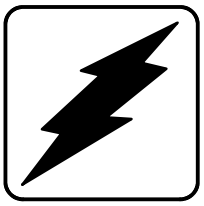
Operation and Installation

Automatic Transfer Switches



Models:

MMT, MNT

Power Switching Devices:
Molded-case Circuit Breakers
Molded-case Switches

40–1250 Amperes

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-5973 1/99a

Table of Contents

Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained. To prevent accidents be aware of potential dangers and act safely. Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

This manual has several types of safety precautions and instructions: Danger, Warning, Caution, and Notice.

DANGER

Danger indicates the presence of a hazard that ***will cause severe personal injury, death***, or ***substantial property damage***.

WARNING

Warning indicates the presence of a hazard that ***can cause severe personal injury, death,*** or ***substantial property damage***.

CAUTION

Caution indicates the presence of a hazard that ***will*** or ***can cause minor personal injury*** or ***property damage***.

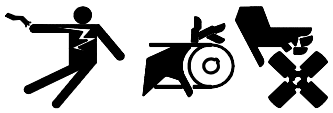
NOTICE

Notice communicates installation, operation, or maintenance information that is safety related but not hazard related.

Safety decals affixed to the equipment in prominent places alert the operator or service technician to potential hazards and explain how to act safely. The decals are shown throughout this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

Battery

WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

Battery acid. Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in the battery can cause blindness and burn skin. Always wear splashproof safety goggles when working near the battery. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

⚠ WARNING

Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove wristwatch, rings, and other jewelry before handling the battery. Never connect the negative (–) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together. Sparks could ignite the battery gases or fuel vapors. Ventilate the compartments containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Remove the negative (–) lead first when disconnecting the battery. Reconnect the negative (–) lead last when reconnecting the battery.

Hazardous Voltage/ Electrical Shock

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

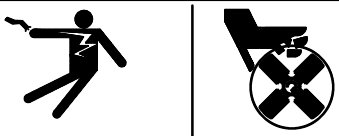
⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

⚠ WARNING



Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Hazardous voltage can cause severe injury or death. To prevent electrical shock disconnect the harness plug before installing accessories that will be connected to transformer assembly primary terminals 76, 77, 78, and 79. Terminals are at line voltage. *(Models with E33+, S340, S340+, 340, R340, and R33 controls only)*

Installing accessories to the transformer assembly. Hazardous voltage can cause severe injury or death. To prevent electrical shock disconnect the harness plug before installing accessories that will be connected to the transformer assembly primary terminals on microprocessor logic models. Terminals are at line voltage.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove rings, wristwatch, and jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Servicing the transfer switch controls and accessories within the enclosure. Hazardous voltage can cause severe injury or death. Disconnect the transfer switch controls at the inline connector to deenergize the circuit boards and logic circuitry but allow the transfer switch to continue to supply power to the load. Disconnect all power sources to accessories that are mounted within the enclosure but are not wired through the controls and deenergized by inline connector separation. Test circuits with a voltmeter to verify that they are deenergized before servicing.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove rings, wristwatch, and jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Use adequate lifting capacity.
Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized.

Moving Parts

⚠ WARNING

Hazardous voltage. Moving rotor. Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Notice

NOTICE

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

Foreign material contamination. Cover the transfer switch during installation to keep dirt, grit, metal drill chips, and other debris out of the components. Cover the solenoid mechanism during installation. After installation, use the manual operating handle to cycle the contactor to verify that it operates freely. Do not use a screwdriver to force the contactor mechanism.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

This manual provides operation and installation instructions for Kohler MMT/MNT automatic transfer switches (ATS) that use a pair of interlocked 40- to 1250-ampere molded-case circuit breakers or molded-case switches as the power switching device.

All information in this publication represents data available at time of print. Kohler Co. reserves the right to change this literature and the products represented without incurring obligation.

Read through this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with equipment for future reference.

Equipment service requirements are very important to safe and efficient operation. Inspect parts often and perform required service at the prescribed intervals. An authorized service distributor/dealer should perform required service to keep equipment in top condition.

List of Related Materials

This manual covers the operation and installation of the transfer switch's power switching device. Use the chart in Section 1.4 of this manual to decode the transfer switch model number from the transfer switch nameplate on the inside of the enclosure door. Verify that the transfer switch's power switching device matches the model shown on the front cover of this manual before proceeding with operation or installation.

A separate manual covers service and parts information for transfer switch power switching devices. The following table shows the manual part number.

Power Switching Device	Service/ Parts Manual
MMT/MNT	TP-5974

The transfer switch model number will also show which type of logic controller is installed on the transfer switch. A separate operation and installation manual provides information specific to the logic controller and completes the operation and installation instructions for the transfer switch.

Kohler offers three types of logic controllers with this transfer switch. The table below lists the logic controllers and the operation and installation manual part numbers.

Logic Controller	Operation/ Installation Manual
E33+ (Solid State)	TP-5662
S340+ (Solid State)	TP-5663
M340+ (Microprocessor)	TP-5664

Separate manuals cover service and parts information for transfer switch logic controllers. The following table lists the manuals and their part numbers.

Logic Controller	Service/ Parts Manual
E33+ (Solid State)	TP-5670
S340+ (Solid State)	TP-5671
M340+ (Microprocessor)	TP-5672

Transfer switches with microprocessor electrical controls and communication options can be monitored and controlled with a personal computer and software. The following table lists the available manuals and part numbers.

Communication Item	Operation/ Installation Manual
Remote Monitoring and Control Communication (Monitor) Software	TP-5823
Communication Kits	TT-847

Service Assistance

Service Information

Please contact a local authorized distributor or dealer for sales, service, or other information about Kohler Generator Division products.

To locate a local authorized distributor or dealer

- Look on the product or the information included with the product
- Consult the Yellow Pages under the heading Generators—Electric
- Visit the Kohler Generator Division web site at www.kohlergenerators.com
- Call 1-800-544-2444 (inside the U.S.A. and Canada) or 920-565-3381 (outside the U.S.A. and Canada)

Product Identification

Product identification numbers determine service parts. Record the product identification numbers in the spaces below immediately after unpacking the products so that the numbers are readily available for future reference. Record field-installed kit numbers after installing the kits.

Transfer Switch Identification Numbers

Record the product identification numbers from the transfer switch nameplate.

Part Number _____

Serial Number _____

Accessory Number	Accessory Description

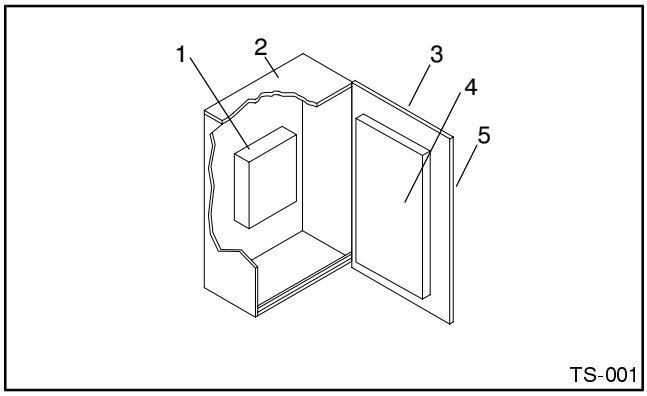
1.1 Purpose

An automatic transfer switch (ATS) transfers electrical loads from a normal (preferred) source of electrical power to an emergency (standby or replacement) source to maintain acceptable voltage and frequency levels when the normal source fails.

Upon normal source failure, the automatic transfer switch (ATS) signals the generator set to start. When the emergency source reaches a minimum voltage and/or frequency level, the ATS transfers the load from the normal source to the emergency source. The ATS continuously senses the normal source and transfers the load back to the normal source when the normal source returns. After transfer of the load back to the normal source, the ATS removes the generator set start signal, allowing the generator set to shut down.

1.2 Component Overview

A typical automatic transfer switch (ATS) consists of the functional units mounted in an enclosure with a hinged front door. See Figure 1-1. The power switching device connects the load to the normal or emergency sources of power. An inner panel mounted on the inside of the enclosure door contains the controller circuitry that monitors power sources, controls the power switching device, and signals the generator to start when needed. Enclosure door-mounted controls and indicators allow the operator to control the ATS operation mode and obtain system status information. A wire harness, with inline connectors to facilitate component replacement and door removal, connects the controller to the power switching device.



1. Power switching device
2. Enclosure
3. Enclosure door
4. Inner panel logic (controller)
5. Controls and indicators (mounted on enclosure door)

Figure 1-1. Typical ATS Components

The models covered by this manual use a power switching device made of two molded-case switches or circuit breakers. Each switch or circuit breaker has a motor operator to provide automatic operation. The transfer switch also includes a provision for manual operation. Mechanical and electrical interlocks on the power switching device prevent the closing of both switches or circuit breakers at the same time. Interlocking ensures load servicing without cross-coupling of power sources.

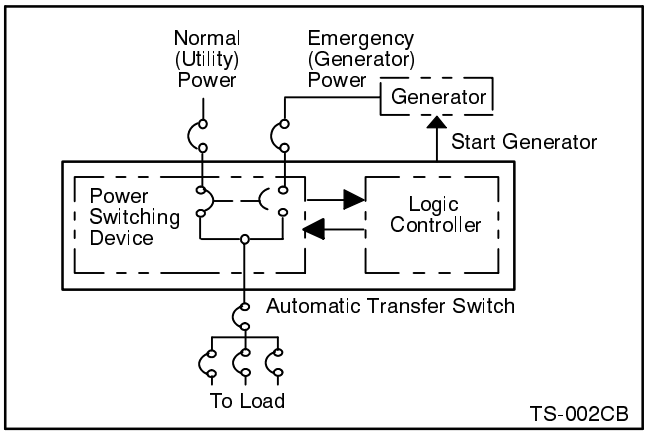
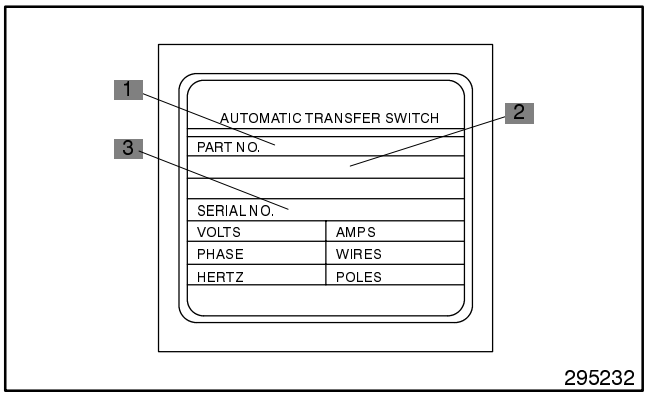


Figure 1-2. Typical ATS Block Diagram

1.3 Nameplate

A nameplate is attached to the ATS enclosure door. See Figure 1-3. The nameplate includes a factory part number, a serial number, ratings, and other information that is needed for installation and operation. Copy the part number into the blank spaces provided in Figure 1-4 and then use the chart in Figure 1-4 to interpret the part number.

Copy the part number, serial number, and accessory infromation from the nameplate into the spaces provided in the Service Assistance section in the Introduction of this manual for use when requesting service or parts.



1. Part number used to identify the type of ATS
2. Factory-installed accessory numbers
3. ATS serial number

Figure 1-3. Typical Transfer Switch Nameplate

1.4 Model Code

Use the chart below to record and interpret the transfer switch part number.

