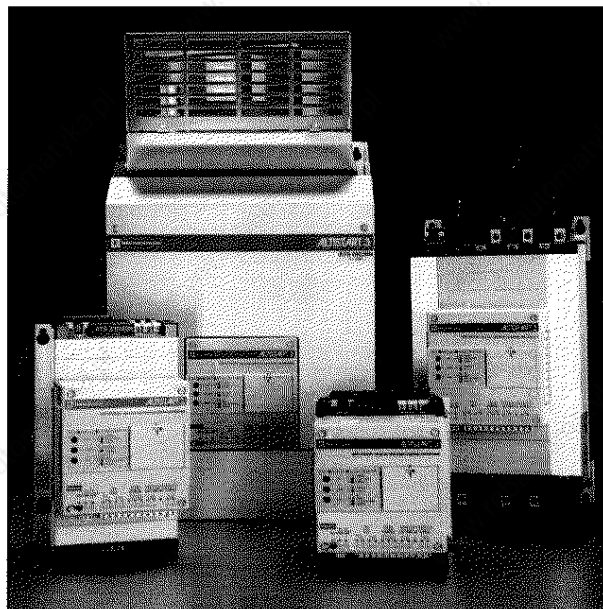


Instruction Bulletin

50006-359-01C

September, 1996

Replaces 50006-359-01B dated 5/95



ALTISTART[®] 3

Series 23 Soft Start

208-220-230 V

380-400-415 V

440-460-500 V

DANGER

HAZARDOUS VOLTAGE

- Read and understand this manual in its entirety before installing or operating ALTISTART controllers. Installation, adjustment, repair, and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing controller.
- DO NOT touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figures 6 through 10 for grounding points.
- Many parts in this controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools while making adjustments.

Before installing controller:

- Disconnect all power.
- Place a "DO NOT TURN ON" label on the controller disconnect.
- Lock disconnect in open position.

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

REVISION NOTICE:

This manual describes product manufactured after October 1, 1993 and replaces Instruction Bulletin 50006-359-01B. The primary changes to the product in this revision include updates on:

- Circuit diagrams (Figures 21 - 23).
- Component recommendations (Table 10).

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Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service, or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

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INTRODUCTION

The ALTISTART® 3, Series 23 Soft Start offers full-featured, solid-state soft starting of standard three-phase asynchronous induction motors. ALTISTART controllers are available in 14 power ratings from 7 to 1200 A. Each can be configured for 208/230, 380/400 or 460/500 V. The ALTISTART controllers are available in standard (ATS-23) and pump (ATS-23P) versions.

The ALTISTART controller starts motors on the gamma principle, an advanced control method that ensures smooth rotation throughout the starting ramp without mechanical instability at the end of starting. A microprocessor continuously monitors the main operating parameters of the starter and motor to provide maximum protection and reliability of motor and machine. Thermal protection is standard and is achieved by continuously calculating the temperature rise of the motor and starter. The protection remains effective when contactor shorting is used or during a total loss of power.

DEFINITION OF TERMS

Some of the terms and acronyms used throughout this manual are defined Table 1.

Table 1 Definition of Terms

Term	Definition
FLA	Full load amps: the current rating of an induction motor at rated speed and load. This value is the current rating found on the motor nameplate.
HOA	A selector switch that has three positions: Hand, Off and Automatic. Hand allows the motor to run, Off commands the motor to stop, and Automatic allows the motor to run when commanded by additional control logic.
In	Nominal current rating of controller. For the ALTISTART controllers, these values are shown in Table 2 on page 4.
I _r	Rated current of motor. Same as FLA.
V _n	Nominal voltage of supply power (mains supply). This should correspond to the motor rated voltage found on the motor nameplate.

AVAILABLE TORQUE

The asynchronous motor associated with the ALTISTART controller must be capable of starting the load when it is supplied with reduced voltage and current. Figure 1 shows the torque/speed characteristics of a squirrel cage motor as a function of the supply voltage. The torque varies as the square of the voltage at a fixed frequency. The progressive increase of voltage limits torque and current at starting.

Figure 2 shows the change of torque as a function of starting current with a solid-state soft starter. The limitation of the starting current (I_d) to a predetermined value (I_{d1}) causes a reduction of torque almost equal to the ratio of the square of currents:

$$T_{d1} \cong T_d \left(\frac{I_{d1}}{I_d} \right)^2$$

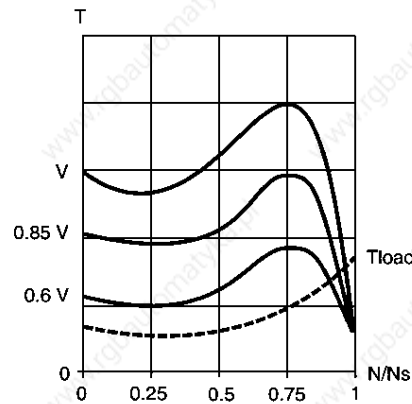


Figure 1 Torque/Speed Characteristics

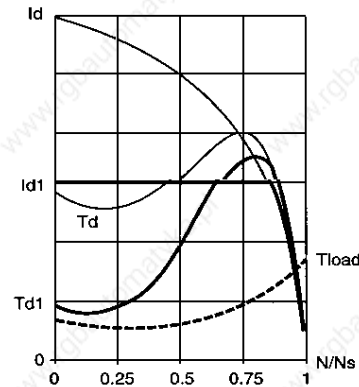


Figure 2 Change of Torque as Function of Starting Current

MOTOR SELECTION

ATS-23 and ATS-23P

Large frame motors (exceeding 500 T) of either NEMA A design or with a delta-connected stator should not be used with the ATS-23 controller since this may cause unstable operation. This precaution is essential for machines operating at no load if the controller is not equipped with a shorting contactor, or if it is necessary to use DC injection braking.

ATS-23P

When using the pump version starter, the asynchronous motor driving a centrifugal pump must, at full load, draw a current greater than or equal to 0.8 times its rated full load amps (FLA). This load condition is necessary for the starter to operate correctly on deceleration.

STARTER SELECTION

The ALTISTART controller must be selected according to the nameplate current of the motor. The starter should not be used upstream of a motor supply transformer.

Table 2 Starter Selection

Motor				Starter (12 starts per hour, Maximum 3 In for 60 s or equivalent)				
Maximum Power Rating ^[1]				Standard ATS-23	Pump ATS-23P	Current (In) Amps	Maximum Line Fuse ^[5] FU1, FU2, FU3 Class RK5/L	Short- Circuit Withstand A rms sym
208 V hp	230 V hp	380 V kW	460 V hp					
2	2	3	5	ATS23U70N	ATS23PU70N	7.6	9	5000
3	3	5.5	7.5	ATS23D12N	ATS23PD12N	12	15	5000
5	5	7.5	10	ATS23D16N	ATS23PD16N	16	20	5000
10	10	15	20	ATS23D30N	ATS23PD30N	30	40	5000
15	15	22	30	ATS23D44N	ATS23PD44N	44	60	5000
25	25	37	50	ATS23D72N	ATS23PD72N	72	90	10,000
30	40	55	75	ATS23C10N ^[4]	ATS23PC10N	105	125	10,000
50	50	75	100	ATS23C15N	ATS23PC15N	150	175	10,000
75	100	132	200	ATS23C24N ^[2,4]	AS23PC24N ^[2]	248	350	18,000
100	125	160	250	ATS23C30N ^[4]	ATS23PC30N	312	400	18,000
150	150	225	350	ATS23C41N ^[4]	ATS23PC41N	415	500	18,000
200	250	315	500	ATS23C58N	ATS23PC58N	602	800 ^[3]	30,000
300	300	450	700	ATS23C82N ^[4]	ATS23PC82N	840	1100 ^[3]	42,000
400	500	630	1000	ATS23M12N	ATS23PM12N	1200	1600 ^[3]	85,000

^[1] Horsepower and kilowatts are shown as a reference. Correct selection of a soft start is made based upon motor nameplate amperes.

^[2] Designed for 300% In (nominal current) for 15 s. For 300% In for 60 s, the starter current rating is limited to 210 A.

^[3] Class L fuse.

^[4] If DC Injection is adjusted for a time exceeding 30 seconds, derate starter by 20%.

^[5] The fuses listed in the table provide Type 1 protection to the starter when the power source short-circuit current capability is less than or equal to the fault current withstand values listed.

Table 3 Technical Characteristics

Environment	Degree of protection	NEMA Open Device: IP20 ATS23•U70N to C15N; IP00 ATS23•C24N to M12N.		
	Conformity to standards	Conforms to UL508, listed by UL and CSA Shock resistance: conforming to IEC 68-2-27 Vibration resistance: conforming to IEC 68-2-6 Immunity to radio-electrical interference: conforming to IEC 801- 3		
	Ambient air temperature	Operation: 0 to 40 °C without derating. Between +40 and +60 °C, derate starter current In by 1.2 % for each °C. 0 to 60 °C without derating if shorting contactor is used (not to exceed 2 starts/hour) Storage: -25 to +70 °C		
	Maximum relative humidity	93% without condensation or dripping water [1]		
	Maximum operating altitude	1000 m without derating. Above this, derate starter current In by 0.5 % for each additional 100 m up to 3000 m maximum.		
	Operating position	Vertical		
	Pollution	Protect controller against dust, corrosive gases, and splashing liquid [1]		
Electrical Characteristics	Three-phase supply voltage	208 V -10% to 240 V +10%; 380 V -15% to 415 V + 10%; 440 V -10% to 500 V + 10%		
	Frequency	50 or 60 Hz self-adjusting		
	Rated current In	14 ratings from 7.6 to 1200 A (operating range of 10% to 100% In)		
	Motor power	2 to 1000 hp		
	Motor voltage	208-220-230-240-380-440-460-500 V		
	Methods of starting:			
	Voltage ramp	Adjustable from 1 to 30 s by potentiometer, controlled from 0.3 Vn to Vn		
	Current limitation	ATS-23: adjustable from 2 to 5 Ir by potentiometer ATS-23P: adjustable from 2 to 4 Ir by potentiometer		
	Booster start-up pulse	ATS-23: full-voltage starting for 5 mains cycles (selection by switch)		
	Methods of stopping:			
	Freewheeling	Freewheel stop (factory setting for non-enclosed devices)		
	Control by voltage ramp (Selection by switch)	Adjustable from 2 to 60 s by potentiometer ATS-23P: possible to adjust up to 120 s using configuration switch		
	DC injection braking (Selection by switch)	ATS-23: automatic injection of current of 3.2 Ir for 60 s maximum (time adjustable by potentiometer)		
	LED display:	Steady light	Fast flashing	Slow flashing
	Fault (red)	Internal fault	Phase failure	Thermal fault
	Alarm (yellow)	Cooling	—	Overload
	Drive (green)	Run	Starting/Stopping	Ready
Output relays:	ATS-23: Fault: 1 N.O. + 1 N.C., Overload: 1 Form-C, End of Starting: 1 N.O., DC Braking: 1 N.O. ATS-23P: Fault: 1 N.O. + 1 N.C., Load: 1 Form-C, End of Starting: 1 N.O.			
Maximum operating power	With 115 VAC auxiliary contactor: Inrush 2000 VA, sealed 200 VA			
Minimum switching capacity	100 mA - 24 VDC			
Rated operating current	0.5 A inductive: 240 VAC or 48 VDC 5 A resistive: 240 VAC or 48 VDC			
Protection	Built-in solid-state thermal overload			
Thermal early warning (Pre-alarm)	When calculated motor temperature exceeds 110 % of rated motor temperature rise. Signalled by LED and Output relay.			
Thermal fault	When calculated motor temperature exceeds 120 % of rated motor temperature rise. Signalled by LED and Output relay. Controller stops.			
Mains protection	Phase failure signalled by LED and Output relay. Controller stops.			
Thermal switch	72 A and above have 2 thermal switches, one controls the fan (50 °C), the other protects against overheating.			
[1] Controller electrical creepages are designed for use in a Pollution Degree 3 environment per NEMA ICS-1 and IEC 664-1.				

THERMAL OVERLOAD PROTECTION

A microprocessor-controlled solid-state thermal overload continuously calculates temperature rise of the motor and starter based on the motor rated current (I_r) and the actual motor current. An electronic circuit with a time constant which simulates the cooling curve of the motor stores the thermal state even after disconnection of the power supply. Calculation of the motor heating is continuous with or without the use of shorting contactors. Rises in motor temperature can be caused by a slight or severe overload of long or short duration. Temperature rises are accurately monitored by a digital model based on two thermal images. The first (T1) represents the level of the temperature rise corresponding to "iron" (motor frame). The second (T2) represents the level of the temperature rise corresponding to "copper" (stator windings).

The thermal tripping curves shown in Figure 3 and Figure 4 are established according to a time constant based upon the motor FLA (I_r) and correspond to the "cold" state (with the motor at its rated ambient temperature). For each thermal image, two levels of alarm in series detect the level of the temperature rise:

1. An overload pre-alarm which indicates that the motor has exceeded 110% of its rated temperature rise threshold.
2. A thermal fault signal which stops the motor if the temperature rise exceeds the critical threshold of 121%.

These conditions are signalled by two indicator lights and two Output relays. Following a stop, the thermal overload control of the starter prevents restarting if the calculated temperature of the motor is still too high.

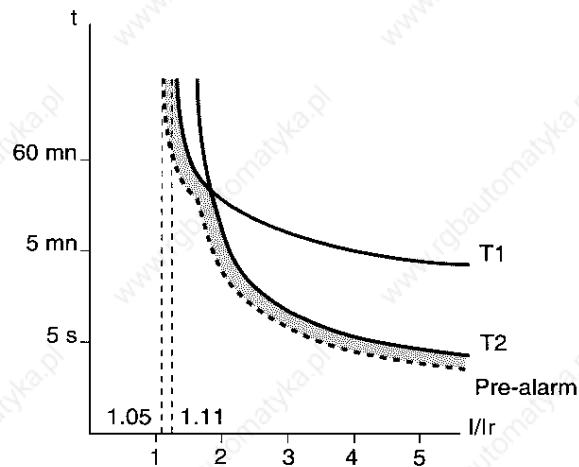


Figure 3 Trip Curves

CAUTION

MOTOR OVERHEATING

Motor current draw above nameplate rating will result in motor temperature rise. Extended exposure to overcurrents will cause the motor to overheat resulting in thermal overload fault or equipment damage.

