press Legacy Method	0	0–1	-	1603	***Page 100***
A02-01	User Parameter 1	-	-	-	0106	***Page 101***
A02-02	User Parameter 2	-	-	-	0107	***Page 101***
A02-03	User Parameter 3	-	-	-	0108	***Page 101***
A02-04	User Parameter 4	-	-	-	0109	***Page 101***
A02-05	User Parameter 5	-	-	-	010A	***Page 101***
A02-06	User Parameter 6	-	-	-	010B	***Page 101***
A02-07	User Parameter 7	-	-	-	010C	***Page 101***
A02-08	User Parameter 8	-	-	-	010D	***Page 101***
A02-09	User Parameter 9	-	-	-	010E	***Page 101***
A02-10	User Parameter 10	-	-	-	010F	***Page 101***
A02-11	User Parameter 11	-	-	-	0110	***Page 101***
A02-12	User Parameter 12	-	-	-	0111	***Page 101***
A02-13	User Parameter 13	-	-	-	0112	***Page 101***
A02-14	User Parameter 14	-	-	-	0113	***Page 101***
A02-15	User Parameter 15	-	-	-	0114	***Page 101***
A02-16	User Parameter 16	-	-	-	0115	***Page 101***
A02-17	User Parameter 17	-	-	-	0116	***Page 101***
A02-18	User Parameter 18	-	-	-	0117	***Page 101***
A02-19	User Parameter 19	-	-	-	0118	***Page 101***
A02-20	User Parameter 20	-	-	-	0119	***Page 101***
A02-21	User Parameter 21	-	-	-	011A	***Page 101***
A02-22	User Parameter 22	-	-	-	011B	***Page 101***
A02-23	User Parameter 23	-	-	-	011C	***Page 101***
A02-24	User Parameter 24	-	-	-	011D	***Page 101***
A02-25	User Parameter 25	-	-	-	011E	***Page 101***
A02-26	User Parameter 26	-	-	-	011F	***Page 101***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
A02-27	User Parameter 27	-	-	-	0120	***Page 101***
A02-28	User Parameter 28	-	-	-	0121	***Page 101***
A02-29	User Parameter 29	-	-	-	0122	***Page 101***
A02-30	User Parameter 30	-	-	-	0123	***Page 101***
A02-31	User Parameter 31	-	-	-	0124	***Page 101***
A02-32	User Parameter 32	-	-	-	0125	***Page 101***
b01-01	Reference 1	15.00*	0.00–E01-04	Hz	0280	***Page 106***
b01-02	Reference 2	30.00*	0.00–E01-04	Hz	0281	***Page 106***
b01-03	Reference 3	60.00*	0.00–E01-04	Hz	0282	***Page 106***
b01-04	Reference 4	0.00*	0.00–E01-04	Hz	0283	***Page 106***
b01-05	Reference 5	0.00*	0.00–E01-04	Hz	0284	***Page 106***
b01-06	Reference 6	0.00	0.00–E01-04	Hz	0285	***Page 106***
b01-07	Reference 7	0.00	0.00–E01-04	Hz	0286	***Page 106***
b01-08	Reference 8	0.00	0.00–E01-04	Hz	0287	***Page 106***
b01-09	Reference 9	0.00	0.00–E01-04	Hz	0288	***Page 106***
b01-10	Reference 10	0.00	0.00–E01-04	Hz	028B	***Page 106***
b01-11	Reference 11	0.00	0.00–E01-04	Hz	028C	***Page 106***
b01-12	Reference 12	0.00	0.00–E01-04	Hz	028D	***Page 106***
b01-13	Reference 13	0.00	0.00–E01-04	Hz	028E	***Page 106***
b01-14	Reference 14	0.00	0.00–E01-04	Hz	028F	***Page 106***
b01-15	Reference 15	0.00	0.00–E01-04	Hz	0290	***Page 106***
b01-16	Reference 16	0.00	0.00–E01-04	Hz	0291	***Page 106***
b01-17	Jog Reference	6.00*	0.00–E01-04	Hz	0292	***Page 106***
b01-20	Inf-Var Start Speed	6.00	0.00–E01-04	Hz	02A6	***Page 106***
b01-21	Inf-Var Max Reference 1	60.00	0.00–E01-04	Hz	02A7	***Page 106***
b01-22	Inf-Var Max Reference 2	60.00	0.00–E01-04	Hz	02A8	***Page 106***
b02-01	Frequency Reference Upper Limit	100.0*	0.0–110.0	%	0289	***Page 108***
b02-02	Frequency Reference Lower Limit	G+: 2.0 VG+: 0.0	0.0–110.0	%	028A	***Page 108***
b02-04	Alternate Frequency Upper Limit	0.0	0.0–110.0	%	0298	***Page 108***
b03-01	Frequency Reference Selection 1	0*	0–5	-	0180	***Page 109***
b03-02	Run Command Selection 1	1*	0–3	-	0181	***Page 109***
b03-03	Stopping Method Selection	G+: 0* VG+: 6*	0, 1, 4, 6	-	0182	***Page 110***
b03-04	Phase Order Selection	0	0–1	-	01C3	***Page 112***
b03-06	Digital Input Reading	1	0–1	-	0185	***Page 112***
b03-08	Run Command Select in PRG Mode	0	0–2	-	0187	***Page 113***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
b03-10	Run Command at Power Up	0	0–1	-	01C6	***Page 113***
b03-15	Frequency Reference Selection 2	0	0–5	-	01C4	***Page 113***
b03-16	Run Command Selection 2	1	0–3	-	01C5	***Page 113***
b03-35	Digital Input Deadband Time	0.0	0.0–100.0	ms	1117	***Page 113***
b05-01	Acceleration Time 1	5.00*	0.00–60.00	sec	0200	***Page 114***
b05-02	Deceleration Time 1	3.00*	0.00–60.00	sec	0201	***Page 114***
b05-03	Acceleration Time 2	10.00	0.00–60.00	sec	0202	***Page 114***
b05-04	Deceleration Time 2	10.00	0.00–60.00	sec	0203	***Page 114***
b05-05	Switch Frequency Accel Time	2.00	0.00–60.00	sec	0204	***Page 115***
b05-06	Switch Frequency Decel Time	2.00	0.00–60.00	sec	0205	***Page 115***
b05-08	Fast Stop Time	0.50	0.00–60.00	sec	022D	***Page 115***
b05-09	Accel/Decel Time Setting Units	0	0–1	-	022E	***Page 115***
b05-10	Accel/Decel Time Switchover Freq	0.0	0.0–300.0	Hz	022F	***Page 115***
b05-11	Switch Frequency Compare	0	0–1	-	0206	***Page 115***
b05-12	Acceleration Time 3	3.00	0.00–60.00	sec	0207	***Page 115***
b05-13	Deceleration Time 3	3.00	0.00–60.00	sec	0208	***Page 115***
b05-14	Acceleration Time 4	3.00	0.00–60.00	sec	0209	***Page 115***
b05-15	Deceleration Time 4	3.00	0.00–60.00	sec	020A	***Page 115***
b05-16	Accel/Decel Rate Frequency	60.0	0.0–300.0	Hz	0230	***Page 115***
b08-01	Jump Frequency 1	0.0	0.0–300.0	Hz	0294	***Page 116***
b08-02	Jump Frequency 2	0.0	0.0–300.0	Hz	0295	***Page 116***
b08-03	Jump Frequency 3	0.0	0.0–300.0	Hz	0296	***Page 116***
b08-04	Jump Frequency Width	1.0	0.0–20.0	Hz	0297	***Page 116***
b08-05	Offset Frequency 1	0.0	-100.0–100.0	%	02B2	***Page 117***
b08-06	Offset Frequency 2	0.0	-100.0–100.0	%	02B3	***Page 117***
b08-07	Offset Frequency 3	0.0	-100.0–100.0	%	02B4	***Page 117***
b09-03	Field Forcing Selection	0	0–1	-	02A2	***Page 117***
b09-06	Field Forcing Limit	200	100–400	%	02A5	***Page 117***
C01-01	Quick Stop	0*	0–1	-	161B	***Page 119***
C01-02	Quick Stop Time	1.0	0.0–25.5	sec	161C	***Page 119***
C01-03	Reverse Plug	0*	0–1	-	161D	***Page 120***
C01-04	Reverse Plug Deceleration Time	2.0	0.0–25.5	sec	161E	***Page 120***
C01-05	Reverse Plug Acceleration Time	0.0	0.0–25.5	sec	161F	***Page 120***
C02-01	Micro-Speed Gain 1	1.000	Hoist: 0.001–1.000 Traverse: 0.001–2.000	-	1620	***Page 121***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C02-02	Micro-Speed Gain 2	1.000	Hoist: 0.001–1.000 Traverse: 0.001–2.000	-	1621	***Page 121***
C03-01	UL1 Speed	6.00	0.00–E01-04	Hz	1623	***Page 122***
C03-02	UL0/UL1 Deceleration Time	1.0	0.0–25.5	sec	1624	***Page 122***
C03-03	UL2 Deceleration Time	1.0	0.0–25.5	sec	1625	***Page 122***
C03-04	LL1 Speed	6.00	0.00–E01-04	Hz	1626	***Page 122***
C03-05	LL0/LL1 Deceleration Time	1.0	0.0–25.5	sec	1627	***Page 122***
C03-06	LL2 Deceleration Time	1.0	0.0–25.5	sec	1628	***Page 122***
C03-07	UL0 Speed	30.00	0.00–E01-04	Hz	1629	***Page 122***
C03-08	LL0 Speed	30.00	0.00–E01-04	Hz	162A	***Page 122***
C03-09	LL2/UL2 Action	2*	0–2	-	162B	***Page 122***
C03-10	LL3/UL3 Action	1	0–5	-	162C	***Page 122***
C03-11	LL3/UL3 Deceleration Time	1.0	0.0–25.5	sec	162D	***Page 122***
C03-12	Phantom Stop Method	1	0–2	-	162E	***Page 123***
C03-14	Hook Height Revolutions Total	250	0–65535	Revs	1630	***Page 123***
C03-15	Hook Height Home Position	2	0–4	-	1631	***Page 123***
C03-16	Hook Height Analog Output	0	0–1	-	1632	***Page 123***
C03-17	Hook Height Home Input Delay	0.1	0.0–25.5	sec	165C	***Page 123***
C03-20	Electronic Programmable Limits	0	0–5, 10, 11	-	1633	***Page 125***
C03-21	UL3 Revolutions	0	0–65535	Revs	1634	***Page 125***
C03-22	UL2 Revolutions	0	0–65535	Revs	1635	***Page 125***
C03-23	UL1 Revolutions	0	0–65535	Revs	1636	***Page 125***
C03-24	UL0 Revolutions	0	0–65535	Revs	1637	***Page 125***
C03-25	LL0 Revolutions	0	0–65535	Revs	1638	***Page 125***
C03-26	LL1 Revolutions	0	0–65535	Revs	1639	***Page 125***
C03-27	LL2 Revolutions	0	0–65535	Revs	163A	***Page 125***
C03-28	LL3 Revolutions	0	0–65535	Revs	163B	***Page 125***
C03-29	Motor Revolutions At Home Pos	0	0–65535	Revs	163C	***Page 125***
C03-40	Analog Input Programmable Limits	0	0–5, 11	-	163D	***Page 129***
C03-41	UL3 Analog Level	0.0	0.0–100.0	%	163E	***Page 129***
C03-42	UL2 Analog Level	0.0	0.0–100.0	%	163F	***Page 129***
C03-43	UL1 Analog Level	0.0	0.0–100.0	%	1640	***Page 129***
C03-44	UL0 Analog Level	0.0	0.0–100.0	%	1641	***Page 129***
C03-45	LL0 Analog Level	0.0	0.0–100.0	%	1642	***Page 129***
C03-46	LL1 Analog Level	0.0	0.0–100.0	%	1643	***Page 129***
C03-47	LL2 Analog Level	0.0	0.0–100.0	%	1644	***Page 129***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C03-48	LL3 Analog Level	0.0	0.0–100.0	%	1645	***Page 129***
C03-49	MFAI Hysteresis	1.0	0.0–10.0	%	1646	***Page 129***
C03-51	Rate Of Change Fault	5	0–20	%	1648	***Page 130***
C03-52	Rate Of Change Fault Delay	0.5	0.0–5.0	sec	1647	***Page 130***
C03-60	Hook Height Point 1 Function	0	0–2, 9	-	1649	***Page 130***
C03-61	Hook Height Point 1 Revolutions	0	0–65535	Revs	164A	***Page 130***
C03-62	Hook Height Point 2 Function	1	0–2, 9	-	164B	***Page 130***
C03-63	Hook Height Point 2 Revolutions	0	0–65535	Revs	164C	***Page 130***
C03-64	Hook Height Point 3 Function	0	0–2, 9	-	1662	***Page 130***
C03-65	Hook Height Point 3 Revolutions	0	0–65535	Revs	1663	***Page 130***
C03-66	Hook Height Point 4 Function	0	0–2, 9	-	1664	***Page 130***
C03-67	Hook Height Point 4 Revolutions	0	0–65535	Revs	1665	***Page 130***
C04-01	Load Float MFDI Run Time	10	0–65535	sec	1720	***Page 131***
C04-02	Load Float Gain	10*	0–100	-	1721	***Page 131***
C04-05	Load Share	0	0–1	-	1714	***Page 132***
C04-06	Load Share Fault Time	1.5	0.0–25.5	sec	1715	***Page 132***
C05-01	Load Check	0	0, 1, 7–9	-	1723	***Page 134***
C05-02	Load Check Detected Action	5	0, 2–5	-	1724	***Page 134***
C05-03	Load Check Holding Time	0.20	0.00–2.55	sec	1725	***Page 134***
C05-04	Load Check Testing Time	0.20	0.00–2.55	sec	1726	***Page 134***
C05-05	Detection Margin at Acceleration	5	0–50	%	1727	***Page 134***
C05-07	Detection Margin at Speed Agree	10	0–50	%	1728	***Page 134***
C05-08	Alarm Speed	6.0	0.0–30.0	Hz	1729	***Page 134***
C05-09	Load Check Level 01	0	0–250	%	172A	***Page 134***
C05-10	Load Check Level 02	0	0–250	%	172B	***Page 134***
C05-11	Load Check Level 03	0	0–250	%	172C	***Page 134***
C05-12	Load Check Level 04	0	0–250	%	172D	***Page 134***
C05-13	Load Check Level 05	0	0–250	%	172E	***Page 134***
C05-14	Load Check Level 06	0	0–250	%	172F	***Page 134***
C05-15	Load Check Level 07	0	0–250	%	1730	***Page 134***
C05-16	Load Check Level 08	0	0–250	%	1731	***Page 134***
C05-17	Load Check Level 09	0	0–250	%	1732	***Page 135***
C05-18	Load Check Level 10	0	0–250	%	1733	***Page 135***
C05-19	Load Check Level 11	0	0–250	%	1734	***Page 135***
C05-20	Load Check Level 12	0	0–250	%	1735	***Page 135***
C05-21	Load Check Level 13	0	0–250	%	1736	***Page 135***
C05-22	Load Check Level 14	0	0–250	%	1737	***Page 135***
C05-23	Load Check Level 15	0	0–250	%	1738	***Page 135***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C05-24	Load Check Level 16	0	0–250	%	1739	***Page 135***
C05-26	Load Check Delay Time	0.25	0.00–2.55	sec	173B	***Page 135***
C05-27	Load Check REV to FWD Delay	0.0	0.0–25.5	sec	173C	***Page 135***
C05-28	Load Check REV to FWD Frequency	30.0	0.0–60.0	Hz	173D	***Page 135***
C06-01	Ultra-Lift	0	0–4	-	1650	***Page 136***
C06-02	Ultra-Lift Max Forward Speed	60.0	0.1–300.0	Hz	1651	***Page 136***
C06-03	Ultra-Lift Max Reverse Speed	60.0	0.1–300.0	Hz	1652	***Page 136***
C06-04	Ultra-Lift Forward Torque	50	0–100	%	1653	***Page 136***
C06-05	Ultra-Lift Reverse Torque	30	0–100	%	1654	***Page 136***
C06-06	Ultra-Lift Enable Window	0.5	0.1–10.0	Hz	1655	***Page 137***
C06-07	Ultra-Lift Delay Time	2.0	0.0–25.5	sec	1656	***Page 137***
C06-08	Ultra-Lift Accel Multiplier	1.0	0.1–9.9	-	1657	***Page 137***
C06-10	Motor Torque QuickSet	2	0–4	-	1658	***Page 137***
C06-15	Adaptive UL Torque FWD Offset	10	0–100	%	165D	***Page 137***
C06-16	Adaptive UL Torque REV Offset	20	0–100	%	165E	***Page 137***
C07-01	Forward Torque Limit	150	0–300	%	04A7	***Page 139***
C07-02	Reverse Torque Limit	150	0–300	%	04A8	***Page 139***
C07-03	Forward Regenerative Trq Limit	180	0–300	%	04A9	***Page 139***
C07-04	Reverse Regenerative Trq Limit	180	0–300	%	04AA	***Page 139***
C07-05	Torque Limit Forward Gain	1.25	0.50–1.50	-	0477	***Page 139***
C07-06	Torque Limit Reverse Gain	1.25	0.50–1.50	-	0478	***Page 139***
C07-07	Torque Limit Regenerative Gain	1.25	0.50–1.50	-	0479	***Page 139***
C07-08	Torque Limit Integral Time	200	5–10000	ms	04AC	***Page 139***
C07-09	Torque Limit during Accel/Decel	0	0–1	-	04C9	***Page 139***
C07-10	Torque Limit Process at Start	1	0–1	-	044D	***Page 139***
C07-12	Anti-Shock	0	0–2		0517	***Page 141***
C07-13	Anti-Shock Enabling Frequency	6.0	0.0–60.0	Hz	0179	***Page 141***
C07-14	Anti-Shock Reaccelerate Delay	0.20	0.00–2.55	sec	017A	***Page 141***
C07-15	Anti-Shock Torque Delta	10	0–180	%	0518	***Page 141***
C07-16	Anti-Shock Detection Time	0.30	0.01–0.50	sec	0519	***Page 141***
C07-17	Anti-Shock Smoothing Frequency	3.0	0.0–15.0	Hz	051A	***Page 141***
C07-18	Anti-Shock Smoothing Decel Time	0.30	0.00–2.55	sec	051B	***Page 141***
C07-20	Anti-Shock Smoothing Time	0.20	0.00–0.50	sec	05ED	***Page 141***
C07-22	Anti-Shock Alarm Display Time	4	0–30	sec	017B	***Page 141***
C07-23	Anti-Shock No Load Torque	20	0–100	%	04CC	***Page 141***
C07-24	Anti-Shock Activation Torque	75	0–180	%	04CD	***Page 141***
C07-25	Anti-Shock Detection Method	1	0–2	-	04CE	***Page 141***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C07-40	Traverse Torque Limiter	0	0–1	-	047A	***Page 142***
C07-41	Traverse Torque Limiter Window	2.0	0.5–10.0	Hz	047B	***Page 142***
C08-01	BE2 Torque Build Up Time	1.00	0.00–2.55	sec	16AF	***Page 144***
C08-02	BE2 Torque Detection Time	1.00	0.00–2.55	sec	16B0	***Page 144***
C08-03	BE2 Minimum Brake Release Torque	10	0–200	%	16B1	***Page 144***
C08-04	BE1 Rollback Time	0.30	0.00–2.55	sec	16B2	***Page 144***
C08-05	BE1 Rollback Pulse Count	200	0–15000	Pulses	16B3	***Page 144***