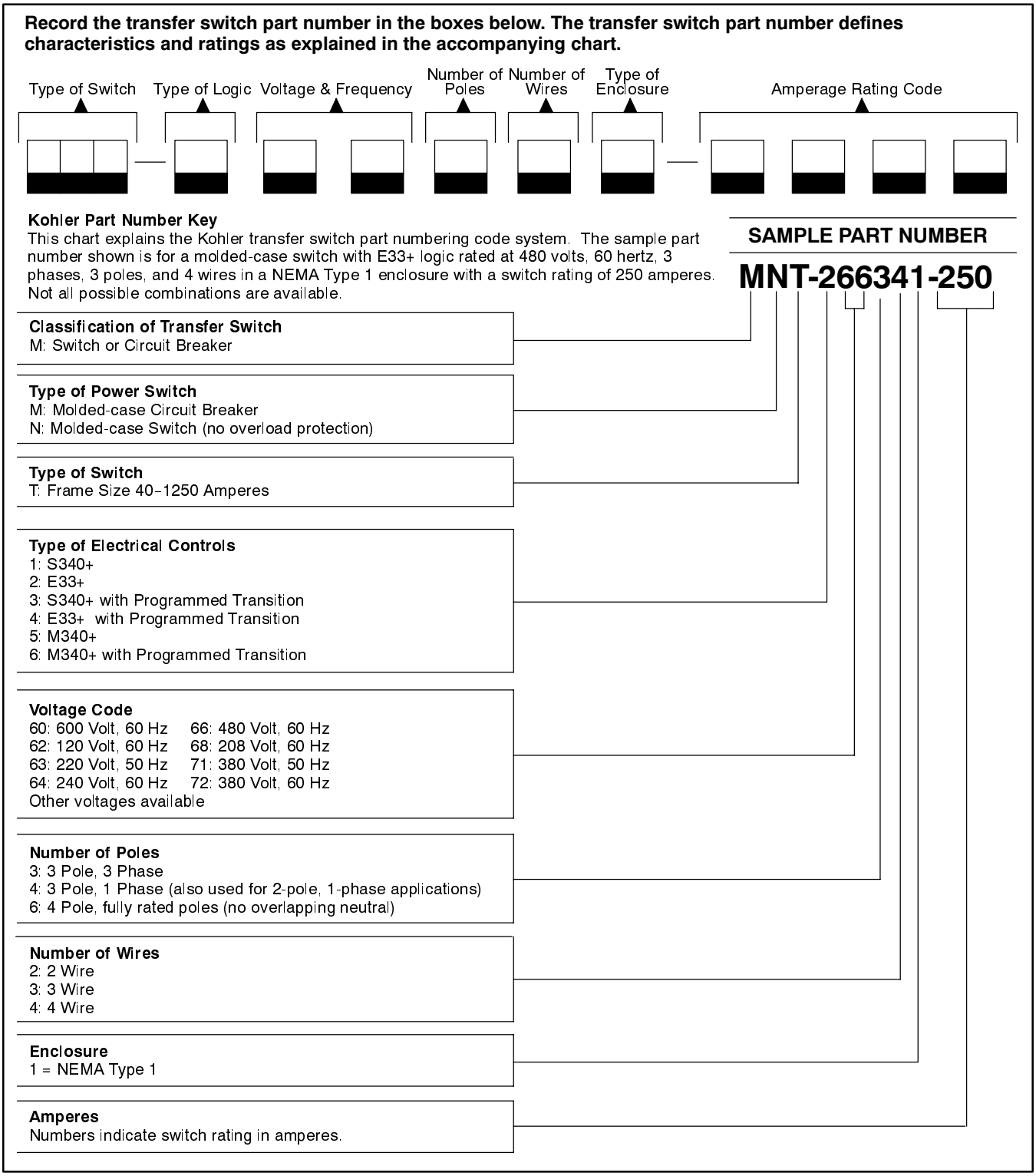


Figure 1-4. Transfer Switch Model Designations

1.5 Standard Features

The standard features listed below are for the MMT/MNT power switching device. Refer to the E33+, S340+, or M340+ logic controller operation and installation manual for logic controller specifications. See the List of Related Materials in the Introduction of this manual.

- Rated per IEC 947-2 and IEC 947-3 standards
- Current ratings from 40 to 1250 amps at 40°C
- Fast five-cycle open/close operation on 40 to 630 amp circuit breakers/switches
- Available in 3- or 4-pole (fully rated) configurations
- Available with molded-case circuit breaker (short circuit and overload protection) or molded-case switch (no overload protection) power switching devices
- Available to 600 vac, 50 or 60 Hz
- Available in NEMA type 1 enclosures
- Available with E33+, S340+, or M340+ controls. See controls specification sheets for control features and available options.
- Indication of circuit breaker/switch position provided
- Power switching devices electrically or manually operated, electrically and mechanically interlocked
- Available programmed transition function disconnects the load from both sources to allow residual voltages to decay before transfer. See controls specification sheets for details.
- Ambient operating temperature range from −5° to 60°C
- Ambient storage temperature range from −55° to 100°C
- Humidity range from 5% to 95% noncondensing

1.6 Weights and Dimensions

Figure 1-5 shows the enclosure dimensions and weights of the complete automatic transfer switches in NEMA 1 enclosures.

Switch Size (amps)	Weight lbs. (kg)	Dimensions, H x W x D in. (mm)
40, 80, 100, 160, 250	206 (93)	39 x 27 x 19 (991 x 686 x 483)
400, 630	314 (142)	51 x 33 x 21 (1295 x 838 x 533)
800, 1000, 1250	610 (277)	58 x 41 x 22 (1470 x 1040 x 559)

Figure 1-5. ATS Weights and Dimensions

1.7 Ratings

Figure 1-6 gives ratings for the circuit breaker/switch power switching devices according to IEC 947-2 and IEC 947-3 standards.

Transfer Switch (amps)	Circuit Breaker Ultimate Breaking Capacity (Icu) * (kA rms) AC 50/60 Hz					Admissible Short-time Current (Icw) *			
						Circuit Breakers		Switches	
	220/240 V	380/415 V	440 V	500 V	660/690 V	kA (rms)	Time (sec)	kA (rms)	Time (sec)
40	85	25	25	18	8	—	—	—	—
80	85	25	25	18	8	—	—	—	—
100	85	25	25	18	8	—	—	1.8	1.0
160	85	36	35	30	8	—	—	2.5	1.0
250	85	36	35	30	8	—	—	3.5	1.0
400	85	45	42	30	10	—	—	5.0	1.0
630	85	45	42	30	10	—	—	6.0	1.0
800	85	50	42	40	25	12	1.0	10.0	1.0
1000	85	50	42	40	25	12	1.0	15.0	1.0
1250	85	50	42	40	25	12	1.0	15.0	1.0

*Icw and circuit breaker Icu ratings according to IEC 947-2 and IEC 947-3

Figure 1-6. Ratings

High temperatures affect the maximum service currents for circuit breakers and switches. For temperatures above 40°C, decrease the service currents to the values shown in Figure 1-7.

Transfer Switch Size (amps)	Maximum Service Current (amps)			
	45°C	50°C	55°C	60°C
Molded-case Circuit Breakers				
40	39	38	37	36
80	78	76	74	72
100	97	95	92	90
160	156	152	147	144
250	244	238	231	225
400	400	400	390	380
630	615	600	585	570
800	790	780	770	760
1000	975	950	925	900
1250	1200	1150	1100	1050
Molded-case Switches				
100	100	100	100	100
160	160	160	160	160
250	250	250	237	237
400	400	400	390	380
630	615	600	585	570
800	790	780	770	760
1000	975	950	925	900
1250	1200	1150	1100	1050

Figure 1-7. Temperature Derating

Multiply the power switching device current rating by the factor shown in Figure 1-8 for altitudes above 2000 meters. Apply the temperature derating shown in Figure 1-7, if applicable, before applying the altitude derating.

Altitude (m)	Maximum Operational Voltage	Current Derating Factor *
2000	690	1.00
3000	550	0.96
4000	480	0.93
5000	420	0.90

*Apply this factor to the maximum service current after applying the temperature derating.

Figure 1-8. Altitude Derating

1.8 Application Data

See Figure 1-9 for application data including the wire sizes and tightening torques for transfer switch source and load connections.

Switch Size (amps)	Strip Length in. (mm)	Range of Wire Sizes, Copper or Aluminum		Tightening Torque ft. lbs. (Nm)	Cables per Pole
		AWG/MCM	mm^2		
Normal and Emergency Source Connections					
40–160	0.8 (20)	#16 to #6 AWG #4 to 3/0 AWG	1.5–16 25–95	9 (12) 15 (20)	1 1
250	0.8 (20)	#6 to #2 AWG #1 AWG to 350 MCM	16–35 50–185	15 (20) 19 (26)	1 1
400	0.8 (20)	#2 AWG to 600 MCM	35–300	23 (31)	1
630	1.2 (30)*	3/0 AWG to 500 MCM	85–240	23 (31)	1 or 2
800	1.5 (38)*	2/0 AWG to 350 MCM	70–185	23 (31)	1 to 3
1000–1250	1.5 (38)*	2/0 AWG to 500 MCM	70–240	31 (42)	1 to 4
Load Connections					
40	0.8 (20)	#6 to 2/0 AWG	16–70	15 (20)	1
80–250	0.8 (20)	#6 AWG to 350 MCM	16–185	25 (34)	1
400	0.8 (20)	#2 AWG to 600 MCM	35–300	23 (31)	1
630	1.2 (30)*	3/0 AWG to 500 MCM	85–240	23 (31)	1 or 2
800	1.5 (38)*	2/0 AWG to 350 MCM	70–185	23 (31)	1 to 3
1000–1250	1.5 (38)*	2/0 AWG to 500 MCM	70–240	31 (42)	1 to 4

*Terminal lug front holes. For rear holes, 2.25 in. (58 mm)

Figure 1-9. Application Data

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

Have preventive maintenance performed on the transfer switch at regular intervals after installation. See Section 4 for preventive maintenance.

DO NOT ENERGIZE THE SWITCH when any wear, damage, deterioration, or malfunction of the transfer switch or its components is evident or suspected. Have trained and qualified personnel from an authorized service center inspect and service the transfer switch.

2.1 Startup

Do not use this section for initial startup. Follow the instructions in Section 6 of this manual and in the installation section of the logic controller operation and installation manual for initial startup.

Use this section when power sources to the transfer switch have been disconnected for an extended period after maintenance or service of the standby system. Follow this procedure to energize the transfer switch and prepare it for automatic operation.

Startup Procedure

1. Move the generator set master switch to the OFF position to prevent the generator from starting.
2. Disconnect all power sources to the transfer switch by opening the upstream circuit breakers or switches leading to the transfer switch.
3. Open the enclosure and check that the wire harnesses for the power switching device and the controller are connected together at the inline plugs. See Figure 6-1 or Figure 6-2.
4. Set the transfer switch circuit breakers/switches to select the normal source and to operate automatically. See Section 2.4—Manual Operation.
5. Close and lock the transfer switch enclosure door.
6. Prepare the generator set that provides standby power for operation. Check the oil level, coolant level, fuel supply, batteries, and items specified by the generator set installation or operation checklist or manual.
7. Move the generator set master switch to the AUTO position. The generator set should start.
8. When the loads can be safely energized, reapply power sources to the transfer switch by closing the circuit breakers or switches.

NOTE

When power is initially applied to the transfer switch, the engine start contacts remain closed, signaling the generator to run until Time Delay Engine Cooldown (TDEC), if equipped, ends.

9. Perform an automatic operation test. Refer to the logic controller operation and installation manual for the automatic test procedure.

Refer to the logic controller operation and installation manual for other setup and startup procedures.

2.2 Operation Sequence

The ATS electrical controls or accessories detect whether a power source is acceptable, has failed, or has been restored, and operate accordingly. A power source is acceptable when the voltage and frequency on all sensed phases remain within a preset range. Failure of a power source occurs when the voltage and/or frequency on one or more sensed phases fall outside of the acceptable range. A power source is restored when the voltage and/or frequency return to acceptable levels after failing.

Automatic transfer switches typically operate in two sequences:

- **Failure of the normal power source** and the resulting transfer to the emergency source.
- **Restoration of the normal power source** and the resulting transfer back to the normal source.

The following sections explain these sequences of operation. Installed controller accessories can change the sequence of operation. See the logic controller operation and installation manual for specifications on time delays, voltage and frequency limits, control adjustments, and accessory information.

2.2.1 Normal Power Failure

When the normal power source fails, the controller starts a time delay called Time Delay Engine Start (TDES). TDES prevents unnecessary generator startup during short normal power interruptions. If the normal power source is restored before TDES ends, the controller resets the time delay. If the normal power failure persists and TDES ends, the controller issues a signal to start the standby (emergency) generator to produce the emergency power source.

After signaling the generator to start, the controller monitors the emergency power source. When the controller determines that the emergency (generator) power source is acceptable, it starts a time delay called Time Delay Normal to Emergency (TDNE). TDNE allows emergency power source stabilization before load connection. When TDNE ends, the controller signals the transfer switch to connect the load to the emergency source.

After load transfer, the switch mechanically latches in the emergency position, supplying emergency source power to the load until normal power source restoration and stabilization.

2.2.2 Normal Power Restoration

After normal power source restoration, the controller starts a time delay called Time Delay Emergency to Normal (TDEN). If the normal power source fails before TDEN ends, the time delay resets. TDEN ensures normal power source stabilization before load reconnection.

When the controller determines that the normal power source has maintained an acceptable level and TDEN ends, the controller signals the circuit breaker/switch to reconnect the load to the normal source.

After load transfer, the switch mechanically latches in the normal position and the controller starts a time delay called Time Delay Engine Cooldown (TDEC). TDEC allows the engine and generator to run unloaded and cool down before shutdown. When TDEC expires, the controller signals the generator set to shut down.

2.3 Resetting Tripped Circuit Breakers

A current overload will automatically trip (open) the circuit breakers. Identify and correct the cause of the overload before resetting the circuit breaker. Turn off or disconnect all power sources and check circuits with a voltmeter to verify that the power is off before opening the enclosure. Follow the manual operation procedure in Section 2.4—Manual Operation to reset the tripped circuit breaker. Then select the desired power source.