The following conditions can cause excessive heating:

- Excessive duty cycle (more than 6 evenly spaced starts per hour)
- Excessive acceleration ramp due to high inertia loads
- Extended or high duty cycle of DC injection
- High ambient temperature

Check with the motor manufacturer for the motor's suitability for operation on a solid-state reduced voltage controller configured for your application.

- Motor thermal sensors built into the motor windings and connected through the control logic may be required for motor protection.
- Specific application duty motors, such as explosion proof and submersible motors will require enhanced protection and special considerations in application. The motor manufacturer **MUST** be consulted when applying these motors.

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

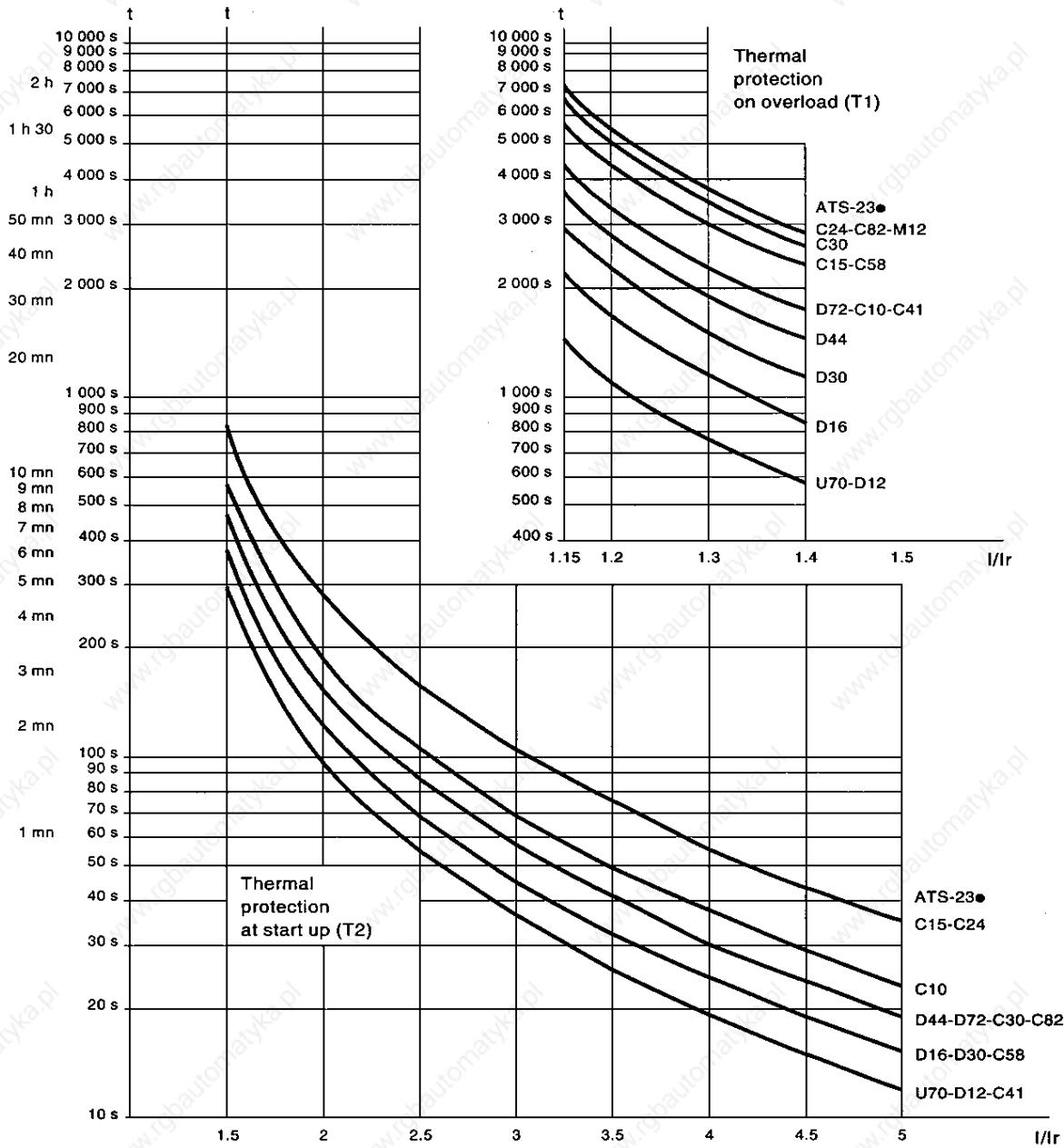


Figure 4 Trip Curves ("Cold" Motor)

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HANDLING THE STARTER

Do not remove starter from the carton until it is at the final installation site. The carton protects the starter and prevents damage to its exterior. Handle the starter carefully to avoid damage to the internal components, frame or exterior. Once removed from the carton, the ATS23C24-M12 starters can be handled:

- With a hoist. When hoisting starters, attach a spreader bar to the two lifting rings on top of the starter as shown in Figure 5.
- In a horizontal position, with the back of the starter resting on a pallet.
- Do not rest unit directly on bus bar connectors.

⚠ WARNING
HANDLING AND LIFTING HAZARD Keep area below any equipment being lifted clear of all personnel and property. Use lifting method shown in Figure 5. Failure to follow this instruction can result in death or serious injury.

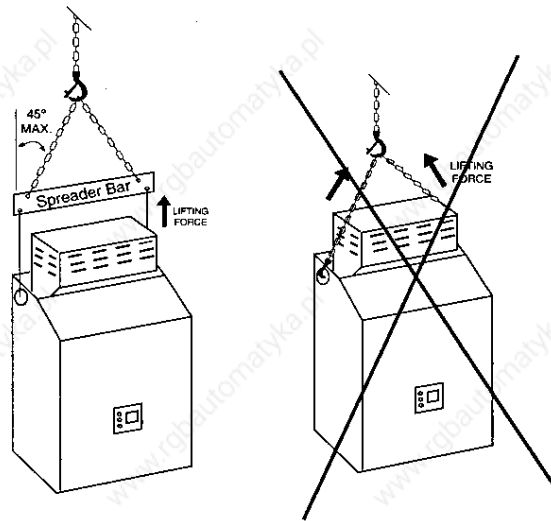


Figure 5 Hoisting the Starter

SERIAL AND MODEL NUMBERS

The serial and model number of the ALTISTART controller appear on the bar code sticker located on the front right side of the component.

	6W9417001001 03833085222A05
Serial No. →	
	ATS23PC10N
Model No. →	

Record the serial number below. This number will assist us in helping you in the future:

Serial Number: 6W _____

INSTALLATION PRECAUTIONS

Follow these precautions when installing the ALTISTART controller:

DANGER

HAZARDOUS VOLTAGE

- Read and understand this manual in its entirety before installing or operating ALTISTART controllers. Installation, adjustment, repair, and maintenance of these controllers must be performed by qualified personnel.
- Disconnect all power before servicing controller.
- **DO NOT** touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers before applying power or starting and stopping the controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. See Figure 6 through Figure 10 for grounding points.
- Many parts in this controller, including printed wiring boards, operate at line voltage. **DO NOT TOUCH.** Use only electrically-insulated tools while making adjustments.

Before installing controller:

- Disconnect all power.
- Place a "DO NOT TURN ON" label on the controller disconnect.
- Lock disconnect in open position.

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

- When installation surface is not even, put a spacer behind the starter mounting pads to eliminate gaps. The starter exterior may be damaged if fastened to an uneven surface.
- Starters are open devices and must be installed in suitable enclosures or controlled access areas. The environment around the starter must meet Pollution Degree 3 requirements as defined in NEMA ICS1-1 or IEC 664-1.

WARNING

HAZARDOUS VOLTAGE

ALTISTART 23 controllers are open style devices and must be mounted in a suitable enclosure.

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

- The starter generates heat. It must be properly ventilated. Refer to "Thermal Considerations for Sizing Enclosures" on page 20 to determine power dissipated.

- When several starters are installed in a control panel, arrange them in a row. Stacking starters is not recommended. Heat generated from the bottom starter can adversely affect the ambient temperature around the top starter.

CAUTION

CONTROLLER OVERHEATING

- Mount the controller vertically.
- Do not locate the controller near heat radiating elements.
- Electrical current through the controller will result in heat losses that must be dissipated into the ambient air immediately surrounding the controller. To prevent thermal fault or equipment damage, provide sufficient enclosure cooling and/or ventilation to limit the ambient temperature around the controller.

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

- Voltage and frequency specifications for the input line must match the starter configuration.
- A disconnect switch must be installed between the input line and the starter.

DANGER

HAZARDOUS VOLTAGE

- The solid-state switches of the controller power circuit do not provide complete isolation from the line. Due to leakage currents through the solid-state switches, hazardous voltages can be present on the controller load-side power circuit whenever power is applied to the line side of the controller.
- Disconnect all power before servicing the controller or motor.

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

- When using an isolation contactor, certain sequencing must be observed with respect to the run signal supplied to the ALTISTART controller. During starting of the controller, closure of the isolation contactor generally should precede or coincide with the application of the controller Run command. If line power is not detected at the L1, L2, and L3 terminals of the controller within 200 ms of this run command, a "Phase Failure" fault will occur. The circuit diagrams on page 27 and page 28 use this feature of the ALTISTART controller.
- External overcurrent protection in the form of fuses must be installed on the line-side connections of the starter. The maximum recommended fuse type and rating, along with the associated starter short-circuit withstand rating, is listed on the starter nameplate. This information is also listed in Table 2 on page 4.

WARNING

OVERCURRENT MUST BE PROPERLY COORDINATED

- Fuses must be installed on the line-side of the ALTISTART 23 controller to achieve published short circuit withstand ratings.
- Do not exceed the maximum fuse ratings shown in Table 2 or the controller nameplate.
- Do not connect the controller to a power feeder whose short circuit capacity exceeds the controller short circuit withstand rating shown in Table 2 or the controller nameplate.

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

- Power factor correction capacitors should not be connected to a motor controlled by an ALTISTART controller. If power factor correction is required, the capacitors must be located on the line-side of the controller. A separate contactor should be used to switch the capacitors off when the motor is off.

▲ CAUTION

EQUIPMENT DAMAGE HAZARD

Do not connect power factor correction capacitors to the load-side power circuit of the ALTISTART controller.

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

- The ALTISTART controller uses solid-state power switches for the control of motor power. When checking the condition of conductor or motor insulation, do not connect the high potential dielectric test equipment or insulation resistance tester to the starter since the test voltages used may damage the starter. Always disconnect the starter from the conductors or motor before performing such tests.

▲ CAUTION

EQUIPMENT DAMAGE HAZARD

- Do not perform high potential dielectric tests on circuits while the circuits are connected to the ALTISTART controller.
- Any circuit requiring high potential dielectric tests must be disconnected from the ALTISTART controller prior to performing the test.

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

- Electronic protection is included within the ALTISTART controller to detect and signal failure of the solid-state switches.
- Since the solid-state switches may be incapable of completely blocking motor power should a failure occur, auxiliary isolation on the line-side of the controller is required. The isolation device must be capable of operation via command from the Fault relay of the controller. An isolation device consisting of either a circuit breaker incorporating a shunt trip coil or an electromagnetic contactor can be used to open the controller power circuit in the event of a controller fault.

Refer to Figures 21 through 23 for typical circuit diagrams which show the logic controlling the isolation device via the Fault relay.

CAUTION

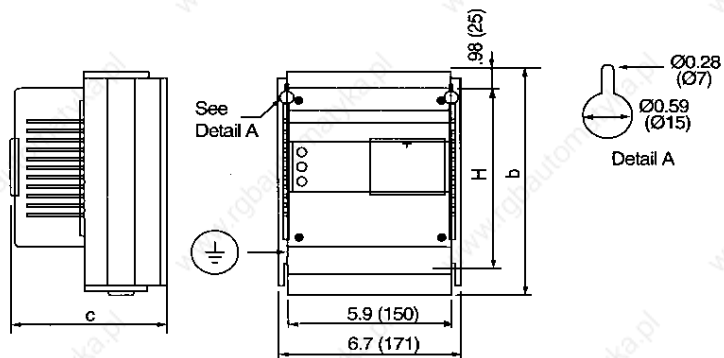
MOTOR OVERHEATING

Failure of the controller solid-state switches can cause single-phase operation of the motor.

- Use an isolation device consisting of either a circuit breaker equipped with a shunt trip coil or an electromagnetic contactor to open the line-side of the controller.
- The isolation device must be capable of interrupting motor locked rotor current.
- Connect the Fault relay of the ALTISTART controller to open the isolation device in the event of a controller fault.

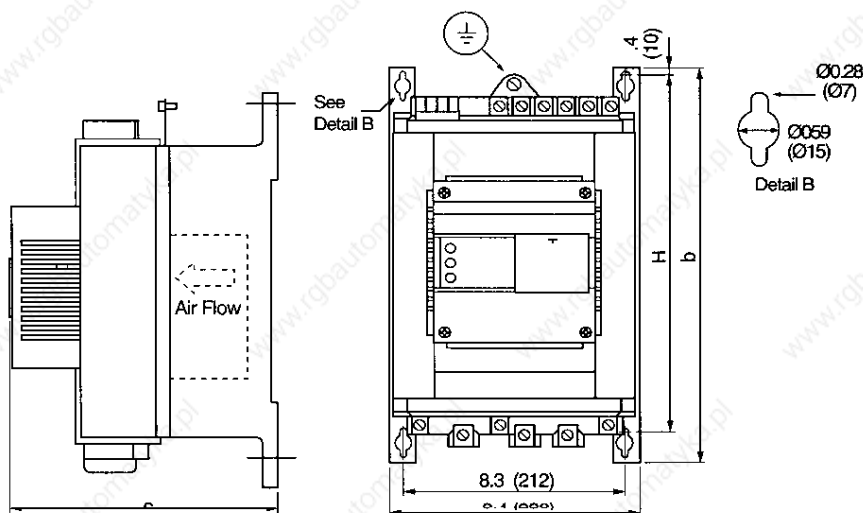
Failure to follow this instruction can result in injury or equipment damage.

