S-Flex™

Adjustable Speed Enclosed Drive
Class 8839

Instruction Bulletin

30072-451-83
Rev. 01 06/2011

Retain for future use.

SQUARE D™

by Schneider Electric

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Hazard Categories and Special Symbols

The following symbols and special messages may appear in this manual or on the equipment to warn of potential hazards.

A lightning bolt or ANSI man symbol in a “Danger” or “Warning” safety label on the equipment indicates an electrical hazard which, as indicated below, can or will result in personal injury if the instructions are not followed.

An exclamation point symbol in a safety message in the manual indicates potential personal injury hazards. Obey all safety messages introduced by this symbol to avoid possible injury or death.

Symbol	Name
	Lightning Bolt
	ANSI Man
	Exclamation Point

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

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

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** property damage.

Product Support

For support and assistance, contact the Product Support Group. The Product Support Group is staffed from 8:00 am until 6:00 pm Eastern time to assist with product selection, start-up, and diagnosis of product or application problems. Emergency phone support is available 24 hours a day, 365 days a year.

Toll Free	1-888-778-2733
E-mail	drive.products.support@us.schneider-electric.com
Fax	919-217-6508

Section 1 —Introduction and Technical Characteristics

Product Overview

The S-Flex™ 21 and S-Flex™ 212 enclosed drives are full-featured adjustable speed package solutions for variable torque applications. The S-Flex enclosed drive is a bypass package that includes an Altivar™ 21 or Altivar™ 212 Adjustable Speed Drive on a wall-mountable back plane with a full voltage bypass power circuit configuration for customer installation and commissioning. The following features are available for the standard bypass package:

- AFC-Off-Bypass selector switch
- Local/Remote configurable on controller
- Power On red LED
- Bypass Run green LED
- Freeze/Firestat interlock
- Form C AFC detected fault contact
- Modbus™ RJ-45 communication port
- Smoke purge relay
- Circuit breaker disconnect
- Optional line disconnect switch or line contactor
- Optional full text keypad
- Optional non-bypass power circuit

About This Document

This manual contains installation, programming, and maintenance instructions for the S-Flex 21 and S-Flex 212 enclosed drives. The following documentation is also provided with the drive:

- *Altivar® 21 Installation Guide,* 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832
- *Altivar® 21 Programming and Operation Guide,* 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838
- *Altivar® 21 Quick Start Guide,* 30072-451-90, or *Altivar 212 Quick Start Guide*, S1A53825
- *Handling, Installation, Operation, and Maintenance of Electrical Control Equipment,* Instruction Bulletin 30072-200-50

NOTE: To replace missing documents, contact your local Schneider Electric field office or download them from the Technical Library at www.Schneider-Electric.us.

Terminology

The following terminology is used throughout this instruction bulletin to distinguish between the S-Flex 21 / S-Flex 212 enclosed drives and the Altivar 21H / Altivar 212H components.

- **Enclosed drive, or controller** refers to the combination of the power converter, enclosure, and the power and control circuits that constitute the S-Flex 21 or S-Flex 212 Adjustable Speed Enclosed Drive.
- **Drive,** as used in this manual refers to the controller portion of the adjustable speed drive as per the NEC.
- **Power converter** refers to the ATV21H or ATV212H series controllers (described in *Altivar® 21 Installation Guide*, 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832) when used as a component within the S-Flex 21 or S-Flex 212 enclosed drive.

Before You Begin

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand this manual before installing or operating the S-Flex 21 or S-Flex 212 drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- Some terminals have voltage on them when the disconnect is open.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- Before servicing the drive:
  - — Disconnect all power including external control power that may be present.
  - — Place a “DO NOT TURN ON” label on all power disconnects.
  - — Lock all power disconnects in the open position.
  - — WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the “DC Bus Voltage Measurement Procedure” on page 36 to verify that the DC voltage is less than 42 V. The drive LED is not an indicator of the absence of DC bus voltage.
- Install and close all covers and doors before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

For 460 V units:

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Never operate energized switch with door open.
- Turn off switch before removing or installing fuses or making load side connections.
- Always use a properly rated voltage sensing device at all line and load fuse clips to confirm switch is off.
- Turn off power supplying switch before doing any other work on or inside switch.
- Do not use renewable link fuses in fused switches.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

For 208 and 230 V units:

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside the equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

Before turning on the drive or upon exiting the configuration menus, ensure that the inputs assigned to the Run command are in a state that will not cause the drive to run. Otherwise, the motor can start immediately.

Failure to follow these instructions will result in death, or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failures of the link[1].
- Each implementation of an S-Flex 21 or S-Flex 212 enclosed drive must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.”

⚠ CAUTION

INCOMPATIBLE LINE VOLTAGE

Before turning on and configuring the drive, ensure that the line voltage is compatible with the line voltage range specified on the drive nameplate. The drive can be damaged if the line voltage is not compatible.

Failure to follow these instructions can result in injury or equipment damage.

Catalog Number Description

The catalog number, located on the nameplate attached to the S-Flex 21 or S-Flex 212 drive, is coded to describe the configuration of the drive. See Figure 1 on page 12 for an example of the S-Flex 21 or S-Flex 212 nameplate.

Use Table 2 to translate the catalog number into a description of the drive. The following example translates the catalog number shown on the nameplate in Figure 1 on page 12.

Table 1: Catalog Number Example: SFD212CG4YN06

Field						
01	**02**	**03**	**04**	**05**	**06**	**07**
SFD212	C	G	4	Y	N06	
	1 hp	Type 1 General Purpose	460 Vac	Full Voltage Bypass	Modbus	No Seismic Certification

Table 2: Catalog Number Description

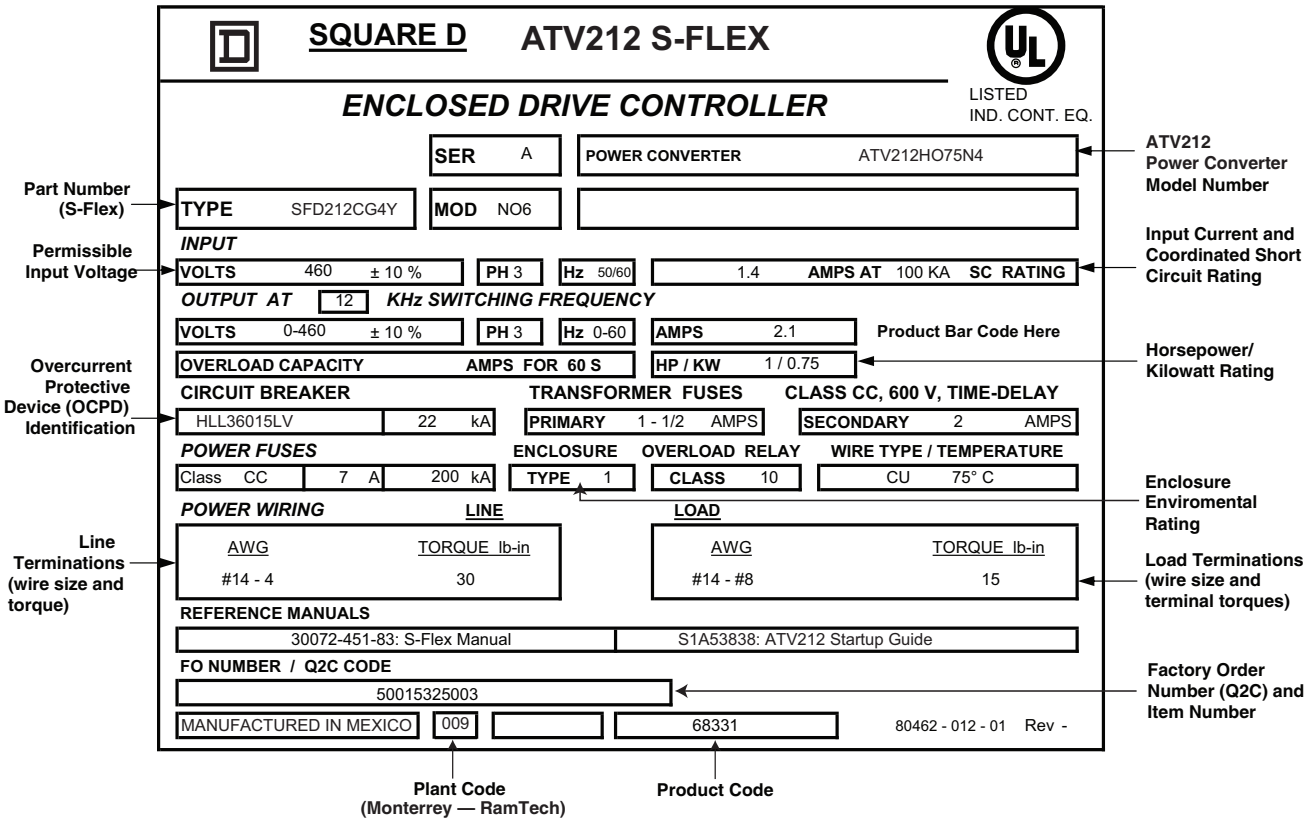
Field	Digit	Characteristic	Description
01	01 – 05	Controller Style	SFD21 = S-Flex 21 Enclosed Drive SFD212 = S-Flex 212 Enclosed Drive
02	06	Horsepower	C = 1 hp D = 2 hp E = 3 hp F = 5 hp G = 7.5 hp H = 10 hp J = 15 hp K = 20 hp L = 25 hp M = 30 hp N = 40 hp P = 50 hp (460 V only) Q = 60 hp (460 V only) R = 75 hp (460 V only) S = 100 hp (460 V only)
03	07	Enclosure Type	G = Type 1 General Purpose
04	08	Voltage	2 = 208 Vac 3 = 230 Vac 4 = 460 Vac
05	09	Power Circuit	W = Without Bypass Y = Full Voltage Bypass
06	010 – 012	Communication Options	A06 = BACnet Card B06 = LonWorks® Card C06 = Metasys® N2 Card D06 = Apogee™ P1 Card N06 = Modbus
07	013 – 015	Miscellaneous Options	A07 = Drive Input Disconnect[1] B07 = Line Contactor[1] S07 = Seismic Certification D07 = Full Text Keypad

[1] Options A07 Drive Input Disconnect and B07 Line Contactor are available only when a full voltage bypass (Y05) option is selected. Options A07 and B07 are mutually exclusive.

Nameplate Identification

The nameplate for the S-Flex 21 or S-Flex 212 enclosed drive is located on the inside of the door. This nameplate, shown in Figure 1, identifies the drive type and modification options. When identifying or describing the S-Flex 21 or S-Flex 212 enclosed drive, use the data from this nameplate.

Figure 1: S-Flex 212 Nameplate Example



Technical Characteristics

Table 3: Variable Torque Ratings

S-Flex Catalog Number[1]	Input Voltage 60 Hz (Vac)	Horse-power Rating (hp)[2]	Kilowatt Rating (kW)	Input Current (A)[3]	Output Current (A)[2]	Max. Transient Output Current 60 s (A)[2]	Total Dissipated Power at Rated Load (W)[2, 4]	Power Converter Part Number[5]
SFD212CG2•	208	1	0.75	3.3	4.8	5.1	184.2	ATV212HO75M3X
SFD212DG2•		2	1.5	6.1	7.8	8.3	228.3	ATV212HU15M3X
SFD212EG2•		3	2.2	8.7	11	11.7	256.0	ATV212HU22M3X
SFD212FG2•		5	4	15.7	17.5	19.3	326.8	ATV212HU40M3X
SFD212GG2•		7.5	5.5	20.8	25.3	26.6	384.7	ATV212HU55M3X
SFD212HG2•		10	7.5	27.9	32.2	35.2	495.0	ATV212HU75M3X
SFD212JG2•		15	11	42.1	48.3	50.8	641.2	ATV212HD11M3X
SFD212KG2•		20	15	56.1	62.1	67.1	846.1	ATV212HD15M3X
SFD212LG2•		25	18.5	67.3	78.2	82.3	939.1	ATV212HD18M3X
SFD212MG2•		30	22	80.4	92	96.8	1017.6	ATV212HD22M3X
SFD212NG2•		40	30	113.3	120	128.7	1414.3	ATV212HD30M3X
SFD212CG3•	230	1	0.75	2.8	4.2	5.1	183.1	ATV212HO75M3X
SFD212DG3•		2	1.5	5.3	6.8	8.3	226.1	ATV212HU15M3X
SFD212EG3•		3	2.2	7.6	9.6	11.7	252.1	ATV212HU22M3X
SFD212FG3•		5	4	13.5	15.2	19.3	323.5	ATV212HU40M3X
SFD212GG3•		7.5	5.5	18.1	22	26.6	381.0	ATV212HU55M3X
SFD212HG3•		10	7.5	24.4	28	35.2	489.1	ATV212HU75M3X
SFD212JG3•		15	11	35.7	42	50.8	630.6	ATV212HD11M3X
SFD212KG3•		20	15	47.6	54	67.1	829.5	ATV212HD15M3X
SFD212LG3•		25	18.5	58.0	68	82.3	918.3	ATV212HD18M3X
SFD212MG3•		30	22	69.0	80	96.8	994.1	ATV212HD22M3X
SFD212NG3•		40	30	93.0	104	128.7	1378.4	ATV212HD30M3X
SFD212CG4•	460	1	0.75	1.4	2.1	2.4	173.1	ATV212HO75N4
SFD212DG4•		2	1.5	2.5	3.4	4	197.6	ATV212HU15N4
SFD212EG4•		3	2.2	4.9	4.8	5.6	224.7	ATV212HU22N4
SFD212FG4•		5	4	6.4	7.6	10	303.6	ATV212HU40N4
SFD212GG4•		7.5	5.5	8.6	11	13.2	352.5	ATV212HU55N4
SFD212HG4•		10	7.5	11.7	14	17.6	418.8	ATV212HU75N4
SFD212JG4•		15	11	16.9	21	24.8	572.9	ATV212HD11N4
SFD212KG4•		20	15	22.6	27	33.6	765.8	ATV212HD15N4
SFD212LG4•		25	18.5	27.8	34	40.7	766.5	ATV212HD18N4
SFD212MG4•		30	22	33.1	40	47.9	806.0	ATV212HD22N4
SFD212NG4•		40	30	44.7	52	64.4	1041.5	ATV212HD30N4
SFD212PG4•		50	37	54.4	65	86.9	1241.6	ATV212HD37N4
SFD212QG4•		60	45	65.9	77	103.4	1622.1	ATV212HD45N4
SFD212RG4•		75	55	89	96	127.6	2007.5	ATV212HD55N4
SFD212SG4•		100	75	111.3	124	176	2866.8	ATV212HD75N4

1 The "•" indicates that the catalog number can end in a "Y" (for an S-flex drive with full voltage bypass) or a "W" (for an S-Flex drive without bypass).

2 These power, amperage, and wattage ratings apply to:
Power converters ATV21H075••• to HD15••• or ATV212H075••• to HD15••• (1–20 hp) operating at a switching frequency of 12 kHz, and at 40 ˚C (104 ˚F) ambient temperature. Power converters ATV21HD18••• to HD75••• or ATV212HD18••• to HD75••• (25–100 hp @ 460 V) operating at a switching frequency of 8 kHz, and at 40 ˚C (104 ˚F) ambient temperature. For a switching frequency between 13 kHz and 16 kHz, select the next largest size drive. If the duty cycle does not exceed 60% (36 s for a 60 s cycle) this is not necessary.

3 Select the conductor based on the input line current or the motor FLA, whichever is greater.

4 For btu/hr, multiply values by 3.413.

5 Drives shown in the table are installed in SFD212 controllers. For drives installed in SFD21 controllers, replace ATV212 with ATV21.

⚠ WARNING

IMPROPER OVERCURRENT COORDINATION

- Protective devices must be properly coordinated.
- Do not connect the drive to a power feeder whose short circuit capacity exceeds the short circuit rating listed on the drive nameplate.

Failure to follow these instructions can result in death or serious injury.

Short Circuit Ratings

All configurations have a short-circuit withstand rating of 100,000 A (symmetrical).

Input Current Ratings

All branch circuit components and equipment must be rated for the input current of the drive or the motor full load current (FLA), which ever is greater. Branch circuit components and equipment include: transformers, feeder cables, disconnect devices, and protective devices.

The input current rating is printed on the nameplate. See Figure 1 on page 12. The branch circuit feeder protection must be sized according to NEC Article 430.

Specifications

Table 4: S-Flex 21 and S-Flex 212 Product Specifications

Electrical Specifications	
Input voltage	208 Vac ± 10%, 230 Vac ± 10%, 460 Vac ± 10%
Displacement power factor	Approximately 0.96
Input frequency	50/60 Hz ± 5%
Output voltage	Three-phase output, maximum voltage equal to input voltage
Galvanic isolation	Galvanic isolation between power and control (inputs, outputs, and power supplies)
Frequency range of the power converter	0.5 to 200 Hz (factory setting of 60 Hz maximum)
Current limit	110% of nominal drive full load current (FLA) for 60 s
Switching frequency	Selectable from 6 to 16 kHz factory setting: 12 kHz[1] 1–20 hp; 8 kHz[2] above 25 hp
Speed reference	VIA: 4 to 20 mA, Impedance = 242 Ω or 0 to 10 Vdc, Impedance = 30 kΩ 0 to 20 mA, Impedance = 242 W (reassignable, X-Y range with keypad display) VIB: 0 to +10 V, Impedance = 30 kΩ
Frequency resolution in analog reference	0.0048 Hz (11 bits)
Speed accuracy 20–100% of motor rated torque	+/- 10% of nominal slip without speed feedback
Efficiency	Typically greater than 95%
Reference sample time	2 ms
Acceleration and deceleration ramps	0.1 to 3200 seconds (adjustable in 0.1 s increments)
Motor protection	Class 10 overload protection with bypass in addition to controller internal electronic thermal protection.
Keypad display	Self-diagnostics with status messages. 7-segment LED display (standard) Full text keypad, 8 languages (optional) Also see *Altivar® 21 Installation Guide*, 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832
Environmental Specifications	
Storage temperature	-13 to +158 °F (-25 to +70 °C)
Operating temperature	+14 to +104°F (-10 to +40 °C)
Humidity	95% with no condensation or dripping water, conforming to IEC 60068-2-3.
Altitude	3,300 ft. (1000 m) maximum without derating; derate the current by 1% for each additional 330 ft. (100 m) up to 10,000 ft. (3000 m).
Enclosure[3]	UL Type 1
Pollution degree	Pollution degree 2 per NEMA ICS-1 and IEC 60664-1
Resistance to vibrations (Power converter only)	According to IEC 60068-2-6: 1.5 mm peak to peak from 3 to 13 Hz 1 g from 13 to 150 Hz
Resistance to shocks (Power converter only)	According to IEC 60068-2: 15 g, 11 ms
Transit test to shock	Conforms to International Safe Transit Association guidelines.
Codes and standards	UL/cUL Listed per UL508C as incorporating Class 10 electronic and electromechanical overload protection. Conforms to applicable NEMA ICS, NFPA, IEC, and ISO 9001 standards. Seismic Certification: • 2003 IBC, NFPA 5000 and ASCE7 • ICC ES AC 156 [4]

1 Above 12 kHz derate the drive per the graphs in the *Altivar® 21 Installation Guide*, 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832.

2 Above 8 kHz derate the drive per the graphs in the *Altivar® 21 Installation Guide*, 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832.

3 Plenum rated; suitable for placement in a compartment handling conditioned air.

4 Acceptance criteria test protocol with an importance factor of 1.5.

Section 2 —Receiving, Handling, and Storing

> **⚠ WARNING**
>
> **DAMAGED EQUIPMENT**
>
> Do not operate or install any S-Flex 21 or S-Flex 212 enclosed drive that appears damaged.
>
> **Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Receiving and Preliminary Inspection

The S-Flex 21 or S-Flex 212 enclosed drive must be thoroughly inspected before it is stored or installed. Upon receipt:

1. Remove the S-Flex 21 or S-Flex 212 enclosed drive from its packaging and visually inspect the exterior for shipping damage.
2. Ensure that the catalog number of the S-Flex 21 or S-Flex 212 enclosed drive, which appears on the nameplate, agrees with the packing slip and corresponding purchase order. See Figure 1 on page 12.
3. If you find any shipping damage, notify the carrier and your Schneider Electric sales representative.

Storing the Equipment

> **CAUTION**
>
> **STACKING DURING STORAGE OR SHIPPING**
>
> - Do not stack S-Flex 21 or S-Flex 212 enclosed drives on top of each other.
> - Do not place any material on top of the S-Flex 21 or S-Flex 212 enclosed drive.
> - Store or ship the S-Flex 21 or S-Flex 212 enclosed drive in the original packaging.
>
> **Failure to follow these instructions can result in equipment damage.**

If you plan to store the S-Flex 21 or S-Flex 212 enclosed drive after receipt, replace it in its original packaging and store it in a clean, dry area where the ambient temperature is between -13 to +158 °F (-25 to +70 °C).
If the drive must be shipped to another location, use the original shipping material and carton to help protect the drive.

NOTE: Storing the equipment in its original packaging until it reaches its final installation site helps protect the equipment and helps prevent damage to its exterior.

Unpacking the Drive

⚠ WARNING

HEAVY EQUIPMENT

- Lifting the S-Flex 21 or S-Flex 212 enclosed drive requires the use of a lifting apparatus or two people.
- Always use safe lifting practices.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Handle the S-Flex 21 or S-Flex 212 enclosed drive carefully to avoid damage to the internal components, frame, and exterior. Lift the S-Flex 21 or S-Flex 212 enclosed drive out of its shipping carton, lifting with two people or a suitable lifting apparatus, and place it on a flat surface.

Before Installing the Drive

Before installing the S-Flex 21 or S-Flex 212 enclosed drive, visually verify that all components are properly seated, securely fastened, and undamaged.

1. Unlatch and open the door of the enclosed drive.
2. Visually verify that:
   - — All internally mounted hardware and terminal connection hardware is properly seated, securely fastened, and undamaged.
   - — The control transformer fuses are in place in the fuse block.
3. Close and latch the S-Flex 21 or S-Flex 212 enclosed drive door.