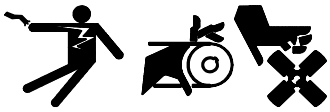
To return to automatic operation after resetting a tripped circuit breaker, follow the manual operation procedure to select the normal source and set the circuit breakers for automatic operation. Close and lock the enclosure before reconnecting the power sources.

2.4 Manual Operation

Manually operate the power switching device to prepare the transfer switch for automatic operation, to reset a tripped circuit breaker, to test or troubleshoot the unit, or to transfer the load if the controller fails.

Power switching devices with 40–630 ampere ratings have different operating procedures than devices with 800–1250 ampere ratings. The following procedures explain how to manually operate the different models.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (-) leads first. Reconnect negative (-) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove rings, wristwatch, and jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

NOTE

A current overload will cause circuit breaker switching devices to trip (open). *Identify and correct the cause of the overload before resetting the tripped circuit breaker.*

NOTE

Mechanical interlocks allow only one switch or circuit breaker to be on at a time. Before turning one circuit breaker/switch on, set the other circuit breaker/switch to the OFF position.

NOTE

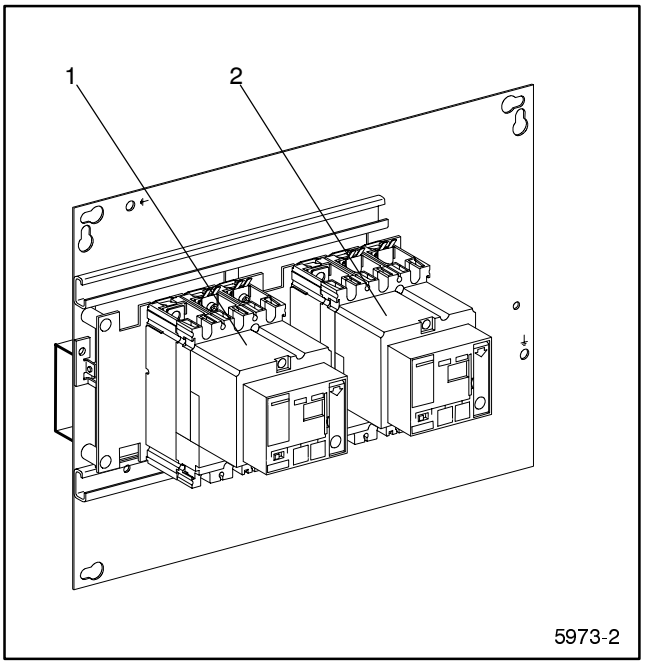
A circuit breaker/switch in normal and serviceable condition transfers smoothly without binding when operated manually. Do not place the transfer switch into service if the circuit breaker/switch does not manually operate smoothly without binding; contact an authorized service center to service the circuit breaker/switch.

2.4.1 40–630 Amp Models

Figure 2-1 shows the normal and emergency circuit breakers/switches. The emergency source circuit breaker/switch is also labeled R for replacement power source. Models rated from 40 through 630 amps use the motor operator shown in Figure 2-2. Use the following procedure to operate these units manually.

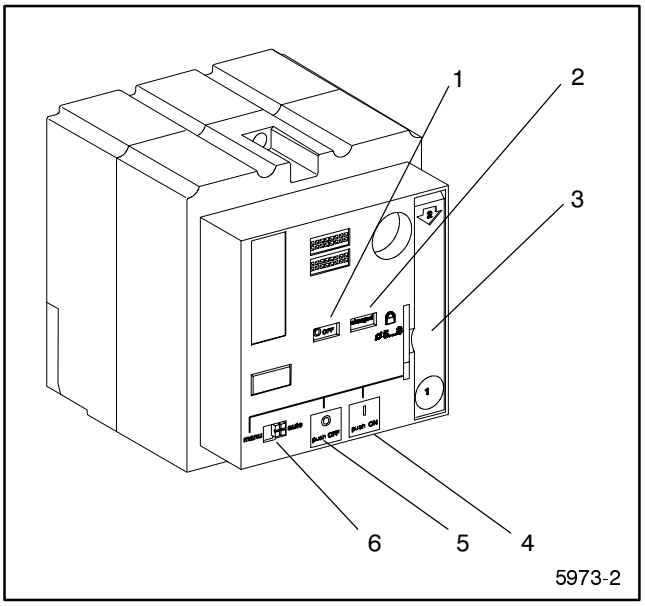
Manual Operation Procedure, 40–630 Amp Models

1. Prevent the emergency power source generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator set battery charger, if installed; and removing the generator set engine start battery cables, negative (–) leads first.
2. Disconnect or turn off *BOTH* the normal and emergency power sources before opening the enclosure door. Use a voltmeter with sufficient voltage rating and electrically-insulated probes to verify that the power is off.
3. Set both automatic/manual slide switches on the motor operators to the MANU position to prevent controller circuitry from operating the circuit breakers/switches.



1. Normal circuit breaker/switch
2. Emergency circuit breaker/switch

Figure 2-1. Normal and Emergency Circuit Breakers/Switches, 40–630 Amp Models



1. ON/OFF indicator
2. Charged/discharged indicator
3. Mechanical charge lever
4. ON button
5. OFF button
6. Automatic/manual slide switch

Figure 2-2. Motor Operator, 40–630 Amp Models

4. Press the OFF buttons on both motor operators. Check the ON/OFF indicators on both motor operators to verify that both are OFF.

NOTE

A circuit breaker/switch must have its motor operator charged electrically or mechanically to allow it to close (turn on).

5. Charge the motor operator for the normal or emergency circuit breaker/switch, if it is not already charged, by pulling down on the charge lever 7 or 8 times until the charged/discharged indicator changes from DISCHARGED to CHARGED. See Figure 2-3.

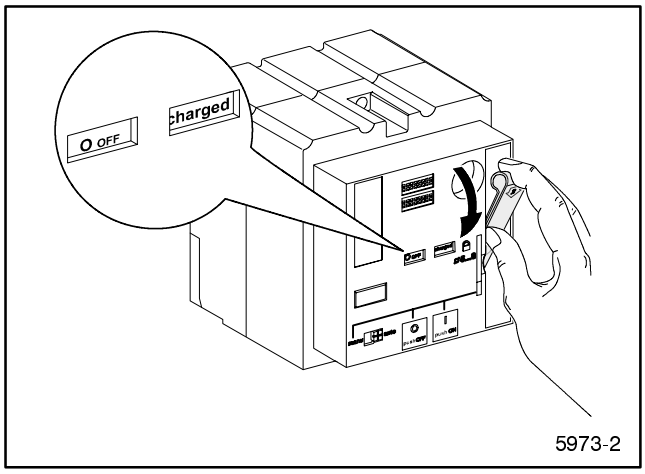


Figure 2-3. Motor Operator Manual Charging, 40–630 Amp Models

6. Push the ON button to close the desired circuit breaker/switch. The indicators will change to ON and DISCHARGED. Mechanical interlocks allow only one circuit breaker/switch to be set to the ON position at any time.
7. Turn the emergency source circuit breaker/switch OFF and the normal source circuit breaker/switch ON before returning the power switching device to automatic operation.
8. Set the automatic/manual slide switches on both motor operators to the AUTO position to return to automatic operation.
9. Close and lock the enclosure door before reapplying power.
10. Reconnect the generator set battery cables, negative (–) leads last; reconnect power to the generator set battery charger, if installed; and move the generator set master switch to the AUTO (automatic) position. The generator may start and run until the time delay engine cooldown (TDEC) expires.

NOTE

Circuit breakers/switches can be padlocked in the OFF position as shown in Figure 2-4.

Locking Procedure, 40–630 Amp Models

1. Pull out the locking tab while pushing the OFF button. See Figure 2-4.
2. Insert from 1 to 3 padlocks.

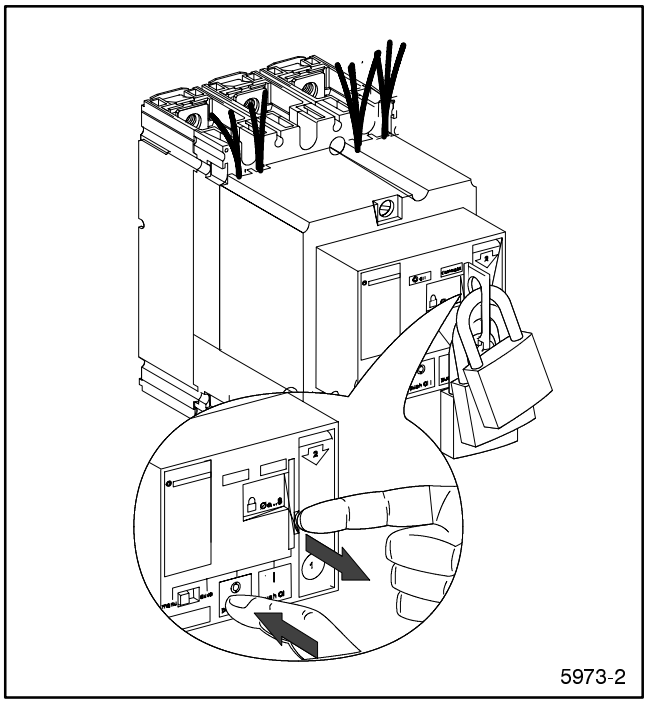


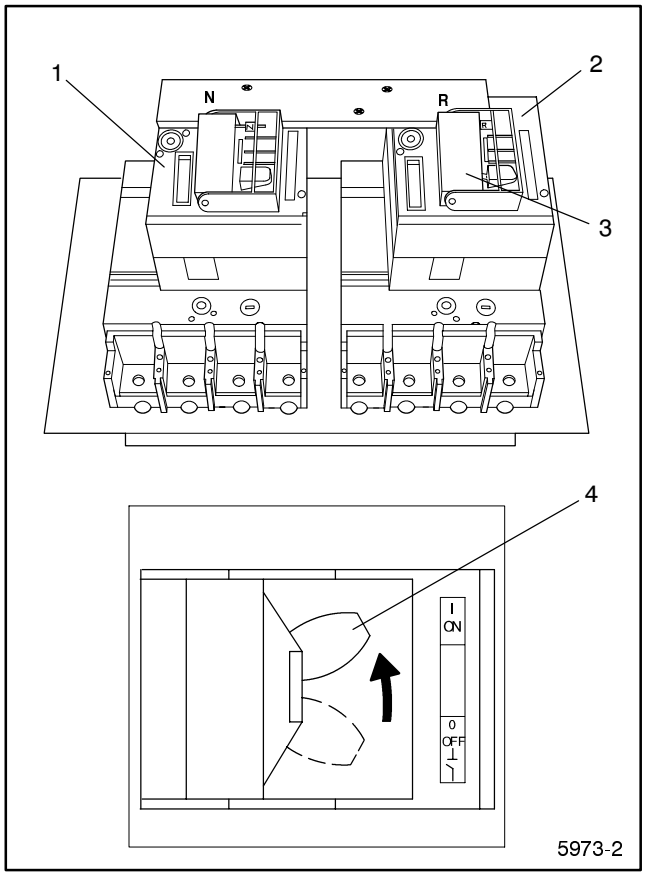
Figure 2-4. Locking Procedure, 40–630 Amp Models

2.4.2 800–1250 Amp Models

Figure 2-5 shows the normal and emergency source circuit breakers/switches. The emergency source circuit breaker/switch is also labeled R for replacement power source. Manually operate these models as described in the following procedure.