DIMENSIONS
[in (mm)]



ATS-23 (P)	b	c	H
U70	8 (202)	5.6 (142)	6.2 (158)
D12	8.9 (227)	5.6 (142)	7.2 (183)
D16	9.9 (252)	6.4 (162)	8.3 (210)
D30	11.9 (302)	6.4 (162)	10.2 (260)

Figure 6 Dimensions: ATS23•U70 to D30



ATS-23 (P)	b	c	H
D44	13.4 (340)	7.1 (180)	11.8 (300)
D72	13.4 (340)	10.0 (254)	11.8 (300)
C10	15.4 (390)	10.0 (254)	13.8 (350)
C15	17.3 (440)	10.0 (254)	15.7 (400)

Figure 7 Dimensions: ATS23•D44 to C15

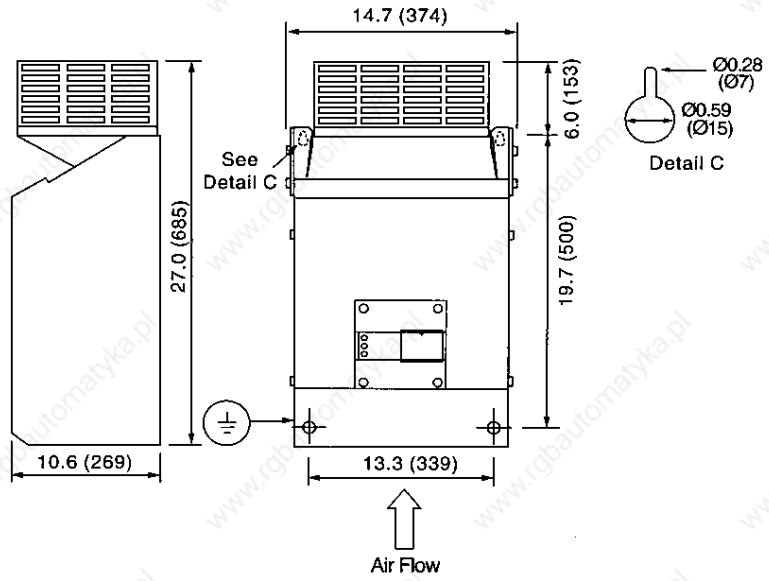


Figure 8 Dimensions: ATS23-C24 and C30

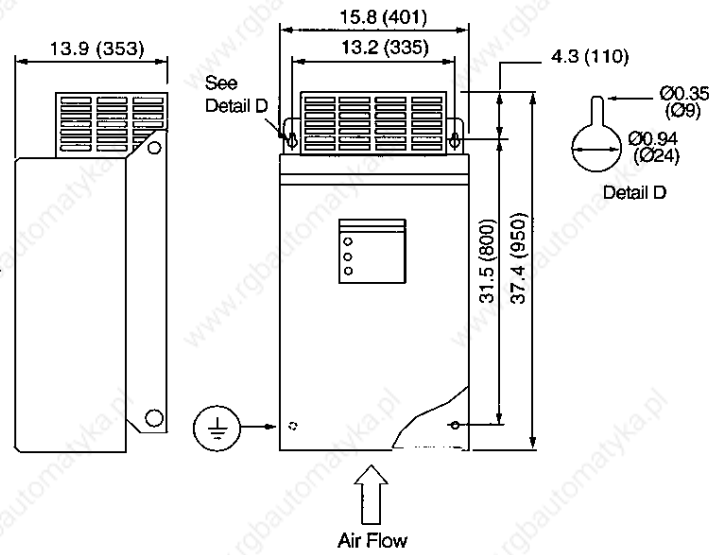


Figure 9 Dimensions: ATS23-C41 and C58

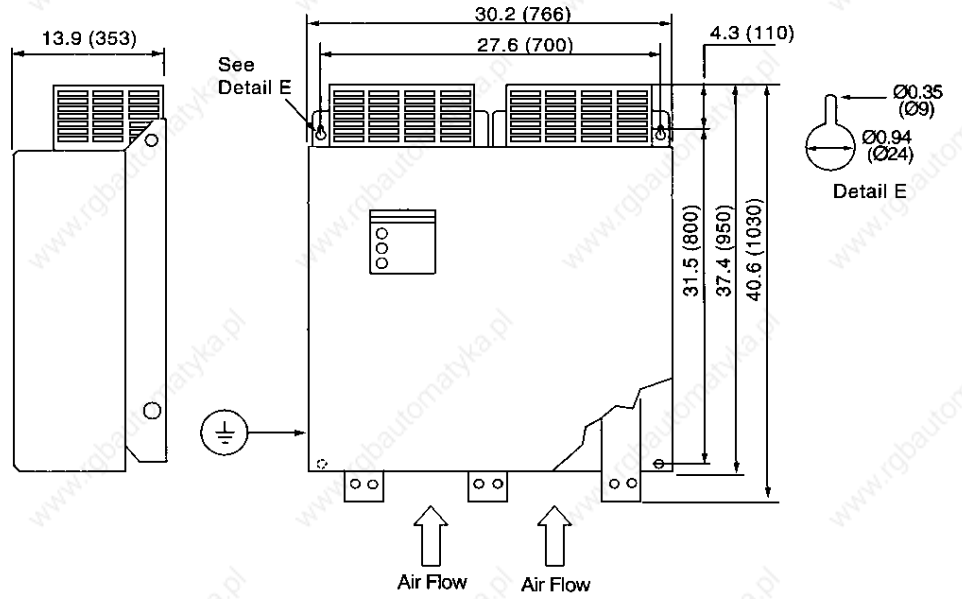


Figure 10 Dimensions: ATS23-C82 and M12

MOUNTING

Precautions

CAUTION

CONTROLLER OVERHEATING

Failure of the controller solid-state switches can cause single-phase operation of the motor.

- Mount the controller vertically.
- Do not locate the controller near heat radiating elements.
- Electrical current through the controller will result in heat losses that must be dissipated into the ambient air immediately surrounding the controller. To prevent thermal fault or equipment damage, provide sufficient enclosure cooling and/or ventilation to limit the ambient temperature around the controller.

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

**Minimum Enclosure Size
(Short Circuit Withstand)**

The ALTISTART 23 controller short circuit withstand rating has been established based upon a certain minimum enclosure size for each starter. When selecting an enclosure, this minimum size constraint should be observed. Table 4 lists the minimum enclosure dimensions for each starter. Minimum enclosure size to meet short circuit withstand ratings may not be sufficient for adequate heat dissipation; see "Thermal Considerations for Sizing Enclosures" on page 20.

**Table 4 Minimum Enclosure Dimensions to Meet Short Circuit Withstand Ratings
(Not Based on Thermal Considerations)**

Starter	Minimum Enclosure Dimensions (inches)		
	Height	Width	Depth
ATS23•U70	39	12.8	7.5
ATS23•D12	39	12.8	7.5
ATS23•D16	39	12.8	7.5
ATS23•D30	39	12.8	7.5
ATS23•D44	39	13.4	12.5
ATS23•D72	39	13.4	12.5
ATS23•C10	30.5	24.5	12.5
ATS23•C15	30.5	24.5	12.5
ATS23•C24	70	30	16
ATS23•C30	70	30	16
ATS23•C41	70	30	16
ATS23•C58	72	39	16
ATS23•C82	72	39	16
ATS23•M12	72	39	16

**Mounting in General Purpose
Metal Enclosure**

Degree of protection: NEMA Type 1 (IP23). To ensure adequate air flow inside the starter:

- Leave sufficient space around starter (see Figure 11): $A \geq 2$ in (50 mm), $B \geq 4$ in (100 mm).
- Provide ventilation.
- Check that ventilation is sufficient. If not, install a cooling fan with filters.

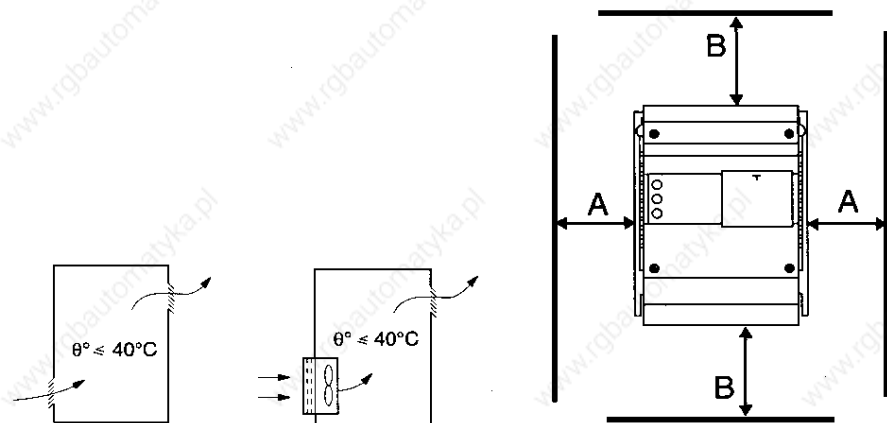


Figure 11 Ventilation and Clearances

Mounting in Dust and Damp-proof Metal Enclosure

Degree of protection: NEMA Type 12 (IP54). Provide a stirring fan to circulate air inside the enclosure and prevent hot spots in the starter. This allows operation of the starter in an enclosure with a maximum internal temperature of 140 °F (60 °C). Derate the starter current I_n by 1.2% per °C for temperatures above 40 °C or, where applicable, use a shorting contactor (duty cycle not to exceed 2 starts per hour). Do not use insulated or non-metallic enclosures as they have poor thermal conduction.

Locate the fan to ensure that ambient temperature around the controller is within the specifications.

To reduce temperature rise within the enclosure, use a shorting contactor (44 A units and higher). Use a heat exchanger when necessary to keep internal temperatures within specification.

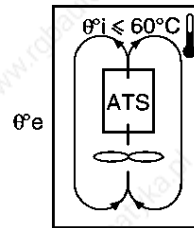


Figure 12 Ventilation for Dust and Damp-proof Enclosure

Thermal Considerations for Sizing Enclosures

When mounting the ALTISTART controller in an enclosure, use the enclosure manufacturers' recommendations for proper sizing based upon thermal considerations. For this, it is necessary to sum the power dissipated by each device within the enclosure. The steady state power dissipation for the ALTISTART may be selected from Table 5 or calculated with the following equation:

$$P^{[1]} = 3(I_{SCR}) + PC$$

I_{SCR} = Current through the SCR's
 PC = Watts dissipated by control and fans (Table 6)

[1] Multiply Watts by 3.41 to obtain BTU/Hr.

Table 5 Power Dissipated by Starter at Rated Current

ATS23•	U70N	D12N	D16N	D30N	D44N	D72N	C10N	C15N	C24N	C30N	C41N	C58N	C82N	M12N
P (W)	35	45	60	100	140	265	365	470	950	1130	1600	2100	3000	4200

Table 6 Power Dissipated by Control Circuitry and Cooling Fans

Control and Ventilation:	PC (W)
ATS23•U70 to D44	10 W
ATS23•D72 to C15	50 W
ATS23•C24 and C30	230 W
ATS23•C41 and C58	360 W
ATS23•C82 and M12	420 W

CABLING

Table 7 Cabling

ATS23*	Max Wire Size ^[2] AWG (Copper only)	Wire Temperature Range	Required Torque lb-in	Recommended Mounting Screw ^[1]
U70N	8	60/75 °C	15	N/A
D12N	8	60/75 °C	15	N/A
D16N	8	60/75 °C	15	N/A
D30N	8	60/75 °C	15	N/A
D44N	2/0	60/75 °C	50 ^[3]	N/A
D72N	2/0	60/75 °C	50 ^[3]	N/A
C10N	2/0	60/75 °C	50 ^[3]	N/A
C15N	2/0	75 °C	50 ^[3]	N/A
C24N	Bus bar	75 °C	500	1/2-13
C30N	Bus bar	75 °C	500	1/2-13
C41N	Bus bar	75 °C	500	1/2-13
C58N	Bus bar	75 °C	500	1/2-13
C82N	Bus bar	75 °C	500	1/2-13
M12N	Bus bar	75 °C	500	1/2-13

[1] Requires user-supplied lug and fastener.

[2] Maximum sizes for control wires are 14 AWG for C-230-380-460/500 and 18 AWG for connections 01 through 54.

[3] For units manufactured after June 1994 with hex-head screws. Units with flat-head screws are limited to 30 lb-in.

Adaptation To the Input Line

The control circuit is completely independent of the power circuit. To select control voltage, follow the instructions on the label located on the top of the starter:

- 208-240 V: move blue terminal cover from position 230 to position 460/500 V and connect single phase voltage supply to terminals C and 230.
- 380-415 V: move blue terminal cover from position 400 to position 460/500 V and connect single phase voltage supply to terminals C and 400.
- 440-500 V: check that exposed control terminals are marked C and 460/500 V. If not, move blue terminal cover from 460/500 V terminal and connect single phase voltage supply to terminals C and 460/500 V.

The power circuit adapts automatically to the input line voltage over a range of 208 to 500 volts (±10%) for standard controllers. The pump version controllers require setting of the voltage feedback selector switch (see "Voltage Feedback" on page 38).