Handling the Drive

⚠ WARNING

HANDLING AND LIFTING HAZARD

- Keep the area below any equipment being lifted clear of all personnel and property.
- Lifting the S-Flex 21 or S-Flex 212 enclosed drive requires the use of a lifting apparatus and two people. Use the lifting method shown in Figure 2 on page 19.
- Before lifting the drive:
  - — Inspect the lifting plates, holes, slots, and eyebolts for any damage.
  - — Attach a spreader bar.
  - — Keep the lifting force vertical.
  - — Limit the swing angle to less than 45°.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

When handling drives:

- Always work with another person. The weight, size, and shape of the drive is such that two people are required to handle it.
- Use gloves.
- Attach a spreader bar to the two top lifting holes on the drive back panel and hoist the controller with chains or straps. See Figure 2 for the proper hoisting method and Figure 3 for the lifting points on the S-Flex 21 or S-Flex 212 enclosed drive.
- Raise the drive from a horizontal position (that is, the back of the controller resting on a pallet).
- Place the drive in an upright position.

  NOTE: The bottom of the drive is on an angle.
- Mount the drive on a flat, solid, noncombustible vertical surface, capable of supporting the controller weight.
- Secure all four corners of the controller with hardware of a sufficient size and type capable of supporting the controller weight.

Figure 2: Hoisting the S-Flex Drives

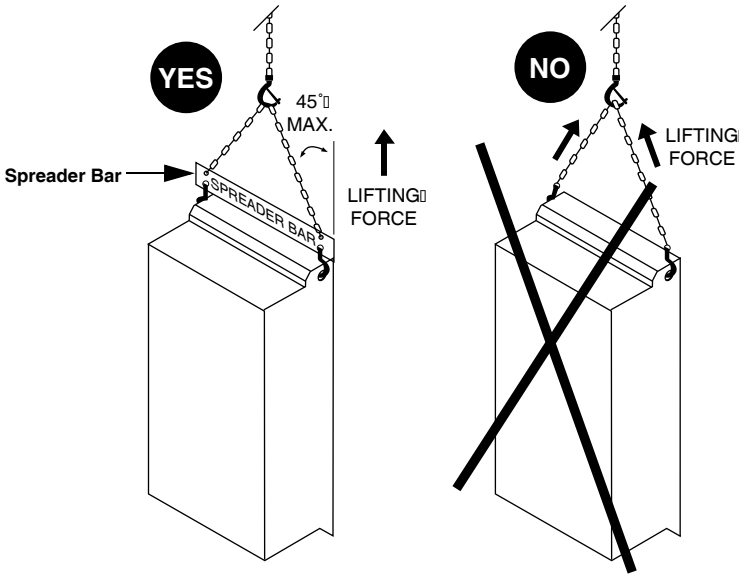
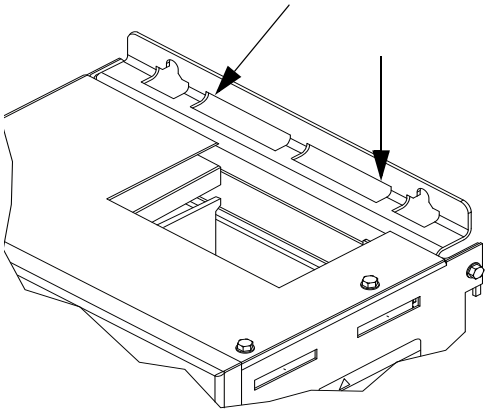


Figure 3: Lifting Points on the S-Flex Drives



Section 3 —Installation and Start-up

Precautions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Read and understand the precautions in “Before You Begin” starting on page 8 before performing the procedures in this section.

Failure to follow these instructions will result in death or serious injury.

Follow these precautions when installing the S-Flex 21 or S-Flex 212 enclosed drive:

- The drive is suitable for installation in a pollution degree 2 environment, as defined in NEMA ICS1 and IEC 60664-1.
- When attaching wall-mountable drives to their mounting surfaces, use fasteners rated for the weight of the drive, the expected shock and vibration of the installation, and the expected environment. See Tables 5–7 on page 22 for S-Flex 21 or S-Flex 212 enclosed drive weights.
- Provide sufficient cooling for the expected heat load. See Table 3 on page 13 for dissapated power at rated load.
- Do not mount the controller in direct sunlight or on hot surfaces. Mount it on a solid, flat surface only.

⚠ WARNING

IMPROPER MOUNTING

Before removing the lifting mechanism:

- Ensure that all hardware is of sufficient size and type for the controller weight.
- Secure and tighten all hardware.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Drive Weights

Table 5: 460 V S-Flex 212 Weights

Catalog Number[1]	Hp	Weight[2] lb (kg)
SFD212CG4•	1	52 (23.5)
SFD212DG4•	2	52 (23.5)
SFD212EG4•	3	52 (23.5)
SFD212FG4•	5	52 (23.5)
SFD212GG4•	7.5	52 (23.5)
SFD212HG4•	10	52 (23.5)
SFD212JG4•	15	52 (23.5)
SFD212KG4•	20	111 (50.3)
SFD212LG4•	25	111 (50.3)
SFD212MG4•	30	140 (63.5)
SFD212NG4•	40	140 (63.5)
SFD212PG4•	50	140 (63.5)
SFD212QG4•	60	140 (63.5)
SFD212RG4•	75	206 (93.4)
SFD212SG4•	100	206 (93.4)

Table 6: 230 V S-Flex 212 Weights

Catalog Number[1]	Hp	Weight[2] lb (kg)
SFD212CG3•	1	52 (23.5)
SFD212DG3•	2	52 (23.5)
SFD212EG3•	3	52 (23.5)
SFD212FG3•	5	52 (23.5)
SFD212GG3•	7.5	52 (23.5)
SFD212HG3•	10	52 (23.5)
SFD212JG3•	15	111 (50.3)
SFD212KG3•	20	111 (50.3)
SFD212LG3•	25	111 (50.3)
SFD212MG3•	30	140 (63.5)
SFD212NG3•	40	206 (93.4)

Table 7: 208 V S-Flex 212 Weights

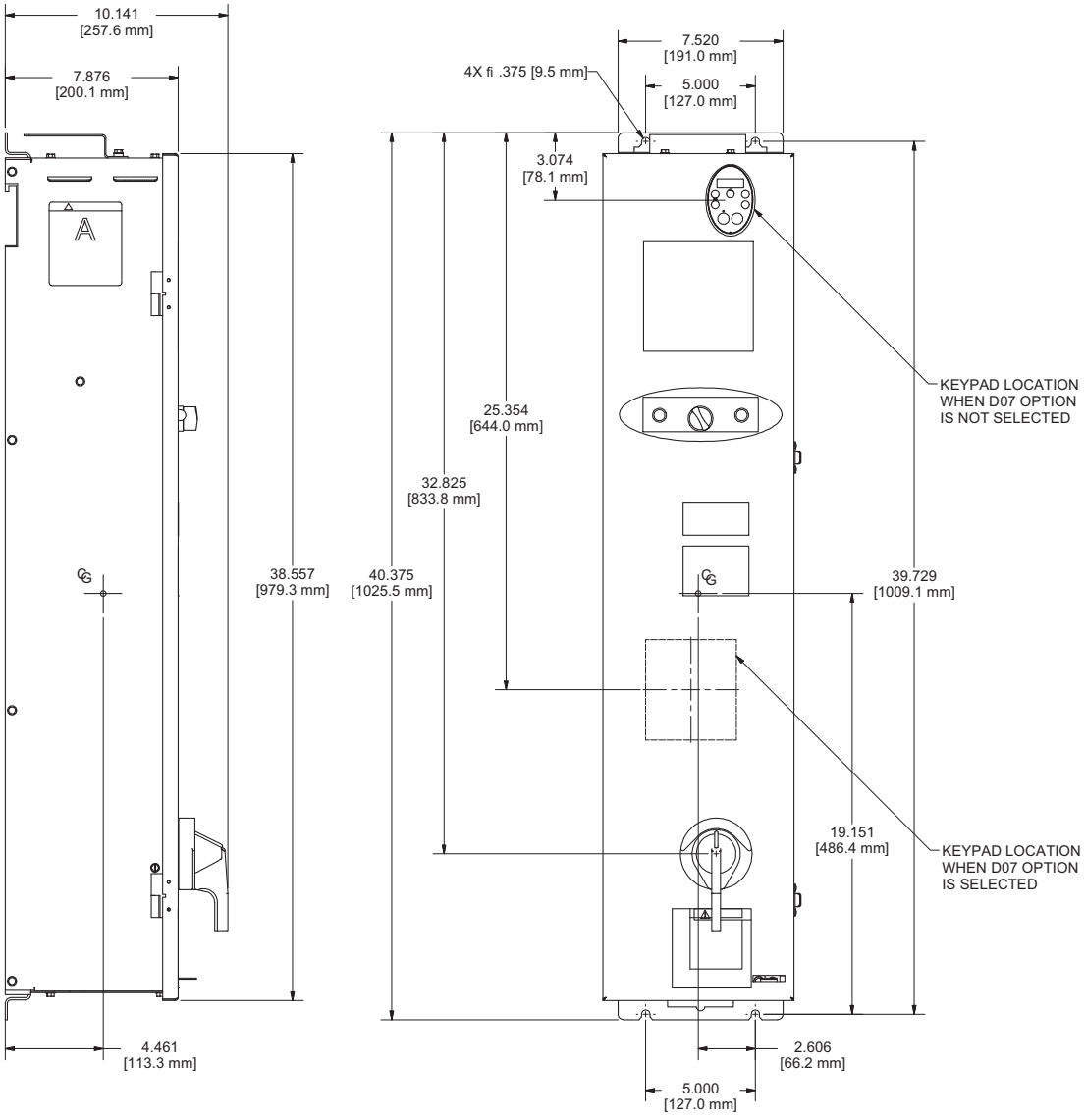
Catalog Number[1]	Hp	Weight[2] lb (kg)
SFD212CG2•	1	52 (23.5)
SFD212DG2•	2	52 (23.5)
SFD212EG2•	3	52 (23.5)
SFD212FG2•	5	52 (23.5)
SFD212GG2•	7.5	52 (23.5)
SFD212HG2•	10	52 (23.5)
SFD212JG2•	15	111 (50.3)
SFD212KG2•	20	111 (50.3)
SFD212LG2•	25	111 (50.3)
SFD212MG2•	30	140 (63.5)
SFD212NG2•	40	206 (93.4)

1 The "•" indicates that the catalog number can end in a "Y" (for an S-flex drive with full voltage bypass) or a "W" (for an S-Flex drive without bypass). Catalog numbers shown are for SFD212 controller style drives. The weights also apply for the corresponding SFD21 controller style drives.

2 The weight varies depending on modification options.

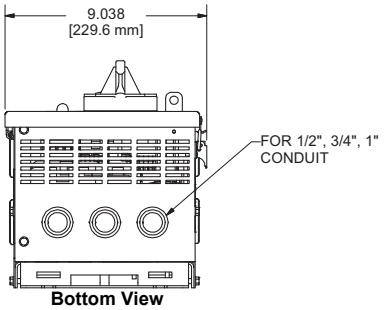
Dimensions for Wall or Panel Mounting

Figure 4: Frame Size A: 1–10 hp 208/230 Vac and 1–15 hp 460 Vac



Left Side View **Front View**

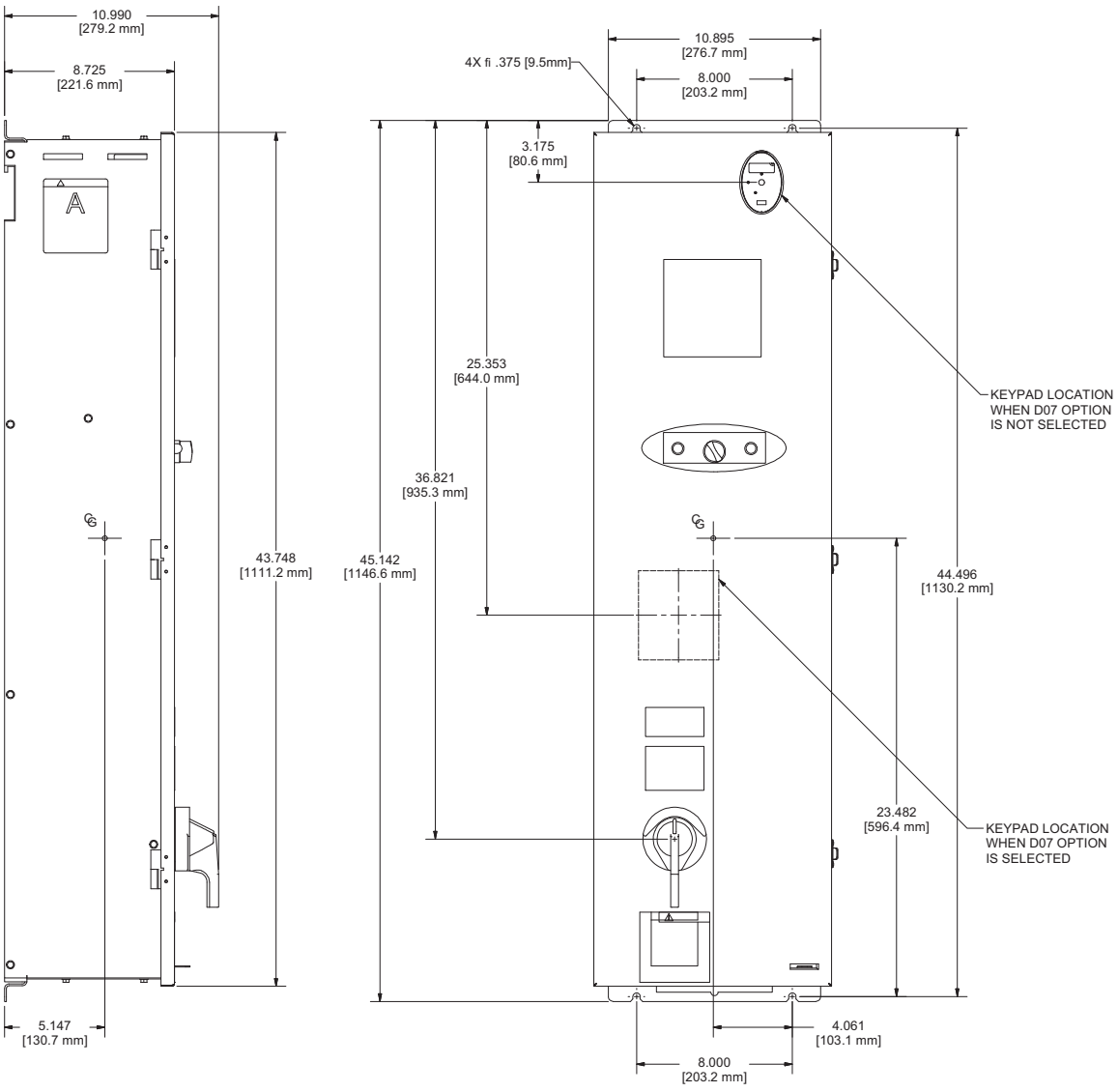
Dimensions: **Inches [mm]**



Bottom View

NOTE: Standard Bypass control package is shown.

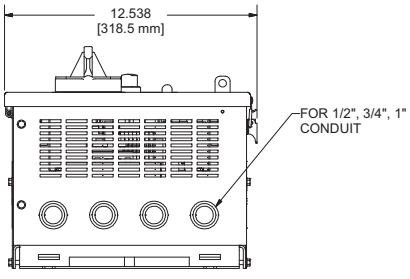
Figure 5: Frame Size B: 15–25 hp 208/230 Vac and 20–25 hp 460 Vac



Left Side View

Front View

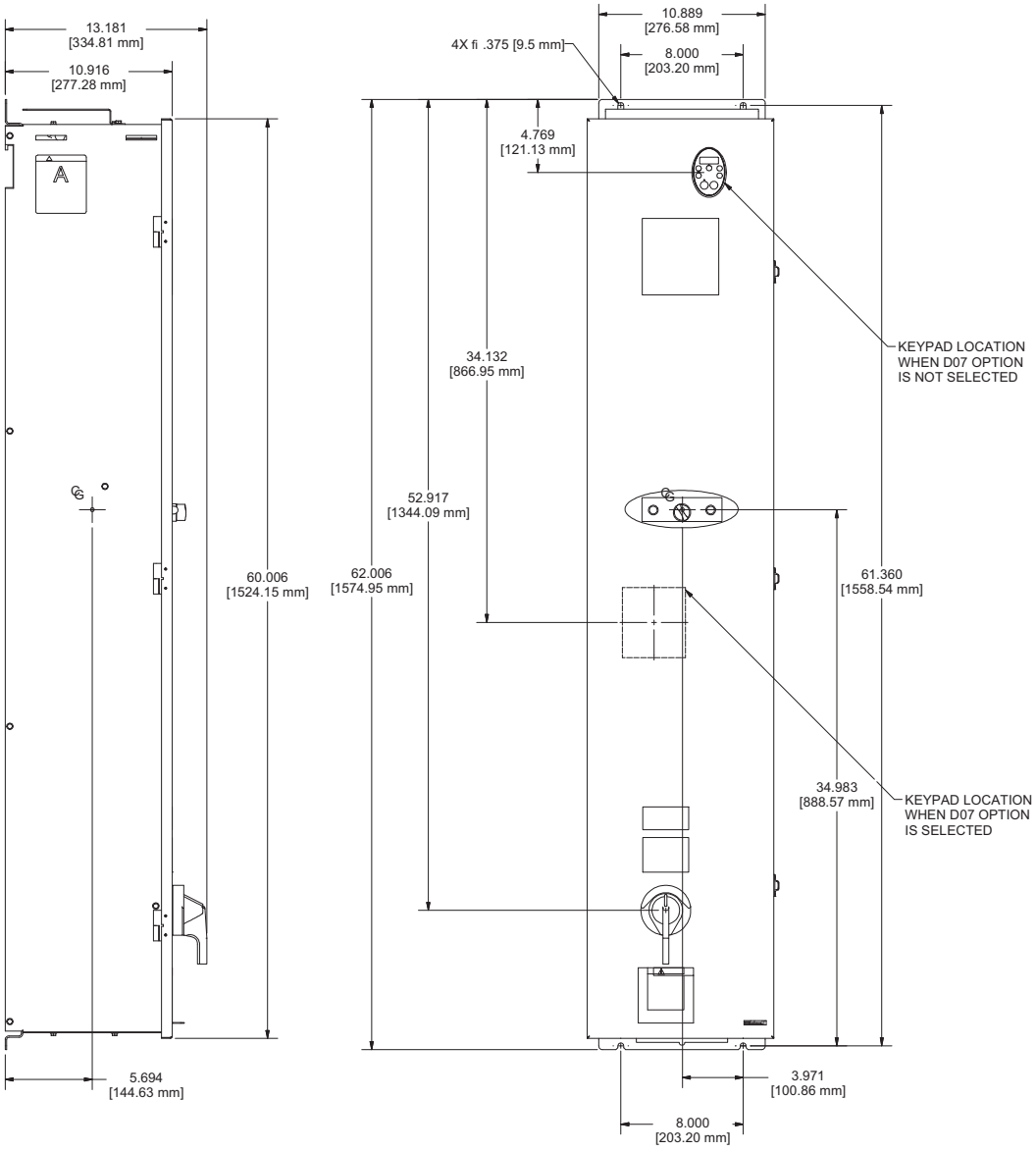
Dimensions: **Inches**
[mm]



Bottom View

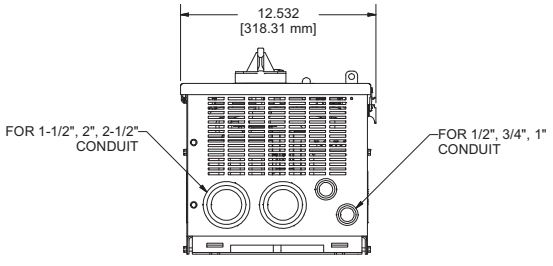
NOTE: Standard Bypass control package as shown.