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C08-07	BE3 Brake Release Pulse Count	10	0–2000	Pulses	16B5	***Page 144***
C08-08	BE3 Reverse Torque Limit	25	0–250	%	16B6	***Page 144***
C08-09	Zero Speed Level	1.0	0.0–5.0	Hz	16B7	***Page 144***
C08-10	Load Float Time	10*	0–65535	sec	16B8	***Page 144***
C08-11	BE5 Brake Set Time	0.7	0.0–25.5	sec	16B9	***Page 144***
C08-12	BE6 Detection Time	5.0	0.0–25.5	sec	16BA	***Page 144***
C08-13	BE6 Maximum Pulse Count	50	0–2000	Pulses	16BB	***Page 144***
C08-14	Brake Set Hold Speed	G+: 2.0 VG+: 0.0	0.0–25.5	%	16BC	***Page 144***
C08-15	Load Float Extension Time	10	0–65535	sec	16BD	***Page 145***
C08-16	Initial Forward Brake Torque	100	10–300	%	166A	***Page 145***
C08-17	Initial Reverse Brake Torque	30	10–300	%	166B	***Page 145***
C08-18	BE5/BE6/BE8 Max Forward Speed	6.00	0.00–300.00	Hz	166C	***Page 145***
C08-19	BE5/BE6/BE8 Brake Slip Reset	0	0–1	-	166D	***Page 145***
C08-20	BE6 Torque Reference	0	0–20	%	1660	***Page 145***
C08-21	Minimum Magnetizing Current	5	0–100	%	1661	***Page 145***
C08-22	BE8 Brake Slip Detection	0	0–1	-	166E	***Page 145***
C08-23	BE8 Detection Sensitivity	0.5	0.0–10.0	Hz	166F	***Page 145***
C08-24	Brake Test Torque	1.25 x [(E02-11 x 5252) / RPM]	50–200% Rated Torque	FtLb	1670	***Page 145***
C08-25	Brake Test Complete Indication	1	0–1	-	1671	***Page 145***
C08-28	BE2 Brake Torque Check Time	0.05	0.00–2.55	sec	1673	***Page 145***
C08-33	Dual Brake Test	0	0–1	-	161A	***Page 145***
C08-34	DIR Fault Torque Level	50	0–100	%	1622	***Page 145***
C08-35	Emergency Lift	0	0–2	-	170C	***Page 146***
C08-36	Emergency Lift Maximum Speed	30	0–150	Hz	170D	***Page 146***
C08-37	Emergency Lift Maximum Time	10	0–20	min	170E	***Page 146***
C09-01	Synchronization Mode	0	0–2	-	16CC	***Page 148***
C09-02	Leader Encoder PPR	1024	0–60000	PPR	16CD	***Page 148***
C09-03	Leader Motor Poles	4	2–48	-	16CE	***Page 148***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C09-04	Sync Ratio Numerator 1	1	1–10000	-	16CF	***Page 148***
C09-05	Sync Ratio Numerator 2	1	1–10000	-	16D0	***Page 148***
C09-06	Sync Ratio Denominator	1	1–10000	-	16D1	***Page 148***
C09-07	Position P Gain	10	0–100	-	16D2	***Page 148***
C09-08	Position I Time	0.10	0.00–100.00	sec	16D3	***Page 149***
C09-09	High Speed Resync Frequency	45.00	0.00–60.00	Hz	16D4	***Page 149***
C09-10	High Speed Resync Revolutions	5	1–1000	Rev	16D5	***Page 149***
C09-12	Sync Error Detect Level	1	1–100	Rev	16D6	***Page 149***
C09-13	Sync Error Action	2	0–2	-	16D7	***Page 149***
C09-14	Auto Resynchronization	0	0–2	-	16D8	***Page 149***
C09-15	Switching Speed	0.5	0.0–10.0	Hz	16D9	***Page 149***
C09-16	Advance/Retard Trim Rate	20	0–1000	-	16DA	***Page 149***
C09-17	Store Position Error	1	0–1	-	16DB	***Page 149***
C09-19	Run Follower Off Delay	0.5	0.0–10.0	sec	16E4	***Page 150***
C09-50	Bucket Control	0	0–2	-	1900	***Page 154***
C09-51	Torque Reference 1	20*	0–250	%	1901	***Page 154***
C09-52	Torque Reference 2	40*	0–250	%	1902	***Page 154***
C09-53	Torque Reference 3	60*	0–250	%	1903	***Page 154***
C09-54	Torque Reference 4	80*	0–250	%	1904	***Page 154***
C09-55	Torque Reference 5	100*	0–250	%	1905	***Page 155***
C09-56	Store Position Error	1	0, 1	-	1906	***Page 155***
C09-57	Bucket Open Revs	250	-9999–9999	Rev	1907	***Page 155***
C09-58	Bucket Closed Threshold	5	0–100	Rev	1908	***Page 155***
C09-59	Switching Speed	1.0	0.0–10.0	Hz	1909	***Page 155***
C09-60	Variable Speed Limits	0	0, 1	-	190A	***Page 155***
C09-61	Load Balancer	0	0, 1	-	190B	***Page 155***
C09-62	Load Balancer Frequency Window	5	5–20	Hz	190C	***Page 155***
C09-63	Load Balancer Torque Window	10	5–50	%	190D	***Page 155***
C09-71	Auto-Grab Close Distance	Closer: 90 Holder: 10	-50–150	%	190F	***Page 155***
C09-72	Auto-Grab Speed	Closer: 20.0 Holder: 10.0	1.0–150.0	Hz	1910	***Page 155***
C09-73	Auto-Grab Torque Restore Time	1.0	0.1–5.0	sec	1911	***Page 155***
C10-01	Load Weight Measurement	0	0–11	-	168C	***Page 166***
C10-02	Hoist Display Conversion	11000	1–39999	-	168D	***Page 166***
C10-03	Hoist Display Units	4	0–5	-	168E	***Page 167***
C10-04	Minimum Test Frequency	6	0–20	Hz	168F	***Page 167***
C10-05	Steady Speed Settling Time	0.50	0.00–2.55	sec	1700	***Page 167***
C10-06	Acceleration Settling Time	0.30	0.00–2.55	sec	1701	***Page 167***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C10-11	Unloaded Feedback at SS 1	0.0	0.0–200.0	%	1703	***Page 167***
C10-12	Unloaded Feedback at SS 2	0.0	0.0–200.0	%	1704	***Page 167***
C10-13	Unloaded Feedback at Accel 1	0.0	0.0–200.0	%	1705	***Page 167***
C10-14	Unloaded Feedback at Accel 2	0.0	0.0–200.0	%	1706	***Page 167***
C10-15	Loaded Feedback at SS 1	0.0	0.0–200.0	%	1707	***Page 167***
C10-16	Loaded Feedback at SS 2	0.0	0.0–200.0	%	1708	***Page 167***
C10-17	Loaded Feedback at Accel 1	0.0	0.0–200.0	%	1709	***Page 167***
C10-18	Loaded Feedback at Accel 2	0.0	0.0–200.0	%	170A	***Page 167***
C10-19	Load Weight Reset Torque	10.0	0.0–200.0	%	170B	***Page 167***
C10-20	Mid Loaded Feedback at SS 1	0.0	0.0–200.0	%	1745	***Page 167***
C10-21	Mid Loaded Feedback at SS 2	0.0	0.0–200.0	%	1746	***Page 167***
C10-22	Mid Loaded Feedback at Accel 1	0.0	0.0–200.0	%	1747	***Page 167***
C10-23	Mid Loaded Feedback at Accel 2	0.0	0.0–200.0	%	1748	***Page 167***
C10-24	Mid Load Weight	0.0	0.0–200.0	%	1749	***Page 167***
C10-28	Hoist Load During Setup Process	100.0	60.0–200.0	%	173A	***Page 168***
C10-29	Hoist/Crane Capacity	0.0	0.0–200.0	%	174A	***Page 168***
C10-30	Hoist Overweight Warning	0	0–200	%	174B	***Page 168***
C10-31	Hoist Overweight	0	0–200	%	174C	***Page 168***
C10-32	Crane Overweight Warning	0	0–200	%	174D	***Page 168***
C10-33	Crane Overweight	0	0–200	%	174E	***Page 168***
C10-34	Overweight Detected Delay	0.0	0.0–5.0	sec	174F	***Page 168***
C10-35	Overweight Detected Action	5	0, 2–5	-	1750	***Page 168***
C10-36	Overweight Alarm Speed	6.0	0.1–60.0	Hz	1751	***Page 168***
C10-37	Crane Display Conversion	11000	1–39999	-	1752	***Page 168***
C10-38	Crane Display Units	4	0–5	-	1753	***Page 168***
C10-39	Load Sum Analog Output Scale	66.7	50.0–100.0	%	1754	***Page 169***
C10-40	Spreader Weight 1	0	0–9999	-	1755	***Page 169***
C10-41	Spreader Weight 2	0	0–9999	-	1756	***Page 169***
C10-42	Spreader Weight 3	0	0–9999	-	1757	***Page 169***
C10-43	Alternate Crane OW Warning	0	0–200	%	1740	***Page 169***
C10-44	Alternate Crane OW	0	0–200	%	1741	***Page 169***
C10-45	Load Sum Chain FBL Detect	0	0–1	-	1744	***Page 169***
C10-50	Taut Line Weight	15	0–100	%	1742	***Page 169***
C10-51	Load Lifted Revolutions	20	0–9999	Revs	1743	***Page 169***
C10-54	Steady Speed Filter Time	2.00	0.00–2.55	sec	16E5	***Page 169***
C10-55	Acceleration Filter Time	0.05	0.00–2.55	sec	16E6	***Page 169***
C10-56	Torque Feedback Filter Time	0.02	0.00–2.55	sec	16E7	***Page 169***
C11-01	Slack Cable	0	0–2	-	1692	***Page 174***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C11-02	Slack Cable Action	2	0–5	-	1693	***Page 174***
C11-03	Slack Cable Detection Torque	30	-50–100	%	1694	***Page 174***
C11-04	Slack Cable Detection Speed 1	2	0–E01-04	Hz	1695	***Page 174***
C11-05	Slack Cable Delay Time 1	0.50	0.00–2.55	sec	1696	***Page 174***
C11-06	Slack Cable Detection Speed 2	60	0–E01-04	Hz	1697	***Page 174***
C11-07	Slack Cable Delay Time 2	0.10	0.00–2.55	sec	1698	***Page 174***
C11-08	Snap Shaft	0	0–2	-	1699	***Page 175***
C11-09	Snap Shaft Action	0	0–1	-	169A	***Page 175***
C11-10	Snap Shaft Delta Speed	30	0–900	RPM	169B	***Page 175***
C11-11	Snap Shaft Delay Time	250	0–2000	ms	169C	***Page 175***
C11-12	Snap Shaft Gear Ratio Numerator	10000	1–65535	-	169D	***Page 175***
C11-13	Snap Shaft Gear Ratio Denominatr	10000	1–65535	-	169E	***Page 175***
C12-01	Brake Set Delay @ Jog	0.0	0.0–100.0	sec	169F	***Page 176***
C12-02	Brake Set Delay @ Run	0.0	0.0–100.0	sec	16A0	***Page 176***
C12-03	Timer Function ON-Delay Time	0.0	0.0–3000.0	sec	01A3	***Page 176***
C12-04	Timer Function OFF-Delay Time	0.0	0.0–3000.0	sec	01A4	***Page 176***
C12-05	Maintenance Run Timer	0	0–32000	Hrs	16EA	***Page 177***
C12-06	Maintenance Alarm Speed Gain	50	0–100	%	16E9	***Page 177***
C12-07	Maintenance On Timer	0	0–32000	Hrs	16EB	***Page 177***
C12-08	Maintenance Brake Cycles	0	0–65000	kCycles	16EC	***Page 177***
C12-10	Terminal M1-M2 ON-Delay Time	0	0–65000	ms	0B30	***Page 178***
C12-11	Terminal M1-M2 OFF-Delay Time	0	0–65000	ms	0B31	***Page 178***
C12-12	Terminal M3-M4 ON-Delay Time	0	0–65000	ms	0B32	***Page 178***
C12-13	Terminal M3-M4 OFF-Delay Time	0	0–65000	ms	0B33	***Page 178***
C12-14	Terminal M5-M6 ON-Delay Time	0	0–65000	ms	0B34	***Page 178***
C12-15	Terminal M5-M6 OFF-Delay Time	0	0–65000	ms	0B35	***Page 178***
C13-01	Inch Run Time	1.00	0.00–2.55	sec	16A3	***Page 179***
C13-02	Inch Repeat Delay Time	1.00	0.00–2.55	sec	16A4	***Page 179***
C13-03	Index Frequency Reference	1.00	0.01–60.00	Hz	16A5	***Page 181***
C13-04	Index Motor Revolutions	0	0–65535	Revs	16A6	***Page 181***
C13-05	Index Motor Pulses	100	0–65535	Pulses	16A7	***Page 181***
C13-06	Index Repeat Delay	0.00	0.00–60.00	sec	16A8	***Page 181***
C13-07	Index Complete Width	10	1–1000	-	16A9	***Page 181***
C13-08	Index Load Float Gain	10	0–100	-	16AA	***Page 181***
C13-09	Index ASR Proportional Gain	30.00	0.00–300.00	-	16AB	***Page 181***
C13-10	Index ASR Integral Time	0.200	0.000–10.000	sec	16AC	***Page 181***
C13-11	Index Accel/Decel Gain	1.0	0.0–5.0	-	16AD	***Page 181***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
C13-12	Index Brake Control	NLB: 2 else: 0	NLB: 0, 2 Traverse: 0–2	-	16AE	***Page 181***
C13-13	Bi-Polar Analog Index Deadzone	0.0*	0.0–20.0	%	02A3	***Page 181***
C14-01	Sway Control	0	0–2	-	16C0	***Page 182***
C14-02	Hook Height	25	0–300	Ft	16C1	***Page 182***
C14-03	Drum to Weighted Limit Offset	5	0–100	Ft	16C2	***Page 182***
C14-04	Center of Gravity Offset by MFDI	1	0–10	Ft	16C3	***Page 183***
C14-05	Center of Gravity Offset by MFAI	1	0–10	Ft	16C4	***Page 183***
C14-06	Acceleration Aggression	9.0	0.0–10.0	-	16C5	***Page 183***
C14-07	Deceleration Aggression	9.0	0.0–10.0	-	16C6	***Page 183***
C14-08	Sway Control Disabled In	4	0–4	-	16C7	***Page 183***
C14-09	Alternate Hook Height	20	0–300	Ft	16C8	***Page 183***
C14-10	Sway Control Algorithm Gain	100	0-100	%	16C9	***Page 183***
C14-11	End at Zero Speed	1	0–1	-	16CA	***Page 183***
C14-12	Trav Limit Decel Method	0	0–2	-	16CB	***Page 183***
C14-13	Main/Aux Height Feedback	0	0–1	-	165A	***Page 184***
C14-14	SCS Enable Speed	0.0	0.0–20.0	Hz	165B	***Page 184***
C15-01	Torque Reference 1	20*	0–250	%	16F0	***Page 195***
C15-02	Torque Reference 2	40*	0–250	%	16F1	***Page 195***
C15-03	Torque Reference 3	60*	0–250	%	16F2	***Page 195***
C15-04	Torque Reference 4	80*	0–250	%	16F3	***Page 195***
C15-05	Torque Reference 5	100*	0–250	%	16F4	***Page 195***
C15-07	Foot Brake Action	2	0–2	-	16F5	***Page 195***
C15-08	Variable Speed Limit	0	0–1	-	16F6	***Page 195***
C15-10	Parking Brake Set Frequency	1.0	0.0–20.0	Hz	16F8	***Page 195***
C15-11	Parking Brake Set Time	1.0	0.0–6000.0	sec	16F9	***Page 195***
C15-12	Neutral Torque Enable	0	0–1	-	16FA	***Page 195***
C15-13	Neutral Torque	0	0–200	%	16FB	***Page 195***
C15-14	Slowdown Limits Engage RUN Cmd	0	0–1	-	16FC	***Page 195***
C15-15	Run Extend Time	0.5	0.0–5.0	sec	16FD	***Page 195***
d01-01	DC Injection/Zero SpeedThreshold	0.5	0.0–10.0	Hz	0189	***Page 209***
d01-02	DC Injection Braking Current	50	0–100	%	018A	***Page 209***
d01-03	DC Inject Braking Time at Start	0.00	0.00–10.00	sec	018B	***Page 209***
d01-04	DC Inject Braking Time at Stop	0.05	0.00–10.00	sec	018C	***Page 209***
d01-08	Magnetic Flux Compensation Value	0	0–1000	%	0190	***Page 209***
d02-01	Slip Compensation Gain	V/f: 0.0 OLV: 1.0 CLV: 1.0	0.0–2.5	-	020F	***Page 210***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
d02-02	Slip Compensation Delay Time	V/f: 2000 OLV: 200	0–10000	ms	0210	***Page 210***
d02-03	Slip Compensation Limit	200	0–250	%	0211	***Page 210***
d02-04	Slip Compensation at Regen	0	0–2	-	0212	***Page 210***
d02-05	Output Voltage Limit Selection	0	0–1	-	0213	***Page 210***
d02-16	Vout Modulation Limit Start Lvl	90.0	70.0–d02-17	%	0261	***Page 210***
d02-17	Vout Modulation Limit Max Level	100.0	85.0–100.0	%	0262	***Page 210***
d02-18	Output Voltage Limit Level	90.0	50.0–100.0	%	0263	***Page 210***
d02-21	Motor 2 Slip Compensation Gain	V/f: 0.0 OLV: 1.0	0.0–2.5	-	033E	***Page 210***
d02-22	Motor 2 Slip Comp Delay Time	V/f: 2000 OLV: 200	0–10000	ms	0241	***Page 210***
d02-23	Motor 2 Slip Compensation Limit	200	0–250	%	0242	***Page 210***
d02-24	Motor 2 Slip Comp during Regen	0	0–2	-	0243	***Page 210***
d03-01	Torque Compensation Gain	1.00	0.00–2.50	-	0215	***Page 211***
d03-02	Torque Compensation Delay Time	V/f: 200 OLV: 20	0–60000	ms	0216	***Page 211***
d03-03	Torque Compensation @ FWD Start	0.0	0.0–200.0	%	0217	***Page 211***
d03-04	Torque Compensation @ REV Start	0.0	-200.0–0.0	%	0218	***Page 211***
d03-05	Torque Compensation Time	10	0–200	ms	0219	***Page 211***
d03-06	Motor 2 Torque Comp Delay Time	150	0–10000	ms	021A	***Page 211***
d03-07	Motor 2 Torque Compensation Gain	1.00	0.00–2.50	-	0341	***Page 211***
d03-19	Torque Ripple Suppress Min Freq	0.1	0.0–10.0	Hz	0B8D	***Page 211***
d03-20	Voltage Compensation Adjust 1	120	0–200	Hz	0BCB	***Page 211***
d03-21	Voltage Compensation Adjust 2	5	0–10	-	0BCC	***Page 211***
d03-23	Current Control Gain	1.00	0.50–2.50	-	1583	***Page 211***
d04-01	ASR Proportional Gain 1	20.00	0.00–300.00	-	021B	***Page 214***
d04-02	ASR Integral Time 1	0.500	0.000–10.000	sec	021C	***Page 214***
d04-03	ASR Proportional Gain 2	20.00	0.00–300.00	-	021D	***Page 214***
d04-04	ASR Integral Time 2	0.500	0.000–10.000	sec	021E	***Page 214***