Power Connections

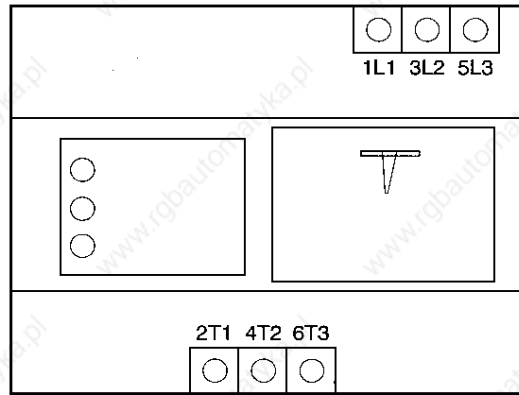


Figure 13 Power Connections: ATS23-U70 to D30

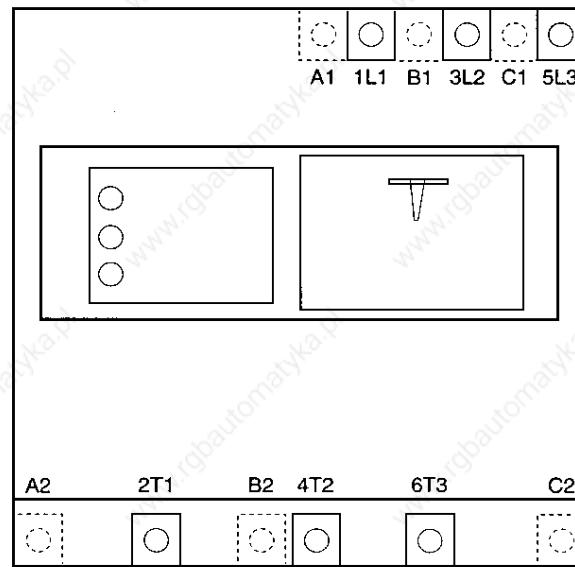


Figure 14 Power Connections: ATS23-D44 to C15

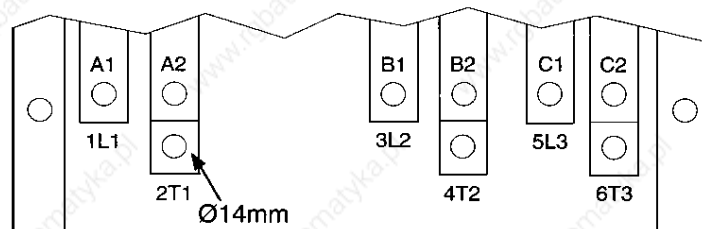


Figure 15 Bus Bar Power Connections: ATS23-C24 to C30

Bus Connection
Dimensions (inches)

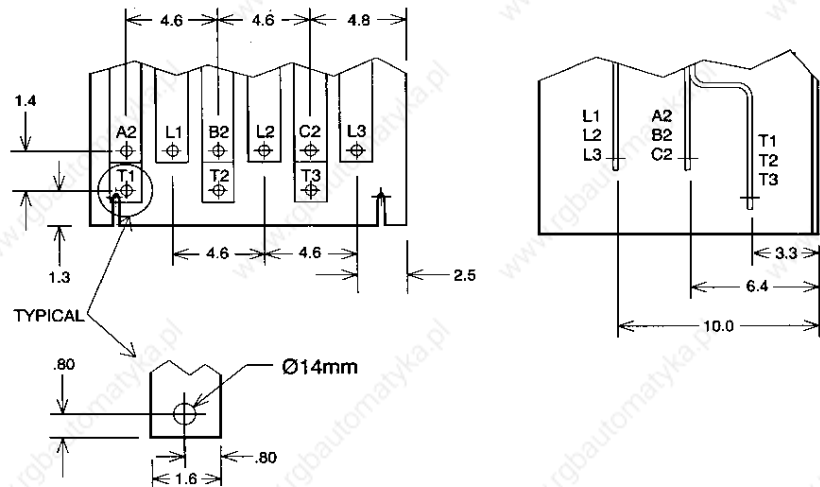


Figure 16 Bus Bar Power Connection Dimensions: ATS23-C41N to C58N

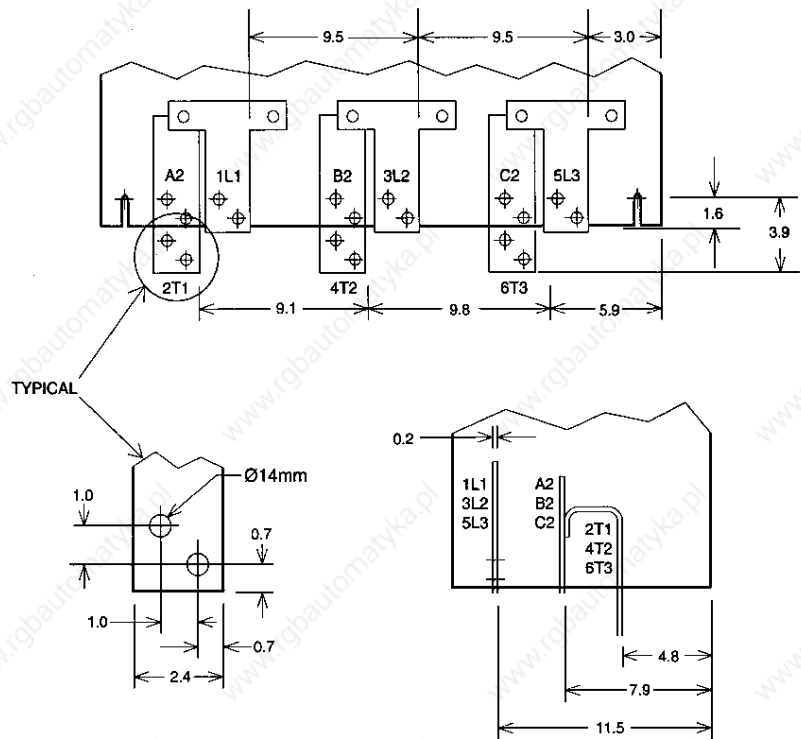


Figure 17 Bus Connection Dimensions: ATS23-C82N to M12

CONTROL CONNECTIONS

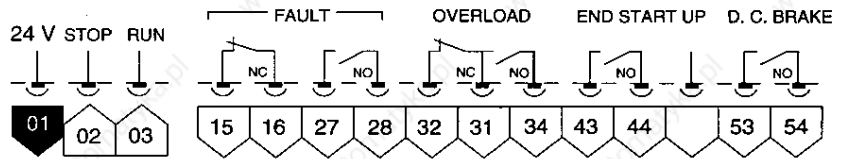


Figure 18 ATS-23 Standard Control Connections

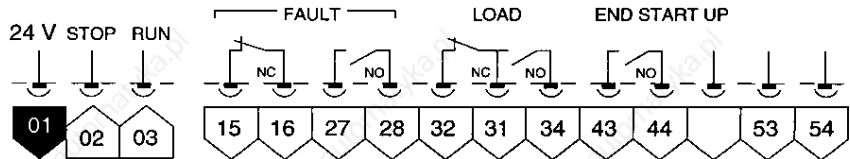


Figure 19 ATS-23P Pump Control Connections

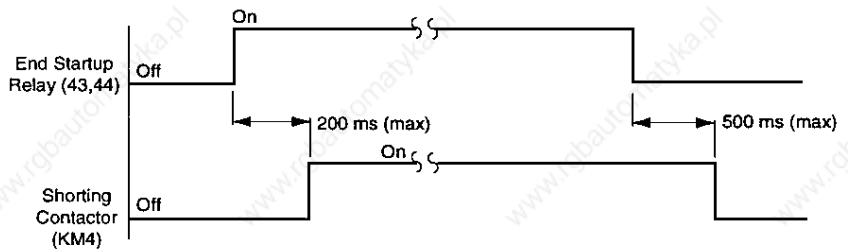


Figure 20 Shorting Contactor Timing Diagram

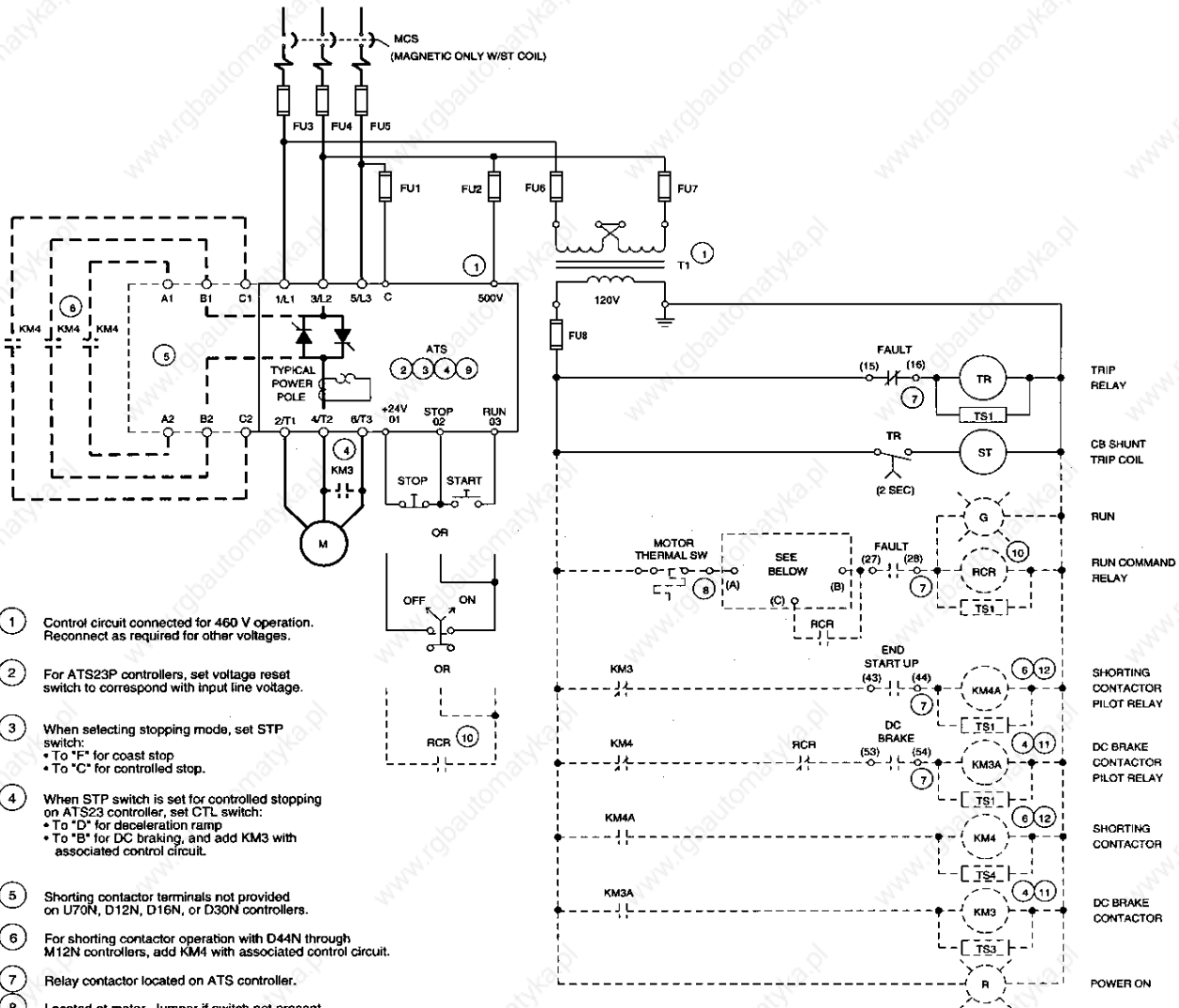
Table 8 Control Connections

ATS23•	Function	Type	Points		Description
All	24 V	Voltage	01		24 volt supply for use with run/stop logic only.
All	STOP	Input	02		Starter will allow motor to run only when this connection is made to point 01. Removal of connection will initiate a stop command. This input point overrides point 03.
All	RUN	Input	03		Controller will start motor when connection is made between this point and 01. This connection may be momentary.
All	FAULT	Relay output	16-15 27-28	N.C. ^[1] N.O. ^[1]	Upon application of control power to starter, this relay will energize when internal diagnostics show no problem with starter. Power need not be present at line terminals. Relay will de-energize if any of the faults described in Chapter 4 causes the red Fault LED to light. The Fault relay will remain energized upon a phase fault when the starter is configured for Auto restart with the Stop (02) and Run (03) inputs remaining energized during and after the fault.
Standard	OVERLOAD	Relay output	31-32 31-34	N.C. ^[1] N.O. ^[1]	Motor thermal pre-alarm. Relay will energize when motor temperature has been calculated to be above its rated thermal state, but not necessarily exceeding a level requiring shutting off (trip) of starter. Following a thermal fault trip, this relay will stay energized until motor is cool enough to restart.
All	END START-UP	Relay output	43-44	N.O. ^[1]	Relay contact will close when starter has completed the voltage ramp and the current draw by the motor is under 130% of motor's FLA (as set by potentiometer Ir). Contact is coordinated with the thyristors on stop command or fault condition. This relay is typically used to control a contactor that short-circuits the starter power devices, thus allowing cooler operation within the enclosure. Figure 20 on page 24 shows the timing diagram for this configuration. If a shorting contactor is not used, the status of this relay may be indeterminate following a phase failure fault.
Standard	DC BRAKE	Relay output	53-54	N.O. ^[1]	When controlled stopping by DC braking has been selected, relay closes upon a stop command after the End Start-up contact has opened. Relay opens when braking is complete as set by the DEC (Voltage Ramp Time on Deceleration) potentiometer (page 37). This relay is used to control the braking contactor shown in wiring diagrams.
Pump	LOAD	Relay output	31-32 31-34	N.C. ^[1] N.O. ^[1]	Relay operates identical to Overload relay of the standard controller or can be configured to identify a low load condition that may be associated with a pump that has lost suction.

^[1] State of relay contact with all power removed from product.

CIRCUIT DIAGRAMS

Figures 21, 22 (page 27), and 23 (page 28) are recommended circuit diagrams for general application. Refer to Table 9 on page 29 for description of logic.



- 1 Control circuit connected for 460 V operation. Reconnect as required for other voltages.
- 2 For ATS23P controllers, set voltage reset switch to correspond with input line voltage.
- 3 When selecting stopping mode, set STP switch:
 - To "F" for coast stop
 - To "C" for controlled stop.
- 4 When STP switch is set for controlled stopping on ATS23 controller, set CTL switch:
 - To "D" for deceleration ramp
 - To "B" for DC braking, and add KM3 with associated control circuit.
- 5 Shorting contactor terminals not provided on U70N, D12N, D16N, or D30N controllers.
- 6 For shorting contactor operation with D44N through M12N controllers, add KM4 with associated control circuit.
- 7 Relay contactor located on ATS controller.
- 8 Located at motor. Jumper if switch not present.
- 9 Set RET switch to "M".
- 10 Use RCR switch logic for ATS 2-wire or 3-wire control when using shorting contactor or DC braking.
- 11 For U70 through C30 controllers using DC braking, pilot relay KM3A is not required. Substitute coil of KM3 contactor in place of KM3A pilot relay.
- 12 For D44 through C10 controllers using a shorting contactor, pilot relay KM4A is not required. Substitute coil of KM4 contactor in place of KM4A pilot relay.

