Instruction Bulletin
50006-519-01B
December 1996
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Price $30.00

ALTIVAR™ 56

Fan and Pump Drive

Adjustable Speed Drive Controllers
For Asynchronous Motors

User's Manual

Variable Torque
1 to 100 hp, 460 V and 1 to 50 hp, 230 V

SQUARE D

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand this bulletin in its entirety before installing or operating ALTIVAR 56 drive controllers. Installation, adjustment, repair and maintenance of these drive controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT ONE MINUTE until DC bus capacitors discharge, then measure DC bus capacitor voltage between PA and (-) terminals to verify DC voltage is less than 45 V (see page 42). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the drive controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to the terminal connection drawings on Figure 9 on page 22.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive controller:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on drive controller disconnect.
- Lock disconnect in open position.

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

Chapter 1 — Receiving and Installation

INTRODUCTION

ALTIVAR™ 56 is a family of 1 to 100 hp, 460 V and 1 to 50 hp, 208 / 230 V adjustable frequency AC drive controllers. The ALTIVAR 56 family consists of 20 devices in 5 outlines. The ALTIVAR 56 drive controllers may function as stand-alone drive controllers or as part of complex drive systems.

The ALTIVAR 56 controller is also available as a combination device drive controller. The Class 8839 ALTIVAR 56 is a family of 1 to 100 hp, 460 V and 1 to 50 hp, 208 / 230 V combination devices consisting of the drive controller, power circuit box with options, and back pan.

The ALTIVAR 56 family also includes optional peripherals. Consult catalog for descriptions.

Scope

This manual covers receiving, installation, start-up, and configuration of the 460 V, 208 V, and 230 V lines of ALTIVAR 56 and Class 8839 drive controllers. Information on diagnostics is also included.

Several options are available for the ALTIVAR 56 drive controller. Refer to the catalog for a description of these options. A manual or instruction sheet is provided with each option.

Revision Level

This is Revision B. It replaces 50006-519-01A dated November, 1996, and includes information on the Class 8839 ALTIVAR 56 combination device.

HAZARD LABELING

The ALTIVAR 56 drive controller is shipped with an English safety label applied to the control board. If a Spanish, German, or French label is required, affix it to the main control board above the English label (see Figure 1). Do not obstruct the English label.

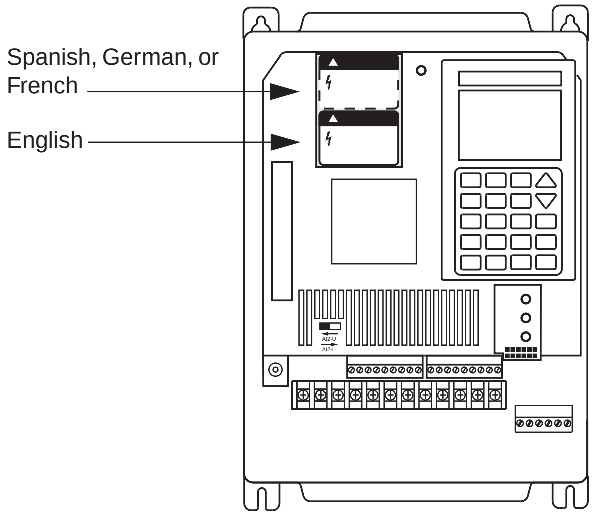


Figure 1: Hazard Labeling

TECHNICAL CHARACTERISTICS

Tables 1 and 2 show the power and current ratings for 460 V drive controllers when set for variable torque (Table 1) and variable torque, low noise (Table 2).

Table 1: Variable Torque Drive Controller Ratings, 460 V

460 V ±15%, 60 Hz ±5%
Switching Frequency: ATV56U41N4 to D46N4 = 4 kHz, ATV56D54N4 to D79N4 = 2 kHz

Outline	Drive Controller Part No.	Motor Power 460 V 60 Hz hp	Input Line Current 5,000 AIC or 10,000 AIC [1] A	Input Line Current 22,000 AIC A	Output Current A	Max. Transient Current (60 s) A	Total Dissipated Power W
1	ATV56U41N4	1 2 3	2.7 4.7 6.5	3.2 5.7 8	1.8 3.4 4.8	5.3 5.3 5.3	90 110 130
1	ATV56U54N4	5	9.8	11.9	7.6	8.4	180
1	ATV56U72N4	7.5	14	17	11	12.1	205
2	ATV56U90N4	10	17.7	21.4	14	15.4	265
2	ATV56D12N4	15	25.1	30.6	21	23.1	350
3	ATV56D16N4	20	31.8	38.3	27	29.7	480
3	ATV56D23N4	25	38.7	47	34	37.4	560
4	ATV56D33N4	40	57.1	67.6	52	57.2	800
4	ATV56D46N4	50	68.6	81.2	65	71.5	910
5	ATV56D54N4	60	86.4*	94.6	77	84.7	960
5	ATV56D64N4	75	106*	116	96	105.6	1150
5	ATV56D79N4	100	138*	150	124	136.4	1400

[1] 10,000 AIC denoted by asterisk (*).

Table 2: Variable Torque, Low Noise Drive Controller Ratings, 460 V

460 V ±15%, 60 Hz ±5%
Switching Frequency: ATV56U41N4 to D46N4 = 10 kHz, ATV56D54N4 to D79N4 = 4 kHz

Outline	Drive Controller Part No.	Motor Power 460 V 60 Hz hp	Input Line Current 5,000 AIC or 10,000AIC [1] A	Input Line Current 22,000 AIC A	Output Current A	Max. Transient Current (60 s) A	Total Dissipated Power W
1	ATV56U41N4	1 2 3	2.7 4.7 6.5	3.2 5.7 8	1.8 3.4 4.8	5.3 5.3 5.3	90 110 130
1	ATV56U72N4	5	9.8	11.9	7.6	8.4	180
2	ATV56U90N4	7.5	13.9	16.7	11	12.1	205
2	ATV56D12N4	10	17.6	21.4	14	15.4	265
3	ATV56D16N4	15	24.8	29.9	21	23.1	350
3	ATV56D23N4	20	31.9	38.7	27	29.7	480
4	ATV56D33N4	30	44	52.4	40	44	600
4	ATV56D46N4	40	57.1	67.6	52	57.2	800
5	ATV56D54N4	50	68.3	80.8	65	71.5	910
5	ATV56D64N4	60	86.4*	94.6	77	84.7	960
5	ATV56D79N4	75	106*	116	96	105.6	1150

[1] 10,000 AIC denoted by asterisk (*).

Tables 3 and 4 show the power and current ratings for 230 V drive controllers when set for variable torque (Table 3) and variable torque, low noise (Table 4).

Table 3: Variable Torque Drive Controller Ratings, 208/230 V

Outline	208 V ±10% and 230 V ±15%, 60 Hz ±5% Switching Frequency: ATV56U41M2 to D33M2 = 4 kHz, ATV56D46M2 = 2 kHz							
	Drive Controller Part No.	Motor Power 208/230 V 60 Hz	Input Line Current 208 V 8,800 AIC	Input Line Current 230 V 5,000 AIC	Input Line Current 230 V 22,000 AIC	Output Current	Max. Transient Current (60 s)	Total Dissipated Power
		hp	A	A	A	A	A	W
1	ATV56U41M2	1 2 3	5.7 10.2 14.0	4.9 8.6 11.8	5.8 10.2 14.0	4.0 7.5 10.6	11.7 11.7 11.7	120 140 170
2	ATV56U72M2	7.5	30.6	25.8	30.6	24.2	26.6	302
	ATV56U90M2	10	38.8	32.7	38.8	31	34	414
3	ATV56D12M2	15	54.7	46.2	54.8	47	51	559
4	ATV56D23M2	20	69.3	58.7	69.4	60	65	770
		25	84.4	71.5	84.4	75	82	831
	ATV56D33M2	40	124.9	102.7	125.9	116	126	1260
5	ATV56D46M2	50	149.3	122.6	151.1	143	158	1528

Table 4: Variable Torque, Low Noise Drive Controller Ratings, 208/230 V

Outline	208 V ±10% and 230 V ±15%, 60 Hz ±5% Switching Frequency: ATV56U41M2 to D33M2 = 10 kHz, ATV56D46M2 = 4 kHz							
	Drive Controller Part No.	Motor Power 208/230 V 60 Hz	Input Line Current 208 V 8,800 AIC	Input Line Current 230 V 5,000 AIC	Input Line Current 230 V 22,000 AIC	Output Current	Max. Transient Current (60 s)	Total Dissipated Power
		hp	A	A	A	A	A	W
1	ATV56U41M2	1 2 3	5.8 10.4 14.3	5.4 8.8 12.0	6.4 10.4 14.3	4.0 7.5 10.6	11.7 11.7 11.7	125 150 181
2	ATV56U72M2	5	21.8	18.3	21.8	16.7	18.4	252
	ATV56U90M2	7.5	30.6	25.8	30.7	24.2	26.6	375
3	ATV56D12M2	10	38.9	32.8	39.0	31	34	459
	ATV56D16M2	15	55.1	46.5	55.2	47	51	619
4	ATV56D23M2	20	70.3	59.6	70.3	60	66	785
	ATV56D33M2	30	97.2	80.8	97.2	88	97	1127
5	ATV56D46M2	40	124.2	102.0	125.4	115	126	1332

Specifications

Table 5 contains specifications for 460 V and 208/230 V drive controllers.

Table 5: Specifications

Input voltage	460 V ±15% or 208 V ±10% and 230 V ±15%
Displacement power factor	Approximately 0.96
Input frequency	47.5 to 63 Hz
Output voltage	Maximum voltage equal to input line voltage

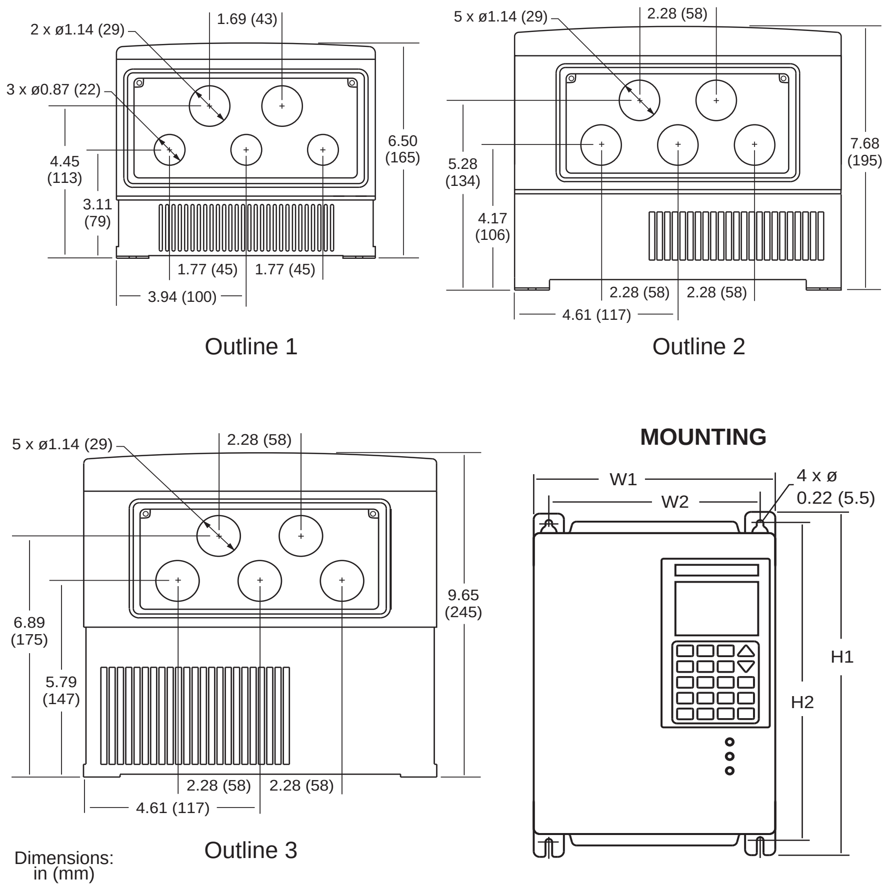
Table 5: Specifications (Continued)

Frequency resolution	Drive controller: Input AI1: (High Speed/1,024) Hz [1] Input AI2: (High Speed/512) Hz [1] Keypad display: 0.1 Hz increments Processor: 0.015 Hz increments With Option Board: Option board analog inputs: (High Speed/4096) Hz [1]
Frequency accuracy	±(0.0075 Hz + 0.00005 times High Speed)
Temperature drift [2]	Drive controller: Analog inputs: 3 x 10^{-4} times High Speed/°C typical Keypad display: 7 x 10^{-7} times High Speed/°C maximum With option board: Option board analog inputs: 2.5 x 10^{-5} times High Speed/ °C typical
Frequency range	ATV56U41N4 to D79N4: 0.1 to 72 Hz ATV56U41M2 to D46M2: 0.1 to 72 Hz
Torque/overtorque	See page 37.
Speed reference	AI1: 0-10 V AI2: 4-20 mA 0-5 V with switch on control board 0-20 mA, x-20 mA, 20-4 mA with keypad display
Speed regulation	V/f: determined by motor slip, typically 3% SLFV (sensorless flux vector): 1%
Efficiency	Typically greater than 96%
Reference sample time	10 ms
Ramps	Acceleration: 0.1 to 999.9 seconds Deceleration: 0.1 to 999.9 seconds
Braking to standstill	By DC injection: Automatic for 0.5 s if frequency drops below 1 Hz Manual by external signal
Drive controller protection	Against short circuits: • between output phases • between output phases and ground • on the outputs of internal supplies • on the logic and analog outputs Against input line supply under/overvoltage Against overheating: by thermal sensor
Motor protection	Incorporated electronic thermal protection (see page 11 and page 36)
Keypad display	• Self-diagnostics with full fault messages in seven languages • Also refer to Chapter 5
Temperature	Operation: +32 to +104 °F (0 to +40 °C) Storage: -13 to +158 °F (-25 to +70 °C)
Humidity	95% maximum without condensation or dripping water
Altitude	≤ 3,300 ft (1,000 m); above this derate by 1.2% for every 300 ft (100 m), max. 6,600 ft (2,000 m)
Enclosure	NEMA Type 1 (IP30)
Pollution Degree	Pollution Degree 3 per NEMA ICS-1 and IEC 664-1
Resistance to vibration	Conforming to IEC 68-2-6: • ATV56U41N4 to D46N4 and ATV56U41M2 to D33M2: 1 mm peak to peak from 5 to 22.3 Hz and 2 g peak from 22.3 to 150 Hz • ATV56D54N4 to D79N4 and ATV56D46M2: 0.15 mm peak to peak from 10 to 58 Hz and 1 g peak from 58 to 150 Hz
Resistance to shock	Conforming to IEC 68-2-27: 15 g peak for 11 ms
Codes and standards	• UL Listed per UL 508C under category NMMS as incorporating electronic overload protection • CSA certified • Conforms to applicable NEMA ICS, NFPA, IEC, & ISO 9001 standards

[1] Resolution limited to processor resolution.
[2] Drive Controller at operating load and temperature.

DIMENSIONS & WEIGHTS FOR WALL OR PANEL MOUNTING

CONDUIT ENTRIES - BOTTOM VIEW



MOUNTING DIMENSIONS

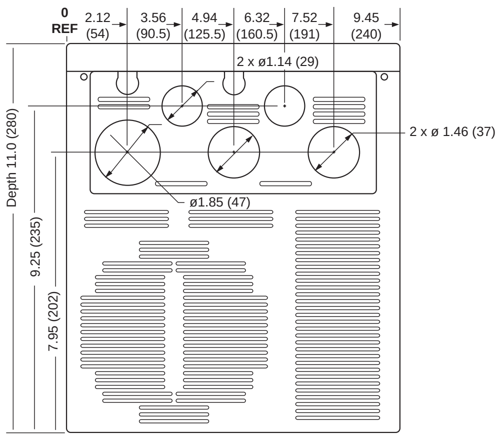
Outline	Drive Controller ATV56•••N4	Drive Controller ATV56•••M2	H1		H2		W1		W2		Ø		Weight		Door Swing Clearance [1]	
			in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	in	mm
1	U41 - U72	U41	11.6	295	10.9	280	7.8	200	6.9	175	0.22	5.5	10.4	4.7	7.8	200
2	U90, D12	U72, U90	12.8	325	12.2	310	9.2	234	8.2	209	0.22	5.5	16.1	7.3	9.2	234
3	D16, D23	D12, D16	16.3	415	15.7	400	9.2	234	8.2	209	0.22	5.5	30.9	14	9.2	234

[1] Door hinges on left-hand side of drive controller.

Figure 2: Mounting Information for ATV56U41N4 to D23N4 & ATV56U41M2 to D16M2

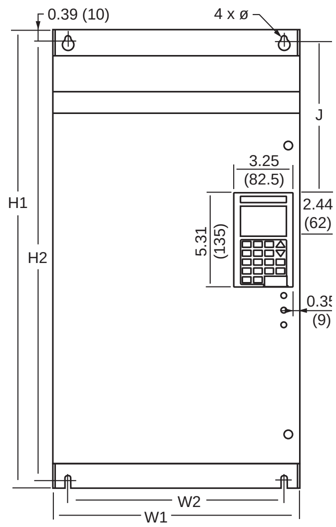
NOTE: When metallic conduit is used with drive controllers of outlines 1-3, install a metal conduit entry plate (kit VY1A66201 – separately ordered). Kit mounts in place of the existing plastic plate and has a conduit hole pattern identical to those shown for outlines 1 through 3.

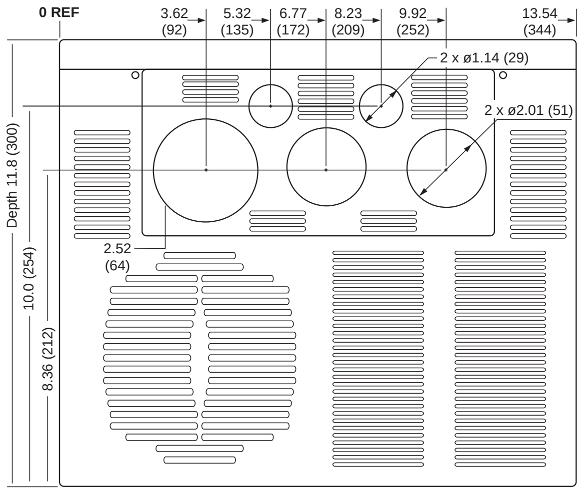
CONDUIT ENTRIES - BOTTOM VIEW



Outline 4

MOUNTING





Dimensions:
in (mm)

Outline 5

MOUNTING DIMENSIONS

Outline	Drive Controller ATV56•••N4	Drive Controller ATV56•••M2	H1		H2		W1		W2		Ø		J		Weight		Door Swing Clearance [1]	
			in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	lb	kg	in	mm
4	D33, D46	D23, D33	23.6	600	22.8	580	9.5	240	8.1	205	0.28	7	3.19	81	59.5	27	9.5	240
5	D54 - D79	D46	25.6	650	24.4	620	13.8	350	11.8	300	0.35	9	3.39	86	88.2 90.4	40 41	13.8	350

[1] Door hinges on left-hand side of drive controller.

Figure 3: Mounting Information for ATV56D33N4 to D79N4 & ATV56D33M2 to D46M2

HANDLING DRIVE CONTROLLERS

Do not remove drive controller from carton until it is at final installation site. The carton protects the drive controller and prevents damage to its exterior. Handle drive controller carefully to avoid damage to internal components, frame or exterior. When handling drive controller, balance it carefully to keep it from tipping.

ATV56U41N4 through D46N4 and ATV56U41M2 through D33M2 drive controllers can be removed from their packing and installed manually.

After being removed from the carton or shipping wrap, ATV56D54N4 through D79N4 and ATV56D46M2 drive controllers require some type of mechanical lifting. Handle drive controllers:

- With a hoist, attaching a spreader bar to the two lifting rings on top of the drive controller (see Figure 4) or
- For ATV56D54N4 through D79N4 and ATV56D46M2, in a horizontal position, with back of drive controller resting on a pallet.

⚠ WARNING

HANDLING AND LIFTING HAZARD

Keep area below any equipment being lifted clear of all personnel and property. Use lifting method shown below in Figure 4.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

To hoist the drive controller, attach a spreader bar to the two lifting rings on top of the drive controller, as shown in Figure 4. Handle the drive controller carefully to avoid damage to the internal components, frame or exterior. Place the drive controller in an upright position.

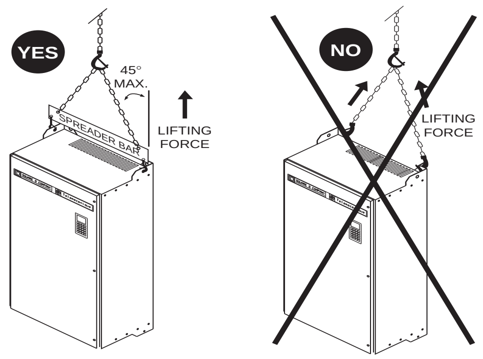


Figure 4: Hoisting ATV56D54N4 to D79N4 and ATV56D46M2

PRELIMINARY INSPECTION

The drive controller must be thoroughly inspected before storing or installing. Upon receipt:

1. Remove the drive controller from its packaging and visually inspect exterior for shipping damage.
2. Ensure that the drive controller catalog number agrees with the packing slip and corresponding purchase order. The catalog number appears on the drive controller nameplate and shipping package label. Refer to page 16 for location of drive controller nameplate.
3. If any shipping damage is found, notify your carrier and sales representative.
4. If drive controller is to be stored after receipt, replace it in original packing material and observe storage temperature specifications on page 4.

Prior to installation:

1. Open the drive controller door or remove access covers.
2. Visually verify that all internal mounting hardware and terminal connection hardware is properly seated, securely fastened and undamaged.
3. Visually verify that the control board is properly seated, securely fastened and undamaged. Verify that internal wiring connections are tight. Inspect all connections for damage.
4. Close and secure the drive controller door or replace access covers.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Do not operate or install any drive controller that appears damaged.

Failure to follow this instruction can result in injury or equipment damage.

INSTALLATION PRECAUTIONS

To avoid equipment damage, follow these precautions when installing the drive controller:

- Electrical current through drive controller will result in heat losses that must be dissipated into the ambient air immediately surrounding the drive controller. To prevent thermal fault or equipment damage, provide sufficient enclosure cooling and / or ventilation to limit the ambient temperature around drive controller to a maximum of 40 °C. For power dissipation, refer to Tables 1 through 4 on pages 3- 4. Minimum clearances required around the drive controller for unobstructed air flow are shown in Figure 5. For proper thermal dissipation, the minimum enclosure size must not be based on clearances alone. Refer to section “MOUNTING IN GENERAL PURPOSE METAL ENCLOSURE” on page 10 for additional information.

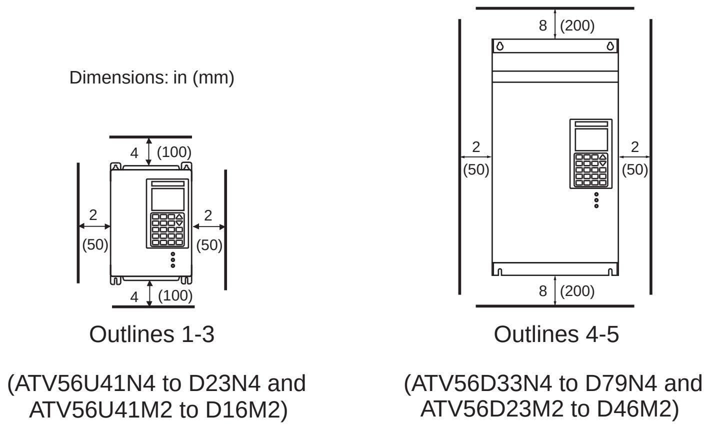


Figure 5: Clearances for Drive Controllers

- Mount drive controller vertically.
- Do not locate drive controller near heat radiating elements.
- When installation surface is uneven, put a spacer behind the drive controller mounting pads to eliminate gaps. The drive controller exterior may be damaged if fastened to an uneven surface.
- Drive controllers are Type 1 enclosed devices and must be installed in a suitable environment. The environment around drive controller must not exceed Pollution Degree 3 requirements as defined in NEMA ICS 1 or IEC 664.

- Verify that the voltage and frequency characteristics of the input line match the drive controller nameplate rating.
- Installation of a disconnect switch between the input line and drive controller is recommended. Follow national and local codes.
- Overcurrent protection is required. Install line power fuses (F1-F3) recommended in Table 11 on page 30 and Table 13 on page 31.
- Turn off all power before installing the drive controller. Place a “DO NOT TURN ON” label on the drive controller disconnect. Before proceeding with installation, lock the disconnect in the open position.
- The ATV56U41N4 to ATV56D79N4 and ATV56U41M2 to ATV56D46M2 drive controllers may be mounted inside another enclosure to increase the degree of protection or size of the enclosure. See “MOUNTING IN GENERAL PURPOSE METAL ENCLOSURE” on page 10 and “MOUNTING IN TYPE 12 (IP54) METAL ENCLOSURE” on page 12.
- To improve ventilation, the front cover may be removed when mounting the drive controller in an enclosure. For ATV56U41N4 to D23N4 and ATV56U41M2 to ATV56D16M2 drive controllers, the front cover is removed by first opening the cover, then separating the retaining clips on the cover from the side panel. For ATV56D33N4 to D79N4 and ATV56D23M2 to ATV56D46M2 drive controllers, the front cover is removed by first opening the cover, then lifting it vertically.
- With the front cover removed, the ATV56U41N4 to D79N4 and ATV56U41M2 to ATV56D46M2 drive controllers have an IP20 enclosure rating.
- The solid state switches of the drive controller power circuit do not provide complete isolation from the line. Leakage currents and voltages may be present at the U / T1, V / T2, and W / T3 terminals of the drive controller whenever power is present.

MOUNTING IN GENERAL PURPOSE METAL ENCLOSURE

The ALTIVAR 56 drive controller is a Type 1 / IP30 enclosed product. However, certain application considerations may require that the drive controller be installed inside a larger enclosure. If so, observe the following precautions:

Ventilation

Forced air cooling is provided on all drive controllers. A fan is located in the bottom of the drive controller (see Figure 6 on page 11) and is protected by a perforated cover. The fan draws in ambient air from underneath or from the front of the enclosure over the heat sink fins, and expels it vertically from the top of the enclosure. When mounting the drive controller, be sure the air inlets and outlets are not obstructed.

- Follow the installation precautions on pages 9 and 10.
- Observe minimum clearance distances as indicated in Figure 5 on page 9.
- If the enclosure does not provide sufficient free air flow, an enclosure ventilation fan is required to exhaust the heat to the enclosure outside ambient. The enclosure fan should have a greater fan flow rate than the drive controller fan flow rate listed in Table 6 on page 11.
- If there is a possibility of condensation, keep the control supply switched on during periods when the motor is not running or install thermostatically controlled strip heaters.

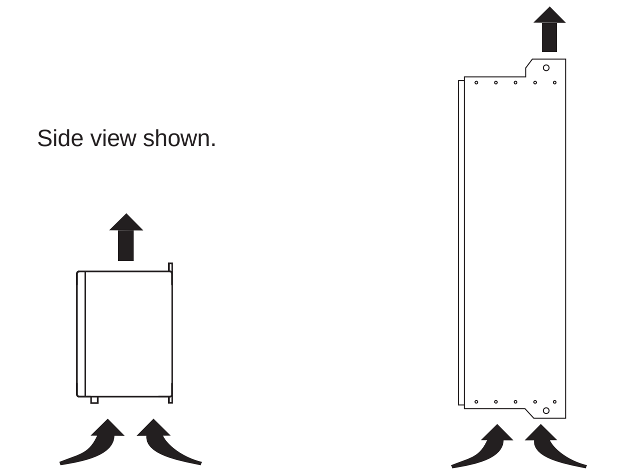


Figure 6: Ventilation for ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2

Table 6: Flow Rates for ALTIVAR 56 Drive Controller Fans

Drive Controller	Fan Flow Rate [1]	
	CFM	dm^3/s
ATV56U41N4, ATV56U54N4	10	5
ATV56U72N4, ATV56U41M2	20	10
ATV56U90N4, ATV56D12N4, ATV56U72M2, ATV56U90M2	44	22
ATV56D16N4, ATV56D23N4, ATV56D12M2, ATV56D16M2	94	47
ATV56D33N4, ATV56D46N4, ATV56D54N4, ATV56D64N4, ATV56D79N4, ATV56D23M2, ATV56D33M2, ATV56D46M2	200	100

[1] Free air flow rates.

For ATV56D16N4 to D79N4 and ATV56D12M2 to D46M2 drive controllers, the yellow pre-alarm LED flashes when the drive controller approaches the thermal limit. When the drive controller is running at rated load, this pre-alarm is issued at least one minute before the thermal limit is reached.

Thermal protection of all drive controllers is ensured by a thermal sensor attached to the heat sink. When the sensor opens:

- Drive controller trips, the fault LED is illuminated and a fault message appears on the keypad display.
- Ventilation system continues operating if control supply is maintained, enabling the drive controller to be rapidly cooled down.

MOUNTING IN TYPE 12 (IP54) METAL ENCLOSURE

The ALTIVAR 56 drive controller is a Type 1 / IP30 enclosed product, however certain applications may require Type 12 or IP54 protection. The following kits are available:

- Recess mounting kits for mounting drive controller with the heat sink outside the enclosure. There are two types available (see page 13).

Calculating Non-Ventilated Enclosure Size

Below is the equation for calculating Rth (°C / W), the maximum allowable thermal resistance of the enclosure:

$$Rth = \frac{T_i - T_o}{P}$$

T_i = Max. internal ambient temp. (°C) around drive controller
T_o = Max. external ambient temp. (°C) around enclosure
P = Total power dissipated in enclosure (W)

For the power dissipated by the drive controllers at rated load, see Tables 1 through 4 on pages 3-4.

Useful heat exchange surface area, S (in^2), of a wall-mounted enclosure generally consists of the sides, top and front. The minimum surface area required for a drive controller enclosure is calculated as follows:

$$S = \frac{K}{Rth}$$

Rth = Thermal resistance of the enclosure (calculated previously)
K = 300 for painted metal

The following points should be considered when sizing the enclosure:

- Use only metallic enclosures, since they have good thermal conduction.
- This procedure does not consider radiant or convected heat load from external sources. Do not install enclosures where external heat sources (such as direct sunlight) can add to enclosure heat load.
- If additional devices are present inside the enclosure, the heat load of the devices must be considered in the calculation.
- The actual useful area for convection cooling of the enclosure will vary depending upon the method of mounting. The method of mounting must allow for free air movement over all surfaces considered for convection cooling.

Below is a sample calculation of the enclosure size for an ATV56U72N4 (5 hp) drive controller mounted in a Type 12 enclosure.

- Maximum external temperature: T_o = 25 °C
- Power dissipated inside enclosure: P = 165 W
- Maximum internal temperature: T_i = 40 °C
- Area resistivity for painted metal: K = 300
- Calculate maximum allowable thermal resistance, Rth:

$$Rth = \frac{40\ °C - 25\ °C}{165\ W} = 0.091\ °C/W$$

- Calculate minimum useful heat exchange surface area, S:

$$S = \frac{300}{0.091} = 3300\ in^2$$

Useful heat exchange surface area (S) of the proposed wall-mounted enclosure:

- Height: 40 in (1016 mm)
- Width: 40 in (1016 mm)
- Depth: 20 in (508 mm)

$$S = \underbrace{(40 \times 40)}_{\text{front area}} + \underbrace{(20 \times 40)}_{\text{top area}} + 2\underbrace{(40 \times 20)}_{\text{side area}} = 4000 \text{ in}^2$$

If the selected enclosure does not provide the required surface area or does not meet application needs, consider the following:

- Use a larger enclosure.
- Use one of the recess mounting kits (ATV56U41N4 to D23N4 and ATV56U41M2 to D16M2 drive controllers). Refer to Table 7.
- Add a passive heat exchanger to the enclosure.
- Add an air conditioning unit to the enclosure.

Ventilation

When the drive controller is mounted inside a Type 12 or IP54 enclosure, observe the following ventilation precautions:

- Observe minimum clearance distances shown in Figure 5 on page 9.
- Follow the installation precautions on pages 9 and 10.
- A stirring fan may be necessary to circulate the air inside the enclosure and prevent hot spots in the drive controller and to distribute the heat uniformly to surfaces used for convection cooling.
- If there is a possibility of condensation, keep the control supply switched on during periods when the motor is not running or install thermostatically controlled strip heaters.

Recess Mounting

To reduce power dissipated in an enclosure, ATV56U41N4 to D23N4 and ATV56U41M2 to D16M2 drive controllers may be recess mounted in a wall of the enclosure, with the heat sink on the outside. This requires a cutout in the enclosure and a recess mounting kit for recess mounting. When this kit is used, the majority of the drive controller heat load is dissipated outside the enclosure.

The power dissipated in the enclosure (P_i) must be dissipated by the available surface area of the enclosure. The heat sink assembly, which is mounted outside the enclosure, is rated for Type 12 / IP54 protection when used with this kit.

There are two types of recess mounting kits, the Gasket Kit, which contains only the gasket necessary for recess mounting, and the Mounting Adaptor Plate Kit which provides mounting plates along with gaskets to allow assembling the drive controller to the plates before bolting the assembly into the enclosure. This aids in installation and maintenance of the drive controller.

Table 7: Recess Mounting Kits

Gasket Kit	Mounting Adaptor Plate Kit	Drive Controller	P_i [1] (W)
VW3-A66801T	VW3-A66806	ATV56U41N4 ATV56U54N4 ATV56U72N4 ATV56U41M2	70
VW3-A66802T	VW3-A66807	ATV56U90N4 ATV56D12N4 ATV56U72M2 ATV56U90M2	75
VW3-A66803T	VW3-A66808	ATV56D16N4 ATV56D23N4 ATV56D12M2 ATV56D16M2	110 130 110 130

[1] P_i = power dissipated in the enclosure by a recess-mounted drive controller.

Chapter 2 — Wiring

WIRING
General Wiring Practices

Good wiring practice requires the separation of control circuit wiring from all power (line and load) 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 in the same conduit**. This separation reduces the possibility of coupling electrical noise between circuits.

When wiring ALTIVAR™ 56 drive controllers, follow the wiring practices required by national and local electrical codes in addition to the following:

- When metallic conduit is used with ATV56U41N4 to D23N4 and ATV56U41M2 to D16M2 drive controllers, a metal conduit entry plate, kit VY1A66201, must be used. It mounts in place of the existing plastic plate and is held in place with two screws. A bond wire is included, which must be connected to ground (GND) on the J2 terminal strip.
- Use metallic conduit for all drive controller wiring. Do not run control and power wiring in the same conduit.
- Metallic conduits carrying power wiring or low-level control wiring must be separated by at least 3 in (8 cm).
- Non-metallic conduits or cable trays used to carry power wiring must be separated from metallic conduit carrying low-level control wiring by at least 12 in (30.5 cm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- In some installations, conducted emissions to the line from the drive controller must be attenuated to prevent interference with telecommunication, radio and sensitive electronic equipment. In these instances, attenuating filters may be required. Consult catalog for selection and application of these filters.

Branch Circuit Connections

All branch circuit components and equipment (such as transformers, feeder cables, disconnect devices and protective devices) must be rated for the maximum input current of the ALTIVAR 56 drive controller, not the motor full load current. The drive controller input current is stamped on the nameplate. Since maximum input current depends on the impedance of the power system, several nameplate values are listed. The input current values listed are based on available fault current at the drive input terminals. Select the input current corresponding to the available fault current capability. If current limiting fuses or circuit breakers are used to reduce the available fault current, use the maximum input current listed. On the ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2 drive controllers, the nameplate is located in the bottom right corner of the right side of the drive controller.

⚠ WARNING

OVERCURRENT PROTECTIVE DEVICES MUST BE PROPERLY COORDINATED

- To achieve published fault withstand current ratings, install the specified fuses listed on drive controller nameplate and in Table 11 on page 30.
- Do not connect drive controller to power feeder whose short circuit capacity exceeds drive controller withstand fault rating listed on drive controller nameplate.

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

All ALTIVAR 56 drive controllers require fuse protection. ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2 drive controllers require user-supplied external fuses as indicated on the nameplate and in Table 11 on page 30 and Table 13 on page 31.

Control Wiring Precautions

All control inputs and outputs of the drive controller are isolated from the input lines, however certain control wiring precautions must be followed:

- Control wiring conductor runs must be kept short and direct. Follow the conduit and circuit separation requirements listed in “WIRING” on page 16.
- Control contacts used with the drive controller inputs must be rated for operation at open circuit voltages of 24 VDC and closed circuit currents of 10 mADC.
- Twisted cable with a pitch of 1 to 2 inches is required for analog inputs and outputs. Use of a cable shield is recommended. The shield must be terminated to ground at one end only. It is recommended that the shield be terminated at the drive controller. Shield connection terminals are provided on the ALTIVAR 56 drive controller for this purpose.
- The coils of all relays and solenoids connected to the output contacts of the drive controller must be equipped with appropriate transient suppressors.
- For proper control wiring, conductors must be routed to avoid contact with other voltage potentials in the drive controller. Wire insulation must have the appropriate voltage rating for the voltage present.

Output Wiring Precautions

⚠ WARNING

DRIVE CONTROLLER DAMAGE

Drive controller will be damaged if input line voltage is applied to output terminals (U/T1, V/T2, W/T3). Check power connections before energizing drive controller.

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

The drive controller 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 controller may trip. Follow the guidelines below when selecting output cable:

- Cable type: the cable selected must have 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 100 ft (30.5 m) may cause problems.
- Proximity to output cables from other drive controllers: because of the high frequency switching and increased capacitance, the drive may fault under some conditions.
- Do not use lightning arrestors or power factor correction capacitors on output of drive controller.

For installation where cable capacitances may be a problem, an inductor can be installed between the drive controller and the motor. See catalog or consult factory for additional information.

⚠ CAUTION

DRIVE CONTROLLER SWITCH FAILURE

For proper drive controller electronic short circuit protection, inductance is required in the output power wiring. Provide at least 48 in (122 cm) of cable at the drive controller output (U/T1, V/T2, W/T3).

Failure to follow this instruction can result in equipment damage.

Grounding

For safe, dependable operation, drive controllers must be grounded according to all national and local codes. To ground the drive controller:

- Connect a copper wire from the grounding terminal to the power system ground conductor. Wire size is determined by the drive controller size and by national and local codes.
- Verify that resistance to ground is one ohm or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

HAZARDOUS VOLTAGE—INADEQUATE GROUNDING

- Ground equipment using screw provided. Drive controller must be properly grounded before applying power.
- Do not use metallic conduits or shields as a ground conductor.

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

Multiple drive controllers must be grounded as shown in Figure 7. Do not loop or series the ground cables.

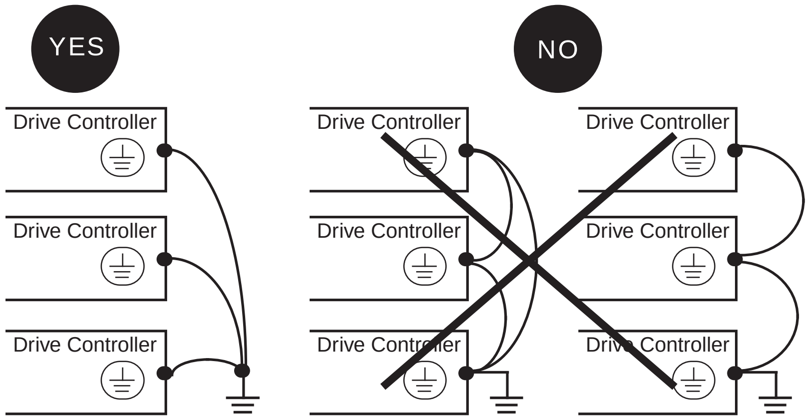
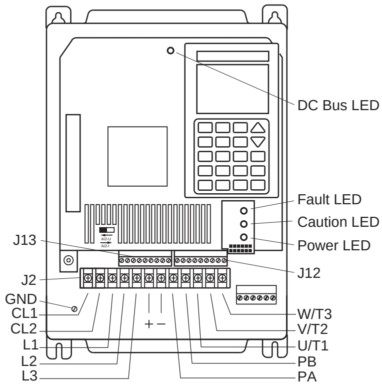


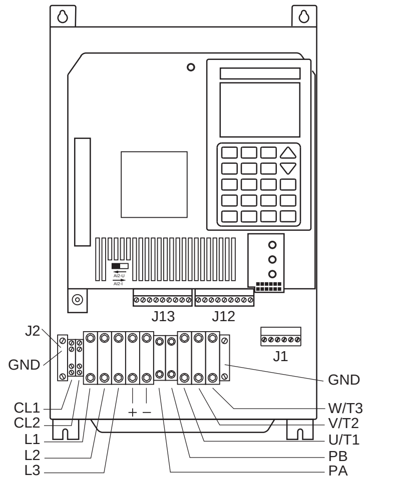
Figure 7: Grounding Multiple Drive Controllers

- When using the metal conduit entry plate (kit VY1A66201) with ATV56U41N4 to D23N4 and ATV56U41M2 to D16M2 drive controllers, the bond wire must be connected to ground (GND) as shown in Figure 9 on page 22.

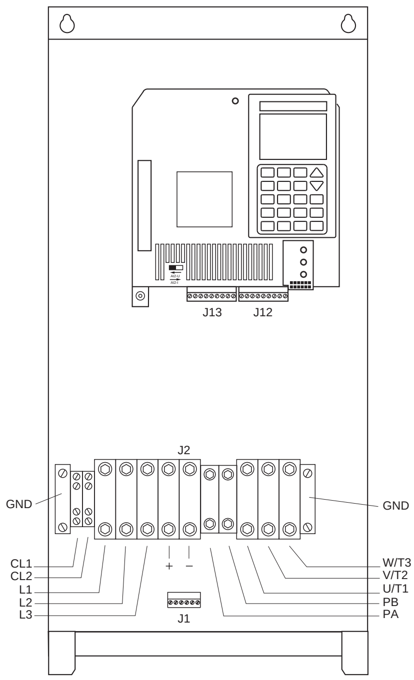
TERMINAL STRIP LOCATIONS



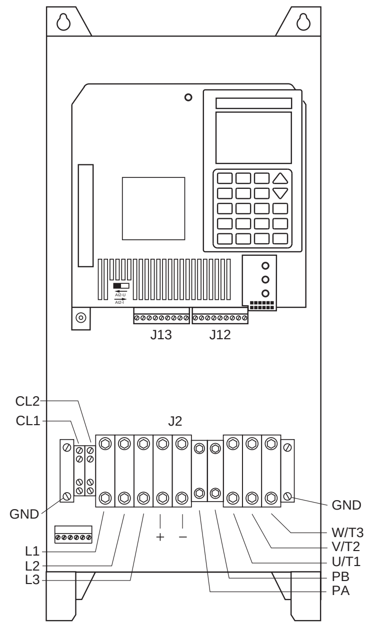
Outlines 1 & 2
ATV66U41N4 to D12N4 and ATV66U41M2 to U90M2



Outline 3
ATV66D16N4 to D23N4 and ATV66D12M2 to D16M2



Outline 5
ATV66D54N4 to D79N4 and ATV66D46M2



Outline 4
ATV66D33N4 to D46N4 and ATV66D23M2 to D33M2

Figure 8: Terminal Strip Locations: ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2

POWER WIRING

Table 8: Power Terminal Strip Characteristics [1]

Connector	Terminal [2]	Function	Characteristics
J2	GND L1 L2 L3	3-phase power supply	460 VAC ±15% (ATV56•••N4 units) 208 V ±10% / 230 V ±15% (ATV56•••M2 units) 47 to 63 Hz
	+ –	Filtered DC voltage	620 to 850 VDC (ATV56•••N4 units) 275 to 425 VDC (ATV56•••M2 units)
	U/T1 V/T2 W/T3 GND	Output connections to motor	0 to 460 VAC 0 to 208 VAC / 0 to 230 VAC
	CL1 [3] CL2	Single-phase control supply	460 VAC ±15% (ATV56•••N4 units) 208 V ± 10% / 230 V ± 15% (ATV56•••M2 units) 47 to 63 Hz
	PA PB	Reserved	Reserved. Do not wire to PA, PB terminals.
	CL21 CL22	Tap for CL1 and CL2	460 VAC ±15% (ATV56•••N4 units) 208 V ± 10% / 230 V ± 15% (ATV56•••M2 units) 47 to 63 Hz ATV56D16N4 to D79N4 drive controllers only

[1] For power terminal strip locations, refer to Figure 9 on page 22.
[2] See circuit diagrams on page 28 and 29.
[3] The CL1 and CL2 terminals are connected with jumpers to L1 and L2 terminals. When using a line contactor, the jumpers must be removed and CL1 and CL2 supplied separately to maintain control power. See circuit diagrams on page 28 and page 29. CL1 and CL2 must be connected to the same feeder conductors that supply L1, L2 and L3 of the drive controller.

Table 9: Power Terminal Wire Range

NOTE: All wire entries in AWG or Thousand Circular Mills (MCM) represent the maximum allowable conductor size for the referenced field wiring terminal. All wire entries in square mm (mm²) represent the recommended size of conductor based on IEC 364 conductor dimensioning criteria. Do not use the IEC 364 conductor selections for installations requiring dimensioning per NFPA 70 or CSA C22.

Terminals			Drive Controller (ATV56•••••)				
			U41N4 U54N4 U72N4 U41M2 [1]	**U90N4 D12N4 U72M2 U90M2 [1]**	**D16N4 D23N4 D12M2 D16M2 [1]**	**D33N4 D46N4 D23M2 D33M2 [2]**	**D54N4 D64N4 D79N4 D46M2 [2]**
CL1, CL21 CL2, CL22	Max. Wire Size	AWG mm²	10 2.5	6 10	12 2.5	12 2.5	12 2.5
	Terminal Torque	lb-in N•m	6.73 0.76	35.4 4	6.73 0.76	6.73 0.76	6.73 0.76
L1 L2 L3	Max. Wire Size	AWG mm²	10 2.5	6 10	4 10	2/0 35	4/0 70
	Terminal Torque	lb-in N•m	6.73 0.76	35.4 4	17.7 2	26.5 3	170 19
U/T1 V/T2 W/T3	Max. Wire Size	AWG mm²	10 2.5	6 10	4 10	2/0 35	4/0 70
	Terminal Torque	lb-in N•m	6.73 0.76	35.4 4	17.7 2	26.5 3	170 19
+ –	Max. Wire Size	AWG mm²	10 2.5	6 10	4 10	2/0 35	4/0 70
	Terminal Torque	lb-in N•m	6.73 0.76	35.4 4	17.7 2	26.5 3	170 19
PA PB	Max. Wire Size	AWG mm²	[3]	[3]	[3]	[3]	[3]
	Terminal Torque	lb-in N•m	[3]	[3]	[3]	[3]	[3]
GND IN	Max. Wire Size	AWG mm²	6 6	6 10	4 10	4 16	2 35
	Terminal Torque	lb-in N•m	17.4 1.96	35.4 4	17.7 2	26.5 3	26.5 3
GND OUT	Max. Wire Size	AWG mm²	6 6	6 10	4 10	4 16	2 35
	Terminal Torque	lb-in N•m	17.4 1.96	35.4 4	17.7 2	26.5 3	26.5 3

[1] 60/75 °C copper.
[2] 75 °C copper.
[3] Reserved. Do not wire to PA, PB terminals.

CONTROL WIRING

NOTE:

The logic inputs and outputs and analog inputs and outputs are all referenced to Common (COM on J12 and J13). This Common is isolated from the input line and from ground (S on J13).

RMS voltage rating of the isolation barrier between Common and ground is 250 V. If Common is elevated with respect to earth by external user connections, then all devices connected to Common must be rated for the applied voltage.

J1 is located on the power board.

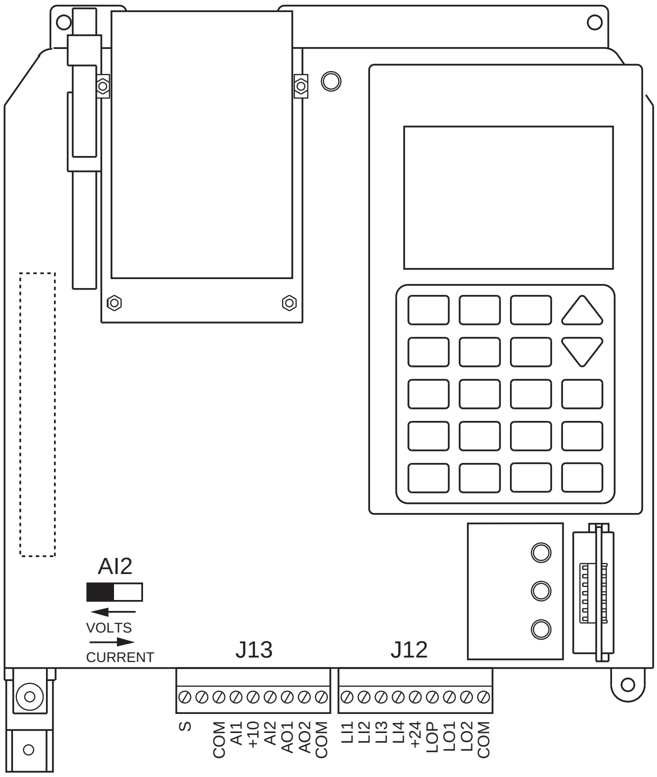


Figure 9: Terminal Strip Connections for Control Board

Table 10: Control Terminal Strip Characteristics

Connector	Terminal [1]	Function		Characteristics
J1 [2]	R1A [3] R1B R1C	N.O. contact [4] N.C. contact Common	Fault relay output	Minimum: 10 mA, 24 VDC Maximum: inductive load of: 2.0 A, 120 VAC; max: 0.10 J/operation, 80 operations/minute 1.0 A, 220 VAC; max: 0.25 J/operation, 25 operations/minute 2.0 A, 24 VDC; max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel with relay contacts
	R2A R2B R2C	N.O. contact [4] N.C. contact Common	Programmable relay output	
J12 [2]	LI1 LI2 LI3 LI4 +24 LOP LO1 LO2 COM	Logic input 1 Logic input 2 Logic input 3 Logic input 4 Control supply LO supply input Logic output 1 Logic output 2 Logic common		24 V, 10 mA; State 0: V<5 V; State 1: V>12 V; Vmax = 30 V 24 V, 10 mA; State 0: V<5 V; State 1: V>12 V; Vmax = 30 V 24 V, 10 mA; State 0: V<5 V; State 1: V>12 V; Vmax = 30 V 24 V, 10 mA; State 0: V<5 V; State 1: V>12 V; Vmax = 30 V Is = 210 mA max. [5] Minimum: 12 V, Maximum: 30 V, quiescent current: typical 15 mA 24 V, 200 mA max. [5] 24 V, 200 mA max. [5] 0 V
J13 [2]	S COM AI1 +10 AI2	Shield/Ground Space, for isolation Speed ref. common Input 1: Speed ref.voltage Reference supply Input 2: Speed ref. current		 0 V 0-10 V, Z = 30 kΩ 10 V, Is = 10 mA max. 4-20 mA [6], Z = 250 Ω
	AO1 AO2 COM	Analog output 1 Analog output 2 Analog common		0-20 mA, 12 V max. (programmable as 4-20 mA w/ keypad display) 0-20 mA, 12 V max. (programmable as 4-20 mA w/ keypad display) 0 V

[1] See circuit diagrams on page 28 and 29.
[2] Max. wire size for all terminals: 14 AWG (2.5 mm^2). Tightening torque: 3.5 lb-in (0.4 n•m).
[3] Relay coil deenergizes on fault.
[4] Contact state with drive controller deenergized.
[5] Total current of + 24 V internal supply is 210 mA. Available current of the two logic outputs can be calculated as follows: each logic input requires 10 mA, each analog output requires 20 mA and the typical quiescent current of LOP is 15 mA. For example, in an application where three logic inputs and one analog output are used, the total available current is 210 mA - (3 x 10 mA) - (1 x 20 mA) - 15 mA = 145 mA to drive the logic output loads. If more current is required, an external supply must be used.
[6] 0-20 mA, x-20 mA, 20-4 mA programmable with keypad display. 0-5 V (Z = 30 kΩ) selectable with switch on control board.