Figure 6: Frame Size C: 30 hp 208/230 Vac and 30–60 hp 460 Vac



Left Side View **Front View**

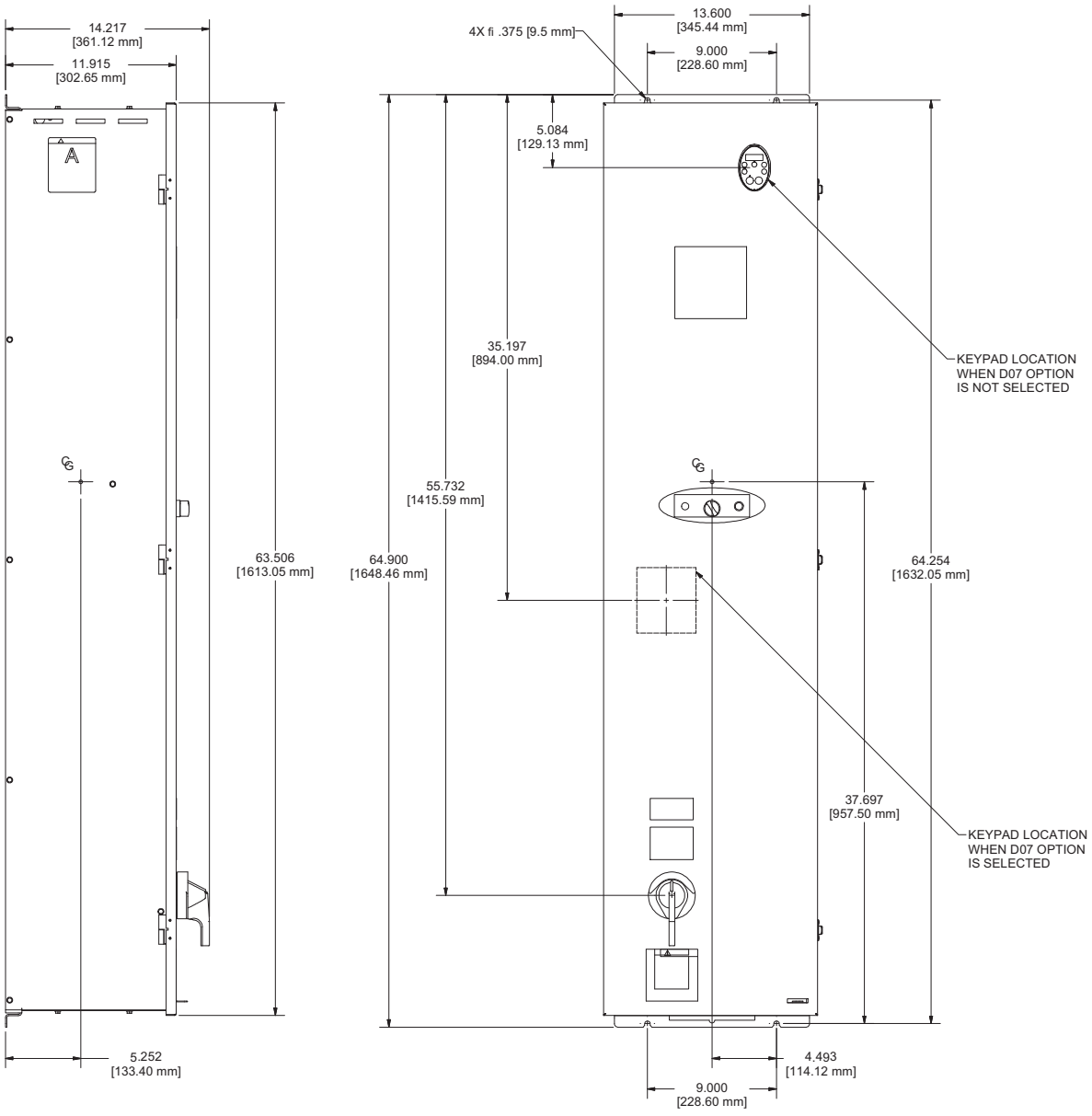
Dimensions: **Inches [mm]**



Bottom View

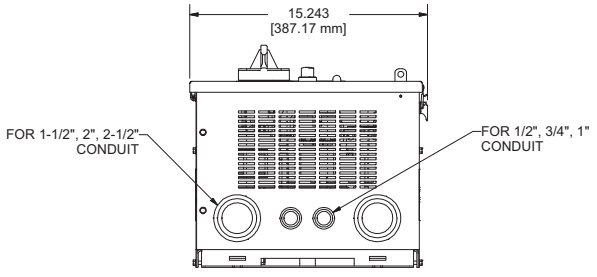
NOTE: Standard Bypass control package as shown.

Figure 7: Frame Size D: 40 hp 208/230 Vac



Left Side View **Front View**

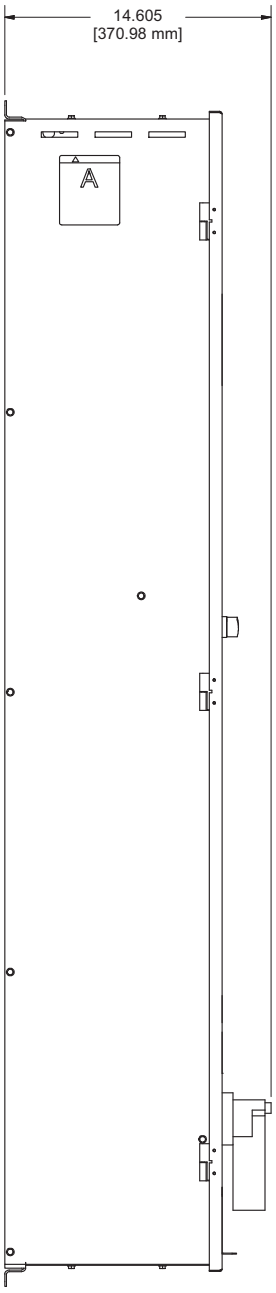
Dimensions: Inches [mm]



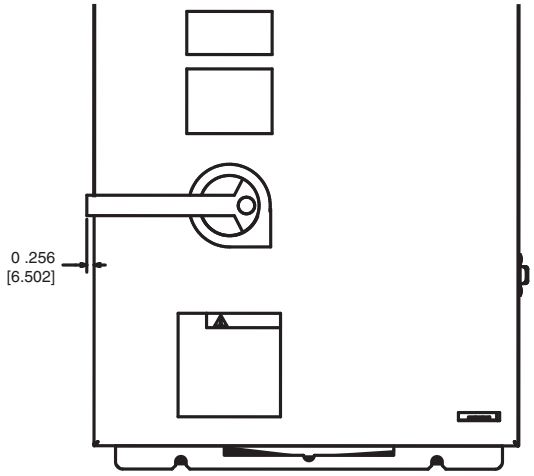
Bottom View

NOTE: Standard Bypass control package as shown.

Figure 8: Frame Size D: 75–100 hp, 460 Vac With Handle in ON Position



Left Side View



Front View

Dimensions: Inches [mm]

Mounting Recommendations

Mount each device so that the door can be opened at least 90°. The following are spacing recommendations:

- Mount all units with a minimum of 6.0 in. (152 mm) of space to the top and bottom.
- Mount 1–40 hp 208/230 V and 1–60 hp 460 V units with a minimum of 3.5 in. (89 mm) of space to the left and right.
- Mount 75–100 hp 460 V units with a minimum of 4.0 in. (102 mm) of space to the left and right.

Mounting on an EZM Mounting Channel

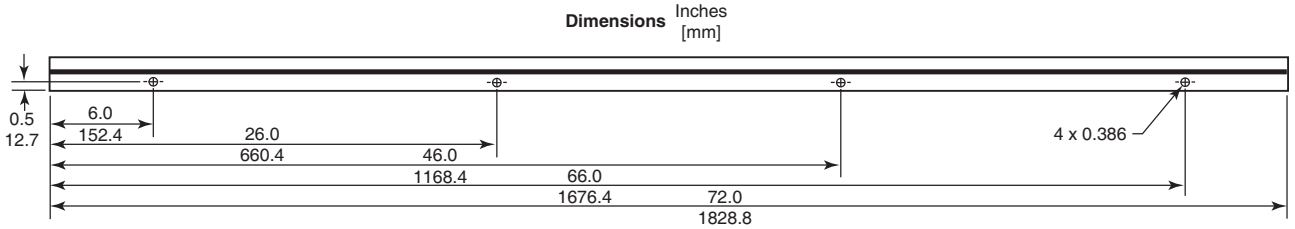
This section explains how to mount the drive on an EZM72MC mounting channel. This mounting method is available for:

- Frame Size A Enclosures: 1–15 hp @ 460 V, 1–10 hp @ 208/230 V
- Frame Size B Enclosures: 20–25 hp @ 460 V, 15–25 hp @ 208/230 V
- Frame Size C Enclosures: 30–60 hp @ 460 V, 30 hp @ 208/230 V

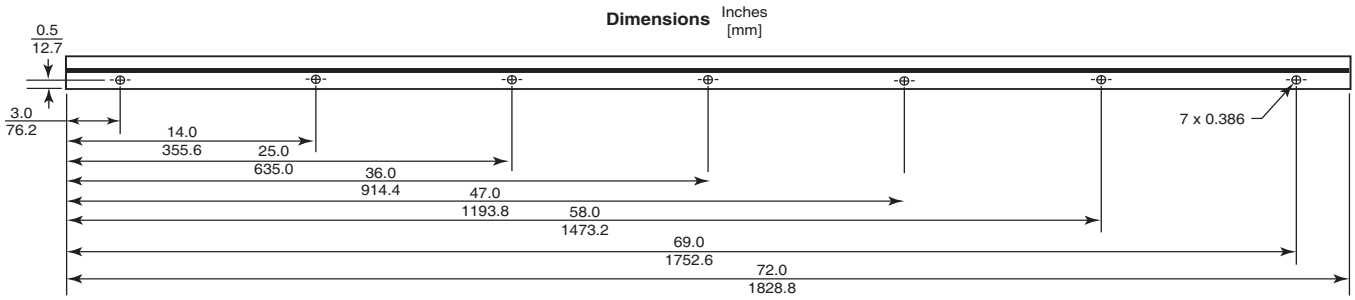
NOTE: EZM mounting cannot meet seismic requirements. Normal mounting methods must be used to meet seismic requirements.

The EZM channel is used to mount enclosures or assist in the alignment of multiple enclosures. Observe the following requirements for EZM mounting:

- Securely fasten the EZM mounting channel to a wall that is rated to support the total weight of the drives.
- Add additional wall anchor points to the EZM mounting channel as follows, with consideration given to wall construction:
  - — **Frame Size A enclosures only**: For a 72 in. long rail with a maximum of eight size A drives, do not locate the rail anchor points more than 6 in. from each end, and do not allow more than 20 in. between each additional anchor point.

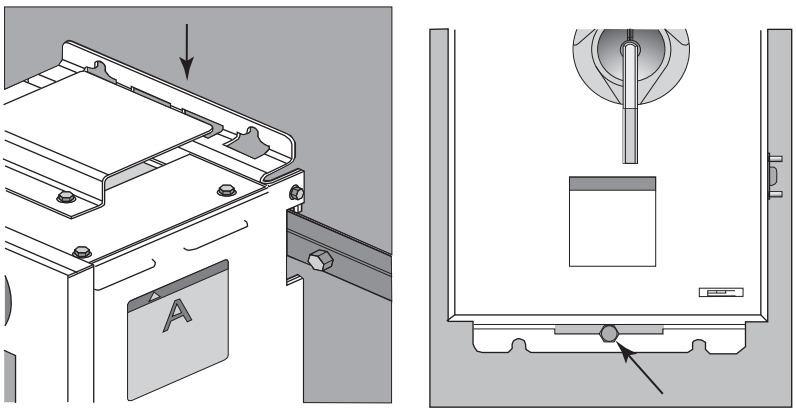


  - — **Frame Size B and C enclosures:** For a 72 in. long rail with a maximum of six size B or C drives (or any combination of these drives), do not locate the rail anchor points more than 3 in. from each end, and do not allow more than 11 in. between each additional anchor point.



- Use SAE grade 5-3/8 in. or better hardware to secure the rail to the wall. Use additional anchor hardware if needed for the material used in the wall construction.
- Add additional 5/16 in. hardware to the bottom flange of the enclosure. See Figure 9.

Figure 9: EZM Mounting Hardware



Seismic Qualification Mounting Criteria

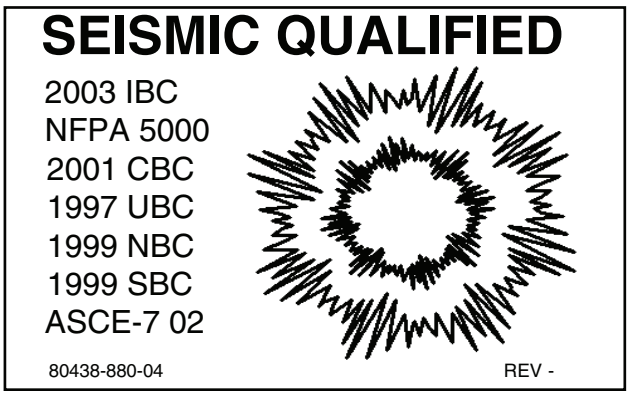
Seismic qualification (MOD S07) harmonizes the following standards in compliance to ICC ES AC156 acceptance criteria test protocol with an importance factor of 1.5:

- 2003 IBC (International Building Code)
- NFPA 5000 (Building Code – National Fire Protection Agency)
- 2001 CBC (Canadian Building Code)
- 1997 UBC (Uniform Building Code)
- 1999 NBC (BOCA National Building Code)
- 1999 SBC (Standard Building Code)
- ASCE 7 (American Society of Civil Engineers)

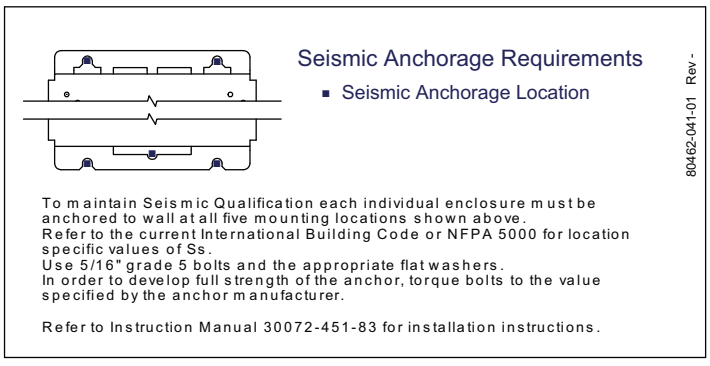
For seismic rating installation compliance, follow the seismic qualification labels attached to the drive (see Figure 10) for anchorage, lateral, and mounting guidelines using **SAE grade 5 bolts and washers**.

Figure 10: Seismic Qualification Labels

Certification Label



Wall Mounting



Electrical Installation

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Turn off all power (main and remote) before installing the equipment. Refer to “Before You Begin” starting on page 8 for important information and precautions.

Failure to follow these instructions will result in death or serious injury.

General Wiring Practices

Before wiring the drive, perform the DC Bus Voltage Measurement Procedure on page 36. Good wiring practice requires the separation of control circuit wiring from all power wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive or other drives.
Do not run power and/or control or multiple power wiring in the same conduit. This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits.

⚠ CAUTION

IMPROPER WIRING HAZARD

Follow the wiring practices described in this document in addition to those already required by the National Electrical Code and local codes.

Failure to follow these instructions can result in injury or equipment damage.

Follow the practices below when wiring the S-Flex 21 or S-Flex 212 enclosed drive:

- Use the supplied knockouts to feed control wiring into the cabinet. Do not run control wires through the drive vents or rear air intake.
- Use metallic conduit for all drive wiring. Do not run control and power wiring in the same conduit.
- Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 inches (76 mm).
- Separate existing, non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 inches (305 mm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- Equip all inductive circuits near the controller (relays, contactors, solenoid valves) with noise suppressors.

Input Wiring

The ampacity of the input power conductors should be sized according to the National Electrical Code and applicable local codes based on the drive input current or motor full load current (whichever is greater).

Grounding

Ground the S-Flex 21 or S-Flex 212 enclosed drive according to the National Electrical Code and all local codes. To ground the drive:

- Connect a copper wire from the grounding bar terminal to the power system ground.
- Verify that the resistance to ground is 1 Ω or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

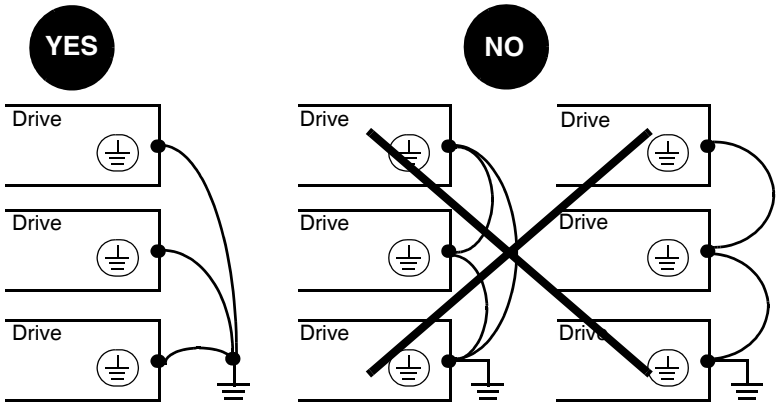
HAZARD OF ELECTRIC SHOCK

- Ground equipment using the provided grounding connection point as shown in Figure 13 on page 39. The drive panel must be properly grounded before power is applied.
- Do not use metallic conduit as a grounding conductor.

Failure to follow these instructions will result in death or serious injury.

Ground multiple drives as shown in Figure 11. Use one grounding conductor per device. Do not loop grounding conductors or install them in series.

Figure 11: Grounding Multiple Drives



Connection to Ungrounded or High-Resistance Grounded Systems

Altivar 21 and Altivar 212 480 V drive controllers feature built-in radio frequency interference (RFI) filters with grounded capacitors. When using the drive controller on an ungrounded, resistance grounded, or delta connected system, to isolate the RFI filters from ground to help prevent reduction of their operating life. Refer to the *Altivar® 21 Installation Guide,* 30072-451-61, or *Altivar 212 Installation Guide,* S1A53832*,* for information on disconnecting the filter ground.

Wiring and Electromagnetic Compatibility

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and over travel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failures of the link[1].
- Each implementation of a S-Flex 21 or S-Flex 212 enclosed drive must be individually and thoroughly tested for proper operation before being placed into service.

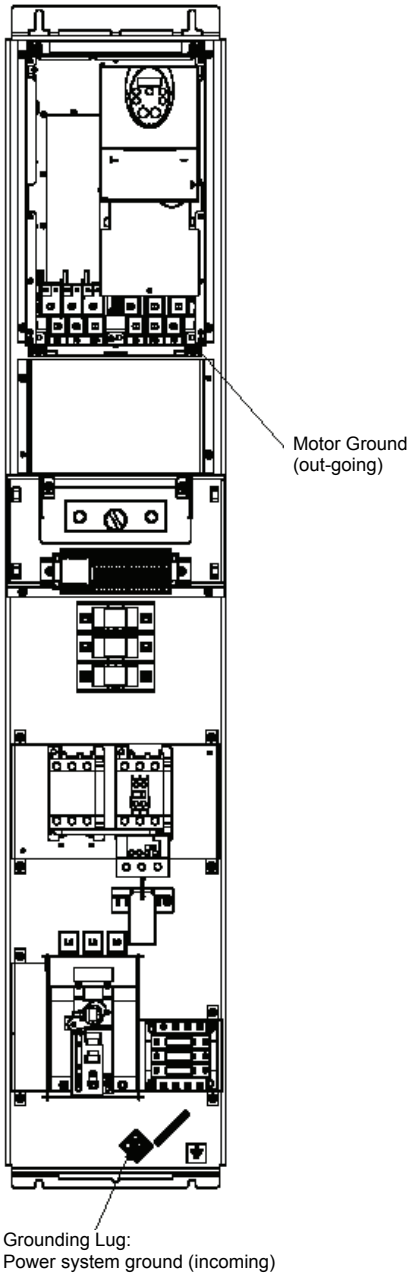
Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.”

The high frequency equipotential grounding connection between the drive, motor, and cable shielding does not eliminate the need to connect the grounding (PE) conductors (green-yellow) to the appropriate terminals on each unit. To help accomplish this, follow these guidelines:

- To avoid communication interference, grounds between the drive, motor and cable shields must have high frequency equipotentiality.
- When using shielded cable for the motor, use a 4-conductor cable so that one wire will be the grounding connection between the motor and the drive. Size the grounding conductor in compliance with local and national codes. The shield can then be grounded at both ends. Metal ducting or conduit can be used for part or all of the shielding length, provided there is no break in continuity.
- When using shielded cable for control signals, if the cable is connecting equipment that is close together and the grounds are bonded together, then both ends of the shield can be grounded. If the cable is connected to equipment that may have a different ground potential, then ground the shield at one end only to prevent large currents from flowing in the shield. The shield on the ungrounded end may be tied to ground with a capacitor (for example: 10 nF, 100V or higher) in order to provide a path for the higher frequency noise.
- Ensure maximum separation between the power supply cable (line supply) and the motor cable and also ensure maximum separation between the control cables and any power cables.

Figure 12: Grounding Connection Diagram



Connecting the motor ground wire directly to the power converter chassis as shown in Figure 12 is the preferred grounding method. This method reduces the amount of high frequency noise generated by the power converter PWM that may be coupled into communication or control wiring. The drive has two or more marked terminals for making grounding connections.

Output Wiring

Size the ampacity of motor power conductors according to the motor full load current, National Electrical Code, and applicable local codes.

Connect motor conductors to the lugs provided and connect the motor ground to the power converter chassis. Connect motor conductors to T1, T2, and T3 on the overload relay when the controller is supplied with a bypass circuit. Connect motor conductors to T1/U, T2/V, and T3/W on the power converter, or T1, T2, and T3 on the distribution block (if supplied), when the controller is supplied without a bypass circuit. See Figure 13 on page 39.

The drive is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the drive may trip on overcurrent.

Output Cable

Follow these guidelines when selecting output cable:

- Cable type: select cable with a low capacitance phase-to-phase and to ground. Do not use mineral-impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- Cable length: the longer the cable, the greater the capacitance. Cable lengths greater than 164 ft (50 m) may appear as a ground fault condition to the drive. For installations where cable capacitances may be a problem, a reactor or motor protection filter can be installed between the drive and the motor.

The following guidelines are designed to address maximum cable length for typical drive/motor applications:

- Many variables can affect the performance of the drive, the motor, and the cables in long lead applications. Motor protection filters can provide substantial benefits when you are using:
  - 460 V or higher rated AC drives
  - Existing general purpose motors subject to retrofit to an AC drive
  - Shielded cables

- NEMA MG-1 Part 31 compliant motors are recommended but not required. However, consult the motor manufacturer or vendor literature to address any specific limitations governing the application.
  - — Proximity to other output cables: because of high frequency switching and increased capacitance, the drive may trip under some conditions.
  - **— Do not use lightning arrestors or power factor correction capacitors on the output of the drive.**

For proper drive short circuit protection, certain values of inductance may be required in the output power wiring. Inductance can be supplied by the power wiring or auxiliary inductors.

⚠ CAUTION

INSUFFICIENT OUTPUT INDUCTANCE

Provide at least 500 mm (20 in.) of cable at the drive output (U/T1, V/T2, W/T3) to help protect the drive output when short circuits occur.

Failure to follow these instructions can result in injury or equipment damage.

The S-Flex 21 or S-Flex 212 enclosed drive is not intended to be used where extremely long output cable runs are required. Maximum output cable length for standard duty motors should be limited to 100 m (328 ft). For applications exceeding this cable length, consult the factory.