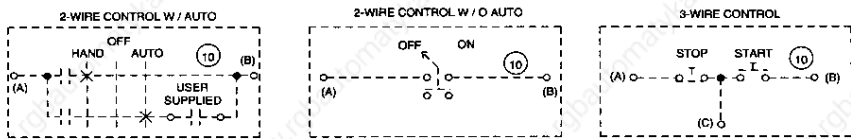
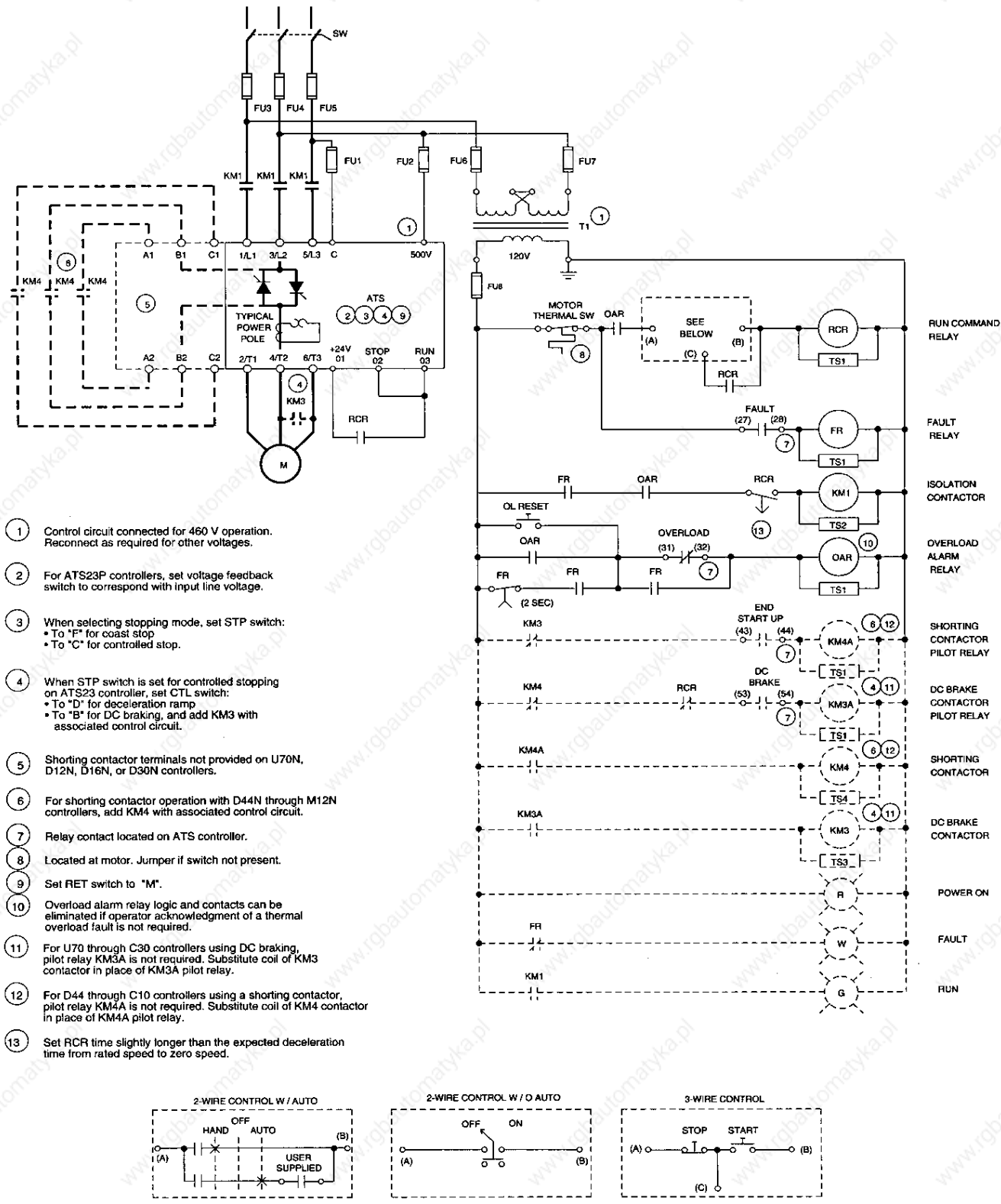
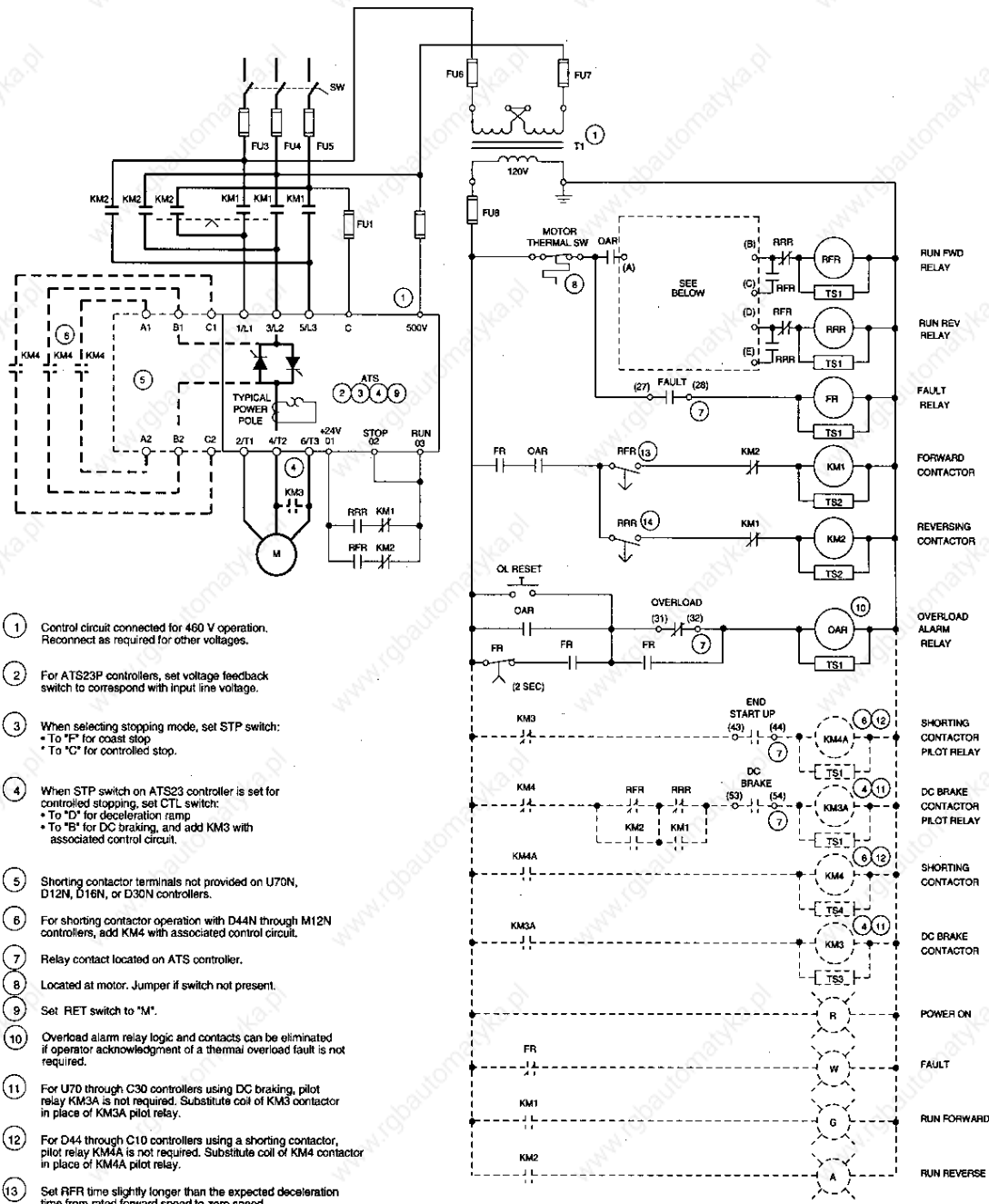


Figure 21 Nonreversing, Shunt Trip Circuit Breaker



- 1 Control circuit connected for 460 V operation. Reconnect as required for other voltages.
- 2 For ATS23P controllers, set voltage feedback switch to correspond with input line voltage.
- 3 When selecting stopping mode, set STP switch:
 - To "F" for coast stop
 - To "C" for controlled stop.
- 4 When STP switch is set for controlled stopping on ATS23 controller, set CTL switch:
 - To "D" for deceleration ramp
 - To "B" for DC braking, and add KM3 with associated control circuit.
- 5 Shorting contactor terminals not provided on U70N, D12N, D16N, or D30N controllers.
- 6 For shorting contactor operation with D44N through M12N controllers, add KM4 with associated control circuit.
- 7 Relay contact located on ATS controller.
- 8 Located at motor. Jumper if switch not present.
- 9 Set RET switch to "M".
- 10 Overload alarm relay logic and contacts can be eliminated if operator acknowledgment of a thermal overload fault is not required.
- 11 For U70 through C30 controllers using DC braking, pilot relay KM3A is not required. Substitute coil of KM3 contactor in place of KM3A pilot relay.
- 12 For D44 through C10 controllers using a shorting contactor, pilot relay KM4A is not required. Substitute coil of KM4 contactor in place of KM4A pilot relay.
- 13 Set RCR time slightly longer than the expected deceleration time from rated speed to zero speed.

Figure 22 Nonreversing with Isolation Contactor



- 1 Control circuit connected for 460 V operation. Reconnect as required for other voltages.
- 2 For ATS23P controllers, set voltage feedback switch to correspond with input line voltage.
- 3 When selecting stopping mode, set STP switch:
 * To "F" for coast stop
 * To "C" for controlled stop.
- 4 When STP switch on ATS23 controller is set for controlled stopping, set CTL switch:
 * To "D" for deceleration ramp
 * To "B" for DC braking, and add KM3 with associated control circuit.
- 5 Shorting contactor terminals not provided on U70N, D12N, D16N, or D30N controllers.
- 6 For shorting contactor operation with D44N through M12N controllers, add KM4 with associated control circuit.
- 7 Relay contact located on ATS controller.
- 8 Located at motor. Jumper if switch not present.
- 9 Set RET switch to "M".
- 10 Overload alarm relay logic and contacts can be eliminated if operator acknowledgment of a thermal overload fault is not required.
- 11 For U70 through C30 controllers using DC braking, pilot relay KM3A is not required. Substitute coil of KM3 contactor in place of KM3A pilot relay.
- 12 For D44 through C10 controllers using a shorting contactor, pilot relay KM4A is not required. Substitute coil of KM4 contactor in place of KM4A pilot relay.
- 13 Set RFR time slightly longer than the expected deceleration time from rated forward speed to zero speed.
- 14 Set RRR time slightly longer than the expected deceleration time from rated reverse speed to zero speed.
- 15 Remove these contacts to inhibit direction reversal without first depressing STOP pushbutton.

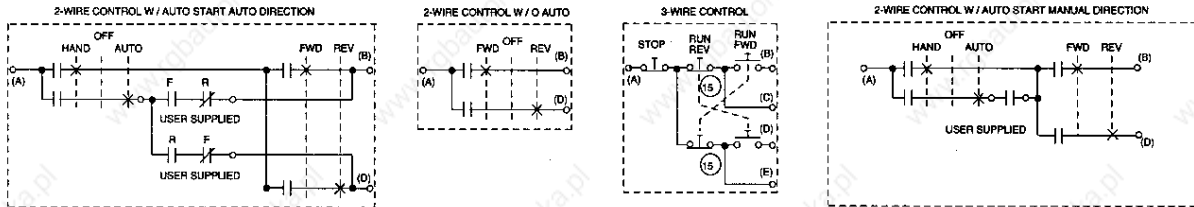


Figure 23 Reversing with Isolation Contactors

Table 9 Description of Logic for Recommended Circuit Diagrams

Item	Name	Description
FR	Fault Relay	Used with logic diagrams that use an isolation contactor. The fault relay is energized during normal operation and de-energizes if the starter Fault contacts open or if the motor thermal switch (if supplied) opens. FR also provides additional contacts for the starter fault output.
KM1	Isolation Contactor (Forward)	The isolation contactor logic closes KM1 upon a start command and opens KM1 after the stop is complete. The RCR (or RFR and RRR for reversing) are timed contacts that must have a time delay greater than the deceleration ramp time or the DC injection time. When a coast stop is selected, the time delay must be set for a time that will allow a complete decay of the motor residual voltage. The isolation contactor will open immediately upon a fault.
KM2	Isolation Contactor (Reverse)	Used for reversing applications only, the KM2 must be mechanically interlocked to KM1. A reversing contactor may be used for the combination of KM1 and KM2. In general, the operation of KM2 is identical to KM1.
KM3 KM3A	DC Brake Contactor & Pilot Relay	The braking contactor is used to maximize the braking effect when the DC injection stop feature is selected. The starter provides the proper sequencing of the contactor by the "DC Brake" relay. The DC brake contactor is interlocked with KM4 contactor and RCR (RFR and RRR for reversing) to prevent a phase to phase short circuit. The pilot relay (KM3A) is required when the KM3 contactor coil exceeds the relay rating.
KM4 KM4A	Shorting Contactor & Pilot Relay	The shorting contactor is used to reduce the heat dissipated by the controller when the motor is operating at full speed and voltage. The starter provides proper sequencing of this contactor by the "end-start-up" relay. When the start is completed, the shorting contactor will be commanded to close. The starter will continue to monitor the motor thermal state and provide motor overload protection. Upon a stop command, the KM4 contactor will open, transferring the motor current to the SCRs to allow for controlled deceleration if desired (refer to Figure 20 on page 24). The shorting contactor is electrically interlocked with KM3 contactor to prevent a phase to phase short circuit. The pilot relay (KM4A) is required when the KM4 contactor coil exceeds the relay rating.
OAR	Overload Alarm Relay	Used with logic diagrams that incorporate an isolation contactor. This relay identifies that the fault condition is due to a motor thermal overload. Operator acknowledgment (reset) is required after the motor has cooled thereby emulating the overload relay operation of an electromechanical starter. Provided that the motor has cooled, the OAR circuit can also be reset by removing and then reapplying control power to the relay logic.
RCR	Run Command Relay	Used in all non-reversing logic (optional in shunt trip) for proper sequencing of contactor logic. When energized, RCR initiates the start sequence. When de-energized, stopping is initiated. Operator controls can be either on/off selector switch, HOA selector switch or start/stop push buttons. RCR remains energized during a fault. Once the fault condition has been cleared, RCR must be de-energized by a "stop" command then re-energized to restart the controller.
RFR	Run Forward Relay	Used for reversing applications only, this coil duplicates the functionality of RCR for the forward direction and is interlocked with the RFR relay.
RRR	Run Reverse Relay	Used for reversing applications only, this coil duplicates the functionality of RCR for the reverse direction and is interlocked with the RRR relay.
ST	Shunt Trip Coil	This coil is attached to the shunt trip circuit breaker (CB) and will energize 2 seconds after a starter fault by the TR timer contact. The time delay is to prevent nuisance tripping of the circuit breaker during controller power-up or during line undervoltage conditions.
TR	Trip Relay	Used in shunt trip circuit breaker logic only; coil energized upon a starter fault.
TS	Transient Suppressors	Transient suppression of all relay and contactor coils (except ST) is recommended to minimize the possibility of electrical interference with the starter electronics and to increase relay contact life.