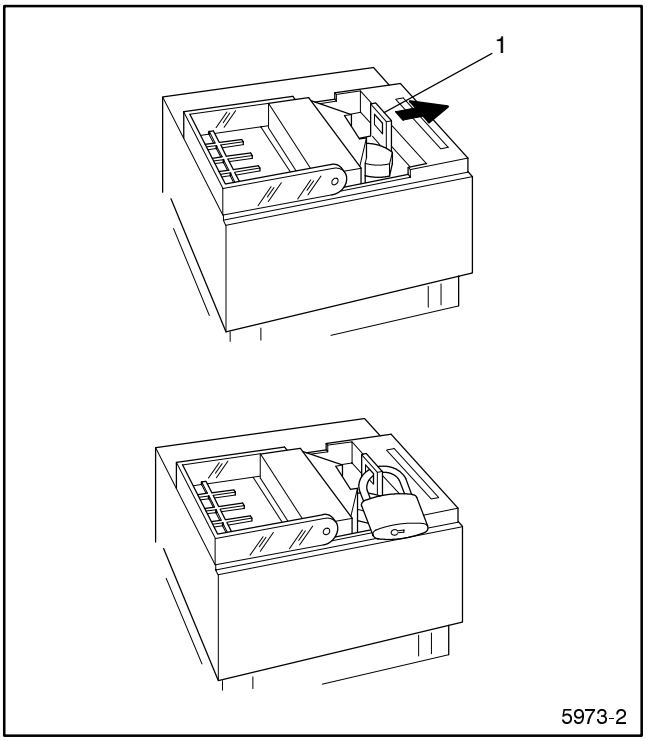
Manual Operation Procedure, 800–1250 Amp Models

1. Prevent the emergency power source generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator set battery charger, if installed; and removing the generator set engine start battery cables, negative (–) leads first.
2. Disconnect or turn off *BOTH* the normal and emergency power sources before opening the enclosure door. Check circuits with a voltmeter to verify that the power is off.
3. Open the plastic doors on the normal and emergency circuit breakers/switches to prevent controller circuitry from operating the circuit breakers/switches and to allow access to the motor operator lever.
4. Slide the switch lever on the desired circuit breaker/switch to the ON (1) position. See Figure 2-5. Mechanical interlocks allow only one circuit breaker/switch to be set to the ON position at any time.
5. Turn the emergency power circuit breaker/switch OFF and the normal power circuit breaker/switch ON before returning to automatic operation.
6. Close the plastic doors over both circuit breakers/switches to return to automatic operation.
7. Close and lock the enclosure door.
8. Reconnect the power supplies to the transfer switch.
9. Reconnect the generator set battery cables, negative (–) leads last; reconnect power to the generator set battery charger, if installed; and move the generator set master switch to the AUTO (automatic) position. The generator may start and run until the time delay engine cooldown (TDEC) expires.



1. Normal circuit breaker/switch
2. Emergency circuit breaker/switch
3. Plastic door
4. Lever

Figure 2-5. Manual Operation, 800–1250 Amp Models



1. Locking tab

Figure 2-6. Locking Procedure, 800–1250 Amp Models

NOTE

Circuit breakers/switches can be padlocked in the OFF position as shown in Figure 2-6.

Locking Procedure, 800–1250 Amp Models

1. Move the circuit breaker/switch handle to the OFF (0) position.
2. Pull out the locking tab as shown in Figure 2-6.
3. Insert a padlock as shown in Figure 2-6.

Notes

3.1 Programmed Transition

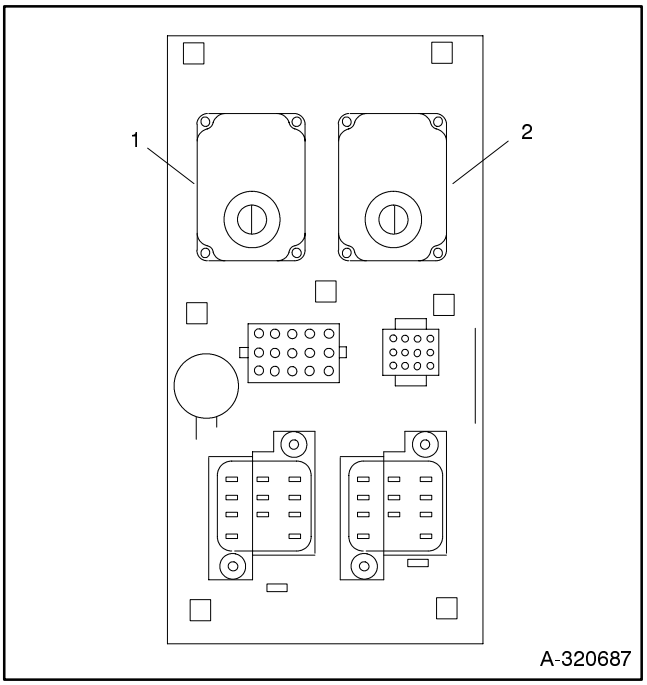
NOTE

For automatic transfer switches utilizing the M340+ logic control, the programmed transition function is accomplished within the microprocessor; therefore, no timing relays are required. See the operation and installation manual for the controller, TP-5664, for operational details. *Do not use this section.*

3.1.1 Description

The programmed transition accessory consists of two timing relays that plug into the interface board. See Figure 3-1. See the drawings in Section 5 for the location of the interface panel. When these relays are mounted on the interface board, power will transfer from the normal to emergency power source or from the emergency to normal power source in the following sequence:

1. The switch or circuit breaker for the previously connected power source opens.
2. A delay period, adjustable from 2 to 40 seconds, allows residual voltage in the load circuit to decay.
3. The switch or circuit breaker for the new power source closes.



1. K3 (TDON)
2. K4 (TDOE)

Figure 3-1. Interface Board with Programmed Transition Timing Relays

3.1.2 Adjustment

Two separate timing relays are used. One relay produces the time delay for the normal to emergency power transfer, Time Delay Off to Emergency (TDOE). The other relay produces the time delay for the emergency to normal power transfer, Time Delay Off to Normal (TDON). Each relay has a separate adjustment. Adjust the relays according to the following procedure.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

Timing Relay Adjustment Procedure

1. Disconnect all power sources before opening the enclosure door.
2. Locate the TDOE or TDON relay on the interface board inside the enclosure. See Figure 3-1.
3. Insert a screwdriver into the slot of the adjustment screw visible through the cover of the relay. Turn the adjustment screw until the slot points to the desired time delay period.
4. Close and lock the enclosure door.
5. Reconnect the power sources.
6. Operate the automatic transfer switch automatically and check the time delay off period to ensure that it is properly adjusted.

3.2 Other Accessories

All other accessories are controller accessories. For controller accessory information and procedures, refer to the operation and installation manual for the logic controller type specified by the model number shown on the transfer switch nameplate. See the List of Related Materials in the Introduction of this manual.

Notes

Scheduled preventive maintenance ensures safe and reliable operation and extends the life of the transfer switch. Preventive maintenance includes periodic testing, cleaning, inspection, and replacement of worn or missing components.

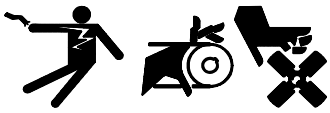
A local authorized distributor or dealer (authorized service center) can provide complete preventive maintenance and services to keep the transfer switch in top condition. The Service Assistance section in this manual explains how to locate a local distributor or dealer.

Read this entire section carefully before attempting any maintenance or service. Unless otherwise specified, have maintenance or service performed by trained and qualified personnel who follow all applicable codes and standards.

Keep records of all maintenance and service.

Replace all barriers and close and lock the enclosure door after maintenance or service and before reapplying power.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

⚠ WARNING

Hazardous voltage. Moving rotor.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Servicing the transfer switch. Hazardous voltage can cause severe injury or death. Deenergize all power sources before servicing. Open the main circuit breakers of all transfer switch power sources and disable all generator sets as follows: (1) Move all generator set master controller switches to the OFF position. (2) Disconnect power to all battery chargers. (3) Disconnect all battery cables, negative (–) leads first. Reconnect negative (–) leads last when reconnecting the battery cables after servicing. Follow these precautions to prevent the starting of generator sets by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer. Before servicing any components inside the enclosure: (1) Remove rings, wristwatch, and jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Test circuits with a voltmeter to verify that they are deenergized.

Servicing the transfer switch controls and accessories within the enclosure. Hazardous voltage can cause severe injury or death. Disconnect the transfer switch controls at the inline connector to deenergize the circuit boards and logic circuitry but allow the transfer switch to continue to supply power to the load. Disconnect all power sources to accessories that are mounted within the enclosure but are not wired through the controls and deenergized by inline connector separation. Test circuits with a voltmeter to verify that they are deenergized before servicing.

NOTICE

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

4.1 Inspection and Service

Contact an authorized service center to inspect and service the transfer switch when wear, damage, deterioration, or malfunction of the transfer switch or its components is evident or suspected.

4.1.1 General Inspection

External Inspection

Keep the transfer switch clean and in good condition by performing a weekly external inspection of the transfer switch. Look for signs of vibration, leakage, noise, extreme temperatures, contamination, or deterioration. Remove dirt, dust or other contaminants from the transfer switch external components or the enclosure with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in components and damage the transfer switch.* Replace worn, missing, or broken components with manufacturer-recommended replacement parts. Tighten loose external hardware.

Internal Inspection

Disconnect all power sources and use a voltmeter to verify that the power is off before opening the transfer switch enclosure door. Inspect the internal components monthly or when vibration, leakage, extreme temperatures, contamination, or deterioration noticed during an external inspection may have affected internal components. If the power interruption required to perform an internal inspection is unacceptable, have the internal inspection performed by an authorized service center.

Contact an authorized service center to inspect and service the transfer switch if any of the following conditions exist inside the transfer switch enclosure.

- Accumulations of dirt, dust, moisture, or contaminants
- Signs of corrosion
- Worn, missing, or broken components
- Loose hardware
- Wire or cable insulation deterioration, cuts, or abrasions
- Signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor
- Other evidence of wear, damage, or malfunction of the transfer switch or its components

Replace all barriers and close and lock the enclosure door after service or maintenance and before reapplying power.

4.1.2 Other Inspections and Service

Have an authorized service center perform maintenance and service that ensures the safe and reliable operation of the transfer switch. See Section 4.3—Service Schedule for the recommended maintenance items and service intervals.

Have an authorized service center repair or replace components inside the transfer switch enclosure with manufacturer-recommended replacement parts. Do not adjust or repair factory-sealed molded-case circuit breakers or switches.

The factory lubricates the operating mechanisms of molded-case circuit breakers/switches. Under normal conditions, the circuit breakers/switches require no further lubrication.

4.2 Testing

4.2.1 Weekly Generator Set Exercise

Use a plant exerciser or manual test to start and run the generator set under load once a week to maximize the reliability of the emergency power system. See the logic controller operation and installation manual for the procedure to exercise the generator set. See the List of Related Materials in the Introduction.

4.2.2 Monthly Automatic Operation Test

Test the transfer switch's automatic control system monthly. See the logic controller operation and installation manual for the test procedure. Verify that the expected sequence of operations occurs as the switch transfers the load to the emergency source when a normal source failure occurs or is simulated. Observe the indicator lamps and LEDs on the transfer switch to check their operation. When the switch transfers the load to the emergency source, end the test and verify that the expected sequence of operations occurs as the transfer switch retransfers to the available normal source and signals the generator set to shut down after a cooldown period.

4.3 Service Schedule

Follow the service schedule below for the recommended service intervals.

System Component or Procedure	See Section	Inspect	Check*	Change	Clean	Test†	Frequency
ELECTRICAL SYSTEM							
Check for signs of overheating or loose connections: discoloration of metal, melted plastic, or a burning odor.	4.1.1	X	X			D	M
Check wires and cables for deterioration, cuts, or or abrasion. Repair or replace damaged wiring.	4.1.1	X					M
	4.1.2	D	D	D, R			Q
Tighten source, load, and control cable connections and bus bars to specifications.	1.8, 4.1.1, 6.4, L		D			D	Y
Check the operation of the mechanical interlocks. Replace the entire power switching device assembly on 40–630 amp units if the interlocks fail to operate. Repair or replace the interlocks on 800–1250 amp units.	2.4		D	D, R			Y
Perform a thermal scan to check for high-resistance contacts in power circuits. Replace worn circuit breakers/switches.	4.1.2			D, R		D	Y
Test wire and cable insulation for electrical breakdown.	4.1.2			D, R		D	Every 3 Years
Test calibration of voltage-sensing circuitry and setpoints. Recalibrate circuitry if necessary.	4.1.2			D		D	Every 5 Years
CONTROL SYSTEM							
Exercise the generator set under load.	4.1.2, L					X	W
Test the transfer switch's automatic control system.	4.1.2, L	X				X	M
Test indicator lamps and LEDs and remote control circuits for operation.	L	X	D	D, R		D	Y
GENERAL EQUIPMENT CONDITION							
Inspect the outside of the transfer switch for any condition of vibration, leakage, noise, extreme temperature, contamination, or deterioration.‡	4.1.1	X			X		W
Check that all external hardware is in place, tightened, and not badly worn. Replace worn or damaged hardware.	4.1.1	X	X	X			W
Inspect the inside of the transfer switch for any condition of vibration, leakage, noise, extreme temperature, contamination, or deterioration.‡	4.1.1	X	X		D		M
	4.1.2	D	D		D		M
Check that all internal hardware is in place, tightened, and not badly worn. Replace worn or damaged hardware.	4.1.2	X	D	D, R			M

* Check requires moving the system components and the use of nonvisual indicators.

† Test may require tools, equipment, or training available only through an authorized service center.

‡ Service more frequently if operated in dusty areas.

X Operator action

L See the transfer switch logic controller operation and installation manual for the procedure.