d04-06	ASR Delay Time	0.004	0.000–0.500	sec	0220	***Page 214***
d04-07	ASR Gain Switchover Frequency	0.0	0.0–150.0	Hz	0221	***Page 214***
d04-08	ASR Integral Limit	400	0–400	%	0222	***Page 214***
d04-17	Motor Inertia	0.0015**	0.0001–600.0000	kgm^2	0276	***Page 214***
d04-18	Load Inertia Ratio	1.0	0.0–6000.0	-	0277	***Page 214***
d04-29	Speed Control Response	0	0–1	-	0B18	***Page 214***
d04-37	Motor 2 Inertia	0.0015**	0.0001–600.0000	kgm^2	0278	***Page 214***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
d04-38	Motor 2 Load Inertia Ratio	1.0	0.0–6000.0	-	0279	***Page 214***
d04-50	Notch Filter Frequency	0	0–100	Hz	0B14	***Page 214***
d04-51	Notch Filter Bandwidth	1.0	0.5–5.0	-	0B15	***Page 214***
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d08-03	Dwell Reference at Stop	0.0	0.0–150.0	Hz	01B8	***Page 217***
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E01-01	Input AC Supply Voltage	230V: 240 460V: 480 575V: 575	230V: 155–255 460V: 310–510 575V: 446–733	VAC	0300	***Page 221***
E01-03	V/f Pattern Selection	0*	V/f: 0–9, A–F, FF OLV: F, FF	-	0302	***Page 221***
E01-04	Maximum Output Frequency	60.0	20.0–300.0	Hz	0303	***Page 221***
E01-05	Maximum Output Voltage	**	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0304	***Page 221***
E01-06	Base Frequency	60.0	0.0–300.0	Hz	0305	***Page 221***
E01-07	Mid Point A Frequency	Depends on E01-03	0.0–300.0	Hz	0306	***Page 221***
E01-08	Mid Point A Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0307	***Page 221***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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E01-10	Minimum Output Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0309	***Page 222***
E01-11	Mid Point B Frequency	0.0	0.0–300.0	Hz	030A	***Page 222***
E01-12	Mid Point B Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	030B	***Page 222***
E01-13	Base Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	030C	***Page 222***
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E02-04	Motor Pole Count	4	2–48	-	0311	***Page 231***
E02-05	Motor Line-to-Line Resistance	**	0.000–65.000	Ω	0312	***Page 231***
E02-06	Motor Leakage Inductance	19.6**	0.0–60.0	%	0313	***Page 231***
E02-07	Motor Saturation Coefficient 1	0.50	0.00–0.50	-	0314	***Page 231***
E02-08	Motor Saturation Coefficient 2	0.75	E02-07–0.75	-	0315	***Page 231***
E02-09	Motor Mechanical Loss	0.0	0.0–10.0	%	0316	***Page 231***
E02-10	Motor Iron Loss	**	0–65535	W	0317	***Page 231***
E02-11	Motor Rated Power	**	0.00–650.00	HP/kW	0318	***Page 231***
E03-01	Motor 2 Control Mode Selection	2	0, 2	-	0319	***Page 233***
E03-02	Motor 2 Stopping Method	1	0–1	-	0348	***Page 233***
E03-04	Motor 2 Maximum Output Frequency	60.0	20.0–300.0	Hz	031A	***Page 233***
E03-05	Motor 2 Maximum Output Voltage	**	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	031B	***Page 233***
E03-06	Motor 2 Base Frequency	60.0	0.0–300.0	Hz	031C	***Page 233***
E03-07	Motor 2 Mid Point A Frequency	Depends on E01-03	0.0–300.0	Hz	031D	***Page 233***
E03-08	Motor 2 Mid Point A Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	031E	***Page 233***
E03-09	Motor 2 Minimum Output Frequency	Depends on E01-03	0.0–300.0	Hz	031F	***Page 233***
E03-10	Motor 2 Minimum Output Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0320	***Page 233***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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E03-12	Motor 2 Mid Point B Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0346	***Page 233***
E03-13	Motor 2 Base Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	0347	***Page 233***
E04-01	Motor 2 Rated Current	**	**	A	0321	***Page 234***
E04-02	Motor 2 Rated Slip	**	0.000–20.000	Hz	0322	***Page 234***
E04-03	Motor 2 Rated No-Load Current	**	0.00–(E04-01–0.01)	A	0323	***Page 234***
E04-04	Motor 2 Motor Poles	4	2–48	-	0324	***Page 234***
E04-05	Motor 2 Line-to-Line Resistance	**	0.000–65.000	Ω	0325	***Page 234***
E04-06	Motor 2 Leakage Inductance	19.6**	0.0–60.0	%	0326	***Page 234***
E04-07	Motor 2 Saturation Coefficient 1	0.50	0.00–0.50	-	0343	***Page 234***
E04-08	Motor 2 Saturation Coefficient 2	0.75	E04-07–0.75	-	0344	***Page 234***
E04-09	Motor 2 Mechanical Loss	0.0	0.0–10.0	%	033F	***Page 234***
E04-10	Motor 2 Iron Loss	**	0–65535	W	0340	***Page 234***
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E07-01	Test Mode Control Mode Selection	2	0, 2	-	06F0	***Page 235***
E07-02	Test Mode Stopping Method	1	0–1	-	06F1	***Page 235***
E07-04	Test Mode Max Output Frequency	60.0	20.0–300.0	Hz	06F4	***Page 235***
E07-05	Test Mode Max Output Voltage	**	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	06F5	***Page 235***
E07-06	Test Mode Base Frequency	60.0	0.0–300.0	Hz	06F6	***Page 235***
E07-07	Test Mode Mid Point A Frequency	Depends on E01-03	0.0–300.0	Hz	06F7	***Page 235***
E07-08	Test Mode Mid Point A Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	06F8	***Page 235***
E07-09	Test Mode Minimum Output Freq	Depends on E01-03	0.0–300.0	Hz	06F9	***Page 235***
E07-10	Test Mode Minimum Output Voltage	Depends on E01-03	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	06FA	***Page 235***
E07-11	Test Mode Mid Point B Frequency	0.0	0.0–300.0	Hz	06FB	***Page 235***
E07-12	Test Mode Mid Point B Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	06FC	***Page 235***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
E07-13	Test Mode Base Voltage	0.0	230V: 0.0–255.0 460V: 0.0–510.0 575V: 0.0–733.1	VAC	06FD	***Page 235***
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F01-02	Encoder 1 Rotation Selection	0	0–1	-	0384	***Page 236***
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F01-06	Encoder 1 PCB Disconnect Detect	15	0–200	ms	03B4	***Page 236***
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F01-12	Encoder 2 Rotation Selection	0	0–1	-	03B1	***Page 236***
F01-15	Encoder 2 Pulse Monitor Scaling	1	1–132	-	03BE	***Page 236***
F01-16	Encoder 2 PCB Disconnect Detect	15	0–200	ms	03B5	***Page 236***
F01-21	Encoder Signal Loss Detect Sel	1	Traverse: 0–4 NLB: 1	-	0381	***Page 236***
F01-22	Encoder Open-Circuit Detect Time	2.0	0.0–10.0	sec	038D	***Page 237***
F01-23	Overspeed Detection Selection	1	Traverse: 0–3 NLB: 1	-	0382	***Page 237***
F01-24	Overspeed Detection Level	105	0–120	%	0387	***Page 237***
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F01-26	Speed Deviation Detection Select	5	Traverse: 0–7 NLB: 5	-	0383	***Page 237***
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F01-28	Speed Deviation Detect Delay Time	0.3	0.0–10.0	sec	038A	***Page 237***
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F03-04	Digital Input 3 Function	F	0–17B	-	167A	***Page 238***
F03-05	Digital Input 4 Function	F	0–17B	-	167B	***Page 238***
F03-06	Digital Input 5 Function	F	0–17B	-	167C	***Page 238***
F03-07	Digital Input 6 Function	F	0–17B	-	167D	***Page 238***
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F03-10	Digital Input 9 Function	F	0–17B	-	1680	***Page 238***
F03-11	Digital Input 10 Function	F	0–17B	-	1681	***Page 238***
F03-12	Digital Input 11 Function	F	0–17B	-	1682	***Page 238***
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F03-15	Digital Input 14 Function	F	0–17B	-	1685	***Page 238***
F03-16	Digital Input 15 Function	F	0–17B	-	1686	***Page 238***
F03-17	Digital Input 16 Function	F	0–17B	-	1687	***Page 238***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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F04-02	Terminal V1 Gain	100.0	-999.9–999.9	%	0392	***Page 239***
F04-03	Terminal V2 Function Selection	103	0–712	-	0393	***Page 239***
F04-04	Terminal V2 Gain	50.0	-999.9–999.9	%	0394	***Page 239***
F04-05	Terminal V1 Bias	0.0	-999.9–999.9	%	0395	***Page 239***
F04-06	Terminal V2 Bias	0.0	-999.9–999.9	%	0396	***Page 239***
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F07-67	PZD8 Write	0	Modbus Address 0x----	-	0787	***Page 243***
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Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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H01-53	Mbus Reg 15C0h bit13 Input Func	F	0–98	-	0BAD	***Page 253***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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H01-55	Mbus Reg 15C0h bit15 Input Func	F	0–98	-	0BAF	***Page 253***
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H02-02	Term M3-M4 Function Selection	F*	0–171	-	040C	***Page 254***
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H02-07	Fault Relay State During Decel	0	0–1	-	043A	***Page 254***
H02-16	Fault Annunciate A	2E1	100–4FF	-	0B60	***Page 254***
H02-17	Fault Annunciate B	100	100–4FF	-	0B61	***Page 254***
H02-18	Fault Annunciate C	100	100–4FF	-	0B62	***Page 254***
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H02-40	Mbus Reg 15E0h bit0 Output Func	F	0–171	-	0B58	***Page 261***
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H02-42	Mbus Reg 15E0h bit2 Output Func	F	0–171	-	0B5A	***Page 261***
H02-43	Mbus Reg 15E0h bit3 Output Func	F	0–171	-	0B68	***Page 261***
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H02-61	Terminal M1-M2 Logical Operation	0	0–8	-	1B47	***Page 262***
H02-62	Terminal M1-M2 Delay Time	0.1	0.0–25.0	sec	1B48	***Page 262***
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H02-64	Terminal M3-M4 Logical Operation	0	0–8	-	1B4A	***Page 262***
H02-65	Terminal M3-M4 Delay Time	0.1	0.0–25.0	sec	1B4B	***Page 262***
H02-66	Term M5-M6 Secondary Function	F	0–71	-	1B4C	***Page 262***
H02-67	Terminal M5-M6 Logical Operation	0	0–8	-	1B4D	***Page 262***
H02-68	Terminal M5-M6 Delay Time	0.1	0.0–25.0	sec	1B4E	***Page 262***
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H03-02	Terminal A1 Function Selection	0*	0–36	-	0434	***Page 263***
H03-03	Terminal A1 Gain Setting	100.0	-999.9–999.9	%	0411	***Page 263***
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H03-11	Terminal A2 Gain Setting	100.0	-999.9–999.9	%	0419	***Page 263***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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H03-19	4-20mA Feedback Loss Time	0.0	0.0–2.0	sec	02F3	***Page 263***
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H04-02	Terminal FM Analog Output Gain	100.0	-999.9–999.9	%	041E	***Page 267***
H04-03	Terminal FM Analog Output Bias	0.0	-999.9–999.9	%	041F	***Page 267***
H04-04	Terminal AM Analog Output Select	103	0–712	-	0420	***Page 267***
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H04-06	Terminal AM Analog Output Bias	0.0	-999.9–999.9	%	0422	***Page 267***
H04-07	Terminal FM Signal Level Select	0	0–2	-	0423	***Page 267***
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H05-05	Comm Fault Detection Selection	1	0–1	-	0429	***Page 268***
H05-06	Drive Transmit Wait Time	5	0–65	ms	042A	***Page 268***
H05-09	CE Detection Time	1.0	0.0–10.0	sec	0435	***Page 268***
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Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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H06-04	Terminal RP Function Bias	0.0	-100.0–100.0	%	042F	***Page 310***
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H07-00	Virtual MFIO selection	0	0–1	-	116F	***Page 311***
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H07-13	Virtual Output 2 Delay Time	0.1	0.0–25.0	sec	11A7	***Page 311***
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H07-17	Virtual Output 4 Delay Time	0.1	0.0–25.0	sec	11AB	***Page 311***
H07-30	Virtual Analog Input Selection	1F	0–36	-	1177	***Page 311***
H07-31	Virtual Analog Input Gain	100.0	-999.9–999.9	%	1178	***Page 311***
H07-32	Virtual Analog Input Bias	0.0	-999.9–999.9	%	1179	***Page 311***
H07-40	Virtual Analog Out Signal Select	0	0–2	-	1163	***Page 311***
H07-41	Virtual Analog Output Function	102	0–712	-	1164	***Page 311***
H07-42	Virtual Analog Output FilterTime	0.00	0.00–2.00	sec	1165	***Page 311***
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L01-02	Motor Overload Protection Time	1.0	0.1–5.0	min	0481	***Page 312***
L01-03	Motor Thermistor oH Alarm Select	3	0–3	-	0482	***Page 313***
L01-04	Motor Thermistor oH Fault Select	1	0–2	-	0483	***Page 313***
L01-05	Motor Thermistor Filter Time	0.20	0.00–10.00	sec	0484	***Page 313***
L01-06	Klixon Action	2	0–2, 4, 5	-	162F	***Page 313***
L01-08	oL1 Current Level	0.00	0.00–(150% VFD Rated Current)	A	1103	***Page 313***
L01-09	oL1 Current Level for Motor 2	0.00	0.00–(150% VFD Rated Current)	A	1104	***Page 313***
L01-13	Motor Overload Memory Selection	1	0–1	-	046D	***Page 313***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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L02-02	Power Loss Ride Through Time	2.0**	0.0–25.5	sec	0486	***Page 315***
L02-03	Minimum Baseblock Time	1.0**	0.1–5.0	sec	0487	***Page 315***
L02-04	Powerloss V/f Recovery Ramp Time	0.6**	0.0–5.0	sec	0488	***Page 315***
L02-05	Undervoltage Detection Lvl (Uv1)	190 380 500	230V: 150–210 460V: 300–420 575V: 431–604	VDC	0489	***Page 315***
L02-06	Kinetic Energy Backup Decel Time	0.0	0.0–6000.0	sec	048A	***Page 315***
L02-07	Kinetic Energy Backup Accel Time	0.0	0.0–6000.0	sec	048B	***Page 315***
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L02-10	Minimum KEB Time	50	0–25500	ms	048E	***Page 315***
L02-11	KEB DC Bus Voltage Setpoint	E01-01 x 1.22	230V: 150–400 460V: 300–800 575V: 431–1015	VDC	0461	***Page 315***
L02-29	Kinetic Energy Backup Method	0	0–3	-	0475	***Page 315***
L02-30	KEB Zero Speed Operation	0	0–1	-	045E	***Page 315***
L02-31	KEB Start Voltage Offset Level	0	230V: 0–100 460V: 0–200 575V: 0–287	VDC	045D	***Page 315***