USING THE LOGIC INPUTS (J12)

The logic inputs may be operated from either the internal supply or an external supply. Figure 10 shows the connections for operating the logic inputs from the internal power supply.

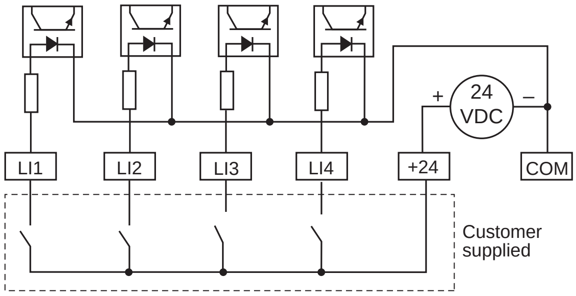


Figure 10: Operating the Logic Inputs from Internal Power Supply

Figure 11 shows the connections for operating the logic inputs from an external power supply.

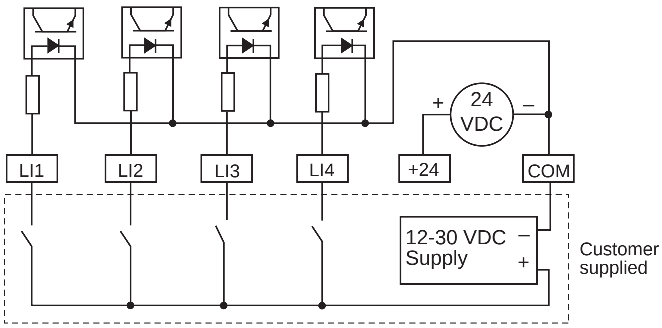


Figure 11: Operating the Logic Inputs from External Power Supply

The logic inputs may be assigned to other functions than those set at the factory. Factory settings are listed in Table 16 on page 34. For information on other functions, refer to Chapter 5.

USING THE LOGIC OUTPUTS (J12)

The logic outputs can be operated from either the internal supply or an external supply. An external supply is required if the logic outputs drive a load at a voltage other than 24 V or if the current required is greater than the available current as calculated in Note 5 in Table 10 on page 23.

NOTE: If the internal supply is used, LOP must be connected to +24.

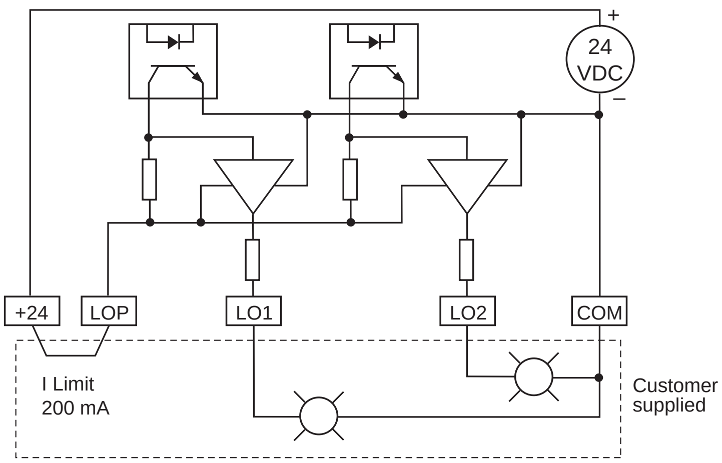


Figure 12: Operating the Logic Outputs from Internal Power Supply

Figure 13 shows the connection of an external supply for operating the logic outputs.

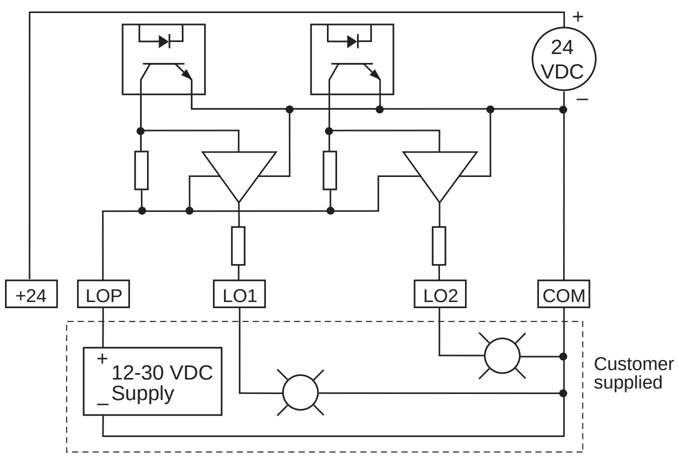


Figure 13: Operating the Logic Outputs from External Power Supply

USING THE SPEED REFERENCE INPUTS (J13)

The ALTIVAR 56 drive controller has two analog inputs for the speed reference, AI1 and AI2. AI1 is a 0-10 V voltage input. A speed potentiometer between 2.2 kΩ and 2.5 kΩ can be connected at COM, AI1 and +10 V as shown in Figure 14. AI2 is factory set as a 4-20 mA current input. It can be programmed to 0-20 mA, x-20 mA or 20-4 mA with the keypad display. It can also be set for 0-5 V with a switch on the control board.

- The speed reference controls the frequency of applied power to the motor. The actual shaft speed remains dependent on the acceleration and deceleration ramps, the torque capabilities of the motor / drive controller combination, the control type selected (see page 35), and the number of poles on the motor.
- The speed range is limited by Low Speed and High Speed settings. Factory settings are zero and nominal or base frequency.
- The speed reference inputs share the same common and are isolated from the input line and from ground.
- The +10 V internal supply (terminals +10 / COM) has a 10 mA supply capability and is protected against short circuits.
- If signals are present on both inputs, the values are summed for the speed reference. With the keypad display, they can be configured to be independent. For more information on configuration of the analog inputs, refer to Chapter 5.

Figure 14 shows how the speed reference inputs may be connected. The speed reference inputs are isolated from the input line.

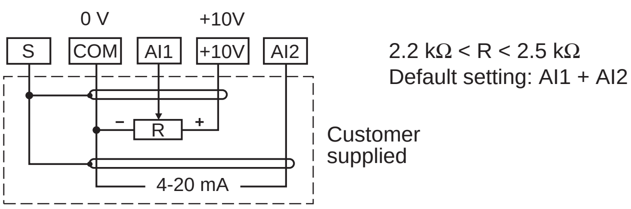


Figure 14: Using Speed Reference Inputs

USING THE ANALOG OUTPUTS (J13)

The ALTIVAR 56 drive controller has two 0-20 mA analog outputs, AO1 and AO2. They are both 0-20 mA current inputs. AO1 is factory set as proportional to motor frequency, with 20 mA corresponding to High Speed. AO2 is factory set as proportional to motor current, with 20 mA corresponding to twice the rated output current of the drive controller (see Tables 1 to 4 on pages 3-4).

- Maximum driving voltage is +12 V with an internal impedance of 100 Ω.
- The analog outputs can be assigned to other functions than those set at the factory. For information on other functions, refer to Chapter 5.

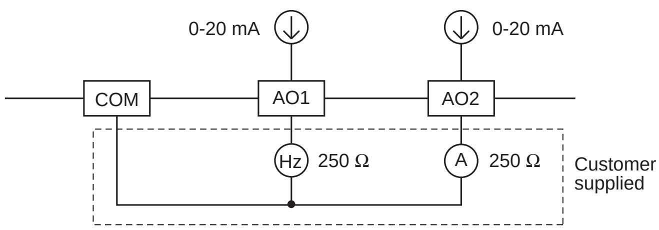


Figure 15: Analog Outputs

USING THE RELAY OUTPUTS (J1)

The ALTIVAR 56 drive controller has two voltage-free Form C relay output contacts (see Figure 16). The contacts have the following characteristics:

- Minimum voltage: +24 VDC; minimum current: 10 mA
- Maximum voltage: +30 VDC; maximum current: 2 A
- 120 VAC: maximum current 2 A
- 220 VAC: maximum current 1 A
- R1 is the drive controller fault relay. It is not programmable.

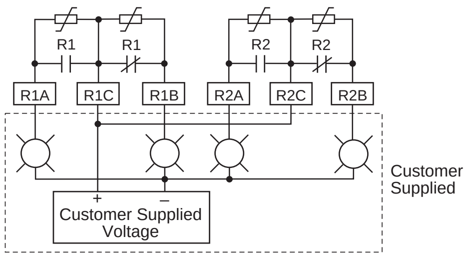


Figure 16: Relay Outputs

Contact state is shown with drive controller deenergized. Relay contact outputs can be assigned to other functions than those set at the factory. Factory settings are listed in Table 16 on page 34. For information on other functions, refer to Chapter 5.

Maximum recommended fuse type and rating is Bussmann FNQ-2 or equivalent.

REMOVAL OF CL1, CL2 JUMPERS

Jumpers CL1 and CL2 are factory installed. If separate control power is required, these jumpers must be removed. To remove jumpers, use the following procedure:

ATV56U41N4 to D12N4 and ATV56U41M2 to U90M2 drive controllers: Loosen the CL1 and CL2 screws and the L1 and L2 screws. Remove captive jumper wire assembly.

ATV56D16N4 to D79N4 and ATV56D12M2 to D46M2 drive controllers:

1. Loosen the front screws only (see Figure 17).

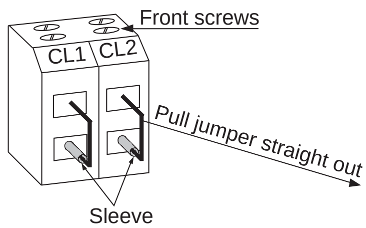


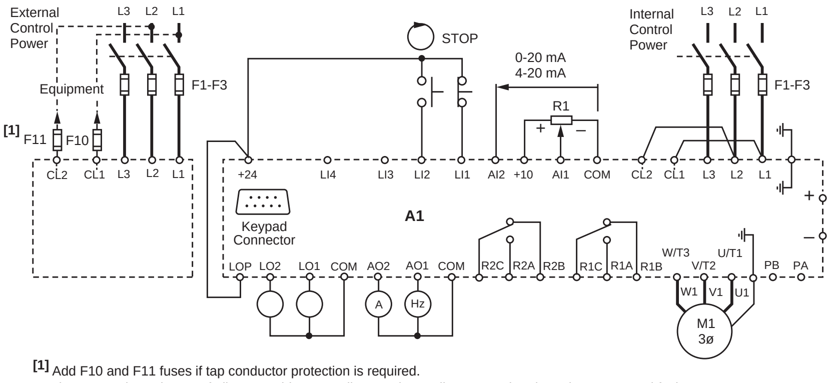
Figure 17: CL1, CL2 Jumper Removal

2. Using a pair of needle nose pliers, grasp the jumpers and pull straight out. The sleeve on the bottom terminal should remain.
3. Connect separate control power to the top terminals. DO NOT make connections to the bottom terminals which contain the sleeves. Leave the bottom terminals open circuited.
4. Tighten the front screws to secure the connections.

CONTROL CIRCUIT DIAGRAMS

This section contains wiring diagrams for 2- and 3-wire control circuits. Operation of 2- and 3-wire control is explained in Chapter 5.

3-Wire Control

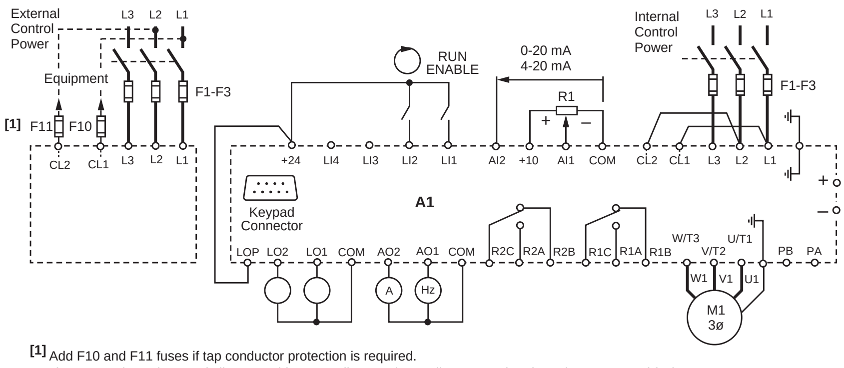


[1] Add F10 and F11 fuses if tap conductor protection is required.
The CL1 and CL2 inputs of all ATV56 drive controllers are internally protected and require no external fusing.

Figure 18: Recommended 3-Wire Control Circuit Diagram

Figure 18 is the recommended 3-wire control circuit diagram. It shows how to connect a branch circuit disconnect device and protective fusing to the drive controller. Additional sequencing logic may be required. Refer to Tables 11 to 15 on pages 30-32 for additional equipment required. The drive controller is factory set for 2-wire control. To set for 3-wire control, refer to Chapter 5.

2-Wire Control

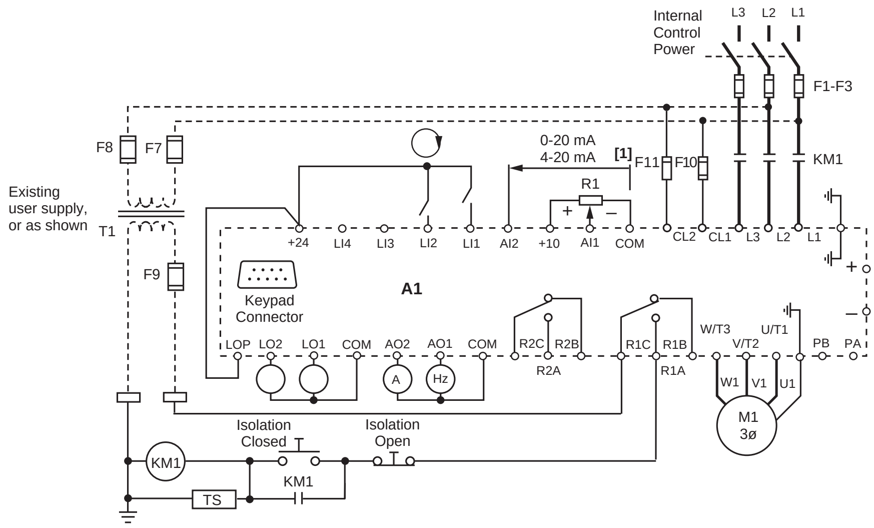


[1] Add F10 and F11 fuses if tap conductor protection is required.
The CL1 and CL2 inputs of all ATV56 drive controllers are internally protected and require no external fusing.

Figure 19: 2-Wire Control Circuit Diagram

Figure 19 is a 2-wire control circuit diagram. It shows how to connect a branch circuit disconnect device and protective fusing to the drive controller. Additional sequencing logic may be required. See Tables 11 to 15 on pages 30-32 for additional equipment required.

2-Wire Control with Isolation Contactor on Line Side (Coast to Stop)



[1] Add F10 and F11 fuses if tap conductor protection is required.
The CL1 and CL2 inputs of all ATV56 drive controllers are internally protected and require no external fusing.

Figure 20: 2-Wire Control Circuit Diagram with Isolation Contactor

Figure 20 is a 2-wire control circuit diagram with an isolation contactor on the line side. It shows how to connect a branch circuit disconnect device and protective fusing to the drive controller. Additional sequencing logic may be required. Refer to Tables 11 to 15 on pages 30-32 for additional equipment required.

The maximum number of operations of the KM1 contactor should not exceed one per minute for the ATV56U41N4 to ATV56D79N4 and ATV56U41M2 to ATV56D46M2 drive controllers.

Table 11: Recommended Equipment for 1 to 100 hp 460 V Drive Controllers

NOTE: The equipment listed in Tables 4 through 8 is valid for all versions of the circuit diagrams.

M1	A1		F1-F3		Input	F10, F11	Control	KM1	TS	T1	F7, F8	F9
Motor	**Controller ATV56•••N4**		**Line Power Fuses Ratings, Fuse Class**		**Fuse Carriers**	**Control Fuses [2]**	**Fuse Carriers**	**Line Contactor**	**Transient Suppressor**	**Xfmr [7]**	**Primary Xfmr Fuses [2]**	**Sec. Xfmr Fuses [2]**
HP	VT Low Noise	VT	CC Fast Acting	T								
1	U41	U41	600 V, 6 A	600 V, 6 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
2	U41	U41	600 V, 10 A	600 V, 10 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
3	U41	U41	600 V, 15 A	600 V, 15 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
4	U54	U41	600 V, 20 A	600 V, 20 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
5	U72	U54	600 V, 20 A	600 V, 20 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
7.5	—	U72	600 V, 25 A	600 V, 25 A	9080-FB3611CC [1] T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
7.5	U90	—		600 V, 30 A	T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
10	D12	U90		600 V, 35 A	T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
15	—	D12		600 V, 60 A	T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
15	D16	—		600 V, 60 A	T60060-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
20	D23	D16		600 V, 70 A	T60100-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D3210G6	LA4-DA2G	9070-K50D20	FNQ-R-1/4	FNQ-R-1/2
25	—	D23		600 V, 90 A	T60100-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D4011G6	LA4-DA2G	9070-K75D20	FNQ-R-3/10	FNQ-R-6/10
30	D33	—		600 V, 90 A	T60100-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D5011G6	LA4-DA2G	9070-K75D20	FNQ-R-3/10	FNQ-R-6/10
40	D46	D33		600 V, 125 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D8011G6	LA4-DA2G	9070-K75D20	FNQ-R-3/10	FNQ-R-6/10
50	D54	D46		600 V, 125 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D8011G6	LA4-DA2G	9070-K75D20	FNQ-R-3/10	FNQ-R-6/10
60	D64	D54		600 V, 175 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-F115G6	LA9-F980	9070-K200D20	FNQ-R-1-1/4	FNQ-R-1-6/10
75	D79	D64		600 V, 200 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-F115G6	LA9-F980	9070-K200D20	FNQ-R-1-1/4	FNQ-R-1-6/10
100	—	D79		600 V, 225 A	3 ea. T60400-1C [2]	KTK-R-3	9080-FB2611CC	LC1-F150G6	LA9-F980	9070-K200D20	FNQ-R-1-1/4	FNQ-R-1-6/10

[1] Square D Class CC Fuse Block numbers.
[2] Bussmann part numbers.
[7] T1 has been dimensioned to supply KM1 coil inrush and sealed VA requirements only. Any user control / pilot device additions may require re-dimensioning of T1 VA capacity.

Table 12: Maximum Allowable Line Fuse (F1 to F3) for 460 V Drive Controllers

Controller ATV56•••N4	Class CC (Fast-Acting)	Class T	Semiconductor
U41, U54, U72	600 V, 25 A	600 V, 35 A	—
U90, D12	—	600 V, 60 A	—
D16, D23	—	600 V, 100 A	—
D33, D46	—	600 V, 125 A	—
D54, D64, D79	—	600 V, 225 A	—

Table 13: Recommended Equipment for 1 to 50 hp 208/230 V Drive Controllers

M1	A1		F1-F3		Input	F1, F2	Control	KM1	TS	T1	F7, F8		F9
Motor	Controller ATV56•••M2		Line Power Fuses Ratings, Fuse Class		Fuse Carriers	Control Fuses [2]	Fuse Carriers	Line Contactor	Transient Suppressor	Xfmr [7]	Primary Xfmr Fuses [2]		Sec. Xfmr Fuses [2]
HP	VT Low Noise	VT	CC Fast Acting	T							208 V	230 V	
1	U41	U41	600 V, 10 A	600 V, 10 A	9080-FB3611CC [1] T60030-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
1.5	U41	U41	600 V, 15 A	600 V, 15 A	9080-FB3611CC [1] T60030-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
2	U41	U41	600 V, 20 A	600 V, 20 A	9080 FB3611CC [1] T60030-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
3	U41	U41	600 V, 25 A	600 V, 25 A	9080-FB3611CC [1] T60030-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
4	—	U41	600 V, 25 A	600 V, 25 A	9080-FB3611CC [1] T60030-3CR [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
5	U72	U72		600 V, 35 A	T60060-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
7.5	U90	U72		600 V, 45 A	T60060-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D2510G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
10	D12	U90		600 V, 60 A	T60060-3C [2]	KTK-R-3	9080-FB2611CC	LC1-D3210G6	LA4-DA2G	9070-K50D20	FNQ-R-1/2	FNQ-R-1/2	FNQ-R-1/2
15	D16	D12		600 V, 90 A	3 ea. T60100-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D4010G6	LA4-DA2G	9070-K75D20	FNQ-R-1	FNQ-R-3/4	FNQ-R-6/10
20	D23	D23		600 V, 110 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D8011G6	LA4-DA2G	9070-K75D20	FNQ-R-1	FNQ-R-3/4	FNQ-R-6/10
25	D33	D23		600 V, 150 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D8011G6	LA4-DA2G	9070-K75D20	FNQ-R-1	FNQ-R-3/4	FNQ-R-6/10
30	D33	D33		600 V, 150 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-D8011G6	LA4-DA2G	9070-K75D20	FNQ-R-1	FNQ-R-3/4	FNQ-R-6/10
40	D46	D33		600 V, 200 A	3 ea. T60200-1C [2]	KTK-R-3	9080-FB2611CC	LC1-F115G6	LA9-F980	9070-K200D20	FNQ-R-2-1/4	FNQ-R-1-6/10	FNQ-R-1-6/10
50	—	D46		600 V, 250 A	3 ea. T60400-1C [2]	KTK-R-3	9080-FB2611CC	LC1-F115G6	LA9-F980	9070-K200D20	FNQ-R-2-1/4	FNQ-R-1-6/10	FNQ-R-1-6/10

[1] Square D Class CC Fuse Block numbers.
[2] Bussmann part numbers.
[7] T1 has been dimensioned to supply KM1 coil inrush and sealed VA requirements only. Any user control / pilot device additions may require re-dimensioning of T1 VA capacity.

Table 14: Maximum Allowable Line Fuse (F1 to F3) for 208/230 V Drive Controllers

Controller ATV56•••M2	Class CC (Fast-Acting)	Class T
U41	600 V, 25 A	600 V, 45 A
U72, U90	—	600 V, 100 A
D12, D16	—	600 V, 125 A
D23, D33	—	600 V, 225 A
D46	—	600 V, 250 A

Table 15: Recommended Equipment for all Drive Controllers

R1	Potentiometer	9001 K2106
—	Push buttons	9001 KR1UH13
—	Control station enclosure (accepts R1 and two push buttons)	9001 KYAF3

Chapter 3 — Start-Up

INTRODUCTION

The ALTIVAR^{TM} 56 drive controller is software driven. Reconfiguration of the factory default settings may be required. If the factory settings do not match the requirements of your application, or if the drive controller must be reconfigured for a new application, refer to Chapter 5.

Generally, at least four key parameters should be checked and adjusted if necessary prior to motor operation:

- Nominal Current
- Motor Overload
- Control Type
- Rotation Normalization (*Note: Changing the wiring of drive controller line terminals L1, L2 and L3 does not affect the motor rotation direction*).

If the ALTIVAR 56 drive controller is supplied as part of a larger system, also refer to the documentation supplied with the system for applicable configuration settings. Observe the following precautions when using Normal control types:

- The adjustment range of the Nominal Current parameter is 45% to 105% of the drive controller rated output current, allowing the use of motors with horsepower equal to or one horsepower size less than the drive controller horsepower. To adjust the Nominal Current parameter, see Chapter 5.
- Before powering up for the first time, compare motor nameplate current rating with output current in Tables 1 through 4 on pages 3-4, depending on drive controller configuration. If the motor rating is not within 45% to 105% of the value in the table, it is necessary to use a different drive controller. For the ATV56U41, use the output current corresponding to motor horsepower and set Motor Power parameter for that value. See Chapter 5.
- The Nominal Current parameter **must** be set on the drive controller keypad display to match the motor full load current rating. If the Nominal Current parameter cannot be adjusted to the motor full load current, Normal control types cannot be used for the application.
- For multiple motor applications, consult the factory.

FACTORY SETTINGS

The ALTIVAR 56 drive controller is factory set to meet most applications. If the values below are compatible with the application, the drive controller can be started up. If the values listed below do not match the requirements of your application, change their settings with the keypad display. For detailed use of the keypad display, refer to Chapter 5.

Table 16: Factory Settings – Functions

Function	Factory Setting
Nominal Output Voltage and Frequency	Automatically set at first power-up according to the input frequency: 60 Hz input: 460 V (ATV56•••N4 units); 230 V (ATV56•••M2 units)
Nominal Current	0.9 times permanent output current of drive controller
Volts/Frequency Law	Normal linear law
Operating Frequency Range	60 Hz input: 0.1 to 60 Hz
Ramp Times	Acceleration: 3 s Deceleration: 3 s Ramp time: automatically adapted in case of overtorque
Braking-To-Standstill (low speed)	Automatic by DC injection for 0.5 s when frequency drops below 0.1 Hz DC current level: 0.7 times the permanent output current of drive controller
Motor Thermal Protection	0.9 times permanent output current of drive controller, see page 36
Control Scheme	Two-wire control

Table 17: Factory Settings – Inputs and Outputs

Inputs and Outputs	Terminal	Factory Setting	Programmable
Logic Inputs	LI1	Run Enable	No
	LI2	Run Forward	No
	LI3	Auto/Manual	Yes
	LI4	Auto Run	Yes
Analog Inputs	AI1	Speed Reference 1	Yes
	AI2	Speed Reference 2	Yes
Logic Outputs	LO1	At Speed	Yes
	LO2	Current Limit	Yes
	R1	Fault	No
	R2	Running State	Yes
Analog Outputs	AO1	Motor Speed	Yes
	AO2	Motor Current	Yes

CONTROL TYPES

The control type affects the amount of available motor torque. The control type setting is dependent on the type of motor used and the application. Control types are described below. For information on changing the control type, see Chapter 5.

Normal

The Normal control type is the factory setting. Normal is a sensorless flux vector control. In order to create high torque at low speeds, the drive controller maintains a 90° phase relationship between the rotor and stator electromagnetic fields by continuously calculating the position of the rotor in relation to the electrical position of the stator. It is generally applicable on asynchronous motors and provides good torque performance. When using Normal control, the motor horsepower must be equal to or one horsepower size less than the drive controller horsepower.

NOLD (No Load)

NOLD control maintains a constant volts / frequency ratio during acceleration but once the motor is stable, voltage to the motor is automatically reduced as a function of load. At light load, the motor voltage is minimized, even at motor base speed. This reduces audible motor noise without reducing motor RPM. NOLD control should not be used with motors in parallel. For more information, see Chapter 5.

MOTOR THERMAL OVERLOAD PROTECTION

⚠ CAUTION

LOSS OF MOTOR OVERLOAD PROTECTION

When using external overload relays connected to drive controller output, overload relay must be capable of operation over the expected range of drive controller output frequencies (including direct current).

When DC injection braking is used:

- Overload relay must be suitable for operation with direct current flowing to the motor.
- Do not use overload relays equipped with current transformers for sensing the motor current.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

MOTOR OVERHEATING

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds and loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.

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

- ALTIVAR 56 drive controllers provide indirect motor thermal protection by continuously calculating the theoretical thermal state of the motor. The drive controller will trip if this state reaches 109% of nominal current.
- The microprocessor calculates the theoretical thermal state of the motor from:
  — Motor thermal time constant based on assumed motor power
  — Operating frequency
  — Current absorbed by the motor
  — Running time
  — Assumed maximum ambient temperature of 40 °C around the motor

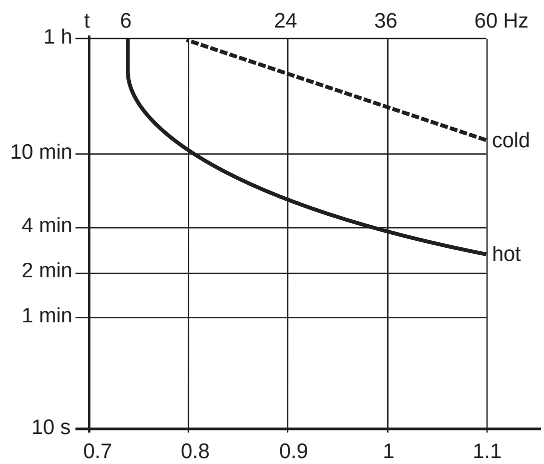


Figure 21: Thermal Curves

- External thermal overload relays are required when more than one motor is connected to the output or when the motor connected to the drive controller is less than half of the drive controller rating.
- The thermal state of the drive controller is not automatically reset when power is removed.

ADJUSTMENT OF MOTOR OVERLOAD

To adjust Motor Overload, first select the type of protection in the 7.4 → Fault Management menu. Two types of protection are available from the Motor Overload screen:

- Self-Cooled Motor
- No Thermal Protection

The drive controller is factory set for a self-cooled motor. Once the type of protection is selected, the Motor Overload current can be set in either the 1 → Parameter Setting menu or in the 7.4 → Fault Management menu. Motor Overload can be adjusted from 0.45 to 1.15 times the nominal drive controller current, factory preset at 0.9 times the nominal drive controller current. Adjust Motor Overload value to nominal motor current. For more information on configuring the drive controller, refer to Chapter 5.

AVAILABLE MOTOR TORQUE

Continuous Duty

For continuous duty reduced speed applications, motor torque derating may be necessary. This derating is linked to two causes:

- Although the current waveform is similar to a sine wave, motor heating is slightly greater than when operating directly from the input line supply. The resulting torque derating is approximately 5%. For 1.0 service factor motors, derating must be considered when choosing the continuous torque production capability of the motor at nameplate speed. For 1.15 service factor motors, derating of motor continuous torque capability is not required at nameplate rated speed.
- For self-ventilating motors, ventilation produced by the internal shaft fan decreases as speed is reduced, therefore requiring derating of the maximum continuous torque capability of the motor. Generally, the required derating occurs at approximately 50% of nameplate motor speed. Since motor designs vary, consult the motor manufacturer for the required derating for a specific motor.

Overtorque Capability and Speed Range

The driving overtorque capabilities of a given motor are determined by: the motor NEMA design category (Design B, Design D, etc.), no-load (magnetizing) current of the motor at nameplate speed, maximum transient output current of the drive controller, and the applied V/Hz at reduced speed.

Maximum transient overtorque capability is typically:

- Normal control type:
  - — ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2: 110% over 50:1 speed range
- NOLD control type:
  - — ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2: 110% over 10:1 speed range

With NOLD control, the motor overtorque capability begins to decrease below 50% of motor nameplate speed.

Overspeed Operation (f ≥ 60 Hz)

With an adjustable frequency drive controller, operation at speeds greater than motor nameplate speed may be possible. The following must be considered:

CAUTION

MACHINERY OVERSPEED

Some motors and/or loads may not be suited for operation above nameplate motor speed and frequency. Consult motor manufacturer before operating motor above rated speed.

Failure to follow this instruction can result in injury or equipment damage.

The drive controller is incapable of producing additional output voltage when operating above the nominal output frequency (60 Hz). When operating above the nominal output frequency, the available continuous motor torque will begin to decrease along with the motor maximum overtorque capability. Consult the motor manufacturer for continuous and overtorque torque capabilities of the particular motor.

Driving Torque Production Envelope

Figure 22 illustrates a typical continuous torque and overtorque driving capability for a typical NEMA Design B, 1.0 service factor motor with variable torque loads.

For 1.15 service factor motors, the continuous torque rating is 1.0 times the motor rated torque value from 50 to 100% of motor nameplate rated speed.

- Normal control type:
  - 100% torque typical at 50% of nominal frequency (over 2:1 speed range)
  - Torque decreases linearly to 50% at 0.1 Hz
  - Transient overtorque, typical ±10%:
  - ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2: 110% torque for 60 s.
- NOLD control type:
  - 100% torque typical at 50% of nominal frequency (over 2:1 speed range)
  - Torque decreases linearly to 50% at 10% of nominal frequency
  - Transient overtorque, typical ±10%:
  - ATV56U41N4 to D79N4 and ATV56U41M2 to D46M2: 110% torque for 60 s.

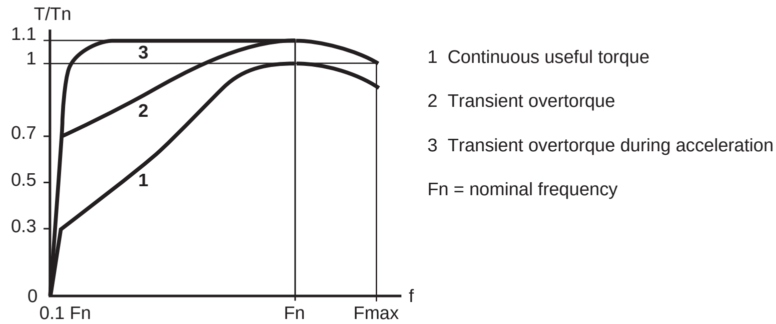


Figure 22: Typical Torque Curves

MOTOR CONSIDERATIONS

Many factors must be considered when controlling a motor with a drive controller. The following sections describe several drive controller characteristics as they relate to motor protection and performance.

Motor Insulation

ALTIVAR 56 drive controllers use pulse width modulation. Verify that the motor insulation is designed for this modulation method.

Motors in Parallel

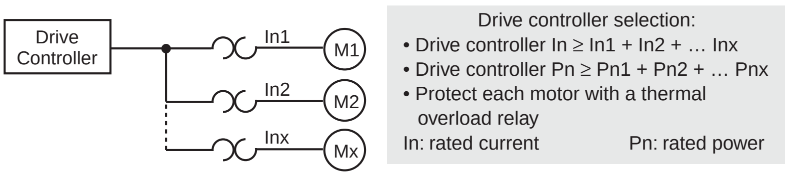


Figure 23: Motors in Parallel

To operate motors in parallel, use the keypad display to set the Control Type to “Normal.” For information on adjusting and disabling parameters, see Chapter 5.

If three or more motors are to be installed in parallel, consult factory.

Output Contactor Between Motor and Drive Controller

When using an output contactor between the drive controller and motor, use of the Bypass application function is recommended. In order to set the motor parameters for optimum performance, the motor must be directly connected to the output of the drive controller at least one time during drive controller power-up. For more information, refer to Chapter 5.

Additional Motor Connected Downstream of the Drive Controller

When connecting an additional motor, comply with the recommendation for “Motors in Parallel” on page 39.

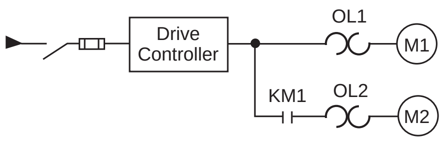


Figure 24: Connecting an Additional Motor

If the motor is to be connected to the drive controller while the drive controller is running, the sum of the running motor current(s) plus the expected starting current of the switched motor must not exceed 90% of the drive controller’s transient output current rating.

Table 18: Operating Non-Standard Motors

Description	Overload	Control Type
Motors in parallel	Disable [1]	Normal
Additional motor	Disable [1]	Normal
Synchronous permanent magnet	Not Recommended	
Synchronous wound field	Not Recommended	
Synchronous reluctance	Not Recommended	

[1] An external thermal overload relay is required if the drive controller protection is disabled.

Chapter 4 — Diagnostics

PRECAUTIONS

Read the safety statement below before proceeding with any maintenance or troubleshooting procedures.

Table 27 on pages 45-48 lists fault messages (displayed on the keypad display), probable causes or faults, and associated corrective action. Before taking corrective action, remove all power and check the bus voltage (Procedure 1), input line voltage (Procedure 2 on page 43) and peripheral equipment (Procedure 3 on page 43).

⚠ DANGER

HAZARDOUS VOLTAGE

Read and understand these procedures before servicing ALTIVAR 56 drive controllers. Installation, adjustment, repair and maintenance of these drive controllers must be performed by qualified personnel.

Failure to follow this instruction will result in death or serious injury.

PROCEDURE 1: BUS VOLTAGE MEASUREMENT

⚠ DANGER

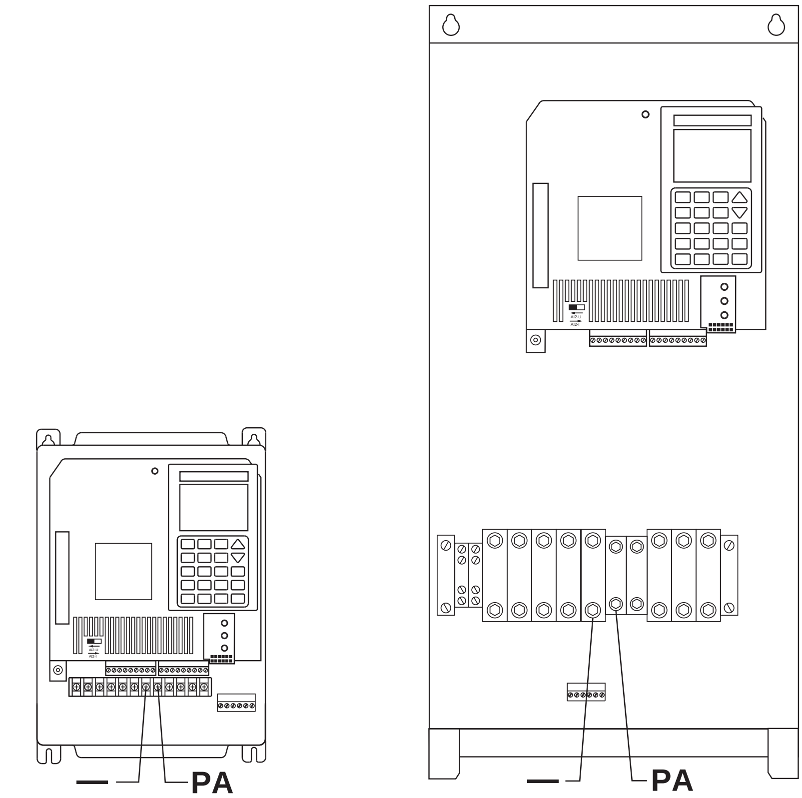
HAZARDOUS VOLTAGE

- This device contains energy storage devices. Read and understand Bus Voltage Measurement Procedure before performing procedure. Measurement of DC bus capacitor voltage must be performed by qualified personnel.
- DC bus LED is not an accurate indication of absence of DC bus voltage.
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

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

The PA and – terminals are located inside the drive controller (see Figure 25 on page 43). To measure the bus capacitor voltage:

1. Disconnect and verify all power is removed from drive controller.
2. Wait 1 minute to allow the DC bus to discharge.
3. Open the front cover of the drive controller.
4. Set the voltmeter to the 1000 VDC scale. Measure the bus capacitor voltage between the PA and – terminals to verify the DC voltage is less than 45 V. **Do not short across capacitor terminals with voltage present!**
5. If the bus capacitors are not fully discharged, contact your local representative. **Do not operate the drive controller**.



ATV56U41N4 to D12N4 and
ATV56U41M2 to U90M2

ATV56D16N4 to D79N4 and
ATV56D12M2 to D46M2

Figure 25: Location of PA and – Terminals: ATV56U41N4 to D79N4 & ATV56U41M2 to D46M2

PROCEDURE 2: INPUT LINE VOLTAGE MEASUREMENT

To measure the input line voltage:

1. Perform Bus Voltage Measurement procedure (see page 42).
2. Attach meter leads to L1 and L2. Set voltmeter to the 600 VAC scale.
3. Reapply power. Check for correct line voltage per drive controller nameplate rating.
4. Remove power and repeat procedure for L2 and L3, and L1 and L3.
5. When all phases have been measured, remove power. Remove meter leads and reinstall covers.

PROCEDURE 3: CHECKING PERIPHERAL EQUIPMENT

The following equipment may need to be checked. Follow the manufacturer’s procedures when checking this equipment.

1. A protective device such as a fuse or circuit breaker may have tripped.
2. A switching device such as a contactor may not be closing at the correct time.
3. Conductors may require repair or replacement.
4. Connection of cables to the motor or connections to ground may need to be checked. Follow NEMA standard procedure WC-53.
5. Motor insulation may need to be checked. Follow NEMA standard procedure MG-1. Do not apply high voltage to drive controller output terminals (U/T1, V/T2 or W/T3). Do not connect high potential dielectric test equipment or insulation resistance tester to the drive controller since the test voltages utilized may damage the drive controller. Always disconnect the drive controller from the conductors or motor while performing such tests.

PREVENTIVE MAINTENANCE

Before performing preventive maintenance, remove all power and check the bus voltage (Procedure 1 on page 42).

The following preventive maintenance procedures are recommended at regular intervals:

- Check the condition and tightness of the connections.
- Make sure the ventilation is effective and temperature around the drive controller remains at an acceptable level.
- Remove dust and debris from the drive controller, if necessary.
- If anything unusual occurs when putting the drive controller into service or during operation, be sure all recommendations relating to the environment, mounting and connecting the drive controller have been followed.

LEDS

The LEDs on the front of the drive controller indicate the following:

FAULT (Red)	**Illuminated:** Fault exists.
CAUTION (Yellow)	**Illuminated with Fault LED OFF:** Drive controller is running and in current limit. *NOTE: LED may appear to flash rapidly as drive controller regulates at current limit.* **Slow Flashing with Fault LED OFF:** This Pre-Alarm indicates either a Drive Overtemperature Fault (ATV56D16N4 to D79N4 and ATV56D12M2 to D46M2) or a Motor Overload Fault. Consult Keypad Display for Motor Thermal State or Drive Thermal State (ATV56D16N4 to D79N4 and ATV56D12M2 to D46M2) to determine which condition is causing the Pre-Alarm. If either of these thermal states exceeds 100%, the Caution LED will flash slowly. **Illuminated with Fault LED ON:** Drive controller fault exists on either Motor Overload or Drive Overtemperature and the cool-down period has not yet expired. Consult the fault display on the keypad or the fault history in Menu 3 to determine the most recent fault.
POWER (Green)	**Illuminated:** Drive controller is powered; DC bus ≥ 50 V or voltage is present at CL1-CL2.
DC BUS (RED)	**Illuminated:** DC bus ≥ 50 V

Figure 26: Drive Controller LEDs

FAULT MESSAGES

The ALTIVAR 56 drive controller can store up to eight faults and display them as messages on the keypad display. These fault messages, listed in Table 27, allow access to Fault History Screens, which display the drive controller run status at the time of each fault. For more information on Fault History Screens, see Chapter 5.

Figure 27: Fault Messages

Fault Message	Probable Cause	Troubleshooting Procedure
(Display off or partial display)	1. No control supply. 2. Control voltage too low.	1. Check input line voltage (Procedure 2 on page 43). 2. Check fuses and circuit breaker (Procedure 3 on page 43). 3. Check CL1-CL2 control terminal connections.
IN-PHASE LOSS (Input phase loss)	1. No supply to terminals L1-L2-L3. 2. Power fuses blown. 3. Brief input line failure (t ≥ 200 ms). 4. Internal connections.	1. Check input line voltage (Procedure 2 on page 43). 2. Check fuses and circuit breaker (Procedure 3 on page 43). 3. Reset drive controller. 4. Check connections.
UNDERVOLTAGE [1]	1. Supply too low: V ≤ 380 V (ATV56•••N4) V ≤ 170 V (ATV56•••M2) 2. Temporary voltage drop (t ≥200 ms). 3. Internal connections.	1. Check input line voltage (Procedure 2 on page 43). Check Nominal Motor Voltage parameter (see Chapter 5). 2. Reset drive controller. 3. Check connections.
AC-LIN. OVERVOL [1] (AC Line Overvoltage)	1. Supply too high: V ≥ 550 V (ATV56•••N4) V ≥ 270 V (ATV56•••M2)	1. Check input line voltage (Procedure 2 on page 43). Check Nominal Motor Voltage parameter (see Chapter 5).
DC-BUS OVERVOL [1] (DC Bus Overvoltage)	1. Overvoltage or overcurrent due to excessive braking or an overhauling load.	1. Increase deceleration time. Add braking option if necessary. Reset is possible if line voltage ≤ 550 V.
OVERTEMP DRIVE (Drive Overtemp.)	1. Heat sink temperature too high (≥ 203 °F / 95 °C).	1. Check motor load, fan and ambient temperature around drive controller. Wait for drive controller to cool down before resetting.
MOT. OVERLOAD (Motor Overload)	1. If thermal trip setting is ≥ 118% of normal thermal state (109% of nominal current), thermal trip is due to prolonged overload or output phase failure. 2. Motor power rating too low for application.	1. Check setting of MOT. OVERLOAD parameter and compare with motor In. Check load and compare with operating speed. Check braking conditions (possibility of single phase operation). Wait approximately 7 minutes before resetting. 2. Verify motor and drive controller selection is correct for application. 3. For motors with continuous current rating less than 50% of drive controller current rating, see Chapter 5.

[1] Fault cannot be disabled; always causes a freewheel stop.
[2] Occurs upon power up only.

Figure 27: Fault Messages (Continued)

Fault Message	Probable Cause	Troubleshooting Procedure
SHORT CIRCUIT [1] (SHORT CKT_ = Desaturation SHORT CKT. = LIC exceeded)	1. Short circuit or grounding on drive controller output. (Short circuit_ or short circuit.) 2. Internal drive fault. (Short circuit_) 3. Motor improperly applied. (Short circuit.)	1. Remove all power. With drive controller disconnected, check connecting cables and motor insulation. 2. Use drive controller self-diagnostics. See Chapter 5. 3. See "MOTOR CONSIDERATIONS" on page 39.
PRECHARGE FAIL[2]	1. Capacitor charge relay closure control fault.	1. Check connections in drive controller after following Bus Voltage Measurement Procedure (see page 42).
INTERNAL FAULT [1]	1. Internal connection fault. 2. Missing connections on CL1 and CL2.	1. Check internal connections after following Bus Voltage Measurement procedure (see page 42).
LOSS FOLLOWER	1. Loss of 4-20 mA signal on AI2 input.	1. Verify signal connections. 2. Check signal.
GROUND FAULT [1]	1. Short circuit of phase to earth or grounding on the output of the drive controller.	1. Remove all power. With drive controller disconnected, check connecting cables and motor insulation. 2. Use drive controller diagnostics. See Chapter 5.
MEMORY FAILURE [2]	1. EEPROM memory storage fault.	1. Recall factory or customer settings with keypad.
AUTO-TEST FAIL[2]	1. Main control board failure.	1. Remove all power. Check control board connections with drive controller disconnected. 2. Replace main control board.
CONTROL SUPPLY [2]	1. CL1/CL2 not connected.	1. Check connection of CL1 and CL2.
OVERSPEED	1. Output frequency is 20% above Maximum Frequency parameter setting (no tachometer present).	1. Check load base speed and power rating, compare with operating speed and drive controller/motor power rating. 2. Check setting of damping and bandwidth (if used) adjustments.
DYNAMIC BRAKE	1. DB transistor short circuit. 2. DB resistor short or open circuited. 3. Braking resistor thermal contact tripped.	1. Remove all power. Check connecting cables and DB resistor with drive controller disconnected. 2. Use drive controller self-diagnostics.See Chapter 5. 3. Check dynamic brake connections. Change resistor if necessary.
LINK FAULT	1. Internal fault. 2. Software execution stopped.	1. Note LED sequence on drive controller: – FAULT, CAUTION, POWER all illuminated, or – CAUTION, POWER illuminated 2. Cycle power. 3. If fault persists, replace keypad or main control board.

[1] Fault cannot be disabled; always causes a freewheel stop.
[2] Occurs upon power up only.

Figure 27: Fault Messages (Continued)

Fault Message	Probable Cause	Troubleshooting Procedure
SEQUENCE T. OUT (Sequence Time out)	1. Sequence input not received after Run command within programmed time (Bypass function).	1. Check connection between user-supplied contact and logic input, ensuring it is connected to programmed input. 2. Verify operation of contact. 3. Verify operation of external control sequencing.
PROCESS TIME OUT	1. Process input not received after Run command within programmed time (Bypass function).	1. Check connection between user-supplied contact and logic input, ensuring it is connected to programmed input. 2. Verify operation of contact. 3. Verify operation of process.
TRANS. SHORT C. or GF (Transistor Short Circuit)	1. Transistor is in short circuit.	1. Contact local service representative.
OPEN TRANSISTOR	1. Transistor has failed open.	1. Contact local service representative.
OUT. PHASE LOSS	1. Motor power rating too small for controller. 2. Output phases disconnected.	1. Motor power rating must be > 45% of controller power rating. 2. Check output power conductors and connectors for lack of continuity. 3. Check output contactor sequencing.

[1] Fault cannot be disabled; always causes a freewheel stop.
[2] Occurs upon power up only.

The additional faults listed in Table 19 may be displayed if an option module is installed and a fault occurs.

Table 19: Fault Messages from Option Modules

Fault Messages	Probable Cause	Troubleshooting Procedure
OVERSPEED	**Without tachometer:** 1. Output frequency is 20% above Maximum Frequency parameter setting.	1. Check load base speed and power rating, compare with operating speed and drive controller/motor power rating.
	With tachometer: 1. Incorrect adjustment of tachometer feedback. 2. Machine overload. 3. No tachometer signal. 4. Tachometer polarity incorrect.	1. Check feedback. 2. Check load base speed and power rating, compare with operating speed and drive controller/motor power rating. 3. Check tachometer connection. 4. Check tachometer polarity.
CUSTOM. FAULT	1. User defined.	1. Dependent on user setting.
FEEDBACK LOSS	1. No tachometer feedback signal.	1. Check tachometer wiring.