DC Bus Voltage Measurement Procedure

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand the DC Bus Voltage Measurement Procedure before performing the procedure.
- Measurement of bus capacitor voltage must be performed by qualified personnel.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- DO NOT touch unshielded components or terminal strip screw connections with voltage present.
- Use only electrically insulated tools.
- Before servicing the drive:
  - — Disconnect all power including external control power that may be present.
  - — Always use a properly rated voltage sensing device to confirm power is off.
  - — Place a “DO NOT TURN ON” label on all power disconnects.
  - — Lock all power disconnects in the open position.
  - — WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the “DC Bus Voltage Measurement Procedure” below to verify that the DC voltage is less than 42 V. The drive LED is not an indicator of the absence of DC bus voltage.
- Replace all devices, doors and covers before turning on power to this equipment or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

The DC bus voltage level is determined by monitoring the PA/+ and PC/– terminals. The location of these terminals varies by power converter model number. Read the model number of the power converter from the nameplate, and identify the corresponding PA/+ and PC/– terminals. See Figure 1 on page 12.

To measure the DC bus capacitor voltage:

1. Remove all power from the drive. Use a properly rated voltage sensing device to confirm power is off. Also, be sure to remove all external control power that may be present such as on the control board and the option board terminals.
2. Wait fifteen minutes for the DC bus capacitors to discharge.
3. Open the door of the drive.
4. Set the voltmeter to the 1000 Vdc scale. Measure the voltage between the PA/+ and PC/– terminals.

5. Verify that the DC bus voltage has discharged below 42 V before servicing the drive. If the DC bus capacitors will not discharge below 42 V, contact your local Schneider Electric representative. **Do not operate the drive.**
6. After servicing the drive, close and secure door.

Wire Routing and Interconnection

Wire Class

The Wire Class describes the compatibility of the field wiring terminal with the conductor material and insulation system. When used in conjunction with the required conductor current rating and the controller ambient temperature rating, the Wire Class forms the basis for selecting a conductor size that limits the temperature on the conductor insulation at the field wiring terminal to acceptable limits. Conductors with operating temperatures exceeding those given by the Wire Class can be used, but the conductor size must be selected based on the Wire Class limits.

Noise Class

The Noise Class categorizes the electromagnetic properties of the voltages and currents present. The six Noise Class categories determine proper wiring methods and physical segregation.

Quiet Wiring 1 (QW1)

High-susceptibility analog and digital control signals. Signals falling under the classification of QW1 include digital communication/network circuits, controller analog I/O and analog process signals.

Quiet Wiring 2 (QW2)

Medium-susceptibility analog and digital control signals. Signals falling under the classification of QW2 include 24 Vdc and 24 Vac control circuits.

Standard Wiring 1 (SW1)

Low-Susceptibility control or power circuits rated less than 600 Vac (250 Vdc) and less than 15 A (voltage and current spectra are generally contained within 0.05–9 kHz). Signals falling under the classification of SW1 include 120 Vac control circuits.

Standard Wiring 2 (SW2)

Power circuits rated greater than 15 A (voltage and current spectra are generally contained with 0.05–9 kHz). Signals falling under the classification of SW2 include line power to controllers.

Standard Wiring 3 (SW3)

Reserved.

Pulse Wiring 1 (PW1)

Control or power circuits whose voltage or current spectra significantly exceed 9 kHz. Signals falling under the classification of PW1 include motor and dynamic braking circuits fed from PWM (pulse width modulation) power converters.

Voltage Class

The Voltage Class groups the voltages present into recognized conductor insulation categories (30,150, 300, and 600 V) for selection of conductor insulation voltage rating and physical segregation.

Wiring Methods

Based on the Noise Class and Voltage Class of the conductors, apply the wiring methods in Table 8 to the drive.

Table 8: Wire Routing and Interconnection

Wiring Methods and Considerations	Noise Class of Conductors[1]				
	QW1	QW2	SW1	SW2	PW1
Conductor Grouping in Wireways and Conduits					
1. Bundle all conductors of 1- or 3-phase AC power circuits to minimize stray magnetic fields.			X	X	X
2. Bundle all conductors of a DC power circuit to minimize stray magnetic fields.			X	X	X
3. When parallel conductors must be run in separate wireways or conduit, bundle the conductors into groups to minimize stray magnetic fields.				X	X
4. Maintain conductor runs that are as short and direct as possible.	X	X	X	X	X
Separation of Circuits					
1. Do not run different Noise Class conductors in the same conduit.	X	X	X	X	X
2. Do not run different Voltage Class conductors in the same conduit unless all conductors are insulated for the maximum Voltage Class present.	X	X	X	X	X
3. Separate all conductors by Noise Class. Use the following circuit separation when conductors run parallel for more than 12 inches.					
• Metallic conduit: 3 in. from QW to SW or PW	X	X	X	X	X
• Metallic tray: 3 in. from SW to PW			X	X	X
• Metallic tray: 6 in. from QW to SW or PW	X	X	X	X	X
• Against continuous metal surface: 3 in. from SW to PW			X	X	X
• Against continuous metal surface: 6 in. from QW to SW or PW	X	X	X	X	X
• Metallic conduit housing QW: 12 in. to non-metallic conduit SW or PW	X	X	X	X	X
• Non-metallic conduit: 3 in. from SW to PW			X	X	X
• Non-metallic conduit: 23 in. from QW to SW or PW	X	X	X	X	X
4. All PW conductor groups must be individually separated using metallic conduit.					X
5. If QW and SW1 wiring must cross SW2 or PW1 wiring, cross the bundles at right angles.	X	X	X	X	X
Common Mode Noise Issues					
1. Provide adjacent signal returns using twisted pair cable.	X	X			
2. Galvanically isolate the signal and the associated signal return path when possible.	X	X			
Shielding					
1. Use metallic conduit for all power and control circuits external to the controller enclosure.	X	X	X	X	X
2. Use shields that are continuous and equipped with a drain wire.	X	X	X		
3. Do not group different Noise Class conductors within the same shield.	X	X	X	X	X
4. Minimize the non-shielded portion of the conductor at the end of the shielded cable.	X	X	X	X	X
5. When shielding AC or DC power conductors, group the conductors to minimize the magnetic field in the shield.			X	X	X
Grounding					
1. Ground shields only at the controller end.	X	X	X	X	X
2. Use a separate ground wire for each shield ground.	X	X	X	X	X
3. Provide a ground wire with all conductor groups, whether in tray or conduit.			X	X	X
4. When multiple grounds must be made to a shielded power cable, the shield must have the same short circuit withstand capability as the grounding conductor in the power cable.			X	X	X
5. Terminate all power grounds and power shield grounds to the controller grounding point or power converter chassis.			X	X	X
6. Terminate all signal shield grounds to the terminals provided.	X	X			
7. Always supply a separate equipment grounding conductor with the controller power feed. Do not depend on metallic conduit for the grounding connection.			X	X	X

[1] "X" indicates applicability to the specified Noise Class.

Terminal Block Location

Figures 13 and 14 (page 40) show the component identification and terminal strip location on the S-Flex 21 and S-Flex 212 enclosed drives. Table 10 on page 42 lists the wire size and terminal torque requirements.

Figure 13: Typical Component Identification and Terminal Strip Location (1–30 hp @ 208/230 Vac and 1–60 hp @ 460 Vac)

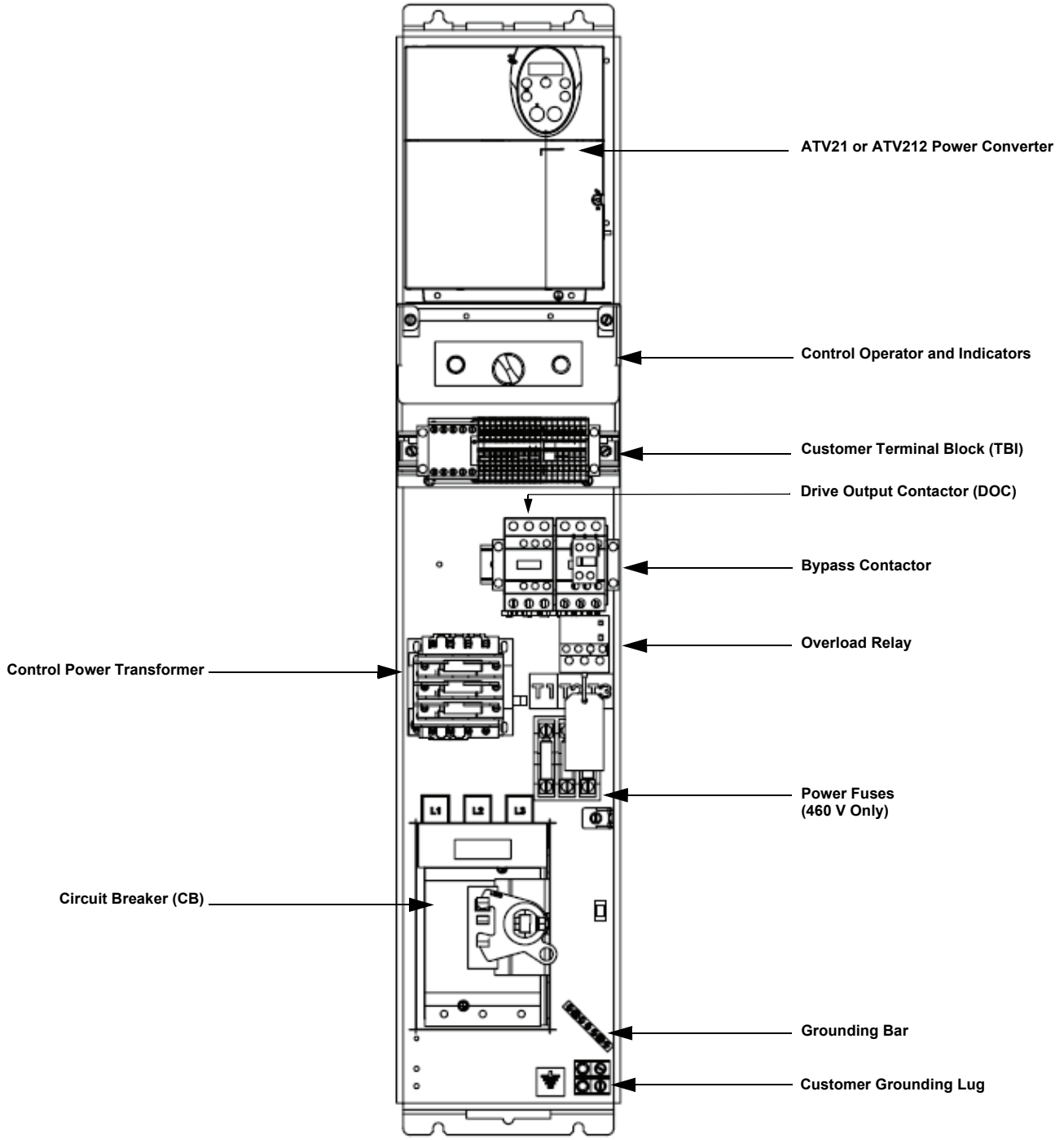
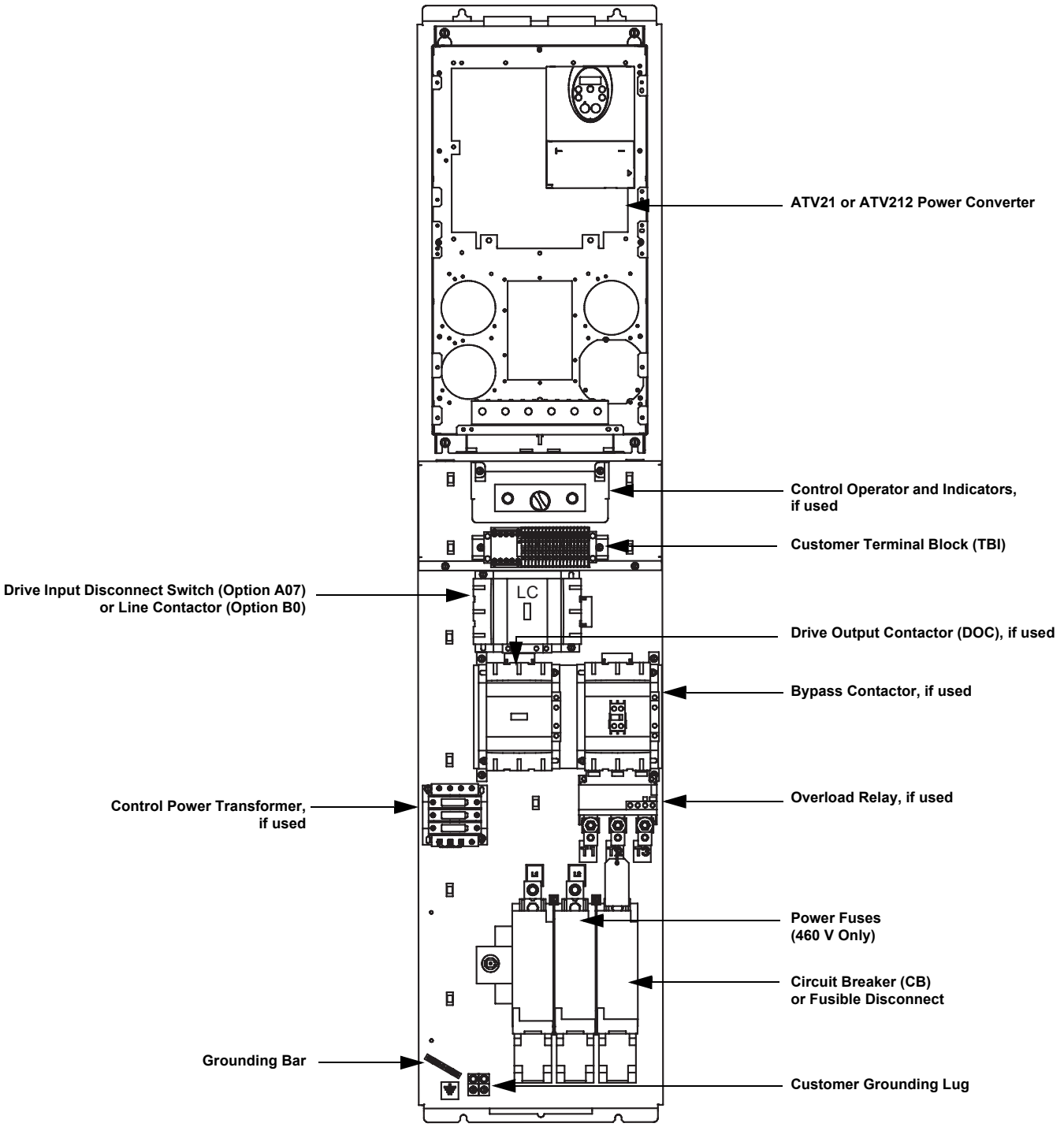


Figure 14: Typical Component Identification and Terminal Strip Location (40 hp @ 208/230 Vac and 75–100 hp @ 460 Vac)



Power Wiring

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- Some terminals have voltage on them when the disconnect is open.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm that power is off.
- Replace covers before turning on power to equipment.
- Refer to “Before You Begin” starting on page 8 for important safety messages and precautions.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

IMPROPER WIRING

- Do not connect input power leads to the drive output terminals (T1, T2, T3 or U, V, W). This damages the controller and voids the warranty.
- Check the power connections before energizing the controller.

Failure to follow these instructions can result in injury or equipment damage.

⚠ CAUTION

HEAT AND FIRE DAMAGE

Follow the torque requirements specified on the S-Flex controller nameplate.

Failure to follow these instructions can result in injury or equipment damage.

Table 9: Power Terminal Characteristics

Terminal	Function	Characteristics[1]
GND	Ground (to grounding lug on panel)	—
L1, L2, L3	Three-phase power supply (to top of circuit breaker)	208 Vac +/- 10% (SFD212G2• units) 230 Vac +/- 10% (SFD212G3• units) 460 Vac +/- 10% (SFD212G4• units)
T1/U, T2/V, T3/W	Output connections to motor (from overload relay or power converter terminals)	208 Vac +/- 10% (SFD212G2• units) 230 Vac +/- 10% (SFD212G3• units) 460 Vac +/- 10% (SFD212G4• units)

1 The "•" indicates that the catalog number can end in a "Y" (for an S-flex drive with full voltage bypass) or a "W" (for an S-Flex drive without bypass).

Table 10: Power Terminal Wire Range and Torque Requirements for FH Mag-Gard™ Circuit Breaker [1]

SFD21•••	Circuit Breaker L1, L2, L3 (Line)		Overload Relay T1, T2, T3 (Load–Power Circuit Y)		Power Converter U, V, W (Load–Power Circuit W or Motor Grounding Point)		Distribution Block T1, T2, T3 (Load–Power Circuit W)		GND Bar		GND Lug	
HP	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)
1–3 @ 208 V 1–3 @ 230 V 1–7.5 @ 460 V	#14–4 (2.1–21.1)	30 (4.00)	#14–#8 (2.1–8.4)	15 (1.69)	#14–#10 (2.1–6)	11.5 (1.30)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
5 @ 208 V 5 @ 230 V	#14–4 (2.1–21.1)	30 (4.00)	#14–#8 (2.1–8.4)	22.1 (2.50)	#12–#10 (3.3–6)	11.5 (1.30)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
10–15 @ 460 V	#14–4 (2.1–21.1)	30 (4.00)	#14–#8 (2.1–8.4)	22.1 (2.50)	#12–#6 (3.3–13.3)	22 (2.70)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
7.5–10 @ 208 V 7.5–10 @ 230 V	#14–1/0 (2.1–53.4)	80 (9.04)	#14–#8 (2.1–8.4)	22.1 (2.50)	#12–#6 (3.3–13.3)	22 (2.70)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
20 @ 460 V	#14–1/0 (2.1–53.4)	80 (9.04)	#14–#8 (2.1–8.4)	22.1 (2.50)	#8–#3 (8.4–26.7)	40.0 (4.50)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
15–25 @ 208 V 15–25 @ 230 V 25 @ 460 V	#14–1/0 (2.1–53.4)	80 (9.04)	#10–#2 (5.3–33.6)	100 (11.30)	#8–#3 (8.4–26.7)	40.0 (4.50)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
30–60 @ 460	#14–1/0 (2.1–53.4)	80 (9.04)	#10–#2 (5.3–33.6)	100 (11.30)	#8–1/0 (8.4–53.4)	212 (24.0)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)

Table 11: Power Terminal Wire Range and Torque Requirements for the PowerPact™ H Frame Circuit Breaker[1]

SFD21•••	Circuit Breaker L1, L2, L3 (Line)		Overload Relay T1, T2, T3 (Load–Power Circuit Y)		Power Converter U, V, W (Load–Power Circuit W or Motor Grounding Point)		Distribution Block T1, T2, T3 (Load–Power Circuit W)		GND Bar		GND Lug	
HP	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)	AWG (mm^2)	lb-in (N•m)
1–3 @ 208 V 1–3 @ 230 V 1–7.5 @ 460 V	#14–#10 (2.1–6)	50 (5.65)	#14–#8 (2.1–8.4)	15 (1.69)	#14–#10 (2.1–6)	11.5 (1.30)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
5 @ 208 V 5 @ 230 V	#14–#10 (2.1–6)	50 (5.65)	#14–#8 (2.1–8.4)	22.1 (2.5)	#12–#10 (3.3–6)	11.5 (1.30)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
7.5–10 @ 208 V 7.5–10 @ 230 V 10–15 @ 460 V	#8–#1 (8.4–42.4)	120 (13.56)	#14–#8 (2.1–8.4)	22.1 (2.5)	#12–#6 (3.3–13.3)	22 (2.70)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
20 @ 460 V	#8–#1 (8.4–42.4)	120 (13.56)	#14–#8 (2.1–8.4)	22.1 (2.5)	#8–#3 (8.4–26.7)	40 (4.50)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
15–25 @ 208 V 15–25 @ 230 V 25 @ 460 V	#8–#1 (8.4–42.4)	120 (13.56)	#10–#2 (5.3–33.6)	100 (11.3)	#8–#3 (8.4–26.7)	40 (4.50)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
30 @ 208 V 30 @ 230 V	#8–1/0 (8.4–53.4)	120 (13.56)	#10–#1 (5.3–42.4)	100 (11.3)	#8–1/0 (8.4–53.4)	212 (24.0)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
30–60 @ 460 V	#8–1/0 (8.4–53.4)	120 (13.56)	#10–#2 (5.3–33.6)	100 (11.3)	#8–1/0 (8.4–53.4)	212 (24.0)	—	—	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
40 @ 208 V	#8–3/0 (8.4–53.4)	120 (13.56)	#6–#3/0 (13.3–85)	160 (18.07)	#3–300 MCM (26.7–150)	212 (24.0)	#10–350 MCM (6–177)	250 (28.3)	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
40 @ 230 V	#8–3/0 (8.4–53.4)	120 (13.56)	#10–#1 (5.3–42.4)	100 (11.3)	#3–300 MCM (26.7–150)	212 (24.0)	#10–350 MCM (6–177)	250 (28.3)	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
75 @ 460 V	#6–3/0 (13.3–85)	200 (22.6)	#10–#1 (5.3–42.4)	100 (11.3)	#3–300 MCM (26.7–150)	363 (41.0)	#10–350 MCM (6–177)	250 (28.3)	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)
100 @ 460 V	#6–3/0 (13.3–85)	200 (22.6)	#6–3/0 (13.3–85)	160 (18.07)	#3–300 MCM (26.7–150)	363 (41.0)	#10–350 MCM (6–177)	250 (28.3)	#14–4 (2.1–21.1)	35 (3.95)	#14–1/0 (2.1–53.4)	100 (11.30)

NOTE: For wire sizes in the range of 14–10 AWG, the required torque for the PowerPact H Frame CB is 50 lb-in. For wire sizes larger than 10 AWG, the required torque for the PowerPact H Frame CB is 120 lb-in.

1 See Figures 18 and 19 on page 52 for circuit breaker identification.

Control Wiring

Connect the control wiring to the bottom portion of the terminal block TB1. See Figure 15.