L03-01	Stall Prevention during Accel	1	0–3	-	048F	***Page 316***
L03-02	Stall Prevent Level during Accel	150	0–150	%	0490	***Page 316***
L03-03	Stall Prevent Limit during Accel	50	0–100	%	0491	***Page 316***
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L03-11	Overvoltage Suppression Select	0	0–1	-	04C7	***Page 316***
L03-17	DC Bus Regulation Level	375 750 930	230V: 150–400 460V: 300–800 575V: 431–1150	VDC	0462	***Page 316***
L03-20	DC Bus Voltage Adjustment Gain	V/f: 1.00 OLV: 0.30 CLV: 0.30	0.00–5.00	-	0465	***Page 316***
L03-21	OVSuppression Accel/Decel P Gain	1.00	0.10–10.00	-	0466	***Page 316***
L03-23	Stall P Reduction at Constant HP	0	0–1	-	04FD	***Page 316***
L03-24	Motor Accel Time @ Rated Torque	0.265**	0.001–10.000	sec	046E	***Page 317***
L03-25	Load Inertia Ratio	1.0	0.1–1000.0	-	046F	***Page 317***
L03-26	Additional DC Bus Capacitors	0	0–65000	uF	0455	***Page 317***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
L03-27	Stall Prevention Detection Time	50	0–5000	ms	0456	***Page 317***
L03-36	Current Suppression Gain@Accel	V/f: 10.0 OLV: 20.0	0.0–100.0	-	11D0	***Page 317***
L03-37	Current Limit P Gain @ Accel	5	0–100	ms	11D1	***Page 317***
L03-38	Current Limit I Time @ Accel	10.0	0.0–100.0	-	11D2	***Page 317***
L03-39	Current Limit Filter Time @Accel	100.0	1.0–1000.0	ms	11D3	***Page 317***
L03-40	Current Limit S-Curve @ Acc/Dec	0	0–1	-	11D4	***Page 317***
L04-01	Speed Agree Detection Level	0.0	0.0–150.0	Hz	0499	***Page 318***
L04-02	Speed Agree Detection Width	2.0	0.0–20.0	Hz	049A	***Page 318***
L04-03	Speed Agree Detection Level(+/-)	0.0	-150.0–150.0	Hz	049B	***Page 318***
L04-04	Speed Agree Detection Width(+/-)	2.0	0.0–20.0	Hz	049C	***Page 318***
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L04-06	Frequency Reference @Loss of Ref	80.0	0.0–100.0	%	04C2	***Page 319***
L04-07	Speed Agree Detection Selection	0	0–1	-	0470	***Page 319***
L06-01	Torque Detection Selection 1	0	0–8	-	04A1	***Page 319***
L06-02	Torque Detection Level 1	150	0–300	%	04A2	***Page 320***
L06-03	Torque Detection Time 1	0.1	0.0–10.0	sec	04A3	***Page 320***
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L06-06	Torque Detection Time 2	0.1	0.0–10.0	sec	04A6	***Page 321***
L06-07	Torque Detection Filter Time	0	0–1000	ms	04E5	***Page 321***
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Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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L09-14	Fault Latch Select 1	0000	0000–FFFF	-	03CE	***Page 326***
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n01-01	Hunting Prevention Selection	1	0–2	-	0580	***Page 327***
n01-02	Hunting Prevention Gain Setting	1.00	0.00–2.50	-	0581	***Page 327***
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n01-05	Hunting Prevent Gain in Reverse	0.00	0.00–2.50	-	0530	***Page 327***
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n01-13	DC Bus Stabilization Control	0	0–1	-	1B59	***Page 327***
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o01-24	Custom Monitor 1	101	0, 101–648	-	11AD	***Page 329***
o01-25	Custom Monitor 2	102	0, 101–648	-	11AE	***Page 329***
o01-26	Custom Monitor 3	103	0, 101–648	-	11AF	***Page 329***
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o01-36	LCD Backlight Brightness	4	1–5	-	11B9	***Page 329***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
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o01-41	1st Monitor Area Selection	0	0–1	-	11C1	***Page 329***
o01-42	1st Monitor Area Setting	100.0	0.0–100.0	%	11C2	***Page 329***
o01-43	2nd Monitor Area Selection	0	0–1	-	11C3	***Page 329***
o01-44	2nd Monitor Area Setting	100.0	0.0–100.0	%	11C4	***Page 330***
o01-45	3rd Monitor Area Selection	0	0–1	-	11C5	***Page 330***
o01-46	3rd Monitor Area Setting	100.0	0.0–100.0	%	11C6	***Page 330***
o01-47	Trend Plot 1 Scale Minimum Value	-100.0	-300.0–(o01-48 - 0.1)	%	11C7	***Page 330***
o01-48	Trend Plot 1 Scale Maximum Value	100.0	(o01-47 + 0.1)–300.0	%	11C8	***Page 330***
o01-49	Trend Plot 2 Scale Minimum Value	-100.0	-300.0–(o01-50 - 0.1)	%	11C9	***Page 330***
o01-50	Trend Plot 2 Scale Maximum Value	100.0	(o01-49 + 0.1)–300.0	%	11CA	***Page 330***
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o01-56	Analog Gauge Area Setting	100.0	0.0–100.0	%	11EF	***Page 330***
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o02-03	User Parameter Default Value	0	0–2	-	0507	***Page 331***
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o03-03	Fan Operation Time Setting	0	0–9999 x 10	Hrs	050E	***Page 335***
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o03-07	Softcharge Relay Maintenance Set	0	0–150	%	0523	***Page 335***
o03-09	IGBT Maintenance Setting	0	0–150	%	0525	***Page 335***
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o03-13	RUN Command Counter @ Initialize	0	0–1	-	0528	***Page 335***
o03-14	OL/LC/OW Counter Reset	0	0–1	-	0529	***Page 335***
o03-22	Time Format	1	0–2	-	154F	***Page 335***
o03-23	Date Format	2	0–2	-	1550	***Page 335***
o03-24	bAT Detection Selection	0	0–2	-	310F	***Page 336***
o06-01	User Stored Data 0	0	0–65535	-	1520	***Page 336***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
o06-02	User Stored Data 1	0	0–65535	-	1521	***Page 336***
o06-03	User Stored Data 2	0	0–65535	-	1522	***Page 336***
o06-04	User Stored Data 3	0	0–65535	-	1523	***Page 336***
o06-05	User Stored Data 4	0	0–65535	-	1524	***Page 336***
o06-06	User Stored Data 5	0	0–65535	-	1525	***Page 336***
o06-07	User Stored Data 6	0	0–65535	-	1526	***Page 336***
o06-08	User Stored Data 7	0	0–65535	-	1527	***Page 336***
o06-09	User Stored Data 8	0	0–65535	-	1528	***Page 336***
o06-10	User Stored Data 9	0	0–65535	-	1529	***Page 336***
o06-11	User Stored Data 10	0	0–65535	-	152A	***Page 336***
o06-12	User Stored Data 11	0	0–65535	-	152B	***Page 336***
o06-13	User Stored Data 12	0	0–65535	-	152C	***Page 336***
o06-14	User Stored Data 13	0	0–65535	-	152D	***Page 336***
o06-15	User Stored Data 14	0	0–65535	-	152E	***Page 336***
o06-16	User Stored Data 15	0	0–65535	-	152F	***Page 336***
U01-01	Frequency Reference	-	-	Hz	0040	***Page 337***
U01-02	Output Frequency	-	-	Hz	0041	***Page 337***
U01-03	Output Current	-	-	A	0042	***Page 337***
U01-04	Control Method	-	-	-	0043	***Page 337***
U01-05	Motor Speed	-	-	Hz	0044	***Page 337***
U01-06	Output Voltage Reference	-	-	VAC	0045	***Page 337***
U01-07	DC Bus Voltage	-	-	VDC	0046	***Page 337***
U01-08	Output Power	-	-	HP/kW	0047	***Page 337***
U01-09	Torque Reference	-	-	%	0048	***Page 337***
U01-10	Input Terminal Status	-	-	-	0049	***Page 337***
U01-11	Output Terminal Status	-	-	-	004A	***Page 337***
U01-12	Drive Status	-	-	-	004B	***Page 338***
U01-14	Software Number Flash	-	-	-	004D	***Page 338***
U01-15	Terminal A1 Level	-	-	%	004E	***Page 338***
U01-16	Terminal A2 Level	-	-	%	004F	***Page 338***
U01-17	Terminal A3 Level	-	-	%	0050	***Page 338***
U01-18	FM Output Level	-	-	%	0069	***Page 338***
U01-19	AM Output Level	-	-	%	006A	***Page 338***
U01-20	SFS Output Frequency	-	-	Hz	0053	***Page 338***
U01-24	Option Card MFDO 8 bits	-	-	-	00A0	***Page 338***
U01-25	Option Card MFDI Lower 8 bits	-	-	-	009D	***Page 338***
U01-26	Option Card MFDI Upper 8 bits	-	-	-	009E	***Page 338***
U01-30	SS Delta Speed	-	-	RPM	17C8	***Page 338***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
U01-31	Hoist Weight	-	-	C10-03	17C5	***Page 338***
U01-32	Crane Weight Sum	-	-	C10-38	17B6	***Page 338***
U01-34	oPE Fault Parameter	-	-	-	0061	***Page 338***
U01-39	MEMOBUS/Modbus Error Code	-	-	-	0066	***Page 338***
U01-48	SCS - Revs to Stop	-	-	Revs	17A1	***Page 338***
U01-49	Swing Length	-	-	Ft	17A2	***Page 338***
U01-50	Hook Height	-	-	%	17A3	***Page 338***
U01-51	Motor Revolution	-	-	Revs	17A4	***Page 338***
U01-53	Index Count	-	-	Revs	17A6	***Page 338***
U01-54	Input Pulse Monitor	-	-	Hz	007D	***Page 338***
U01-60	Encoder 1 Pulse Counter	-	-	Pulses	07CD	***Page 338***
U01-61	Encoder 2 Pulse Counter	-	-	Pulses	07E5	***Page 339***
U01-68	Load Check Zone	-	-	-	17AF	***Page 339***
U01-69	Load Check Margin	-	-	%	17B0	***Page 339***
U01-73	OL/LC Count	-	-	-	17B1	***Page 339***
U01-81	WMS Torque @ Accel 1	-	-	%	17B2	***Page 339***
U01-82	WMS Torque @ Accel 2	-	-	%	17B3	***Page 339***
U01-86	Brake Test Torque	-	-	FtLb	17C7	***Page 339***
U01-91	Output Voltage	-	-	VAC	154E	***Page 339***
U02-01	Current Fault	-	-	-	0080	***Page 339***
U02-02	Previous Fault	-	-	-	0081	***Page 339***
U02-03	Frequency Reference @ Fault	-	-	Hz	0082	***Page 339***
U02-04	Output Frequency @ Fault	-	-	Hz	0083	***Page 339***
U02-05	Output Current @ Fault	-	-	A	0084	***Page 339***
U02-06	Motor Speed @ Fault	-	-	Hz	0085	***Page 339***
U02-07	Output Voltage @ Fault	-	-	VAC	0086	***Page 339***
U02-08	DC Bus Voltage @ Fault	-	-	VDC	0087	***Page 339***
U02-09	Output Power @ Fault	-	-	HP/kW	0088	***Page 339***
U02-10	Torque Reference @ Fault	-	-	%	0089	***Page 339***
U02-11	Input Terminal Status @ Fault	-	-	-	008A	***Page 339***
U02-12	Output Terminal Status @ Fault	-	-	-	008B	***Page 339***
U02-13	Operation Status @ Fault	-	-	-	008C	***Page 339***
U02-14	Elapsed Time @ Fault	-	-	Hrs	008D	***Page 339***
U02-15	SFS Output @ Fault	-	-	Hz	07E0	***Page 339***
U02-16	q-Axis Current @ Fault	-	-	%	07E1	***Page 339***
U02-17	d-Axis Current @ Fault	-	-	%	07E2	***Page 339***
U02-20	Heatsink Temperature @ Fault	-	-	°C	008E	***Page 339***
U03-01	1st Most Recent Fault	-	-	-	0800	***Page 340***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
U03-02	2nd Most Recent Fault	-	-	-	0801	***Page 340***
U03-03	3rd Most Recent Fault	-	-	-	0802	***Page 340***
U03-04	4th Most Recent Fault	-	-	-	0803	***Page 340***
U03-05	5th Most Recent Fault	-	-	-	0804	***Page 340***
U03-06	6th Most Recent Fault	-	-	-	0805	***Page 340***
U03-07	7th Most Recent Fault	-	-	-	0806	***Page 340***
U03-08	8th Most Recent Fault	-	-	-	0807	***Page 340***
U03-09	9th Most Recent Fault	-	-	-	0808	***Page 340***
U03-10	10th Most Recent Fault	-	-	-	0809	***Page 340***
U03-11	Elapsed Time @ 1st Fault	-	-	Hrs	080A	***Page 340***
U03-12	Elapsed Time @ 2nd Fault	-	-	Hrs	080B	***Page 340***
U03-13	Elapsed Time @ 3rd Fault	-	-	Hrs	080C	***Page 340***
U03-14	Elapsed Time @ 4th Fault	-	-	Hrs	080D	***Page 340***
U03-15	Elapsed Time @ 5th Fault	-	-	Hrs	080E	***Page 340***
U03-16	Elapsed Time @ 6th Fault	-	-	Hrs	080F	***Page 340***
U03-17	Elapsed Time @ 7th Fault	-	-	Hrs	0810	***Page 340***
U03-18	Elapsed Time @ 8th Fault	-	-	Hrs	0811	***Page 340***
U03-19	Elapsed Time @ 9th Fault	-	-	Hrs	0812	***Page 340***
U03-20	Elapsed Time @ 10th Fault	-	-	Hrs	0813	***Page 340***
U04-01	Cumulative Operation Time	-	-	Hrs	004C	***Page 340***
U04-03	Cooling Fan Operation Time	-	-	Hrs	0067	***Page 340***
U04-04	Cooling Fan Maintenance	-	-	%	007E	***Page 340***
U04-05	Capacitor Maintenance	-	-	%	007C	***Page 340***
U04-06	Precharge Relay Maintenance	-	-	%	07D6	***Page 340***
U04-07	IGBT Maintenance	-	-	%	07D7	***Page 340***
U04-08	Heatsink Temperature	-	-	°C	0068	***Page 340***
U04-09	LED Check	-	-	-	005E	***Page 340***
U04-10	kWh, Lower 4 Digits	-	-	kWH	005C	***Page 341***
U04-11	kWh, Upper 5 Digits	-	-	MWH	005D	***Page 341***
U04-13	Peak Hold Current	-	-	A	07CF	***Page 341***
U04-14	Peak Hold Output Frequency	-	-	Hz	07D0	***Page 341***
U04-16	Motor oL1 Level	-	-	%	07D8	***Page 341***
U04-17	Drive oL2 Level	-	-	%	07D9	***Page 341***
U04-18	Reference Source	-	-	-	07DA	***Page 341***
U04-19	Modbus Frequency Reference	-	-	%	07DB	***Page 341***
U04-20	Option Frequency Reference	-	-	%	07DC	***Page 341***
U04-21	Run Command Source	-	-	-	07DD	***Page 341***
U04-22	Modbus Command Data	-	-	-	07DE	***Page 341***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
U04-23	Option Command Data	-	-	-	07DF	***Page 341***
U04-24	Number of Runs (Low)	-	-	-	07E6	***Page 341***
U04-25	Number of Runs (High)	-	-	-	07E7	***Page 341***
U04-26	OL/LC/OW Count	-	-	-	07E8	***Page 341***
U04-27	Run Time Elapsed	-	-	Hrs	1210	***Page 341***
U04-28	Run Time Remaining	-	-	Hrs	1211	***Page 341***
U04-29	On Time Elapsed	-	-	Hrs	1212	***Page 341***
U04-30	On Time Remaining	-	-	Hrs	1213	***Page 341***
U04-31	Brake Cycle Counts (Low)	-	-	-	1214	***Page 341***
U04-32	Brake Cycle Counts (High)	-	-	-	1215	-
U04-33	Brake Cycles Remaining (Low)	-	-	-	1216	***Page 341***
U04-34	Brake Cycles Remaining (High)	-	-	-	1217	-
U04-35	Lift Counter (Low)	-	-	-	072C	***Page 341***
U04-36	Lift Counter (High)	-	-	-	072D	-
U04-49	Password Challenge	-	-	-	158F	***Page 341***
U04-52	Torque Reference from Comm	-	-	%	1592	***Page 341***
U06-01	Iq Secondary Current	-	-	%	0051	***Page 342***
U06-02	Id Excitation Current	-	-	%	0052	***Page 342***
U06-03	ASR Input	-	-	%	0054	***Page 342***
U06-04	ASR Output	-	-	%	0055	***Page 342***
U06-05	Output Voltage Reference (Vq)	-	-	VAC	0059	***Page 342***
U06-06	Output Voltage Reference (Vd)	-	-	VAC	005A	***Page 342***
U06-07	q-Axis ACR Output	-	-	%	005F	***Page 342***
U06-08	d-Axis ACR Output	-	-	%	0060	***Page 342***
U06-21	Offset Frequency	-	-	%	07D5	***Page 342***
U06-31	Torque Detect Monitor	-	-	%	007B	***Page 342***
U06-36	Comm Errors-Host	-	-	-	0720	***Page 342***
U06-37	Comm Errors-Sensor	-	-	-	0721	***Page 342***
U06-48	ASIC Comm Errors	-	-	-	072E	***Page 342***
U06-80	Option IP Address 1	-	-	-	07B0	***Page 342***
U06-81	Option IP Address 2	-	-	-	07B1	***Page 342***
U06-82	Option IP Address 3	-	-	-	07B2	***Page 342***
U06-83	Option IP Address 4	-	-	-	07B3	***Page 342***
U06-84	Option Subnet 1	-	-	-	07B4	***Page 342***
U06-85	Option Subnet 2	-	-	-	07B5	***Page 342***
U06-86	Option Subnet 3	-	-	-	07B6	***Page 342***
U06-87	Option Subnet 4	-	-	-	07B7	***Page 342***
U06-88	Option Gateway 1	-	-	-	07B8	***Page 342***