Other faults may be displayed depending on how the drive controller is programmed. For more information on faults and self-diagnostics, refer to Chapter 5.

Chapter 5 — Configuration

KEYPAD DISPLAY

The ALTIVAR 56 drive controller includes a keypad display mounted on front for:

- Identification of the drive controller
- Display of parameters and faults
- Recall and adjustment of drive controller parameters
- Local command of the drive controller

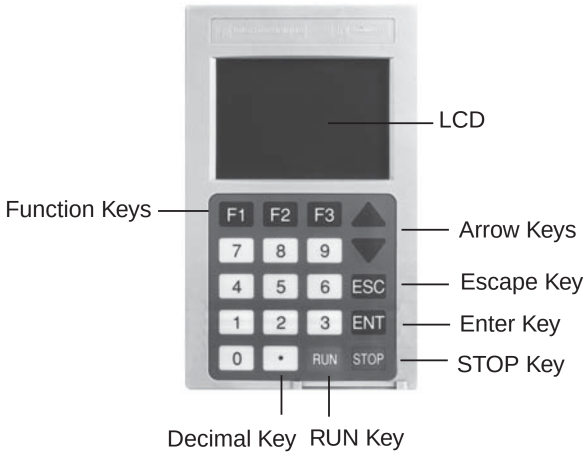


Figure 28: Keypad Layout

LCD Display

The LCD display is a 128 x 64 point graphic screen consisting of six 21-character lines. The display can be programmed to show text lines and bar graphs, and has reverse video capability for enhancement of text or numbers on the screen.

ENT Key

Use the ENT (Enter) key to:

- Confirm a menu selection
- Go to the next menu

ESC Key

Use the ESC (Escape) key to:

- Reset an adjustment to its original value
- Leave the present menu and go back to the previous menu

Arrow (▲ ▼) Keys

Use the arrow keys to:

- Scroll through the screens and menus
- Select an item or function
- Increase or decrease numeric parameters (i.e. from 12.5 A to 12.6 A). The arrow keys adjust the portion of the parameter value highlighted on the display. To increase the scrolling speed, press and hold the arrow key for two seconds.

Numeric Keys

Use the numeric and decimal point keys to enter numeric values for parameter adjustments. The format and limits of values entered are checked by the control software according to the nature of the parameter.

Function Keys

Use the function keys to program the drive controller or issue commands. Operation of the function keys depends on whether the drive controller is in Terminal Command or Keypad Command mode.

In Terminal Command (drive controller receives its Run, Stop, and Reference Frequency signals from the drive controller terminal strip) the function keys operate as follows:

- F1 calls up the Help menu
- F2 returns to the Display Mode screen (page 53 and page 55), unless set for Terminal / Keypad switching in the 5→Keypad Configuration menu
- F3 functions as a jump key

To jump directly to a menu, press F3. A window will appear. Enter the menu's index number and press ENT. The display will jump directly to that menu. Index numbers are found in the upper left corner of the display for each menu, and are also listed in Table 22 on page 57. Throughout this manual, menu names are preceded by their index numbers. For example, in a reference such as "1→Parameter Setting," "1" is the index number for the Parameter Setting menu.

In Keypad Command (drive controller receives its Run, Stop and Reference Frequency signals from the keypad display). The functions of the keys are:

- F1 Resets the drive controller after a fault.
- F2 Scrolls through the displays.
- F3 Not assigned (No functionality).

Terminal Command and Keypad Command are described further in the 5→Keypad Configuration menu section (page 64).

Key Cover

A plastic cover is factory-installed over the RUN and STOP keys. For access to RUN and STOP keys and local command of drive controller, this cover must be removed. See Figure 32 on page 52. The key cover can be re-installed to cover RUN and STOP keys.

STOP Key

The STOP key, active in Terminal and Keypad Command modes, commands normal stop of the motor. The motor follows ramp as determined by selected deceleration time.

⚠ WARNING

INABILITY TO INITIATE STOP

- With the key cover removed, the STOP key is enabled and active in both Terminal Command and Keypad Command modes.
- When the key cover is installed, the STOP key is not accessible. Verify that appropriate system STOP functions are in place when the STOP key is not accessible.

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

RUN Key

The RUN key commands the motor to run when the drive controller is in Keypad Command mode. The motor follows the ramp determined by the selected acceleration time. LI1 (Run Enable) on J12 must be high for the RUN key to command the motor.

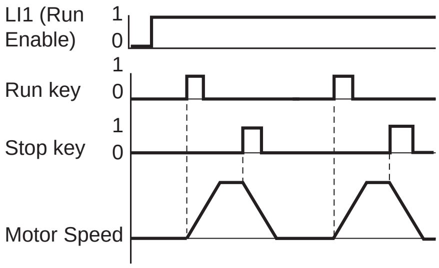
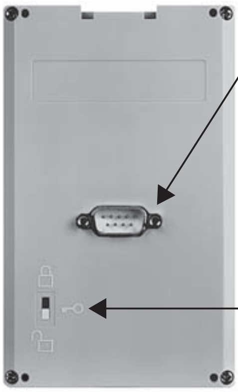


Figure 29: Run Timing Diagram

Keypad Display Connections



Sub D 9-pin connector for connection to the drive controller.

- For remote handheld use, connect terminal with a 3-meter cable (part # VW3-A66311) or 2-meter cable (part # VW3-A66312).
- For mounting in an enclosure door, use kit # VW3-A66101 (3-meter cable) or VW3-A66100 (2-meter cable).

Switch for access locking to prohibit or authorize changes to the configuration.

Figure 30: Rear View of Keypad Display

Figure 31: Removing Keypad

NOTE: Keypad supplied with this drive controller has been matched with the software revision level. Do not install keypad on another drive controller. Installation of an incompatible keypad may result in non-recognition of the keypad by the drive controller at power-up.

Figure 32: Access to RUN and STOP Keys

MENU OVERVIEW

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Unlocking keypad display (page 56) gives access to parameters.
- Parameter changes affect drive controller operation. Most parameter changes require pressing ENT. Some parameter changes, such as reference frequency, take effect as soon as you press the ▲ or ▼ key.
- Read and understand this manual before using the keypad display.

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

Selecting the Language

When drive controller is powered up for the first time, the Language menu appears allowing you to choose the language used on all menus. Scroll through the language choices with the ▲ and ▼ keys, and make a selection by pressing ENT. Upon subsequent power ups, the display passes directly to the Display screen. To display Language menu after first power up, press the ESC key twice.

Drive Configuration

The Drive Configuration screen shows factory settings of the configuration parameters. Voltage is fixed at 460 V for the 460 V units (ATV56•••N4) and is set to 230 V at first power up for 230 V units (ATV56•••M2). This screen is only shown on first power up or after a total return to factory settings. Advance to the Drive Configuration screen from the Language menu by pressing ENT.

Drive Identification

The Drive Identification screen is automatically displayed on power up, or can be accessed from the Drive Configuration screen by pressing ENT. The Drive Identification screen displays the following nameplate information:

- ATV56 catalog number
- Software version
- Motor power
- Drive nominal current
- I maximum / I nominal
- Voltage

Display Mode

From the Drive Identification screen, press ENT to advance to the Display screen. While the drive controller is running, the default display is a bar graph showing reference frequency and drive status. The type and number of functions displayed can be modified in the 4→Display Configuration menu (page 62). If the drive controller is in fault state, the Display screen shows the fault type. If the drive controller has been programmed for Keypad Command, the last line of the Display screen indicates the functions of F1, F2, and F3 keys.

Main Menu

From the Display screen, press ENT to advance to the Main menu. Depending on the access level selected (page 56), the Main menu contains two (Total Lock), or nine (Total Unlock) sub-menus.

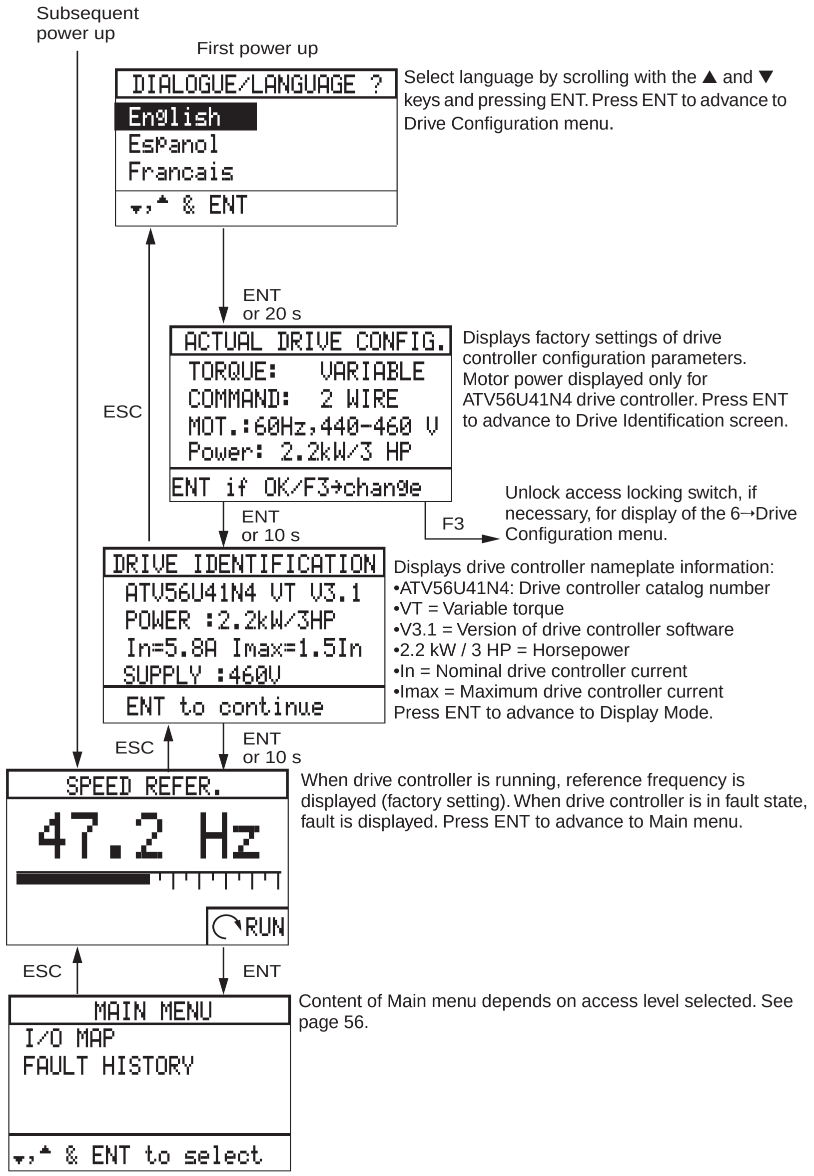
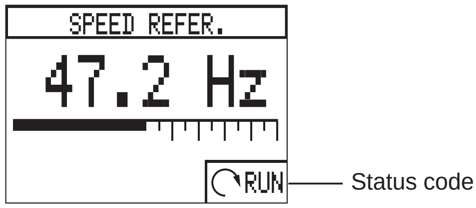


Figure 33: Menus Viewed at First Power Up (Factory Default Screens)

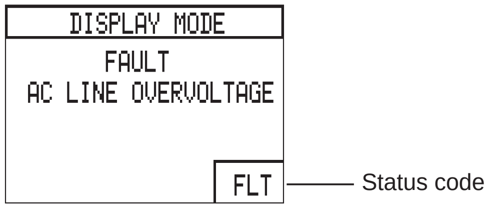
DISPLAY MODE

Drive Controller Running



When the drive controller is running, the Display screen can show one bar graph, two bar graphs, or fourteen items in four tables. Factory setting is one bar graph displaying reference frequency. Drive controller status is also displayed in the lower right corner of the screen. Status codes are defined in Table 20. The type and number of functions shown can be modified in the 4→Display Configuration menu (page 62) when access level is set to Total Unlock.

Drive Controller in Fault State



When a fault appears, the drive controller trips, the motor follows the programmed fault stop (page 100), and the Display screen shows the fault type. Table 21 lists the faults that the drive controller can display.

Table 20: Display Mode Status Codes

Code	Definition	Code	Definition
NLP	No Line Power (control power supplied separately)	CLI	Current Limit
RDY	Drive Ready	DCB	DC Injection Braking
RUN	Drive Running (at speed)	NRP	No Run Permissive (LI1 open)
↻	Forward Direction	BRK	Braking
ACC	Accelerating	FLT	Fault
DEC	Decelerating		

Table 21: Faults Displayed on Display Mode Screen

Fault Designation	Description
IN-PHASE LOSS	Input Phase Loss: loss of power or blown fuses. A brief loss of input supply phase (≤ 200 ms) is not detected
UNDERVOLTAGE	Undervoltage: input voltage ≤ 380 V (60 Hz, 460 V) ATV56•••N4 or input voltage ≤ 170 V ATV56•••M2 or temporary voltage loss (t ≥ 200 ms)
AC-LIN.OVERVOL.	AC line overvoltage: input voltage to power supply too high input voltage ≥ 550 V (60 Hz, 460 V) ATV56•••N4 or input voltage ≥ 270 V ATV56•••M2
DRIVE OVERTEMP.	Drive overtemperature: heatsink temperature too high
MOT. OVERLOAD	Motor overload: thermal trip because of prolonged overload or running in single phase on the output, or motor power rating too low for application
LOSS FOLLOWER	Loss of follower: loss of the 4-20 mA or 20-4 mA reference at AI2 input
OUT. PHASE LOSS	Loss of an output phase
DC-BUS OVERVOL.	DC bus overvoltage/overcurrent due to excessive braking or overhauling load

Table 21: Faults Displayed on Display Mode Screen (Continued)

Fault Designation	Description
SHORT CIRCUIT or SHORT CIRCUIT.	Short circuit or grounding on drive controller output; may be internal or external
GROUND FAULT	Ground fault: short circuit to earth on the output of the drive controller
PRECHARGE FAIL	Precharge failure: capacitor precharge relay fault
INTERNAL FAULT	Internal fault or missing connections on CL1 and CL2
MEMORY FAILURE	Error in storing to EEPROM
AUTO-TEST FAIL	Main control board failure
OVERSPEED	Without a tachometer, fault occurs when output frequency is 20% above Maximum Frequency parameter setting for 250 mS.
SEQUENCE T. OUT	Sequence time-out: sequence input not received after Run command within programmed time. Used with Bypass function. See page 85.
PROCESS TIME OUT	Process time-out: process input not received after Run command within programmed time. Used with Bypass function. See page 85.
DYNAMIC BRAKE	Dynamic brake resistor lost or connection open. See page 108.
TRANS. SHORT C. or GF	Short circuit in transistor
OPEN TRANSISTOR	Transistor has failed open
CONTROL SUPPLY	CL1/CL2 not connected. Only recognized upon power-up.
--No Fault--	No fault recorded

ACCESS LEVELS

The keypad display can be locked to limit access to drive controller configuration and adjustment parameters. Two access levels are available: Total Lock (factory default) and Total Unlock.

Access levels are selected by positioning the access locking switch on back of the keypad display (Figure 30 on page 52).

Total Lock

When the access locking switch is in locked position, the keypad display is in Total Lock mode. **Total Lock is the factory preset condition of the drive controller.**

In Total Lock mode, the choices available from the Main menu are 2→ I / O Map and 3→ Fault History. If Keypad Command is active (page 64), the keypad display can be used for local command of the drive controller; however, all drive controller adjustment and configuration parameters are protected from change.

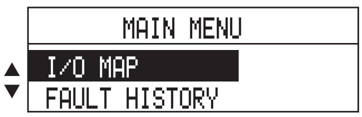


Figure 34: Main Menu in Total Lock Mode

To change access level when in Total Lock mode:

1. If Keypad Command is active, from any point in the Level 1 & 2 Software stop the drive controller, disconnect the keypad display, and set the access locking switch to unlock. If Terminal Command is active, it is not necessary to stop the drive controller before disconnecting the keypad display.
2. Reconnect the keypad display.
3. Press ENT and display will return to the Drive Configuration menu. The drive controller is now in Total Unlock mode. Press ENT to advance through the power-up screens to the Main menu.

Total Unlock

When the access locking switch is in the unlocked position, all drive controller adjustments and configurations are accessible from the Main menu.

MENU SUMMARY: USING THIS CHAPTER

Table 22 is an overview of all sub-menus accessible from the Main menu. Use the table as a reference for menu index numbers. The menu index numbers can be used with the F3 key when it is set to Jump (factory setting) to go directly to the associated menu. Use the table also as a guide to this manual. To find a menu description in the manual, go to the page number indicated in the table.

Table 22: Menu Summary

Access Level			Index No	Menu	Page No.
Total Lock	Partial Unlock	Total Unlock			
No	Yes [1]	Yes [1]	1→	Parameter Setting	58
Yes [1]	Yes [1]	Yes [1]	2→ 2.1→ 2.2→ 2.3→ 2.4→	I/O Map Logic Input Map Analog Input Map Logic Output Map Analog Output Map	61
Yes [1]	Yes [1]	Yes [1]	3→	Fault History	62
No	No	Yes [1]	4→ 4.1→ 4.2→ 4.3→	Display Configuration One Bar Graph Two Bar Graphs Scroll, Four Tables	62 63 64 64
No	No	Yes	5→	Keypad Configuration	64
No	Yes	Yes	6→ 6.1→ 6.2→ 6.3→	Drive Configuration Torque Type Command Type Motor Power (ATV56U41 only)	66 67 67 67
No	No	Yes	7→ 7.1→ 7.2→ 7.3→ 7.4→	General Configuration Drive Parameters Application Functions Output Assignments Fault Management	69 69 77 96 100
No	No	Yes	8→	Diagnostic Mode	109
No	No	Yes	9→ 9.1→ 9.2→ 9.3→	Drive Initialization Total Factory Settings Store User Settings Recall User Settings	112 112 112 113

[1] Accessible with motor running

1→PARAMETER SETTING MENU

```
1→PARAMETER SETTING
LOW SPEED     :  0Hz
HIGH SPEED    : 60Hz
ACCELERATION  :  3 s
DECELERATION  :  3 s
▼,▲ & ENT to modify
PROFILE       :   20%
DAMPING       :   33%
MOT. OVERLOAD:     7A
SP GAIN       : +9999
OFFSET        :    +0
KP            :  100%
KI            :     0
PI FLT RATIO  :  100%
PI SET POINT  :     0
PI SP MANUAL  :0.0 Hz
```

The functions accessible from the Parameter Setting menu depend not only on the control type selected (page 76) but also on whether or not the drive controller is configured for PI Regulator. Factory configuration is Normal control type and no PI Regulator. Table 23 on page 58 illustrates the functions available with the various configurations.

Table 23: Parameter Setting Menu

Variable Torque or Variable Torque Low Noise	
Normal	**NOLD**
Low Speed	Low Speed
High Speed	High Speed
Acceleration	Acceleration
Deceleration	Deceleration
Profile	Damping
Damping	Motor Overload
Motor Overload	SP Gain [1] Offset [1] KP [1] KI [1] PI FLT Ratio[1] PI Set Point[2] PI SP Manual[3]

[1]Appears only if Yes, Set Point has been selected in the PI Regulator menu (page 88)
[2]Appears only if Keypad has been selected for setpoint entry in the Set Point menu (page 89)
[2]Appears only if Keypad has been selected for manual setpoint entry in the Setpoint Manual menu (page 94)

The following sections describe the functions available from the 1→Parameter Setting menu. To change the settings of these parameters, scroll to the parameter on the menu, type in a value, and press ENT.

Low Speed

Low Speed corresponds to the lower limit of the speed reference at AI1 or AI2 (see Figure 35) and limits the minimum commanded running frequency to a value between 0 and High Speed. It does not affect the starting frequency. If the drive controller is commanded to run below the programmed Low Speed, the output will be limited to the Low Speed value. Factory setting is 0 Hz.

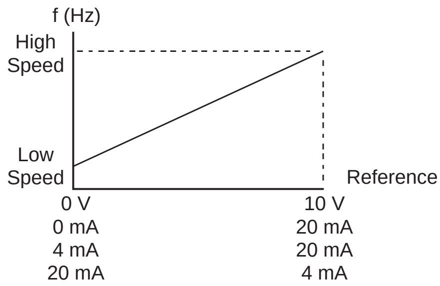


Figure 35: Speed Reference

High Speed

High Speed corresponds to the upper limit of the speed reference at AI1 or AI2 (see Figure 35) and limits the maximum commanded running frequency to a value between Low Speed and Maximum Frequency (set in the 7.12→Control Parameters menu). If the drive controller is commanded to run above the programmed High Speed, the output will be limited to the High Speed value. Factory setting is 60 Hz.

Acceleration Time

Acceleration Time is adjustable between 0.1 and 999.9 seconds and represents the time the drive controller will take to accelerate between 0 Hz and Nominal Frequency (set in the 7.11→Motor Parameters menu). Acceleration Time determines the base line slope used by the drive controller to accelerate between frequencies. Factory setting is 3 seconds.

If the acceleration slope is too steep for the motor to accelerate the connected load, the acceleration slope will be modified to minimize the possibility of a nuisance trip.

Deceleration Time

Deceleration Time is adjustable between 0.1 and 999.9 seconds and represents the time the drive controller will take to decelerate between Nominal Frequency (set in the 7.11→Motor Parameters menu) and 0 Hz. Deceleration Time determines the base line slope used by the drive controller to decelerate between frequencies. Factory setting is 3 seconds.

If the deceleration slope is too steep for the motor to decelerate the connected load, the deceleration slope will be modified to minimize the possibility of a nuisance trip.

Damping

Damping is available with any drive controller configuration (page 67). This parameter adjusts the integral gain of the frequency loop to match the inertial response of the load to the frequency response of the drive controller. The adjustable range varies with the drive controller configuration:

- 1 to 100% for NOLD control with either variable torque configuration
- 1 to 800% for Normal control with either variable torque configuration

When Damping is properly adjusted and the drive controller is not in current limit or ramp modification, the motor speed should follow the speed reference ramp without oscillation and with little overshoot. During steady-state operation with constant load, the motor speed should remain constant with no oscillation. If the motor load changes, the drive controller should correct the motor speed disturbance rapidly with little or no oscillation.

The factory preset value of Damping is 20% which corresponds to 1.5 times the factory set motor inertia for the selected motor power rating. Most applications do not require Damping adjustment.

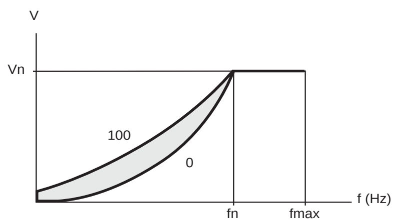
If the motor speed oscillates or overshoots the desired speed during changes in the motor speed reference or during steady-state operation with constant load, Damping is set too low and should be increased.

If the motor speed follows the speed reference ramp sluggishly or tends to vary during steady-state operation with constant load, Damping is set too high and should be decreased.

Profile

Profile is used only when the drive controller is configured for Normal control type. This parameter shapes the V / Hz profile of the output. Profile can be set to a value between 0 and 100, factory preset to 20.

During changes in speed command, the V / Hz profile becomes linear, intersecting the Vn and fn points of Figure 36. As a result, there is no reduction in available motor torque during speed changes.



Shaded area denotes zone within which drive functions when Profile is set between 0 and 100.

Figure 36: Profile

Profile is not available when NOLD control type is selected.

Motor Overload

⚠ CAUTION

MOTOR OVERHEATING

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds or loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.

Failure to follow this instruction can result in injury or equipment damage.

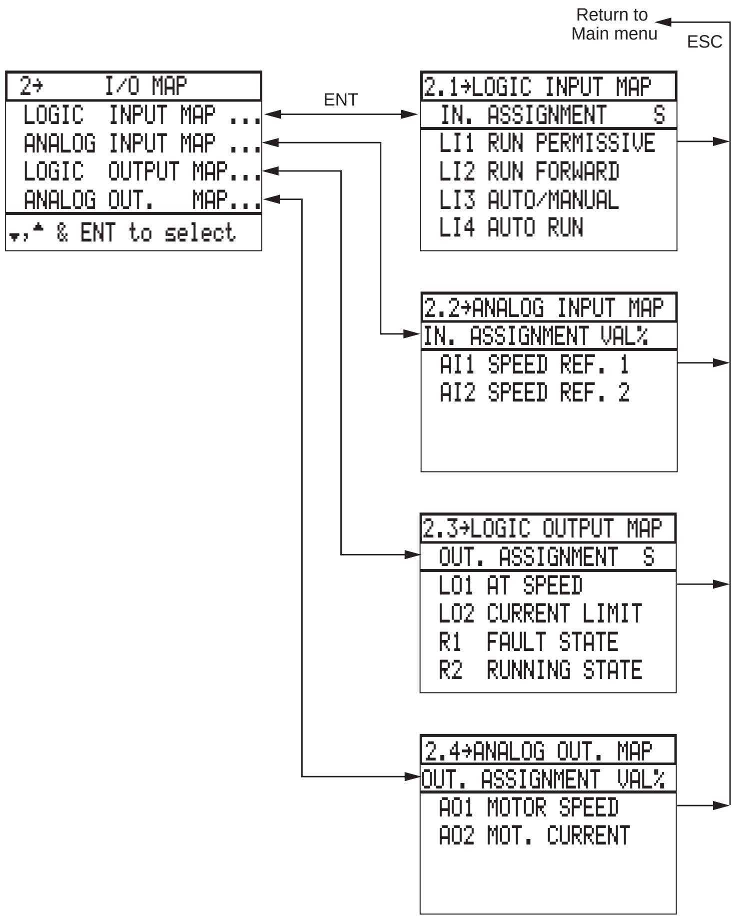
Motor Overload enables the drive controller to protect a standard induction motor from overload. This function can replace a conventional thermal overload relay for single motor applications; however, multi-motor applications require individual external thermal overload motor protection.

This function is more effective in protecting a motor operated from a drive controller because it considers motor speed as well as time and current in its protection algorithm. This is important since most motors applied on drive controllers are self-cooled, and their cooling effectiveness declines at lower speeds. The drive controller’s protection algorithm integrates motor current over time, taking into account factors such as stop time and idle time. Two types of motor overload protection can be selected from the 7.4→Fault Management menu (page 100 for details):

1. For Self-Cooled Motor (factory setting)
2. No thermal protection

Motor Overload can be adjusted from 0.45 to 1.15 times the nominal drive controller current, as displayed on the Drive Identification screen. Factory preset is 0.9. Adjust Motor Overload value to nominal motor current (see page 70).

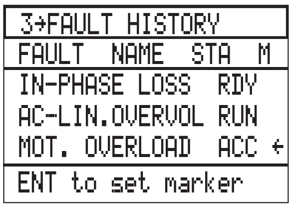
2→I/O MAP



The I/O map is a series of display-only screens that show the analog and logic input/output terminal assignments. I/O Map is helpful for determining which input/output terminals are assigned to which software functions, and for displaying the state of the inputs/outputs while operating the drive controller.

The I/O Map consists of four three-column, display-only screens. The left column of each lists the inputs/outputs, the middle column shows the input/output functions, and the right column displays states or values. I/O states are given as 0 (low logic state) or 1 (high logic state). Refer to Chapter 2 for definitions of logic 1 and logic 0 for applicable logic I/O. Analog I/O values are given in percentages. See page 99 for base of percentage displayed.

3→FAULT HISTORY



The Fault History screen displays the last eight faults stored by the drive controller, and run status at time of fault. The most recent fault is displayed first in the list. The arrow (←) under the “M” column is used to mark a fault so that it can be followed for future observation.

Table 24 lists drive controller run status codes. Table 21 on page 55 lists the faults that can be displayed on the Fault History Screen.

Table 24: Fault History Screen Run Status Codes

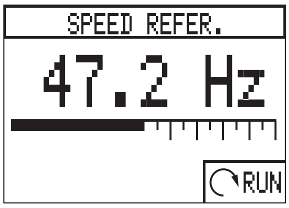
Code	Code Definition
ACC	Accelerating
DEC	Decelerating
RUN	Drive controller running (at speed)
BRK	Braking (dynamic or regenerative)
RDY	Drive controller stopped and ready
DCB	DC injection braking
CLI	Current limit active
FLT	Faulted

Troubleshooting

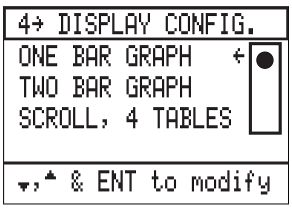
Refer to Chapter 4 for troubleshooting procedure when a fault is displayed. In the case of an internal drive controller fault, autodiagnostics can be run to locate the failed component. See the 8→Diagnostic Mode menu on page 109.

4→DISPLAY CONFIGURATION MENU

By default, the Display screen shows reference frequency in bar graph form.



The type and number of functions shown can be modified from the 4→Display Configuration menu. Modification is possible while the drive controller is running.

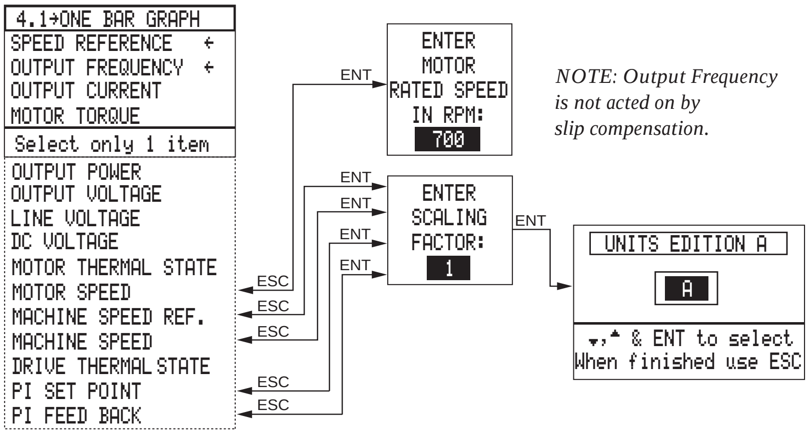


Three display options are available from the 4→Display Configuration screen. An arrow (←) indicates the active display option.

- One function displayed in bar graph form
- Two functions displayed in bar graph form
- Eleven functions displayed in three tables

The One Bar Graph and Two Bar Graph choices have sub-menus. From a list of nine items in these sub-menus, you may select the functions to be displayed. The list of functions is the same for both display choices, and is illustrated in the 4.1→One Bar Graph menu.

4.1→One Bar Graph



Use the ▲ and ▼ keys to select a function from the 4.1→One Bar Graph menu and press ENT.

Five functions on the menu have associated screens for entering actual values. For motor RPM, enter the motor rated speed. The controller will automatically select the closest standard motor speed: 700, 900, 1200, 1800, or 3600.

For Machine Speed Reference, Machine Speed, PI Set Point, and PI Feedback, first enter the scale factor that multiplies motor rated speed in Hz to determine the application units. The scale factor, programmable from 1 to 100, is factory preset at 1.

NOTE: There is only one scaling factor entry available for Machine Speed Reference, Machine Speed, PI Set Point, and PI Feedback. The scaling factor chosen for Machine Speed, for example, will be the same scaling factor fused for PI Set Point.

Second, enter a 4-character label for the application (“ft / s”, for example) in the Units Edition screen. Using the ▲ (moves up) and ▼ (moves down) keys, scroll among the alphabetical characters and press ENT to select a character. Each selected character will appear in the upper band of the screen. Press ESC when you are finished defining the label.

When the screen displays one bar, you may use the ▲ and ▼ to display other functions.

4.2→Two Bar Graphs

The 4.2→Two Bar Graphs menu is the same as the 4.1→One Bar Graph menu; you can, however, make two selections. Figure 37 on page 64 shows the display screen configured for Two Bar Graphs. When the ▲ and ▼ keys are used to scroll, the first bar graph remains fixed, while the other parameters are displayed successively on the second bar graph.

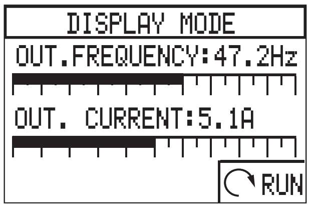


Figure 37: Display Screen Configured for Two Bar Graphs

4.3→Scroll

The Scroll format displays 11 functions in three tables (12 functions for ATV56D16 to ATV56D79 drive controllers). See Figure 38.

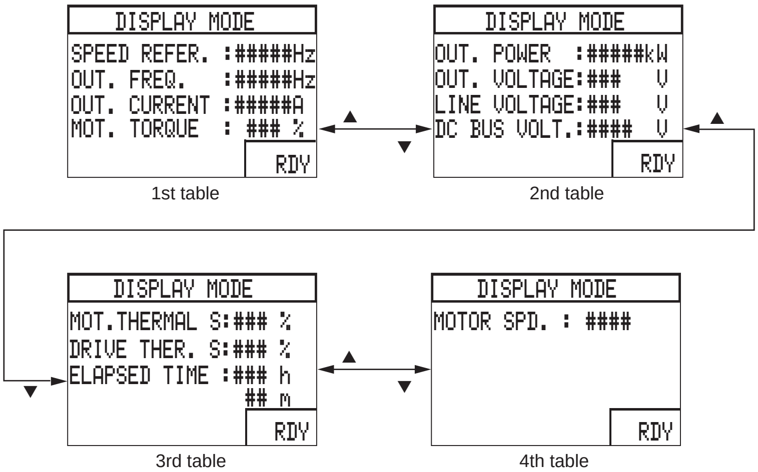
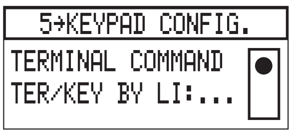


Figure 38: Display Screen Configured for Four Table Scroll

NOTE: For Motor Thermal State (see first line of third table in Figure 38), if Motor Overload is set to No Thermal Overload in the 7.4→Fault Management menu, ntH will be displayed instead of a percentage. Drive Thermal State (second line of third table) appears only for ATV56D16 to ATV56D79 drive controllers.

5→KEYPAD CONFIGURATION MENU



Use the 5→Keypad Configuration menu to configure the drive controller for Terminal Command or to configure a logic input for changing control of the drive controller from Terminal Command to Keypad Command.

In Terminal Command (factory setting), the drive controller takes reference frequency, stop, and run commands from its terminal strip connections.

Keypad Command allows the drive controller to run and receive its reference frequency from the keypad display.

If keypad is removed from drive controller while in keypad command mode, then the controller will stop and may trip on serial link fault.

Command mode can be set in one of two ways:

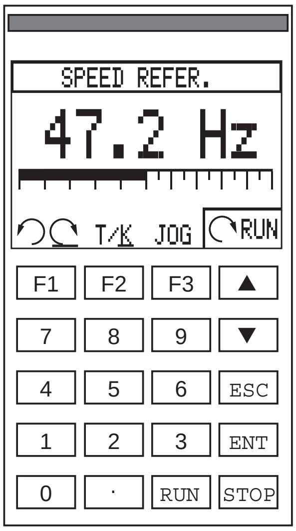
1. Select TERMINAL COMMAND from the menu. The drive controller will operate in the TERMINAL COMMAND mode.
2. Select TER / KEY by LI from the menu and assign a logic input, LI3 or LI4. This enables switching between command modes by logic input. When the assigned logic input is low (state 0), Terminal Command will be active. When the assigned logic input is high (state 1), Keypad Command will be active. To reassign a logic input, follow the instructions on the screen.

NOTE: Keypad Command is only accessible when in Total Lock if TER/KEY by LI has been selected before locking.

Using Keypad Command Mode

Keypad Command allows the drive controller to run independently of its logic and analog inputs. To start the drive controller in Keypad Command, momentarily press the RUN key. The drive controller will start, following the acceleration ramp.

To stop the drive controller, momentarily press the STOP key and the drive controller will stop, following the deceleration ramp. **The LI1 input remains active for an override stop in Keypad Command mode**.



NOTE: When running the drive controller in Keypad Command mode after having been in Terminal Command mode, the drive controller will run in the same direction in which it was running in Terminal Command mode. The drive controller cannot be commanded to change the direction of the motor once Keypad Command mode is entered. Make sure that the motor is rotating in the desired direction before switching from Terminal Command mode to Keypad Command mode.

Table 25: Display Mode Screen in Keypad Command Mode

In Keypad Command mode, the ▲ key is used to increase reference frequency and the ▼ key is used to decrease reference frequency. Note that pressing the ENT key is not necessary—frequency changes automatically upon pressing the ▲ or ▼ keys. A reference frequency can also be entered by pressing the decimal point key, entering a frequency, and pressing the ENT key.

The assignment of each function key is displayed on the last line of the Display Mode screen above the corresponding function key. Table 26 describes the operation of the function keys in keypad command.

While in Keypad Command mode, 0 Hz reference is treated as a speed. Once the RUN key is pressed, the drive controller is in a "run state." After pressing RUN, you may select any speed reference (including 0 Hz) and the drive controller will run at that speed. Pressing the STOP key causes the drive controller to ramp to zero output even though the reference remains at a non-zero frequency. Cycling power resets the reference to zero and causes the drive to be in the "stop state."

Table 26: Operation of Function Keys in Keypad Command

Label	Indication	Action Achieved by Pressing Associated Function Key
RST	Reset fault is assigned to associated function key.	Press function key to reset drive controller after a fault.
SCR	Scroll function is assigned to associated function key.	Press function key to scroll through display screens. ▲ and ▼ keys are used for this function in Terminal Command mode.

6→DRIVE CONFIGURATION MENU

The 6→Drive Configuration menu can be accessed only if the drive controller is stopped. If the drive controller is running, a message appears:

```
IMPOSSIBLE TO
CONFIGURE THE DRIVE
WHILE RUNNING
ESC to return to
Main menu
```

Press ESC to return to the Main menu.

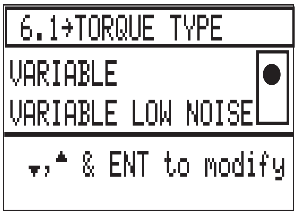
```
6→DRIVE CONFIG.
TORQUE:  VARIABLE
COMMAND: 2 WIRES
MOTOR:60Hz 440-460V
Power: 2.2 kW/3 HP
ESC to quit\F1=Help
```

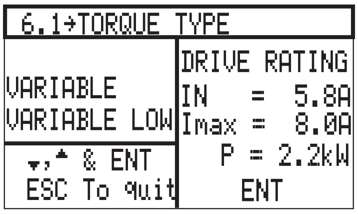
The 6→Drive Configuration menu contains three selections: Torque Type, Command Type, and Motor. "Motor" is a valid selection for the ATV56U41 drive controller only since this drive controller can be used with a 1, 2, or 3 hp motor. Otherwise, selecting "Motor" calls up a message screen:

```
To modify Motor
parameters,please go
to menu 7.11
ENT to continue
```

To access Motor Parameters, go to the 7.11→Motor Parameters menu (page 69).

6.1→Torque Type

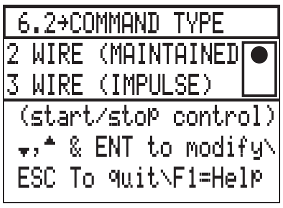




Select type of torque according to the application and press ENT. A window will appear showing the current and power rating of the drive controller. Confirm by pressing ENT. Display returns to the 6→Drive Configuration menu.

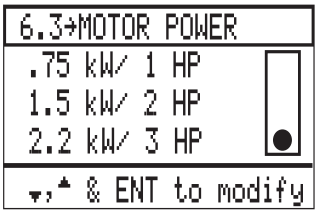
NOTE: Changing Torque Type or Control Type (in the 7.13→ Control Type menu) resets the motor parameters in the 7.11→Motor Parameters menu to the factory settings.

6.2→Command Type



Select 2-wire or 3-wire command. The selection affects the operation of LI1. Factory setting is 2-wire command. See pages 68 and 68 for detailed descriptions of 2-wire and 3-wire command.

6.3→Motor Power
(ATV56U41 only)



For the ATV56U41 drive controller with a motor rated less than 3 hp (or 4 hp variable torque), the 6.3→Motor Power screen can be accessed to select the power of the motor. This screen is only available on the ATV56U41 drive controller.

2-Wire Command

The use of 2-wire command will allow the drive controller to restart without operator intervention after fault reset or restoration of power provided that a run command is present. For applications where automatic restarting may pose a hazard to personnel, the use of 2-wire command is not recommended.

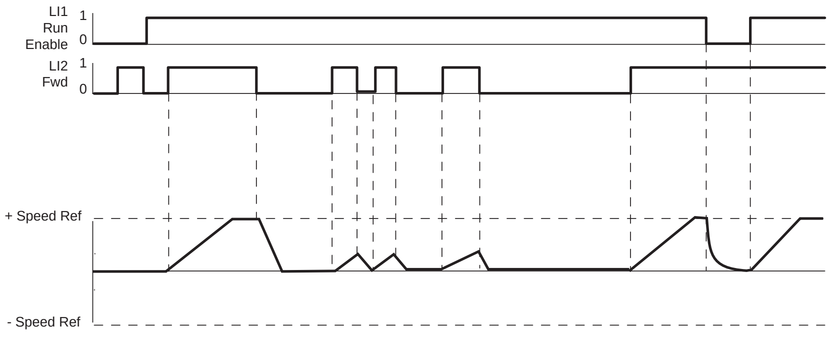


Figure 39: Timing Diagram for 2-Wire Command

If 2-wire command is selected, LI1 is Run Enable and must always be high for the drive controller to run. If drive controller is running and LI1 goes low, the drive controller will freewheel stop.

If the drive controller is running and the keypad STOP key is pressed, regardless of whether the drive is in Keypad or Terminal mode, the drive controller will stop, following the normal ramp.

To restart the drive controller, the Run command must be set to low state. Then the drive controller will restart on the next command to run.

For a wiring diagram, refer to Chapter 2.

3-Wire Command

The use of 3-wire command requires operator intervention after fault reset or restoration of power to restart the drive controller.

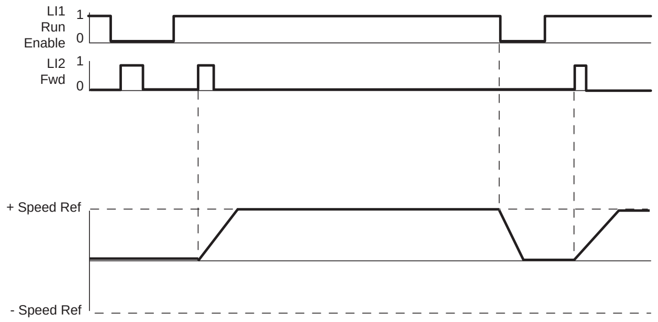


Figure 40: Timing Diagram for 3-Wire Command

If 3-wire command is selected, LI1 is Stop, normally-closed. LI1 must be closed for the drive controller to run. The forward input must momentarily transition to active to start the drive controller. If the drive controller is running and LI1 goes low, the drive controller will stop, following the normal ramp. If the drive controller is running and the keypad STOP key is pressed, regardless of whether the drive is in Keypad or Terminal mode, the drive controller will stop, following the normal ramp.

To restart the drive controller, the Run command must be set to low state. Then the drive controller will restart on the next Run command.

Refer to Chapter 2 for wiring diagram.

7→GENERAL CONFIGURATION MENU

```
7→GENERAL CONFIG.
DRIVE PARAMETERS
APPLICATION FUNC.
OUTPUT ASSIGNMENT
FAULT MANAGEMENT
▲,▼ & ENT to select
```

The 7→General Configuration menu allows access to four sub-menus:

- 7.1→Drive Parameters
- 7.2→Application Functions (including input assignments)
- 7.3→Output Assignments
- 7.4→Fault Management.

These menus can be accessed only if the drive controller is stopped.

7.1→Drive Parameters

```
7.1→DRIVE PARAMETERS
MOTOR PARAMETERS
CONTROL PARAMETERS
CONTROL TYPE: NORMAL

▼,▲ & ENT to modify
```

The 7.1→Drive Parameters menu allows access to basic motor and control parameters, and control type. The menu is accessible only if the drive controller is stopped and in **Terminal Command mode** (page 64). To verify adjustments, return to the Display screen by pressing F2, then start the motor. To readjust, stop the motor and return to the desired menu.

The parameter choices available on the sub-menus vary depending on the torque type selected from the 6.1→Torque Type menu, and the control type selected from the 7.13→Control Type menu. See Table 27.

7.11→Motor Parameters

```
7.11→MOTOR PARAMETER
NOM. CURRENT:     A
NOMINAL FREQ.:    HZ
NOMINAL VOLT.:    V
DAMPING:          %
▼,▲ & ENT to modify
ROTATION NORM: ABC
CURRENT LIMIT   ....
```

Use the 7.11→Motor Parameters menu to adjust basic motor parameters. The functions available from this menu vary depending on the type of control selected (page 76). Table 27 shows the functions available from the menu under the various types of control.

Adjustments to motor parameters are made either to sub-menus or directly on the 7.11→Motor Parameters menu itself. To select a parameter, scroll with the ▲ and ▼ keys and press ENT. Adjust the parameter value to the desired setting, then press ENT to confirm.

Some motor parameters are also accessible from the 1→Parameter Setting menu. Any adjustments made to these parameters from the 7.11→Motor Parameters menu are also automatically displayed in the Parameter Setting menu.

Table 27 shows the selections available from the 7.11→Motor Parameters menu under the various drive controller configurations.

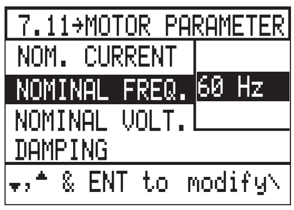
Table 27: 7.11→Motor Parameters Menu

	Variable Torque
Normal Control	Nominal Current Nominal Frequency Nominal Voltage Profile Damping Rotation Normalization Current Limit
NOLD Control	Nominal Current Nominal Frequency Nominal Voltage Damping Rotation Normalization Current Limit

Nominal Current

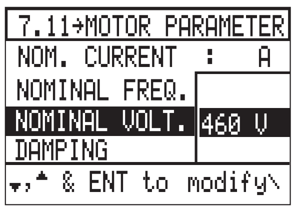
Nominal Current is the motor nameplate value for full load current. Adjustable from 45% to 105% of the drive controller's current rating, the factory preset value is 90%. Set Nominal Current to equal the motor full load current. The Nominal Current parameter does not affect the maximum current that the drive controller can produce, i.e. Current Limit. However, changing the nominal current parameter can change the value of motor overload current in menu 1. Check and adjust, if necessary, the value of motor overload if nominal current is changed.

Nominal Frequency



Nominal Frequency corresponds to the point on the V / Hz curve beyond which voltage remains virtually constant and only frequency increases. Nominal Frequency often corresponds to the base frequency of the motor, which is usually the same as the line frequency of the connected power system. Nominal frequency is fixed at 60 Hz.

Nominal Voltage

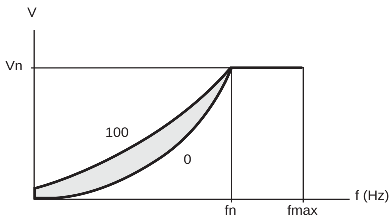


Nominal Voltage corresponds to the point on the V / Hz curve beyond which voltage remains virtually constant and only frequency increases. Nominal Voltage is used with Nominal Frequency to determine the V / Hz baseline. Nominal Voltage often corresponds to the base voltage of the motor, which is usually the same as the line voltage of the connected power system. Nominal voltage is fixed at 460 V for 460 V drive controllers. For 230 V drive controllers, Nominal Voltage is set at 230 V upon first power up, but configurable as either 208 or 230 V.

Profile

Profile is used only when the drive controller is configured for Normal control type. This parameter shapes the V / Hz profile of the output. Profile can be set to a value between 0 and 100, factory preset to 20. Enter the Profile value directly onto the 7.11→Motor Parameters menu.

During changes in speed command, the V / Hz profile becomes linear, intersecting the Vn and fn points of Figure 41. As a result, there is no reduction in available motor torque during speed changes.



Shaded area denotes zone within which drive functions when Profile is set between 0 and 100.

Figure 41: Profile

Profile is not available when NOLD control type is selected.

Damping

Damping is available with any drive controller configuration (page 67). This parameter adjusts the integral gain of the frequency loop to match the inertial response of the load to the frequency response of the drive controller.

The adjustable range varies with the drive controller configuration:

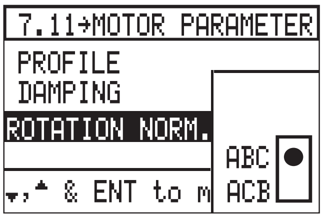
- 1 to 100% for NOLD control with either variable torque configuration
- 1 to 800% for Normal control with either variable torque configuration

When Damping is properly adjusted and the drive controller is not in current limit or ramp modification, the motor speed should follow the speed reference ramp without oscillation and with little overshoot. During steady-state operation with constant load, the motor speed should remain constant with no oscillation. If the motor load changes, the drive controller should correct the motor speed disturbance rapidly with little or no oscillation.

The factory preset value of Damping is 20% which corresponds to 1.5 times the factory set motor inertia for the selected motor power rating. For most applications, no adjustment of Damping should be required.

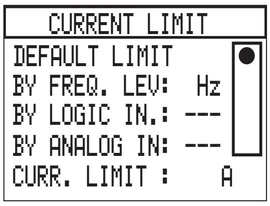
If the motor speed oscillates or overshoots the desired speed during changes in the motor speed reference or during steady-state operation with constant load, Damping is set too low and should be increased. If the motor speed follows the speed reference ramp sluggishly or tends to vary during steady-state operation with constant load, Damping is set too high and should be decreased.

Rotation Normalization



Rewiring the input terminals L1, L2, and L3 will not change the direction of motor shaft rotation; therefore with the Rotation Normalization parameter, direction of rotation can be inverted from ABC to ACB in order for the motor shaft rotation to agree with the forward and reverse logic inputs. Neither the drive controller nor the motor has to be rewired. Select desired phase rotation and press ENT. Factory setting is ABC, corresponding to U / T1, V / T2, W / T3.

Current Limit



Current Limit can be set to a value between 40 to 110% of drive controller output current. Default value is 110% of drive controller output current. Note that the Current Limit value is not affected by the Nominal Current parameter set in the 7.11→Motor Parameters menu.

⚠ CAUTION

UNINTENDED EQUIPMENT ACTION

If Current Limit is set to less than the no-load current of the motor, unstable operation of the drive controller may result.

After adjusting Current Limit, operate the drive controller throughout its speed range with expected motor load. Ensure that:

- The motor rotates in the correct direction.
- Rotation occurs even with small (2-3 Hz) values of speed reference.
- The steady-state motor current does not exceed the motor nameplate current rating.