Each terminal is rated for one wire, 24–16 AWG (0.25 –1.5 mm^2). Torque the terminal screws to 5.3–7.1 lb-in (0.6–0.8 N•m). The customer terminals are designated on the wiring diagrams in this instruction bulletin. See Figure 22 on page 63.

Figure 15: Bypass Power Circuit Y

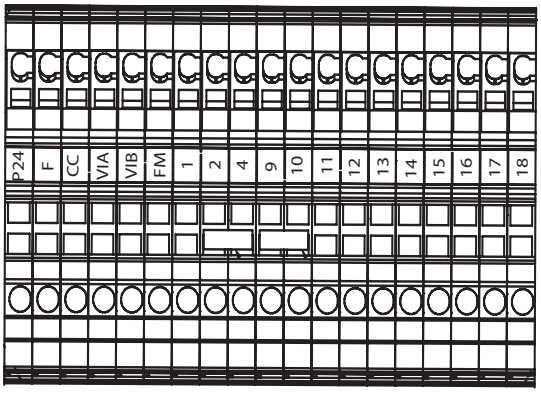


Table 12: TB1 Customer Terminal Connections

Function	Description	Customer Terminals (see Figure 15)	
Auto Start Contact	AFC Mode Run Input	P24	F
0–10 Vdc Input	AFC Speed Reference	VIB	CC
4–20 mA or 0–10 Vdc Input	AFC Speed Reference[1]	VIA	CC
Analog Output Signal	Configurable	FM[1]	CC
Smoke Purge Relay Disable	Add Jumper	1	2
Freeze/Firestat	Remove Jumper / Add Interlock	2	4
Smoke Purge Relay Disable	Remove Jumper	9	10
AFC Run Auxiliary Contact	Closes with AFC Running Motor[1]	11	12
Bypass Run Auxiliary Contact	Closes with Bypass Running Motor	13	14
AFC Detected Fault Auxiliary Contact	Closes on AFC Detected Fault	15	16
Smoke Purge Relay Coil	120 Vac to Energize Coil	17	18

[1] Factory set for current control.
To change the input VIA to voltage control, see *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.

Figure 16: Non-Bypass Power Circuit W

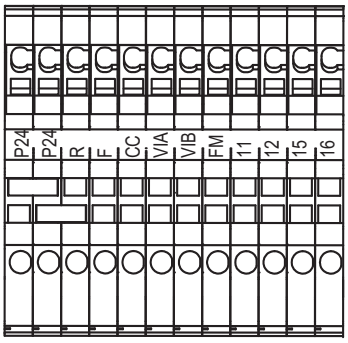


Table 13: TB1 Customer Terminal Connections for Controllers Without Bypass

Function	Description	Customer Terminals (see Figure 16)	
Auto Start Contact	AFC Mode Run Input	P24	F
Freeze/Firestat	Remove Jumper / Add Interlock	P24	R
0–10 Vdc Input	AFC Speed Reference	VIB	CC
4–20 mA or 0–10 Vdc Input	AFC Speed Reference[1]	VIA	CC
Analog Output Signal	Configurable	FM[1]	CC
AFC Run Auxiliary Contact	Closes with AFC Running Motor[1]	11	12
AFC Detected Fault Auxiliary Contact	Closes on AFC Detected Fault	15	16

[1] Factory set for current control.
To change the input VIA to voltage control, see *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.

Keypad Operation

Integrated Keypad

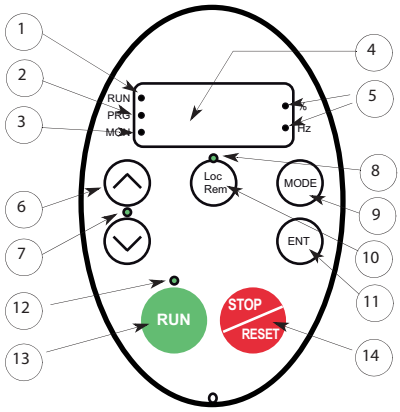


Table 14: Integrated Keypad Features[1]

	LED/Key	Characteristics
1	Display RUN LED	Illuminates when a run command is applied to the drive. Flashes when there is a speed reference present with a Run command.
2	Display PRG LED	Illuminates when Programming mode is active. Flashes when programming parameters within menus (for example AUH, AUF, GrU, I0, or COM).
3	Display MON LED	Illuminates when Monitoring mode is active. Flashes in trip history display mode.
4	Display unit	4 digits, 7 segments
5	Display unit LED	The % LED illuminates when a displayed numeric value is a percentage. The Hz LED illuminates when a displayed numeric value is in hertz.
6	UP/DOWN keys	Depending on the mode, you can use the arrows to: Navigate between the menus Change a value Change the speed reference when the UP/DOWN LED (7) is illuminated.
7	UP/DOWN LED	Illuminates when the navigation arrows are controlling the speed reference.
8	Loc/Rem LED	Illuminates when Local mode is selected.
9	MODE	Press to select the embedded keypad mode. • Run mode (default on power-up) • Programming mode • Monitoring mode Can also be used to go back to the previous menu.
10	Loc/Rem	Switches between Local and Remote modes.
11	ENT	Press to display a parameter's value or to save a changed value.
12	RUN LED	Illuminates when the Run key is enabled.
13	RUN	Pressing this key when the RUN LED is illuminated starts the drive.
14	STOP	Stop/reset key. In Local mode, pressing the STOP key causes the drive to stop based on the setting of parameter [Loc. mot stop mode] (F 12 1). In Remote mode, pressing the STOP key causes the drive to stop based on the setting of parameter [Ext. fault stop Mode] (F 6 0 3). The display will indicate a flashing "E". To reset the drive, cycle the power. If [HMI reset button] (F 13 5) is set to 0 (default setting), pressing the STOP key twice will reset all the resettable detected faults if the trip condition has been resolved.

1 An optional graphic keypad is also available by selecting option D07. See page 46.

Graphic Keypad Option (D07)

The graphic keypad, with FLASH V1.1IE26 or higher, displays more detailed information than can be shown on the integrated keypad.

1 Graphic display

2 Function keys
F1: Code
F2 and F3: not assigned
F4: Loc/Rem

3 STOP/RESET key

4 RUN key

7 ESC key: Press to select the graphic keypad mode.

- — Run mode (default on power-up)
- — Programming mode
- — Monitoring mode

Can also be used to go back to the previous menu.

6 FWD/REV key: Press to reverse the direction of rotation of the motor

5 Jog dial:

- Press (ENT):
  - — To save the current value
  - — To enter the selected menu or parameter
- Turn +/-:
  - — To increase or decrease a value
  - — To go to the next or previous line
  - — To increase or decrease the reference if control via the graphic keypad is activated

NOTE: Keys **3**, **4**, **5** and **6** can be used to control the drive directly, if control via the graphic keypad is activated.

Initial Start-up Procedure

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand this manual before installing or operating the S-Flex 21 or S-Flex 212 drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- Some terminals have voltage on them when the disconnect is open.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- Before servicing the drive:
  - — Disconnect all power including external control power that may be present.
  - — Place a “DO NOT TURN ON” label on all power disconnects.
  - — Lock all power disconnects in the open position.
  - — WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the DC Bus Voltage Measurement Procedure on page 36 to verify that the DC voltage is less than 42 V. The drive LED is not an indicator of the absence of DC bus voltage.
- Install and close all covers and doors before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNQUALIFIED PERSONNEL

- This equipment must be installed and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting requiring electrical conductors to be energized must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards – 29 CFR Part 1910 Subpart S Electrical.

Failure to follow these instructions will result in death or serious injury.

The S-Flex drive has been configured for the installed options and tested at the factory. Minor adjustments to complete the field installation may be required based upon the application requirements. Follow this initial start-up procedure step by step.

With all incoming power removed, make the following equipment checks:

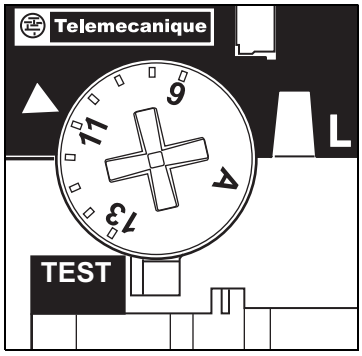
1. Verify that all equipment disconnects are open.
2. Set the AFC-Off-Bypass switch (if used) to Off.
3. Wait 15 minutes, then perform the “DC Bus Voltage Measurement Procedure” described on page 36.

4. Open the enclosure door. To open the door, turn the handle assembly to the Off position.
5. Check the wiring of the input power ground and the motor ground.
6. Ensure that the motor conductors are wired to the T1, T2, and T3 terminals of the overload relay.

   NOTE: When using the bypass circuit, ensure that the motor conductors are wired to the T1, T2, and T3 terminals of the overload relay. When using the power circuit without bypass, ensure that the motor conductors wired to T1/U, T2/V, and T3/W of the controller, or T1, T2, and T3 of the distribution block.

7. If the controller includes a bypass option for running the motor across the line, set the Overload Relay dial (on the load side of the bypass contactor) to the full load ampere rating (FLA) listed on the nameplate of the connected motor. See Figure 17.

Figure 17: Overload Relay Dial



NOTE: The LR2D1516 overload relay is shown. Your dial setting range may be different. Refer to Table 15 on page 53 for range of adjustment.

8. Using a voltmeter set at the 1000 Vac scale, verify that the incoming line voltage at the line side of the disconnecting means is within ± 10% of the input voltage rating on the controller nameplate.
9. When supplied with a Drive Input Disconnect Switch, confirm that the switch is in the On position.
10. Close and secure the enclosure door. Close the equipment disconnect means. The Power On pilot light illuminates (if used for Bypass Power Circuit Y).

    This drive does not provide direct thermal protection for the motor. Consult the motor manufacturer for the thermal capability of the motor when operated over the desired speed range.

⚠ CAUTION

MOTOR OVERHEATING HAZARD

Use a thermal sensor in the motor as required by the motor manufacturer to facilitate overheating protection at all speeds and load conditions.

Failure to follow these instructions can result in injury or equipment damage.

11. Adjust the full load current setting as follows:

    Programming by 7-Segment LED

    — Press the MODE key on the integrated display terminal until the PRG LED is illuminated and the display shows AUF. Press the ENT key once, then press the DOWN arrow key until tHr is displayed.

    — Press the ENT key, then use the UP and DOWN arrow keys to adjust the setting to match the full load current listed on the motor nameplate.

    — Press the ENT key to save the setting, and press the MODE key three times to return to the original menu.

    Programming by Graphic Keypad

    — Press the ESC key until the PROGRAMMING MENU is displayed, turn the Jog dial until QUICK MENU (AUF) is highlighted. Press the Jog dial once, then turn the Jog dial until MOTOR THERMAL PROT. (tHr) is highlighted.

    — Press the Jog dial once to adjust the setting to match the full load current on the motor nameplate.

    — Press the Jog dial once to save the setting. Press the ESC key to exit to the PROGRAMMING MENU.

    NOTE: The settings listed in this procedure are suitable for most applications. If your application requires different operating characteristics, refer to the *Altivar® 21 Programming and Operation Guide,* 30072-451-63*,* or *Altivar 212 Programming and Operation Guide*, S1A53838, for more information.

⚠ WARNING

HAZARDOUS MOVING PARTS

Before starting the drive, ensure that the motor and its connected load are clear of personnel and are ready to run.

Failure to follow these instructions can result in death or serious injury.

12. Set the AFC-Off-Bypass selector switch (if used) to AFC. Check the direction of motor rotation. If correct, proceed to Step 17. If incorrect, turn the AFC-Off-Bypass selector switch back to Off or press STOP on the power converter control keypad.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Turn off all power supplying this equipment.
- Wait 15 minutes.
- Perform the“DC Bus Voltage Measurement Procedure” on page 36 before proceeding.

Failure to follow these instructions will result in death or serious injury.

13. Correct the direction of motor rotation by reversing any two motor leads connected to the controller output (see Step 6, page 48).

14. Close and secure the enclosure door. Close the equipment disconnect means. The Power On pilot light illuminates.
15. Set the AFC-Off-Bypass selector switch to AFC. Check the direction of motor rotation. If correct, this completes the controller mode, motor rotation check. For Non-Bypass Power Circuit W, skip to Step 20.
16. Set the AFC-Off-Bypass selector switch to Off.
17. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If the direction of motor rotation is correct, proceed to Step 20. If incorrect, stop the drive. **Remove all power!**

    NOTE: If the controller circuit breaker trips during this test, a higher trip setting may be required. Refer to “Adjusting Mag-Gard or PowerPact Magnetic Trip Setting” on page 51.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Turn off all power supplying this equipment.
- Wait 15 minutes.
- Perform the “DC Bus Voltage Measurement Procedure” on page 36 before proceeding.

Failure to follow these instructions will result in death or serious injury.

18. Correct the direction of motor rotation by reversing any two incoming leads to the circuit breaker disconnect means marked L1, L2, or L3.
19. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If correct, this completes the bypass mode motor rotation check.
20. Adjust the High Speed (UL) Setting as follows:

    Programming by 7-Segment LED

    Check the High Speed (UL) setting (maximum motor speed). Press the MODE key until AUF is displayed, then press the ENT key. Using the UP and DOWN arrow keys, scroll to UL, then press the ENT key. Use the UP and DOWN arrow keys to adjust the maximum output frequency for the required application (factory default is 60 Hz), then press the ENT key. The controller UL setting is now complete.

    Programming by Graphic Keypad

    Check the High Speed (UL) setting (maximum motor speed.) Press the ESC key until PROGRAMMING MENU is displayed and turn the dial until QUICK MENU (AUF) is highlighted, then press the Jog dial. Turn the Jog dial until UPPER LIMIT FREQ (UL) is highlighted, then press the Jog dial. Turn the Jog dial to adjust the maximum output frequency for the required application (factory default is 60 Hz), then press the Jog dial once to save the setting.

    Refer to the *Altivar® 21 Programming and Operation Guide,* 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.

21. Adjust the Low Speed (LL) Setting as follows:

    Programming by 7-Segment LED

    Check the Low Speed (LL) setting (minimum motor speed). Continuing from Step 20 above, using the UP and DOWN arrow keys, scroll to LL, then press the ENT key. Use the UP and DOWN arrows keys to adjust the minimum output frequency for the required application (preset value is 15 Hz; factory default is 0 Hz), then press the ENT key. The controller LL setting is now complete. Press the MODE key three times to return to the original menu.

    Programming by Graphic Keypad

    Check the Low Speed (LL) setting (minimum motor speed). Continuing from Step 20 above, turn the Jog dial until LOW LIMIT FREQUENCY (LL) is highlighted, then press the Jog dial. Turn the Jog dial to adjust the minimum output frequency for the required application (preset value is 15 Hz; factory default is 0 Hz), then press the Jog dial once to save the setting. The controller LL setting is now complete. Press the ESC to return to the MAIN MENU.

    Refer to the *Altivar® 21 Programming and Operation Guide,* 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.

22. The application may require changing the setting of acceleration (ACC) and deceleration (dEC) times. The preset value is 60 seconds. If the power converter has been replaced or reset to the factory default, the value is model dependent. Refer to the *Altivar® 21 Programming and Operation Guide,* 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838, for information about the settings.

Adjusting Mag-Gard or PowerPact Magnetic Trip Setting

The adjustable magnetic trip setting is factory-set at Lo for Mag-Gard Motor Circuit Protectors. For PowerPact Motor Circuit Protectors, the Full Load Amp (FLA) Setting is factory set to the lowest position and the Instantaneous Trip Setting (Im) is factory set to the Auto 1 position. These settings may have to be adjusted for proper motor start-up. For both Mag-Gard and PowerPact Motor Circuit Protectors, refer to the magnetic trip setpoint limits outlined in the applicable national standards. For PowerPact Motor Circuit Protectors, also refer to the *PowerPact Motor Circuit Protector Settings* instruction bulletin (48940-260-01) shipped with the equipment. Some units include thermal-magnetic circuit breakers which do not require any adjustment.

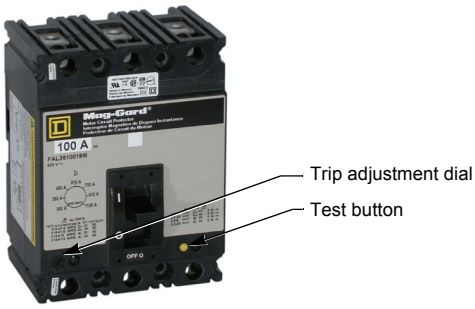
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

Figure 18: FH Mag-Gard Circuit Breaker Trip Adjustment



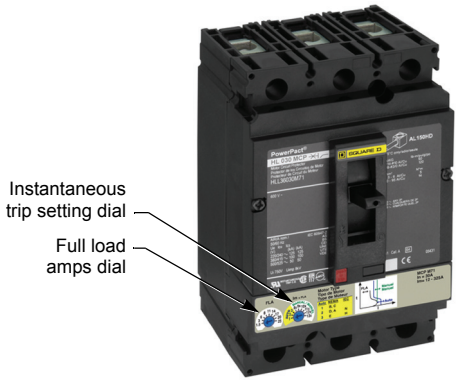
To access the Trip Adjustment dial on the FH Mag-Gard circuit breaker (if included):

1. Turn off all power supplying this equipment before working on or inside the equipment, and follow lockout/tagout procedures. Always use a properly rated voltage sensing device to confirm the power is off.
2. Place the unit handle in the Off position and open the door.

After obtaining the motor full load current from the motor nameplate, select an adjustable trip setpoint to test start the motor. Further adjustments may be required because of motor load characteristics. Refer to applicable national standards for permissible setpoints.

After adjusting the trip setting, reset the circuit breaker by moving the disconnect handle to the On position and then to the Off position.

Figure 19: PowerPact Circuit Breaker Trip Adjustment



To access the Instantaneous Trip Setting (Im) and Full Load Amps (FLA) dials on the PowerPact circuit breaker (if included):

1. Turn off all power supplying this equipment before working on or inside the equipment, and follow lockout/tagout procedures. Always use a properly rated voltage sensing device to confirm the power is off.
2. Place the unit handle in the Off position and open the door.
3. To set the FLA and Im dials, refer to the PowerPact Motor Circuit Protector Settings instruction bulletin (48940-260-01) shipped with the equipment.

NOTE:

- *These circuit breakers are suitable for motors with locked-rotor indicating code letters based on applicable national codes and standards. For other motors, consult your local Schneider Electric field sales representative.*
- *A fusible disconnect is provided with the 75 hp and 100 hp, 460 V drives instead of a circuit breaker.*

Fusible Disconnect

Due to wire routing you may need to disconnect the motor power conductors to access the fuses. When replacing fuses, torque fuse bolts to 275 lb-in (31.1 N•m).

Overload Relay Adjustment

Always verify that the overload relay setting does not exceed the motor full load current or rated controller current found on the S-Flex nameplate, whichever is less.

Table 15 provides the range of adjustment provided for overload relays according to horsepower rating and voltage. Contact the factory if the overload relay range or adjustment does not meet the intended application.

Table 15: Overload Relay Adjustment Range

HP	208 V	230 V	460 V
1	4–6	4–6	1.6–2.5
2	5.5–8	5.5–8	2.5–4
3	9–13	7–10	4–6
5	12–18	12–18	7–10
7.5	23–32	16–24	9–13
10	23–32	23–32	12–18
15	37–50	37–50	16–24
20	48–65	48–65	23–32
25	63–80	63–80	30–40
30	80–104	80–104	30–40
40	90–150	95–120	48–65
50	—	—	63–80
60	—	—	63–80
75	—	—	95–120
100	—	—	90–150

Section 4 —Operation

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Read and understand the precautions in “Before You Begin” starting on page 8 before performing the procedures in this section.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

Before operating the S-Flex 21 or S- Flex 212 enclosed drives:

- Read and understand instruction bulletins 30072-451-61 and 30072-451-63 (S-Flex 21) or instruction bulletins S1A53832 and S1A53838 (S-Flex 212) before changing any parameters from the factory defaults. See page 7 for list of instruction bulletins and information for obtaining them.
- Refer to Table 16 on page 56 for parameter setting sequence.
- If the power converter is re-initialized using the total or partial factory setting function, the power converter must be reprogrammed to the values listed in Table 16 on page 56.
- If the power converter or the main control board of the power converter is replaced, the power converter must be reprogrammed according to the programming instructions in Table 16 on page 56.

Failure to follow these instructions can result in death, or serious injury.

Programming the Power Converter

The Altivar 21 and Altivar 212 power converters are factory configured as shown in Table 16. Be sure to configure the power converter’s motor full-load current as shown on the motor nameplate. For additional programming information, see the *Altivar® 21 Quick Start Guide*, 30072-451-90, or the *Altivar 212 Programming and Operation Guide*, S1A53838, supplied with drive.

⚠ WARNING

LOSS OF CONTROL

Changes to factory set parameters must be completed in the sequence of appearance in Table 16 on page 56.

Failure to follow these instructions will result in death, serious injury, or equipment damage.

Changes to factory settings must be completed in the sequence of appearance in Table 16.