Table 10 Component List For Recommended Circuit Diagrams^[1]

Item	Description	Item Part Number					
M	Induction Motor: (Note 1) Hp at 460V Hp at 230V Rated I 460/230V	5 hp 2 hp 7.6A/6.8A	7.5 hp 3 hp 9.6A/11A	10 hp 5 hp 12A/15.2A	20 hp 10 hp 27A/28A	30 hp 15 hp 40A/42A	50 hp 25 hp 65A/68A
ATS	ALTI/START 23: (Note 2) Standard 460/230V Pump 460/230V Rated Current (In) Control Power Burden	ATS23U70N ATS23PU70N 7.6/7A @ 40°C amb 10VA	ATS23D12N ATS23PD12N 12A @ 40°C amb 10VA	ATS23D16N ATS23PD16N 16A @ 40°C amb 10VA	ATS23D30N ATS23PD30N 30A @ 40°C amb 10VA	ATS23D44N ATS23PD44N 44A @ 40°C amb 10VA	ATS23D72N ATS23PD72N 72A @ 40°C amb 50VA
FU1 FU2	ATS Control Fuses: 460V 230V Fuse Holders: 460V/230V	Bussmann FNQR 1/4 Bussmann FNQR 1/4 9080, FB2611CC	Bussmann FNQR 1/4 Bussmann FNQR 1/4 9080, FB2611CC	Bussmann FNQR 1/4 Bussmann FNQR 1/4 9080, FB2611CC	Bussmann FNQR 1/4 Bussmann FNQR 1/4 9080, FB2611CC	Bussmann FNQR 1/4 Bussmann FNQR 1/4 9080, FB2611CC	Bussmann FNQR 1/4 Bussmann FNQR 1/2 9080, FB2611CC
MCS/SW ST	Molded Case Switch (Note 3) Suffix for 120V Shunt Trip Coil	FHL36000M 1021	FHL36000M 1021	FHL36000M 1021	FHL36000M 1021	FHL36000M 1021	FHL36000M 1021
FU3 FU4 FU5	Power Fuse (Note 4): Fuse Class (Vendor) Max. Fuse Rating (Part #) Fuse Holders (Note 5):	RK5 9 A 9080, FB3611R	RK5 15 A 9080, FB3611R	RK5 20 A 9080, FB3611R	RK5 40 A 9080, FB3621R	RK5 60 A 9080, FB3621R	RK5 90 A 9080, FB3631R
KM1 TS2	Isolation Contactor w/Control Contacts (Note 6,11) Transient Suppressor (1 per coil)	LC1-D1210G6 LA4-DA2G	LC1-D1210G6 LA4-DA2G	LC1-D1210G6 LA4-DA2G	LC1-D3210G6 LA4-DA2G	LC1-D4011G6 LA4-DA2G	LC1-D6511G6 LA4-DA2G
KM2	Reversing contactor (Note 6,11) Mechanical Interlock	Note 12	Note 12	Note 12	Note 12	Note 12	Note 12
KM3 TS3	DC Brake Contactor (Notes 6, 7, 10): Transient Suppressor	LC1 D12004G6 LA4 DA2G	LC1 D12004G6 LA4 DA2G	LC1 D12004G6 LA4 DA2G	LC1 D12004G6 LA4 DA2G	LC1 D12004G6 LA4 DA2G	LC1 D12004G6 LA4 DA2G
KM4 TS4	Shorting Contactor (Notes 6, 10): Transient Suppressor	N/A N/A	N/A N/A	N/A N/A	N/A N/A	LC1 D4011G6 LA4 DA2G	LC1 D6511G6 LA4 DA2G
T1	Control Transformer (Note 8) Shunt Trip Configuration: Without KM3 or KM4 With KM3 only Other shown configurations	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1
FU6 FU7 (Note 9)	Primary Fusing @ 460 V Shunt Trip Configuration: Without KM3 or KM4 With KM3 only Other shown configurations	Bussmann FNQR 1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/4	Bussmann FNQR 1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/4	Bussmann FNQR 1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/4	Bussmann FNQR 1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/4	Bussmann FNQR 1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/2	Bussmann FNQR-1/4 Bussmann FNQR 1/4 Bussmann FNQR 1/2
FU8 (Note 9)	Secondary Fusing @ 120 V Shunt Trip Configuration: Without KM3 or KM4 With KM3 only Other shown configurations	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1/2	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1/2	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1/2	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1/2	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1.0	Bussmann FNQR 1/2 Bussmann FNQR 1/2 Bussmann FNQR 1.0

^[1] Refer to page 32 for notes to table. Refer to pages 26-28 for Recommended Circuit Diagrams.

Table 11 Control Relays (FR, TR, RCR, OAR, RFR, RRR, KM3A and KM4A) and Auxiliary Contacts for KM1, KM2, KM3 and KM4

Composition	Control Relay Catalog Number	Suppressor Catalog Number	Auxiliary Contact Catalog Number
4 NO	CA2-DN40G6	LA4-DA2G	LA1-DN40
3 NO, 1 NC	CA2-DN31G6	LA4-DA2G	LA1-DN31
2 NO, 2NC	CA2-DN22G6	LA4-DA2G	LA1-DN22

Item Part Number							
75 hp	100 hp	200 hp	250 hp	350 hp	500 hp	700 hp	1000 hp
40 hp	50 hp	100 hp	125 hp	150 hp	250 hp	350 hp	500 hp
96A/104A	124A/130A	240A/248A	302A/312A	414A/360A	590A/600A	840A/840A	1200A/1200A
ATS23C10N	ATS23C15N	ATS23C24N	ATS23C30N	ATS23C41N	ATS23C58N	ATS23C82N	ATS23M12N
ATS23PC10N	ATS23PC15N	ATS23PC24N	ATS23PC30N	ATS23PC41N	ATS23PC58N	ATS23PC82N	ATS23PM12N
105A @ 40°C amb	150A @ 40°C amb	248A @ 40°C amb	312A @ 40°C amb	415A @ 40°C amb	602A @ 40°C amb	840A @ 40°C amb	1200A @ 40°C amb
50VA	50VA	230VA	230VA	360VA	360VA	540VA	540VA
Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 0.8	Bussmann FNQR 0.8	Bussmann FNQR 1.0	Bussmann FNQR 1.0	Bussmann FNQR 1.5	Bussmann FNQR 1.5
Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1.6	Bussmann FNQR 1.6	Bussmann FNQR 2.0	Bussmann FNQR 2.0	Bussmann FNQR 3.0	Bussmann FNQR 3.0
9080, FB2611CC	9080, FB2611CC	9080, FB2611CC	9080, FB2611CC	9080, FB2611CC	9080, FB2611CC	9080, FB2611CC	9080, FB2611CC
KHL36000M	KHL36000M	LHL36000M	LHL36000M	MHL360006M	MHL360008M	MHL36000M	NCL3600012M
1021	1021	1021	1021	1021	1021	1021	1021
RK5	RK5	RK5	RK5	RK5	L	(Gould Shawmut)	(Gould Shawmut)
125 A	175 A	350 A	400 A	500 A	800 A	(A4BY 1100)	(A4BY 1600)
Marathon	Marathon	Marathon	Marathon	Marathon			
6R200A3BE	6R200A3BE	6R400A3B	6R400A3B	6R600A3B			
LC1-D8011G6	LC1-F150K	LC1-F265F	LC1-F330F	LC1-F400F	LC1-F500F	LC1-F780F	LC1-BM33F22
LA4-DA2G	LA9-F980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980
Note 12	LC1-F150K	LC1-F265F	LC1-F330F	LC1-F400F	LC1-F500F	LC1-F780F	LC1-BM33F22
	LA9FJ970	LA9FJ970	LA9FJ970	LA9FJ970	LA9FJ970	LA9FJ970	EZ2-LB0601
LC1 D25004G6	LC1 D25004G6	LC1 D40004G6	LC1 D40004G6	LC1 F150K	LC1 F150K	LC1 F150K	LC1 F185K
LA4 DA2G	LA4 DA2G	LA4 DA2G	LA4 DA2G	LA9 F980	LA9 F980	LA9 F980	LA9 F980
LC1 D8011G6	LC1-F150K	LC1 F265F	LC1 F330F	LC1 F400F	LC1 F500F	LC1 F630F	LC1 F780F
LA4 DA2G	LA9 F980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980	LA9 D09980
9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1	9070, KF50D1
9070, KF50D1	9070, KF50D1	9070, KF100D1	9070, KF100D1	9070, KF200D1	9070, KF200D1	9070, KF200D1	9070, KF500D1
9070, KF100D1	9070, KF350D1	9070, KF350D1	9070, KF350D1	9070, KF350D1	9070, KF350D1	9070, KF750D1	9070, KF750D1
Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/4
Bussmann FNQR 1/4	Bussmann FNQR 1/4	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1-1/4	Bussmann FNQR 1-1/4	Bussmann FNQR 1-1/4	Bussmann FNQR 2.8
Bussmann FNQR 1/2	Bussmann FNQR 1.6	Bussmann FNQR 1.6	Bussmann FNQR 1.6	Bussmann FNQR 1.6	Bussmann FNQR 1.6	Bussmann FNQR 4.0	Bussmann FNQR 4.0
Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2
Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1 -1/4	Bussmann FNQR 1-1/4	Bussmann FNQR 2-1/4	Bussmann FNQR 2-1/4	Bussmann FNQR 2-1/4	Bussmann FNQR 5.0
Bussmann FNQR 1 -1/4	Bussmann FNQR 4.0	Bussmann FNQR 4.0	Bussmann FNQR 4.0	Bussmann FNQR 4.0	Bussmann FNQR 4.0	Bussmann FNQR 7.5	Bussmann FNQR 7.5
Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 1/2
Bussmann FNQR 1/2	Bussmann FNQR 1/2	Bussmann FNQR 3/4	Bussmann FNQR 1.0	Bussmann FNQR 1.8	Bussmann FNQR 1.8	Bussmann FNQR 1.8	Bussmann FNQR 5.0
Bussmann FNQR 1.0	Bussmann FNQR 3.5	Bussmann FNQR 3.5	Bussmann FNQR 3.5	Bussmann FNQR 3.5	Bussmann FNQR 3.5	Bussmann FNQR 7.5	Bussmann FNQR 7.5

Table 12 Time Delay Contacts for Control Relays

Item	Composition	Catalog Number
FR	1 NCTO (2 s)	LA2-DT0
TR	1 NOTC (2 s)	LA2 -DT0
RCR	1 NOTO (10-180 s)	LA3-DR4
RFR	1 NOTO (10-180 s)	LA3-DR4
RRR	1 NOTO (10-180 s)	LA3-DR4

NOTES TO COMPONENT LIST

Tables 10, 11, and 12 on pages 30-31 are suggested parts lists for the ALTISTART 23 controllers. To select control operators (push buttons, pilot lamps, and selector switches) and wire management devices (control and power terminal strips, wire terminations) indicated on the referenced control circuit configurations, refer to the latest editions of Square D's full line product catalogs.

1. Motor full load currents through 500 hp @ 460 V and 250 hp @ 230 V are taken from UL508 Table 54.2 (NFPA 70, Table 430-150). Above 500 hp @ 460 V and 250 hp @ 230 V, motor full load currents are calculated based upon 1.2 A/hp for 460 V and 2.4 A/hp for 230 V.
2. The ambient temperature indicated in the table represents the temperature of the air surrounding the ALTISTART controller. Any additional temperature factors associated with the enclosure system or actual installation ambient temperature must be considered when determining the actual rated current (I_n) of the starter. For operating ambients above 40 °C but not exceeding 60 °C, the rated current (I_n) of the starter must be derated by 1.2% per °C.
3. The circuit breakers selected require the addition of operator mechanisms to allow operation of the circuit breaker from the exterior of an enclosure. Refer to the latest editions of Square D's full line product catalogs for operator mechanism information. Order circuit breaker (CB) with shunt trip coil as a suffix.
4. The fuses listed in the Table 10 provide Type 1 protection to the starter and auxiliary power equipment when the power source short circuit current capability is less than or equal to the values listed in Table 2 on page 4.
5. Fuse holders listed are for Class R fuses only. Class L fuses require bolt-on connections to user-supplied power bus work.
6. All coils are selected for 120 V, 60 Hz operation. Refer to Table 10 for auxiliary contacts. One block may be added to each contactor.
7. When using the contactors referenced in the component list for the DC braking contactor function, connect all the power poles in parallel.
8. Control circuit transformer continuous and inrush burden ratings have been selected to maintain the control circuit voltage within the range of allowable pick-up voltages for the specified contactors and relays (input mains voltage at 460 V -10% or 230 V -10% respectively) when connected per the referenced control circuit configuration.
9. Control circuit primary and secondary fusing selected to meet or exceed the requirements of NFPA 70-1993 section 430 and UL508 for control transformer overcurrent and overload protection. Time delay characteristics of the fuses has been selected to allow for expected transformer and contactor inrush currents.
10. Power terminals are not included with LC1-F or LC1-B contactors. Refer to the latest editions of Square D's full line product catalogs.
11. Reversing contactors for C15 through M12 controllers must be assembled from components. Parts quantities for a basic contactor assembly, minus the power connection links and terminals, are indicated before each part number. Refer to the latest editions of Square D's full line product catalogs for power connector link and terminal kits. Reversing contactor interlock units used for the C82 through M12 controllers are designed for vertical interlocking of the individual contactors. Horizontally interlocked contactors are used for U70 through C58 controllers.
12. The "D" Line Contactor is available as a reversing configuration. For these applications, change the KM1 part number prefix from LC1- to LC2- to order the KM1 and KM2 combination complete with mechanical interlocks.