For critical applications that cannot be rotated in the reverse direction such as pumps equipped with anti-rotation ratchets, uncouple the motor from the load after adjusting Current Limit and check the motor for the proper rotation direction when starting.

Failure to follow this instruction can result in injury or equipment damage.

The value of Current Limit can affect the operation of other drive controller functions. If Current Limit is set to less than the motor no-load current, then unstable operation of the motor may result. After adjusting Current Limit, operate the drive controller throughout its speed range. The motor should always start in the correct direction and should rotate even with low (2-3 Hz) values of speed reference. The steady-state motor current should not exceed the motor nameplate current rating. For critical loads which cannot be rotated in the reverse direction, always uncouple the motor from the load after adjusting Current Limit and check the motor for the proper direction of rotation.

Set Current Limit to Default Limit, or enter a reduced value and select one of the activation methods:

- Frequency Level: when the drive controller exceeds the programmed frequency level the reduced Current Limit value is activated. To keep the reduced Current Limit value active at all times, set frequency level to 0.
- Logic Input: assign a logic input to Current Limit (see Figure 44 on page 74 for procedure). When the assigned logic input is low (state 0), the Current Limit value is the default setting. When it is high (state 1), the Current Limit is the reduced value.
- Analog Input: assign an analog input to Current Limit (see Figure 43 on page 73 for procedure). The set current limit is ignored and the analog input is scaled so that the adjustment range of current limit is 40% to 110% of the drive controller current. This function could be used as a drive current reference for motor torque control.

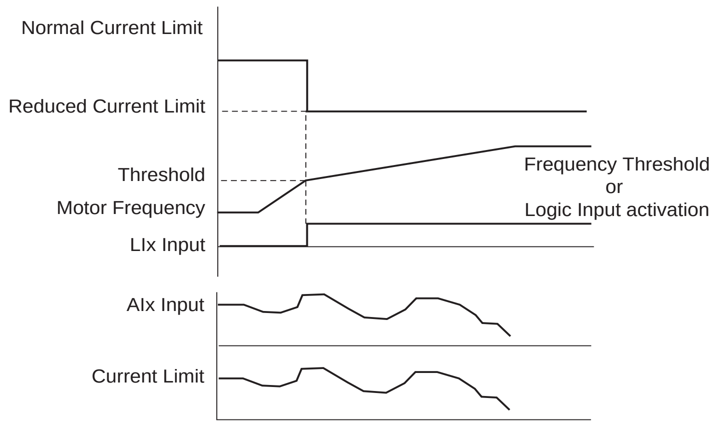


Figure 42: Current Limit Timing

Reassigning Analog and Logic Inputs

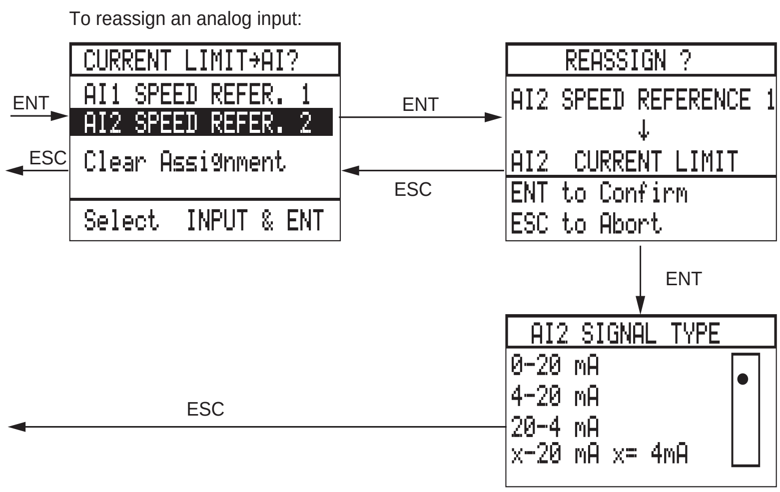


Figure 43: Reassigning Analog Inputs

To reassign a logic input:

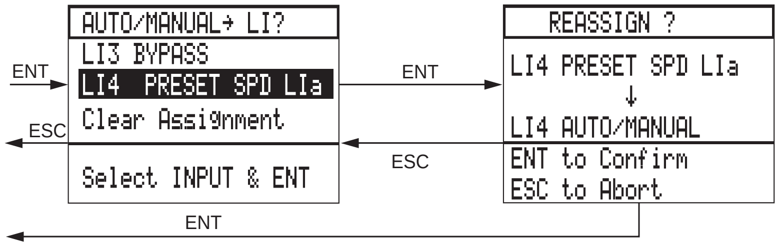
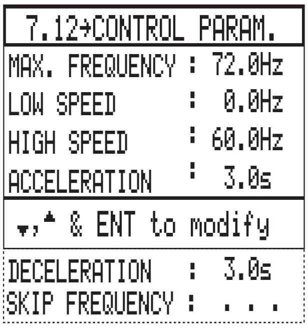


Figure 44: Reassigning Logic Inputs

7.12→Control Parameters



The 7.12→Control Parameters menu allows access to basic drive controller parameters. The default or previously programmed values for each parameter appear in the right column of the menu.

Adjustments to control parameters are made either to submenus or directly on the 7.12→Control Parameter menu. To select a parameter, scroll with the ▲ and ▼ keys and press ENT. Adjust the parameter to desired setting, then press ENT to confirm.

The Control Parameters are discussed in detail in the following pages. Some parameters are also accessible from the 1→Parameter Setting menu. Any adjustments made to these parameters from the 7.12→Control Parameters menu are also displayed in the 1→Parameter Setting menu.

Maximum Frequency

> **⚠ CAUTION**
>
> **MACHINERY OVERSPEED**
>
> - Some motors and/or loads may not be suited for operation above nameplate motor speed and frequency. Consult motor manufacturer before operating motor above rated speed.
> - Under certain steady-state and transient conditions, the output frequency may reach 120% of Maximum Frequency setting. Adjust Maximum Frequency parameter accordingly.
>
> **Failure to follow this instruction can result in injury or equipment damage.**

Maximum Frequency clamps the High Speed setting. Maximum Frequency is fixed at 72 Hz.

Low Speed

Low Speed corresponds to the lower limit of the speed reference at AI1 or AI2 (see Figure 45) and limits the minimum commanded running frequency to a value between 0 and High Speed. It does not affect the starting frequency. If the drive controller is commanded to run below the programmed Low Speed, the output will be limited to the Low Speed value. Factory setting is 0 Hz.

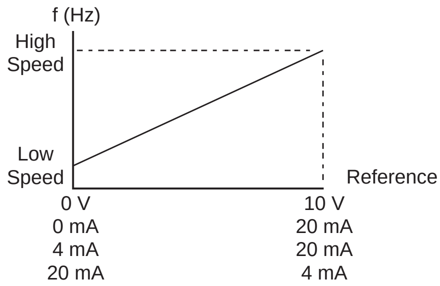


Figure 45: Speed Reference

High Speed

High Speed corresponds to the upper limit of the speed reference at AI1 or AI2 (see Figure 45) and limits the maximum commanded running frequency to a value between Low Speed and Maximum Frequency. If the drive controller is commanded to run above the programmed High Speed, the output will be limited to the High Speed value. Factory setting is 60 Hz.

Acceleration Time

Acceleration Time is adjustable between 0.1 and 999.9 seconds and represents the time the drive controller will take to accelerate between 0 Hz and Nominal Frequency, set in the 7.11→Motor Parameters menu (page 70). Acceleration Time determines the base line slope used by the drive controller to accelerate between frequencies. Factory setting is 3 seconds.

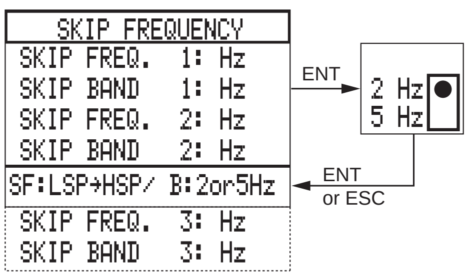
If the acceleration slope is too steep for the motor to accelerate the connected load, the acceleration slope will be modified to minimize the possibility of a nuisance trip.

Deceleration Time

Deceleration Time is adjustable between 0.1 and 999.9 seconds and represents the time the drive controller will take to decelerate between Nominal Frequency, set in the 7.11→Motor Parameters menu (page 70), and 0 Hz. Deceleration Time determines the base line slope used by the drive controller to decelerate between frequencies. Factory setting is 3 seconds.

If the deceleration slope is too steep for the motor to decelerate the connected load, the deceleration slope will be modified to minimize the possibility of a nuisance trip.

Skip Frequencies



Skip Frequencies 1, 2, and 3 are used to avoid mechanical resonance. The adjustable range for skip frequencies is from 0 to 72 Hz. The three skip points may overlap each other. Skip Bands of 2 or 5 Hz can be selected.

If a reference is set in a skip frequency band, the drive controller will not run in that band. Ramps are not modified in the skip frequency bands.

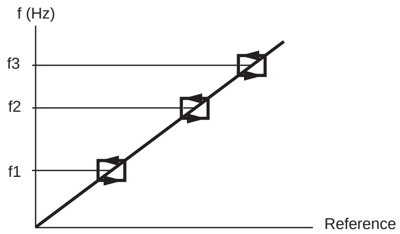
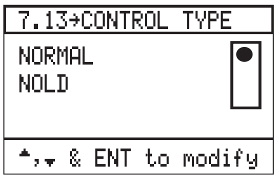


Figure 46: Skip Frequency

7.13→Control Type



NOTE: Changing Control Type resets the motor parameters in menu 7.11 to factory settings.

Normal

Normal control is the factory setting. Normal is a sensorless flux vector control. In order to create high torque at low speeds, the drive controller maintains a 90° phase relationship between the rotor and stator electromagnetic fields by continuously calculating the position of the rotor in relation to the electrical position of the stator. It is generally applicable on asynchronous motors and provides good torque performance. When using Normal control, motor horsepower must be equal to or one horsepower size less than drive controller horsepower.

NOLD (No Load)

For the NOLD control type, the V / Hz profile is linear, intersecting the Vn and fn points of Figure 36 on page 60 during changes in speed command or changes in motor load. During steady-state operation, the slope of the V / Hz line is automatically adjusted to reduce the voltage on the motor, depending on load, at any given speed. If a motor speed change is commanded or the motor load changes, the initial V / Hz profile is immediately reestablished.

The NOLD control type differs from the Normal control type in the following way:

- Motor voltage reduction can occur even at motor nominal frequency for applications where the motor load varies.

Operation with NOLD control type generally results in reduced audible motor noise without reducing motor RPM. In some cases (particularly with motors whose horsepower rating is less than 10 hp), improved motor efficiency may result. NOLD control should not be used with motors in parallel.

7.2→Application Functions

```
7.2→APPLIC. FUNCTIONS
PRESET SPEEDS
SPEED REFERENCE
AUTO/MANUAL
CONTROLLED STOP
▼,▲ & ENT to select
SHUTDOWN
BYPASS
PI REGULATOR
```

```
This function is
not compatible with:

Help F1/ESC → to quit
```

Use the 7.2→Application Functions menu to assign functions to the logic inputs and outputs.

The number of functions assignable is limited by the number of inputs / outputs required by a function (see Table 28 on page 77), the number of inputs / outputs on the drive controller available to be reassigned, and by compatibility of the selected functions (see Figure 47 on page 78). The selection of a function which is not compatible with one already selected causes the message illustrated above to appear on the terminal screen.

The drive controller has two logic inputs that can be reassigned. If more inputs / outputs are required, an I / O Extension module can be ordered. Refer to the catalog (document number VD0C06S201_) for more information.

Table 28: Logic I/O Required by Application Functions

Application Function	No. of LI Inputs Used [1]	No. of AI Inputs Used	No. of LO or R2 Outputs Used
Preset Speeds	1 or 2	0	0
Speed Reference	0	1 or 2	0
Auto/Manual	1 or 2	0	0
Controlled Stop	0 or 1	0	0
Shutdown	0	0	0 or 1
Bypass	2	0	1
PI Regulator	0, 1, or 2	0, 1, 2, or 3	0, 1, 2, or 3

[1] The only LI inputs which can be reprogrammed are LI3 and LI4. LI1 is fixed as Run Enable, and LI2 is fixed as Run Forward. If more inputs are required, the I/O Extension Module can be ordered. See catalog (document VD0C06S201_) for more information.

Read up and across from the ● to identify pairs of incompatible functions.

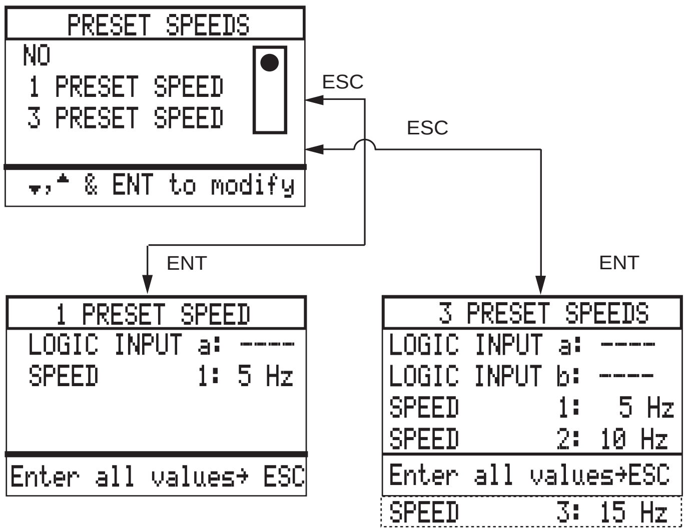
Incompatibilities due to the number of I/O available for reassignment are not shown.

PRESET SPEEDS							●
SPEED REFERENCE							●
AUTO / MANUAL							●
CONTROLLED STOP					[1]		
SHUTDOWN				[1]			●
BYPASS							
PI REGULATOR	●	●	●		●		

[1] Shutdown is incompatible with Controlled Stop by Frequency Threshold and Controlled Stop by Frequency Threshold/Logic Input.

Figure 47: Application Function Incompatibilities

Preset Speeds



This function allows you to program up to preset speeds. If one preset speed is required, one logic input must be assigned. Two logic inputs must be assigned if three preset speeds are required.

The preset speeds are adjustable from 0.1 to 72 Hz. The actual running speed is limited to the setting of High Speed. The programmed values must increase consecutively from speeds 1, 2, and 3. If both logic inputs are low, the speed will be the speed reference, if present, or low speed. The factory preset value for one Preset Speed is 5 Hz, for three Preset Speeds 5, 10, and 15 Hz.

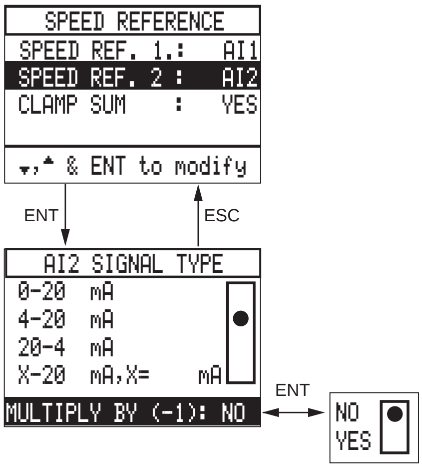
Table 29 gives input states for activation of 3 Preset Speeds. If 1 Preset Speed has been selected, the speed is active when the assigned input is high.

Table 29: Logic Input States for 3 Preset Speeds

	Input a	Input b
Low Speed or Reference	0	0
Preset Speed 1	1	0
Preset Speed 2	0	1
Preset Speed 3	1	1

Seven preset speeds can be obtained with the I/O Extension Module. For more information refer to the catalog (document number VD0C06S201_).

Speed Reference



Speed Reference allows the assignment of the AI1 and AI2 inputs as Speed Reference 1 or Speed Reference 2. Speed Reference also allows you to modify the analog current input, AI2, for type of signal. The adjustment range is 0-20 mA, 4-20 mA, 20-4 mA, or x-20 mA where x can be programmed from 0 to 20 mA in increments of 0.1 mA. Factory setting for AI2 is 4-20 mA. When Speed Reference is set to x-20 mA, the frequency at which the drive controller will run is determined as follows:

$$f = (\text{High Speed} - \text{Low Speed})(\text{Input mA § 20 mA}) + \text{Low Speed}$$

When the value of AI2 is below x mA, the drive will run at the Low Speed setting.

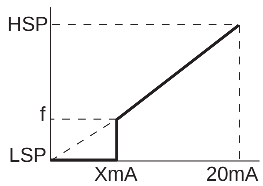


Figure 48: Speed Reference and Drive Controller Frequency

If the switch on the control board is set to voltage, AI2 will be a 0-5 V voltage input. Refer to Chapter 2 for location of switch. AI2 in this case must be set on the keypad display for 0-20 mA. The voltage reference input, AI1, cannot be modified. It is fixed as a 0 to 10 VDC input.

The two inputs, AI1 and AI2, are summed as a factory default, limited to High Speed. However, when Auto/Manual is active the inputs function independently and only one is active at a time. It is possible to multiply AI2 by (-1) by selecting Yes. In this case, AI2 is subtracted from AI1. If Clamp Sum is set to Yes (factory setting) and (AI1-AI2) is zero or negative, the drive controller will run at Low Speed. If Clamp Sum is set to No and (AI1-AI2) is negative, the drive controller will change direction. See *Notes* on page 80.

NOTE: The drive controller cannot be commanded to change the direction of the motor once the Keypad Command mode is entered. If the direction of motor rotation is reversed with speed reference summing, the motor will continue to rotate in this direction if Keypad Command mode is entered. Make sure that the motor is rotating in the desired direction before switching from Terminal Command mode to Keypad Command mode.

NOTE: If 20-4 mA is selected, user should consider effects of broken wire. If broken wire occurs when 20-4 mA is selected, drive controller will run at high speed.

Auto/Manual

```
     AUTO./MANUAL
NO
YES,LOGIC IN.:---
AUTO RUN IN.  :---
▾,▴ & ENT to modify
ESC to quit
```

Auto / Manual allows switching between Speed Reference 1 and Speed Reference 2 by using a logic input. Speed Reference 1 and Speed Reference 2 can be programmed to AI1 or AI2 in the Speed Reference screen (see page 79). The Auto / Manual function eliminates the need for mechanical switching of the low level analog inputs, and allows the Speed References to act independently instead of being summed.

Manual command is defined as Speed Reference 1; Automatic command as Speed Reference 2. When assigned input is high, Auto is active. When it is low, Manual is active.

Auto Run Input is optional. If assigned, it allows the use of a second logic input for an additional 2-wire remote control run command, only active when the drive controller is in Auto mode. Local control can be used as either 2-wire or 3-wire control. See Figure 97 on page 163 and Figure 98 on page 164 for interaction of Auto / Manual and Controlled Stop in 2-wire and 3-wire control.

Controlled Stop

```
   CONTROLLED STOP
NO
BY LOGIC INPUT
BY FREQ. LEVEL
BY LI / FREQ.LEV.
▾,▴ & ENT to modify
```

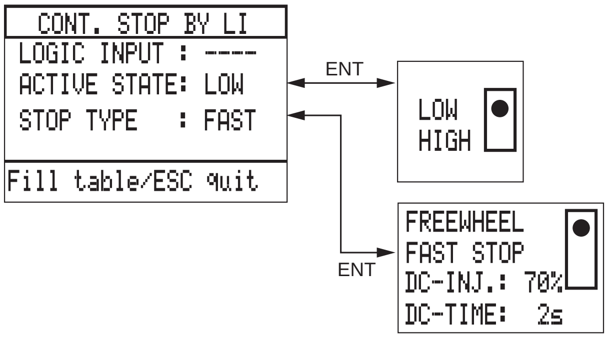
Controlled Stop, which customizes the stopping process, is commanded by:

- Logic Input
- Frequency Threshold
- Frequency Threshold and Logic Input

When Controlled Stop is activated, the drive controller stops according to one of the following methods: Freewheel Stop, Fast Stop, or DC Injection Braking. To enable Controlled Stop, select a command and stop method as explained on the following pages. Command methods are explained on pages 81 to 85; stop methods, on pages 82-85. See Figure 97 and Figure 98 in Appendix A for interaction of Auto / Manual and Controlled Stop in 2-wire and 3-wire control.

Controlled Stop Command Methods

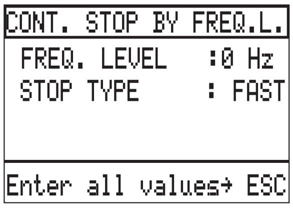
By Logic Input



When Controlled Stop by Logic Input is selected, the activation of the assigned logic input causes the drive controller to stop, following the selected controlled stop method (Freewheel Stop, Fast Stop, or DC Injection Braking). **The controlled stop logic input is only active in Terminal Command mode and is disabled in the Keypad Command mode.**

To enable Controlled Stop by Logic Input, assign a logic input, define its active state as logic low (0) or logic high (1), and choose the stop method.

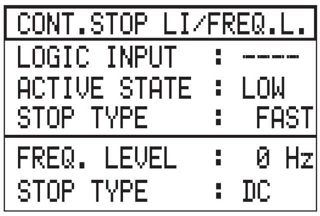
By Frequency Threshold



With Controlled Stop by Frequency Threshold enabled, if a Stop command is initiated, the drive controller follows the active deceleration ramp until the programmed Frequency Threshold is reached. At this point, the drive controller automatically begins the programmed controlled stop method. **Controlled Stop by Frequency Threshold is active in both Terminal Command and Keypad Command modes.**

To enable Controlled Stop by Frequency Threshold, set Frequency Threshold and select a stopping method (Freewheel Stop, Fast Stop, or DC Injection Braking).

By Frequency Threshold / Logic Input



To enable Controlled Stop by Frequency Threshold / Logic Input, assign a logic input and define its active state. Set the Frequency Threshold and select stopping methods for both commands.

If both Logic Input and Frequency Threshold commands are selected and active, the stop type for the Logic Input command has priority; however, both commands can be used in the same stopping sequence.

Controlled Stop Command Methods (continued)

When Frequency Threshold / Logic Input is selected and the drive controller is in Terminal Command mode, controlled stopping is active both at the frequency threshold and with the logic input. When the drive controller is in Keypad Command mode, controlled stopping by frequency threshold is active, but controlled stopping by logic input is disabled.

At the first command to stop, the drive controller stops following the selected controlled stop method (Freewheel Stop, Fast Stop, or DC Injection Braking). If the other command to stop is given, the drive controller will only stop following the controlled stop method corresponding to the second command if the method has priority as compared to the first method. The order of priority is: Freewheel Stop, Fast Stop, DC Injection Braking.

Freewheel Stop

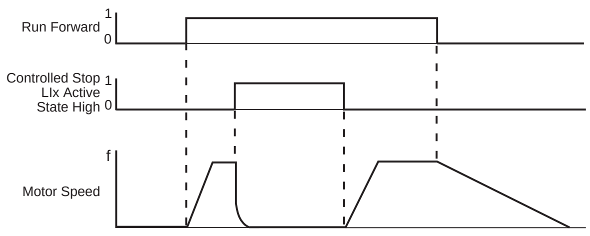


Figure 49: Freewheel Stop Timing Diagram (2-Wire Command)

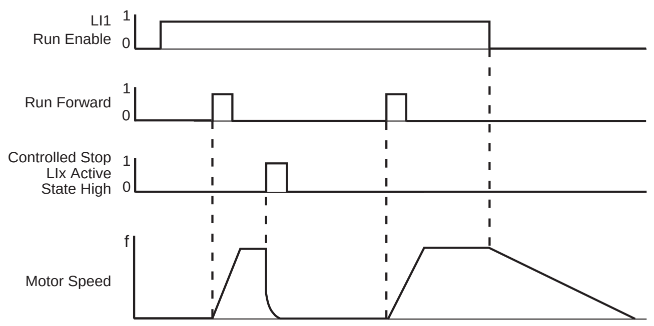


Figure 50: Freewheel Stop Timing Diagram (3-Wire Command)

With Freewheel Stop, the drive controller output is turned off and the motor coasts to a stop. Figure 49 and Figure 50 illustrate the timing sequence for Freewheel Stop.

Fast Stop

⚠ WARNING

EXTENDED STOPPING TIME

Deceleration time during fast stop may be automatically extended depending on braking ability of drive controller. A dynamic brake or mechanical stopping/holding brake may be required for consistent stopping times independent of motor load conditions. Fast Stop does not function during loss of power or drive controller fault.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Controlled Stop Command Methods (continued)

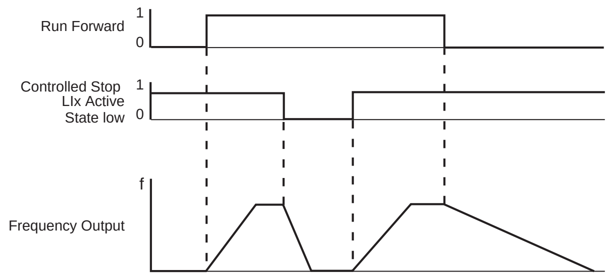


Figure 51: Fast Stop Timing Diagram (2-Wire Command)

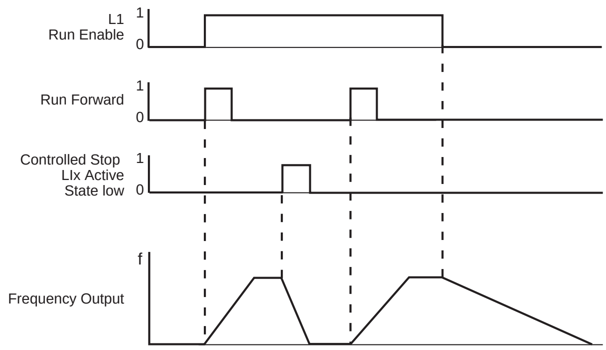


Figure 52: Fast Stop Timing Diagram (3-Wire Command)

With fast stop, the drive controller decelerates as quickly as possible without causing a nuisance trip. Figure 51 and Figure 52 illustrate timing sequence for Fast Stop.

DC Injection Braking

⚠ WARNING

NO HOLDING TORQUE

- DC injection braking does not provide holding torque at zero speed.
- DC injection braking does not function during loss of power or drive controller fault.
- When required, use separate brake function for holding torque.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

⚠ CAUTION

MOTOR OVERHEATING AND DAMAGE

Application of DC injection braking for long periods of time can cause motor overheating and damage. Protect motor from extended periods of DC injection braking.

Failure to follow this instruction can result in injury or equipment damage.

With DC Injection Braking, DC current is injected in the stator creating a stationary magnetic pole which brakes the rotor. This method of braking produces maximum torque at low frequencies.

Controlled Stop Command Methods (continued)

Two adjustable parameters, DC Injection Level and DC Brake Time, control the operation of DC Injection Braking. DC Injection Level sets the current level used for injection braking. The level is programmable between 50 and 110% of nominal drive controller current. Factory setting is 70%. Actual braking torque depends on the motor characteristics. DC Brake Time can be set between 0 and 30 seconds, preset at 2 seconds. If 30.1 seconds is selected, the drive controller brakes for 30 seconds at the adjusted level and then continuously at 50% of rated current.

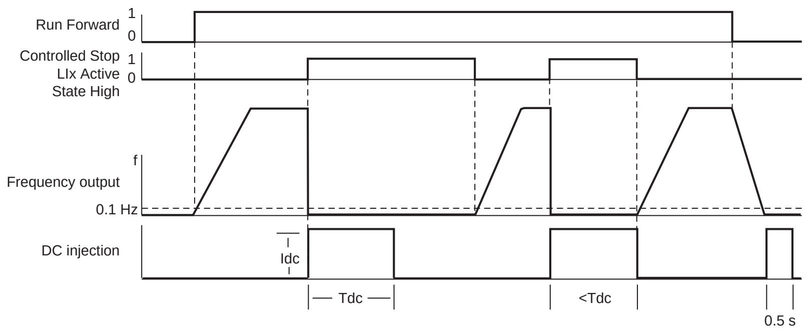


Figure 53: DC Injection Timing Sequence (2-Wire Command)

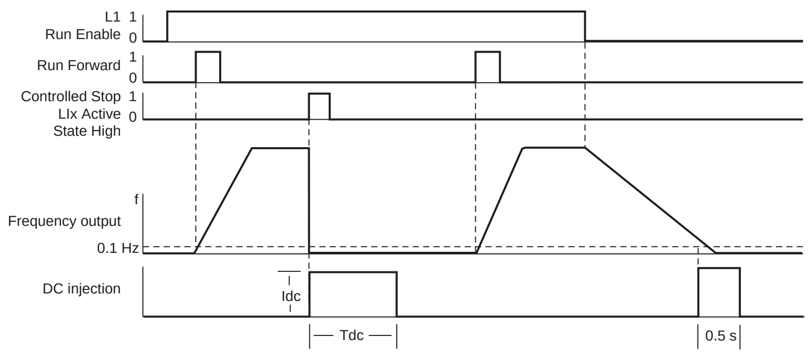
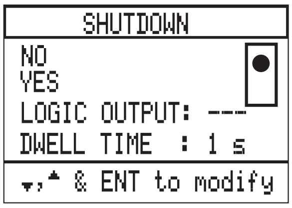


Figure 54: DC Injection Timing Sequence (3-Wire Command)

Shutdown



Shutdown allows the drive controller to dwell at Low Speed for a time period adjustable from 0.1 to 60 seconds before completely stopping. This function is useful in applications such as pumping stations where the dwell time controls the closing of a check valve before the pump is stopped.

To use Shutdown, activate the function by selecting Yes and set dwell time to a value between 0.1 and 60 seconds. The timer begins when the drive controller deceleration ramp reaches Low Speed. Factory setting of dwell time is 1 second.

If the application requires it, a logic output can be assigned to the Shutdown function. When dwell time has expired, the drive controller activates the logic output to indicate end of functioning at Low Speed.

Note that if a Run command is issued during the dwell time, it is not taken into account until the end of the dwell time.

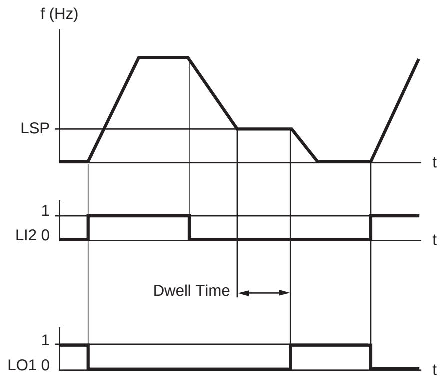
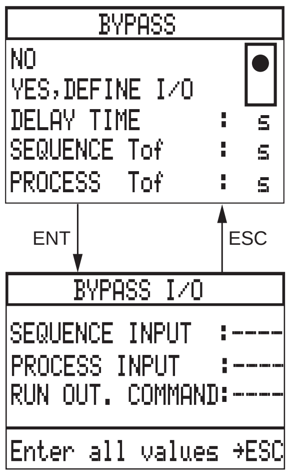


Figure 55: Shutdown Timing Diagram (2-Wire Command)

Bypass



NOTE: Do not set Bypass function if the drive controller is part of a Class 8839 ALTIVAR 56 combination device.

Bypass is used to sequence an output isolation contactor. The output isolation contactor is commonly used in conjunction with a bypass contactor. The bypass contactor and associated power circuit components permit starting, running and stopping of the motor directly from line power. Bypass operation requires the wiring scheme illustrated in Figure 58 on page 87.

To use Bypass, assign a logic input (LI3 for example) to Sequence Input and relay output R2 to Run Output Command. Set time values for Delay Time and Sequence Tof (Time Out Fault). If desired, logic input LI4 can be assigned to Process Input and a time value for Process Tof (Time-out Fault) can be set to verify an optional user-defined event. These parameters are described in Table 56.

Figure 56: Bypass Parameters

Parameter	Description	Range	Default
Delay Time	Programmable delay time to allow for decay of residual motor voltage before restarting the drive controller after operating directly from line power.	0.2-10 s	2 s
Run Output Command	This output is active if the drive controller receives a Run command and Delay Time has expired. Assign relay R2 to Run Output Command.	—	—
Sequence Input	Used to initiate the acceleration ramp. If this input does not go high within the time for which Sequence Time-out Fault is set, the drive controller will not start and displays a Sequence Time-out Fault. If the Sequence Input goes low while the drive controller is operating, the drive controller will fault and freewheel stop.	—	—
Sequence Time-out Fault	The time period after a run command is received during which the Sequence Input must go high to prevent a sequence time-out fault.	0.2-300 s	5 s
Process Input	Verifies the occurrence of a user-defined event after the acceleration ramp has begun. If this input does not go high within the time for which the Process Time-out Fault is set, the drive controller will trip on Process Time-out Fault.	—	—
Process Time-out Fault	The time period after the acceleration ramp has begun during which the Process Input must go high to prevent a Process Time-out fault.	0.2-300 s	60 s

Example Bypass Circuit Description

The bypass scheme shown in Figure 58 on page 87 is an example of integrating electromechanical devices with the Bypass function and agrees with the operation described in Table 56 and Figure 57. Depending upon the application, modifications to this circuit may be required to achieve the desired performance. Command Type must be set in the 6→Drive Configuration to “2-wire” for our example circuit to operate correctly.

NOTE: When using the Bypass function, an external overload relay should be present for motor overload protection. The overload relay is required for protection of the motor against overload/phase loss when operating from either the line (BYP) or drive controller (AS).

Selector switch SW controls the circuit.

- With the switch in the AS (Adjustable Speed) position, the motor is run from the drive controller.
- With the switch in the OFF position, no power is applied to the motor.
- With the switch in the BYP (Bypass) position, the motor is run directly from the input line.

The operation at each transition of SW is as follows:

1. **OFF to AS**: SW contact C closes, causing LI2 (Run Forward) to go high which starts the Delay Time. If the motor had previously been running in Bypass, then the delay time allows the residual motor voltage to decay. After the Delay Time, the R2 relay (Run Output Command) closes, energizing the I (Isolation) contactor, allowing power to the motor. The I contactor interlock connected to LI 3 (Sequence Input) allows the drive controller to start accelerating. The I contactor interlock must close within the Sequence ToF time or a Sequence Time-out Fault will occur. If the pressure switch contactor connected to LI4 (Process Input) does not close within the Process ToF time, a Process Time-out Fault will occur.
2. **AS to OFF**: SW contact C opens, causing LI2 to go low and the drive controller to decelerate and stop the motor. Then R2 (Run Output Command) opens, de-energizing the I contactor.

3. **OFF to BYP**: SW contact A closes, energizing the B (Bypass) contactor. Motor overload protection is provided by OL (thermal overload relay) during running in Bypass. SW contact B opens, disabling the I contactor control circuit. SW contact D opens. Since LI3 (Sequence Input) goes low as a result, the drive controller cannot start. If the drive controller was still in the process of decelerating the motor when previously in “AS”, the drive controller will initiate a Sequence Time-out Fault, signalling that an incorrect SW sequence has occurred. If incorrect SW sequence indication is not desired, the Controlled Stop function can be used along with the Bypass function. To use Controlled Stop, SW contact D must be connected directly into the LI assigned to Controlled Stop and the I contactor interlock is wired to +24. Use of the Controlled Stop function along with the Bypass function requires the addition of an I/O Extension module if a Process Input is used.
4. **BYP to OFF**: SW contact A opens, de-energizing I contactor. The motor stops.

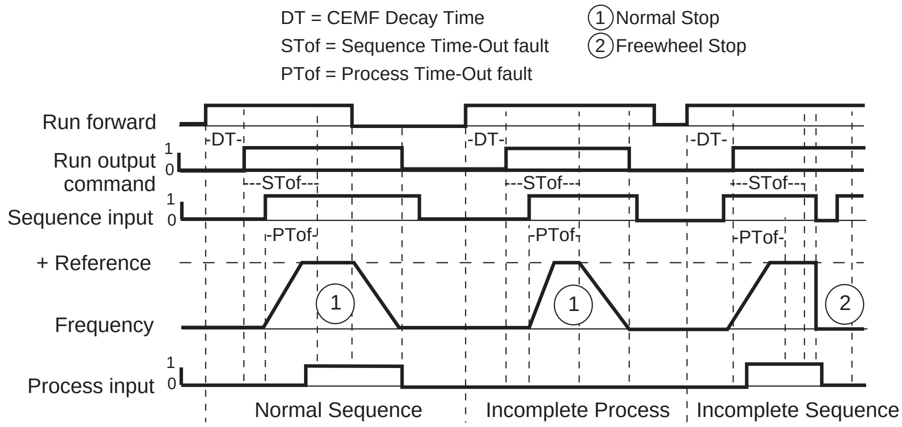
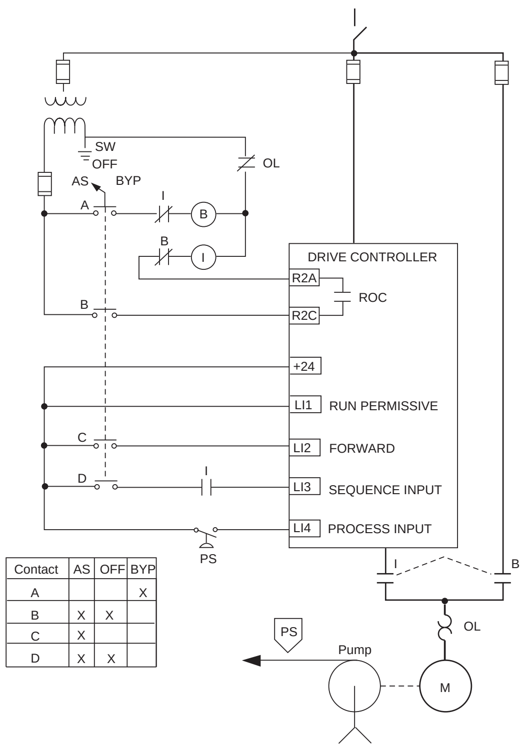


Figure 57: Bypass Timing Diagram



Contact	AS	OFF	BYP
A			X
B	X	X	
C	X		
D	X	X	

Figure 58: Bypass Circuit Diagram

PI Regulator

```
PI REGULATOR
NO                    ●
YES, SET POINT
FEED BACK
SET POINT MANUAL
PI PARAMETERS
```

NOTE: Note: The drive controller has the capability to run in reverse when the PI Regulator function is used. For fan and pump applications in which reverse operation is not permissible, select NO for NEG. VALUES under the PI Parameters screen (Table 36 on page 95).

PI Regulator makes it possible to control a process by adjusting motor speed using a setpoint input and a feedback input. For example, PI Regulator can be used to control the flow or pressure in a pumping system or the liquid level in a reservoir. PI Regulator requires, at minimum, two analog input ports. Additional analog and logic input ports are required for other optional PI Regulator functions. Table 30 describes the items available from the PI Regulator menu. See Figure 59 on page 88 for a block diagram of the PI Regulator function. The menus in this section show factory settings.

Table 30: PI Regulator Menu Items

Menu Item	Description
NO	PI Regulator function is off.
YES, SET POINT	PI Regulator function is on. Selecting this brings up the SET POINT configuration menu. The settings under SET POINT must be defined for PI Regulator to operate. See page 89.
FEED BACK	Feedback configuration menu. The settings under FEED BACK must be defined for PI Regulator to operate. See page 90.
SET POINT MANUAL	Manual speed reference/automatic setpoint configuration menu. The settings under SET POINT MANUAL may be configured to allow switching between an automatic setpoint reference and a manual speed reference. See page 94.
PI PARAMETERS	Miscellaneous PI Regulator configuration parameters menu. The settings under PI PARAMETERS may be configured to fine tune the operation of PI Regulator, or to provide analog and logic reference and status outputs. See page 95.

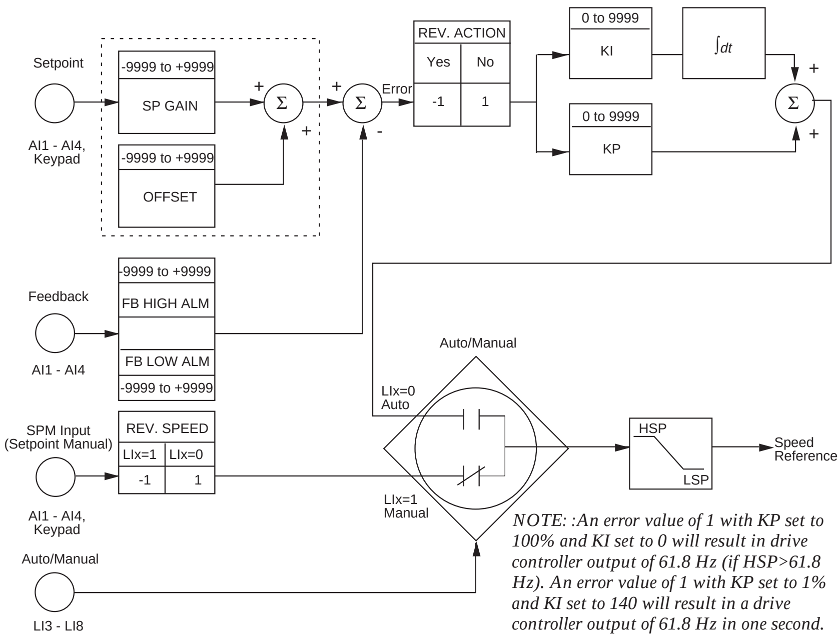


Figure 59: PI Regulator Block Diagram

Function Compatibility

PI Regulator function can only be used when the drive controller is configured for 2-wire control. Table 31 lists the functions which are incompatible with the PI Regulator function.

Table 31: Functions Incompatible with PI Regulator

Function	Menu Number
Keypad Configuration Menu	5
Command Type: 3-wire	6.2
Preset Speeds	7.2
Speed Reference	7.2
Auto/Manual	7.2
Shutdown	7.2
Tach. Feedback	7.2

NOTE: Tach. Feedback (shaded) is only available when an I/O Extension module is present.

Using PI Regulator

To activate the PI Regulator function, choose "YES, SET POINT" from the PI Regulator menu. The SET POINT menu appears.

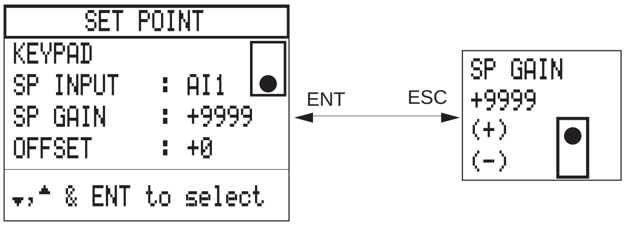


Table 32: SETPOINT Menu Items

Menu Item	Description	Range
KEYPAD	Selects the keypad as the means for entering the setpoint. Enter the setpoint with PI SET POINT in the 1→Parameter Setting menu.	—
SP INPUT	Selects an analog input port as the means for entering the setpoint.	AI1, AI2, AI3, AI4
SP GAIN	Setpoint scaling adjustment. Range corresponds to %. For example: 9999 = 99.99%.	-9999 to +9999
OFFSET	Setpoint offset adjustment. Range corresponds to %. For example: 9999 = 99.99%.	-9999 to +9999

First, select the means for setpoint entry. Choose KEYPAD for entering the setpoint through the keypad, or SP INPUT for entering the setpoint through an analog input port.

If KEYPAD is chosen for setpoint entry, enter the setpoint value in PI SET POINT under the 1→Parameter Setting menu. The setpoint value ranges from 0 to 9999 and is a percentage of the setpoint range (where 9999 represents 99.99%). 0 is setpoint minimum, 9999 is setpoint maximum, and 5000 is the middle (50%) of the setpoint range. Calculate the PI SET POINT value percentage as follows:

$$\text{PI SET POINT} = \left(\frac{\text{Setpoint} - \text{Min. Process Level}}{\text{Max. Process Level} - \text{Min. Process Level}}\right) \times 9999$$

If setpoint is to be entered through an analog input port, chose the analog input port based on the type of setpoint signal used (see Table 33).

Table 33: Analog Input Port Ranges

Analog Input Port	Input Range
AI1	0 to 10 V
AI2	0 to 20 mA; 4 to 20 mA
AI3	-10 V to 10 V [1]
AI4	0 to 20 mA; 4 to 20 mA

[1] **AI3 acts as an absolute value when used for PI Regulator.**

NOTE: The analog inputs (shaded) are available only when an I/O extension module is present.

Next, calculate the system gain and offset values. System gain and offset are determined by the setpoint minimum and maximum process values and the feedback minimum and maximum process values. Use the following formulas to calculate system gain and offset, and then enter the values into the drive controller with the SP GAIN and OFFSET entries on the SET POINT menu.

$$\text{SP GAIN} = \left(\frac{\text{Setpoint Max.} - \text{Setpoint Min.}}{\text{Feedback Max.} - \text{Feedback Min.}}\right) \times 9999$$

$$\text{OFFSET} = \left(\frac{\text{Setpoint Min.} - \text{Feedback Min.}}{\text{Feedback Max.} - \text{Feedback Min.}}\right) \times 9999$$

Setpoint Min.	Process value corresponding to the minimum setpoint signal. Setpoint Min. may either be the maximum process level or the minimum process level, depending on the type of application. Controller will run at low speed at setpoint minimum.
Setpoint Max.	Process value corresponding to the maximum setpoint signal. Setpoint Max. may either be the maximum process level or the minimum process level, depending on the type of application. Controller will run at high speed at setpoint maximum.
Feedback Min.	Process value at which feedback is minimum.
Feedback Max.	Process value at which feedback is maximum.
9999	Process resolution factor. 9999 corresponds to 99.99%.

Feedback

```
FEED BACK
FB INPUT      : AI2
MIN FEED BACK: +0
MAX FEED BACK: +1000
LOW LEVEL ALM: +0
▼,▲ & ENT to select
HIGH LEVEL ALM: +0
```

Table 34: Feedback Menu Items

Menu Item	Description	Range
FB INPUT	Selects an analog input port for receiving the feedback signal.	AI1,AI2,AI3,AI4
MIN FEED BACK	Minimum process value for the process feedback sensor.	-9999 to 9999
MAX FEED BACK	Maximum process value for the process feedback sensor.	-9999 to 9999
LOW LEVEL ALM	Process value below which the FB LOW ALARM logic output activates.	-9999 to 9999
HIGH LEVEL ALM	Process value above which the FB HIGH ALARM logic output activates.	-9999 to 9999

NOTE: LOW LEVEL ALM must be set greater than MIN FEED BACK and HIGH LEVEL ALM must be set less than MAX FEED BACK.

Select an analog input port for receiving the process feedback signal based on the type of signal used. See Table 33 on page 90 for specifications of analog input ports. Enter the minimum process value for the process feedback sensor in MIN FEED BACK and enter the maximum process value for the process feedback sensor in MAX FEED BACK.

LOW LEVEL ALM may be configured in conjunction with FB LOW ALARM to annunciate when the process is below an acceptable level. Enter a process value between -9999 and 9999 corresponding to the level in which the feedback low alarm (FB LOW ALARM) should turn on. Configure the logic output which will annunciate the fault minimum with FB LOW ALARM in the PI Parameters menu (see page 95).

HIGH LEVEL ALM may be configured in conjunction with FB HIGH ALARM to annunciate when the process is above an acceptable level. Enter a process value between -9999 and 9999 corresponding to the level in which the feedback high alarm (FB HIGH ALARM) should turn on. Configure the logic output which will annunciate the fault maximum with FB HIGH ALARM in the PI Parameters menu (see page 95).

PI Regulator Application Examples

Example 1

The drive controller will be used to regulate the level of water in a wet well. The pump will be pumping water out of the wet well to maintain the level between 8 feet and 17 feet. The feedback signal is 0 to 20 mA. At 5 feet the feedback signal is 0 mA, and at 20 feet the feedback signal is 20 mA. A 0 to 10 V signal is used for the setpoint. At 0 V the wet well level is 8 feet, and at 10 V the wet well level is 17 feet.

1. Select YES, SET POINT in the PI Regulator menu.
2. Select SP INPUT.
3. Select AI1 for setpoint input.
4. Calculate SP GAIN and OFFSET and enter the values.

Setpoint Signal Input on AI1	Corresponding Process Value
0 V	8 feet. Setpoint Min. *Process value at low speed.*
10 V	17 feet. Setpoint Max. *Process value at high speed.*

Feedback Signal Input on AI2	Corresponding Process Value
0 mA	5 feet. Feedback Min. *Process value at minimum feedback.*
20 mA	20 feet. Feedback Max. *Process value at maximum feedback.*

$$\text{SP GAIN} = \left(\frac{17-8}{20-5}\right) \times 9999 = 6000$$

$$\text{OFFSET} = \left(\frac{8-5}{20-5}\right) \times 9999 = 2000$$

5. Select FEED BACK in the PI Regulator screen.
6. Select FB INPUT.
7. Select AI2 for feedback input.
8. Select MIN FEED BACK.
9. Enter 5 for the minimum process level.
10. Select MAX FEED BACK.
11. Enter 20 for the maximum process level.
12. If desired, enter optional LOW LEVEL ALM and HIGH LEVEL ALM values.
13. Select YES for REV. ACTION in PI PARAMETERS menu.
14. Adjust KP and KI to achieve the best system response.

Example 2

This example is the same as Example 1, except it uses the keypad as the means for setpoint entry. The desired setpoint is 12.5 feet.

1. Select YES, SET POINT in the PI Regulator menu.
2. Select KEYPAD as means for setpoint entry.
3. Calculate SP GAIN and OFFSET as illustrated in Example 1 and enter the value.
4. Select FEED BACK in the PI Regulator screen.
5. Select FB INPUT.
6. Select AI2 for feedback input.
7. Select MIN FEED BACK.
8. Enter 8 for the minimum process level.
9. Select MAX FEED BACK.
10. Enter 17 for the maximum process level.
11. If desired, enter optional LOW LEVEL ALM and HIGH LEVEL ALM values.
12. Calculate PI SET POINT and enter the value in the 1→Parameter Setting menu.

$$\text{PI SET POINT} = \left(\frac{12.5-8}{17-8}\right) \times 9999 = 5000$$

13. Select YES for REV. ACTION in PI PARAMETERS menu.
14. Adjust KP and KI to achieve the best system response.

Example 3

In this example, the drive controller will be used to regulate the volume of water in a vat. The pump will be pumping water into the vat to maintain the level between 100 m^3 and 10 m^3. The feedback signal is 0 to 20 mA. At 5 m^3 the feedback signal is 0 mA, and at 100 m^3 the feedback signal is 20 mA. A 0 to 10 V signal is used for the setpoint. At 0 V the process level is 100 m^3, and at 10 V the process level is 10 m^3.