Table 16: Power Converter Factory Configuration (*change factory set parameters according to table sequence)*

Parameter	Name	Unit	Description	Factory Setting	Customer Setting
tYP	Parameter reset type	—	60 Hz	2	
AU1	Auto ramp adaptation	—	Disable auto ramp	0	
ACC	Acceleration time 1	seconds	Acceleration time	60	
dEC	Deceleration time 1	seconds	Deceleration time	60	
UL	High speed	Hz	High speed	60	
LL	Low speed	Hz	Low speed	15	
uLu	Motor rated voltage	V	230/208 V models	230/208	
			460 V models	460	
Pt	Motor control mode	—	Variable torque	1	
tHr	Motor rated current overload	A	Overload setting	100% of the drives' output rating	
AU4	Macro programming See *Macro Programming* in the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.	—	Run permissive	1	
r130	RC/RYC – RY/RYA relay primary function See *Relay Output Function* in the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.	—	Drive running	14	
r132	FL relay function See *Relay Output Function* in the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.	—	Inversion of relay	11	
F201	VIA speed reference level	%	4 mA minimum	20	
F605	Output phase failure detection	—	Disabled	0	
F692	Analog output bias	%	4 mA minimum	20	

Additional Factory Programming Configuration for Options A06, B06, C06, and DO6

Parameter	Name	Unit	Description	Factory Setting	Customer Setting
F829	Protocol	—	BACnet (A06)	4	
			LonWorks® (B06)	1	
			Metasys® N2 (C06)	2	
			Apogee™ P1 (D06)	3	
CMOd	Remote mode start/stop control source	—	Serial Communication	2	
FMOd	Remote mode primary speed reference source	—	Serial Communication	4	

Adjustments to the Factory Programming Configuration to Allow Serial Communication Control Through the Modbus RJ-45 port

Parameter	Name	Unit	Description	Factory Setting	Customer Setting
CMOd	Remote mode start/stop control source	—	Serial Communication	2	
FMOd	Remote mode primary speed reference source	—	Serial Communication	4	
F829	Protocol	—	Modbus	1	

Adjustments to the Factory Programming Configuration to Allow Monitoring Only Through Options A06, B06, C06, D06

Parameter	Name	Unit	Description	Factory Setting	Customer Setting
CMOd	Remote mode start/stop control source	—	Terminals	0	
FMOd	Remote mode primary speed reference source	—	VIB	2	
r108	Always active logic function	—	Forced local	48	

Power Circuit Y with Full Voltage Bypass

For power circuit Y with full voltage bypass, the S-Flex 21 and S-Flex 212 enclosed drives operate either by the power controller or at full-speed, full-voltage bypass. You can run the motor in bypass mode in the unlikely event that the power converter becomes inoperative.

The S-Flex 21 and S-Flex 212 enclosed drives consist of:

- An IEC-rated drive output and bypass contactor with electrical interlock and Class 10 overload relay
- A 120 Vac control power transformer (CPT)
- A Square D™ brand circuit breaker disconnect or fusible disconnect with the ability to lock in the open position
- An AFC-Off-Bypass switch
- A power converter

Always verify that the overload relay is set to the motor full load current.

Power Circuit W Without Bypass

For power circuit W without bypass, the S-Flex 21 and S-Flex 212 enclosed drives operate by the power controller only. This power circuit consists of a circuit breaker disconnect with means for locking in the open position, power convertor, and optional equipment as specified.

Operator Controls – General Arrangement and Operation

Operator controls are located on the front of the power converter and the control rail for Bypass Power Circuit Y. AFC-Off-Bypass switch and indicators are not supplied with Non-Bypass Power Circuit W.

The AFC-Off-Bypass switch allows selection of power converter operation of the motor (AFC position) or line power operation of the motor (Bypass position).

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

Before turning on the drive or upon exiting the configuration menus, ensure that the inputs assigned to the Run command are in a state that will not cause the drive to run. Otherwise, the motor can start immediately.

Failure to follow these instructions will result in death, or serious injury.

AFC Operation

AFC operation allows control of the motor with the power converter. To set the S-Flex drive to AFC operation, close the controller disconnect switch located on the front of the drive and place the AFC-Off-Bypass switch (if used) in the AFC position.

The power converter can be operated either locally or remotely depending on the Loc/Rem key setting (integrated keypad) or F4 key setting (graphic keypad). When using the integrated keypad, if the green LED above the Loc/Rem key is illuminated, the power converter is operating in local mode. When the green LED is not illuminated, the power converter is operating in remote mode. When using the graphic keypad, LOCAL or REMOTE is displayed above the F4 key.

- In local mode, the keypad Run and Stop keys can be used to start and stop the drive. Speed can be adjusted by pressing the UP and DOWN arrows on the integrated keypad, or by turning the Jog dial on the graphic keypad. The speed displays as output frequency in hertz.
- In remote mode, a run command and the speed reference signals can be sent to the power converter using either the logic input terminals or a serial communication network.
  - — **Control through the logic input terminals** is the default factory setting when no communication options are selected. Start/stop functionality is available through the user-supplied auto start contact between TB1–P24 and TB1–F. Adjustable speed reference signals are sent through the analog input terminals VIA or VIB. The speed displays as output frequency in hertz.

    The RJ-45 Modbus port is configured for monitoring only as a factory default. See Table 16 on page 56 for Modbus control information.
  - — **Control through serial communication** is the default factory setting when a communication option is selected. The power converter responds to the run command and speed reference signals over the serial communications network. See Table 16 on page 56 for information about monitoring only through serial communications.

    The RJ-45 Modbus port is occupied when graphic keypad (D07) is selected.

Bypass Operation	Bypass operation allows control of the motor with line power. To set the S-Flex drive to bypass operation, close the controller disconnect switch located on the front of the drive and place the AFC-Off-Bypass switch in the Bypass position. This transfers motor operation to line power, full speed operation. Moving the selector switch to the Off position opens the bypass contactor and stops the motor.
Freeze/Firestat Interlocks (If Used)	Terminals TB1-2 and TB1-4 accept a user-supplied, normally-closed (N.C.), freeze/firestat interlock. Remove the factory-installed jumper from the terminals before installing the interlock. If the connection between terminals TB1-2 and TB1-4 is open, the drive output contactor and the drive bypass contactor will open and cause the motor to coast. This feature can be used in conjunction with freeze sensors or in a firestat control system in accordance with NFPA (National Fire Protection Association) and local codes.
Pilot Lights	Pilot lights visually indicate protective functions and circuit status. The LED ratings for the pilot lights is 120 Vac. The functions of the two pilot lights are: • Power On (red): illuminates when the drive disconnect is turned on. When pilot lights are not supplied, Power On is indicated by illumination the of power convertor display. • Bypass Run (green): illuminates while the drive is operating in bypass mode. Pilot Lights are not available with Non-Bypass Power Circuit W.
Smoke Purge Function (Fireman's Override)	Provides a smoke purge operating mode which is controlled by a user-supplied, 120 Vac signal applied between terminals TB1–17 and TB1–18. Supplying 120 Vac to TB1–17 and TB1–18 transfers the motor operation to line power (if not operating in this mode already). This feature can be used in powered, smoke extract systems designed in accordance with NFPA and local codes. To disable the smoke purge function, remove the jumper between terminals TB1–9 and TB1–10 and install the jumper on terminals TB1–1 and TB1–2. The Smoke Purge Function is not available with Non-Bypass Power Circuit W.
Auxiliary Drive Run Contact	Provides a normally-open (N.O.) contact between terminals TB1–11 and TB1–12 that closes when the motor is running in drive mode. Not available with communications options.
Auxiliary Bypass Run Contact	Provides an N.O. contact between terminals TB1–13 and TB1–14 that closes when the bypass contactor is closed and the motor is running in bypass mode.
Auxiliary Detected Fault Contact	Provides an N.C. contact between TB1–15 and TB1–16. Upon successful converter start-up, the contact will open and remain open until the drive detects a fault or is powered down.

Options

MOD A06 – BACnet	The equipment comes pre-programmed for interface with BACnet communication protocol. For SFD21 drives, a BACnet serial communications card is installed, VW3A21315.
MOD B06 – LonWorks	The equipment comes pre-programmed for interface with LonWorks communication protocol. For SFD21 drive, a LonWorks serial communication card is installed VW3A21312. For SFD212 drive, a LonWorks serial communication card is installed VW3A21212.
MOD C06 – Metasys N2	The equipment comes pre-programed for interface with Metasys N2 communication protocol. For SFD21 drives, a Metasys N2 serial communications card is installed, W3A21313.
MOD D06 – Apogee P1	The equipment comes pre-programed for interface with Apogee P1 communication protocol. For SFD21 drives, an Apogee P1 serial communications card is installed, W3A21314.
MOD N06 – ModBus	The drive provides factory standard ModBus communications.
MOD S07 – Seismic Qualified	This option supplies a certification label indicating that the enclosure is qualified with seismic rating AC156 acceptance criteria test protocol with an importance factor of 1.5. Refer to *Seismic Qualification Mounting Criteria* on page 29.
MOD A07 – Drive Input Disconnect Switch	This option provides an input line power disconnect switch between the mains power disconnect and the power converter. The Drive Input Disconnect Switch will disconnect line power to the power converter. The motor can run in bypass mode in the unlikely event the power converter becomes inoperative.
MOD B07 – Line Contactor	This option provides an electrically interlocked line contactor between the mains power disconnect and the power converter. When the drive is in bypass mode, the line contactor disconnects line power from the power converter. **NOTE:** Options A07 Drive Input Disconnect and B07 Line Contactor are available only when full voltage bypass option (Y05) is selected. Options A07 and B07 are mutually exclusive.
Mod D07 – Remote Graphic Keypad	This option provides a full-text door mounted graphic keypad with eight language options. With the graphic keypad, it is possible to display more detailed information than can be shown on the integrated keypad.

Figure 20: Full Voltage Bypass Package, Power Circuit Y

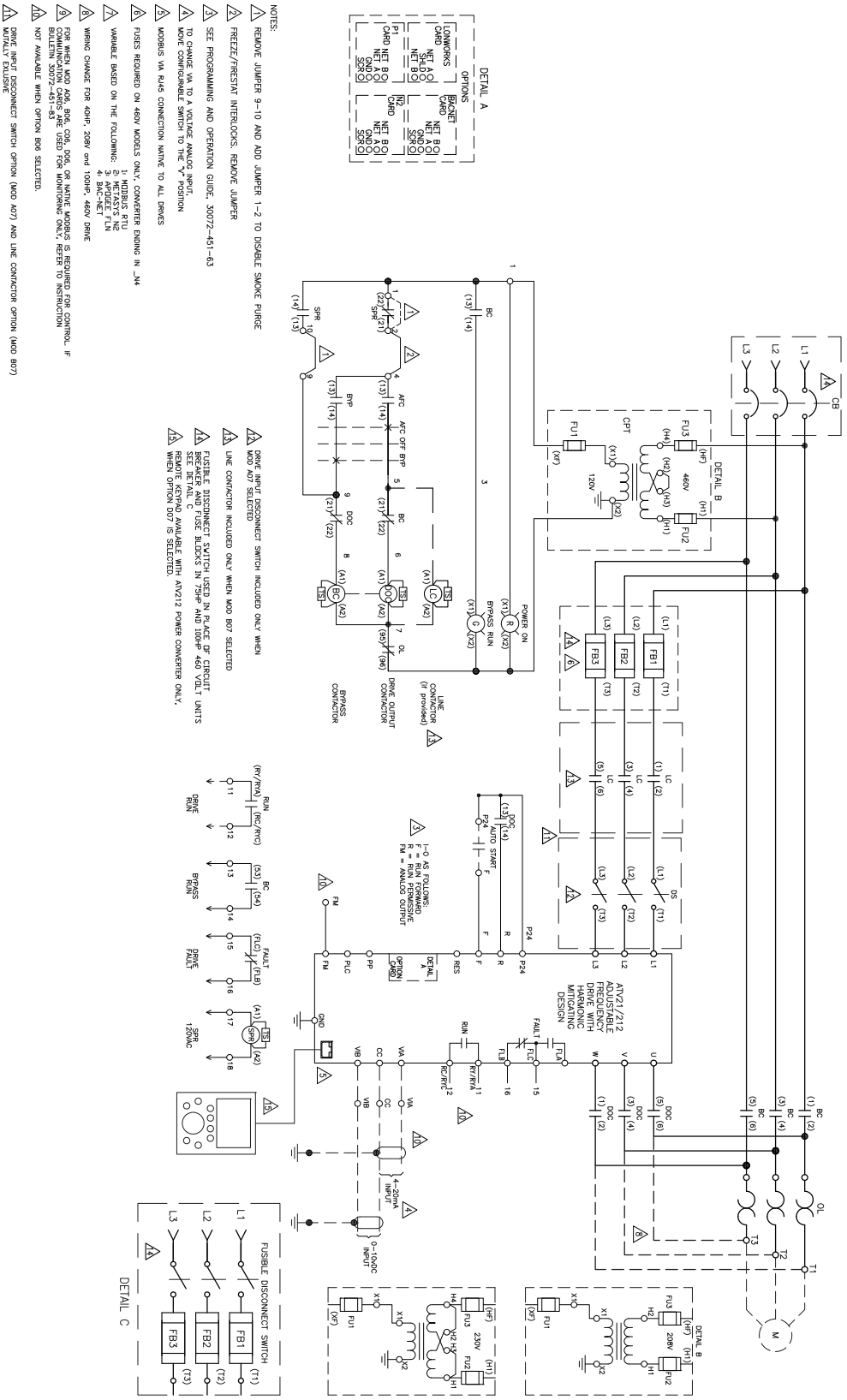
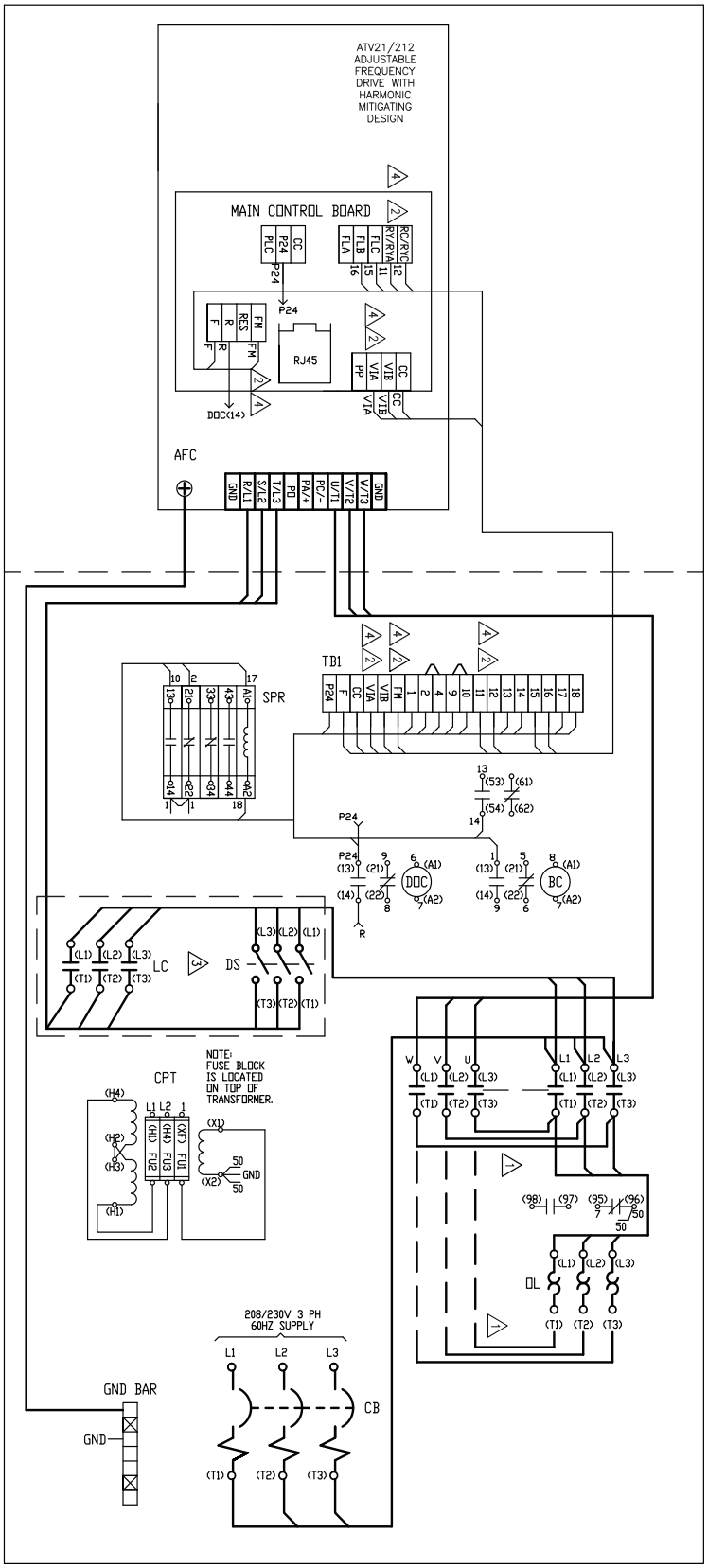
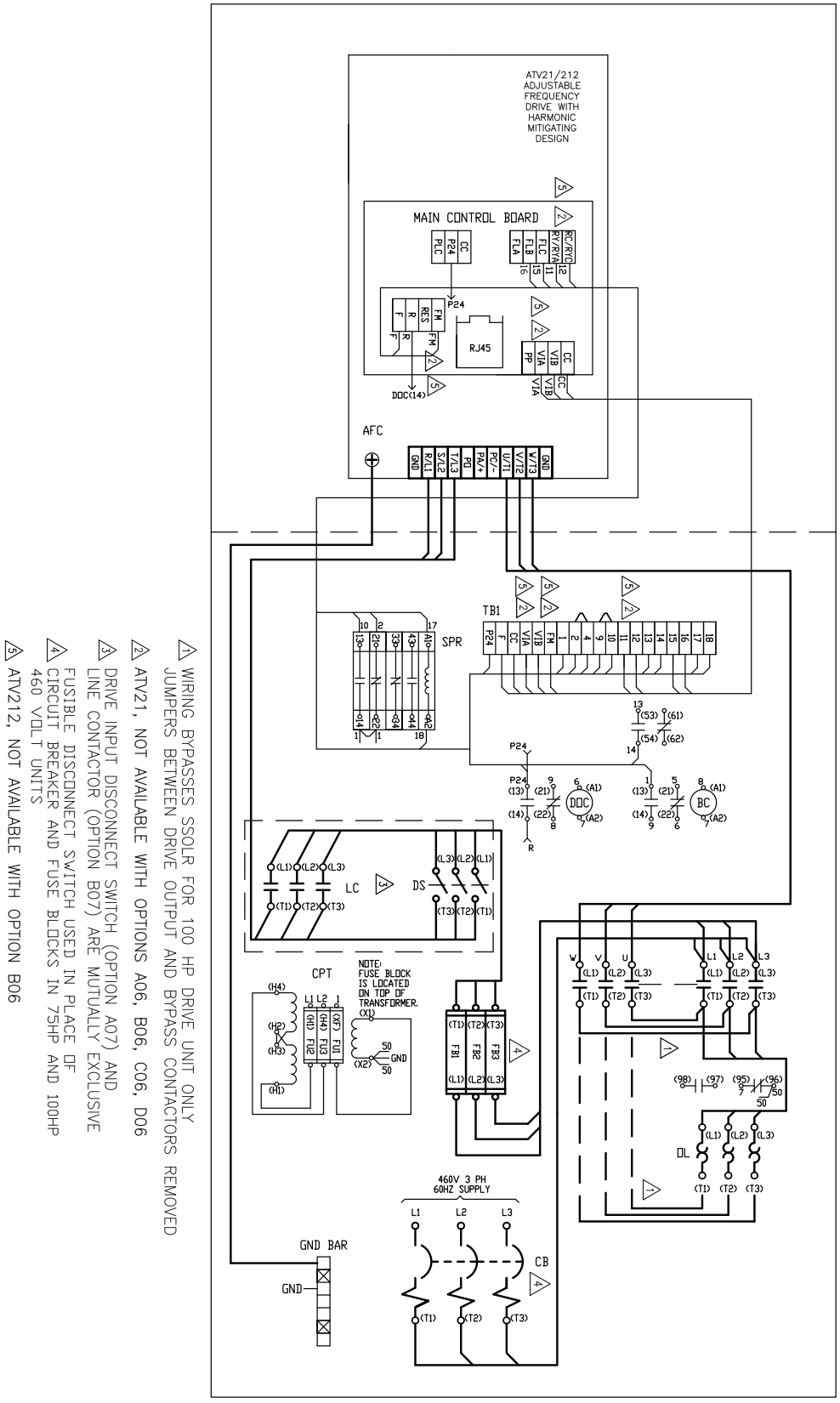


Figure 21: Power Circuit Y Full Voltage Bypass Package, 208 V and 230 V



1. WIRING BYPASSES SSOLR FOR 40 HP, 208V DRIVE UNIT ONLY, JUMPERS BETWEEN DRIVE OUTPUT AND BYPASS CONTACTORS REMOVED
2. FOR ATV21, NOT AVAILABLE WITH OPTIONS A06, B06, C06, D06
3. DRIVE INPUT DISCONNECT SWITCH (OPTION A07) AND LINE CONTACTOR (OPTION B07) ARE MUTUALLY EXCLUSIVE
4. FOR ATV212, NOT AVAILABLE WITH OPTION B06

Figure 22: Power Circuit Y Full Voltage Bypass Package, 460 V



1. WIRING BYPASSES SSOLR FOR 100 HP DRIVE UNIT ONLY JUMPERS BETWEEN DRIVE OUTPUT AND BYPASS CONTACTORS REMOVED
2. ATV21, NOT AVAILABLE WITH OPTIONS A06, B06, C06, D06
3. DRIVE INPUT DISCONNECT SWITCH (OPTION A07) AND LINE CONTACTOR (OPTION B07) ARE MUTUALLY EXCLUSIVE
4. FUSIBLE DISCONNECT SWITCH USED IN PLACE OF CIRCUIT BREAKER AND FUSE BLOCKS IN 75HP AND 100HP 460 VOLT UNITS
5. ATV212, NOT AVAILABLE WITH OPTION B06