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ADJUSTABLE PARAMETERS

Setting Configuration Switches

ALTISTART controllers have several adjustable functions accessible through configuration switches and potentiometers. The ranges, factory preset conditions and methods of adjustment are covered in the following sections.

ATS-23

ATS-23 (standard) and ATS-23P (pump version) starters have four configuration switches for adjustment of the following parameters:

- Manual or automatic reset (RET)
- Freewheel or controlled stopping (STP)
- Ramp or brake-controlled stopping (CTL)
- Overtorque on starting (BST)

ATS-23P



- Manual or automatic reset (RET)
- Freewheel or controlled stopping (STP)
- Short or long ramp (RAMP)
- Overload pre-alarm or underload detection (SC)

ATS-23 and ATS-23P

To access the configuration switches, open the hinged cover on the adjustment compartment of the starter (see Figure 24 on page 36). Set the switches according to the type of operation required. The parameters are defined below and their settings are explained in Table 13 on page 35.

- RET: determines how starter will restart motor after a fault condition has been cleared.
- STP: configures starter for freewheel (coast-to-rest) or controlled stopping.
- CTL: selects method of controlled stopping.
- BST: configures initial voltage supplied to motor (Figure 29 on page 39).
- RAMP: selects range of deceleration.
- SC: configures operation of output relay "LOAD" on front of starter.

Table 13 Configuration Switch Settings

	Switch	Position	Mode of Operation
ATS-23/23P	RET	M: Manual reset ^[1] A: Automatic reset	Requires operator reset of fault following thermal or phase fault. <ul style="list-style-type: none"> • Upon a fault, the Fault relay trips (de-energizes) and contact terminal 27-28 open. • When fault disappears, cycling of the start command on terminal 03 is required to reset the Fault and restart. Allows for automatic restarting of the motor following a thermal or phase fault. Use only with two-wire logic between terminals 01 and 02/03. <ul style="list-style-type: none"> • Fault relay trips on a thermal fault. When the motor has cooled, the fault relay will reset and the controller will restart if the run command is maintained. • Fault relay remains energized on a phase fault if the run command is maintained. When the fault has disappeared, the controller will restart.
	STP	F: Freewheel stop ^[1] C: Controlled stop	Stop command places starter in ready mode. The time it takes for motor to stop depends on inertia of machine and resistive torque. Stop command does not immediately stop controller. Stopping of motor is controlled by starter according to position of CTL (ATS-23) or RAMP (ATS-23P) switch.
ATS-23	CTL	D: Deceleration on ramp ^[1] B: DC injection braking	The time it takes for motor to decelerate to stop depends on ramp time set by DEC potentiometer (1-60s) and load conditions (inertia and resistive torque). Use this mode when deceleration time must be greater than coast (freewheel) time. When stopping motor by DC braking, injection time depends on position of DEC potentiometer (see page 41). Use this mode when braking time must be less than coast (freewheel) time. Selection of DC injection braking requires a contactor connected to T2 and T3 of starter output (see circuit diagrams on page 26 to page 28).
	BST	0: Booster not operating ^[1] 1: Booster operating	No booster on start up. Start up with booster. Full voltage is applied to motor for 5 cycles to obtain the maximum available torque if dry friction or mechanical stiffness are encountered. Following the 5 cycles of full voltage, a current limit start will complete the ramp.
ATS-23P	RAMP	 Long ramp ^[1]  Short ramp	Stopping time of motor by deceleration depends on ramp time set by the DEC potentiometer multiplied by 2 (2-120s) and the load conditions of the pump. Deceleration is controlled by motor voltage regulation in a closed loop. Deceleration time is greater than coast time. The DEC potentiometer is not linear; therefore, the intermediate unmarked graduations do not correspond exactly to relative positions. Stopping operation is identical to the long ramp, but the adjustment range on the DEC potentiometer is 1-60s.
	SC	0: Overload detection ^[1] 1: Underload detection	Overload pre-alarm function of Output relay is retained and is identical to that of standard (ATS-23) starters. That is, relay closes (contact at terminals 31-34) if motor exceeds its rated temperature rise threshold. The Load Output relay function is reassigned to detect a low current condition typically associated with a "loss of suction" condition on pumps, meaning that pump is running dry. Since operating current of the motor driving a pump is 80 to 100% of motor rated current (I _r), the Load relay is de-energized (terminals 31-34 open) when ramp is complete and current is above 0.75 I _r . If current falls below 0.6 I _r , the relay energizes indicating motor underload. Thermal overload protection is not affected by this selection other than the reassignment of the Output relay. Pre-alarm is still indicated by flashing yellow Alarm LED.
^[1] Factory setting for non-enclosed devices.			

Setting the Potentiometers

Four potentiometers (five on the ATS-23P starters) allow for the adjustment of:

- Motor rated current (Ir)
- Starting current limitation (ILT)
- Voltage ramp time on acceleration (ACC)
- Voltage ramp time on deceleration (DEC)
- Voltage drop (ATS-23P starters only)

In addition, the ATS-23P starters have a rotary switch for configuration of voltage feedback. To access the potentiometers, open hinged cover on adjustment compartment of starter. The fifth potentiometer on the ATS-23P starters is accessed by removing the label plate from the adjustment compartment. The following paragraph explains potentiometer settings.

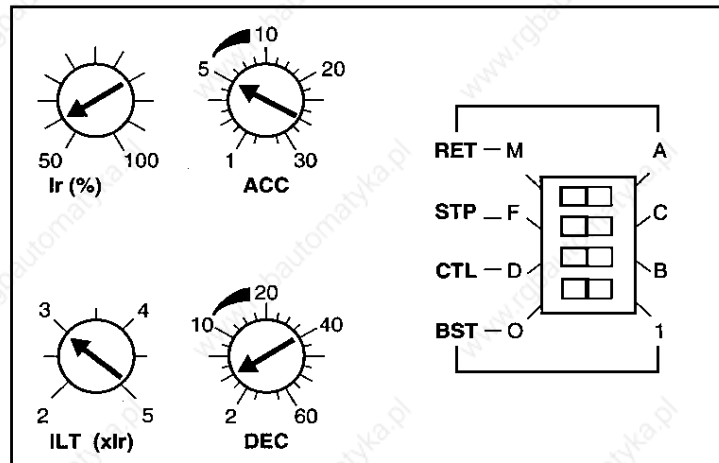


Figure 24 Potentiometers and Configuration Switches: ATS-23

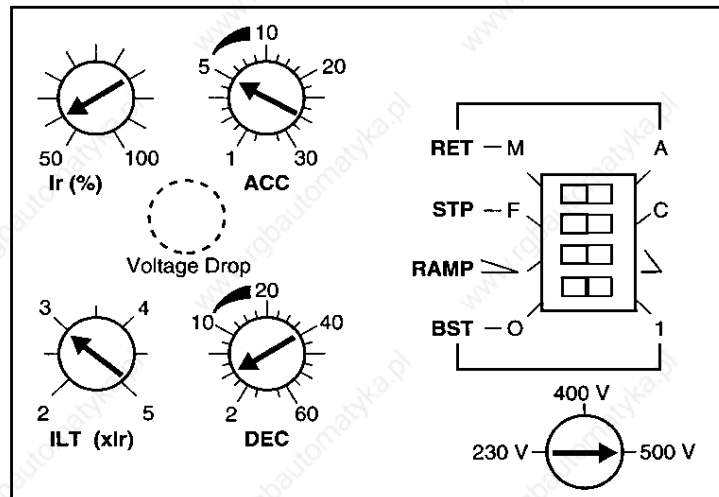



Figure 25 Potentiometers and Configuration Switches: ATS-23P

Motor Rated Current (Ir)	Ir sets motor rated current in percentages of the starter's rated current. Adjustable on both ATS-23 and ATS-23P starters, the allowable range is 50 to 100%. The parameter is factory set to its minimum value, and should be adjusted to correspond to the FLA indicated on the motor rating plate. The Ir setting determines built-in thermal protection and adjustment range of the ILT potentiometer. For example, given an ATS23D72N and 50 hp motor combination with 480 V mains supply, the starter is rated at 72 A, and if motor FLA is 60 A, Ir should be set to 83%.
Starting Current Limitation (ILT)	ILT sets starting current limitation as a multiple of motor operating current (Ir). This parameter is adjustable on both ATS-23 and ATS-23P starters. The allowable range is 2 to 5 for the ATS-23 and 2 to 4 for the ATS-23P, factory set to 3 (i.e., 3 x Ir). Set ILT to the level necessary for obtaining the required starting torque.
Voltage Ramp Time on Acceleration (ACC)	ACC sets voltage ramp time on acceleration. Adjustable on both ATS-23 and ATS-23P starters, the allowable range is 1-30 s. The parameter is factory set to 5 s and should be adjusted to the starting time required by the application. <i>Note: The graduations of the ACC potentiometers are given as indications and correspond to the setting of the ramp times in seconds. The actual acceleration times may be different since they depend on load conditions, such as inertia and resistive torque.</i>
Voltage Ramp Time on Deceleration (DEC)	DEC sets voltage ramp time on deceleration. The parameter is adjustable for both ATS-23 and ATS-23P starters. For this adjustment to be active, switch STP must be in position "C."
ATS-23	On ATS-23 (standard) starters, DEC sets voltage ramp time on deceleration if the CTL configuration switch is in position "D." If the CTL configuration switch is in position "B," DEC sets DC injection time. The allowable range is 2-60 s and the parameter is factory set to 10 s.
ATS-23P	On ATS-23P (pump) starters, DEC sets only deceleration ramp time. The factory setting of the potentiometer is 10 and the RAMP switch is set for long ramp (). The optimum setting of DEC is the shortest ramp that does not result in hydraulic shock of the pumping system (water hammer, pressure surge, etc.). Since hydraulic shock is a property of the piping system, the optimum setting of DEC is a function of the installation. When controlled deceleration is selected, adjust the DEC potentiometer between 20 and 40. If a controlled stop results in hydraulic shock, increase the deceleration time until the condition disappears. If shock is controlled on the first attempt, try lower time settings until the optimum setting is achieved. Verify that the selected deceleration time achieves the desired hydraulic performance under all operating conditions of the pumping system.

Voltage Drop

On ATS-23P starters, a fifth potentiometer located in the center of the adjustment compartment adjusts voltage drop ΔV at the starter output as soon as a stop command is initiated. The initial voltage drop may be adjusted from 5% to 25% line voltage. Factory setting is for the minimum value (Full CCW). The voltage drop for a 480 V supply, for example, is 24 V.

The initial voltage drop affects the speed at which deceleration control begins. If the check valve does not close until the motor speed has dropped significantly, the initial voltage drop may be increased to reduce the total deceleration ramp time. This potentiometer should not require adjustment for most applications.

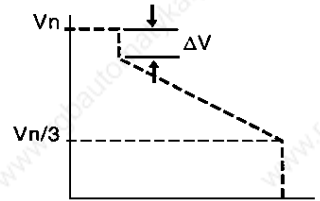


Figure 26 Voltage Drop

Voltage Feedback

On ATS-23P starters, voltage feedback must be selected with the rotary switch inside the adjustment compartment (see Figure 25). The rotary switch is located on the lower right hand side. Ensure that the position of the switch corresponds to line voltage. For example, set the switch to 230 V for a 208-240 V supply. Factory setting is 500 V for a 440/500 V supply.

STARTING

ALTISTART controllers have 3 LEDs on the front panel for indicating starter run status, faults and alarms. When control circuit is powered up, the 3 LEDs light, then go out, and the green (Drive) LED flashes slowly if everything is functioning correctly. For alarm and fault conditions, see Chapter 4.

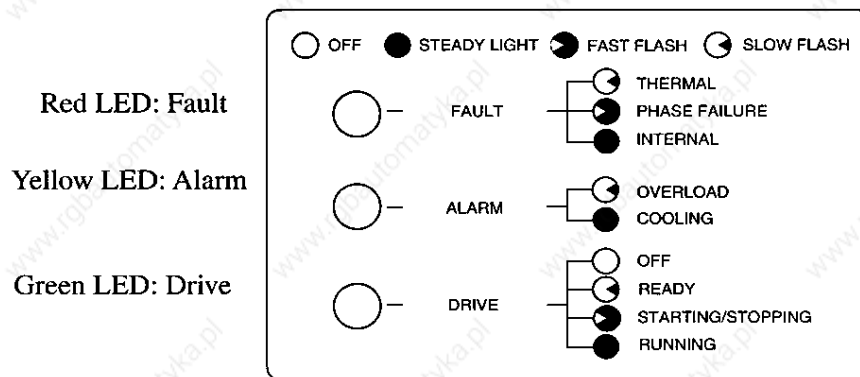


Figure 27 Display

Note: The cooling fan (on 72 to 1200 A starters) does not operate immediately upon start up. The fan is controlled by a thermal switch located on the heatsink of the thyristors. The thermal switch closes at 50°C and opens at 30°C; therefore, the fan may not come on immediately.

**Starting with Ramp and
Current Limitation**

ATS-23 and 23P

When a start command is given, the motor starts and the green (Drive) LED flashes rapidly for the duration of starting. At end of starting (full voltage on motor, and current draw below 130% of motor rating), the green LED changes to a steady light and the End of Starting relay closes (contact at terminals 43-44).

If necessary, adjust the settings of the ILT and ACC potentiometers (see page 36) until required operation is obtained. In general, the voltage ramp is most effective for starting low hp motors, while current limitation is used for starting under high inertia conditions.

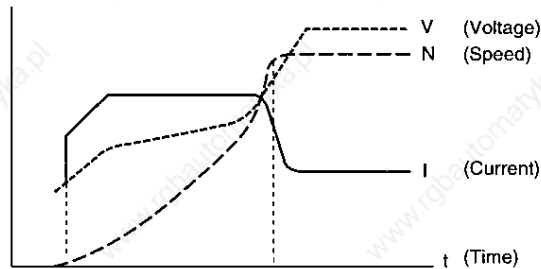


Figure 28 Starting with Ramp and Current Limitation

Starting with Booster

ATS-23

The ATS-23 (standard) controllers have a boost function. If torque is too low on starting due to dry friction, stiff mechanism or high inertia, select the booster (see page 35) to initiate start up.