1. Select YES, SET POINT in the PI Regulator menu.
2. Select SP INPUT.

3. Select AI1 for setpoint input.
4. Calculate SP GAIN and OFFSET and enter the values.

Setpoint Signal Input on AI1	Corresponding Process Value
0 V	100 m^3. Setpoint Min. *Process value at low speed.*
10 V	10 m^3. Setpoint Max. *Process value at high speed.*

Feedback Signal Input on AI2	Corresponding Process Value
0 mA	5 m^3. Feedback Min. *Process value at minimum feedback.*
20 mA	10 m^3. Feedback Max. *Process value at maximum feedback.*

$$\text{SP GAIN} = \left(\frac{10-100}{200-5}\right)\times 9999 = -4615$$

$$\text{OFFSET} = \left(\frac{100-5}{200-5}\right)\times 9999 = 4871$$

5. Select FEED BACK in the PI Regulator screen.
6. Select FB INPUT.
7. Select AI2 for feedback input.
8. Select MIN FEED BACK.
9. Enter 10 for the minimum process level.
10. Select MAX FEED BACK.
11. Enter 100 for the maximum process level.
12. If desired, enter optional LOW LEVEL ALM and HIGH LEVEL ALM values.
13. Adjust KP and KI to achieve the best system response.

Example 4

This example is the same as Example 3 except it uses the keypad as the means for setpoint entry. The desired setpoint point is 55 m^3.

1. Select YES, SET POINT in the PI Regulator menu.
2. Select KEYPAD as means for setpoint entry.
3. Calculate SP GAIN and OFFSET as in Example 3 and enter the value.
4. Select FEED BACK in the PI Regulator screen.
5. Select FB INPUT.
6. Select AI2 for feedback input.
7. Select MIN FEED BACK.
8. Enter 10 for the minimum process level.
9. Select MAX FEED BACK.
10. Enter 100 for the maximum process level.
11. If desired, enter optional LOW LEVEL ALM and HIGH LEVEL ALM values.
12. Calculate PI SET POINT and enter the value in the 1→Parameter Setting menu.

$$\text{PI SET POINT} = \left(\frac{55-10}{100-10}\right)\times 9999 = 5000$$

13. Adjust KP and KI to achieve the best system response.

Setpoint Manual

```
   SETPOINT MANUAL
KEYPAD
SPM INPUT  :___     ●
AUTO/MANU  :___
REV. SPEED :___
▾,▴ & ENT to select
```

Table 35: SETPOINT MANUAL Menu Items

Menu Item	Description	Range
KEYPAD	Selects the keypad as the means for entering the manual speed reference. Enter speed reference with PI SP MANUAL in the 1→Parameter Setting menu when KEYPAD is selected.	-
SPM INPUT	Analog input port used for manual speed reference entry.	AI1,AI2,AI3,AI4
AUTO/MANU	Logic input for switching between automatic setpoint and manual speed reference. When the logic input is high, Manual is selected. When the logic input is low, Auto is selected.	LI3 to LI8
REV. SPEED	Logic input for switching between forward and reverse speed. When the logic input is high, the speed reference will be reversed. When the logic input is low, the speed reference will not be reversed.	LI3 to LI8

Setpoint Manual provides the capability to manually control the controller speed. This function is useful for slowly bringing the system up to the desired setpoint, and then switching the setpoint to automatic control.

If KEYPAD is chosen as the means for manual speed reference entry, enter the speed reference value in the PI SP MANUAL menu item in the 1→Parameter Setting menu. The PI SP MANUAL range, expressed as Hz, is from low speed to high speed.

SPM INPUT is the analog input port which will receive the manual setpoint signal. Select the SPM INPUT based on the type of signal used. See Table 33 on page 90 for specifications on the analog input ports.

AUTO / MANU configures the logic input port which controls whether the manual speed reference or the automatic setpoint is used for setpoint entry. If the logic input is low, the automatic setpoint will be used. If the logic input is high, the manual speed reference will be used.

REVERSE SPEED configures the logic input port which controls the direction in which the drive controller runs in manual. If the logic input is high, the drive controller will run in the reverse direction from the direction commanded by the manual speed reference.

PI Parameters

```
PI PARAMETERS
KP              : 100%
KI              : 0
NEG VALUES      : NO
REV. ACTION     : NO
▼,▲ & ENT to select
PI FLT RATIO    : 100%
PI REF OUTPUT   : ___
PI FB OUTPUT    : ___
PI ERR OUTPUT   : ___
PI INTEGRATOR   : ___
FB LIMIT        : ___
FB HIGH ALARM   : ___
FB LOW ALARM    : ___
```

Table 36 describes the various PI adjustment parameters available with PI Regulator.

Table 36: PI Parameters Menu Items

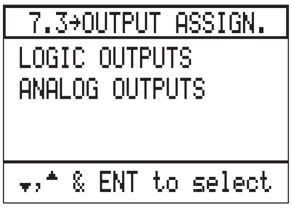
Menu Item	Description	Range
KP	Proportional gain. Adjusts the speed of the reaction to the feedback loop. Range corresponds to %. 9999 corresponds to 99.99%.	0 to 9999%
KI	Integral gain. Adjusts the accuracy of PI regulation. Range corresponds to per second units.	0 to 9999
NEG. VALUES	Determines if the drive controller will be able to run in both directions or in only one direction. **Yes**: The controller can run in both directions. **No**: The controller can run in only one direction.	Yes, No
REV. ACTION	Determines the response to error (Σ) between setpoint and feedback signals. Σ = Setpoint - Feedback **Selection** — **Σ** — **Speed Response** Yes — + — Speed decrease – — Speed increase No — + — Speed increase – — Speed decrease	Yes, No
PI FLT RATIO	User defined error limit between desired setpoint and actual process feedback. Expressed as a percentage of [MAX FEED BACK - MIN FEED BACK]. If the real error exceeds the PI FLT RATIO, the FB LIMIT logic output activates.	0-100%
PI REF OUTPUT	Analog output reference proportional to PI setpoint.	AO1,AO2,AO3
PI FB OUTPUT	Analog output reference proportional to feedback	AO1,AO2,AO3
PI ERR OUTPUT	Analog output reference proportional to PI error. PI error is the percentage difference between desired setpoint and actual feedback compared to the feedback range. The analog output is scaled such that 0 (or 4 mA) is proportional to -5%, and 20 mA is proportional to 5%.	AO1,AO2,AO3
PI INTEGRATOR	Analog output reference proportional to PI integral error.	AO1,AO2,AO3
FB LIMIT	Logic output indicating that PI FLT RATIO has been exceeded. See description of PI FLT RATIO.	LO1 to LO4 RO1 to RO4
FB HIGH ALARM	Logic output indicating that HIGH LEVEL ALM has been exceeded. See description of HIGH LEVEL ALM on page 91.	LO1 to LO4 RO1 to RO4
FB LOW ALARM	Logic output indicating that the feedback is less than LOW LEVEL ALM. See description of LOW LEVEL ALM on page 91.	LO1 to LO4 RO1 to RO4

PI Regulator Settings Configurable from the 1→Parameter Setting Menu

The following PI Regulator Settings are also configurable in the 1→Parameter Setting menu. (PI SET POINT and PI SP MANUAL are *only* configurable in the 1→Parameter Setting menu.) See descriptions of these settings in the “Using PI Regulator” on pages 89 to 90.

- SP GAIN
- OFFSET
- KP
- KI
- PI FLT RATIO
- PI SET POINT (present in the 1→Parameter Setting menu only when KEYPAD is chosen for setpoint entry.)
- PI SP MANUAL (present in the 1→Parameter Setting menu only when KEYPAD is chosen for manual speed reference entry.)

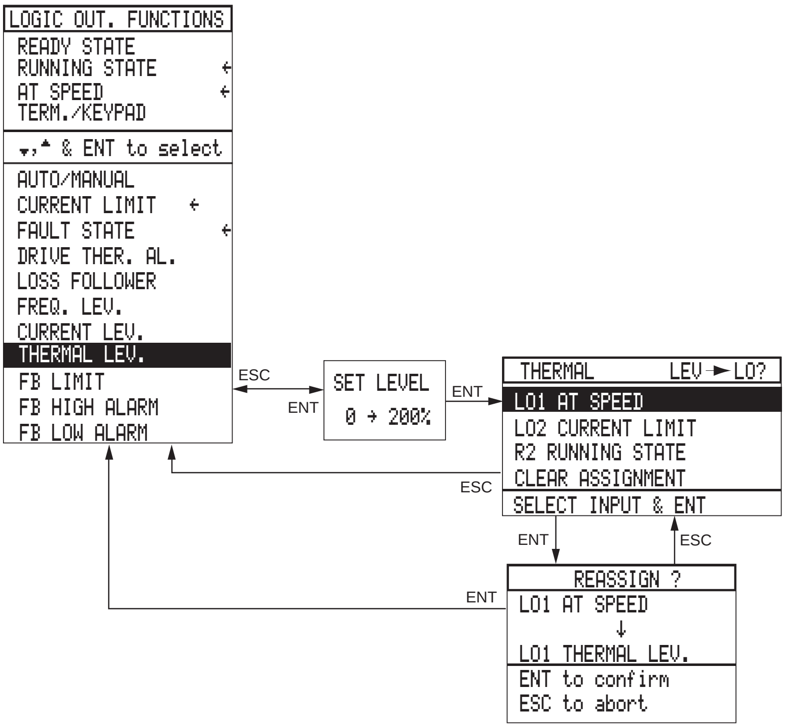
7.3→Output Assignments



The Output Assignment menu allows:

- Display of the logic and analog output assignments
- Assignment of functions to available outputs (i.e., outputs not previously assigned from the 7→General Configuration menu)

Logic Output Functions



This menu displays all functions that can be assigned to the logic outputs and allows reassignment where possible. Only the outputs not previously assigned from the 7.2→Application Function menu can be reassigned here. An arrow indicates a function that is already assigned. Output functions can be assigned to more than one output.

The R1 relay is assigned to the Fault State function and cannot be reassigned. Also, the Drive Thermal Alarm function is only available on drive controllers ATV56D16 to ATV56D79. The menus illustrated above show the procedure for reassigning the logic outputs. The logic output functions are described in the following sections.

Ready State

If drive controller is waiting for a Run command and is not in fault state, logic output is high or relay is energized.

Running State

When a Run command is present, DC injection is not enabled, and there is no fault on the drive controller, logic output is high or relay is energized. If Bypass is enabled, the Sequence Input must also be present for Running State to be high or energized.

At Speed

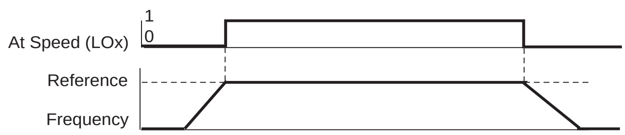


Figure 60: At Speed

When drive controller is commanded to run above zero speed and Output Frequency is equal to Frequency Reference input signal, logic output is high or relay is energized.

Terminal/Keypad

When drive controller is in Keypad Command, logic output is high or relay is energized. When in Terminal Command, logic output is low or relay is not energized.

Auto/Manual

When drive controller is in Auto mode of operation, logic output is high or relay is energized. When in Manual mode of operation, logic output is low or relay is not energized.

Current Limit

When drive controller reaches current limit value (depending on setting in 7.11→Motor Parameters), logic output is high or relay is energized.

Fault State

If drive controller is in fault state, logic output is high or relay is energized. The R1 relay, already assigned to Fault State, deenergizes upon fault.

Drive Thermal Alarm

When the drive controller has reached the thermal alarm, activated a minimum of 60 seconds before a drive controller thermal fault is reached, logic output is high or relay is energized. Available only on drive controllers ATV56D16 to ATV56D79.

Loss of Follower

If current reference at AI2 falls below 3 mA, logic output is high or relay is energized. Can be used only if AI2 is set for 4-20 mA or 20-4 mA.

Frequency Level

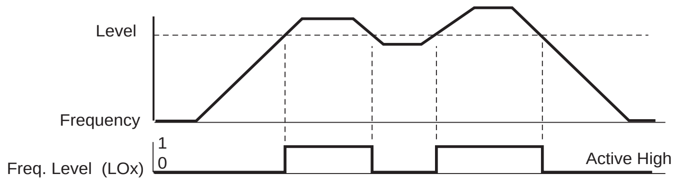


Figure 61: Frequency Level

When output frequency exceeds the programmed frequency level, logic output is high or relay is energized and remains high (or energized) until output frequency falls below the programmed frequency level. Frequency level is adjustable from 0 to 72 Hz.

To indicate with a low logic level, assign a relay output and wire to the correct contacts.

Current Level

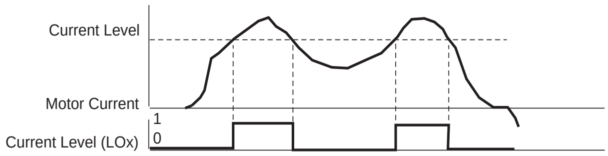


Figure 62: Current Level

When drive controller exceeds programmed current level (adjustable from10 to 110% of nominal drive controller current) logic output is high or relay is energized and remains high (or energized) until drive controller falls below the programmed current level.

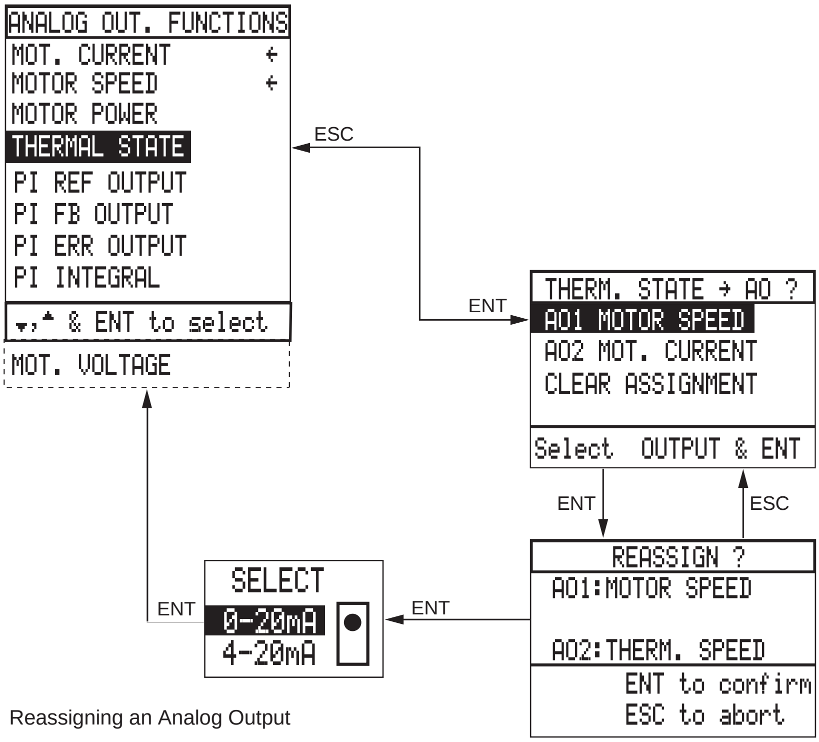
Thermal Level

When thermal motor overload value reaches programmed thermal level (adjustable from 0 to 200% of nominal motor thermal state) logic output is high or relay is energized and remains high (or energized) until thermal motor overload value falls below thermal level.

FB Limit, FB High Alarm, FB Low Alarm

FB Limit, FB High Alarm, and FB Low Alarm are described in Table 36 on page 95.

Analog Output Functions



Reassigning an Analog Output

The Analog Output Functions menu displays all functions that can be assigned to the analog outputs and allows reassignment where possible. Only the outputs not previously assigned from the 7→General Configuration menu can be reassigned here. Arrows indicate previously assigned functions, i.e., functions assigned either by factory default or reassignment.

The menu illustrated above shows the procedure for reassigning the analog outputs. Note that you may change the output signal scaling factor (factory default 0-20 mA) from the Analog Output Functions menu.

Motor Current — 20 mA equals 200% of the motor nominal current rating.

Motor Speed — 20 mA equals High Speed. 0 mA or 4 mA equals 0 speed. Slip compensation does not act on this output.

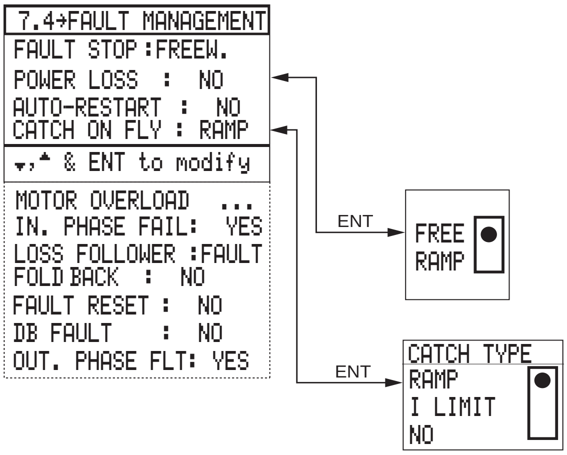
Motor Thermal State — 20 mA equals 200% of the nominal motor thermal state.

Motor Power — 20 mA equals 200% of the motor nameplate power in variable torque, low noise configuration.

Motor Voltage — 20 mA equals 110% of the nominal motor voltage.

PI Ref Output, PI FB Output, PI ERR Output, PI Integral — PI Ref Output, PI FB Output, PI ERR Output, and PI Integral are described in Table 36 on page 95.

7.4→Fault Management



The 7.4→Fault Management menu allows you to program the drive controller for detecting certain fault states and to specify fault stop methods.

NOTE: The user must evaluate the effects of a drive controller fault on the process being controlled and select an appropriate fault management strategy. If a drive controller fault occurs, applications such as those involving safety-critical aspects of a process (continuity of service under unusual service conditions, emergency braking, etc.) may require additional apparatus or control to achieve an appropriate response or level of redundancy.

Fault Stop

Fault Stop determines how the drive controller will stop upon occurrence of a fault. On the ALTIVAR 56 freewheel stop is the fixed method of fault stop. (See Table 37 on page 101.) In freewheel stop, the drive controller output is turned off, allowing the motor to coast to a stop according to inertia and resistant torque.

Drive Controller Restart Methods

There are three methods for resetting the drive controller after a fault:

- Automatic restart (2-wire command only). See page 102.
- Manual reset: removal of all power for longer than 1.0 second, then reapplication of power.
- If input phase failure detection is enabled, an input phase failure lasting longer than 1.0 second may also initiate a manual reset.
- Fault reset by logic input or function key (see page 108).

In all cases, fault reset cannot occur unless the cause of the fault is no longer present. Certain faults, described in Table 37, do not allow an automatic restart.

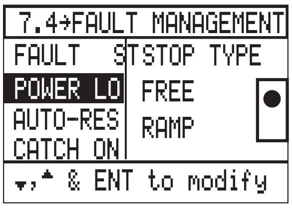
Table 37: Fault Stop and Restart Methods

	Resettable Only By Manual Reset (Removal Of Power)	Fault Reset by LI, Function Key, or Manual Reset	Can be Automatically Reset	Non-Latching Faults [1]
Fault Causing Freewheel Stop	Short circuit Ground fault Precharge failure Internal fault Memory failure Dynamic brake fault Dynamic brake resistor fault Auto-test failure Transistor short circuit Open transistor Link Fault	AC line overvoltage DC bus overvoltage Sequence time-out fault Overspeed Output phase loss Drive overtemperature Motor overload Loss of follower Process time-out fault Serial link fault	AC line overvoltage DC bus overvoltage Sequence time-out fault Overspeed Output phase loss Drive overtemperature Motor overload Loss of follower Process time-out fault	Undervoltage input phase failure

[1] When the fault condition is no longer present, the drive controller will automatically restart the motor if the Command Type is set for 2-wire and the Run Enable and direction inputs are maintained, regardless of the setting of Automatic Restart.

The following sections describe the faults programmable from the 7.4→Fault Management menu.

Power Loss



During loss of input power, certain actions are taken by the drive controller to enable recovery once power is restored. This is possible since the drive controller logic remains active for a least one second after power is lost. The actions taken depend on the settings of Power Loss and Input Phase Failure (see page 107).

With Power Loss set to FREE (factory setting), the following sequence occurs when power is lost or there is a phase failure while the drive controller is running:

- The drive controller freewheel stops (independent of the setting of Input Phase Failure).
- The control logic remains active for at least one second by using the power stored on the drive controller DC bus.
- If input power is restored while the control logic is still active, the drive controller automatically restarts independent of the Command type (in the 6→Drive Configuration menu) selected. If input power is restored when the control logic is no longer active, the drive controller will follow a normal power-up sequence. Restart of the drive controller requires a run command and the absence of faults.

With power loss set to RAMP, the following sequence occurs when power is lost or there is a phase failure while the drive controller is running:

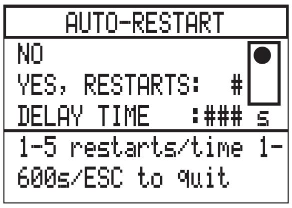
- When the DC bus voltage reaches 80% of its initial value, the drive controller is commanded to decelerate following a ramp. The deceleration attempts to recover inertial energy stored in the load to enable the drive controller to operate the motor for as long as possible during loss of power.
- The control logic remains active for at least one second by using the power stored on the drive controller DC bus.

- Once the DC bus voltage becomes too low to allow motor operation, the drive controller freewheel stops.
- If input power is restored while the control logic is still active, the drive controller will automatically restart independent of the Command type (in the 6→Drive Configuration menu) selected. If input power is restored when the control logic is no longer active, the drive controller will follow a normal power-up sequence. Restart of the drive controller requires a run command and the absence of faults.

To use the RAMP mode of Power Loss, Input Phase Failure must be set to NO. Otherwise, the drive controller will operate as if Power Loss were set to FREE.

The selection of FREE or RAMP depends on the amount and type of disturbance that the load can tolerate during a power loss. Setting Power Loss to FREE allows a longer deceleration time but requires the drive controller to resynchronize to the motor once power returns. FREE is generally best suited for installations which experience long periods of power loss. Setting power Loss to RAMP decelerates the motor more rapidly during power loss and does not require the drive controller to resynchronize to the motor. If power is restored while the motor is still running, recovery to commanded speed occurs rapidly. RAMP is generally best suited for installations which experience short periods of power loss.

Automatic Restart



⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Automatic restart can only be used for machines or installations that present no danger for personnel or equipment in the event of automatic restarting.
- Equipment operation must conform with national and local safety regulations.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Enabling Automatic Restart allows up to five restart attempts after the drive controller has tripped on a fault. The time between restart attempts is programmable from 1 to 600 seconds. The power supply and control commands must be maintained for an Automatic restart.

To enable Automatic Restart, select Yes, specify the number of restart attempts (1-5) and set time between restart attempts (1-600 s).

If the drive controller trips on a fault that is automatically resettable and Automatic Restart is enabled, the drive controller is locked for the programmed time period, then resets the drive controller if the fault condition has disappeared. Then, if commanded to run, the drive controller restarts the motor. If the fault condition remains during the reset attempt, the drive controller locks for the programmed period of time, and the restart command is repeated at the programmed delay time for the programmed number of restarts (maximum of 5 times) before the drive controller trips. See Table 37 on page 101 for faults that can be automatically reset.

Note that only if the drive controller is configured for 2-wire command will it automatically restart the motor. If the drive controller is configured for 3-wire command, Automatic Restart is not available. For 2-wire and 3-wire command, see pages 68 and 68.

Catch On Fly

Catch on Fly is used to regain control of a spinning load after an event such as loss of power or freewheel stop. For proper operation of this function, the drive controller should be configured for 2-wire control. Also, the rotation direction of the freewheeling load must be the same as the rotation direction of the drive controller.

Three possible selections appear for the catch on fly function. These selections are Ilimit, Ramp, and NO. NO is the default setting.

Catch On Fly Set to NO
(Refer to Figure 63)

When commanded to start into a spinning load, the drive controller will reset its output frequency to zero and begin to ramp at the set acceleration ramp rate to the commanded speed. As the frequency increases, the output current increases until the drive controller current limit is reached. The torque produced by the motor current will reduce the speed of the spinning motor to a point where the motor rotational speed matches the drive controller output frequency. Once this occurs, the currents decrease and the drive controller can then accelerate the load to the commanded speed.

The advantage to this control method is that it does not require any user sequencing of the drive controller power or control. In addition, it does not require the presence of any residual voltage at the motor for proper operation. This method does have the disadvantage that the change in motor speed during resynchronization may be unacceptable to some applications since the motor could be forced to near-zero speed before re-acceleration can occur.

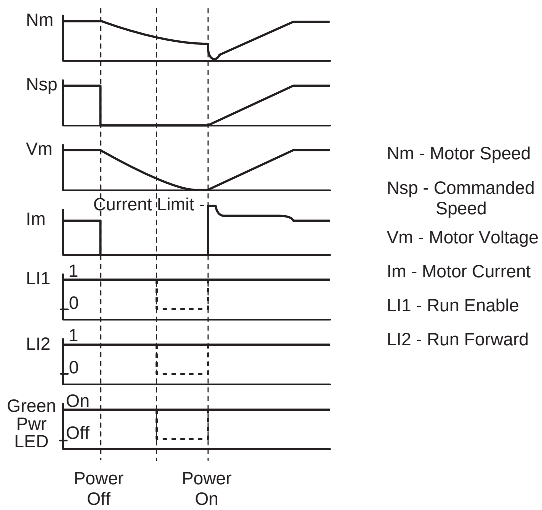


Figure 63: Catch On Fly Set to NO

Catch On Fly Set to RAMP (Refer to Figure 64)

When commanded to start into a spinning load, the drive controller will use the residual voltage present at the motor terminals to estimate motor speed. If no residual voltage is present, then the control method reverts to that described in “Catch On Fly Set to NO.” If residual voltage is present, then the drive controller initial output frequency is set to the estimated speed value allowing the motor to rapidly synchronize to the drive controller output frequency.

The drive controller then increases the motor speed at the set acceleration ramp rate to the commanded speed. If a run command is present, the drive controller will start in this mode when the LI1 input is cycled from logic 1 to logic 0 and back to logic 1 or, following a brief power outage for which the control logic remains active (Green LED on drive controller remains lit). If the control logic becomes inactive during the power outage (Green LED on drive controller goes out), the restart control method reverts to that described in “Catch On Fly Set to NO.”

The advantage to this control method is that it produces the least additional speed disturbance of the three Catch On Fly selections while the motor is synchronizing to the drive controller output. This method does have the disadvantage that residual motor voltage must be present for speed estimation to occur.

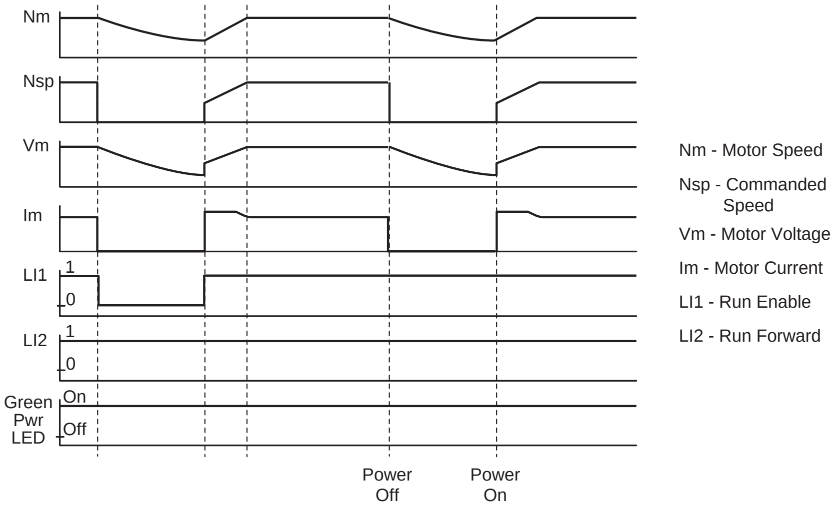


Figure 64: Catch On Fly Set to RAMP

Catch On Fly Set to ILIMIT (Refer to Figure 65)

When commanded to start into a spinning load, the drive controller output voltage is reduced and the drive controller output frequency is set to the commanded frequency. While the voltage is being reduced, the drive controller output voltage is synchronized to the motor. If synchronization is not possible, the restart control method reverts to that described in “Catch On Fly Set to NO.” If synchronization is possible, the drive controller output voltage is then raised causing the motor to rapidly accelerate to commanded speed.

Acceleration generally occurs with the drive controller at current limit. Provided that a run command is present, the drive controller will start following an extended power outage where the control logic is no longer active (Green LED on drive controller is out). The run command must be activated prior to or during the drive controller power-up sequence for this mode to be active.

The advantage to this control method is that it can resynchronize to command speed in the least amount of time of the three Catch on Fly selections, since re-acceleration generally occurs with the controller at current limit. Also, this method, which does not require the presence of residual motor voltage, is useful when regaining control of high inertia loads after extended power outages. If the command speed matches the motor speed, little if any motor disturbance is seen during restarting. This is useful when restarting a single motor on a moving process line.

This method does have the disadvantage that the motor torque disturbance during resynchronization may be unacceptable to some applications, since the motor attempts to accelerate to the commanded speed at the current limit setting of the controller.

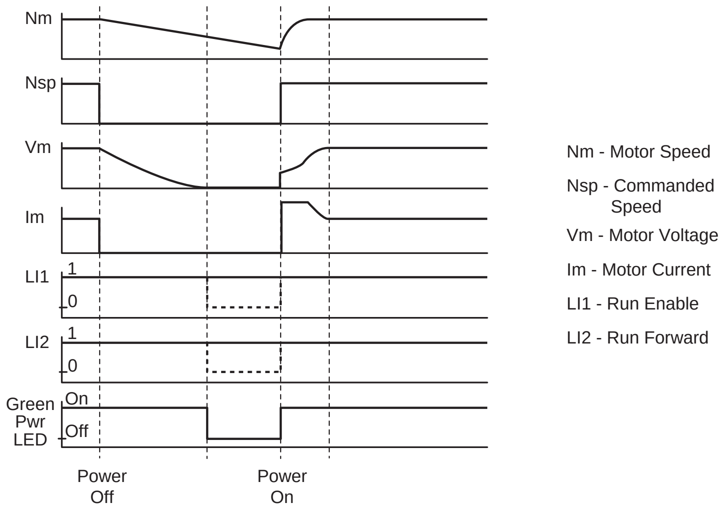
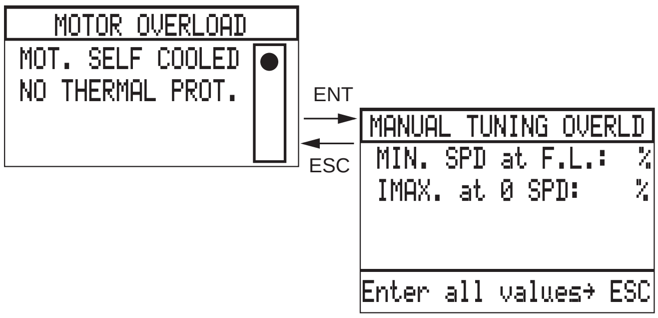


Figure 65: Catch On Fly Set to ILIMIT

Motor Overload

> ⚠ **WARNING**
>
> **MOTOR OVERHEATING**
>
> This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds or loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.
>
> **Failure to follow this instruction can result in death, serious injury, or equipment damage.**



Motor Overload enables the drive controller to protect a standard asynchronous induction motor from overload. This function can replace a conventional class 10 thermal overload relay for single motor applications; however, multi-motor applications require individual external thermal overload motor protection.

This function is more effective in protecting a motor operated from a drive controller because it considers motor speed as well as time and current in its protection algorithm. This is important since most motors applied on drive controllers are self-cooled, and their cooling effectiveness declines at lower speeds. The drive controller's protection algorithm integrates motor current over time, taking into account factors such as stop time and idle time.

Adjustment of Motor Overload

To adjust Motor Overload, first select the type of protection in the 7.4 → Fault Management menu. Two types of protection are available from the Motor Overload screen:

1. For Self-Cooled Motor
2. No thermal protection

Factory setting is Self-Cooled Motor. Once the type of protection is selected, the Motor Overload current can be set in either the 1 →Parameter Setting menu or in this screen. Motor Overload can be adjusted from 0.45 to 1.15 times the nominal drive controller current (see page 54), factory preset is 0.9 times nominal drive controller current (see page 70). Adjust Motor Overload value to nominal motor current. The types of protection are discussed in the following section.

Types of Protection

Self-Cooled Motor

With this type of motor overload protection, the motor base frequency is assumed to be the same as the nominal rated frequency. Enter the motor full load amps for Motor Overload current value.

The overload time–current characteristic is set to allow operation at motor rated current above 50% of motor base speed. Below 50% of motor base speed, the time-current characteristic is linearly tapered so that at zero speed, the drive will trip on overload at continuous operation above 25% of the motor overload setting.

The I^2t curve, which is used to determine when to trip on a motor overheat condition, emulates a class 10 thermal overload curve.

No Thermal Protection

External thermal overload relays are required when more than one motor is connected to the output or when the motor connected to the drive controller is less than half the drive controller rating. When external overload protection is provided, select "No Thermal Protection."

⚠ CAUTION

LOSS OF MOTOR OVERLOAD PROTECTION

When using external overload relays connected to drive controller output, the overload relays must be capable of operation over the expected range of drive controller output frequencies (including direct current). When DC injection braking is used:

- The overload relay must be suitable for operation with direct current flowing in the motor.
- Do not use overload relays equipped with current transformers for sensing the motor current.

Failure to follow this instruction can result in equipment damage.

The thermal state of the drive controller is not automatically reset when power is removed.

⚠ CAUTION

MOTOR OVERHEATING

Repeated reset of the thermal state after a thermal overload can result in thermal stress to the motor.

When faults occur, promptly inspect motor and driven equipment for problems (locked shaft, mechanical overload, etc.) prior to restarting. Also check power supplied to motor for abnormal conditions (phase loss, phase imbalance, etc.).

Failure to follow this instruction can result in damage to the motor.

When a thermal overload fault occurs, a screen appears which asks “Do you want to clear the thermal state?” If **NO** is selected, the motor overload fault cannot be reset until the thermal state of the motor, as calculated by the motor overload algorithm in the drive controller, is less than 100%.

If **YES** is selected, the motor overload fault is restrained. The motor overload fault can be reset and the drive controller restarted. The restraint of the motor overload trip will last for approximately one minute. At the end of one minute, the restraint will clear and a motor overload trip will occur. This function can be used to allow maintenance personnel to perform an orderly shut-down of a process in the event of a motor overload fault. Subsequent restraint is possible, if required. However, repeated use of the restraint function can ultimately lead to motor damage.

Input Phase Failure

Input Phase Failure is used to detect loss of one or all input phases. When set to Yes, if one input phase is lost, the drive controller will trip. If the phase is restored and the drive controller is in 2-wire command with the Run Enable and direction inputs high, the drive controller will automatically restart the motor, regardless of the setting of Automatic Restart. If the phase is restored and the drive controller is in 3-wire command, the drive controller will be reset, but the motor will not start. If more than one phase is lost, the drive will trip on undervoltage.

Input phase failure can be inhibited by selecting No when a line contactor is used with the drive controller and control power is supplied separately to CL1-CL2, or in special applications when a common DC bus tie is used. When set to No, input phase loss will be ignored, however undervoltage will be displayed if the DC bus voltage is less than the undervoltage level but sufficient to maintain the drive controller power supply. The Fault State relay R1 will remain energized whenever voltage is present on CL1 and CL2, as long as there are no other faults. The undervoltage condition must be cleared prior to the drive controller recognizing a run command.

Loss of Follower

Loss of follower is used with the AI2 input and occurs when the 4-20 mA or 20-4 mA reference input is less than 3 mA. The drive controller can be programmed to fault, to run at a preset speed (programmable from Low Speed to High Speed), or to ignore the fault condition (factory preset) when loss of follower is detected.

When “Go to ### Hz” is selected, AI2 must be the only assigned speed reference. All other speed references must be de-selected (see “Speed Reference” on page 79). The adjustment range of “Go to ### Hz” is 0.1 to 72 Hz.

Fold Back

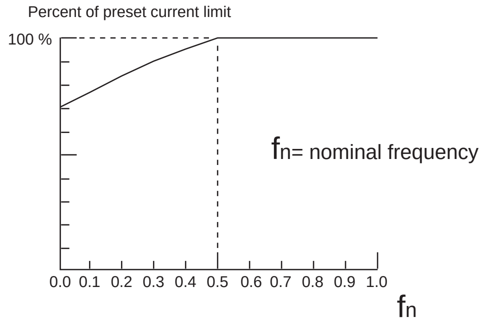
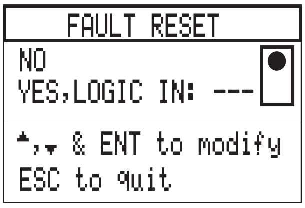


Figure 66: Fold Back

Fold Back is displayed only if the drive controller is configured for variable torque (page 67). Fold Back tapers the current limit curve as shown in Figure 66. Fold Back can be activated or deactivated from the keypad display.

Fault Reset



Enabling Fault Reset allows the drive controller to be reset when in Terminal Command mode after tripping on certain faults when an assigned logic input is high. To enable Fault Reset, select Yes and assign a logic input. The faults resettable with this function are: Overvoltage, DC-Bus Overvoltage, Output Phase Loss, Drive Overtemperature, Motor Overload, Loss of Follower, Sequence time-out fault, and Process time-out fault. When in Keypad Command mode (page 65) a function key can be programmed for Fault Reset.

Dynamic Brake Fault

DB Fault is available on drive controllers with dynamic braking. Enabling the function allows the drive controller to protect the resistor and connection by generating a fault if the DB resistor connection is open.

Output Phase Fault

Output Phase Fault is used to detect a loss of output phase. The fault can be inhibited by setting to No for troubleshooting or when the motor connected to the drive controller is less than 45% of drive controller power. Output Phase Fault is automatically disabled when the Bypass function is used or the drive controller is operated at less than 33% of nominal frequency.

NOTE: Output Phase Fault should be left enabled, except for the reasons stated above. If it must be disabled (either manually or by the selection of the Bypass function), always supply an external motor overload relay. Operation with the presence of an Output Phase Fault can affect the calibration of the Motor Overload Protection function of the drive controller.

8→DIAGNOSTIC MODE

```
8→ DIAGNOSTIC MODE
AUTODIAGNOSTIC
LOGIC INPUT TEST
ANALOG INPUT TEST
LOGIC OUTPUT TEST
▼,▲ & ENT to activate
ANALOG OUTPUT TEST
```

The 8→Diagnostic Mode menu allows access to various tests for locating failed components in case of an internal drive controller fault. This menu is accessible only when:

- The drive controller is stopped
- Supply line power (L1, L2 and L3) is disconnected
- Control power supply (CL1, CL2) is connected

If any of these conditions are not met, an error message appears and access to the Diagnostic Mode is denied. Exit the error message screen and return to the Main menu by pressing ESC.

The motor should be connected when performing tests. The following sections cover the functions available from the Diagnostic Mode menu.

Autodiagnostics

```
AUTODIAGNOSTIC
MEM,±15 SUP & SUP FRQ
TRANSISTORS TEST

▼,▲ & ENT to activate
ESC to quit
```

Two tests are available from the Autodiagnostic Screen. Select either or both of the tests by scrolling with the ▲ and ▼ keys and pressing ENT.

1. Memory, ±15 V Supply, and Supply Frequency initiates a test on the ROM memory, a confirmation of the presence of ± 15 V, and a confirmation of the presence of supply frequency.
2. Transistors Tests initiates a test sequence on the drive controller transistor bridge. Note that the length of time required for this test varies with product size and the number of transistors in the bridge. While the test is in progress the Result display (see Figure 67) will report “In Process” on line 2.

Memory Test

```
AUTODIAGNOSTIC
INTERNAL MEMORY   :OK
±15V SUPPLY       :OK
FREQ. SUP. DETECT : X
OK or X=FAULT
ESC to quit
```

Transistor Test

```
AUTODIAGNOSTIC
CELLS TEST:IN PROCESS
T1:OK   T3:OK   T5:OK
T4:OK   T6:X    T2:?
OK,?=NON TESTED   OR
X=FAULT  ESC to quit
```

Figure 67: Tests Results

There are three possible responses for each element of a test:

- “OK” indicates that the tested element is good.
- “X” indicates that the tested element is defective.
- “?” (transistor test only) indicates that the transistor could not be tested.

Logic Input Test

```
  LOGIC INPUT TEST
IN.  ASSIGNMENTS
LI1  RUN PERMIT    0
LI2  RUN FORWARD   1
LI3  AUTO/MANUAL   1
LI4   ---  -------  0
```

This menu allows you to change the state of the logic inputs to check for good wiring connections. When the Logic Input Test screen is active, changes made to the inputs will change input bit status without affecting the state of the drive controller.

Analog Input Test

```
 ANALOG INPUT TEST
IN.  ASSIGNMENT  VAL%
AI1  SPEED REF. 1  43
AI2  --- -------  ###
```

Analog Input Test is similar to Logic Input Test. When this screen is active, you can change the state of the analog inputs to check for good wiring connections without affecting the state of the drive controller.

Logic Output Test

```
 LOGIC OUTPUT TEST
OUT. ASSIGNMENT    S
LO1  READY STATE   0
LO2  SPEED LEVEL   1
R1   FAULT STATE   0
▾,▴ 1,0 To force &ENT
R2                 1
```

This menu allows you to change the state of the logic outputs to check for good wiring connections without affecting drive controller operation.

When the Logic Output Test screen is active, all outputs are forced to low (0) state regardless of actual drive controller settings. Changes then made to the outputs will alter bit status without affecting the state of the drive controller. When you leave the Diagnostic Mode and return to Main menu, the logic outputs resume the programmed settings in place before the test sequence.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

Forcing drive controller logic and analog outputs may cause undesired activation of connected equipment.

Set the connected equipment to ignore the change of state.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Analog Output Test

```
ANALOG OUTPUT TEST
OUT. ASSIGNMENT VAL%
AO1  ------------   0
AO2  ------------ 100
FORCE:0=MIN,2=FULL

▾,▴  & ENT to valid
```

This menu allows you to change the value of the analog outputs to check for good wiring connections without affecting drive controller operation.

When the Analog Output Test screen is active, all output values are forced to 0 regardless of actual drive controller settings. Changes then made to the outputs will alter the setting without affecting the state of the drive controller. When you leave the Diagnostic Mode and return to Main menu, the analog outputs resume the programmed settings in place before the test sequence.

9→DRIVE INITIALIZATION MENU

```
9→ DRIVE INIT.
TOTAL FACTORY SETT.
USER SETTING STORE
RECALL USER SETTING
```

This menu is only accessible when the drive controller is stopped. It allows the original factory default parameter settings to be restored to the drive controller, or the user configuration and adjustment settings to be saved to or recalled from a memory card (VW3A66901T).

Total Factory Settings

This selection returns all of the drive controller adjustment and configuration parameters to the original factory default settings.

```
9.1→TOT.FACTORY SETT.
Do you want to change
all the parameters
to factory settings?
ENT to confirm
ESC to abort
```

ENT →

```
THIS ACTION CLEARS THE
ACTUAL CONFIGURATION
AND SETTINGS
Are you sure?
ENT to confirm
```

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Factory default settings will be substituted for present settings when Total Factory Settings is selected and confirmed.
- Factory default settings may not be compatible with the application. After returning to total factory settings, verify that default settings are compatible with application requirements.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

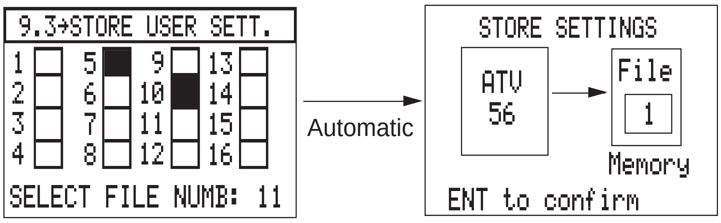
Store User Settings

NOTE: The PCMCIA Memory Card cannot transfer files between drive controllers of different power ratings or between drive controllers which contain different versions of software. See page 54 to determine controller power rating and software version.

Up to 16 configurations can be saved in a PCMCIA memory card (catalog number VW3A66901T). After selecting Store User Settings, a message will appear prompting you to insert a memory card:

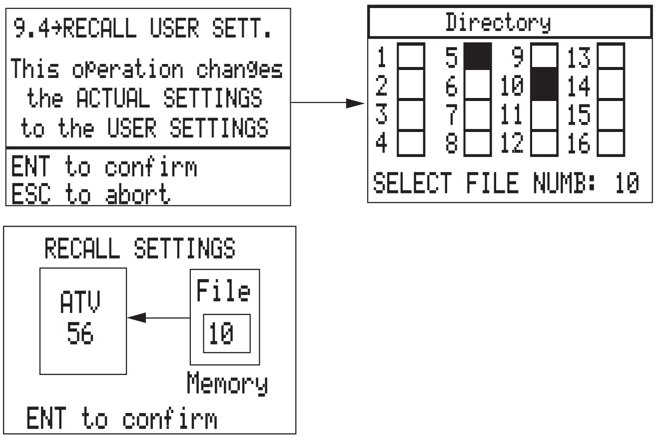
```
PLEASE INSERT
THE MEMORY CARD
INTO THE PCMCIA
CONNECTOR
ENT when ready
```

The following illustration shows the Store User Settings menu. The black boxes correspond to configurations already stored in the card. Select an empty box. In this example, 1 is selected. To store, press ENT. When the configuration has been saved, a message will appear indicating whether or not the save operation was successful.



Recall User Settings

To download a configuration from a PCMCIA memory card to the drive controller, select Recall User Settings. Install the memory card. A message will appear:



Select one black box. In the example shown above, “10” is selected. Press ENT to download. When the configuration has been downloaded, a message will appear indicating whether or not the transfer was successful. If an error was made in selecting a box (file) number, a message will indicate an incompatible or empty file.

NOTE: When recalling user settings, the physical configuration and power rating of the drive controller must match the physical configuration and power rating of the drive controller from which the settings were copied. If the physical configuration and power rating do not match, then a message will indicate an incompatible file.

Chapter 6 — Class 8839 ATV56 Combination Devices

⚠ DANGER

HAZARD OF ELECTRIC SHOCK OR BURN

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off 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.

DRIVE ISOLATION HAZARD

Before servicing the **drive controller**:

- Disconnect all power.
- Place a “Do Not Turn On” label on drive controller
- Lock disconnect in Open position.

Before servicing **basic power converter** when Bypass is selected:

- Perform all functions listed above.
- Measure voltages at disconnect output to verify they are zero.
- Wait 1 minute to allow DC bus to discharge, verify no voltage is present.
- Remove line fuses labeled FU1, FU2, and FU3 with tool provided.
- Replace cover, then close disconnect.

Failure to observe these precautions will result in death or serious injury.

INTRODUCTION

The Class 8839 ALTIVAR 56 drives are combination devices composed of drive controller, power circuit box with options, and wall-mountable back pan. The Class 8839 ALTIVAR 56 drive controllers are available in combination, bypass, or remote starter bypass power circuit configurations.

Terminology

The following terminology is used throughout this chapter and is specific to the Class 8839 ALTIVAR 56 drive controller family.

- When used as a component of the Class 8839 ALTIVAR 56 drive controller, the ATV56U41 through ATV56D79 controllers described in Chapters 1 -5 of this instruction bulletin are referred to as *Power Converters*. This distinction is made to minimize confusion when discussing installation and adjustment practices.
- The combination of the power converter, enclosure, power and control circuits which constitutes the Class 8839 product is referred to as the *Drive Controller* or *Controller*.
- The combination of the controller and motor is referred to as the *Drive*.
- The power circuit box mounted below the power converter is referred to as the *BELE box*.
- The variable torque rating is referred to as *VT*.
- The variable torque, low noise rating is referred to as *VTLN*.

Precautions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

Turn off power supplying this equipment before working inside.

Failure to follow this instruction will result in death, personal injury, or electrical shock.

Follow these precautions unique to the Class 8839 ALTIVAR 56 drive controller:

- The controller is suitable for installation in a Pollution Degree 3 environment as defined in NEMA ICS1 and IEC 664-1. The expected environment must be compatible with this rating.
- When attaching wall-mountable controllers to their mounting surfaces, use fasteners rated for the weight of the apparatus, the expected shock and vibration of the installation, and the expected environment.
- Provide sufficient cooling for expected heat load.

CONTROLLER PART NUMBERS

The controller part number, located on the nameplate attached to the mounting panel, is coded to describe the configuration and options present. Use Table 38 to translate the part number into a description of the drive controller.

Table 38: Controller Part Numbers

Field	Digit	Characteristic	Description
01	01-03	Controller style	**56U** Fan and Pump Drive (US only)
02	04	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 **Q** = 60 hp **R** = 75 hp **S** = 100 hp
03	05	Enclosure type	**G** = Type 1 only
04	06	Voltage	**2** = 200/208 VAC **3** = 230/240 VAC **4** = 460/480 VAC
05	07	Torque/application	**V** = Variable torque rating **L** = Variable torque, low noise rating
06	08	Power circuit type	Defines which of 3 pre-engineered power circuits are supplied: **W** = Combination package **Y** = Bypass package **Z** = Remote starter bypass package
07	09	Miscellaneous options	Defines additional selections to configuration: **A** = Pilot light cluster 1: Power On (Red), Drive Run (Green), Bypass Run (Green), Drive Fault (Yellow) **B** = Pilot light cluster 2: Power On (Red), Drive Run (Green), Auto Mode (Green), Drive Fault (Yellow) **C** = Line isolation contactor **D** = Omit Hand-Off-Auto selector and speed potentiometer **E** = CSA certification **F** = Smoke purge option

CONTROLLER NAMEPLATE IDENTIFICATION

The nameplate for the Class 8839 ALTIVAR 56 drive controller is located on the left hand side of the back panel. This nameplate, shown in Figure 68, carries the controller class, type, and MOD (options) listing. When identifying or describing Class 8839 ALTIVAR 56 drive controllers, use the data from this nameplate.