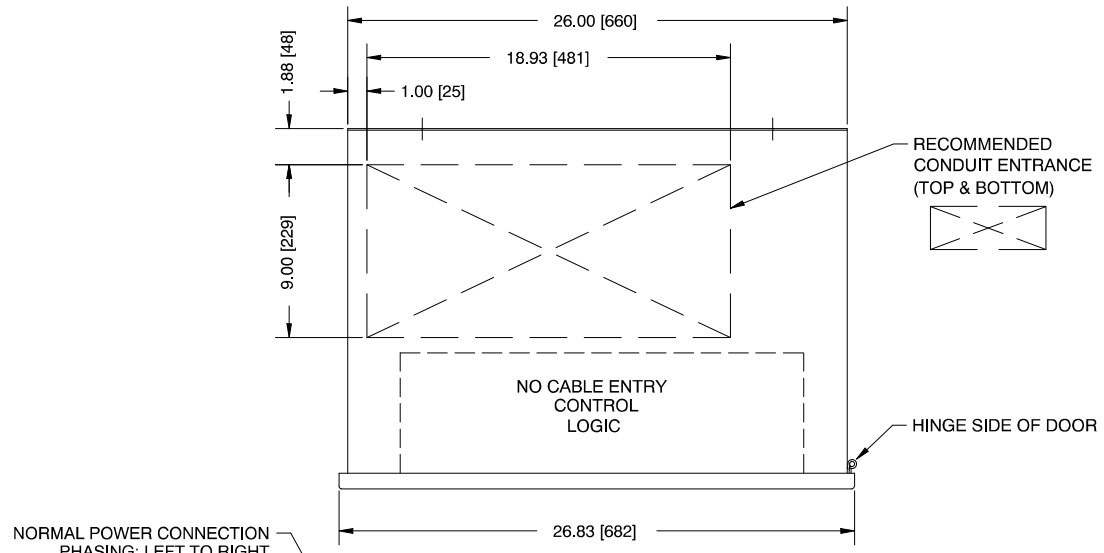
D Have service performed by an authorized service center.

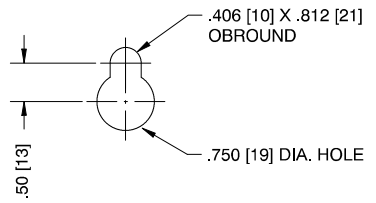
R Have parts replaced only by an authorized service center.

W=Weekly
M=Monthly
Q=Quarterly
S=Six Months
Y=Yearly

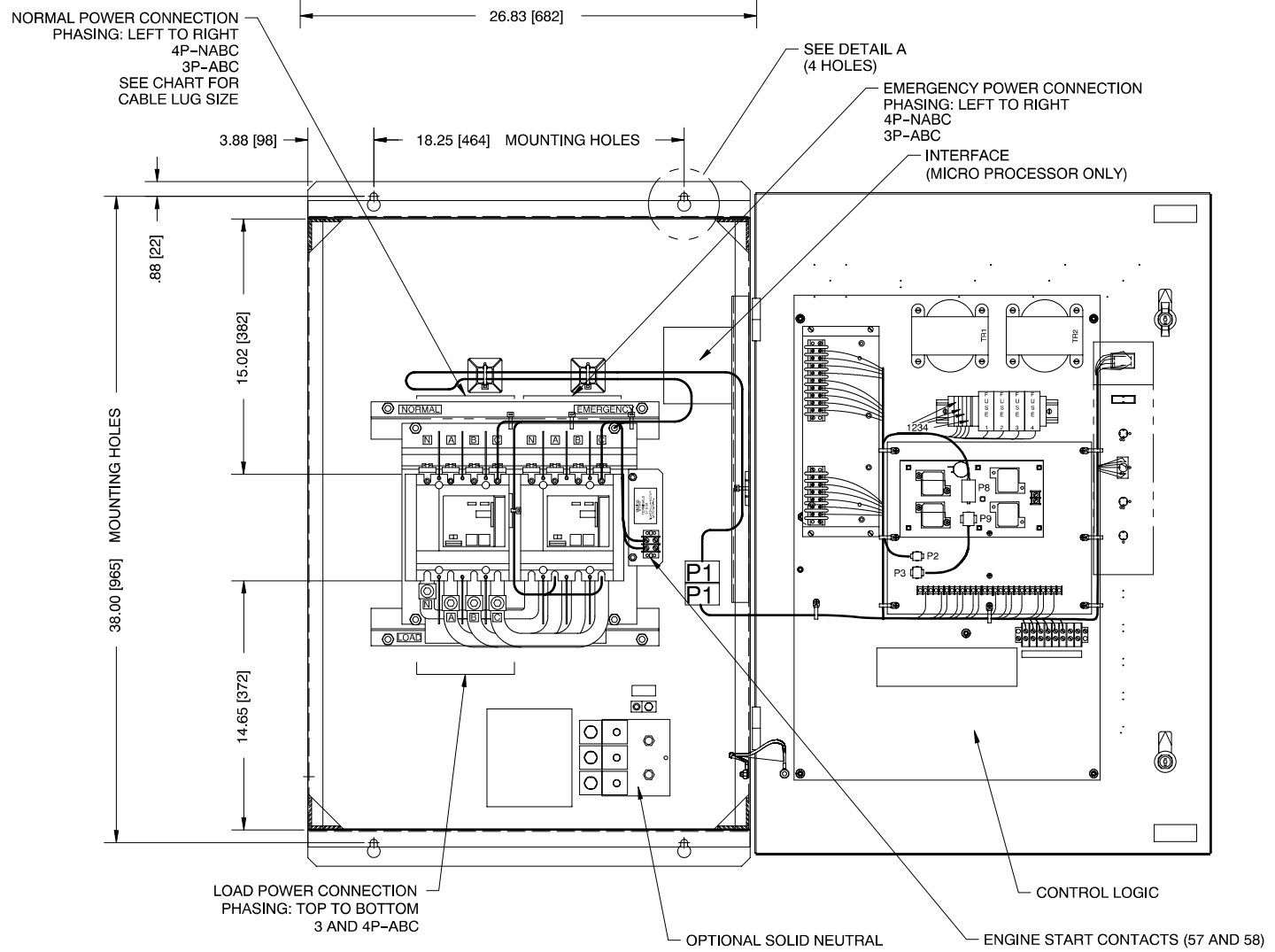
Section 5. Diagrams and Drawings

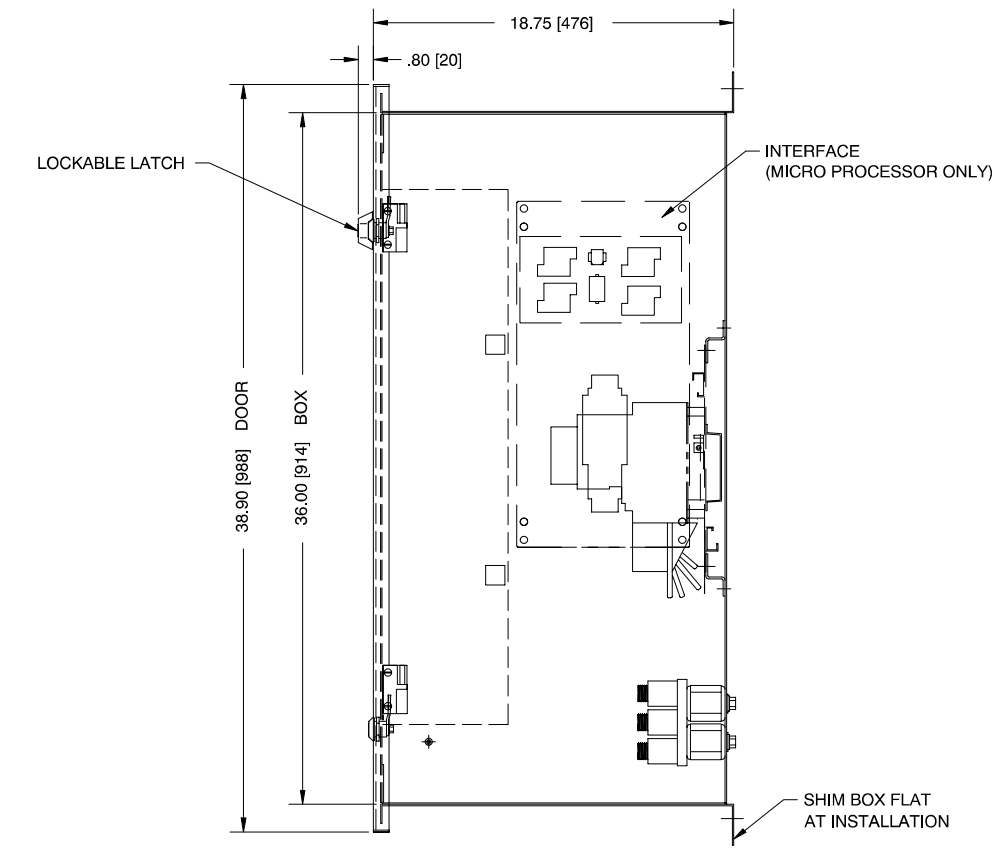
Notes





DETAIL A
(FULL SCALE)



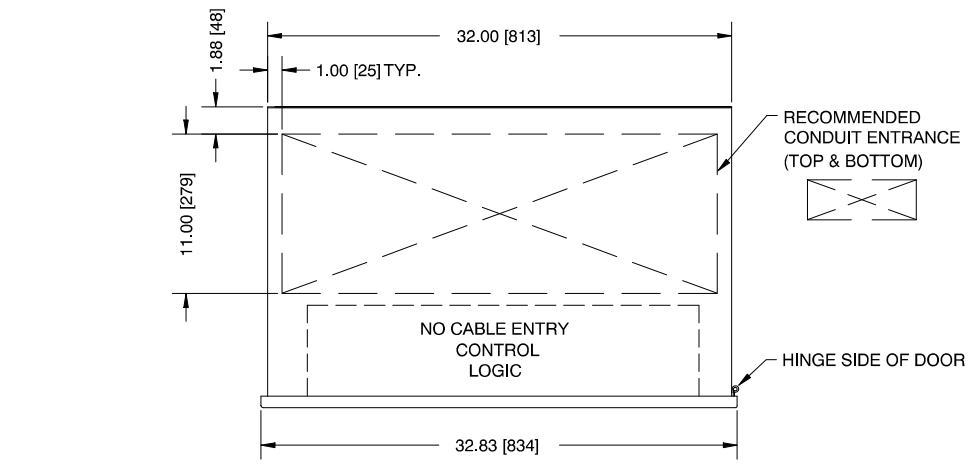


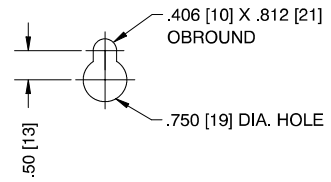
NOTE:
1. DIMENSIONS IN [ ] ARE MILLIMETERS.

AMPS	# OF CABLES	SIZE (USA)	SIZE (METRIC)	TORQUE (Nm)
250	1	#4 to 3/0 AWG	50 to 185 mm^2	26
	1	#16 to #6 AWG	16 to 35 mm^2	20
40 to 160	1	#4 to 3/0 AWG	25 to 95 mm^2	20
	1	#16 to #6 AWG	1.5 to 16 mm^2	12