Figure 23: Non-Bypass Power Circuit W, 208/230 V and 460 V

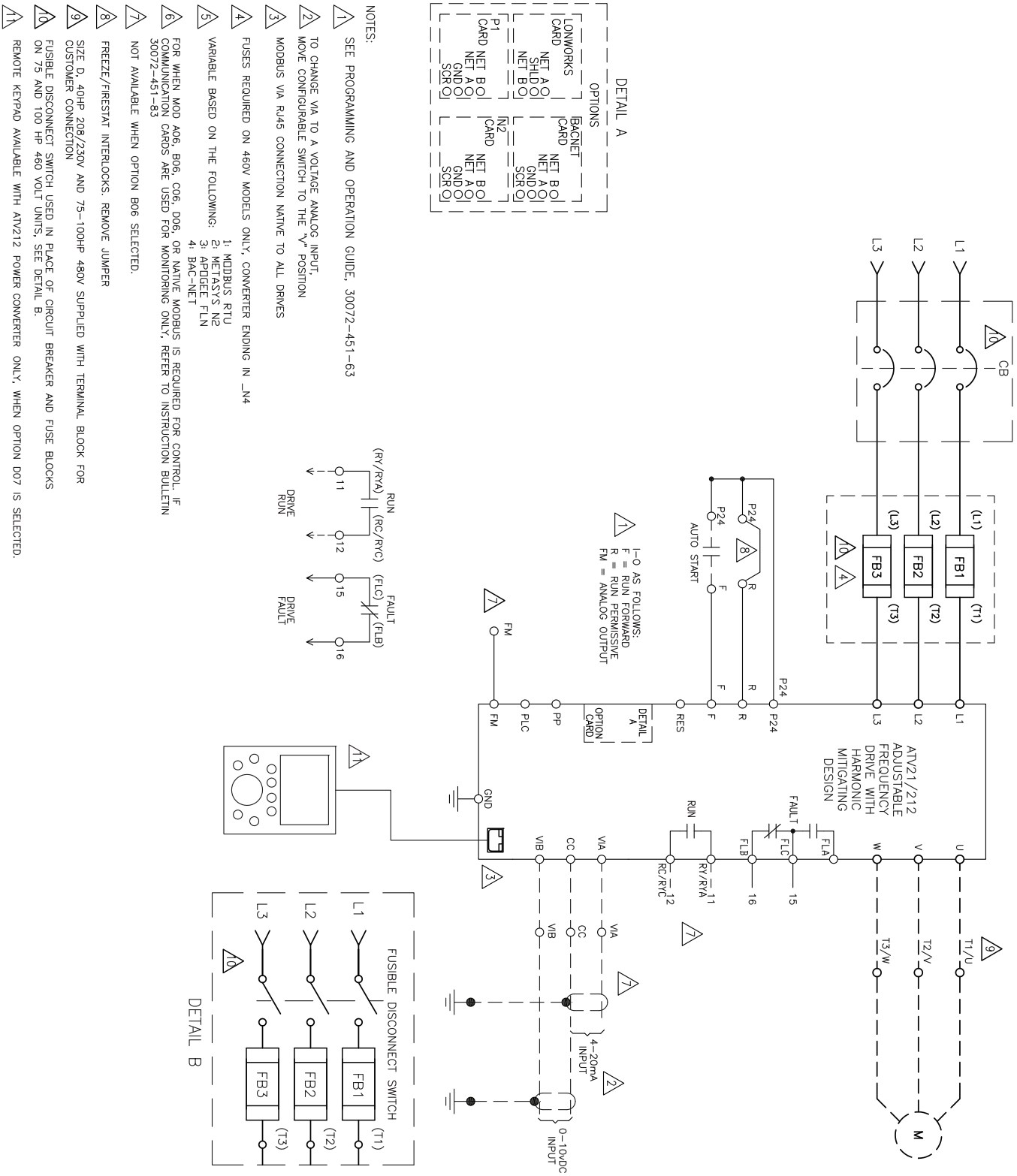


Figure 24: Power Circuit W Bypass Package, 208 V and 230 V

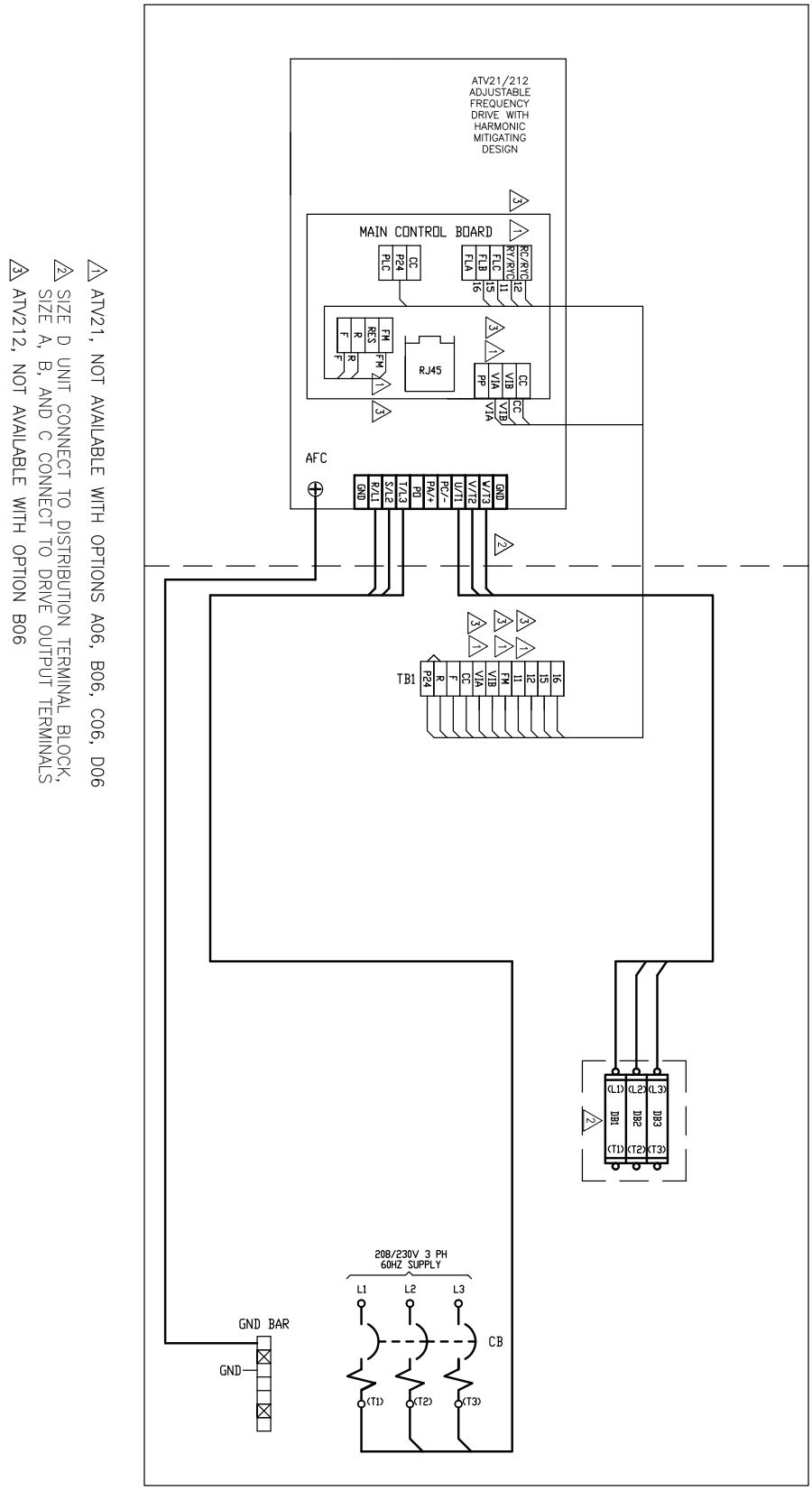
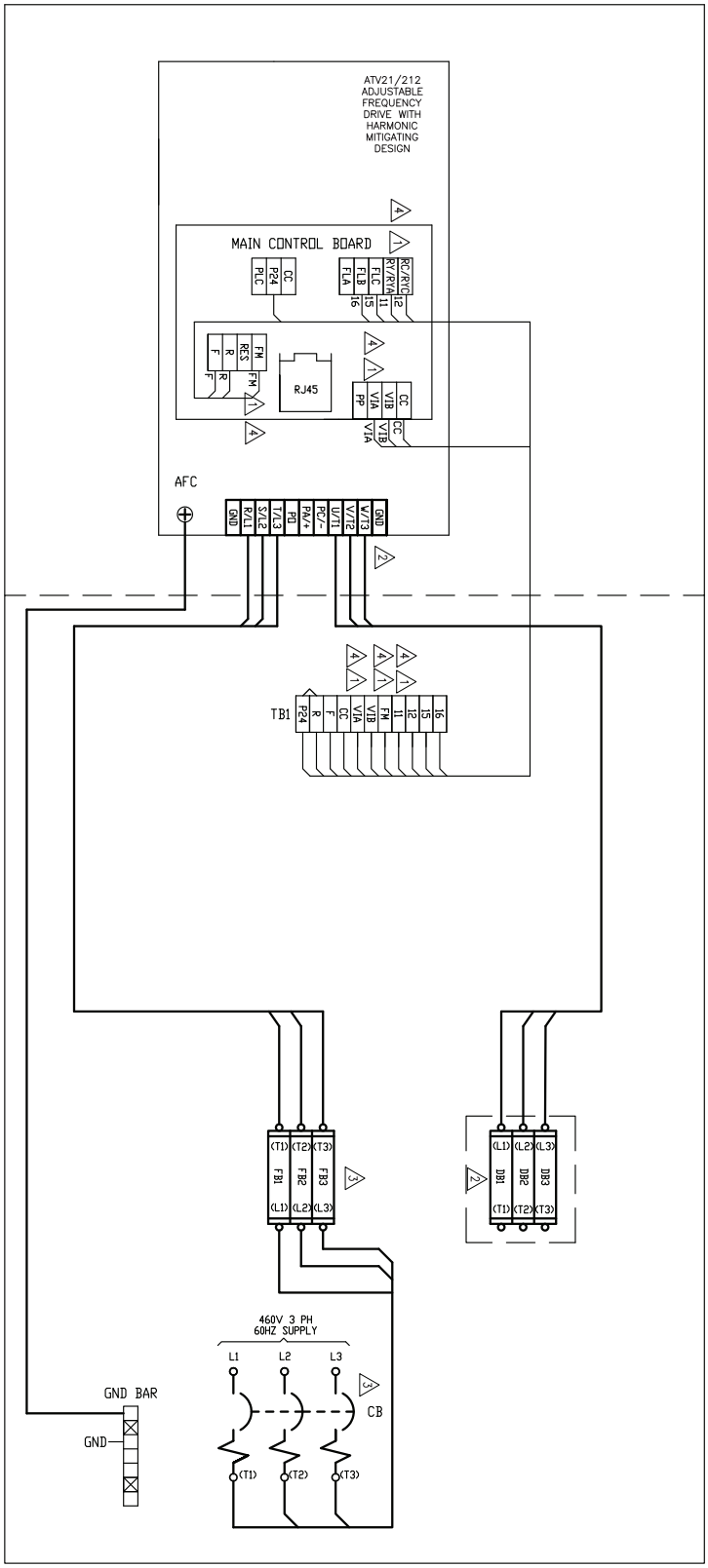


Figure 25: Power Circuit W Non-Bypass Package, 460 V



1. FOR ATV21, NOT AVAILABLE WITH OPTIONS A06, B06, C06, D06
2. SIZE D UNIT CONNECT TO DISTRIBUTION TERMINAL BLOCK, SIZE A, B, AND C CONNECT TO DRIVE OUTPUT TERMINALS
3. FUSIBLE DISCONNECT SWITCH USED IN PLACE OF CIRCUIT BREAKER AND FUSE BLOCKS ON 75 AND 100 HP 460 VOLT UNITS
4. FOR ATV212, NOT AVAILABLE WITH OPTION B06

Section 5 —Proportional–Integral–Derivative Control

⚠ DANGER

HAZARD OF ELECTRICAL SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand this manual before installing or operating the S-Flex drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- DO NOT touch unshielded components or terminal strip screw connections with voltage present.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- Before servicing the drive:
  - — Disconnect all power.
  - — Place a “DO NOT TURN ON” label on all power disconnects.
  - — Lock all power disconnects in the open position.
  - — Disconnect all power, including external control power that may be present, before servicing the drive. WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the “DC Bus Voltage Measurement Procedure” to verify that the DC voltage is less than 42 V. The drive LED is not an indicator of the absence of DC bus voltage.
- Install and close all covers before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

- Test and ensure that any changes made to the parameter settings do not present any danger to personnel and equipment during the drive operation.
- Each control scheme must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions will result in death or serious injury.

Introduction

This section provides programming instructions for using Proportional-Integral-Derivative (PID) control on the S-Flex adjustable speed drive.

PID control provides a method for controlling a process variable using a closed loop feedback system. The error between the desired setpoint and feedback process variable provides continuous corrective action to control the process output. From an application standpoint, the drive output adjusts the speed of the motor to reduce the error to zero. Closed loop control eliminates the cycling normally associated with open loop on-off control methods. PID control aims to regulate the process consistently under changing conditions at a maximum rate with minimum waste and minimum cost of operation.

Process variables such as temperature, pressure, and level can be monitored by the drive as a current or voltage analog feedback signal. The PID regulator calculates the error between the setpoint and feedback for a closed loop, then applies an appropriate frequency reference to adjust the motor speed.

There are three control functions:

1. Proportional (P): The Proportional function determines the responsiveness of control or how quickly the output reacts to the error.
2. Integral (I): The Integral function determines the reaction based on the sum of recent errors and its absence may prevent the system from reaching its target value.
3. Derivative (D): The Derivative function determines the reaction to the rate at which the error has been changing and is very sensitive to measurement noise.

The weighted sum of P, I, and D functions is used to correct the process variable.

By tuning these three functions, the system performance including responsiveness (time to correct the error), overshoot (overage from the reference setpoint) and oscillations (cycling between the highest and lowest point until signal stabilization) can be controlled.

Figure 26: PID Control Concept

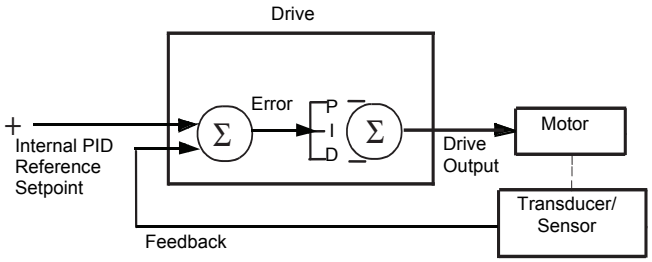
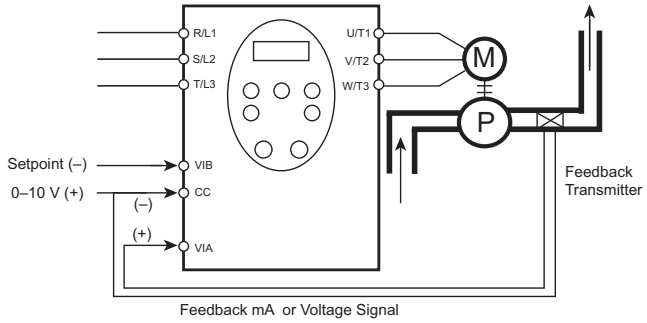


Figure 27: PID Setup for Drive



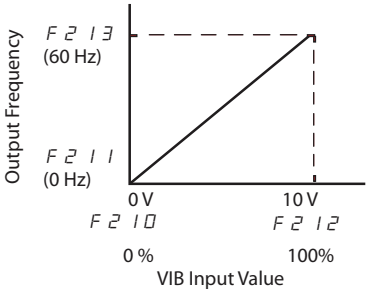
Scaling of PID Parameters

Scaling of PID parameters is required to suit a customer's application or range of the sensor input device providing the feedback signal (or both). Some examples of PID parameters and their ranges are pressure (0 to 20 psi), flow (0 to 500 gpm), and temperature (–100 °F to 300 °F).

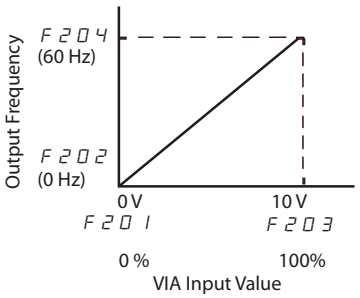
SPEED REFERENCE LEVEL 1 and 2 parameters must be entered as a percentage of the analog input range (VIA or VIB) used as the feedback input signal. The OUTPUT FREQUENCY LEVEL 1 and 2 parameters are entered in Hz and set as a function of the speed reference (see Figure 28).

Figure 28: Examples of Terminal Setting

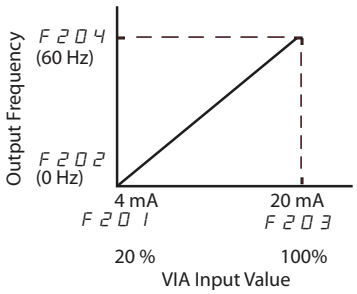
Example of VIB Terminal Setting



Example of VIA Terminal Setting (voltage input)



Example of VIA Terminal Setting (current input)



SPEED REFERENCE LEVEL parameter:

For a 4–6 V signal, set Speed Reference Level 1 to 40 and Speed Reference Level 2 to 60. Figure 28 illustrates scaling for a voltage signal of 0-10 V and a current signal of 4–20 mA.

OUTPUT FREQUENCY LEVEL parameter:

For an Output Frequency of 0–60 Hz, set Output Frequency Level 1 to 0 and Output Frequency Level 2 to 60.

PID Tuning

Tuning of the P, I, and D control functions is required to optimize the process performance based on application needs. There are several methods for tuning including manual, Ziegler-Nichols, and by using several software tools available in the market. The PID proportional gain (F362), Integral gain (F363) and derivative gain (F366) parameters can be adjusted to allow the PID regulator to be tuned for a specific application.

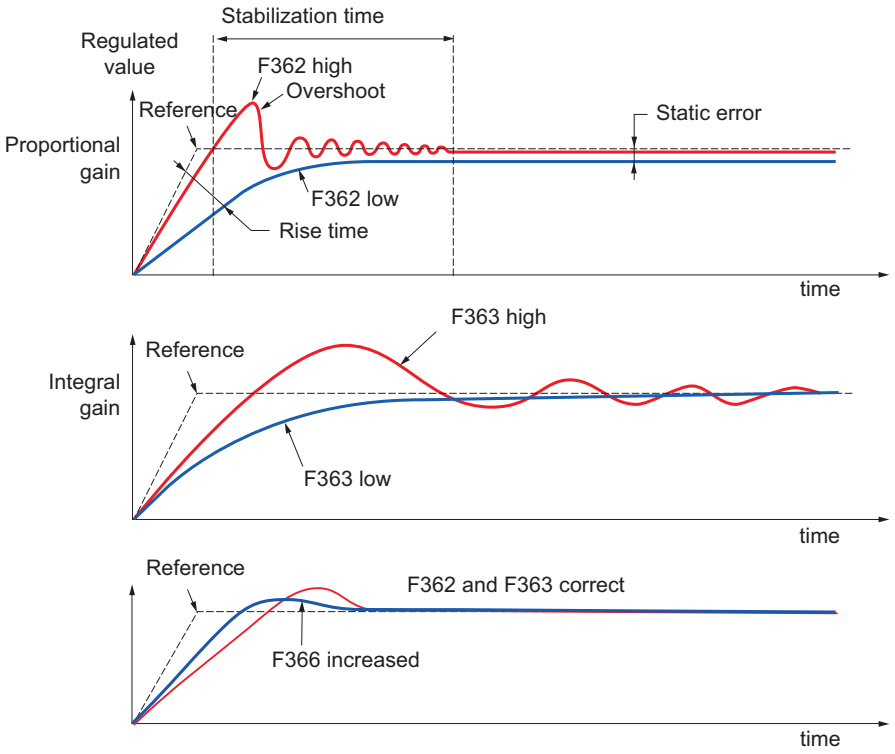
NOTE: Follow the instructions in *Drive Configuration via Integrated or Graphic Keypad* on page 72 to set-up the P, I, and D control functions and access the parameters for gains adjustment.

In many cases the factory settings for these parameters will be sufficient. However, if necessary, adjustments should be gradual and independent. If the system is unstable with the factory settings or the PID reference (setpoint) is not achieved, use the manual method described below:

- Set the integral gain (F363) to minimum.
- Leave the derivative gain (F366) at 0.
- Vary the load or PID reference setpoint a number of times and observe the PID regulator response.
- Set the proportional gain (F362) in order to obtain the best compromise between response time and stability.
- Once stable, if the steady state response varies from the preset value (setpoint), gradually increase the integral gain (F363), reduce the proportional gain (F362) in the event of instability (pump applications), and find a compromise between response time and precision.
- Typically, the derivative gain (F366) is not required, but may permit the reduction of overshoot and the improvement of response time. This can make it more difficult to obtain a compromise in terms of stability since this depends on 3 gains. If F366 is adjusted then the F362 and F363 may require re-adjustment.

Figure 29 on page 71 illustrates the system performance with adjustments in P, I, and D gains.

Figure 29: System Performance With Adjustments in P, I, and D Gains



The oscillation frequency depends on the system's physical parameters and natural response.

Parameter	Rise time	Overshoot	Stabilization time	Static error
F362 ↗	↘↘	↗	=	↘
F363 ↗	↘	↗↗	↗	↘↘
F366 ↗	=	↘	↘	=

Setting PID Control

The procedure for setting PID control for analog inputs with 0–10 Vdc or 4–20 mA signal is described in this section.

For SFD21, PID control with 4–20 mA current feedback is only possible on drives without A06, B06, C06, D06 communication options selected.

For SFD212, PID control with 4–20 mA current feedback is only possible on drives without B06 communication options selected.

Ensure that the factory settings for the enclosed drive and motor parameters are set. For more information, refer to the *Altivar® 21 Programming and Operation Guide,* 30072-451-63*,* or *Altivar 212 Programming and Operation Guide,* S1A53838.

Drive Configuration via Integrated or Graphic Keypad

With the AFC-OFF-BYP selector switch in the Off position and prior to applying a run command to the drive, use the keypad to do the following:

Programming by Integrated Keypad:

1. Press the MODE key until AUF displays; then press ENT.
2. Scroll using the UP and DOWN arrow keys until FMOd displays; then press ENT.
3. Use the UP and DOWN arrow keys to adjust the desired control source.
Procedure is continued on page 73.