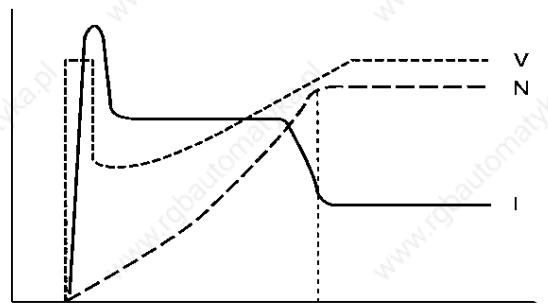


Figure 29 Starting with Booster

STOPPING

For freewheel stopping of the ATS-23 and ATS-23P starters, no setting need be made. The stop command places the starter in ready mode, the green (Drive) LED flashes slowly, and the motor coasts over a period of time depending on inertia and resistive torque of the driven load.

Soft Stopping

ATS-23

For standard ATS-23 starters, soft stopping is selected with the configuration switches (STP="C," CTL="D," page 35) and controlled by adjusting the DEC potentiometer (page 36). When the starter is set up for soft stopping, the stop command does not immediately remove power from motor. Instead, the End of Starting relay opens (contact at terminals 43-44), the green (Drive) LED flashes rapidly for the whole deceleration ramp period, and the motor stops over a period of time according to the ramp time set on the DEC potentiometer and the load conditions. The time to stop with soft stopping is greater than freewheel stop time.

Note: Setting DEC too short could cause motor to freewheel stop.

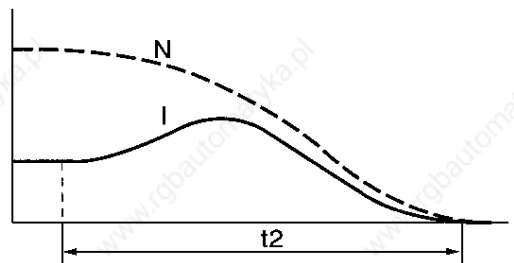


Figure 30 Soft Stopping

ATS-23P

Soft stopping is selected with the STP configuration switch (STP="C") and controlled by adjusting the DEC potentiometer. The optimum deceleration setting is the shortest time that does not result in hydraulic shock. To ensure that the settings are made correctly during tests, the motor must operate at steady state for at least 90 s before any stop command is given.

Gradually adjust the setting of DEC potentiometer until it is just above the point at which hydraulic shock occurs. Verify that the selected deceleration time achieves the desired hydraulic performance under all operating conditions of the installation. During tests, if it is necessary to set the RAMP switch to short ramp position, the setting of the DEC potentiometer must be adjusted to approximately the same ramp time.

Stopping with DC Injection Braking

ATS-23

DC injection braking stops motors faster than a coast stop. The injection period is set by the DEC potentiometer with a maximum injection time of 60 s. For starters ATS23C10N, ATS23C24N, ATS23C30N, ATS23C41N and ATS23C82N, if DC Injection is adjusted for a time exceeding 30 seconds, derate starter by 20%.

The DEC potentiometer setting is the approximate period of injection time.

When DC injection braking is selected, a stop command does not immediately remove power from the motor. Instead, the End of Starting relay (contact at terminals 43-44) opens and the DC Braking relay (contact at terminals 53-54) which controls contactor KM3 closes. The green (Drive) LED flashes rapidly for the whole injection period, then flashes slowly indicating that starting is permissible. Braked stopping of the motor occurs over a period which is less than freewheel stop time.

If a motor thermal overload condition occurs during the injection brake period, braking will continue as set, and when complete, restart will be prohibited until motor has cooled.

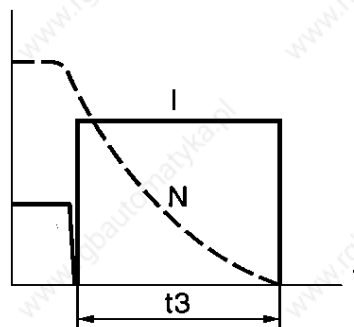


Figure 31 Stopping with DC Injection Braking



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 controller fault.
- When required, use separate brake function for holding torque.

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

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INTRODUCTION

! DANGER

HAZARDOUS VOLTAGE

- Read and understand these procedures before servicing ALTISTART controllers. Installation, adjustment, repair and maintenance of these controllers must be performed by qualified personnel.
- Many parts in this controller, including printed wiring boards, operate at line voltage. **DO NOT TOUCH.** Use only electrically insulated tools while making adjustments.

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

The following procedures are intended for use by qualified electrical maintenance personnel and should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service, or maintain the equipment discussed.

EXCESSIVE CURRENT INDICATION

Three LEDs provide information on the operation of the starter and motor. The green (Drive) LED fast-flashes when the controller is starting or stopping (controlled ramp) the motor. This LED changes to a steady light when voltage has reached full potential and motor current is under 130% of rated FLA (as set by Ir adjustment). If motor current exceeds 130% after this point, the green (Drive) LED will again fast-flash. This is an indication that the motor is drawing excessive current, not a motor thermal indication.

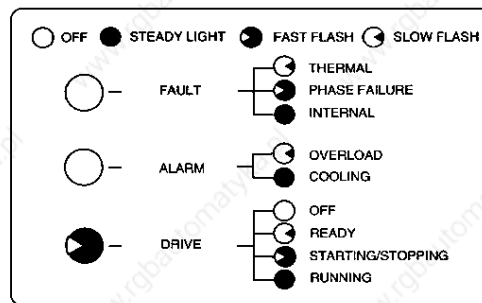


Figure 32 Excessive Current Indication

THERMAL OVERLOAD PRE-ALARM

The yellow (Alarm) LED slowly flashes when motor is in a thermal overload condition, but has not reached a level that would normally warrant shutting controller or motor off. This is a pre-alarm condition which energizes the Overload relay.

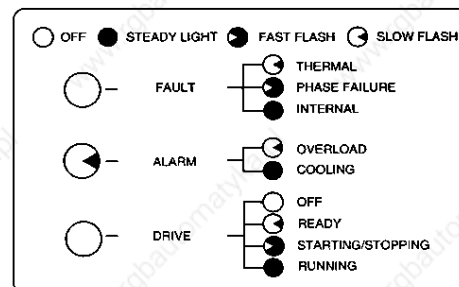


Figure 33 Thermal Overload Pre-alarm

THERMAL FAULT

When the motor exceeds its critical temperature rise threshold, a slowly flashing red (Fault) LED will indicate a thermal fault. The starter stops and the Fault relay de-energizes. A steady yellow (Alarm) LED would indicate that the motor is not cool enough to restart.

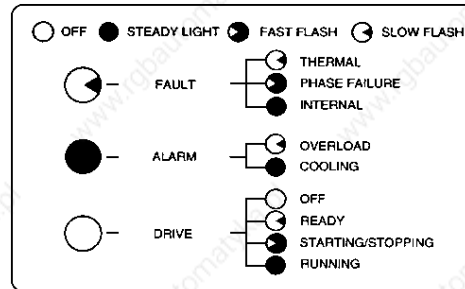


Figure 34 Thermal Fault

The yellow (Alarm) LED remains displayed for the time it takes the motor to cool (as calculated by the microprocessor) and goes out when the temperature of the motor has fallen below the rated temperature rise threshold. The red (Fault) LED remains flashing until reset.

With manual restart, a run command must be given to reset the Fault relay after the yellow light goes out. If 3-wire logic is used, a start command must be given. With 2-wire control, the switch must be turned off then turned back on. With automatic restart, the motor will restart after the yellow (Alarm) LED turns off unless a Stop command has been requested or the Start command removed.



CAUTION

MOTOR OVERHEATING

Automatic restarting of the motor after a thermal overload can result in thermal stress to the motor.

- Use manual thermal overload reset function (see coil "OAR" in recommended wiring diagrams) when applications permit.
- 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.).
- If automatic resetting of the thermal overload function is required, an "excessive number of starts" protection must be provided.

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

The probable causes of a thermal fault are:

- Motor overloaded
- Motor operating current incorrectly set. Check potentiometer Ir.
- Starting or stopping with current limitation is too long. Check the dynamics and the load of the driven machine.
- Motor phase imbalance, check supply power.
- Phase failure when running with shorting contactor. Check fuses, connections and thyristors.

PHASE FAILURE FAULT

Phase failure is a resettable fault indicated by rapid flashing of the red (Fault) LED. With manual reset, the Fault relay de-energizes.

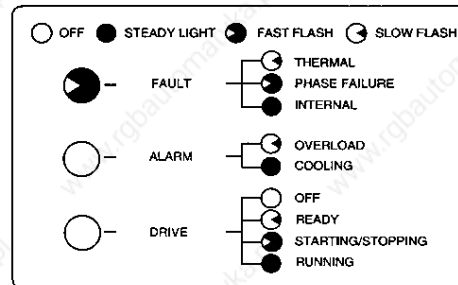


Figure 35 Phase Failure Fault

The probable causes of a phase failure are:

- Mains supply failure greater than 200 ms, but control voltage present.
- Motor current draw less than 10% of controller nominal current rating.
- Mains supply frequency outside acceptable limits: 50/60 Hz \pm 5%.
- Thyristor failure.
- Power factor is greater than 95% lagging.

If the fault is detected immediately upon initiating a start:

- Verify that there is supply voltage present at power input. Isolation contactor must close no later than 200 ms of a run command.
- Check for open phase(s). Possible causes are:
 - Blown fuses
 - Open power connections
 - Thyristor failure (not resettable via control logic)

If the fault is detected after completion of the acceleration ramp:

- Check for faulty or improper connection of starter shorting contactor. Load side of contactor must be to terminals A2, B2 and C2. Units from U70 to D30 do not have these contacts and are not intended for use with a shorting contactor.
- Motor current draw is less than 10% of the controller nominal current rating.



CAUTION

MOTOR OVERHEATING

Phase failure may not be detected when a shorting contactor is in use (energized). In order to obtain phase loss protection for the motor while using a shorting contactor, follow these precautions:

- Set the I_r potentiometer for the motor full load amp rating.
- Select power fuses sized for 125% of the motor full load amp rating.

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

If a shorting contactor is not used, the state of the “End of start up” relay will be indeterminate during the Phase Failure Fault.

Do not select Automatic reset (RET=A) when using 3-wire start/stop control.

INTERNAL FAULT

Internal fault is a non-resettable (via control logic) fault indicated by steady red (Fault) LED. The Fault relay de-energizes in either automatic or manual reset mode.

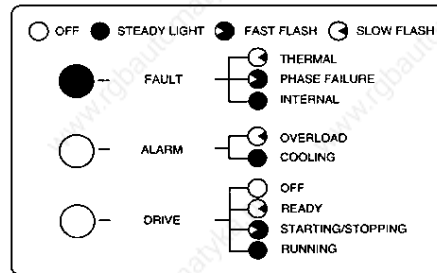


Figure 36 Internal Fault

Probable causes:

- 72 to 1200 A starters: heat sink overtemperature (the heat sink thermal switch opens). Possible causes:
 - Ambient temperature around starter is too high
 - Cooling fan power supply failure
 - Fan thermal switch failure
 - Cooling fan failure
 - Fault in the current measurement board connections.
 - Short circuit of thyristor, if the fault is displayed when switched on.



CAUTION

MOTOR OVERHEATING

Failure of the controller solid-state switches can cause single-phase operation of the motor.

- Use an isolation device consisting of either a circuit breaker equipped with a shunt trip coil or an electromagnetic contactor to open the line side of the controller.
- The isolation device must be capable of interrupting motor locked rotor current.
- Connect the Fault relay of the ALTISTART controller to open the isolation device in the event of a controller fault.

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

To reset, switch the control voltage off, and then on, after the fault has been rectified.

If all 3 LEDs go out, a control voltage failure is indicated.

CHECKING THYRISTORS

With the equipment switched off, isolate the starter by disconnecting the power terminals. Using a battery powered test-bulb, check the thyristors in pairs as shown below, phase by phase, between terminals 1L1-2T1, 3L2-4T2, 5L3-6T3. If the lamp remains lit, at least one of the thyristors is short-circuited.



Figure 37 Checking Thyristors

⚠ DANGER

HAZARDOUS VOLTAGE

Before checking thyristors:

- Disconnect all power.
- Place a "DO NOT TURN ON" label on the controller disconnect.
- Lock disconnect in open position.

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

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INSTALLATION NOTE

Replacement of certain parts, such as thyristor modules, may require the use of special tools and installation procedures. Installation instructions are not included with parts.

Parts installation must be done only by qualified electrical maintenance personnel familiar with this apparatus.

SPARE PARTS

The spare parts available for ALTISTART controllers are listed in Table 14.

Table 14 Spare Parts

Part Description	For ALTISTART ATS-23 & ATS-23P	Part Number	
THYRISTOR MODULES			
6 SCR Module	U70N	VZ3TM6007M16	
2 SCR Module	D12N, D16N	VZ3TM2026M16	
	D30N	VZ3TM2055M16	
	D44N, D72N	VZ3TM2130M16	
	C10N	VZ3TM2160M1601	
	C15N, C24N	VZ3TM2250M16	
1 SCR Module	C30N	VZ3TM1400M16	
2 SCR Module (without board)	C41N, C82N	VZ3TP2900M16	
	C58N, M12N	VZ3TP2M12M16	
Firing Interface Board	C41N-M12N	SF1-LG220	
CONTROL MODULES			
ATS23	All ratings	VW3G231C24Q	
ATS23P	All ratings	VW3GP231C24Q	
CURRENT MEASUREMENT BOARDS			
	U70N	VX4G23100	
	D12N	VX4G23101	
	D16N	VX4G23102	
	D30N	VX4G23103	
	D44N	VX4G23104	
	D72N	VX4G23105	
	C10N	VX4G23106	
	C15N	VX4G23116	
	C24N	VX4G23108	
	C30N	VX4G23115	
	Power Interface Board	C41N-M12N	VX4G23117 ⁽¹⁾
	COOLING FANS		
Fan Assembly	D72N-C15N	SZ1XH07	
	C24N-M12N	VZ3V001	
Fan Cover	D72N-C15N	VY1G23101	
THERMAL SWITCHES			
Heatsink (90 ° C)	D72N-C30N	SY3AT0007	
Heatsink (105 ° C)	C41N-M12N	SY3AT0011	
Fan (50 ° C)	D72N-M12N	VZ1GF01	
OTHER PARTS			
Hood for ATS23C15N	C15N	W813643430111	
Terminal Blocks, Instruction Bulletin, and Stickers		W813643472111	

⁽¹⁾ Switches and jumpers on replacement board must be set identically to the board replaced.

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