Parameter	Parameter Name	Default	Range	Units	Modbus (Hex.)	Reference
U06-89	Option Gateway 2	-	-	-	07B9	***Page 342***
U06-90	Option Gateway 3	-	-	-	07F0	***Page 342***
U06-91	Option Gateway 4	-	-	-	07F1	***Page 342***
U06-92	Online Speed	-	-	-	07F2	***Page 342***
U06-93	Online Duplex	-	-	-	07F3	***Page 342***
U06-94	OPT SPARE 1	-	-	-	07F4	***Page 342***
U06-95	OPT SPARE 2	-	-	-	07F5	***Page 342***
U06-96	OPT SPARE 3	-	-	-	07F6	***Page 343***
U06-97	OPT SPARE 4	-	-	-	07F7	***Page 343***
U06-98	First Fault	-	-	-	07F8	***Page 343***
U06-99	Current Fault	-	-	-	07F9	***Page 343***
U07-01	Leader Reference	-	-	Hz	07EB	***Page 344***
U07-02	Gear Ratio Reference	-	-	Hz	07EC	***Page 344***
U07-03	Sync Error Counts	-	-	Pulses	07ED	***Page 344***
U07-04	Sync Error Revs	-	-	Revs	07EE	***Page 344***
U07-05	Proportional Correct	-	-	Hz	07EF	***Page 344***
U07-06	Integral Correction	-	-	Hz	07CE	***Page 344***
U07-10	Bucket Motor 1 Revs	-	-	Revs	17A7	***Page 344***
U07-11	Bucket Motor 2 Revs	-	-	Revs	17A8	***Page 344***
U07-12	Bucket Delta Revs	-	-	Revs	17A9	***Page 344***