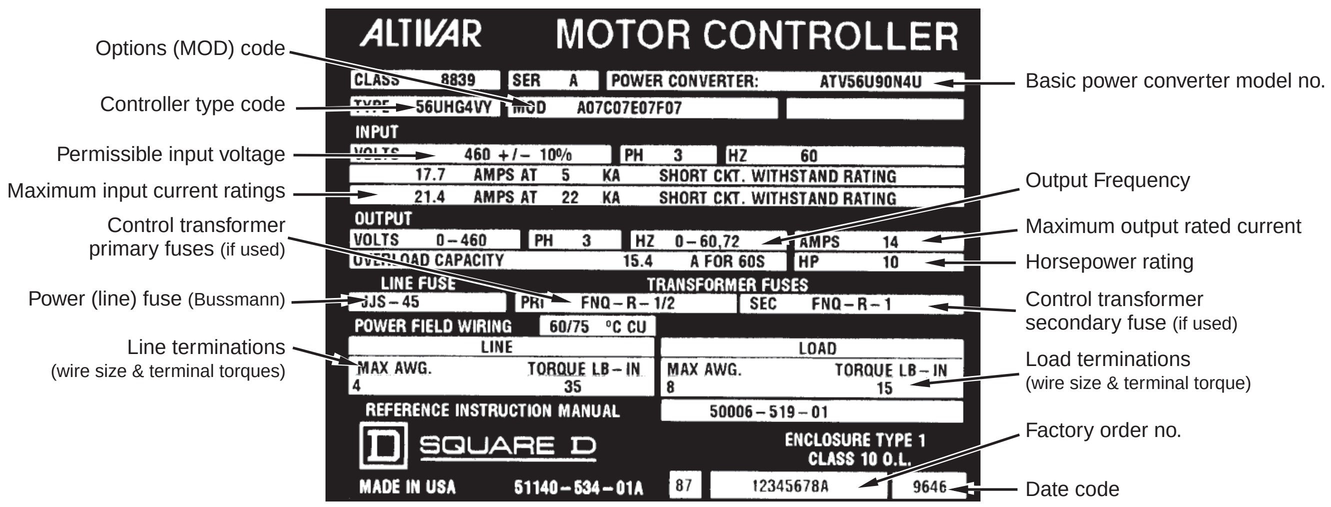


Figure 68: Controller Nameplate

TECHNICAL CHARACTERISTICS

Table 39: Variable Torque Class 8839 Enclosed ATV56 Drive Controller Ratings, 460 VAC ±10%

Switching Frequency: 56UCG4V_ to 56UPG4V_ = 4 kHz; 56UQG4V_ to 56USG4V_ = 2 kHz						
Controller Part No.	**Motor Power** 460 V 60 Hz hp	**Input Line Current [1]** 5,000 A/ 10,000 A [2] A	22,000 A [3] A	**Output Current** A	**Max. Transient Current (60 s)** A	**Power Converter Part No.**
56UCG4V_	1	2.7	3.2	2.1	2.3	ATV56U41N4U
56UDG4V_	2	4.7	5.7	3.4	3.8	
56UEG4V_	3	6.5	8	4.8	5.3	
56UFG4V_	5	9.8	11.9	7.6	8.4	ATV56U54N4U
56UGG4V_	7.5	14	17	11	12	ATV56U72N4U
56UHG4V_	10	17.7	21.4	14	15.4	ATV56U90N4U
56UJG4V_	15	25.1	30.6	21	23	ATV56D12N4U
56UKG4V_	20	31.8	38.3	27	30	ATV56D16N4U
56ULG4V_	25	38.7	47	34	38	ATV56D23N4U
56UMG4V_	30	44	52.4	40	44	ATV56D33N4U
56UNG4V_	40	57.1	67.6	52	57	
56UPG4V_	50	68.6	81.2	65	72	ATV56D46N4U
56UQG4V_	60	86.4*	94.6	77	98	ATV56D54N4U
56URG4V_	75	106*	116	96	116	ATV56D64N4U
56USG4V_	100	138*	150	124	144	ATV56D79N4U

[1] Short-circuit current available at controller input.
[2] 10,000 AIC denoted by asterisk (*).
[3] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 22,000 A.

Table 40: Variable Torque, Low Noise Class 8839 Enclosed ATV56 Drive Controller Ratings, 460 VAC ±10%

Switching Frequency: 56UCG4L_ to 56UNG4L_ = 10 kHz; 56UPG4L_ to 56URG4L_ = 4 kHz						
Controller Part No.	**Motor Power** 460 V 60 Hz hp	**Input Line Current [1]** 5,000 A/ 10,000 A [2] A	22,000 A [3] A	**Output Current** A	**Max. Transient Current (60 s)** A	**Power Converter Part No.**
56UCG4L_	1	2.7	3.2	2.1	2.3	ATV56U41N4U
56UDG4L_	2	4.7	5.7	3.4	3.8	
56UEG4L_	3	6.5	8	4.8	5.3	
56UFG4L_	5	9.8	11.9	7.6	8.4	ATV56U72N4U
56UGG4L_	7.5	13.9	16.7	11	12	ATV56U90N4U
56UHG4L_	10	17.6	21.4	14	15.4	ATV56D12N4U
56UJG4L_	15	24.8	29.9	21	23	ATV56D16N4U
56UKG4L_	20	31.9	38.7	27	30	ATV56D23N4U
56ULG4L_	25	38.7	47	34	38	ATV56D33N4U
56UMG4L_	30	44	52.4	40	44	
56UNG4L_	40	57.1	67.6	52	57	ATV56D46N4U
56UPG4L_	50	68.3	80.8	65	72	ATV56D54N4U
56UQG4L_	60	86.4*	94.6	77	98	ATV56D64N4U
56URG4L_	75	106*	116	96	116	ATV56D79N4U

[1] Short-circuit current available at controller input.
[2] 10,000 AIC denoted by asterisk (*).
[3] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 22,000 A.

Table 41: Variable Torque Class 8839 Enclosed ATV56 Drive Controller Ratings, 230 VAC ±10%

Switching Frequency: 4 kHz						
Controller Part No.	**Motor Power** 230 V 60 Hz	**Input Line Current [1]**		**Output Current**	**Max. Transient Current (60 s)**	**Power Converter Part No.**
		5,000 A	22,000 A [2]			
	hp	A	A	A	A	
56UCG3V_	1	4.9	5.8	4.2	5.1	ATV56U41M2U
56UDG3V_	2	8.6	10.2	6.8	8.3	
56UEG3V_	3	11.8	14	9.6	11.7	
56UFG3V_	5	17.8	21.2	15.2	18.4	ATV56U72M2U
56UGG3V_	7.5	25.8	30.6	22	26.6	
56UHG3V_	10	32.7	38.8	28	34	ATV56U90M2U
56UJG3V_	15	46.2	54.8	42	51	ATV56D12M2U
56UKG3V_	20	58.7	69.4	54	66	ATV56D23M2U
56ULG3V_	25	71.5	84.4	68	83	
56UMG3V_	30	81.1	97.7	80	97	ATV56D33M2U
56UNG3V_	40	102.7	125.9	104	126	
56UPG3V_	50	122.6	151.1	130	158	ATV56D46M2U

[1] Short-circuit current available at controller input.
[2] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 22,000 A.

Table 42: Variable Torque Class 8839 Enclosed ATV56 Drive Controller Ratings, 230 VAC ±10%

Switching Frequency: 56UCG3L_ to 56UMG3L_ = 10 Khz; 56UNG3L_ = 4 kHz						
Controller Part No.	**Motor Power** 230 V 60 Hz	**Input Line Current [1]**		**Output Current**	**Max. Transient Current (60 s)**	**Power Converter Part No.**
		5,000 A	22,000 A [2]			
	hp	A	A	A	A	
56UCG3L_	1	5.4	6.4	4.2	5.1	ATV56U41M2U
56UDG3L_	2	8.8	10.4	6.8	8.3	
56UEG3L_	3	12	14.3	9.6	11.7	
56UFG3L_	5	18.3	21.8	15.2	18.4	ATV56U72M2U
56UGG3L_	7.5	25.8	30.7	22	26.6	ATV56U90M2U
56UHG3L_	10	32.8	39	28	34	ATV56D12M2U
56UJG3L_	15	46.5	55.2	42	51	ATV56D16M2U
56UKG3L_	20	59.6	70.3	54	66	ATV56D23M2U
56ULG3L_	25	71.7	84.7	68	83	ATV56D33M2U
56UMG3L_	30	80.8	97.2	80	97	
56UNG3L_	40	102	125.4	104	126	ATV56D46M2U

[1] Short-circuit current available at controller input.
[2] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 22,000 A.

Table 43: Variable Torque Class 8839 Enclosed ATV56 Drive Controller Ratings, 208 VAC ±10%

Switching Frequency: 4 kHz						
Controller Part No.	Motor Power 208 V 60 Hz hp	Input Line Current [1] 5,000 A A	Input Line Current [1] 8,800 A [2] A	Output Current A	Max. Transient Current (60 s) A	Power Converter Part No.
56UCG2V_	1	5.3	5.7	4.6	5.1	ATV56U41M2U
56UDG2V_	2	9.4	10.2	7.5	8.3	
56UEG2V_	3	12.9	14	10.6	11.7	
56UFG2V_	5	19.5	21.1	16.7	18.4	ATV56U72M2U
56UGG2V_	7.5	28.2	30.6	24.2	26.6	
56UHG2V_	10	35.8	38.7	31	34	ATV56U90M2U
56UJG2V_	15	50.6	54.7	47	51	ATV56D12M2U
56UKG2V_	20	64.2	69.3	60	66	ATV56D23M2U
56ULG2V_	25	77.9	84.4	75	83	
56UMG2V_	30	88	97.7	88	97	ATV56D33M2U
56UNG2V_	40	112	124.9	114	126	
56UPG2V_	50	134.3	149.3	143	158	ATV56D46M2U

[1] Short-circuit current available at controller input.
[2] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 22,000 A.

Table 44: Variable Torque Class 8839 Enclosed ATV56 Drive Controller Ratings, 208 VAC ±10%

Switching Frequency: 56UCG2L_ to 56UMG2L_ = 10 kHz; 56UNG2L_ = 4 kHz						
Controller Part No.	Motor Power 208 V 60 Hz hp	Input Line Current [1] 5,000A A	Input Line Current [1] 8,800 A [2] A	Output Current A	Max. Transient Current (60 s) A	Power Converter Part No.
56UCG2L_	1	5.4	5.8	4.6	5.1	ATV56U41M2U
56UDG2L_	2	9.6	10.4	7.5	8.3	
56UEG3L_	3	13.2	14.3	10.6	11.7	
56UFG3L_	5	20.1	21.8	16.7	18.4	ATV56U72M2U
56UGG3L_	7.5	28.3	30.6	24.2	26.6	ATV56U90M2U
56UHG3L_	10	35.9	38.9	31	34	ATV56D12M2U
56UJG3L_	15	51	55.1	47	51	ATV56D16M2U
56UKG3L_	20	65.2	70.3	60	66	ATV56D23M2U
56ULG3L_	25	77.4	84.7	75	83	ATV56D33M2U
56UMG3L_	30	87.5	97.2	88	97	
56UNG3L_	40	111.3	124.2	114	126	ATV56D46M2U

[1] Short-circuit current available at controller input.
[2] For controllers with the Remote Starter Bypass power circuit, the short circuit withstand rating depends on the overcurrent protective device in the user-supplied bypass starter. It cannot exceed 8,800 A.

Specifications

Table 45 contains specifications for 460 V and 208 / 230 V drive controllers.

Table 45: Specifications

Input voltage	460 V ±10%, or 208 V ±10%, or 230 V ±10%
Displacement power factor	Approximately 0.96
Input frequency	60 Hz ±2%
Output voltage	Maximum voltage equal to input line voltage
Frequency resolution	Input AI1: (High Speed/1,024) Hz [1] Input AI2: (High Speed/512) Hz [1] Keypad display: 0.1 Hz increments Processor: 0.015 Hz increments Option Module: Input AI3: (High Speed/4,096) Hz [1] Input AI4: (High Speed/4,096) Hz [1]
Frequency accuracy	±(0.0075 Hz + 0.00005 times High Speed)
Temperature drift [2]	Analog inputs: 3 x 10^{-4} times High Speed/°C typical Keypad display: 7 x 10^{-7} times High Speed/°C maximum
Frequency range of power converter	ATV56U41N4 to D79N4: 0.1 to 72 Hz ATV56U41M2 to D46M2: 0.1 to 72 Hz
Torque/overtorque	See Chapter 3
Speed reference	AI1: 0-10 V AI2: 4-20 mA 0-5 V with switch on control board 0-20 mA, x-20 mA, 20-4 mA with keypad display Manual speed potentiometer to AI1
Speed regulation	V/f: determined by motor slip, typically 3% SLFV (sensorless flux vector): 1%
Efficiency	Typically greater than 96%
Reference sample time	10 ms
Ramps	Acceleration: 0.1 to 999.9 seconds Deceleration: 0.1 to 999.9 seconds
Motor protection	Class 10 overload protection with bypass option in addition to controller internal electronic thermal protection
Keypad display	• Self-diagnostics with full fault messages in three languages • Also refer to Chapter 5
Temperature	Operation: +32 to +104 °F (0 to +40 °C) Storage: -13 to +158 °F (-25 to +70 °C)
Humidity	95% maximum without condensation or dripping water
Altitude	≤ 3,300 ft (1,000 m); above this derate by 1.2% for every 300 ft (100 m), max. 6,600 ft (2,000 m)
Enclosure	Type 1
Pollution degree	Pollution Degree 3 per NEMA ICS-1 and IEC 664-1
Operational test vibration	Conforming to IEC 721-3-3-3M3 amplitude 1.5 mm peak to peak from 2 to 9 Hz
Transit test to shock	Conforming to National Safe Transit Association and International Safe Transit Association test for packages weighing 100 lbs and over
Codes and standards	• UL Listed per UL 508C under category NMMS as incorporating Class 10 electronic and electromechanical overload protection • CSA Certified (Label is optional) • Conforms to applicable NEMA ICS, NFPA, IEC, and ISO 9001 standards

[1] Resolution limited to processor resolution.
[2] Drive Controller at operating load and temperature.

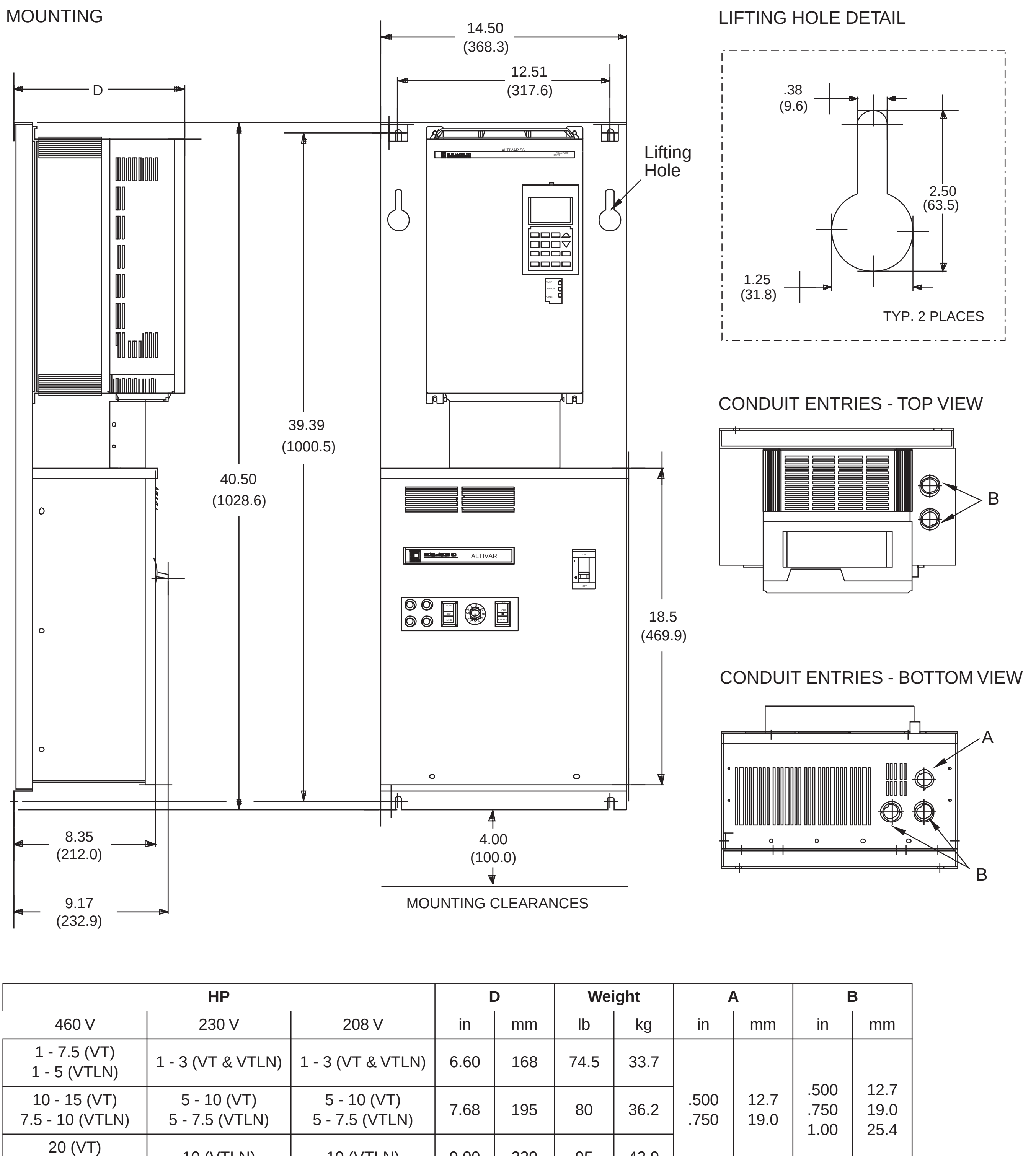
Short-Circuit Withstand Ratings

Table 46: Short-Circuit Withstand Rating of Controller Power Circuits

Controller Part No.	Short-CIrcuit Withstand Rating (Symmetrical)	Bypass Path Overcurrent Protective Device
56UCG2VW to 56UPG2VW 56UCG2LW to 56UNG2LW	8,800 A	—
56UCG2VY to 56UPG2VY 56UCG2LY to 56UNG2LY	8,800 A	Motor Circuit Protector
56UCG2VZ to 56UPG2VZ 56UCG2LZ to 56UNG2LZ	8,800 A	Dependent upon OCPD by user-supplied bypass starter [1]
56UCG3VW to 56UPG3VW 56UCG3LW to 56UNG3LW	22,000 A	—
56UCG3VY to 56UPG3VY 56UCG3LY to 56UNG3LY	22,000 A	Motor Circuit Protector
56UCG3VZ to 56UPG3VZ 56UCG3LZ to 56UNG3LZ	22,000 A	Dependent upon OCPD by user-supplied bypass starter [1]
56UCG4VW to 56UPG4VW 56UCG4LW to 56URG4LW	22,000 A	—
56UCG4VY to 56USG4VY 56UCG4LY to 56URG4LY	22,000 A	Motor Circuit Protector
56UCG4VZ to 56USG4VZ 56UCG4LZ to 56URG4LZ	22,000 A	Dependent upon OCPD by user-supplied bypass starter [1]

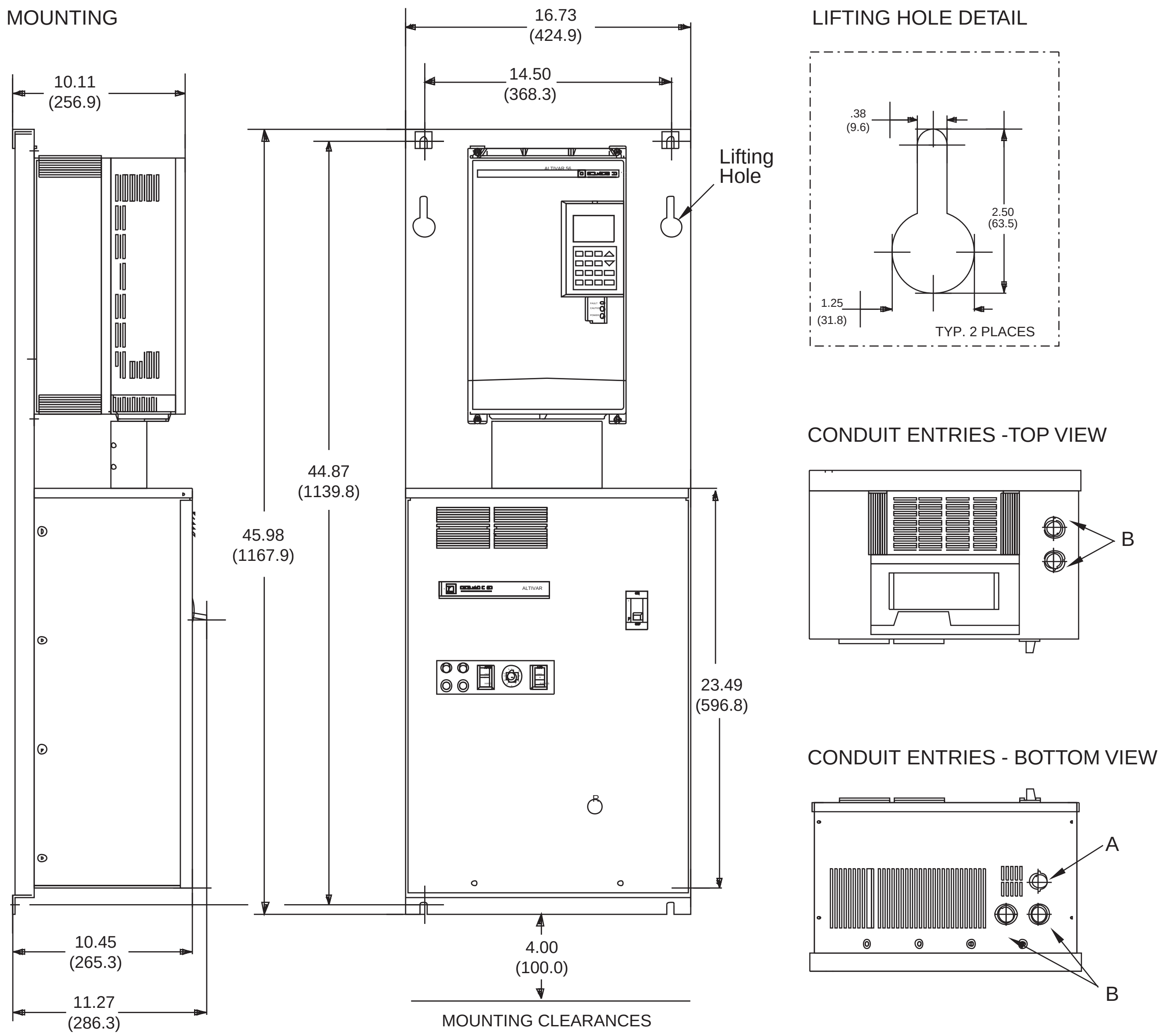
[1] OCPD = Overcurrent Protective Device – limited by available short-circuit current rating of user-supplied bypass starter, ≤ 22,000 A.

DIMENSIONS AND WEIGHTS FOR WALL OR PANEL MOUNTING



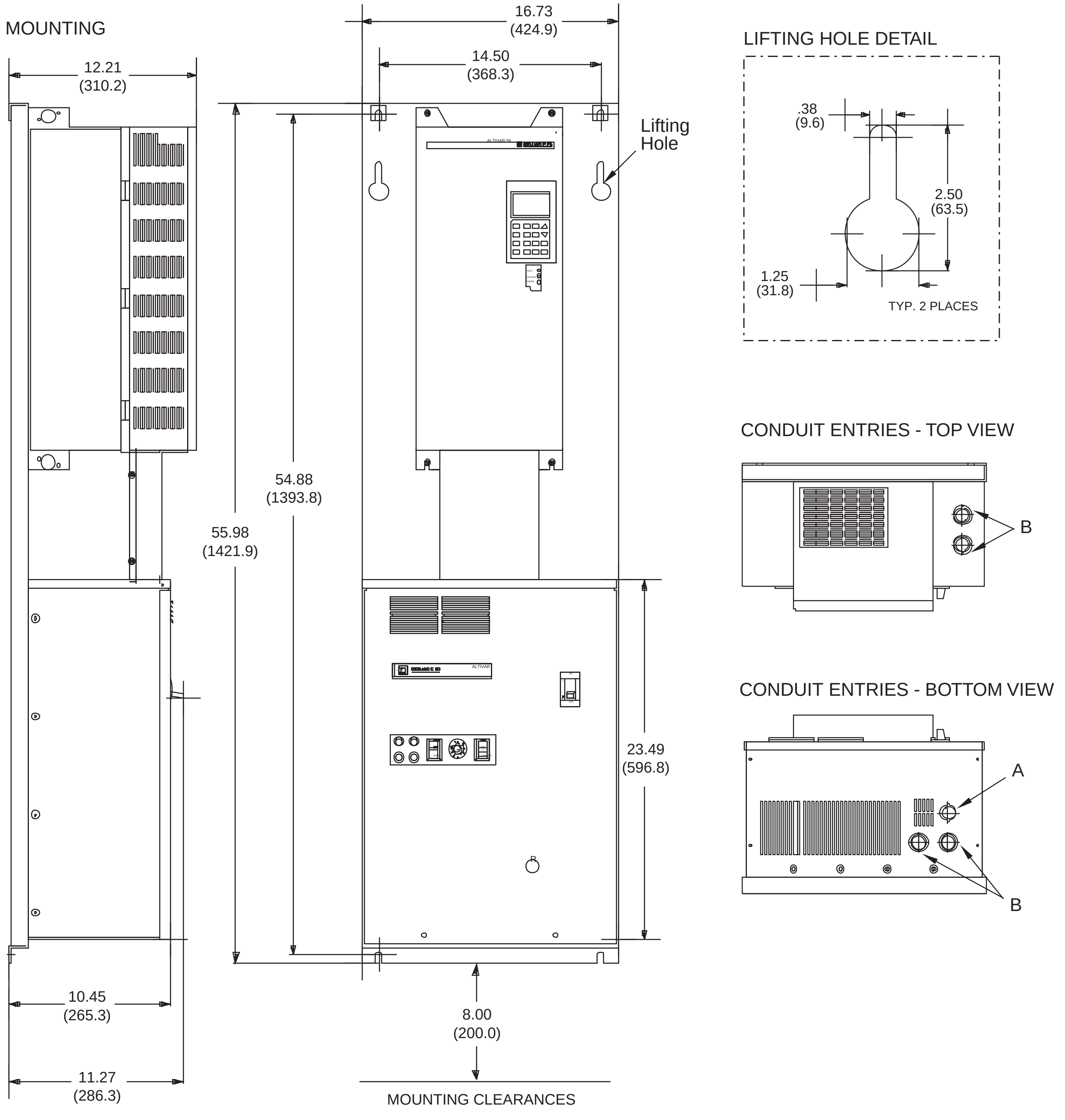
HP			D		Weight		A		B	
460 V	230 V	208 V	in	mm	lb	kg	in	mm	in	mm
1 - 7.5 (VT) 1 - 5 (VTLN)	1 - 3 (VT & VTLN)	1 - 3 (VT & VTLN)	6.60	168	74.5	33.7	.500 .750	12.7 19.0	.500 .750 1.00	12.7 19.0 25.4
10 - 15 (VT) 7.5 - 10 (VTLN)	5 - 10 (VT) 5 - 7.5 (VTLN)	5 - 10 (VT) 5 - 7.5 (VTLN)	7.68	195	80	36.2				
20 (VT) 15 - 20 (VTLN)	10 (VTLN)	10 (VTLN)	9.00	229	95	42.9				

Figure 69: Mounting Information for 1 - 20 hp VT & VTLN, 460 V; 1 - 10 hp VT & VTLN, 208/230 V



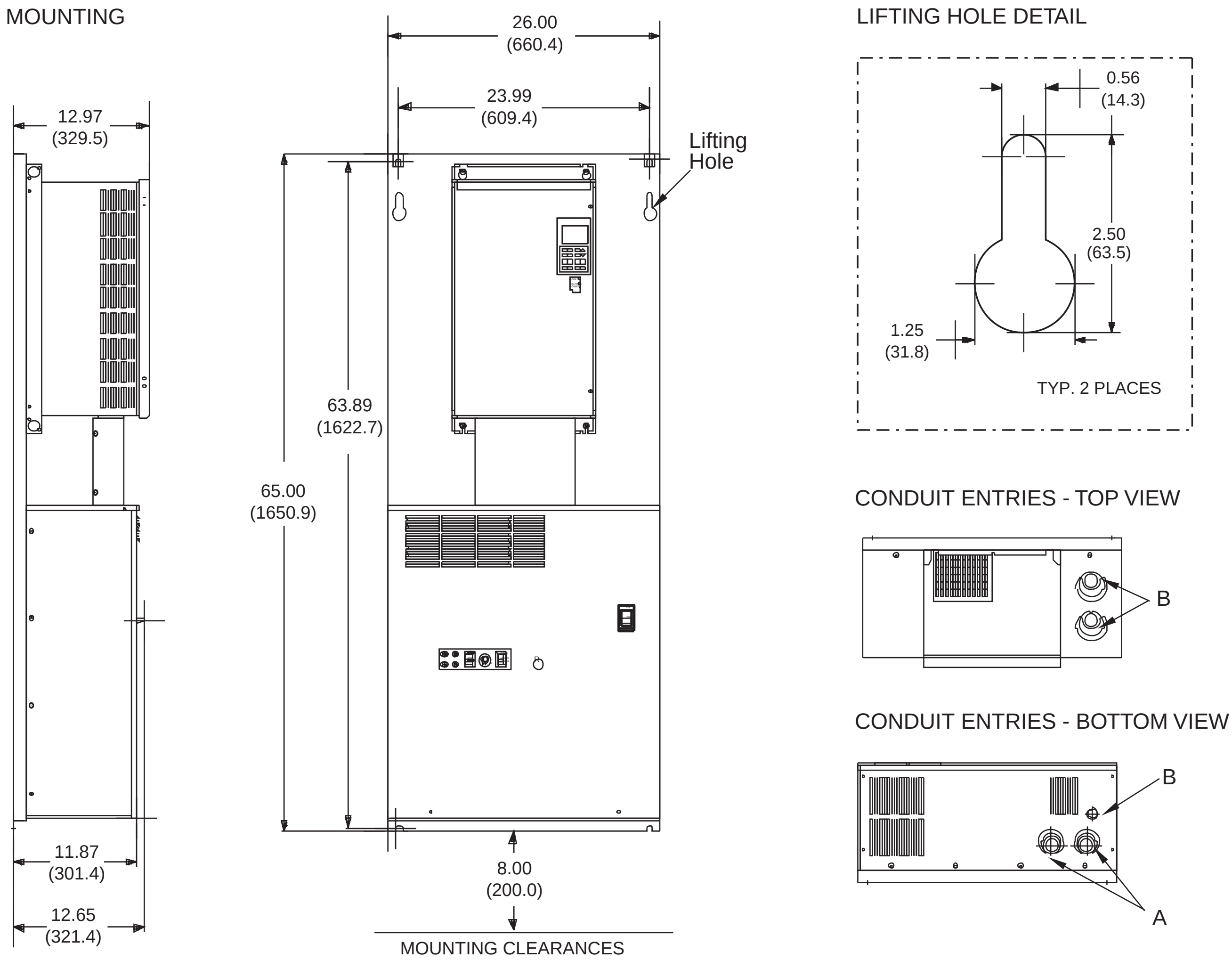
HP			Weight		A		B	
460 V	230 V	208 V	lb	kg	in	mm	in	mm
25 (VT)	15 (VT & VTLN)	15 (VT & VTLN)	138	62.3	.500 .750	12.7 19.0	.500 .750 1.00	12.7 19.0 25.4

Figure 70: Mounting Information for 25 hp VT, 460 V; 15 hp VT & VTLN, 208/230V



HP			Weight		A		B	
460 V	230 V	208 V	lb	kg	in	mm	in	mm
30 - 50 (VT) 25 - 40 (VTLN)	20 - 25 (VT & VTLN)	20 - 25 (VT & VTLN)	170	76.9	.500 .750	12.7 19.0	.500 .750 1.00	12.7 19.0 25.4

Figure 71: Mounting Information for 30 - 50 hp VT & 25 - 40 hp VTLN, 460 V; 20 - 25 hp VT & VTLN, 208/230 V



HP			Weight		A		B	
460 V	230 V	208 V	lb	kg	in	mm	in	mm
60 - 100 (VT) 50 - 75 (VTLN)	30 - 50 (VT) 30 - 40 (VTLN)	30 - 50 (VT) 30 - 40 (VTLN)	275	125	1.00 1.25 2.00 2.50	25.4 31.75 50.80 63.50	.500 .750	12.7 19.0

Figure 72: Mounting Information for 60 - 100 hp VT & 50-75 hp VTLN, 460 V; 30 - 50 hp VT & 30 - 40 hp VTLN, 208/230 V

HANDLING DRIVE CONTROLLERS

Do not remove a drive controller from its packaging until it is at the final installation site. The packaging protects the drive controller and prevents damage to its exterior. Handle the drive controller carefully to avoid damage to the internal components, frame, or exterior. When handling a drive controller, balance it carefully to keep it from tipping. After removing packaging materials, the drive controllers require some type of mechanical lifting. Handle drive controllers:

- With a hoist, attaching a spreader bar to the two lifting holes on top of the drive controller back panel (see Figure 73).
- In a horizontal position, with back of drive controller resting on a pallet.

⚠ WARNING

HANDLING AND LIFTING HAZARD

Keep area below any equipment being lifted clear of all personnel and property. Use lifting method shown in Figure 73.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

To hoist the drive controller, attach a spreader bar to the lifting holes located on top of the drive controller back panel, as shown in Figure 73. Handle the drive controller carefully to avoid damage to the internal components, frame, or exterior. Place the drive controller in an upright position.

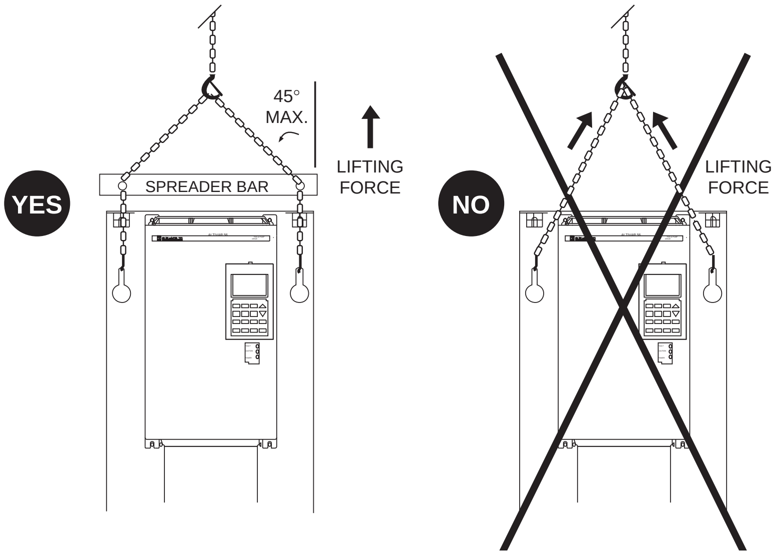


Figure 73: Hoisting Class 8839 ALTIVAR 56 Combination Devices

PRELIMINARY INSPECTION

The drive controller must be thoroughly inspected before storing or installing. Upon receipt:

1. Remove the drive controller from its packaging and visually inspect exterior for shipping damage.
2. Ensure that the reference number of the drive controller, which appears on the nameplate, agrees with the packaging slip and corresponding purchase order.
3. If you find any shipping damage, notify the carrier and your sales representative.
4. If you plan to store the drive controller after receipt, replace it in original packaging material and observe storage temperature specifications on page 122.

Prior to installation:

1. Open the power converter door and remove access cover located on the drive controller BELE box.
2. Visually verify that all internal mounting hardware and terminal connection hardware is properly seated, securely fastened, and undamaged.
3. Visually verify that the control board on the power converter is properly seated, securely fastened, and undamaged. Verify that internal wiring connections are tight. Inspect all connections for damage.
4. Close and secure the drive controller door and replace access cover.

⚠ CAUTION
EQUIPMENT DAMAGE HAZARD Do not operate or install any drive controller that appears damaged. **Failure to follow this instruction can result in injury or equipment damage.**

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 controller rated ambient temperature, the Wire Class forms the basis for the selection of a conductor size which will limit the temperature on the conductor insulation at the field wiring terminal within acceptable limits. Conductors with operating temperatures exceeding those given by the Wire Class may be used, but the conductor size must be selected based on the Wire Class limits.

Noise Class

The Noise Class is used to categorize the electromagnetic properties of the voltages and currents present. Wiring is classified into six categories for selection of wiring methods and physical segregation purposes.

Quiet Wiring 1 (QW1)

High susceptibility analog and digital control signals. Signals falling under this classification 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 this classification include 24 VDC and AC 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 this classification include 120 VAC control circuits.

Standard Wiring 2 (SW2)

Power circuits rated greater than 15 A (voltage and current spectra are generally contained within 0.05-9 kHz). Signals falling under this classification 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 this classification include motor and dynamic braking circuits fed from PWM power converters.

Voltage Class

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

Based upon the Noise Class and Voltage Class of the conductors, the wiring methods in Table 47 should be applied to the drive system.

Table 47: Wire Routing and Interconnection

Wiring Methods and Considerations	Noise Class of Conductors [1]				
	QW1	QW2	SW1	SW2	PW1
Conductor Grouping in Wireways/Conduits 1. All conductors of 1 or 3 phase AC power circuits must be bundled to minimize stray magnetic fields.			X	X	X
2. All conductors of a DC power circuit must be bundled to minimize stray magnetic fields.			X	X	X
3. When paralleled conductors must be run in separate wireways or conduit, bundle conductors into groups that minimize stray magnetic fields.				X	X
4. Maintain conductor runs as short and direct as practical.	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 same conduit unless all conductors are insulated for the maximum Voltage Class present.	X	X	X	X	X
3. All PW conductor groups must be individually segregated using metallic conduit.					X
4. Segregate all conductors by Noise Class. Use the following circuit separation when conductors can run parallel for more than 12 inches.					
• Metallic conduit: 3 in between QW to SW/PW	X	X	X	X	X
• Metallic tray: 3 in between SW to PW			X	X	X
• Metallic tray: 6 in between QW to SW/PW	X	X	X	X	X
• Against continuous metal surface: 3 in between SW to PW			X	X	X
• Against continuous metal surface: 6 in between QW to SW/PW	X	X	X	X	X
• Metallic conduit housing QW: 12 in to non-metallic conduit SW/PW	X	X	X	X	X
• Non-metallic conduit: 3 in between SW to PW			X	X	X
• Non-metallic conduit: 24 in between QW to SW/PW	X	X	X	X	X
5. If QW and SW1 wiring must cross SW2 or PW1 wiring, the bundles must cross 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 signal and 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. Shields must be 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 non-shielded portion of conductor at the ends of shielded cable.	X	X	X	X	X
5. When shielding AC or DC power conductors, group conductors to minimize magnetic field in shield.			X	X	X
Grounding 1. Ground shields at one end only (the controller end).	X	X	X	X	X
2. Use 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 ground conductor in the power cable.			X	X	X
5. Terminate all power grounds and power shield grounds to the controller grounding point or bar.			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 upon metallic conduit for ground connection.			X	X	X

[1] Resolution limited to processor resolution.

TERMINAL STRIP LOCATIONS

Figures 74 through 78 show terminal strip locations for Class 8839 ALTIVAR 56 combination devices. Tables 48 through 51 list wire size and torque requirements.

NOTE: Typical device shown with options.

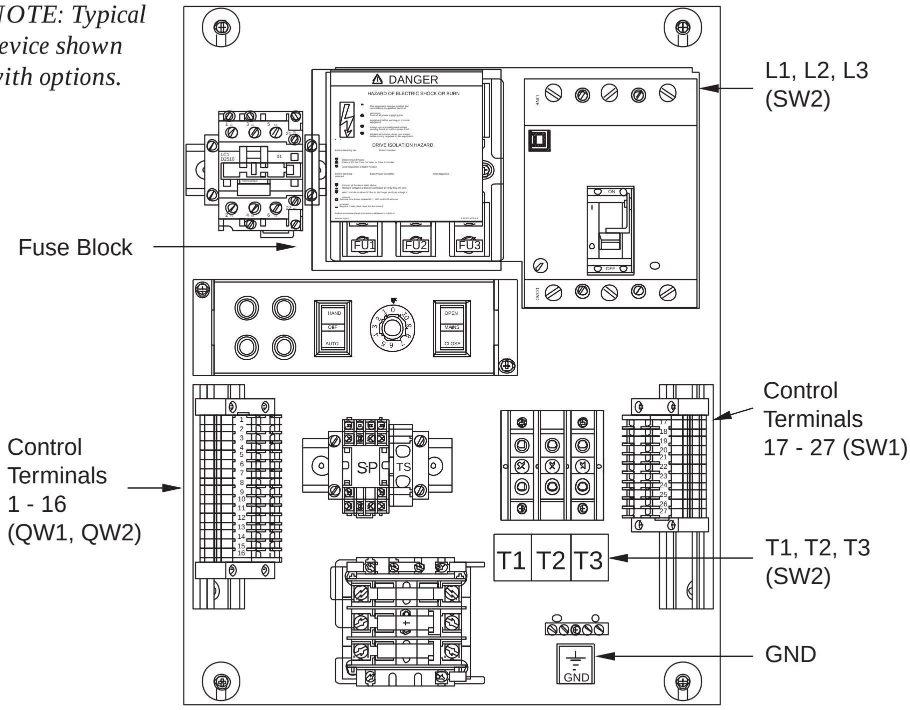


Figure 74: Terminal Strip Locations for 1 - 50 hp VT & 1 - 40 hp VTLN, 460 V; 1 - 25 hp VT & VTLN, 208/230 V (Power Circuit W)

NOTE: Typical device shown with options.

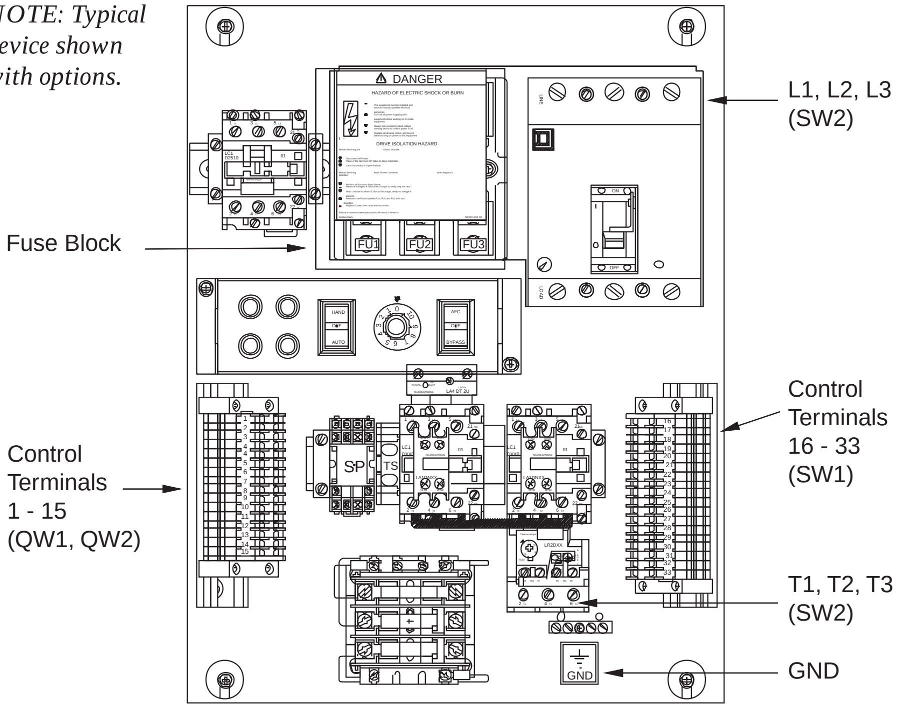


Figure 75: Terminal Strip Locations for 1 - 50 hp VT & 1 - 40 hp VTLN, 460 V; 1 - 25 hp VT & VTLN, 208/230 V (Power Circuit Y or Z)

NOTE: Typical device shown with options.

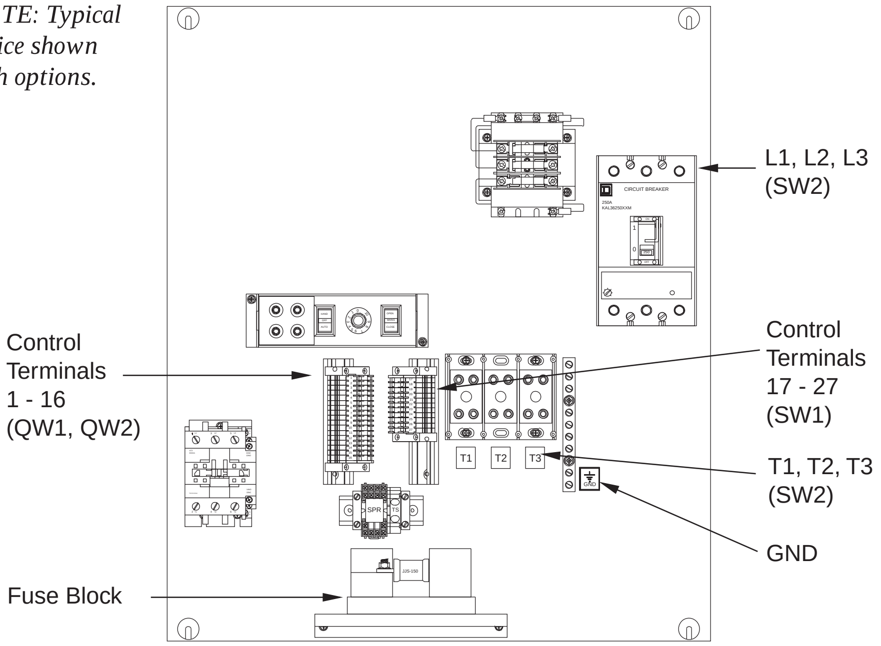


Figure 76: Terminal Strip Locations for 60 - 100 hp VT & 50 - 75 hp VTLN, 460 V; 30 - 50 hp VT & 30 - 40 hp VTLN, 208/230 V (Power Circuit W)

NOTE: Typical device shown with options.

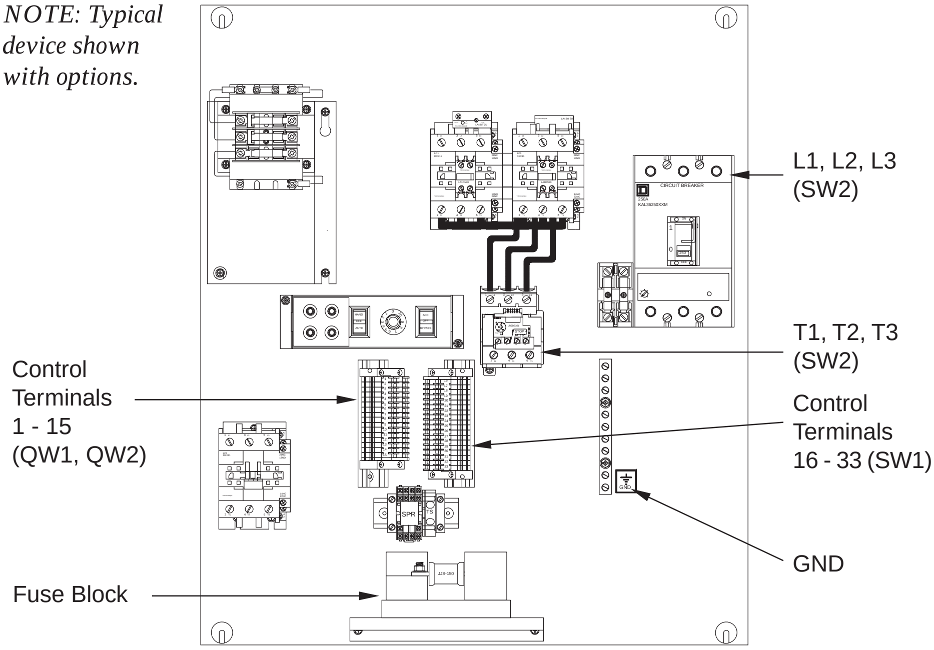


Figure 77: Terminal Strip Locations for 60 hp VT & 50 - 60 hp VTLN, 460 V (Power Circuit Y or Z)

NOTE: Typical device shown with options.