ADV-6386-

Enclosure Dimensions, 40-250 Amp, ADV-6386-





DETAIL A
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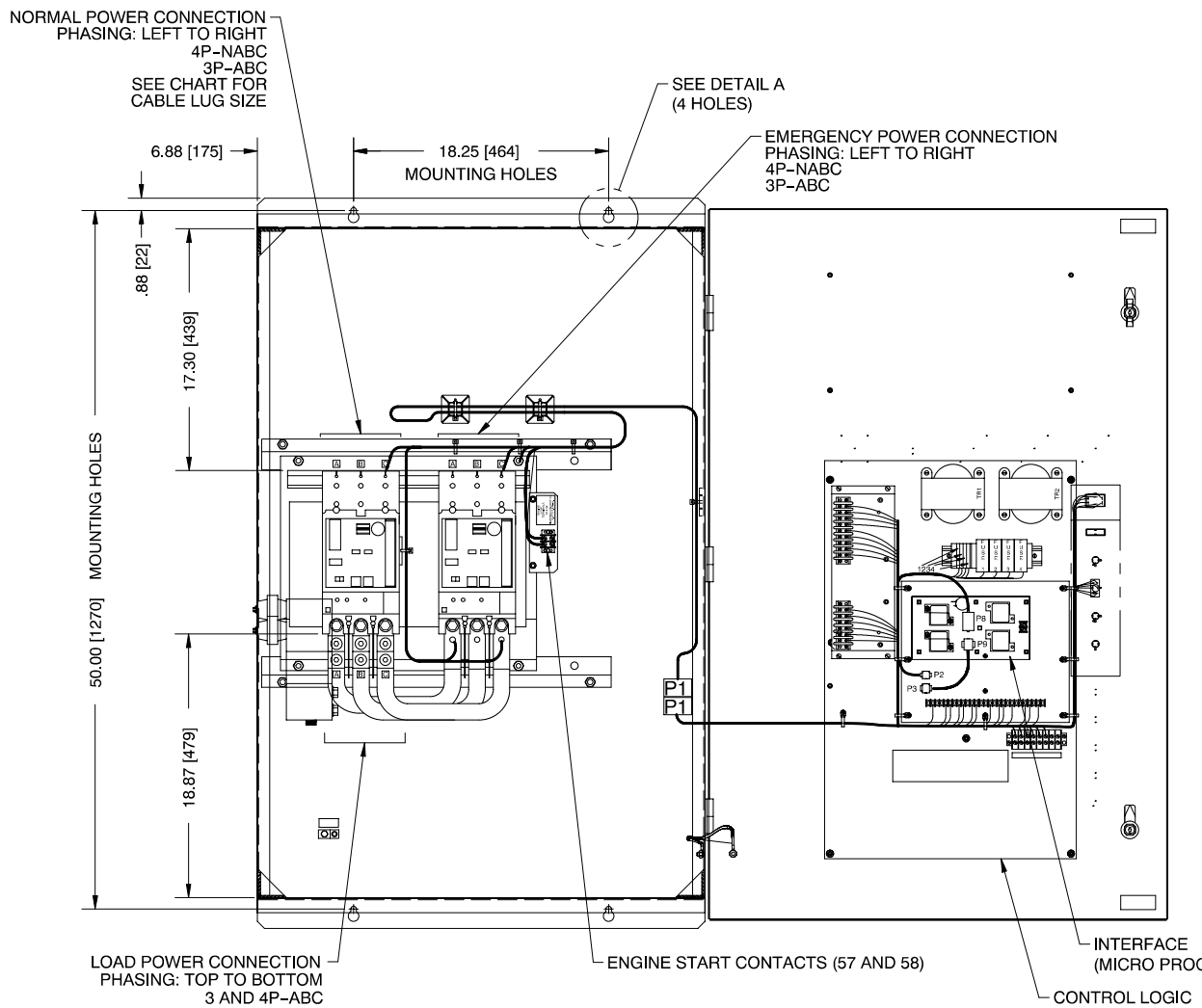
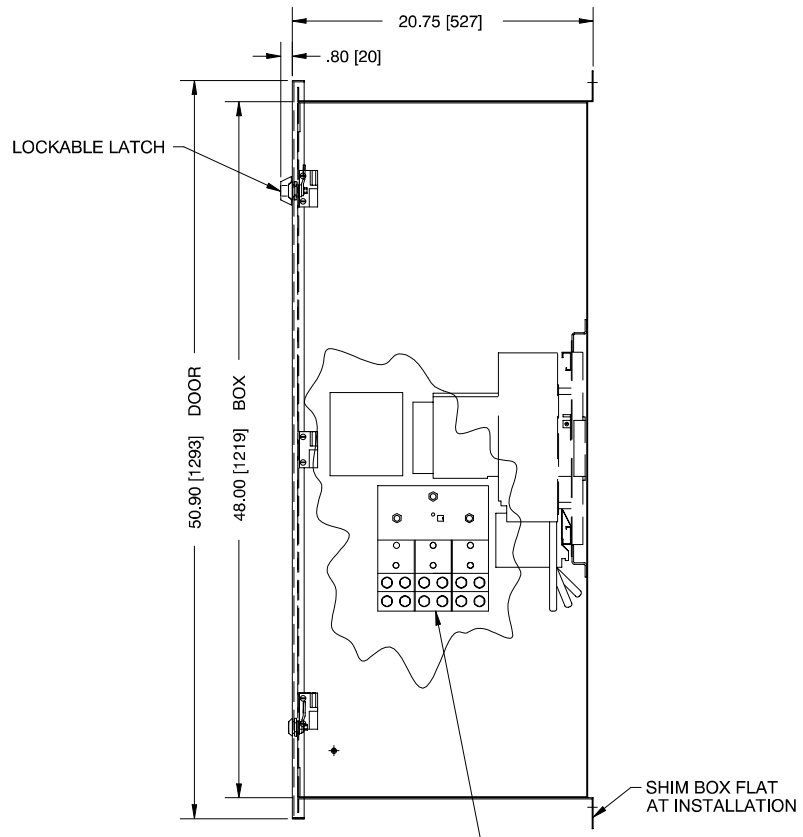


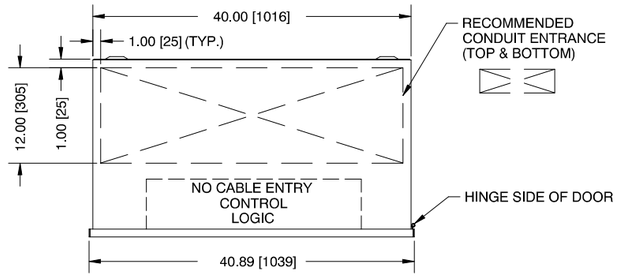


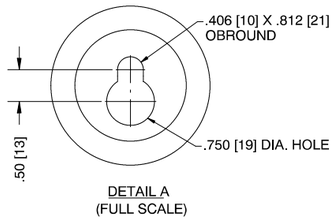
NOTE:
1. DIMENSIONS IN [ ] ARE MILLIMETERS.

AMPS	# OF CABLES	SIZE (USA)	SIZE (METRIC)	TORQUE (Nm)
630	2	3/0 AWG to 500 MCM	85 to 240 mm^2	31
400	1	#2 AWG to 600 MCM	35 to 300 mm^2	31

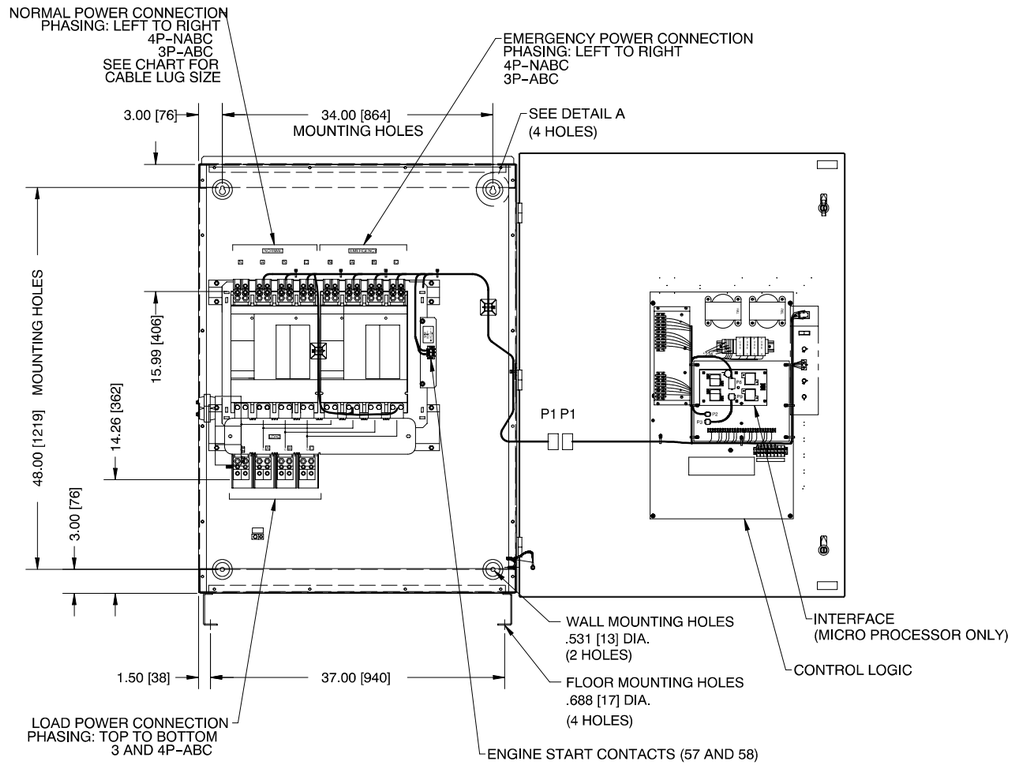
ADV-6387-

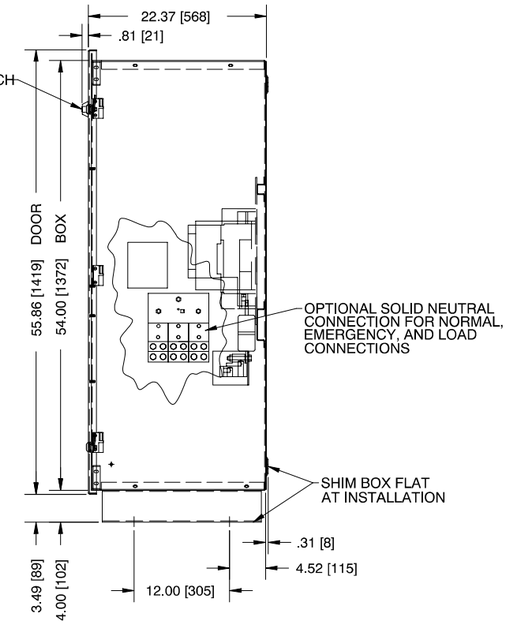
Enclosure Dimensions, 400-630 Amp, ADV-6387-





DETAIL A
(FULL SCALE)



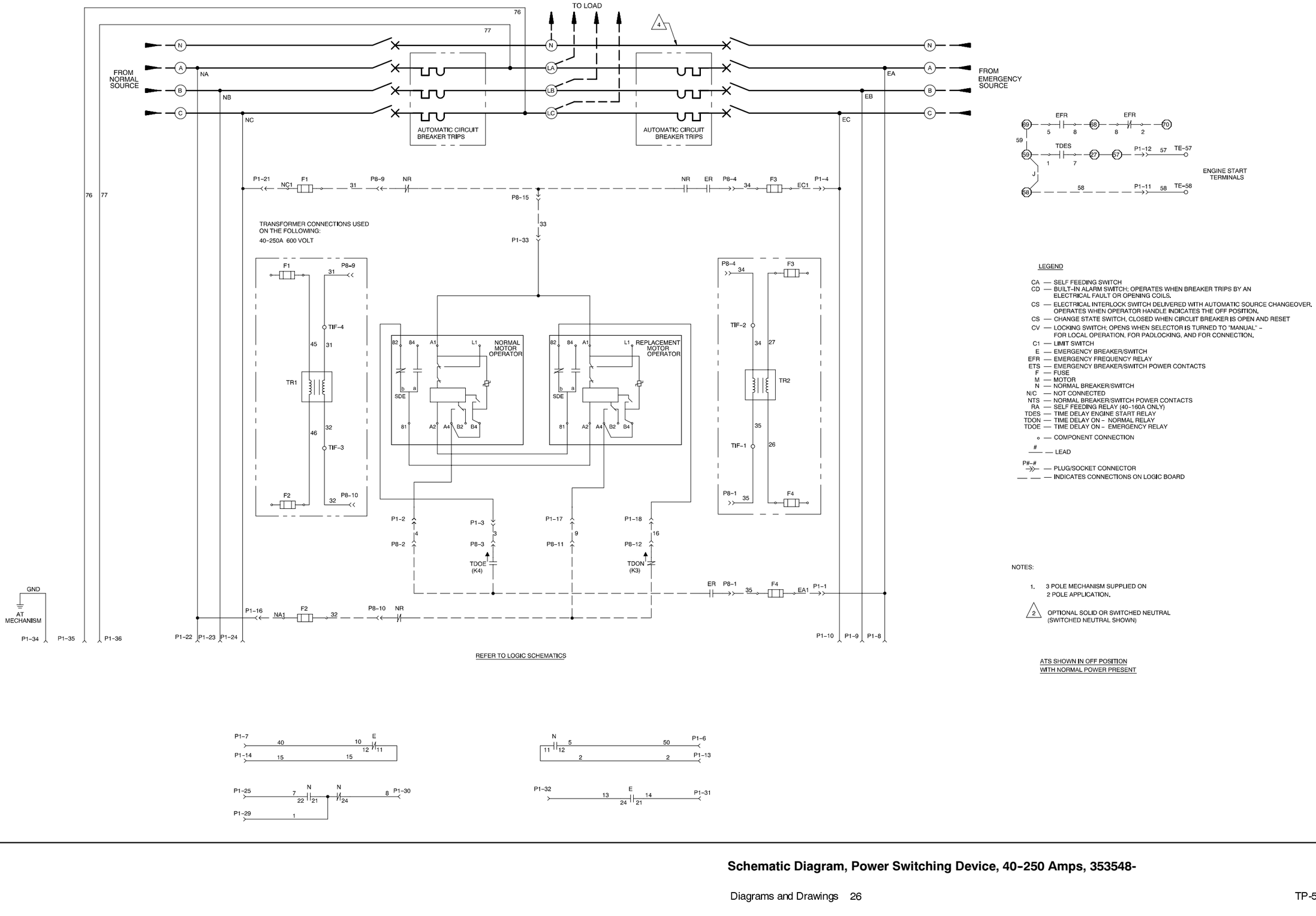


NOTE:
1. DIMENSIONS IN [ ] ARE MILLIMETERS.