* *Initial value is set by X-Press Programming (**Section 4.3.3.6 starting on page 93**).*

** *Initial value is determined by o02-04 (VFD Model Selection).*

Appendix B: Standards Compliance

B1 European Standards

B1.1 Electromagnetic Compatibility (EMC)

Figure B-1: CE Mark

The CE mark indicates compliance with European safety and environmental regulations. It is required for engaging in business and commerce in Europe.

European standards include the Machinery Directive for machine manufacturers, the Low Voltage Directive for electronics manufacturers, and the EMC guidelines for controlling electric noise.

This VFD displays the CE mark based on the EMC guidelines and the Low Voltage Directive.

- Low Voltage Directive: 2014/35/EU (Harmonized Standard: EN 61800-5-1)

Devices used in combination with this VFD must also be CE certified and display the CE mark. When using VFDs displaying the CE mark in combination with other devices, it is ultimately the responsibility of the user to ensure compliance with CE standards. After setting up the device, verify that conditions meet European standards.

EMC Guidelines Compliance

This VFD is tested according to EMC Directive 2014/30/EU (Harmonized Standard: EN 61800-3).

Since the device is intended exclusively for commercial applications, it is not subject to the requirements of the EN 61000-3-2 standard for the emission of harmonic current emissions.

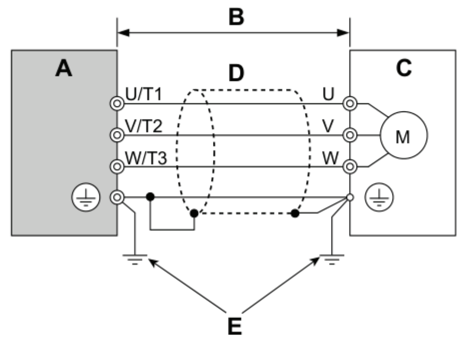
EMC Filter Installation

The following conditions must be met to ensure continued compliance with guidelines. Options are available for external EMC filters as well as VFD models with built-in EMC filters. Reference the following sections for specifications, installation instructions, and acceptable grounding for each option.

Installing an EMC Noise Filter

Verify the following installation conditions to ensure that other devices and machinery used in combination with this VFD also comply with EMC guidelines.

1. Install an EMC noise filter to the input side of the VFD, or use a VFD model with built-in EMC filter, for compliance with European standards.
2. If using an external filter, place the VFD and EMC noise filter in the same enclosure.
3. Use braided shield cable for the VFD and motor wiring, or run the wiring through a metal conduit.
4. Keep wiring as short as possible. Ground the shield on both the VFD side and the motor side.

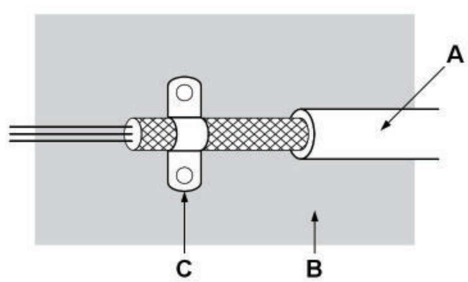


A – Drive
B – 10 m max cable length between drive and motor
C – Motor
D – Metal conduit
E – Ground wire should be as short as possible.

Figure B-2: Installation Method

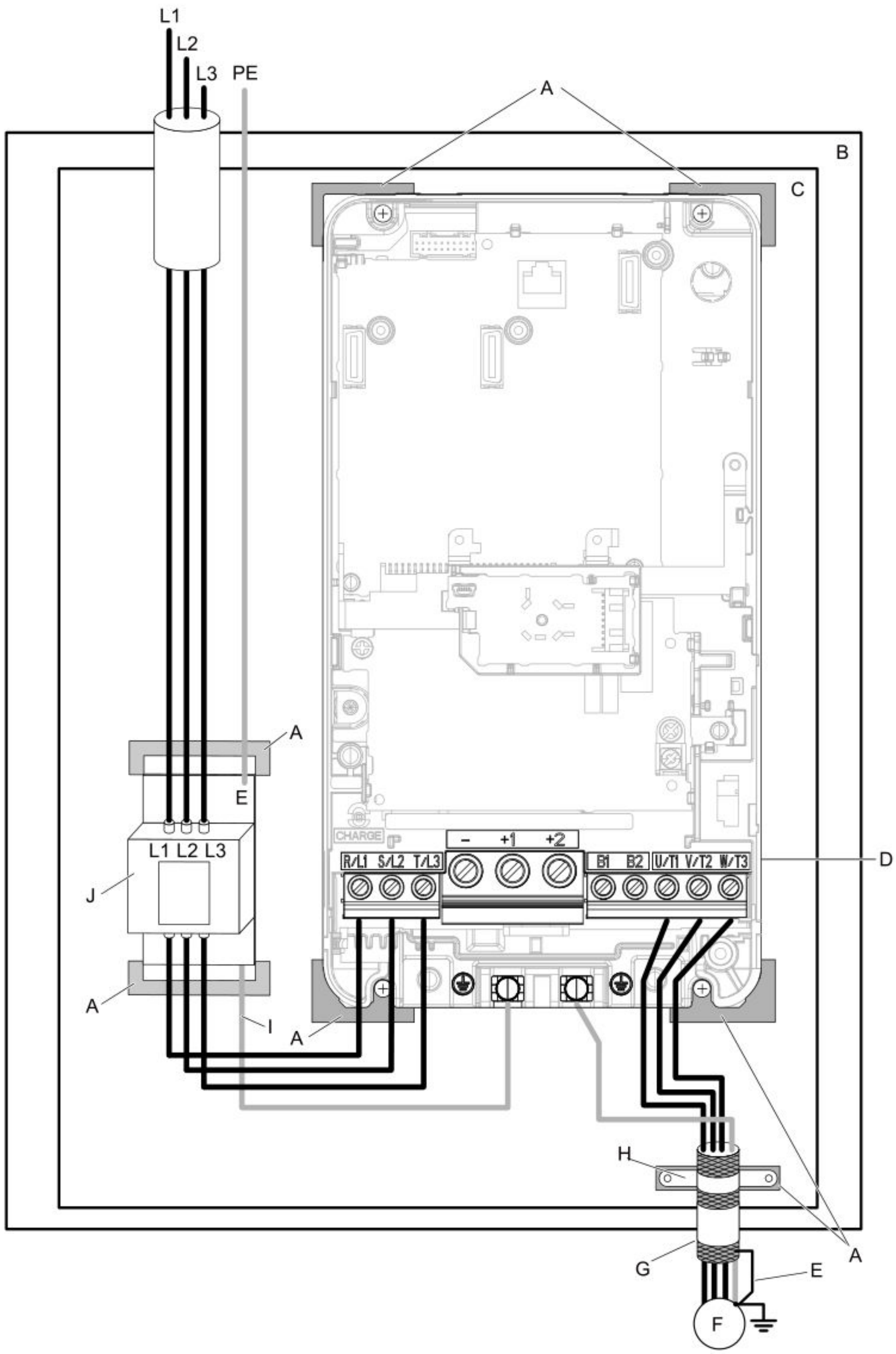
5. Make sure the protective earthing conductor complies with technical standards and local safety regulations.

> **WARNING**
>
> Electrical Shock Hazard. Because the leakage current exceeds 3.5 mA in models 4370 to 41090-G+/VG+S5, IEC 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor, or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.



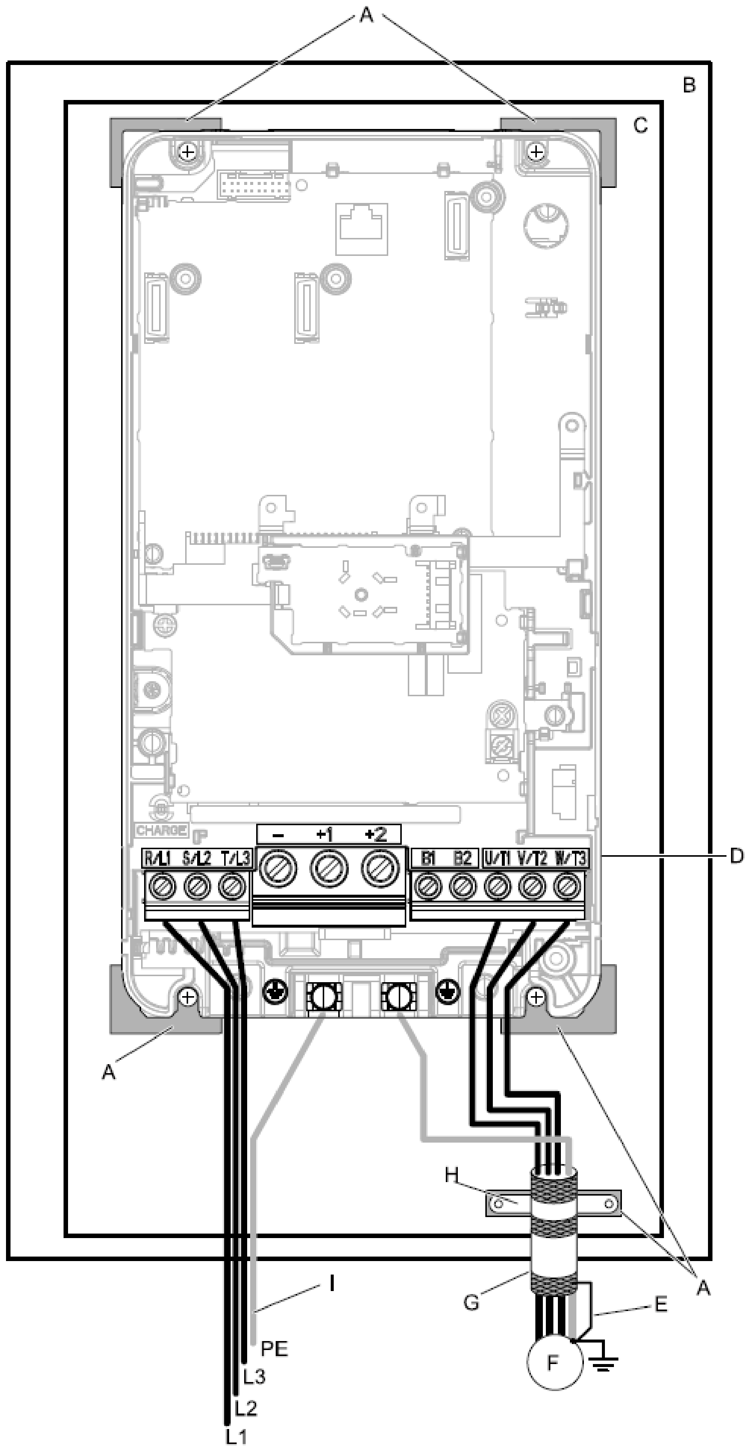
A – Braided shield cable
B – Metal panel
C – Cable clamp (conductive)

Figure B-3: Ground the Shield



A - Grounding surface (Remove any paint)
B - Enclosure panel
C - Metal plate
D - VFD
E - Ground the shield.
F - Motor
G - Motor cable (Braided shield cable: 10 m (32.8 ft) maximum)
H - Cable clamp
I - Grounding wire
J - EMC noise filter

Figure B-4: External EMC Filter and VFD Installation for CE Compliance



A - Grounding surface (Remove any paint)
B - Enclosure panel
C - Metal plate
D - VFD
E - Ground the shield.
F - Motor
G - Motor cable
H - Cable clamp
I - Grounding wire

Figure B-5: VFD with Built-in EMC Filter Installation for CE Compliance

Grounding

A symmetric grounding network must be used when using an external EMC filter or VFD with built-in EMC filter. Ground the neutral point on the power supply to comply with the EMC Directive. Figure B-6 shows the acceptable symmetric grounding topography.

WARNING

Using a non-grounded network, high-resistance ground, or asymmetric grounding network will cause damage to the VFD.

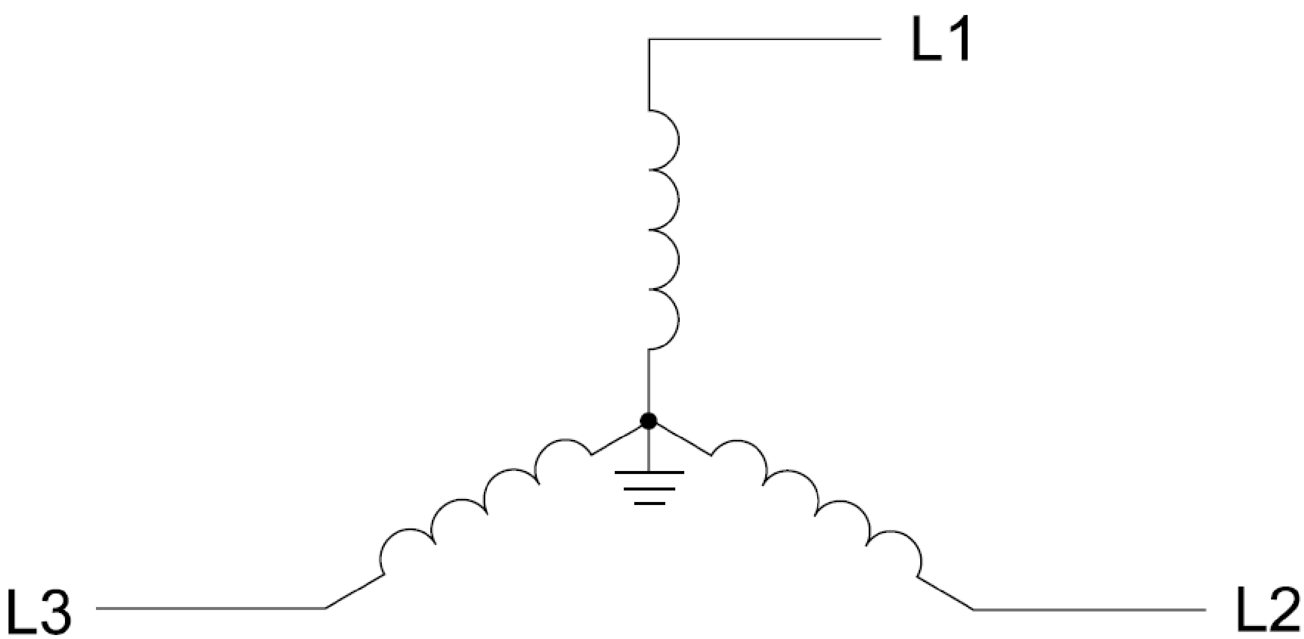


Figure B-6: Symmetric Grounding (Acceptable)

External EMC Filters

If installing the VFD with an external EMC filter, reference the information listed in ***Table B-1*** and ***Table B-2*** to comply with the EN 61800-3 requirements.