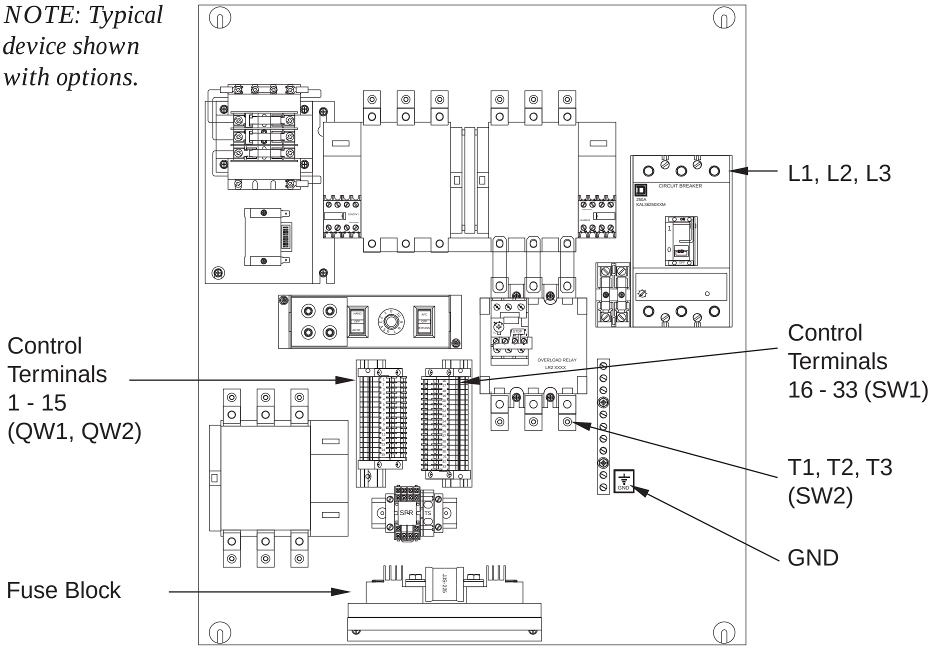


Figure 78: Terminal Strip Locations for 75 - 100 hp VT & 75 hp VTLN, 460 V; 30 - 50 hp VT & 30 - 40 hp VTLN, 208/230 V (Power Circuit Y or Z)

POWER WIRING

Table 48: Power Terminal Strip Characteristics

Terminal	Function	Characteristic
GND	3-phase power supply	208 VAC ±10% (56U•G2•• units)
L1		230 VAC ±10% (56U•G3•• units)
L2		460 VAC ±10% (56U•G4•• units)
L3		47 to 63 Hz
T1	Output Connections to motor	0 to 208 VAC (56U•G2•• units)
T2		0 to 230 VAC (56U•G3•• units)
T3		0 to 460 VAC (56U•G4•• units)

Table 49: Power Terminal Wire Range

Class 8839 Drive Controller Type		Terminals					
		L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND	
208/230 VAC	460 VAC	Max. Wire Size (AWG)	Terminal Torque (lb-in)	Max. Wire Size (AWG)	Terminal Torque (lb-in)	Max. Wire Size (AWG)	Terminal Torque (lb-in)
56UCG2/3*W to 56UFG2/3*W	56UCG4*W to 56UHG4*W	4	35	2/0	120	4	35
56UGG2/3*W to 56UHG2/3*W	56UJG4*W to 56UKG4*W	1/0	80	2/0	120	4	35
56UJG2/3*W to 56ULG2/3*W	56ULG4*W to 56UPG4VW	1/0	80	2/0	120	1/0	45
	56UPG4LW	1/0	80	4/0	150	1/0	45
56UMG2/3*W to 56UPG2/3*W	56UQG4*W to 56USG4*W	350	250	4/0	150	1/0	45
56UCG2/3*Y to 56UFG2/3*Y 56UCG2/3*Z to 56UFG2/3*Z	56UCG4*Y to 56UHG4*Y 56UCG4*Z to 56UHG4*Z	4	35	8	15	4	35
56UGG2/3*Y 56UGG2/3*Z	56UJG4*Y 56UJG4*Z	1/0	80	8	15	4	35
56UHG2/3*Y 56UHG2/3*Z	56UKG4*Y 56UKG4*Z	1/0	80	6	15	4	35
56UJG2/3*Y to 56ULG2/3*Y 56UJG2/3*Z to 56ULG2/3*Z	56ULG4*Y to 56UPG4*Y 56ULG4*Z to 56UPG4*Z	1/0	80	1/0	75	1/0	45
	56UQG4*Y 56UQG4*Z	350	250	1/0	75	1/0	45
56UMG2/3*Y to 56UNG2/3*Y 56UMG2/3*Z to 56UNG2/3*Z	56URG4*Y 56URG4*Z	350	250	3/0	200	1/0	45
56UPG2/3*Y 56UPG2/3*Z	56USG4*Y 56USG4*Z	350	250	3/0	200	1/0	45

CONTROL WIRING

Table 50: Control Terminal Strip Characteristics (Power Circuit W)

Terminal [1] [2]	Function	Characteristics
1	LO1 (Logic Output 1)	24 V, 200 mA max. [5]
2	LO2 (Logic Output 2)	24 V, 200 mA max. [5]
3	COM (Logic Common)	0 V
4	+24 (+24 V Control Supply)	Minimum: 12 V; Maximum: 30 V Quiescent current: 15 mA typical Is = 210 mA max. [5]
5	LI1 (Logic Input 1)	24 V, 10 mA State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
6	LI2 (Logic Input 2)	24 V, 10 mA; State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
7	LI3 (Logic Input 3)	24 V, 10 mA; State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
8	LI4 (Logic Input 4)	24 V, 10 mA; State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
9	+10 V Reference Supply	10 V, Is = 10 mA max.
10	AI1 (Analog Input 1: Speed Reference Voltage)	0-10 V, Z = 30 kΩ
11	COM (Speed Reference Common)	0 V
12	GND, S (Ground/Shield)	
13	AI2 (Analog Input 2: Speed Reference Current)	4-20 mA [6], Z = 250 Ω
14	COM (Analog Common)	0 V
15	AO1 (Analog Output 1)	0-20 mA, 12 V max. (programmable as 4-20 mA w/ keypad display)
16	Auxiliary Terminal [7]	Terminal jumpered to Terminal 4
17	+115 V (Control Transformer) [7]	
18	115 V Rated Terminal [7]	
19	GND (Control Transformer) [7]	
20 21	120 V SPR Relay Coil 21 [7]	115-120 V/60 Hz supply (user-supplied)
22 23	R1 Relay, N.C. Contact (Fault Relay Output)	Minimum: 10 mA, 24 VDC Maximum inductive load of: • 2.0 A, 120 VAC; Max: 0.10 J/operation, 80 operations/minute • 1.0 A, 220 VAC; Max: 0.25 J/operation, 25 operations/minute • 2.0 A, 24 VAC; Max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel w/ relay contacts.
24 [4] 25	R2 Relay, N.O. Contact (Run Relay Output)	Minimum: 10 mA, 24 VDC Maximum inductive load of: • 2.0 A, 120 VAC; Max: 0.10 J/operation, 80 operations/minute • 1.0 A, 220 VAC; Max: 0.25 J/operation, 25 operations/minute • 2.0 A, 24 VAC; Max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel w/ relay contacts.
26 27	Auxiliary Contact (AFC Mode Status) [7]	• 15 A, 125 VAC • 10 A, 250 VAC

[1] See control circuit diagrams on pages 151 and 152.
[2] All terminals are rated 600 V, 30 A (Class 9080, Type GM6). Maximum wire size for all terminals is 10 AWG (2.5 mm^2).
[3] Relay coil deenergizes on fault.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 210 mA. Available current of the two logic outputs can be calculated as follows: each input requires 10 mA, each analog output requires 20 mA and the typical quiescent current of LOP is 15 mA.
[6] 0-20 mA, x-20 mA, 20-4 mA programmable with keypad display. 0-5 V (Z = 30 kΩ) selectable with switch on control board.
[7] Available only when options are included.

Table 51: Control Terminal Strip Characteristics (Power Circuits Y & Z)

Terminal [1] [2]	Function	Characteristics
1	LO1 (Logic Output 1)	24 V, 200 mA max. [5]
2	LO2 (Logic Output 2)	24 V, 200 mA max. [5]
3	COM (Logic Common)	0 V
4	+24 (+24 V Control Supply)	Minimum: 12 V; Maximum: 30 V Quiescent current: 15 mAtypical Is = 210 mA max. [5]
5	LI1 (Logic Input 1)	24 V, 10 mA; State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
6	LI2 (Logic Input 2)	24 V, 10 mA; State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
7	LI3 (Logic Input 3)	24 V, 10 mA State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
8	LI4 (Logic Input 4)	24 V, 10 mA State 0: V < 5 V; State 1: V > 12 V; Vmax = 30 V
9	+10 V Reference Supply	10 V, Is = 10 mA max.
10	AI1 (Analog Input 1: Speed Reference Voltage)	0 - 10 V, Z = 30 kΩ
11	COM (Speed Reference Common)	0 V
12	GND, S (Ground/Shield)	
13	AI2 (Analog Input 2: Speed Reference Current)	4 - 20 mA [6], Z = 250 Ω
14	COM (Analog Common)	0 V
15	AO1 (Analog Output 1)	0 - 20 mA, 12 V max. (programmable as 4-20 mA w/ keypad display)
16	+115 V (Control Transformer)	
17 [8]	+115 V Rated Terminal	
18 19	AFC Mode Select	Normally jumpered or N.C. SPR contact when option is supplied.
20 21	Bypass Mode Select	Normally jumpered or N.C. SPR contact when option is supplied.
22 23	Freeze/Fire Stat Interlocks [7]	Normally jumpered or N.C. SPR contact when option is supplied. Provision for user-supplied N.C. Freeze/Fire state contact.
24 [3] 25	Bypass Run, N.O. Contact [7]	Minimum: 10 mA, 24 VDC Maximum inductive load of: • 2.0 A, 120 VAC; Max: 0.10 J/operation, 80 operations/minute • 1.0 A, 220 VAC; Max: 0.25 J/operation, 25 operations/minute • 2.0 A, 24 VAC; Max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel w/ relay contacts.

[1] See control circuit diagrams on pages 153 - 156.
[2] All terminals are rated 600 V, 30 A (Class 9080, Type GM6). Maximum wire size for all terminals is 10 AWG ($2.5\ mm^2$). Tightening torque 7 - 8 lb-in (0.8 - 0.9 N•m).
[3] Relay coil deenergizes on fault.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 210 mA. Available current of the two logic outputs can be calculated as follows: each input requires 10 mA, each analog output requires 20 mA and the typical quiescent current of LOP is 15 mA.
[6] 0 - 20 mA, x - 20 mA, 20 - 4 mA programmable with keypad display. 0 - 5 V (Z = 30 kΩ) selectable with switch on control board.
[7] Available only when options are included.
[8] On when bypass contactor is energized.

Table 51: Control Terminal Strip Characteristics (Power Circuits Y & Z)

Terminal [1] [2]	Function	Characteristics
26 [7] 27	120 V SPR Relay Coil (if used)	115 - 120 V / 60 Hz supply (user-supplied)
28 [3] 29	R1 Relay, N.C. Contact (Fault Relay Output)	Minimum: 10 mA, 24 VDC Maximum inductive load of: • 2.0 A, 120 VAC; Max: 0.10 J/operation, 80 operations/minute • 1.0 A, 220 VAC; Max: 0.25 J/operation, 25 operations/minute • 2.0 A, 24 VAC; Max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel w/ relay contacts.
30 [4] 31	R2 Relay, N.O. Contact (Run Relay Output)	Minimum: 10 mA, 24 VDC Maximum inductive load of: • 2.0 A, 120 VAC; Max: 0.10 J/operation, 80 operations/minute • 1.0 A, 220 VAC; Max: 0.25 J/operation, 25 operations/minute • 2.0 A, 24 VAC; Max: 0.10 J/operation, 80 operations/minute Arc suppression provided by varistors in parallel w/ relay contacts.
32 [7] 33	Auxiliary Contact (AFC Mode Status)	• 15 A, 125 VAC • 10 A, 250 VAC

[1] See control circuit diagrams on pages 153 - 156.
[2] All terminals are rated 600 V, 30 A (Class 9080, Type GM6). Maximum wire size for all terminals is 10 AWG ($2.5\ mm^2$). Tightening torque 7 - 8 lb-in (0.8 - 0.9 N•m).
[3] Relay coil deenergizes on fault.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 210 mA. Available current of the two logic outputs can be calculated as follows: each input requires 10 mA, each analog output requires 20 mA and the typical quiescent current of LOP is 15 mA.
[6] 0 - 20 mA, x - 20 mA, 20 - 4 mA programmable with keypad display. 0 - 5 V (Z = 30 kΩ) selectable with switch on control board.
[7] Available only when options are included.
[8] On when bypass contactor is energized.

SEQUENCE OF OPERATION AND OPTIONS

This section describes basic sequences of controller operation for the three pre-engineered power circuit configurations and available options. The options are:

- Power Circuit W: combination package
- Power Circuit Y: bypass package
- Power Circuit Z: remote starter bypass package

Terminal Command Mode vs. Keypad Command Mode

In order for factory and / or user supplied pilot devices and controls to be recognized, the Class 8839 ALTIVAR 56 combination drive controller is factory configured to operate in the Terminal Command mode. Switching from Terminal Command mode to Keypad Command mode will disable power converter logic inputs. Factory and / or user-provided control devices will be ignored. For this reason, do not operate the Class 8839 ALTIVAR 56 drive controller in the Keypad Command mode.

Consult the factory configuration listing on the applicable control circuit diagram (pages 151 to 156), and refer to Chapter 5 before reprogramming logic inputs, outputs, torque types, or control types. Changing certain factory settings will adversely affect the performance of the Class 8839 ALTIVAR 56 drive controller.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Controller has been factory programmed. Alteration of factory programming may create incompatibilities with supplied controller configuration.
- Read and understand Chapter 5 as well as programming information on applicable controller schematics, Figures 91 - 96.
- If the power converter unit is re-initialized using the TOTAL or PARTIAL FACTORY SETTING function, the power converter must be re-programmed per the programming instructions on applicable controller schematics, Figures 91 - 96.
- If the power converter unit or the main control board of the power converter is replaced, the power converter must be re-programmed per the programming instructions on applicable controller schematics, Figures 91 - 96.

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

POWER CIRCUIT W COMBINATION PACKAGE

The Combination Package is designed for running the motor strictly from the power converter. The Combination Package consists of line fuses, 120 V fused control transformer (when control options are present), motor circuit protector disconnect with means for locking in the open position, and a Hand-Off-Auto switch with manual speed potentiometer.

Operator Controls – General Arrangement and Operation

Operator controls are located on the front of the BELE box cover unless option D07 is included. Option D07 omits the Hand-Off-Auto switch and manual speed potentiometer, and no operator controls are present on the BELE box cover. If option B07 is included, a pilot light cluster is also present on the front of the BELE box cover.

The Hand-Off-Auto switch and manual speed potentiometer control the operation of the power converter which is factory configured to operate in terminal command mode.

Adjustable Speed Operation

To operate the controller, the controller disconnect switch located on the front of the BELE box must be in the closed position. There are three modes of operation with the Hand-Off-Auto switch: Hand, Off, and Auto.

Hand mode is for local control. As soon as Hand mode is entered, the power converter is placed in running mode. In Hand mode, the speed potentiometer mounted on the BELE box is used to control the speed of the controller.

Off mode commands the power converter to stop the motor by either following the programmed deceleration ramp (factory setting) or by freewheel stopping.

Auto mode is for remote control. In Auto mode, the power converter is placed in running mode as soon as a user-supplied run contact is closed between controller terminals TB5 and TB8. In Auto mode, motor speed is varied by adjusting the user-supplied auto speed reference signal (4-20 mA) supplied to the terminals TB13 (+), TB11 (-), and TB12 (Shield) in the BELE box. Refer to Chapter 5 for scaling of this signal.

Freeze/Fire Stats Interlocks (if used)

Terminals TB4 and TB5 are dedicated terminals for accepting a user-supplied freeze / fire stat interlock (normally closed). The power converter will stop operation if the connection between TB4 and TB5 is opened. Remove the factory jumper wire located on these terminals before installing interlock.

MOD B07 Group 2 Pilot Light Cluster (if used)

This pilot light cluster provides visual indication of protective functions and circuit status. Listed below are the four pilot lights provided and their functions.

1. Power On (Red): illuminates whenever mains power is applied to the controller. The LED is rated 120 V.
2. AFC Run (Green): illuminates whenever LO1 is high (programmed for running state) to annunciate a drive run condition. The LED is rated 24 V.
3. Auto Mode (Green): illuminates whenever the drive is running in the Auto mode. The LED is sequenced by the Hand-Off-Auto selector switch and is rated 24 V.
4. AFC Fault (Yellow): illuminates whenever LO2 (programmed for fault state) is high to annunciate a drive fail condition. This light is normally not lighted until a controller protective circuit has caused an abnormal shutdown. The LED is rated 24 V.

MOD C07 Line Isolation Contactor (if used)

MOD C07 provides a line isolation contactor factory wired between the line fuses (FU1, FU2, and FU3) and the power converter (L1, L2, and L3). An Open-Close switch is provided on the controller door for controlling the contactor. The line isolation contactor is energized whenever the Open-Close switch is in the closed position.

MOD D07
Omit Hand-Off-Auto Switch and Manual Speed Potentiometer (if used)

MOD D07 omits the Hand-Off-Auto selector switch and manual speed potentiometer. It is used when the user prefers to supply external control devices.

There are a number of ways to sequence the operation of the power converter when the Hand-Off-Auto switch and manual speed potentiometer are not present. Figures 79 - 82 show recommended sequencing diagrams for commonly used control methods.

Figure 79 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 0 - 10 VDC speed reference signal.

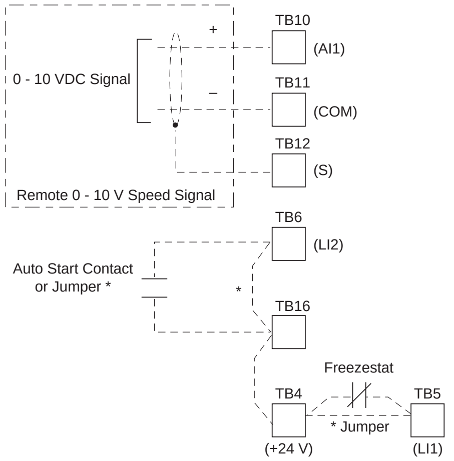


Figure 79: Speed Reference #1 Signal (0 - 10 VDC) Only

Figure 80 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 4 - 20 mA DC speed reference signal.

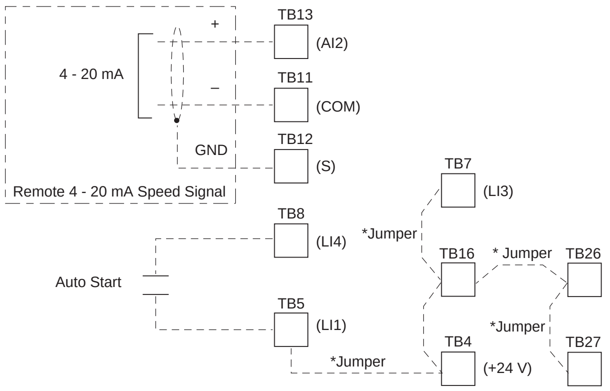


Figure 80: Speed Reference #2 Signal (4 - 20 mA) Only

Figure 81 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied remote speed potentiometer.

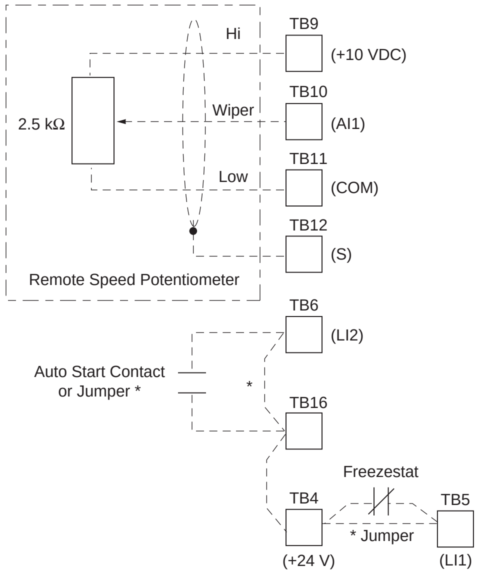


Figure 81: Remote Manual Speed Potentiometer Reference Only

Figure 82 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Hand-Off-Auto switch, and the speed is controlled by a user-supplied speed potentiometer (Hand mode) and a user-supplied 4 - 20 mA DC speed reference signal (Auto mode).

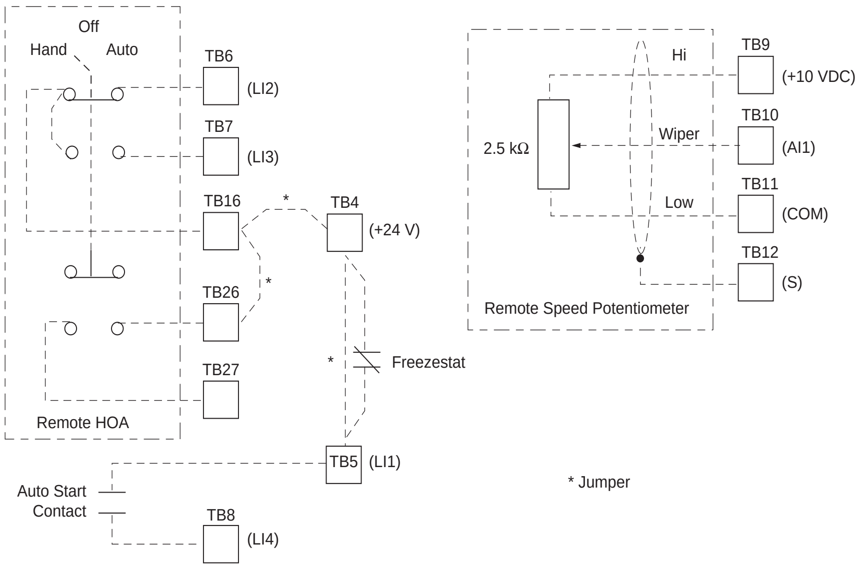


Figure 82: Remote Wired Hand-Off-Auto and Manual Speed Potentiometer

MOD E07
CSA Certification (if used)

MOD E07 provides a Canadian Standards Association (CSA) certification label when required by local code requirements.

MOD F07
Smoke Purge Option (if used)

MOD F07 provides a smoke purge operating mode controlled by a user-supplied 120 VAC signal applied between terminals TB20 and TB21. When 120 VAC is supplied to TB20 and TB21, the drive controller runs the motor at 60 Hz. The jumper between terminals TB4 and TB16 must be removed before using this mode.

POWER CIRCUIT Y BYPASS PACKAGE

The Bypass Package allows you to run the motor from the power converter or from full voltage line power (bypass mode). The motor can be run in the bypass mode in the unlikely event the power converter becomes inoperative. The Bypass Package consists of IEC rated isolation and bypass contactors with Class 10 overloads, line fuses, 120 V control transformer, motor circuit protector disconnect with means for locking in the open position, AFC-Off-Bypass switch, Hand-Off-Auto switch, and a manual speed potentiometer. A 7/16", 1/2", or 9/16" socket hand tool is included for removing line fuses to isolate the power converter during servicing. See “PROPER DRIVE ISOLATION METHOD” on page 150.

Operator Controls — General Arrangement and Operation

Operator controls are located on the front of the BELE box cover unless option D07 is included. Option D07 omits the Hand-Off-Auto switch and manual speed potentiometer, and no operator controls are present on the BELE box cover. If option A07 or B07 is included, a pilot light cluster is also present on the front of the BELE box cover.

The AFC-Off-Bypass switch allows you to select either adjustable speed operation of the motor through the power converter (AFC position) or line power operation of the motor (Bypass position).

The Hand-Off-Auto switch and manual speed potentiometer control the operation of the power converter which is factory configured to operate in terminal command mode.

Adjustable Speed Operation

To control the operation of the motor with the power converter, the controller disconnect switch located on the front of the BELE box must be in the closed position and the AFC-Off-Bypass switch must be in the AFC position. There are three modes of operation with the Hand-Off-Auto switch: Hand, Off, and Auto.

Hand mode is for local control. As soon as Hand mode is entered, the power converter is placed in running mode. In Hand mode, the speed potentiometer mounted on the BELE box is used to control the speed of the controller.

Off mode commands the power converter to stop the motor by either following the programmed deceleration ramp (factory setting) or by freewheel stopping.

Auto mode is for remote control. In Auto mode, the power converter is placed in running mode as soon as a user-supplied run contact is closed between controller terminals TB4 and TB8. In Auto mode, motor speed is varied by adjusting the user-supplied auto speed reference signal (4 - 20 mA) supplied to the terminals TB13 (+), TB11 (–), and TB12 (Shield) in the BELE box. Refer to Chapter 5 for scaling of this signal.

Bypass Operation

To control the operation of the motor with line power, the controller disconnect switch located on the front of the BELE box must be in the closed position and the AFC-Off-Bypass switch must be in the Bypass position. If the AFC-Off-Bypass selector switch is placed in the Bypass position, motor operation is transferred to line power. If the selector switch is moved to the Off position, the bypass contactor opens and the motor will stop.

Freeze/Fire Stats Interlock (if used)

Terminals TB22 and TB23 are dedicated terminals for accepting a user-supplied freeze / fire stat interlock (normally closed). The drive output isolation contactor and drive bypass contactor open if the connection between terminals TB22 and TB23 is opened. As a result, the motor will stop. Remove the factory jumper wire located on these terminals prior to installation of interlock.

MOD A07
Group 1 Pilot Light Cluster
(if used)

This pilot light cluster provides visual indication of protective functions and circuit status. Listed below are the four pilot lights provided and their functions.

1. Power On (Red): illuminates whenever mains power is applied to the controller. The LED is rated 120 V.
2. AFC Run (Green): illuminates whenever LO1 is high (programmed for running state) to annunciate a drive run condition. The LED is rated 24 V.
3. Bypass Run (Green): illuminates whenever the bypass contactor coil is energized and the motor is running from line power. The LED is rated 120 V.
4. AFC Fault (Yellow): illuminates whenever LO2 (programmed for fault state) is high to annunciate a drive fail condition. This light is normally not lighted until a controller protective circuit has caused an abnormal shutdown. The LED is rated 24 V.

MOD B07
Group 2 Pilot Light Cluster
(if used)

This pilot light cluster provides visual indication of protective functions and circuit status. Listed below are the four pilot lights provided and their functions.

1. Power On (Red): illuminates whenever mains power is applied to the controller. The LED is rated 120 V.
2. AFC Run (Green): illuminates whenever LO1 is high (programmed for running state) to annunciate a drive run condition. The LED is rated 24 V.
3. Auto Mode (Green): illuminates whenever the drive is running in Auto mode. The LED is sequenced by the Hand-Off-Auto selector switch and is rated 24 V.
4. AFC Fault (Yellow): illuminates whenever LO2 (programmed for fault state) is high to annunciate a drive fail condition. This light is normally not lighted until a controller protective circuit has caused an abnormal shutdown. The LED is rated 24 V.

MOD C07
Line Isolation Contactor
(if used)

MOD C07 provides a line isolation contactor factory wired between the line fuses (FU1, FU2, and FU3) and the power converter (L1, L2, and L3). The line isolation contactor is energized whenever the AFC-OFF-Bypass switch is in the AFC position.

MOD D07
Omit Hand-Off-Auto Switch
and Manual Speed
Potentiometer (if used)

MOD D07 omits the Hand-Off-Auto selector switch and manual speed potentiometer. It is used when the user prefers to supply external control devices.

There are a number of ways to sequence the operation of the power converter when the Hand-Off-Auto switch and manual speed potentiometer are not present. Figures 83 - 86 show the recommended sequencing diagrams for commonly used control methods.

The diagram shown in Figure 83 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 0 - 10 VDC speed reference signal.

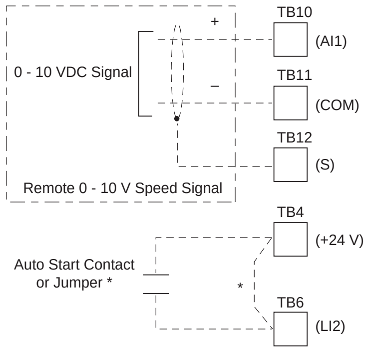


Figure 83: Speed Reference #1 Signal (0-10 VDC) Only

The diagram shown in Figure 84 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 4 - 20 mA DC speed reference signal.

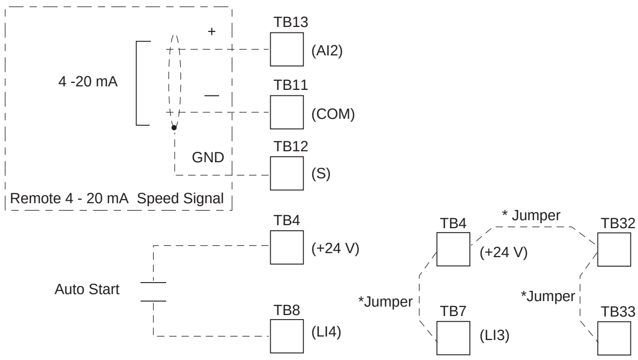


Figure 84: Speed Reference #2 Signal (4-20 mA) Only

The diagram shown in Figure 85 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied remote speed potentiometer.

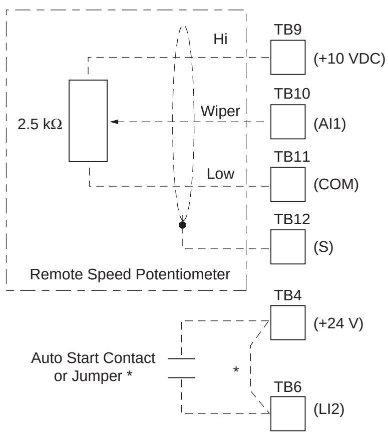


Figure 85: Remote Manual Speed Potentiometer Reference Only

The diagram shown in Figure 86 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Hand-Off-Auto switch, and speed is controlled by a user-supplied speed potentiometer (for Hand mode) and a user-supplied 4 - 20 mA DC speed reference signal (for Auto mode).

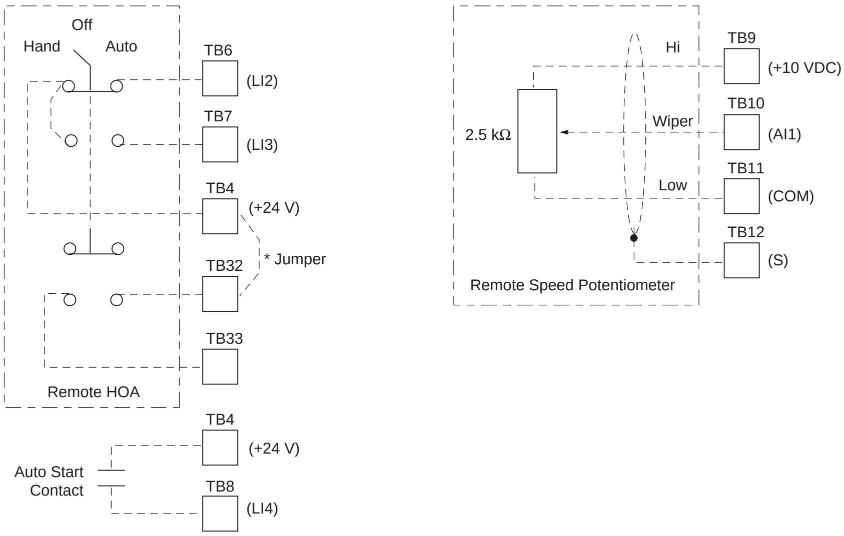


Figure 86: Remote Wired Hand-Off-Auto and Manual Speed Potentiometer

MOD E07
CSA Certification (if used)

MOD E07 Provides a Canadian Standards Association (CSA) certification label when required by local code requirements.

MOD F07
Smoke Purge Option (if used)

MOD F07 provides a smoke purge operating mode controlled by a user-supplied 120 VAC signal applied between terminals TB26 and TB27. When 120 VAC is supplied to TB26 and TB27, motor operation is transferred to line power (if not operating in this mode already). The jumpers between terminals TB18 and TB19, TB20 and TB21, and TB22 and TB23 must be removed before using this mode.

POWER CIRCUIT Z REMOTE STARTER BYPASS PACKAGE

The Remote Starter Bypass Package allows you to run the motor from the power converter or from a user-supplied, separately-mounted full or reduced voltage starter (bypass mode). The motor can be run in the bypass mode in the unlikely event the power converter becomes inoperative.

The Remote Starter Bypass Package consists of IEC rated isolation and transfer contactors with Class 10 overloads, line fuses, 120 V control transformer, motor circuit protector disconnect with means for locking in the open position, AFC-Off-Bypass switch, Hand-Off-Auto switch, and a manual speed potentiometer. A 7/16", 1/2", or 9/16" socket hand tool is included for removing line fuses to isolate the power converter during servicing. See “PROPER DRIVE ISOLATION METHOD” on page 150.

Operator Controls — General Arrangement and Operation

Operator controls are located on the front of the BELE box cover unless option D07 is included. Option D07 omits the Hand-Off-Auto switch and manual speed potentiometer, and no operator controls are present on the BELE box cover. If option A07 or B07 is included, a pilot light cluster will also be present on the front of the BELE box cover. The AFC-Off-Bypass switch allows you to select either adjustable speed operation of the motor through the power converter (AFC position), or to transfer control of the motor to a user-supplied, remote-mounted full or reduced voltage starter (Bypass position). The Hand-Off-Auto switch and manual speed potentiometer control operation of the power converter which is factory configured for terminal command mode.

Adjustable Speed Operation

To control the operation of the motor with the power converter, the controller disconnect switch located on the front of the BELE box must be in the closed position, and the AFC-Off-Bypass switch must be in the AFC position. There are three modes of operation with the Hand-Off-Auto switch: Hand, Off, and Auto.

Hand mode is for local control. As soon as Hand mode is entered, the power converter is placed in running mode. In Hand mode, the speed potentiometer mounted on the BELE box is used to control the speed of the controller.

Off mode commands the power converter to stop the motor by either following the programmed deceleration ramp (factory setting) or by freewheel stopping.

Auto mode is for remote control and places the power converter in a running mode as soon as a user-supplied run contact is closed between controller terminals TB4 and TB8. In Auto mode, motor speed is varied by adjusting the user-supplied auto speed reference signal (4 - 20 mA) supplied to the terminals TB13 (+), TB11 (–), and TB12 (Shield) in the BELE box. Refer to Chapter 5 for scaling of this signal.

Bypass Operation

To control the operation of the motor with a user-supplied, separately-mounted starter, the AFC-Off-Bypass switch must be in the Bypass position. When the AFC-Off-Bypass selector switch is placed in the Bypass position, motor operation is transferred to the user-supplied starter. If the selector switch is moved to the Off position, the transfer contactor will open and the motor will stop.

Freeze/Fire Stats Interlocks (if used)

Terminals TB22 and TB23 are dedicated terminals for accepting a user-supplied freeze / fire stat interlock (normally closed). The drive output isolation contactor and transfer contactor will open if the connection between terminals TB22 and TB23 is opened. As a result, the motor will stop. Remove the factory jumper wire located on these terminals prior to installation of interlock.

MOD A07
Group 1 Pilot Light Cluster
(if used)

The pilot light cluster provides visual indication of protective functions and circuit status. Listed below are the four pilot lights provided and their functions.

1. Power On (Red): illuminates whenever mains power is applied to the controller. The LED is rated 120 V.
2. AFC Run (Green): illuminates whenever LO1 is high (programmed for running state) to annunciate a drive run condition. The LED is rated 24 V.
3. Bypass Run (Green): illuminates whenever the transfer contactor coil is energized and the motor is running from a user-supplied separately mounted starter. The LED is rated 120 V.
4. AFC Fault (Yellow): illuminates whenever LO2 (programmed for fault state) is high to annunciate a drive fail condition. This light is normally not lighted until a controller protective circuit has caused an abnormal shutdown. The LED is rated 24 V.

MOD B07
Group 2 Pilot Light Cluster
(if used)

This pilot light cluster provides visual indication of protective functions and circuit status. Listed below are the four pilot lights provided and their functions.

1. Power On (Red): illuminates whenever mains power is applied to the controller. The LED is rated 120 V.
2. AFC Run (Green): illuminates whenever LO1 is high (programmed for running state) to annunciate a drive run condition. The LED is rated 24 V.
3. Auto Mode (Green): illuminates whenever the drive is running in Auto mode. The LED is sequenced by the Hand-Off-Auto selector switch and is rated 24 V.
4. AFC Fault (Yellow): illuminates whenever LO2 (programmed for fault state) is high to annunciate a drive fail condition. This light is normally not lighted until a controller protective circuit has caused an abnormal shutdown. The LED is rated 24 V.

MOD C07
Line Isolation Contactor
(if used)

MOD C07 provides a line isolation contactor factory wired between the line fuses (FU1, FU2, and FU3) and the power converter (L1, L2, and L3). The line isolation contactor is energized whenever the AFC-OFF-Bypass is in the AFC position.

MOD D07
Omit Hand-Off-Auto Switch and Manual Speed Potentiometer (if used)

MOD D07 omits the Hand-Off-Auto selector switch and manual speed potentiometer. It is used when the user prefers to supply external control devices.

There are a number of ways to sequence the operation of the power converter when the Hand-Off-Auto switch and manual speed potentiometer are not present. Figures 87 - 90 show recommended sequencing diagrams for commonly used control methods.

Figure 87 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 0 - 10 VDC speed reference signal.

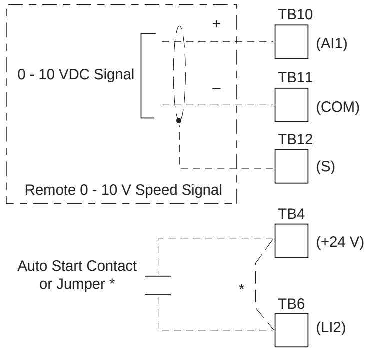


Figure 87: Speed Reference #1 Signal (0-10 VDC) Only

Figure 88 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied 4-20 mA DC speed reference signal.

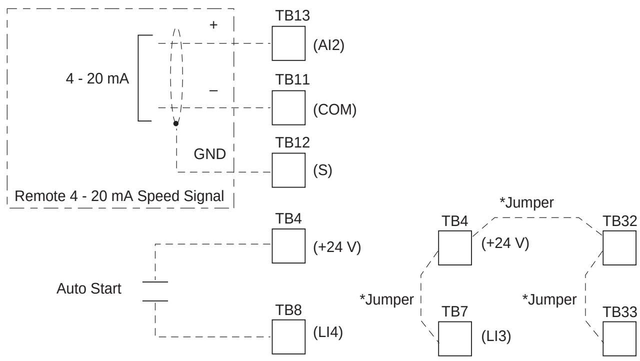


Figure 88: Speed Reference #2 Signal (4-20 mA) Only

Figure 89 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Auto contact, and the speed is controlled by a user-supplied remote speed potentiometer.

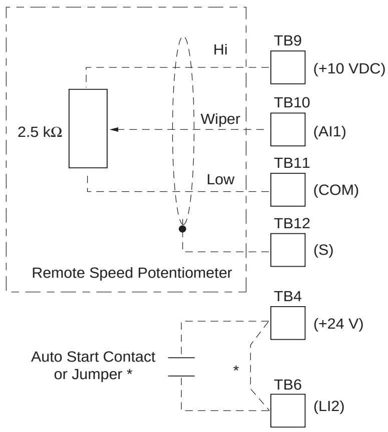


Figure 89: Remote Manual Speed Potentiometer Reference Only

Figure 90 can be used for applications in which the power converter start / stop operation is controlled by a user-supplied Hand-Off-Auto switch, and speed is controlled by a user-supplied speed potentiometer (for Hand mode) and a user-supplied 4-20 mA DC speed reference signal (for Auto mode).

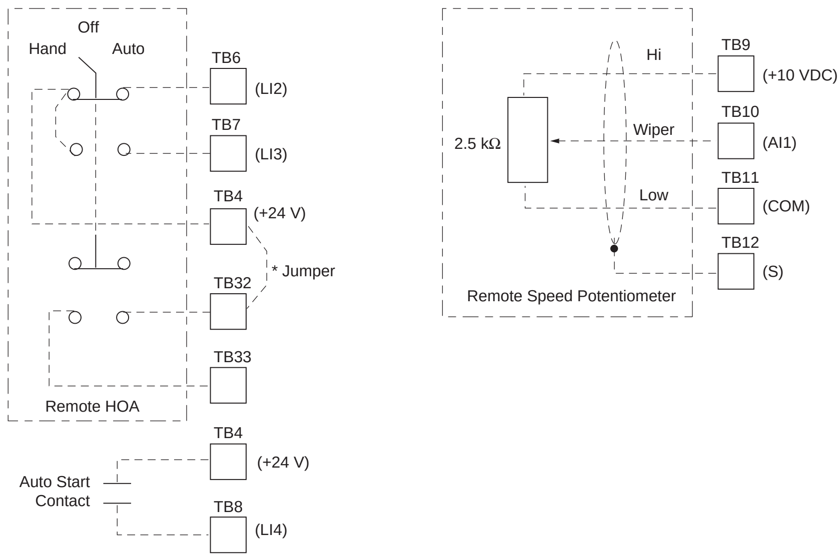


Figure 90: Remote Wired Hand-Off-Auto and Manual Speed Potentiometer

MOD E07
CSA Certification (if used)

MOD E07 provides a Canadian Standards Association (CSA) certification label when required by local code requirements.

MOD F07
Smoke Purge (if used)

MOD F07 provides a smoke purge operating mode controlled by a user-supplied 120 VAC signal applied between terminals TB26 and TB27. When 120 VAC is supplied to TB26 and TB27, motor operation will be transferred to a user-supplied, separately-mounted starter (if not operating in this mode already). The jumpers between terminals TB18 and TB19, TB20 and TB21, and TB22 and TB23 must be removed before using this mode.

PROPER DRIVE ISOLATION METHOD

To properly isolate the power converter for service or repair and still operate the controller in Bypass mode, it is necessary to remove the line fuses installed in the BELE box. This procedure applies to Bypass and Remote Starter Bypass Package units (Power Circuits Y and Z).

A 7/16", 1/2", or 9/16" socket hand tool is attached in the BELE box and provided for line fuse removal. Before performing any maintenance or service on the controller, review the following precautions and follow all precautions designated on the controller equipment.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK OR BURN

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off 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.

DRIVE ISOLATION HAZARD

Before servicing the **drive controller**:

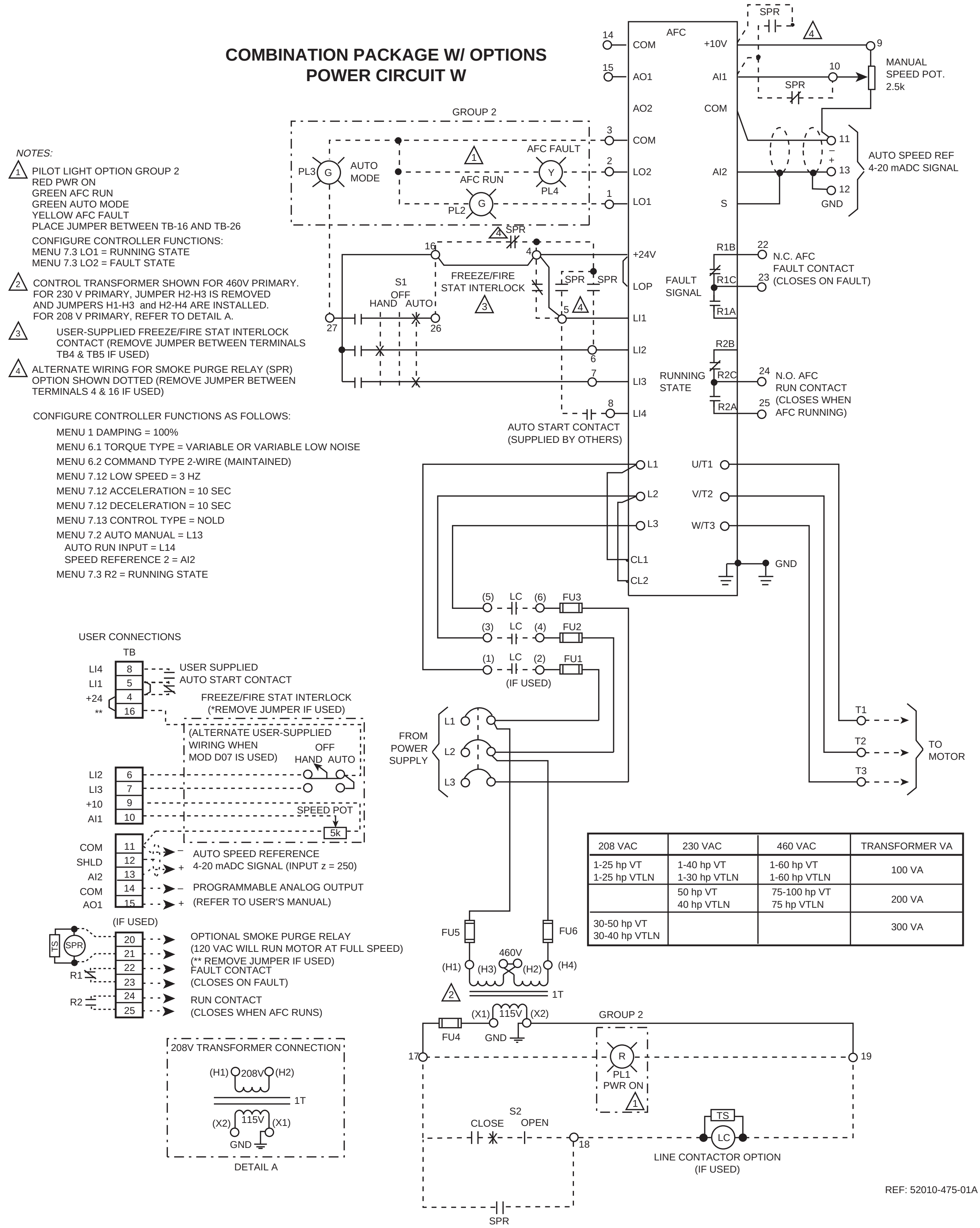
- Disconnect all power.
- Place a “Do Not Turn On” label on drive controller
- Lock disconnect in Open position.

Before servicing **basic power converter** when Bypass is selected:

- Perform all functions listed above.
- Measure voltages at disconnect output to verify they are zero.
- Wait 1 minute to allow DC bus to discharge, verify no voltage is present.
- Remove line fuses labeled FU1, FU2, and FU3 with tool provided.
- Replace cover, then close disconnect.

Failure to observe these precautions will result in death or serious injury.

CONTROL CIRCUIT DIAGRAMS



208 VAC	230 VAC	460 VAC	TRANSFORMER VA
1-25 hp VT 1-25 hp VTLN	1-40 hp VT 1-30 hp VTLN	1-60 hp VT 1-60 hp VTLN	100 VA
	50 hp VT 40 hp VTLN	75-100 hp VT 75 hp VTLN	200 VA
30-50 hp VT 30-40 hp VTLN			300 VA

Figure 91: Combination Package “Power Circuit W” with Options

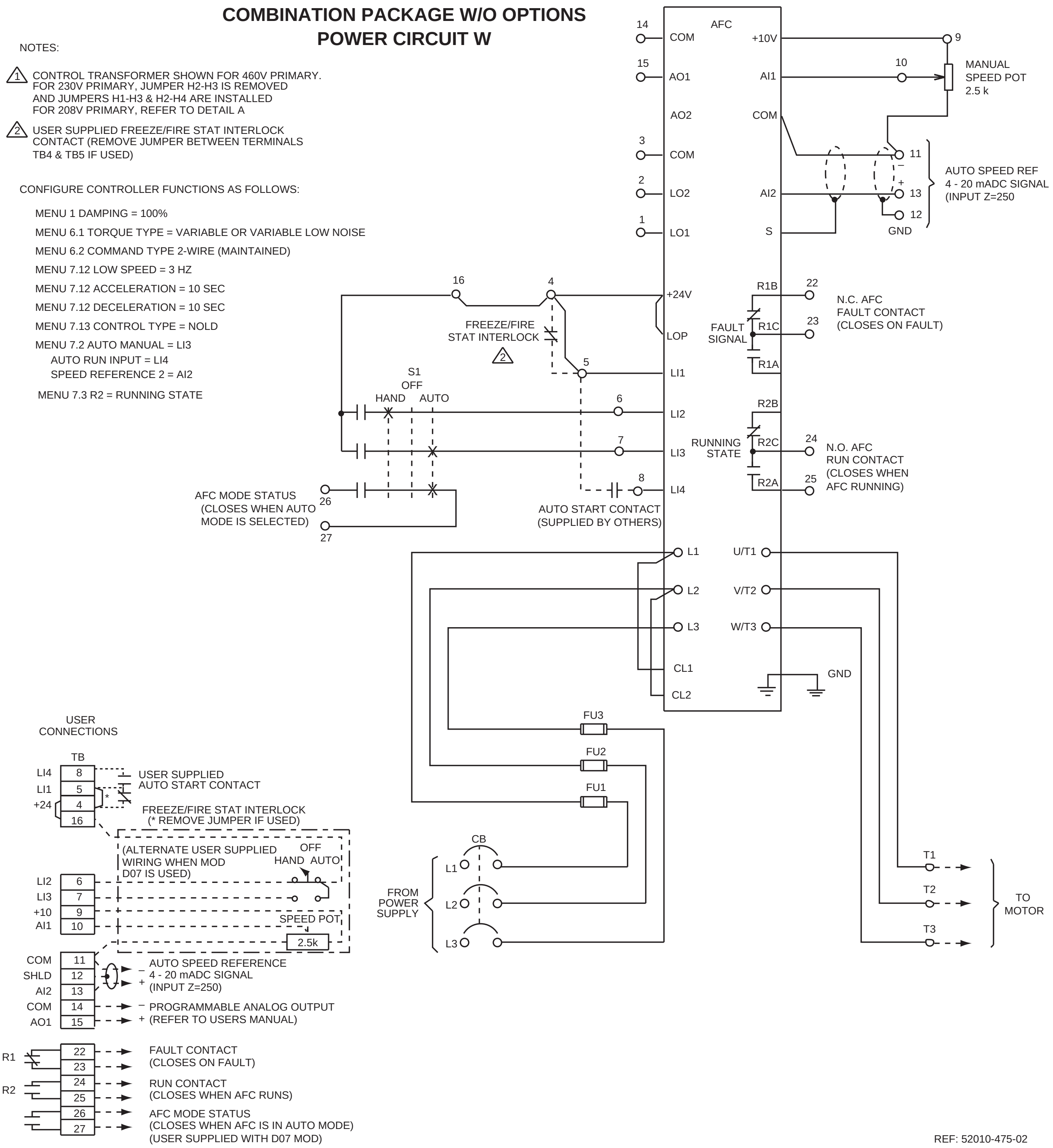


Figure 92: Combination Package “Power Circuit W” without Options

BYPASS PACKAGE W/ OPTIONS
POWER CIRCUIT Y

NOTES:

1. PILOT LIGHT CLUSTER (A07) RED PWR ON
GREEN AFC RUN
GREEN BYP RUN
YELLOW AFC FAULT

   CONFIGURE CONTROLLER FUNCTIONS:
   MENU 7.3 LO1 = RUNNING STATE
   MENU 7.3 LO2 = FAULT STATE

2. PILOT LIGHT CLUSTER (B07)
RED PWR ON
GREEN AFC RUN
GREEN AUTO MODE
YELLOW AFC FAULT
PLACE JUMPER BETWEEN TB-4 & TB-32

   CONFIGURE CONTROLLER FUNCTIONS:
   MENU 7.3 LO1 = RUNNING STATE
   MENU 7.3 LO2 = FAULT STATE

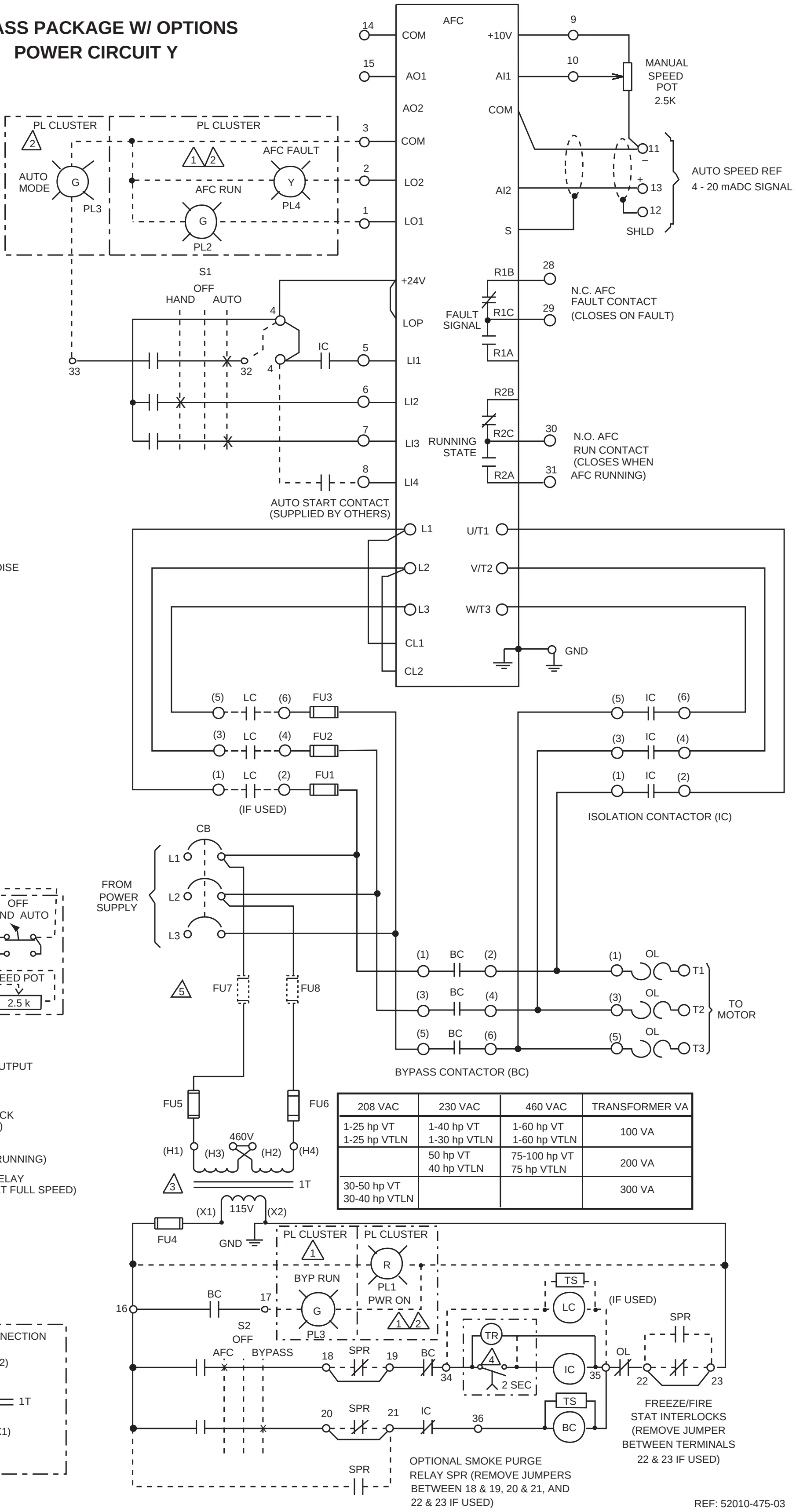
3. CONTROL TRANSFORMER SHOWN FOR 460V PRIMARY. FOR 230V PRIMARY, JUMPER H2-H3 IS REMOVED AND JUMPERS H1-H3 & H2-H4 ARE INSTALLED FOR 208V PRIMARY, REFER TO DETAIL A

4. DELAY TIMER TR IS CONNECTED ACROSS COIL TERMINALS A1 & A2 ON IC CONTACTOR FOR ALL CONTACTORS EXCEPT THOSE WITH PART #S LC1FXXX. FOR THESE, TR IS CONNECTED IN SERIES WITH COIL TERMINAL A1.