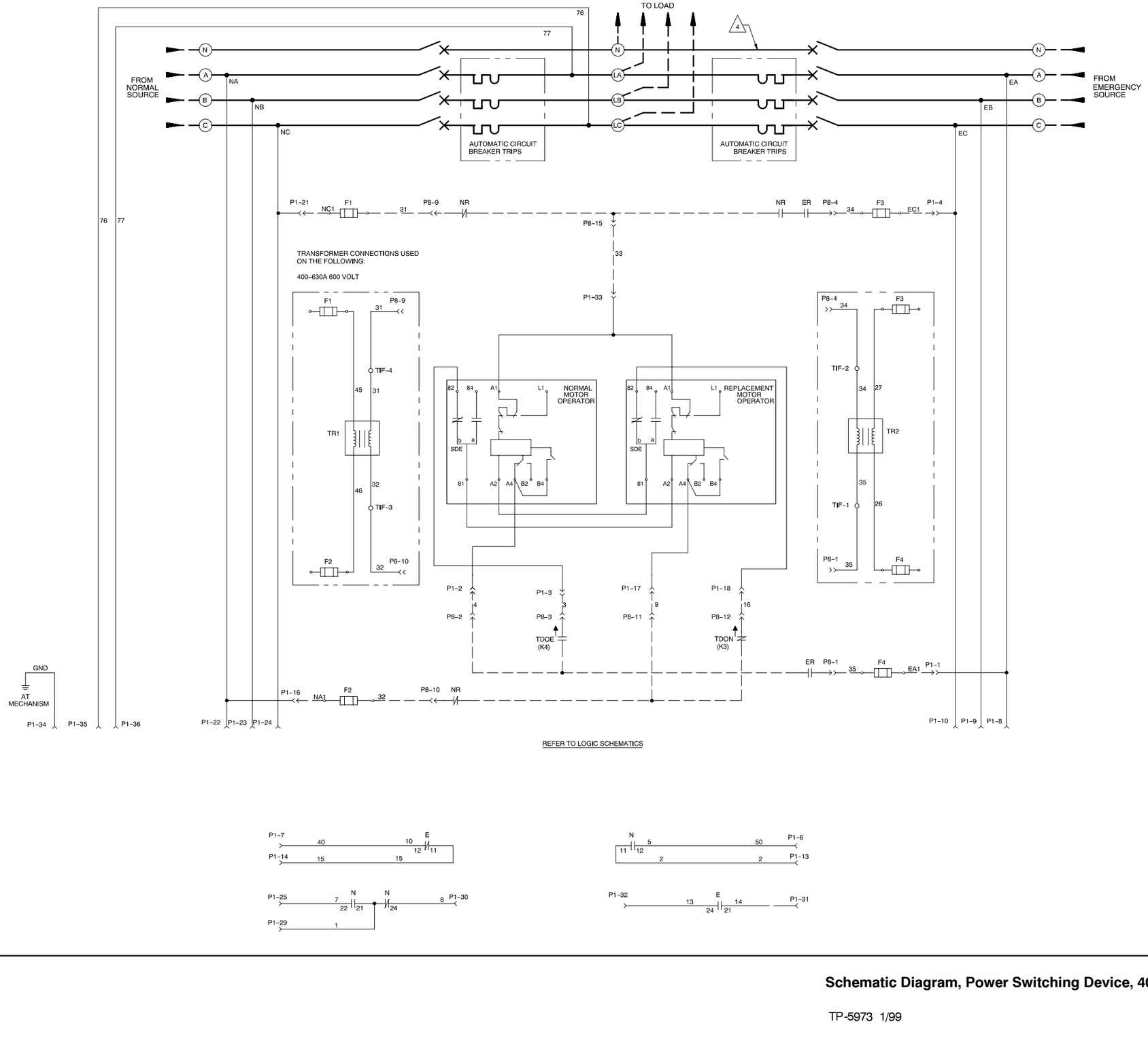
AMPS	# OF CABLES	SIZE (USA)	SIZE (METRIC)	TORQUE (Nm)
1250	4	2/0 AWG to 500 MCM	70 to 240 mm^2	42
1000	4	2/0 AWG to 500 MCM	70 to 240 mm^2	42
800	3	2/0 AWG to 350 MCM	70 to 185 mm^2	31

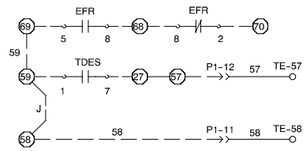
ADV-6385-

Enclosure Dimensions, 800-1250 Amp, ADV-6385-



Schematic Diagram, Power Switching Device, 40-250 Amps, 353548-





LEGEND

CA — SELF FEEDING SWITCH
CD — BUILT-IN ALARM SWITCH; OPERATES WHEN BREAKER TRIPS BY AN ELECTRICAL FAULT OR OPENING COILS.
CS — ELECTRICAL INTERLOCK SWITCH DELIVERED WITH AUTOMATIC SOURCE CHANGEOVER. OPERATES WHEN OPERATOR HANDLE INDICATES THE OFF POSITION.
CS — CHANGE STATE SWITCH, CLOSED WHEN CIRCUIT BREAKER IS OPEN AND RESET
CV — LOCKING SWITCH; OPENS WHEN SELECTOR IS TURNED TO "MANUAL" - FOR LOCAL OPERATION, FOR PADLOCKING, AND FOR CONNECTION.
C1 — LIMIT SWITCH
E — EMERGENCY BREAKER/SWITCH
EFR — EMERGENCY FREQUENCY RELAY
ETS — EMERGENCY BREAKER/SWITCH POWER CONTACTS
F — FUSE
M — MOTOR
N — NORMAL BREAKER/SWITCH
N/C — NOT CONNECTED
NTS — NORMAL BREAKER/SWITCH POWER CONTACTS
RA — SELF FEEDING RELAY (40–160A ONLY)
TDES — TIME DELAY ENGINE START RELAY
TDON — TIME DELAY ON – NORMAL RELAY
TDOE — TIME DELAY ON – EMERGENCY RELAY
∘ — COMPONENT CONNECTION
— LEAD
P#–# — PLUG/SOCKET CONNECTOR
— — — — INDICATES CONNECTIONS ON LOGIC BOARD

NOTES:

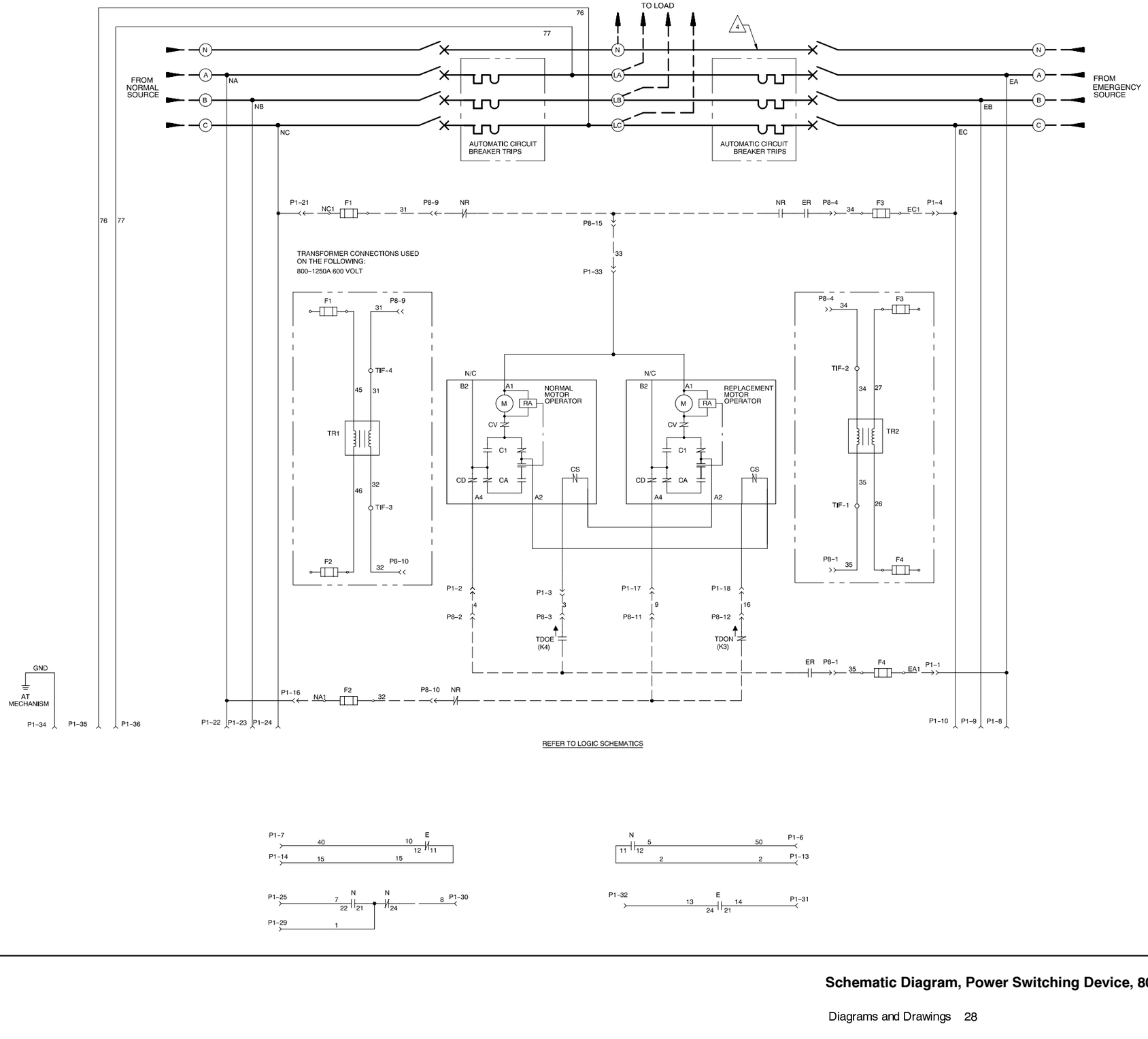
1. 3 POLE MECHANISM SUPPLIED ON 2 POLE APPLICATION.

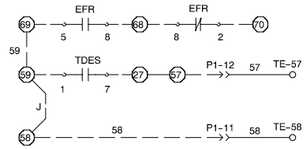
2 OPTIONAL SOLID OR SWITCHED NEUTRAL (SWITCHED NEUTRAL SHOWN)

ATS SHOWN IN OFF POSITION WITH NORMAL POWER PRESENT

353538-

Schematic Diagram, Power Switching Device, 400–630 Amps, 353538-





LEGEND

CA — SELF FEEDING SWITCH
CD — BUILT–IN ALARM SWITCH; OPERATES WHEN BREAKER TRIPS BY AN ELECTRICAL FAULT OR OPENING COILS.
CS — ELECTRICAL INTERLOCK SWITCH DELIVERED WITH AUTOMATIC SOURCE CHANGEOVER. OPERATES WHEN OPERATOR HANDLE INDICATES THE OFF POSITION.
CS — CHANGE STATE SWITCH, CLOSED WHEN CIRCUIT BREAKER IS OPEN AND RESET
CV — LOCKING SWITCH; OPENS WHEN SELECTOR IS TURNED TO "MANUAL" – FOR LOCAL OPERATION, FOR PADLOCKING, AND FOR CONNECTION.
C1 — LIMIT SWITCH
E — EMERGENCY BREAKER/SWITCH
EFR — EMERGENCY FREQUENCY RELAY
ETS — EMERGENCY BREAKER/SWITCH POWER CONTACTS
F — FUSE
M — MOTOR
N — NORMAL BREAKER/SWITCH
N/C — NOT CONNECTED
NTS — NORMAL BREAKER/SWITCH POWER CONTACTS
RA — SELF FEEDING RELAY (40–160A ONLY)
TDES — TIME DELAY ENGINE START RELAY
TDON — TIME DELAY ON – NORMAL RELAY
TDOE — TIME DELAY ON – EMERGENCY RELAY
∘ — COMPONENT CONNECTION
— LEAD
P#–# — PLUG/SOCKET CONNECTOR
— — — — INDICATES CONNECTIONS ON LOGIC BOARD