Table B-1: External EMC Filters – 230 V Class

VFD Model	Filter Specifications				
	Filter Model	**Rated Current (A)**	**Weight lb (kg)**	**Dimensions W x H x D (in) [W x H x D (mm)]**	**Mounting Dimensions W1 x H1 (in) [W1 x H1 (mm)]**
2003	RTEN-5006	6	0.9 (0.4)	2.5 x 4.7 x 1.7 (63 x 120 x 42)	2.1 x 4.3 (53 x 110)
2005	RTEN-5010	10			
2007					
2008	RTEN-5020	20	1.3 (0.6)	2.8 x 5.5 x 1.7 (70 x 140 x 42)	2.4 x 5.1 (60 x 130)
2011					
2014	RTEN-5030	30			
2017					
2025	RTEN-5060	60	2.4 (1.1)	3.5 x 6.7 x 2.1 (90 x 170 x 54	3.1 x 6.3 (80 x 160)
2033					
2047	RTEN-5080	80	8.6 (3.9)	6.3 x 10.5 x 3.3 (161 x 267 x 85)	5.3 x 9.7 (135 x 247)
2060	FS5972-100-35	100	7.5 (3.4)	3.5 x 13.0 x 5.9 (90 x 330 x 150)	2.6 x 10.0 (65 x 255)
2075					
2088	FS5972-170-40	170	13.2 (6.0)	4.7 x 17.8 x 6.7 (120 x 451 x 170)	4.0 x 14.4 (102 x 365)
2115					
2145					
2180	FS5972-250-37	250	25.8 (11.7)	5.1 x 24.0 x 9.5 (130 x 610 x 240)	3.5 x 19.6 (90 x 498)
2215	FS5972-410-99	410	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
2283					
2346					
2415	FS5972-600-99	600	24.3 (11)	10.2 x 15.2 x 5.3 (260 x 386 x 135)	9.3 x 9.4 (235 x 240)

Table B-2: External EMC Filters - 460V Class

VFD Model	Filter Specifications: Filter Model	Rated Current (A)	Weight lb (kg)	Dimensions W x H x D (in) [W x H x D (mm)]	Mounting Dimensions W1 x H1 (in) [W1 x H1 (mm)]
4001	B84143A0010R106	10	0.9 (0.4)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4003	B84143A0010R106	10	0.9 (0.4)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4004	B84143A0010R106	10	0.9 (0.4)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4005	B84143A0010R106	10	0.9 (0.4)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4007	B84143A0020R106	20	1.3 (0.6)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4009	B84143A0020R106	20	1.3 (0.6)	2.2 x 5.9 x 2.3 (55 x 150 x 58)	1.1 x 5.2 (28 x 132)
4014	B84143A0035R106	35	2.0 (0.9)	2.8 x 6.3 x 2.8 (70 x 160 x 71)	2.0 x 5.6 (50 x 143)
4018	B84143A0035R106	35	2.0 (0.9)	2.8 x 6.3 x 2.8 (70 x 160 x 71)	2.0 x 5.6 (50 x 143)
4024	B84143A0050R106	50	3.1 (1.4)	3.2 x 6.7 x 3.1 (82 x 170 x 80)	2.6 x 6.0 (65 x 153)
4031	B84143A0065R106	65	4.2 (1.9)	3.2 x 6.7 x 3.1 (82 x 170 x 80)	2.6 x 6.0 (65 x 153)
4039	B84143A0065R106	65	4.2 (1.9)	3.2 x 6.7 x 3.1 (82 x 170 x 80)	2.6 x 6.0 (65 x 153)
4045	B84143A0065R106	65	4.2 (1.9)	3.2 x 6.7 x 3.1 (82 x 170 x 80)	2.6 x 6.0 (65 x 153)
4060	B84143A0080R106	80	5.3 (2.4)	3.6 x 7.9 x 3.5 (92 x 200 x 90)	3.0 x 7.2 (75 x 183)
4075	FS5972-100-35	100	7.5 (3.4)	3.5 x 13.0 x 5.9 (90 x 330 x 150)	2.6 x 10.0 (65 x 255)
4091	FS5972-170-40	170	13.2 (6.0)	4.7 x 17.8 x 6.7 (120 x 451 x 170)	4.0 x 14.4 (102 x 365)
4112	FS5972-170-40	170	13.2 (6.0)	4.7 x 17.8 x 6.7 (120 x 451 x 170)	4.0 x 14.4 (102 x 365)
4150	FS5972-170-40	170	13.2 (6.0)	4.7 x 17.8 x 6.7 (120 x 451 x 170)	4.0 x 14.4 (102 x 365)
4180	FS5972-250-37	250	25.8 (11.7)	5.1 x 24.0 x 9.5 (130 x 610 x 240)	3.5 x 19.6 (90 x 498)
4216	FS5972-250-37	250	25.8 (11.7)	5.1 x 24.0 x 9.5 (130 x 610 x 240)	3.5 x 19.6 (90 x 498)
4260	FS5972-410-99	410	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
4304	FS5972-410-99	410	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
4371	FS5972-410-99	410	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
4414	FS5972-600-99	600	24.3 (11)	10.2 x 15.2 x 5.3 (260 x 386 x 135)	9.3 x 9.4 (235 x 240)
4477 / 4453*	FS5972-600-99	600	24.3 (11)	10.2 x 15.2 x 5.3 (260 x 386 x 135)	9.3 x 9.4 (235 x 240)
4515	FS5972-410-99 (Quantity 2)	410 (each)	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
4605	FS5972-410-99 (Quantity 2)	410 (each)	23.1 (10.5)	10.2 x 15.2 x 4.5 (260 x 386 x 115)	9.3 x 9.4 (235 x 240)
4720	FS5972-600-99 (Quantity 2)	600 (each)	24.3 (11)	10.2 15.2 x 5.3 (260 x 386 x 135)	9.3 x 9.4 (235 x 240)
4810	FS5972-600-99 (Quantity 2)	600 (each)	24.3 (11)	10.2 15.2 x 5.3 (260 x 386 x 135)	9.3 x 9.4 (235 x 240)
4930	FS5972-800-99 (Quantity 2)	800 (each)	69.4 (31.5)	11.8 x 28.2 x 6.3 (300 x 716 x 160)	10.8 x 16.6 (275 x 420)
41090	FS5972-800-99 (Quantity 2)	800 (each)	69.4 (31.5)	11.8 x 28.2 x 6.3 (300 x 716 x 160)	10.8 x 16.6 (275 x 420)

** The 4453 model is only available in Europe.*

Internal EMC Filters (Built-in to VFD)

If installing a VFD with a built-in category C3 EMC filter, reference the following Figures for how to enable the filter. Each Figure is specific to a range of VFD models. Move the screw or screws to turn ON and OFF (enable and disable) the EMC filter.

Table B-3: Enabling Screw Size and Tightening Torque

Model	Screw Size	Tightening Torque (N·m)
2003 - 2075, 4001 - 4045	M4 x 20	1.0 - 1.3
2088 - 2180, 4060 - 4150	M4 x 25	1.0 - 1.3
2215 - 2415, 4180 - 4605	M5 x 25	2.0 - 2.5