Programming by Graphic Keypad:

1. Press the ESC key to display the PROGRAMMING MENU and turn the Jog dial until FREQUENCY MODE SEL. (FMOd) is highlighted; then press the Jog dial.
2. Turn the Jog dial to adjust the desired control source, then press the Jog dial when the desired control source is highlighted.
Procedure is continued on page 73.

Table 17: Parameters

Parameter	Name	Setting
FMOd	Remote mode primary speed reference source (VIA)	1
	Remote mode primary speed reference source (VIB)	2
	Panel input setting Internal preset speed setting	3
	Remote mode primary speed reference source (Serial Comm.)	4

NOTE: VIA accepts a 0–10 Vdc voltage signal or a 4–20 mA current signal, VIB accepts a 0–10 Vdc voltage input signal. Refer to the *Altivar® 21 Installation Guide,* 30072-451-61, or *Altivar 212 Installation Guide,* S1A53832*,* for instructions on accessing SW3.

When operating with internal setpoint, the adjusted range is taken as a percentage value reference and not an actual speed value and may only be set between the lower speed limit (LL) and upper speed limit (UL). For example, if the intended reference output frequency is 30 Hz and UL is set for 60 Hz, the drive requires a reference signal corresponding to 50%. If LL is set to 30 Hz, the setpoint cannot be set below 50% using this method. Additional signal manipulation may be required to convert the fundamental output frequency to rotational speed, pressure, or flow.

Programming by Integrated Keypad:
Continued from Step 3 on page 72.

4. Press the ENT key to save the selection and to exit the FMOd parameter.
5. Use the UP and DOWN arrow keys until F--- (extended parameters) displays; then press the ENT key.
6. Use the UP and DOWN arrows to select the appropriate parameter and press ENT to modify the parameter.

Programming by Graphic Keypad:
Continued from Step 2 on page 72.

3. Turn the Jog dial until EXTENDED MENU (F---) is displayed; then press the Jog dial.
4. Turn the Jog dial to select the appropriate parameter and press the Jog dial to confirm the parameter setting.

NOTE: Press the ENT key after modifying each parameter value to save and exit the parameter value selection menu and return to the F--- menu.

Control Loop Configuration

To enable PID control, configure the analog feedback signal to VIA or VIB as required based on the type of transducer feedback signal used.

If VIB is used as the speed reference, then enable VIA to be used as the feedback signal. Use the UP and DOWN arrow keys to adjust the following parameter using the rules in Table 18.

Table 18: Parameters

Parameter	Name	Setting	Adjustment Range	Description
F360	PID Control Enable VIA (0–10 Vdc or 4–20 mA dc)	1	—	—
	PID Control Enable VIB (0–10 Vdc)	2	—	—
F362	PID Proportional Gain	—	0.01 to 100.0	Parameter F362 adjusts the proportional gain applied during PID control. The speed change applied to the motor is a correctional value proportional to the product of this parameter's setting and the process error.
F363	PID Integral Gain	—	0.01 to 100.0	Parameter F363 adjusts the integral gain applied during PID control. Any residual process errors that remain after correction by the proportional gain are cleared to zero over time by the integral gain function
F366	PID Derivative Gain	—	0.00 to 2.55	Parameter F366 adjusts the derivative gain applied during PID control. This gain adjusts the response time of the drive to rapid changes in the process.

Control Loop Configuration

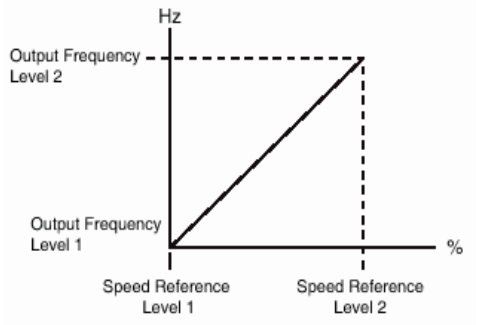
If FMOd (FREQUENCY MODE SEL) is set to 2, adjust parameters F201–F204 (for analog input control from VIA) or F210–F213 (for analog input control from VIB) according to the ranges in Table 19 to define the performance characteristics of the drive.

Table 19: Analog Input Control Parameters

Parameter	Name	Adjustment Range
F201	VIA reference point 1	0 to 100 (%)
F202	VIA frequency point 1	0 to 200 (Hz)
F203	VIA reference point 2	0 to 100 (%)
F204	VIA frequency point 2	0 to 200 (Hz)
F210	VIB reference point 1	0 to 100 (%)
F211	VIB frequency point 1	0 to 200 (Hz)
F212	VIB reference point 2	0 to 100 (%)
F213	VIB frequency point 2	0 to 200 (Hz)

Do not set the same frequency values for both VIA frequency points 1 (F202) and 2 (F204) or VIB frequency points 1 (F211) and 2 (F213). This will cause an Err1 error.

Figure 30: Analog Input Speed Reference and Output Frequency



A refinement to the bias and slope of the analog input signals can be made with parameters F470–F473. Refer to the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838.

Sleep/Wake Operation

Parameter	Name	Adjustment Range
F256	Sleep/Wake Operation Time	0 to 600 (s)

Setting parameter F256 enables Sleep/Wake Operation. If the drive operates continuously at low speed (LL) for a time period equal to the setting of F256 in seconds, the drive will ramp the motor to a stop.

While the motor is stopped, LStP will flash on the drive keypad until a speed reference above LL is provided. The factory setting is 0, which disables this function. By default LL is set to 15 Hz and can be modified.

Refer to the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide*, S1A53838, for more information.

PID Control Waiting Time

Parameter	Name	Adjustment Range
F359	PID Control Waiting Time	0 to 2400 s

By setting F359, the drive will not enter PID control until the time set by F359 has elapsed. The factory setting is 0, which disables this function. Factory default acceleration time is set at 60 seconds. If default acceleration time is changed or a factory reset is performed, adjust parameter F359 to match the desired acceleration and wait times.

Refer to the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide,* S1A53838, for more information.

Attain Speed Relay

Attain Speed Relay is only compatible with analog feedback control. Refer to the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide,* S1A53838, for additional relay configurations and settings.

Table 20: Attain Speed Relay Parameters

Parameter	Name	Setting	Adjustment Range	Description
F137	RA–RC (ATV21) RYC–RYA (ATV212) Relay Secondary Function	60	—	To enable the run command signal relay (RA–RC and RYC–RYA) to include attain speed signal functionality, set parameter F137 to 60. The relay will only energize when the drive speed reference equals the VIB signal and a run command is received.
F167	Frequency command agreement detection range	—	0.0 to FH (Hz)	Parameter F167 determines the bandwidth around the VIB speed reference driving the relay output function.

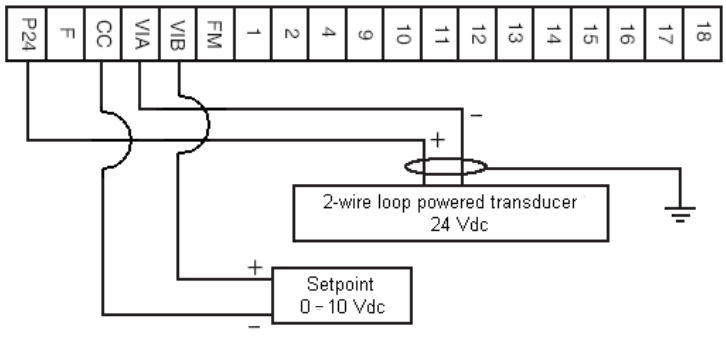
Control Wiring

For analog PID control, wire terminals VIA, VIB, and CC as shown in Figure 31 (for two-wire loop powered) and in Figure 32 (for separately powered transducer).

- If the feedback is a 4–20 mA signal, set switch SW3 to the I (current) position.
- If the feedback is a 0–10 Vdc signal, set switch SW3 to the V (voltage) position.

Refer to the *Altivar® 21 Installation Guide,* 30072-451-61, or *Altivar 212 Installation Guide,* S1A53832 for instructions on accessing SW3.

Figure 31: Two-wire Loop Powered Transducer



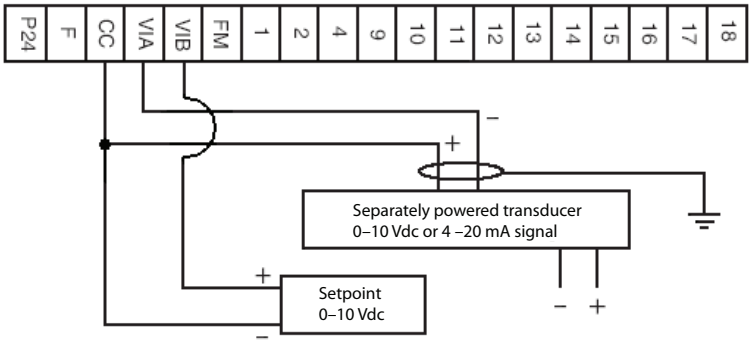
⚠ CAUTION

UNINTENDED MOTOR SPEED

Ensure adequate current for the transducer. The 24 Vdc power supply is current-limited to 200 mA. A load greater than the limit will cause the control voltage to dip and may result in erroneous readings from the transducer.

Failure to follow these instructions can result in injury or equipment damage.

Figure 32: Separately Powered Transducer



Ground the shield only at one end to prevent large currents from flowing in the shield. The shield on the ungrounded end may be tied to ground with a capacitor (for example,10 nF, 100 V or higher) to provide a path for the higher frequency noise.

Application Notes

To set up the drive for a potentiometer using the drive supplied 10 Vdc supply or keypad speed reference, refer to the *Altivar® 21 Installation Guide*, 30072-451-61, or *Altivar 212 Installation Guide*, S1A53832, for additional details on power converter terminal block characteristics. Actual terminal arrangement and termination availability may vary depending on the communications option selected.

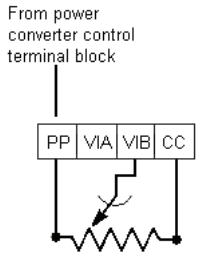
Programming the PID Internal Setpoint with the Keypad

Set the following parameter: = FNOd to 3. This allows you to program the internal setpoint with the keypad.

When a run command is issued the default display for the drive will be the is output frequency.

Press the Up or Down arrow button while watching the gauge that shows the actual value. Once the actual value reaches the point you want to maintain, press enter. The setpoint will be shown on the display in a percentage between Low Speed (LL) and High Speed (UL). For example, 30 is 50%. See “Graphic Keypad Option (D07)” on page 46.

Figure 33: Control Terminals



One internal 10 Vdc supply is accessible through terminal PP, integral to the power converter. Refer to Figure 33. The power supply is short-circuit and overload protected and capable of supplying up to 10 mA supply current. Size the reference potentiometer accordingly within a 1 to10 k range. Connect the potentiometer as shown in Figure 33.

Set parameters CMOd and FMOd to the values shown in Table 21 to accept reference from the VIB terminal using the reference potentiometer.

Table 21: Parameters

Parameter	Name	Setting
CMOd	Control terminal logic input	0
FMOd	Remote mode primary speed reference source (VIB)	2

To control the PID reference setpoint from the keypad, press the Loc/Rem key at any time and provide a speed reference command from the keypad display using the UP/DOWN arrows.

NOTE: Parameter F732 must be set to 0 to enable Loc/Rem.

Refer to the *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide,* S1A53838, for more information.

Section 6 —Maintenance

Before replacing any parts in the S-Flex 21 or S-Flex 212 enclosed drive, read and observe the following safety messages and all other safety messages provided in this bulletin.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Read and understand this instruction bulletin before installing or operating the S-Flex 21 or S-Flex 212 drive. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.
- The user is responsible for compliance with all international and national electrical code requirements with respect to grounding of all equipment.
- Many parts of this drive, including the printed circuit boards, operate at the line voltage. DO NOT TOUCH. Use only electrically insulated tools.
- Some terminals have voltage on them when the disconnect is open.
- DO NOT short across terminals PA/+ and PC/– or across the DC bus capacitors.
- Before servicing the drive:
  - — Disconnect all power including external control power that may be present before servicing the drive.
  - — Place a “DO NOT TURN ON” label on the drive disconnect.
  - — Lock disconnect in the open position.
  - — WAIT 15 MINUTES to allow the DC bus capacitors to discharge. Then follow the “DC Bus Voltage Measurement Procedure” on page 36 to verify that the DC voltage is less than 42 V. The drive LEDs are not indicators of the absence of DC bus voltage.
- Install and close all covers and doors before applying power or starting and stopping the drive.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

For 460 V units:

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must only be installed and serviced by qualified electrical personnel.
- Never operate energized switch with door open.
- Turn off switch before removing or installing fuses or making load side connections.
- Always use a properly rated voltage sensing device at all line and load fuse clips to confirm switch is off.
- Turn off power supplying switch before doing any other work on or inside switch.
- Do not use renewable link fuses in fused switches.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

For 208 and 230 V units:

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside the equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

UNINTENDED EQUIPMENT OPERATION

Before turning on the drive or upon exiting the configuration menus, ensure that the inputs assigned to the Run command are in a state that will not cause the drive to run. Otherwise, the motor can start immediately.

Failure to follow these instructions will result in death, or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failures of the link[1].
- Each implementation of an S-Flex 21 or S-Flex 212 enclosed drive must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.”

⚠ CAUTION

INCOMPATIBLE LINE VOLTAGE

Before turning on and configuring the drive, ensure that the line voltage is compatible with the line voltage range specified on the drive nameplate. The drive can be damaged if the line voltage is not compatible.

Failure to follow these instructions can result in injury or equipment damage.

A number of diagnostic and status codes are included on the power converter. See the Troubleshooting Sheet on page 83. The graphic display terminal provides a visual indication of the controller’s operating and protective circuit functions, as well as indicator lights for maintenance and troubleshooting assistance.

If the controller trips while operating, the codes must be viewed before power is removed because removing power resets the detected fault code.

External Signs of Damage

The following are signs of external damage:

- Cracked, charred, or damaged covers or enclosure parts
- Damage to the graphic display terminal such as scratches, punctures, burn marks, chemical burns, or moisture in the screen
- Oil or electrolyte on the bottom of the drive which might have leaked from the capacitors inside
- Excessive surface temperatures of enclosures and conduits
- Damage to power or control conductors
- Unusual noise or odors from any of the equipment
- Abnormal temperature, humidity, or vibration

If any of these signs are found while the equipment is powered up, immediately inform operating personnel and assess the risk of leaving the drive system powered up. Before removing power from the equipment, always consult with the operating personnel responsible for the machinery and process.

Technical Support

When troubleshooting the S-Flex 21 or S-Flex 212 enclosed drive, discuss the symptoms of the reported problems with operating personnel. Ask them to describe the problem, identify when they first observed the problem, and where the problem was seen.

Observe the drive system and process. Record the drive motor and peripheral equipment nameplate data on the Troubleshooting Sheet provided on page 83. Copy this form as needed.

For support and assistance, contact the Drives Product Support Group. The Product Support Group is staffed from 8:00 am until 6:00 pm Eastern time, Monday through Friday, to assist with product selection, start-up, and diagnosis of product or application problems. Emergency phone support is available 24 hours a day, 365 days a year.

Toll free	1-888-778-2733
E-mail	drive.products.support@us.schneider-electric.com
Fax	919-217-6508

S-Flex 21 / S-Flex 212 TROUBLESHOOTING SHEET

When requesting after-sales service, it is important to disclose all conditions under which the Schneider Electric equipment currently operates. This will help in diagnosing the system quickly.
Call the Product Support Group at 888–778–2733.

DATE: _____
CONTACT NAME: _____
COMPANY: _____
ADDRESS: _____
CITY: _____
STATE: _____
PHONE: _____
FAX: _____

DRIVE CONFIGURATION

CATALOG NUMBER: TYPE **SFD21 or SFD212**:
APPLICATION/EQUIPMENT DESIGNATION:

MOTOR NAMEPLATE DATA

HORSEPOWER:_____ VOLTAGE (3 PHASE):_____ FREQUENCY:_____ RPM:_____ FLA:_____
SERVICE FACTOR:_____ MOTOR INSULATION: ☐ NEW OR ☐ EXISTING
MOTOR CABLE TYPE:_____ LENGTH IN FEET:_____
IS MOTOR DESIGNED TO COMPLY WITH NEMA MG-1 PART 31 GUIDELINES? ☐ YES ☐ NO

POWER SOURCE AND ENVIRONMENT

VOLTAGE BETWEEN: L1 AND L2:_____ L2 AND L3:_____ L3 AND L1:_____
SERVICE TRANSFORMER RATING: _____KVA _____% Z FREQUENCY: ☐ 60 HZ OR ☐ 50 HZ
AMBIENT TEMPERATURES: MIN °C (°F)_____ MAX °C (°F)_____ HUMIDITY:_____
ALTITUDE IF GREATER THAN 3300 FEET ABOVE SEA LEVEL, SPECIFY:_____FT

DRIVE DETECTED FAULT CODES

Refer to *Altivar® 21 Programming and Operation Guide*, 30072-451-63, or *Altivar 212 Programming and Operation Guide,* S1A53838 for possible causes, corrective actions, and additional detected fault codes.

☐ **E-19**	☐ **Err7**	☐ **OC3P**	☐ **OP1**
BREAK IN VIA SIGNAL CABLE	CURRENT SENSOR	GROUND CONSTANT SPEED	OVERVOLTAGE ACCELERATION
☐ **E-21**	☐ **EtYP**	☐ **OCL**	☐ **OP2**
CPU	DRIVE TYPE	SHORT CIRCUIT	OVERVOLTAGE DECELERATION
☐ **EF2**	☐ **OC1**	☐ **OH**	☐ **OP3**
GROUND FAULT	OVERCURRENT ACCELERATION	OVERTEMPERATURE	OVERVOLTAGE CONSTANT SPEED
☐ **EPH1**	☐ **OC1P**	☐ **OL1**	☐ **Ot**
INPUT PHASE LOSS	GROUND FAULT ACCELERATION	DRIVE OVERLOAD	OVERTORQUE FAULT
☐ **EPH0**	☐ **OC2P**	☐ **OL2**	☐ **UC**
OUTPUT PHASE LOSS	GROUND FAULT	MOTOR OVERLOAD	UNDERLOAD FAULT

DETAILED DESCRIPTION OF PROBLEM

Renewable Parts

Schneider Electric provides a limited number of renewable parts for the Altivar 21/212 power converters and the S-Flex 21/212 enclosed drives. Before replacing any parts, consult your local field sales representative. Renewable parts must be installed by qualified personnel.

Table 22: Recommended Renewable Parts

Renewable Part		208 V Rating	230 V Rating	460 V Rating		
Power Converter[1]						
	1 hp	ATV212HO75M3X	ATV212HO75M3X	ATV212HO75N4		
	2 hp	ATV212HU15M3X	ATV212HU15M3X	ATV212HU15N4		
	3 hp	ATV212HU22M3X	ATV212HU22M3X	ATV212HU22N4		
	5 hp	ATV212HU40M3X	ATV212HU40M3X	ATV212HU40N4		
	7.5 hp	ATV212HU55M3X	ATV212HU55M3X	ATV212HU55N4		
	10 hp	ATV212HU75M3X	ATV212HU75M3X	ATV212HU75N4		
	15 hp	ATV212HD11M3X	ATV212HD11M3X	ATV212HD11N4		
	20 hp	ATV212HD15M3X	ATV212HD15M3X	ATV212HD15N4		
	25 hp	ATV212HD18M3X	ATV212HD18M3X	ATV212HD18N4		
	30 hp	ATV212HD22M3X	ATV212HD22M3X	ATV212HD22N4		
	40 hp	ATV212HD30M3X	ATV212HD30M3X	ATV212HD30N4		
	50 hp	—	—	ATV212HD37N4		
	60 hp	—	—	ATV212HD45N4		
	75 hp	—	—	ATV212HD55N4		
	100 hp	—	—	ATV212HD75N4		
FB1, FB2, FB3 Power Fuses [2]					**Rating (A)**	**Class**
	1 hp	—	—	25430-20300	3	CC
	2 hp	—	—	25430-20600	6	CC
	3 hp	—	—	25430-20700	7	CC
	5 hp	—	—	25430-21500	15	CC
	7.5 hp	—	—	25430-21500	15	CC
	10 hp	—	—	25430-22000	20	CC
	15 hp	—	—	25430-23000	30	CC
	20 hp	—	—	25423-30400	40	J
	25 hp	—	—	25423-30500	50	J
	30 hp	—	—	25423-30600	60	J
	40 hp	—	—	25423-30800	80	J
	50 hp	—	—	25423-31000	100	J
	60 hp	—	—	25423-31000	100	J
	75 hp	—	—	25423-31500	150	J
	100 hp	—	—	25423-31750	175	J

FU2, FU3

		Rating (A)	Class		Rating (A)	Class		Rating (A)	Class
Control Power Transformer (Primary Fuse)	25430-20350 [3]	3.5	CC	25430-20321 [3]	3.2	CC	25430-20150 [3]	1.5	CC
	25430-20225 [4]	2.25	CC	25430-20200 [4]	2	CC	25430-20100 [4]	1	CC

FU1

Control Power Transformer (Secondary Fuse)	25430-20200 [3]	2	CC	25430-20200 [3]	2	CC	25430-20200 [3]	2	CC
	25430-20140 [4]	1.4	CC	25430-20140 [4]	1.4	CC	25430-20140 [4]	1.4	CC

1 Drives shown in the table are installed in SFD212 controllers. For drives installed in SFD21 controllers, replace ATV212 with ATV21.

2 Use Class CC or J fast acting fuses. Control power transformer and fuses are supplied only with power circuit Y05.

3 Fuses are supplied for 15 to 40 hp, 208/230 V and 25 to 100 hp, 460V with MOD B07.

4 Fuses are supplied for all power ratings without MOD B07. Fuses are supplied for 1 to 10 hp, 208/230 V and 1 to 20 hp, 260 V with MOD B07.

S-Flex™ Adjustable Speed Enclosed Drive
Instruction Bulletin

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