5. FUSES FU7 & FU8 SUPPLIED ONLY ON 50-100HP @ 460 VAC OR 30-50HP @ 208/230 VAC.

CONFIGURE CONTROLLER FUNCTIONS AS FOLLOWS:

MENU 1 DAMPING = 100%
MENU 6.1 TORQUE TYPE = VARIABLE OR VARIABLE LOW NOISE
MENU 6.2 COMMAND TYPE 2-WIRE (MAINTAINED)
MENU 7.12 LOW SPEED = 3 HZ
MENU 7.12 ACCELERATION = 10 SEC
MENU 7.12 DECELERATION = 10 SEC
MENU 7.13 CONTROL TYPE = NOLD
MENU 7.2 AUTO MANUAL = LI3
  AUTO RUN INPUT = LI4
  SPEED REFERENCE 2 = AI2
MENU 7.3 R2 = RUNNING STATE



208 VAC	230 VAC	460 VAC	TRANSFORMER VA
1-25 hp VT 1-25 hp VTLN	1-40 hp VT 1-30 hp VTLN	1-60 hp VT 1-60 hp VTLN	100 VA
	50 hp VT 40 hp VTLN	75-100 hp VT 75 hp VTLN	200 VA
30-50 hp VT 30-40 hp VTLN			300 VA

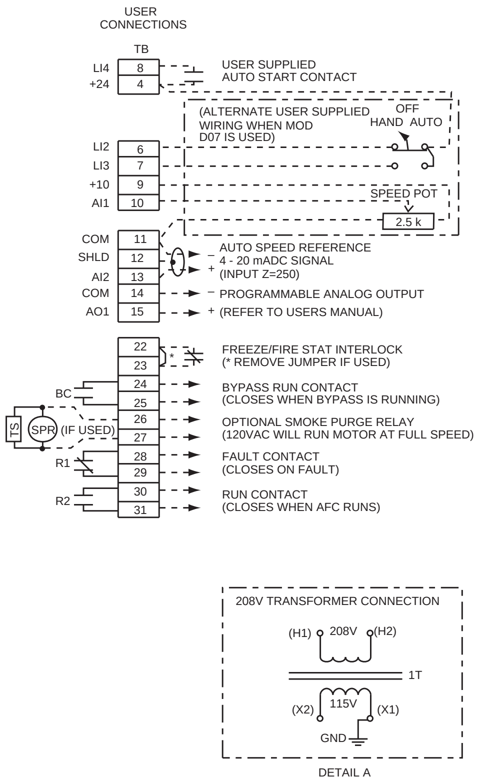
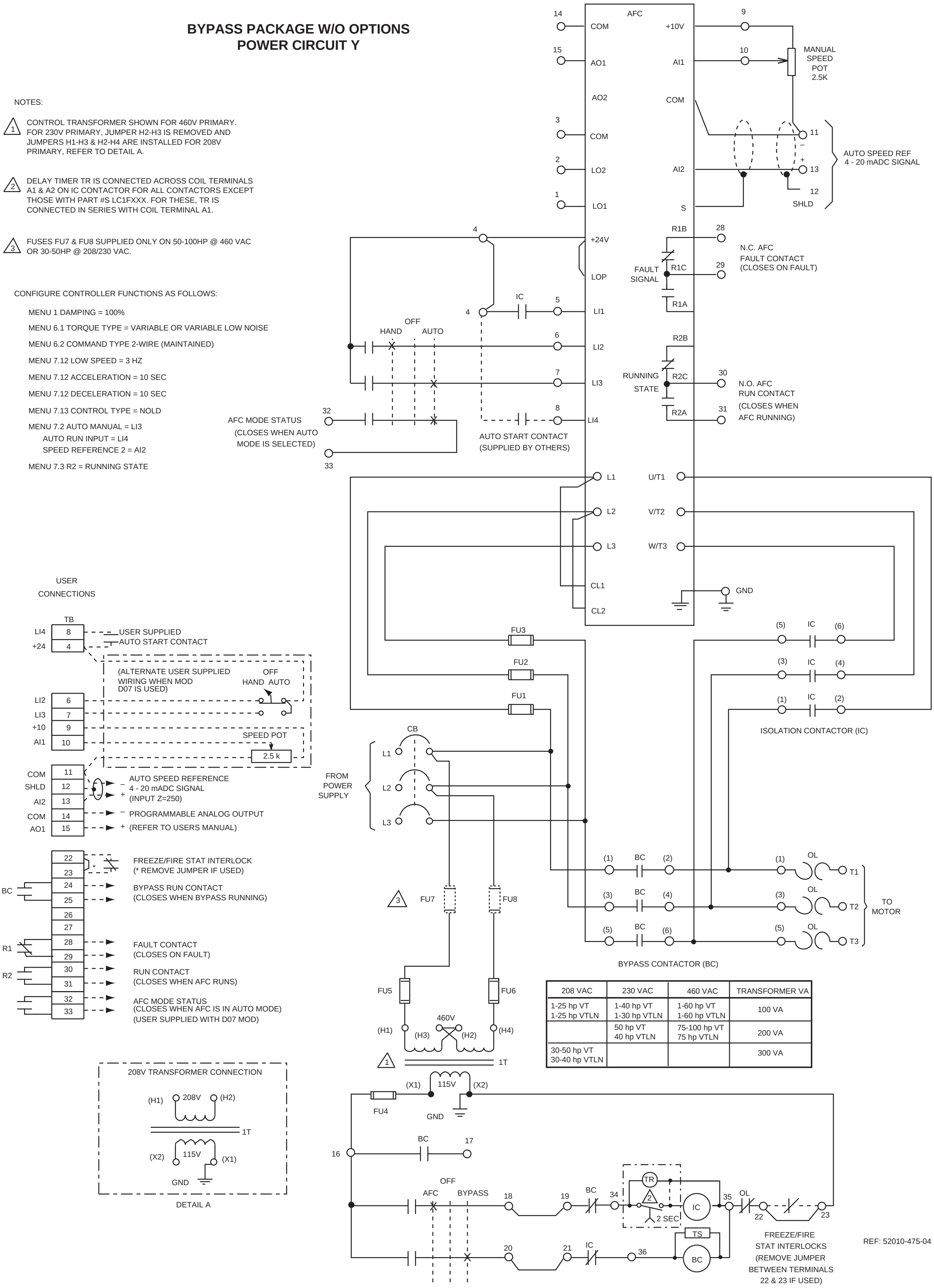
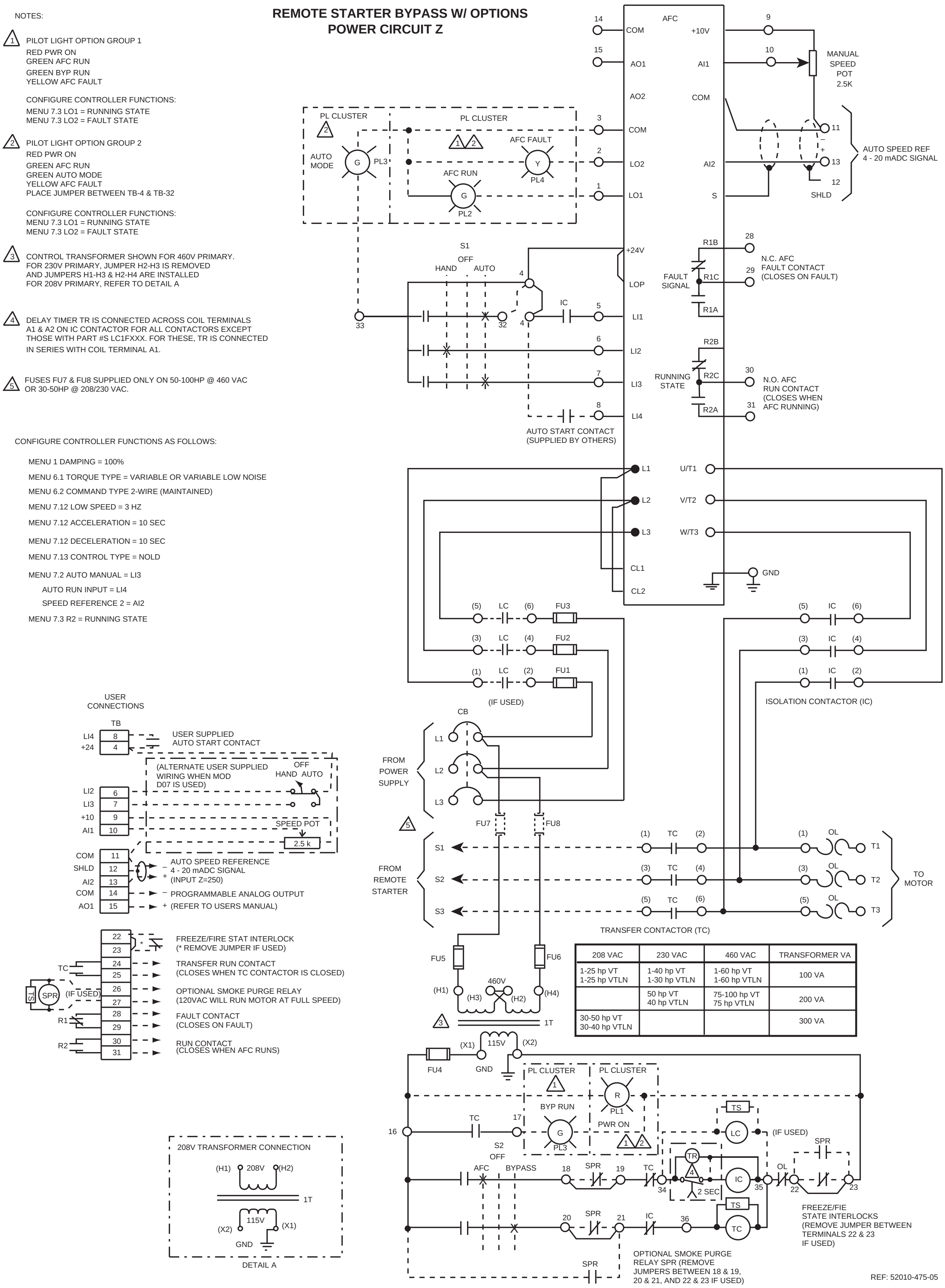


Figure 93: Bypass Package “Power Circuit Y” with Options



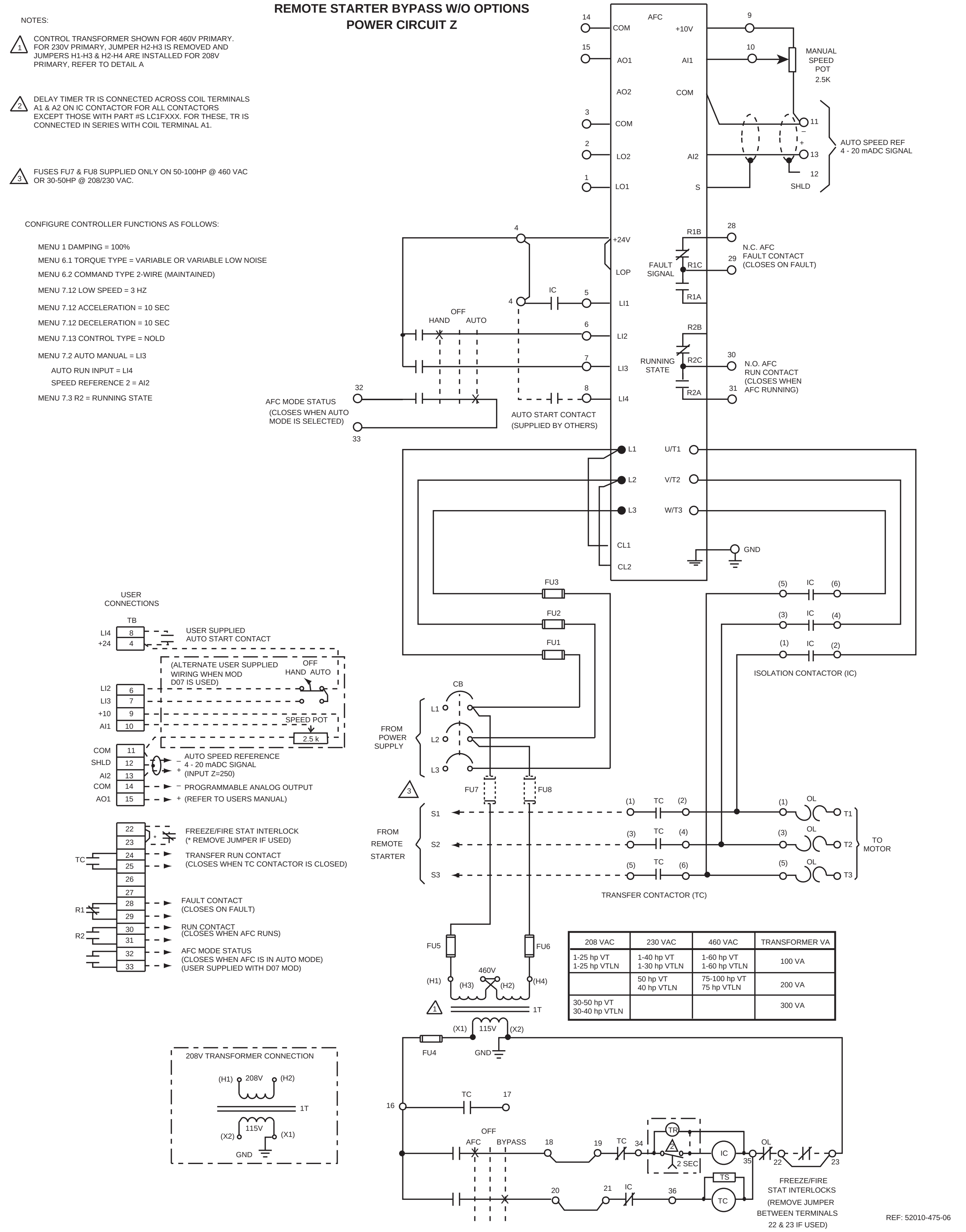
208 VAC	230 VAC	460 VAC	TRANSFORMER VA
1-25 hp VT 1-25 hp VTLN	1-40 hp VT 1-30 hp VTLN	1-60 hp VT 1-60 hp VTLN	100 VA
	50 hp VT 40 hp VTLN	75-100 hp VT 75 hp VTLN	200 VA
30-50 hp VT 30-40 hp VTLN			300 VA

Figure 94: Bypass Package “Power Circuit Y” without Options



208 VAC	230 VAC	460 VAC	TRANSFORMER VA
1-25 hp VT 1-25 hp VTLN	1-40 hp VT 1-30 hp VTLN	1-60 hp VT 1-60 hp VTLN	100 VA
	50 hp VT 40 hp VTLN	75-100 hp VT 75 hp VTLN	200 VA
30-50 hp VT 30-40 hp VTLN			300 VA

Figure 95: Remote Starter Bypass Package “Power Circuit Z” with Options



208 VAC	230 VAC	460 VAC	TRANSFORMER VA
1-25 hp VT 1-25 hp VTLN	1-40 hp VT 1-30 hp VTLN	1-60 hp VT 1-60 hp VTLN	100 VA
	50 hp VT 40 hp VTLN	75-100 hp VT 75 hp VTLN	200 VA
30-50 hp VT 30-40 hp VTLN			300 VA

Figure 96: Remote Starter Bypass Package "Power Circuit Z" "without Options

Appendix A — Parameter Summary

This Appendix contains a general summary and description of parameters. Refer to Chapter 5 for complete explanations of the parameters and applicable precautions.

1→PARAMETER SETTING MENU

Parameter	Range	Factory Setting	Description
Low Speed	0 to High Speed	0 Hz	Low speed setting.
High Speed	Low Speed to Maximum Frequency	60 Hz	High speed setting.
Acceleration	0.1 to 999.9 s	3 s	Length of time to accelerate from zero speed to nominal frequency.
Deceleration	0.1 to 999.9 s	3 s	Length of time to decelerate from nominal frequency to zero speed.
Damping	NOLD: 1 to 100%; Normal: 1 to 800%	20%	Matches the response of the load to the frequency response of the drive controller by adjusting the integral gain of the frequency loop.
Profile	0 to 100	20	Shapes the V/Hz profile of the output for variable torque applications in normal control type.
Motor Overload	0.45 to 1.15 times nominal drive controller current	0.9 times nominal drive controller current	Takes speed, time and current into account to calculate thermal overload state.
SP Gain	-9999 to +9999	+9999	System gain in PI Regulator
Offset	-9999 to +9999	+0	System offset in PI Regulator
KP	0 to 9999	100	Proportional gain in PI Regulator
KI	0 to 9999	0	Integral gain in PI Regulator
PI FLT RATIO	0 to 100%	100%	Limitation of error between desired setpoint and actual process feedback
PI SET POINT	-9999 to +9999	0	Setpoint in PI Regulator
PI SP MANUAL	0 to High Speed	0 Hz	Manual speed reference with PI Regulator

2→I/O MAP

2.1→Logic Input Map

Logic Input	Factory Setting	Reassignable
LI1	Run enable	No
LI2	Run forward	No
LI3	Auto/manual	Yes
LI4	Auto run	Yes

2.2→Analog Input Map

Analog Input	Factory Setting	Reconfigurable
AI1	Speed reference1	No
AI2	Speed reference 2	Yes

2.3→Logic Output Map

Logic Input	Factory Setting	Reassignable
LO1	At speed	Yes
LO2	Current limit	Yes
R1	Fault	No
R2	Running state	Yes

2.4→Analog Output Map

Analog Output	Factory Setting	Reassignable
AO1	Motor speed	Yes
AO2	Motor current	Yes

6→DRIVE CONFIGURATION MENU

Parameter	Range	Factory Setting	Description
Torque Type	Variable Variable Low Noise	Variable	Type of Torque.
Command Type	2-wire (maintained) 3-wire (impulse)	2-wire	Type of control circuit which is wired into the drive controller, affecting operation of the Forward and Reverse inputs.
Motor Power (ATV56U41 only)	.75 kW / 1 hp 1.5 kW / 2 hp 2.2 kW / 3 hp	2.2 kW / 3 hp	Used to select motor power for ATV56U41 drive controller.

7→GENERAL CONFIGURATION MENU

7.11→Motor Parameters

Parameter	Range	Factory Setting	Description
Nominal Current	45 to 105% of drive controller current rating	90%	Motor nameplate value for full load current.
Nominal Frequency	60 Hz	60 Hz	Point on the V/Hz curve beyond which voltage remains virtually constant and only frequency increases.
Nominal Voltage	460 V (ATV56•••N4 units) 208-230 V (ATV56•••M2 units)	460 V for ATV56•••N4 units 230 V for ATV56•••M2 units	Point on the V/Hz curve beyond which voltage remains virtually constant and only frequency increases.
Profile	0 to 100	20	Shapes the V/Hz profile of the output for variable torque applications in normal control type.
Damping	NOLD: 1 to 100%; Normal: 1 to 800%	20%	Matches the response of the load to the frequency response of the drive controller by adjusting the integral gain of the frequency loop.
Rotation Normalization	ABC, ACB	ABC	Inverts direction of motor rotation without rewiring.
Current Limit	Default limit, Alternate value: 40 -110% of nominal drive controller current Current limit by frequency adjustable from 0.1-72 Hz	Default value: 110%	Allows alternate current limit value by frequency level, logic input or analog input.

7.12→Control Parameters

Parameter	Range	Factory Setting	Description
Maximum Frequency	72 Hz	72 Hz	Maximum output frequency.
Low Speed	0 to High Speed	0 Hz	Low speed setting.
High Speed	Low Speed to Maximum Frequency	60 Hz	High speed setting.
Acceleration	0.1 to 999.9 s	3 s	Length of time to accelerate from zero speed to nominal frequency.
Deceleration	0.1 to 999.9 s	3 s	Length of time to decelerate from nominal frequency to zero.
Skip Frequencies	Low speed to 72 Hz Skip bands: 2 or 5 Hz	None	Drive controller reference will not stop on the skip frequency which causes mechanical resonance. Up to 3 can be programmed.

7.13→Control Type

Control Type	Range	Factory Setting
Variable Torque:	Normal, NOLD	Normal

7.2→Application Functions

Parameter	Range	Factory Setting	Description
Preset Speeds	No 1 Preset speed 3 Preset speeds 72 Hz	No (When preset speeds are selected, factory settings are 5, 10 and 15 Hz)	Input 1 Input 2 0 0 Low/reference speed 1 0 Preset Speed 1 0 1 Preset Speed 2 1 0 Preset Speed 3
Speed Reference	0-20 mA 4-20 mA 20-4 mA x-20 mA	4-20 mA	Modification of AI2 for the type of signal.
Auto/Manual	No Yes, Logic input	No	Allows switching between AI1 and AI2 by logic command. AI1 is manual reference. AI2 is automatic. See Figure A-1 and Figure A-2.
Controlled Stop	No By Logic input By Frequency level 0.1-72 Hz By LI /Frequency level 0.1-72 Hz Stopping Methods: Freewheel stop Fast stop DC injection	No Freewheel stop	Allows frequency threshold and Logic Input to work together to tailor the stopping process.
Shutdown	No Yes Dwell time: 0.1 to 60 s	No 1 s	Allows drive controller to dwell at low speed for a time adjustable between 1 and 30 seconds before completely stopping.
Bypass	No Yes, Define I/O Delay time: 0.2 to 10 s Sequence Time-out Fault: 0.2 to 300 s. Process Time-out Fault: 0.2 s to 300 s.	No 2 s 5 s 5 s	Used to run machine at full speed when the drive must be taken off line for service or repair. Allows for isolation of the motor by means of a contactor installed between the drive and the motor with a special command sequence.
PI Regulator	No Yes, Set Point Feed Back Set Point Manual PI Parameters	No	Used for controlling level or flow of a process with setpoint and feedback inputs

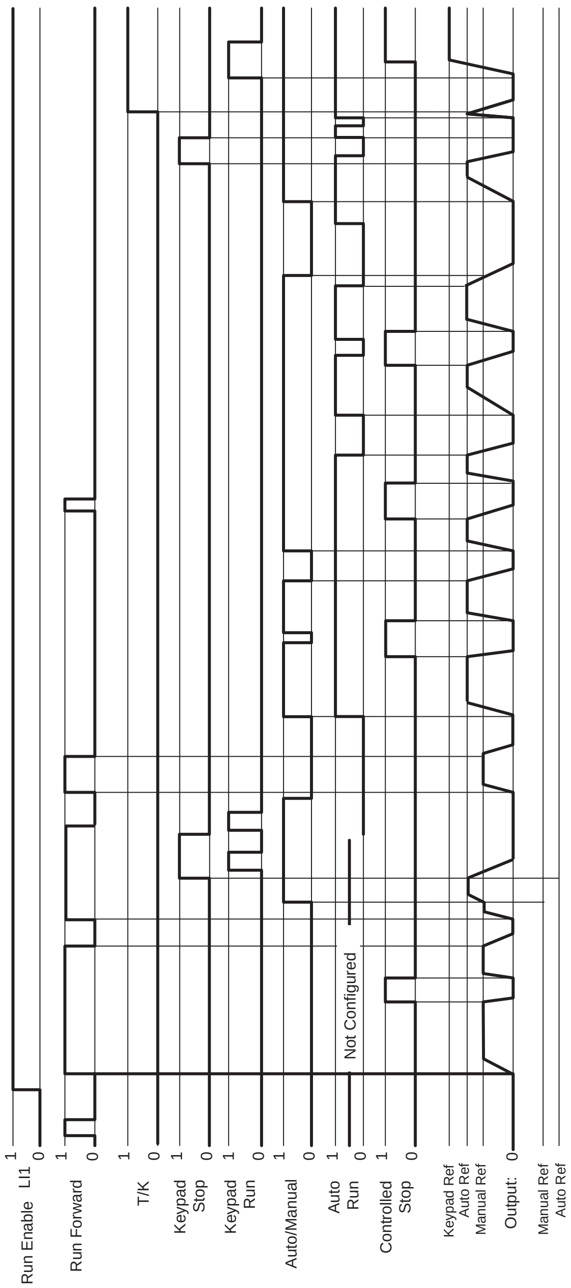


Figure 97: Auto/Manual in 2-Wire Command with Controlled Stop Active High

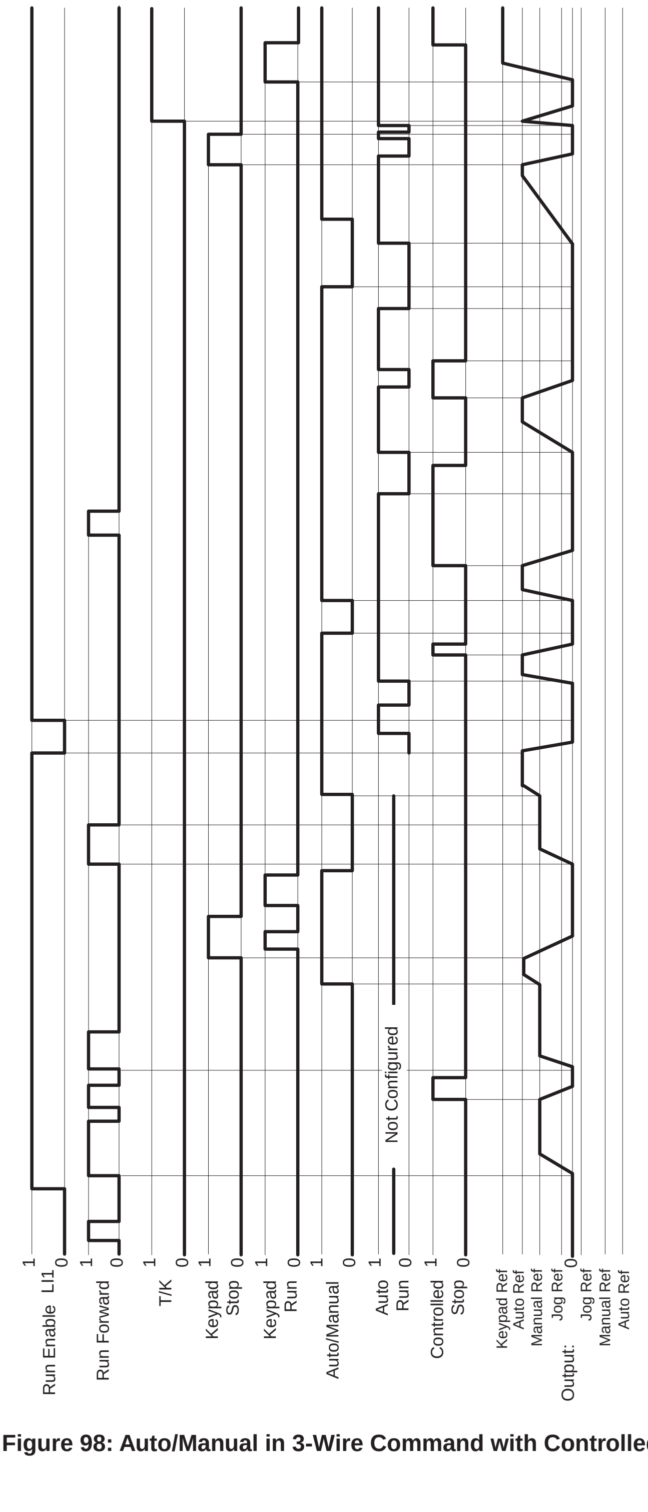
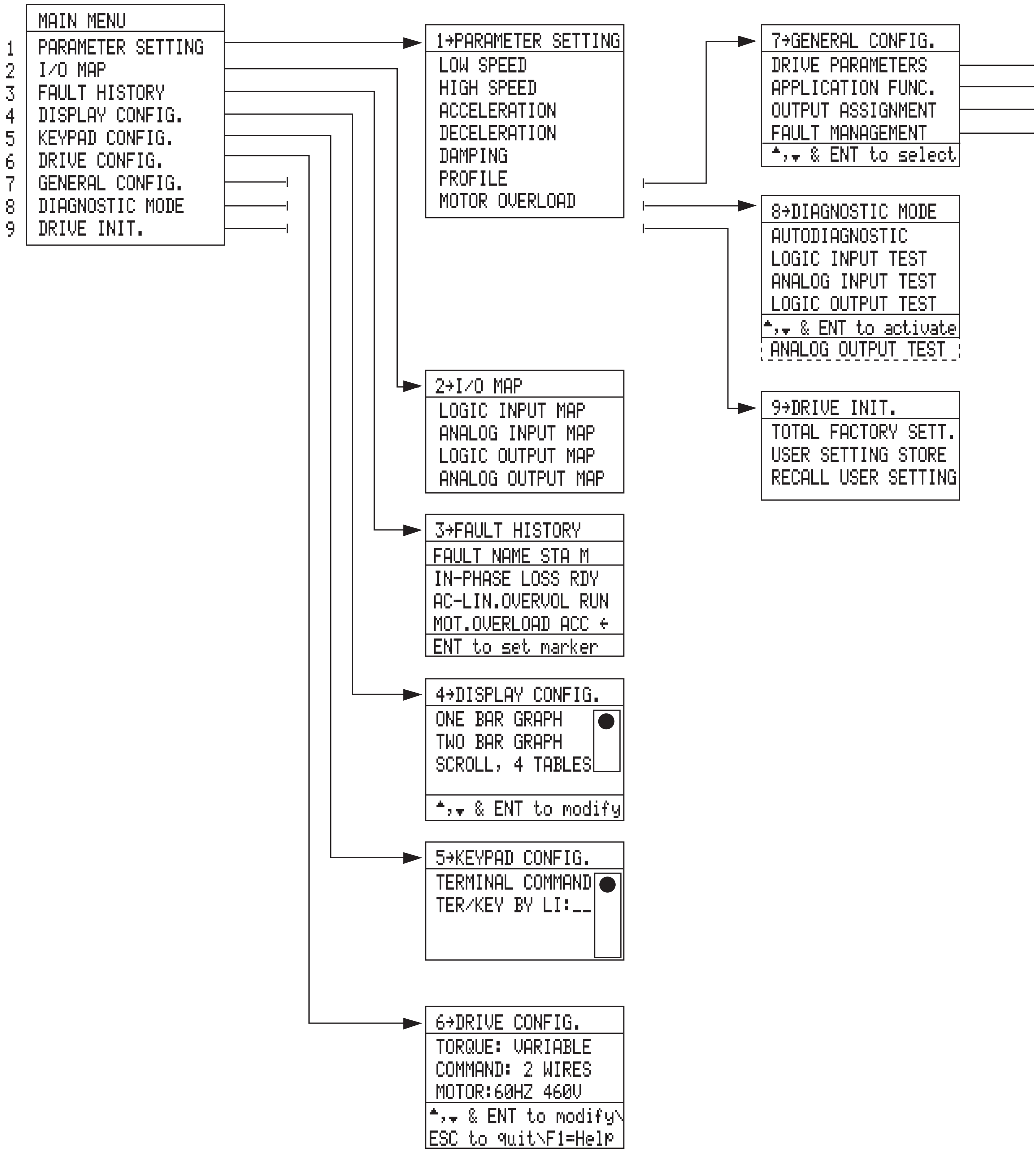
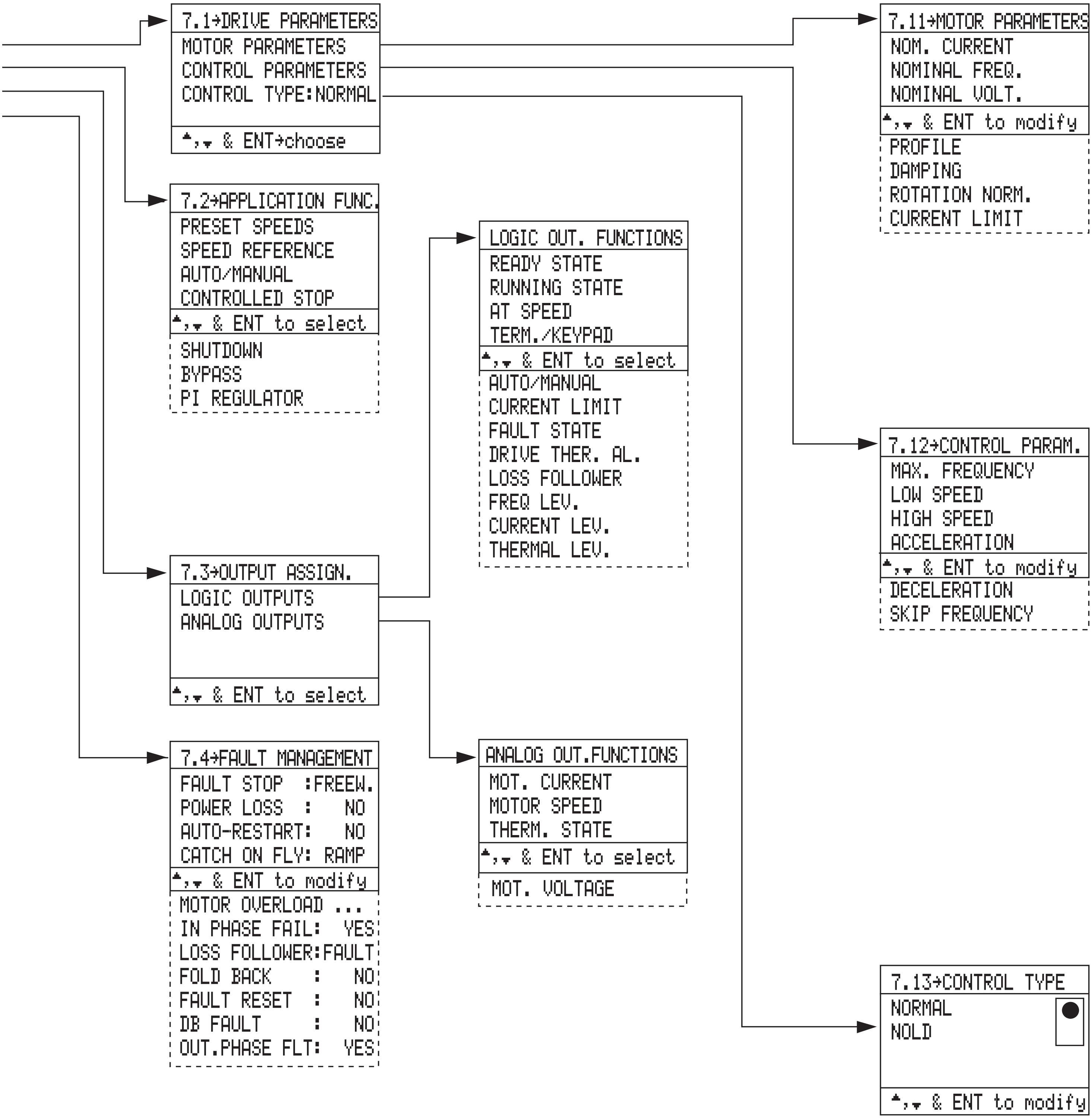


Figure 98: Auto/Manual in 3-Wire Command with Controlled Stop Active High

Appendix B — Menu Summary

This Appendix contains a summary of Level 1 and 2 Configuration Software menus. Use it as a quick reference for menu flow and contents. Refer to Chapter 5 for complete explanations of the menus.


MAIN MENU
1 PARAMETER SETTING
2 I/O MAP
3 FAULT HISTORY
4 DISPLAY CONFIG.
5 KEYPAD CONFIG.
6 DRIVE CONFIG.
7 GENERAL CONFIG.
8 DIAGNOSTIC MODE
9 DRIVE INIT.
1→PARAMETER SETTING
LOW SPEED
HIGH SPEED
ACCELERATION
DECELERATION
DAMPING
PROFILE
MOTOR OVERLOAD
2→I/O MAP
LOGIC INPUT MAP
ANALOG INPUT MAP
LOGIC OUTPUT MAP
ANALOG OUTPUT MAP
3→FAULT HISTORY
FAULT NAME STA M
IN-PHASE LOSS RDY
AC-LIN.OVERVOL RUN
MOT.OVERLOAD ACC ←
ENT to set marker
4→DISPLAY CONFIG.
ONE BAR GRAPH
TWO BAR GRAPH
SCROLL, 4 TABLES
▲,▼ & ENT to modify
5→KEYPAD CONFIG.
TERMINAL COMMAND
TER/KEY BY LI:__
6→DRIVE CONFIG.
TORQUE: VARIABLE
COMMAND: 2 WIRES
MOTOR:60HZ 460V
▲,▼ & ENT to modify\
ESC to quit\F1=Help
7→GENERAL CONFIG.
DRIVE PARAMETERS
APPLICATION FUNC.
OUTPUT ASSIGNMENT
FAULT MANAGEMENT
▲,▼ & ENT to select
8→DIAGNOSTIC MODE
AUTODIAGNOSTIC
LOGIC INPUT TEST
ANALOG INPUT TEST
LOGIC OUTPUT TEST
▲,▼ & ENT to activate
ANALOG OUTPUT TEST
9→DRIVE INIT.
TOTAL FACTORY SETT.
USER SETTING STORE
RECALL USER SETTING


7.1→DRIVE PARAMETERS
MOTOR PARAMETERS
CONTROL PARAMETERS
CONTROL TYPE:NORMAL
▲,▼ & ENT→choose
7.2→APPLICATION FUNC.
PRESET SPEEDS
SPEED REFERENCE
AUTO/MANUAL
CONTROLLED STOP
▲,▼ & ENT to select
SHUTDOWN
BYPASS
PI REGULATOR
7.3→OUTPUT ASSIGN.
LOGIC OUTPUTS
ANALOG OUTPUTS
▲,▼ & ENT to select
7.4→FAULT MANAGEMENT
FAULT STOP :FREEW.
POWER LOSS : NO
AUTO-RESTART: NO
CATCH ON FLY: RAMP
▲,▼ & ENT to modify
MOTOR OVERLOAD ...
IN PHASE FAIL: YES
LOSS FOLLOWER:FAULT
FOLD BACK : NO
FAULT RESET : NO
DB FAULT : NO
OUT.PHASE FLT: YES
LOGIC OUT. FUNCTIONS
READY STATE
RUNNING STATE
AT SPEED
TERM./KEYPAD
▲,▼ & ENT to select
AUTO/MANUAL
CURRENT LIMIT
FAULT STATE
DRIVE THER. AL.
LOSS FOLLOWER
FREQ LEV.
CURRENT LEV.
THERMAL LEV.
ANALOG OUT.FUNCTIONS
MOT. CURRENT
MOTOR SPEED
THERM. STATE
▲,▼ & ENT to select
MOT. VOLTAGE
7.11→MOTOR PARAMETERS
NOM. CURRENT
NOMINAL FREQ.
NOMINAL VOLT.
▲,▼ & ENT to modify
PROFILE
DAMPING
ROTATION NORM.
CURRENT LIMIT
7.12→CONTROL PARAM.
MAX. FREQUENCY
LOW SPEED
HIGH SPEED
ACCELERATION
▲,▼ & ENT to modify
DECELERATION
SKIP FREQUENCY
7.13→CONTROL TYPE
NORMAL
NOLD
▲,▼ & ENT to modify

Appendix C — Spare Parts

Replacement of spare parts requires the use of special tools and installation procedures not included with the spare parts kits. Before replacing any spare part, consult the Adjustable Frequency Drive Controller Service and Troubleshooting Manual, bulletin no.VD0C06S701_. Spare parts must be removed and installed only by qualified electrical personnel familiar with the Service and Troubleshooting Manual.

Spare Parts List

Description	Rating	Drive Controller	Reference No.
Adjustable Frequency Drive Controller Service and Troubleshooting Manual	—	ATV56 all sizes	VD0C06S701
Control Kit (with control basket and keypad)	—	ATV56U41N4 to D79N4 ATV56U41M2 to D46M2	VX4-A56CK1 VX4-A56CK1
Programming Keypad	—	ATV56 all sizes	Consult factory
Removable Control Terminal Strips (for J1, J12, J13)	—	ATV56 all sizes	VZ3-N006
Power Boards	—	ATV56U41N4	VX5-A56U41N4
	—	ATV56U54N4	VX5-A56U54N4
	—	ATV56U72N4	VX5-A56U72N4
	—	ATV56U90N4	VX5-A56U90N4
	—	ATV56D12N4	VX5-A56D12N4
	—	ATV56D16N4	VX5-A56D16N4
	—	ATV56D23N4	VX5-A56D23N4
	—	ATV56D33N4	VX5-A66D33N4
	—	ATV56D46N4	VX5-A66D46N4
	—	ATV56D54N4	VX5-A66D54N4
	—	ATV56D64N4	VX5-A66D64N4
	—	ATV56D79N4	VX5-A66D79N4
	—	ATV56U41M2	VX5-A56U41M2
	—	ATV56U72M2	VX5-A56U72M2
	—	ATV56U90M2	VX5-A56U90M2
	—	ATV56D12M2	VX5-A56D12M2
	—	ATV56D16M2	VX5-A56D16M2
	—	ATV56D23M2	VX5-A66D23M2
	—	ATV56D33M2	VX5-A66D33M2
	—	ATV56D46M2	VX5-A66D46M2
Gate Driver Boards	—	ATV56D16N4	VX5-A66103
	—	ATV56D23N4	VX5-A66104
	—	ATV56D33N4	VX5-A56105
	—	ATV56D46N4	VX5-A56106
	—	ATV56D54N4	VX5-A56107
	—	ATV56D64N4	VX5-A56108
	—	ATV56D79N4	VX5-A56109
	—	ATV56D12M2	VX5-A66112
	—	ATV56D16M2	VX5-A66113
	—	ATV56D23M2	VX5-A56107
	—	ATV56D33M2	VX5-A56108
	—	ATV56D46M2	VX5-A56109
Filter Boards	—	ATV56D16N4, D23N4	VX4-A66103
	—	ATV56D33N4, D46N4	VX4-A66104
	—	ATV56D54N4 to D79N4	VX4-A66105
	—	ATV56D12M2, D16M2	VX4-A66103
	—	ATV56D23M2, D33M2	VX4-A66104
	—	ATV56D46M2	VX4-A66105

Spare Parts List (Continued)

Description	Rating	Drive Controller	Reference No.
Control Power Transformer	—	ATV56D33N4 to D79N4	VY1-ADA604
	—	ATV56D23M2, D46M2	VY1-ADA614
Screws for mounting power components	—	ATV56D16N4, D23N4	VY1-ADV603
	—	ATV56D33N4, D46N4	VY1-ADV604
	—	ATV56D54N4 to D79N4	VY1-ADV605
2 IGBT Modules	50 A / 1200 V	ATV56D16N4	VZ3-IM2050M1201
	75 A / 1200 V	ATV56D23N4	VZ3-IM2075M1201
	100 A / 1200 V	ATV56D33N4	VZ3-IM2100M1201
	150 A / 1200 V	ATV56D46N4, D54N4	VZ3-IM2150M1201
	200 A / 1200 V	ATV56D64N4	VZ3-IM2200M1201
	300 A / 1200 V	ATV56D79N4	VZ3-IM2300M1201
	75 A / 600 V	ATV56D12M2	VZ3-IM2075M0601
	100 A / 600 V	ATV56D16M2	VZ3-IM2100M0601
	150 A / 600 V	ATV56D23M2	VZ3-IM2150M0601
	200 A / 600 V	ATV56D33M2	VZ3-IM2200M0601
	300 A / 600 V	ATV56D46M2	VZ3-IM2300M0601
DB Transistor Modules	20 A / 1200 V	ATV56D16N4, D23N4	VZ3-IM1025M1001
	50 A / 1200 V	ATV56D33N4, D46N4	VZ3-IM2050M1201
	75 A / 1200 V	ATV56D54N4	VZ3-IM2100M1201
	150 A / 1200 V	ATV56D64N4, D79N4	VZ3-IM2150M1201
	60 A / 600 V	ATV56D12M2, D16M2	VZ3-IM1060M0601
	75 A / 600 V	ATV56D23M2	VZ3-IM2075M0601
	100 A / 600 V	ATV56D33M2	VZ3-IM2100M0601
	150 A / 600 V	ATV56D46M2	VZ3-IM2150M0601
6-Diode Rectifier	75 A / 1600 V	ATV56D16N4, D23N4	VZ3-DM6075M1601
	75 A / 1600 V	ATV56D12M2, D16M2	VZ3-DM6075M1601
2-Diode Rectifier	80 A / 1600 V	ATV56D33N4	VZ3-DM2080M1606
	100 A / 1600 V	ATV56D46N4	VZ3-DM2100M1601
	160 A / 1600 V	ATV56D54N4 to D79N4	VZ3-DM2160M1606
	80 A / 1600 V	ATV56D23M2	VZ3-DM2080M1606
	100 A / 1600 V	ATV56D33M2	VZ3-DM2100M1601
	160 A / 1600 V	ATV56D46M2	VZ3-DM2160M1606
Fan Sub-Assemblies	Flow 10 CFM	ATV56U41N4, U54N4	VZ3-V661
	Flow 20 CFM	ATV56U72N4	VZ3-V662
	Flow 44 CFM	ATV56U90N4, D12N4	VZ3-V663
	Flow 94 CFM	ATV56D16N4, D23N4	VZ3-V664
	Flow 200 CFM	ATV56D33N4 to D79N4	VZ3-V665
	Board Fan	ATV56D33N4 to D79N4	VZ3-V6654
	Flow 20 CFM	ATV56U41M2	VZ3-V662
	Flow 44 CFM	ATV56U72M2, U90M2	VZ3-V663
	Flow 94 CFM	ATV56D12M2, D16M2	VZ3-V664
	Flow 200 CFM	ATV56D23M2, D46M2	VZ3-V665
	Board Fan	ATV56D23N4 to D46M2	VZ3-V6654
Precharge Resistors	33 Ω / 8.5 W	ATV56D16N4, D23N4	VZ3-R033W009
	10 Ω / 25 W	ATV56D33N4, D46N4	VZ3-R010W025
	10 Ω / 480 W	ATV56D54N4, D79N4	VZ3-R010W481
	33 Ω / 8.5 W	ATV56D12M2, D16M2	VZ3-R033W009
	10 Ω / 25 W	ATV56D23M2, D33M2	VZ3-R010W025
	10 Ω / 480 W	ATV56D46M2	VZ3-R010W481
Discharge Resistor	5 kΩ / 40 W	ATV56D33N4 to D79N4	VZ3-R5K0W040
	5 kΩ / 40 W	ATV56D23M2 to D46M2	VZ3-R5K0W040
Capacitor	1500µF/450 V	ATV56D16N4, D23N4	VY1-ADC152V450
	4700µF/450 V	ATV56D33N4, D46N4	VY1-ADC472V450
	1500µF/450 V	ATV56D12M2, D16M2	VY1-ADC152V450
	4700µF/450 V	ATV56D23M2, D33M2	VY1-ADC472V450

Spare Parts List (Continued)

Description	Rating	Drive Controller	Reference No.
Capacitor Sub-Assemblies	—	ATV56D54N4	VY1-ADC605
(contain 1 capacitor and 1 balancing resistor)	—	ATV56D64N4, D79N4	VY1-ADC606
(contains 6 capacitors and 6 balancing resistors)	—	ATV56D46M2	VY1-ADC605
Current Sensors (2)	—	ATV56D33N4 to D46N4	VY1-A66104
	—	ATV56D54N4 to D79N4	VY1-A66105
	—	ATV56D23M2	VY1-A66104
	—	ATV56D33M2, D46M2	VY1-A66105

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