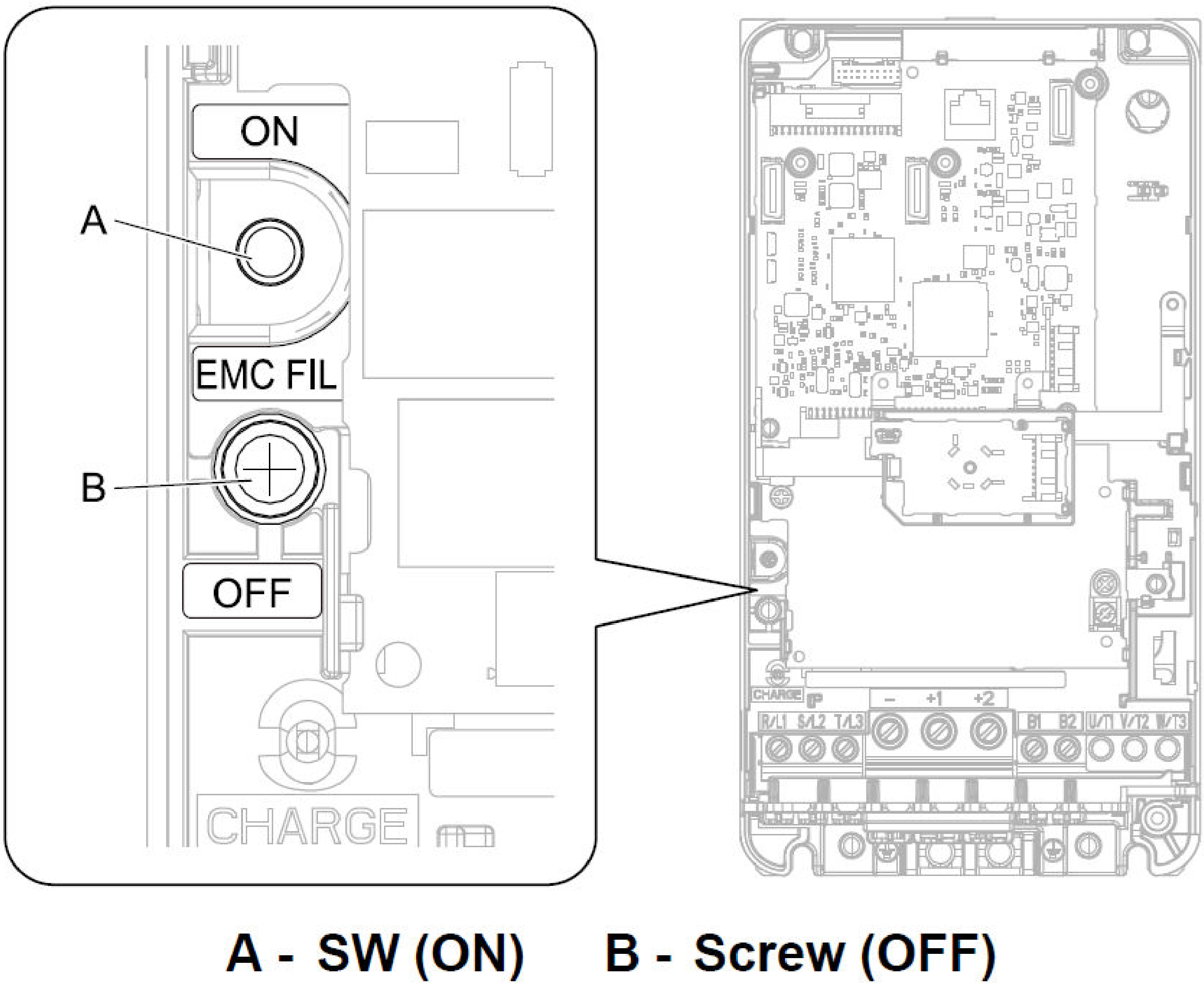


Figure B-7: EMC Filter Switch Location - Models 2003C - 2033C, 4001C - 4018C

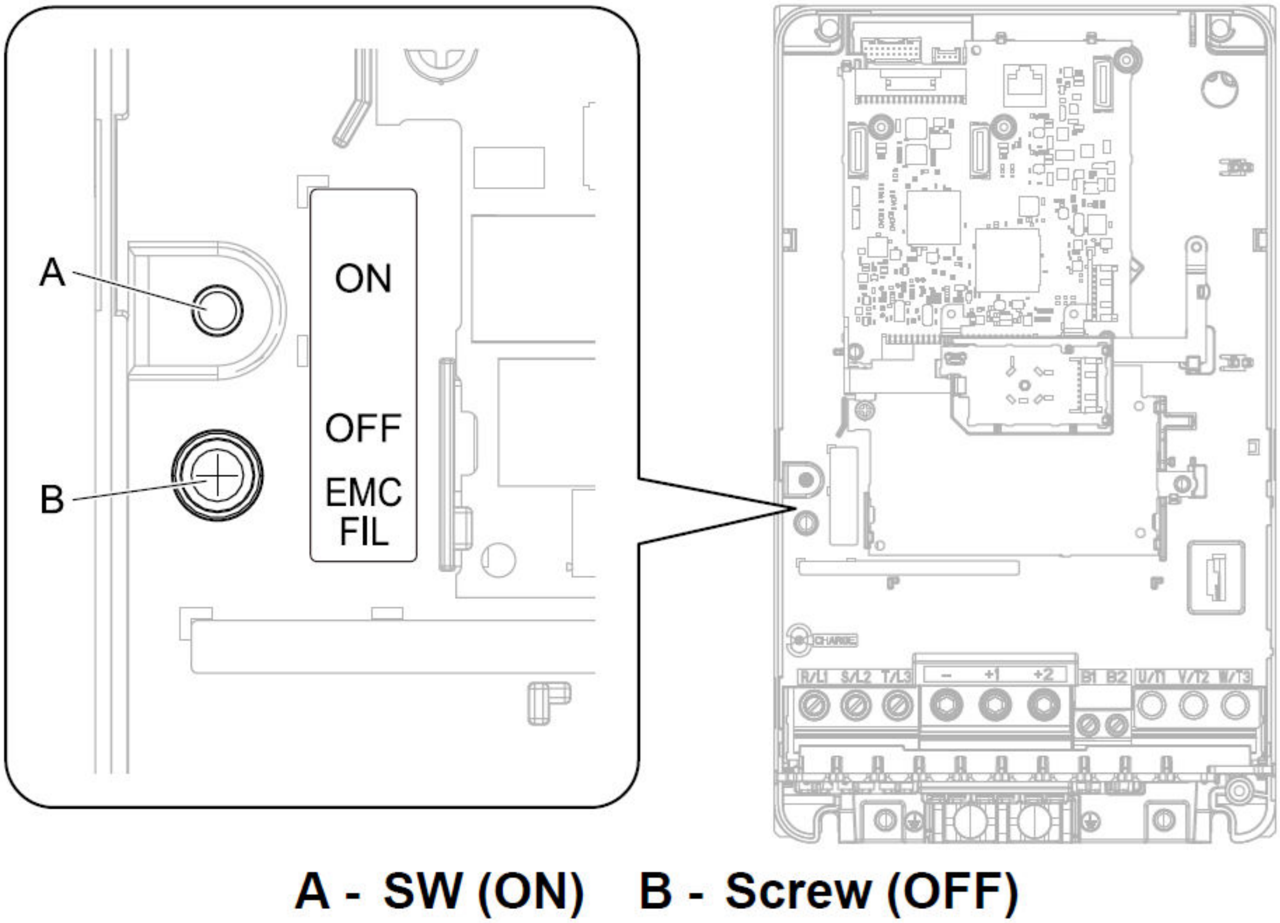


Figure B-8: EMC Filter Switch Location - Models 2047C, 4024C, 4031C

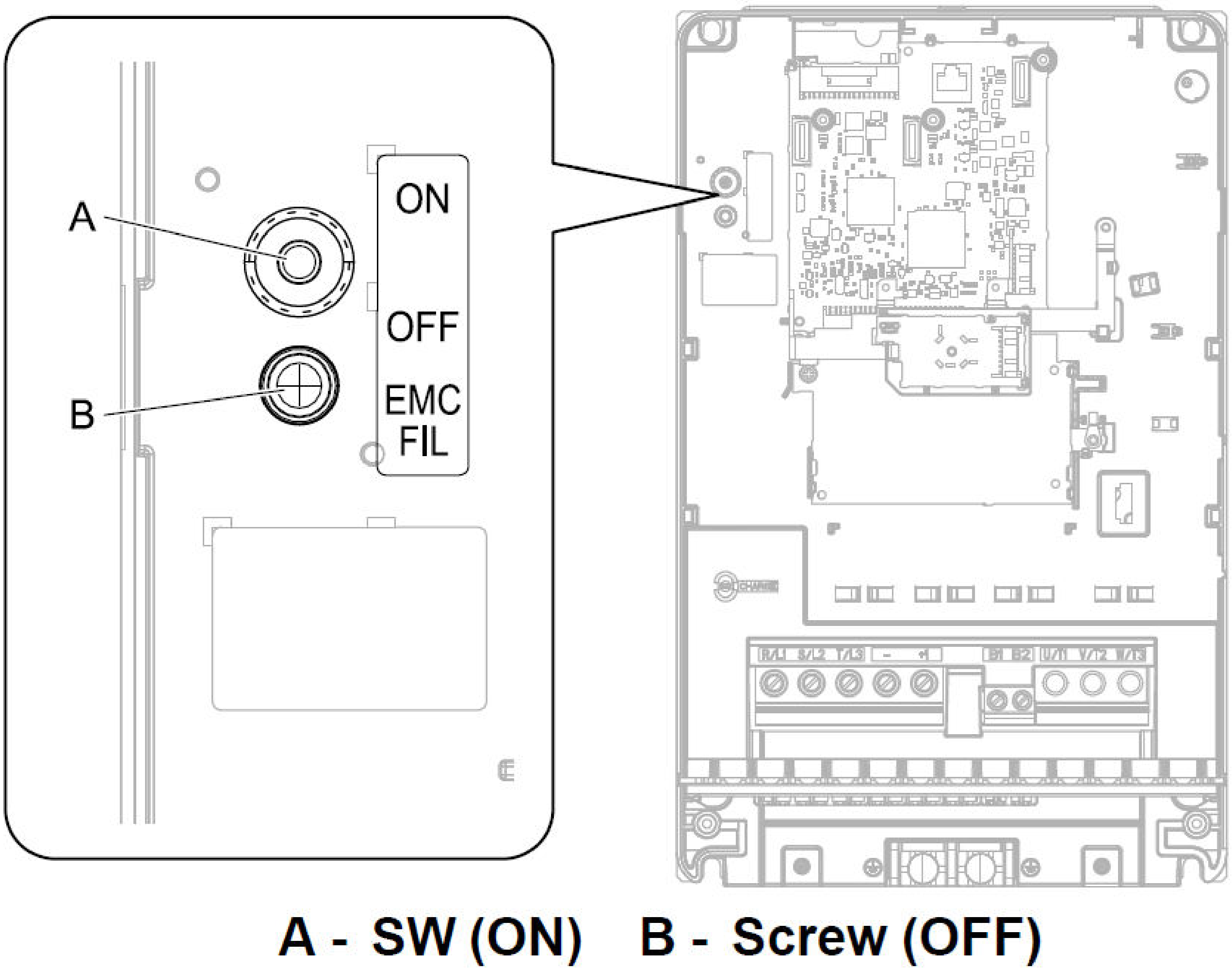


Figure B-9: EMC Filter Switch Location - Models 2060C, 2075C, 4039C, 4045C

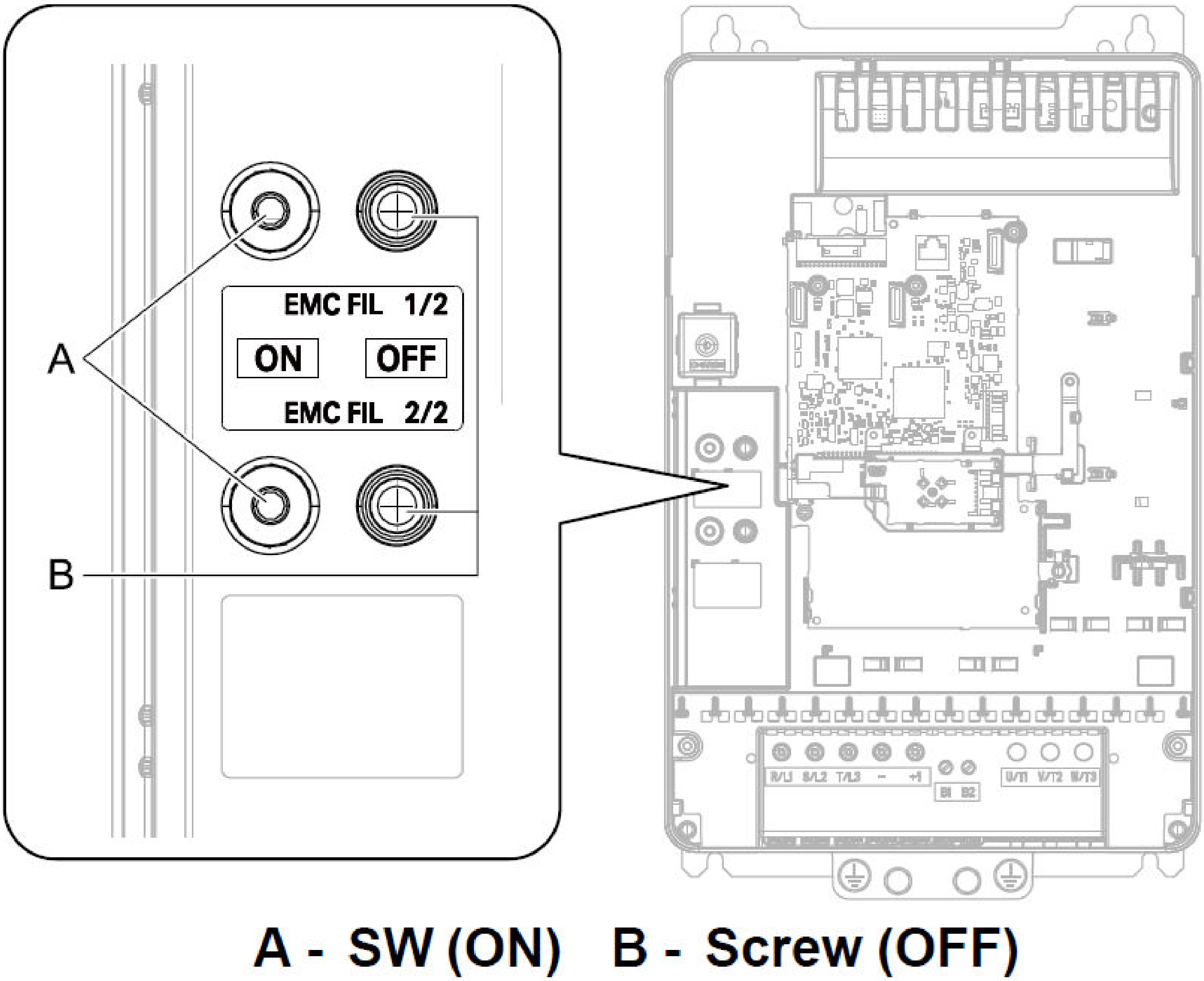


Figure B-10: EMC Filter Switch Location - Models 2088C - 2180C, 4060C - 4150C

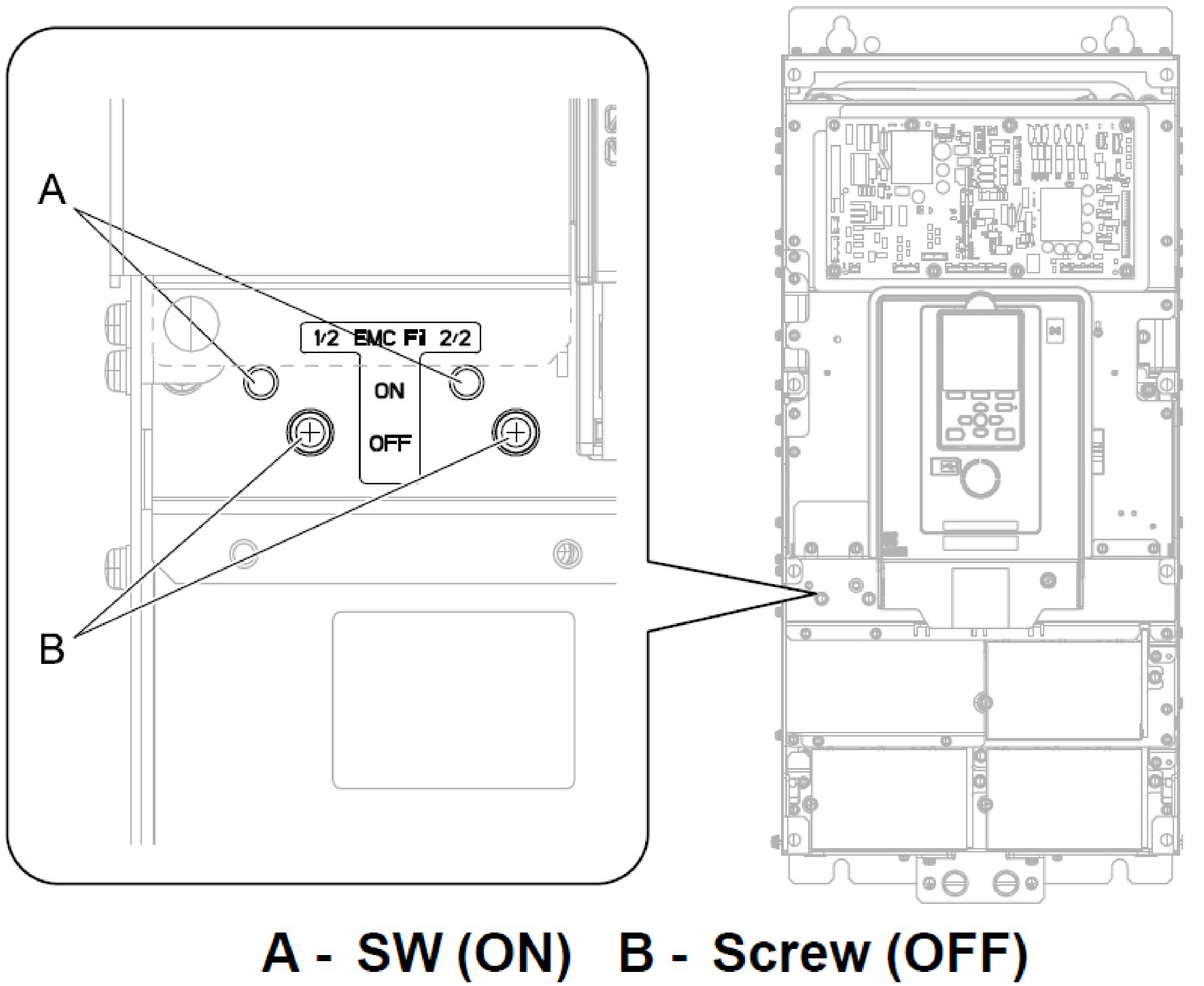


Figure B-11: EMC Filter Switch Location - Models 2215C - 2283C, 4180C - 4260C

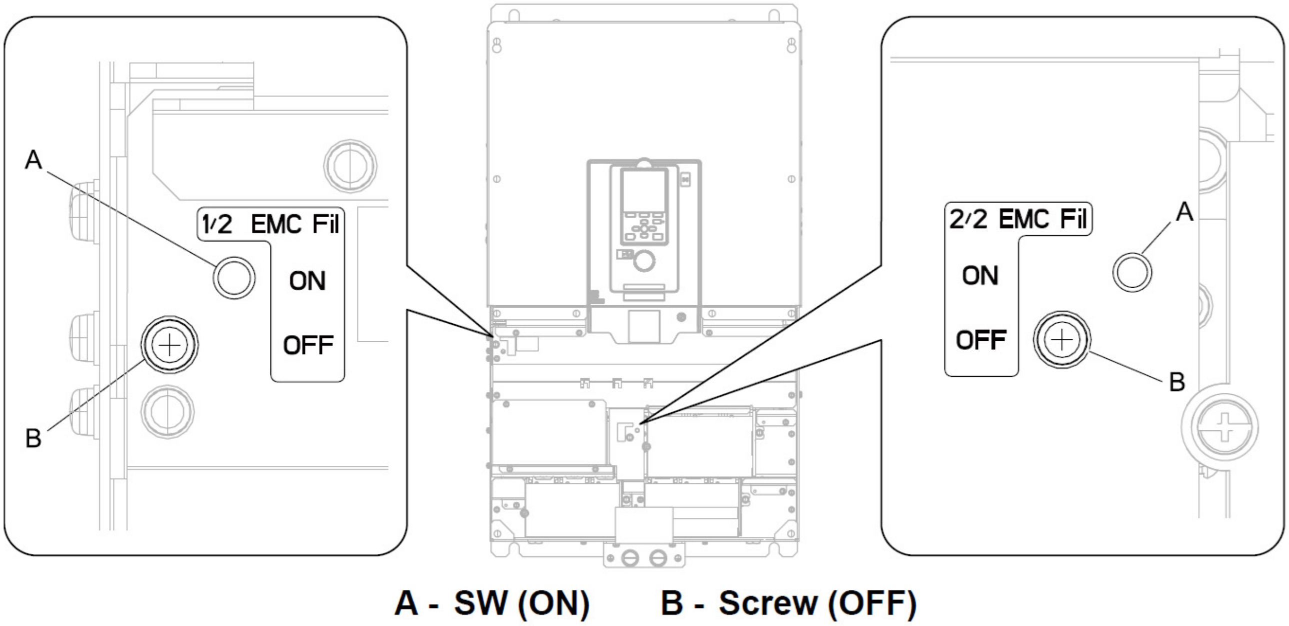


Figure B-12: EMC Filter Switch Location - Models 2346C, 2415C, 4304C, 4371C

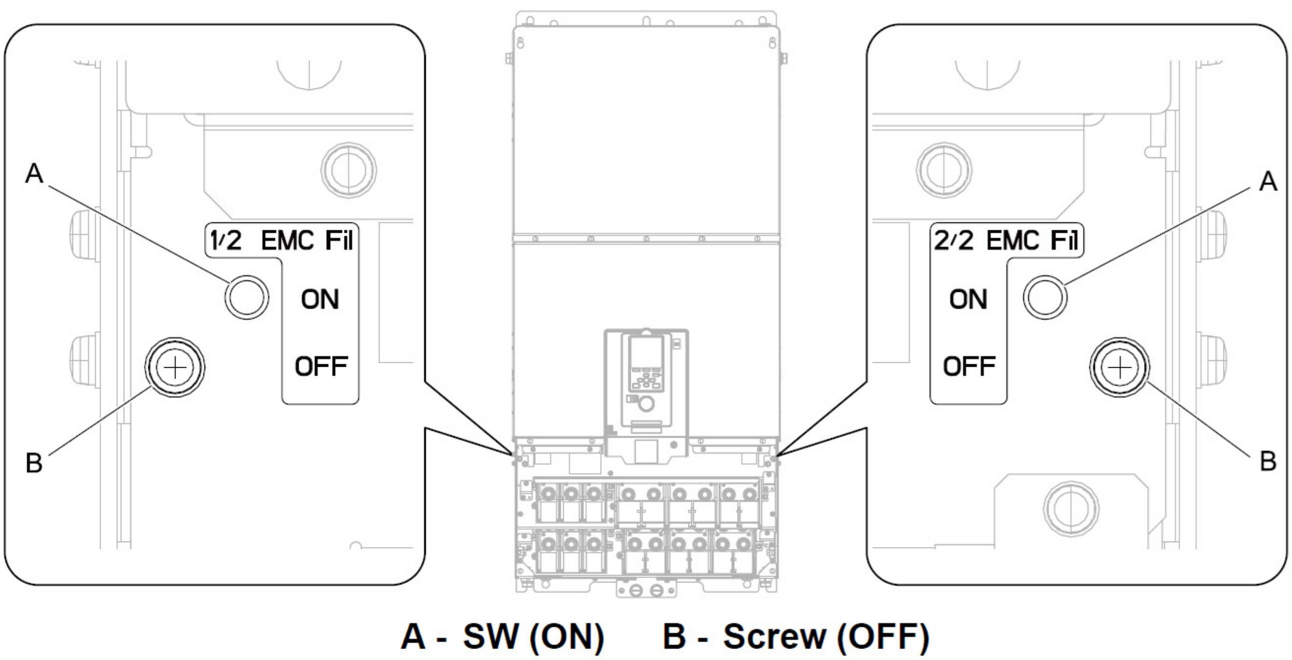


Figure B-13: EMC Filter Switch Location - Models 4414C - 4605C

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