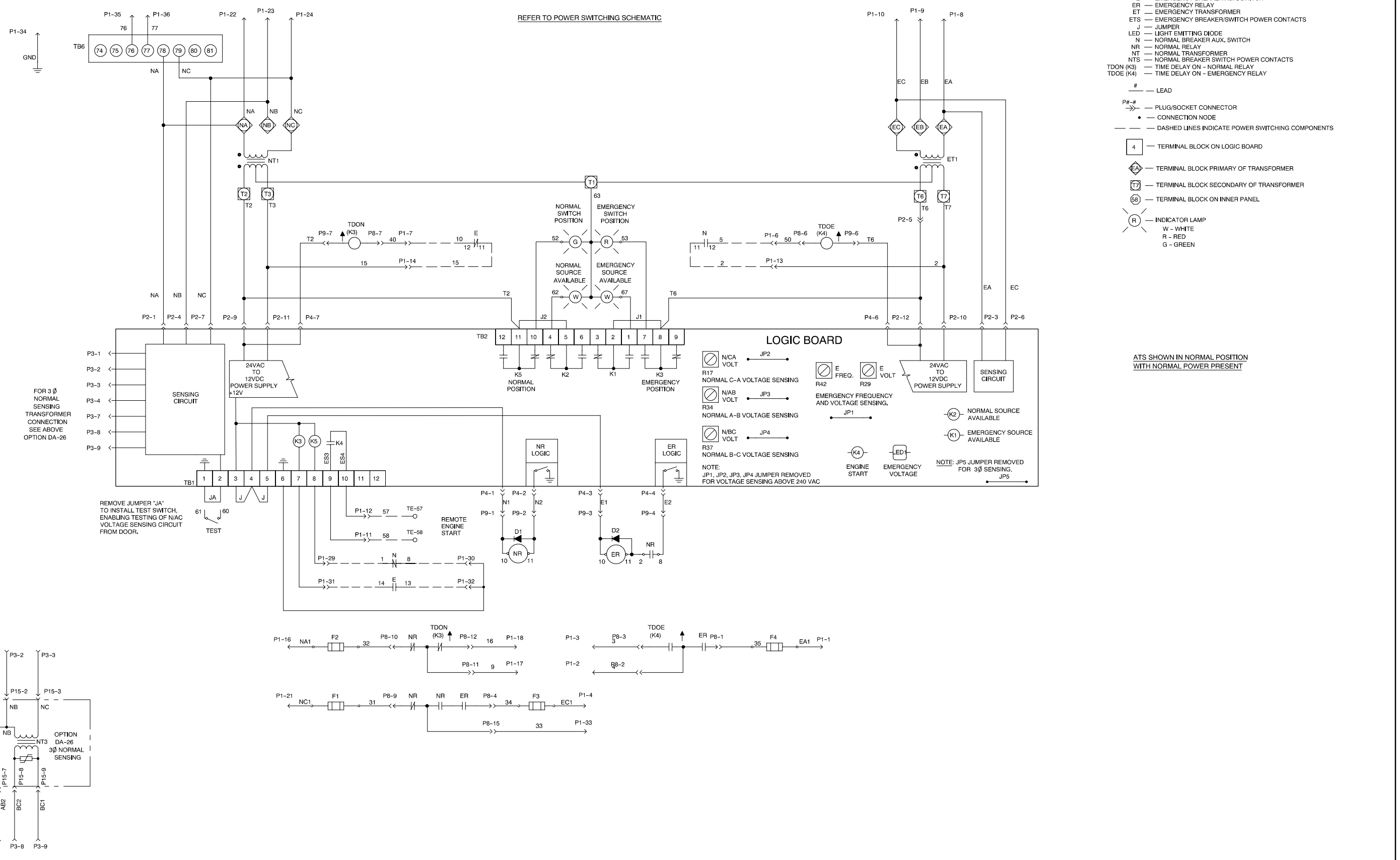
NOTES:

1. 3 POLE MECHANISM SUPPLIED ON 2 POLE APPLICATION.
2. OPTIONAL SOLID OR SWITCHED NEUTRAL (SWITCHED NEUTRAL SHOWN)

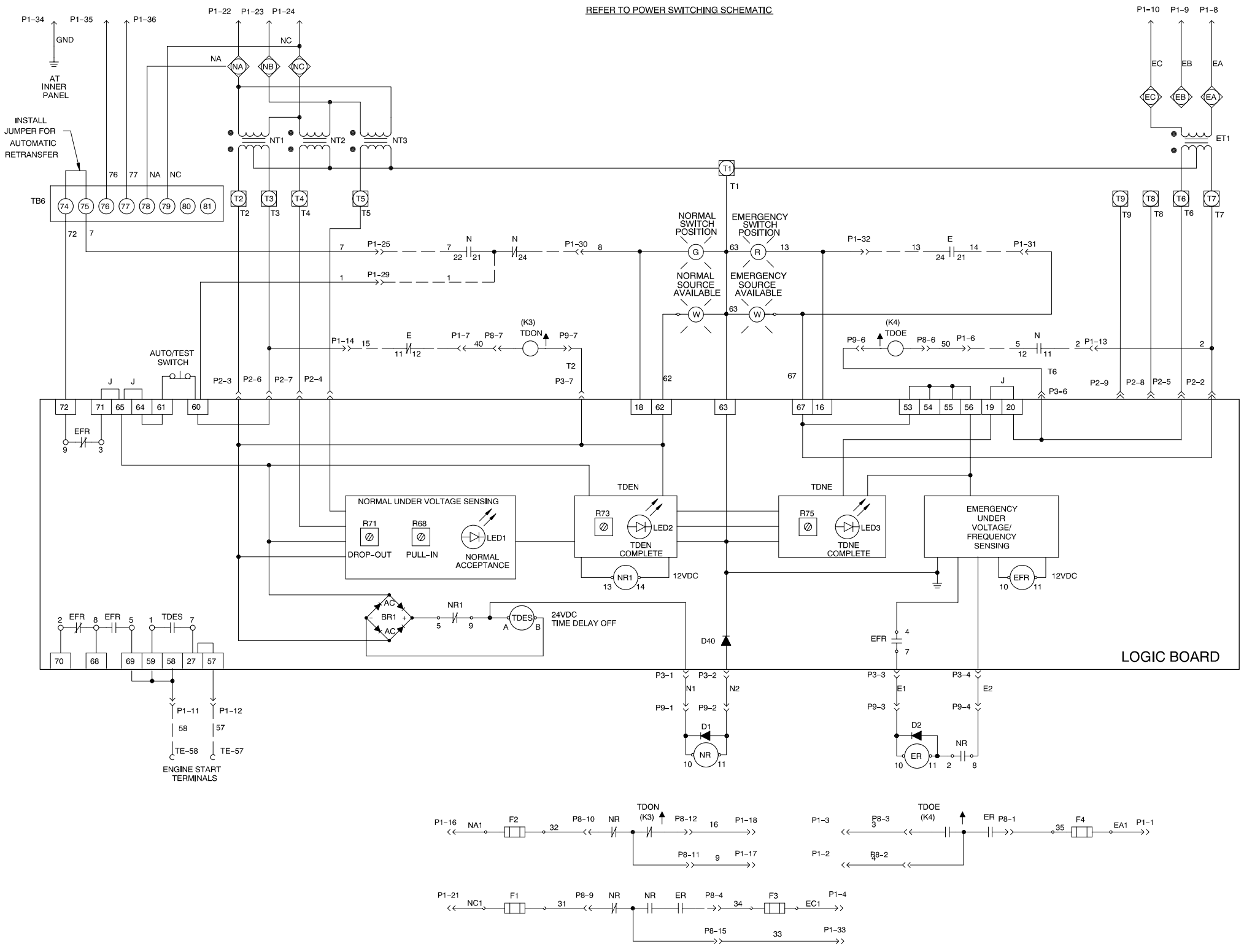
ATS SHOWN IN OFF POSITION WITH NORMAL POWER PRESENT

353539-

Schematic Diagram, Power Switching Device, 800–1250 Amps, 353539-



Schematic Diagram, E33+ Logic, 353552-



LEGEND

BR	— BRIDGE RECTIFIER
C	— CAPACITOR
D	— DIODE
E	— EMERGENCY BREAKER/SWITCH
EFR	— EMERGENCY FAILURE RELAY
ER	— EMERGENCY RELAY
ET	— EMERGENCY SENSING TRANSFORMER
F	— FUSE
J	— JUMPER
LED	— LIGHT EMITTING DIODE
N	— NORMAL BREAKER/SWITCH
NR	— NORMAL RELAY
NR1	— NORMAL RELAY #1
NT	— NORMAL SENSING TRANSFORMER
NTS	— NORMAL BREAKER/SWITCH POWER CONTACTS
Q	— TRANSISTOR
R	— RESISTOR
TDEN	— TIME DELAY EMERGENCY TO NORMAL CIRCUIT
TDES	— TIME DELAY ENGINE START RELAY
TDON	— TIME DELAY ON - NORMAL RELAY
TDNE	— TIME DELAY NORMAL TO EMERGENCY CIRCUIT
TDOE	— TIME DELAY ON - EMERGENCY RELAY

- ○ ### — COMPONENT CONNECTION
- # —— — LEAD
- P#-# — PLUG/SOCKET CONNECTOR
- LOGIC BOARD DIP CONNECTOR
- • — CONNECTION NODE
- (4) — TERMINAL BLOCK ON INNER PANEL AND/OR TRANSFER SWITCH POWER TERMINALS
- EA — TERMINAL BLOCK PRIMARY OF TRANSFORMER
- T7 — TERMINAL BLOCK SECONDARY OF TRANSFORMER

(R) — INDICATOR LAMP
W - WHITE
R - RED
G - GREEN

ATS SHOWN IN NORMAL POSITION WITH NORMAL POWER PRESENT

353554-

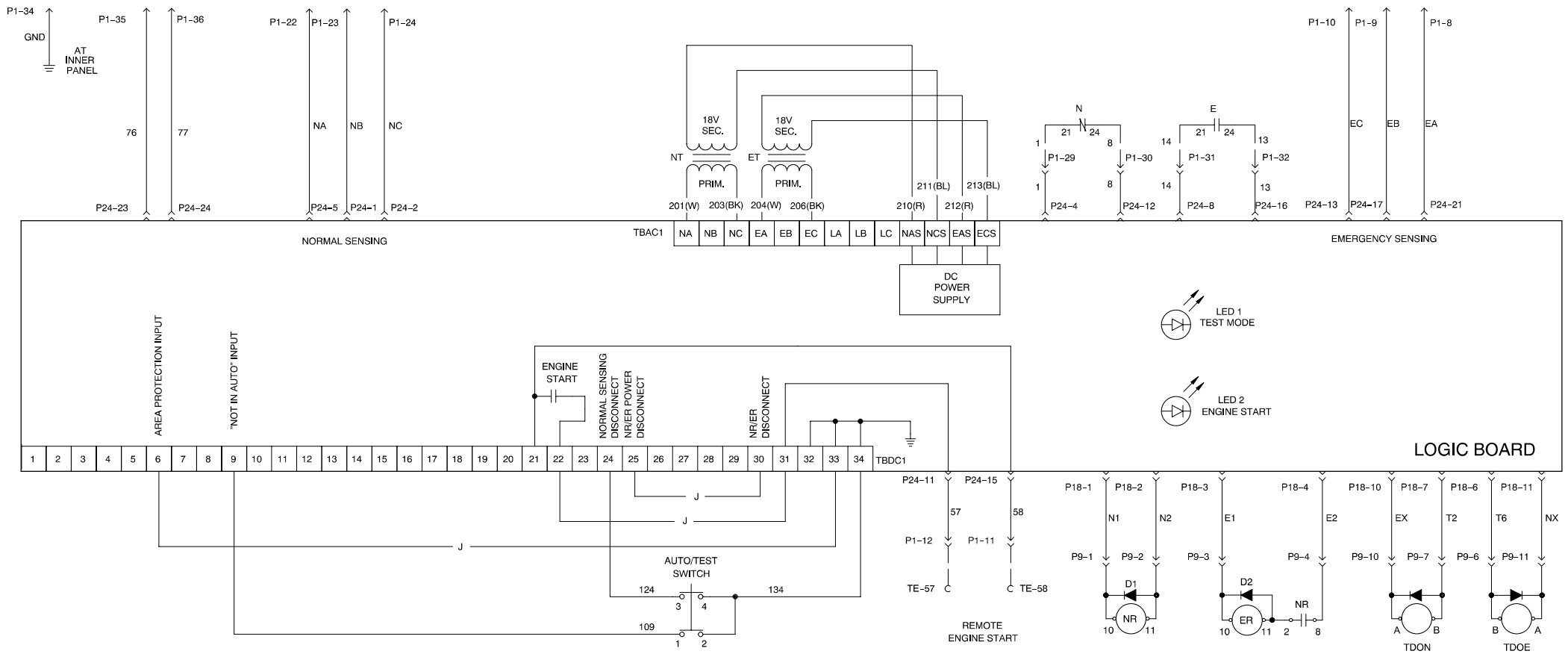
Schematic Diagram, S340+ Logic, 353554-

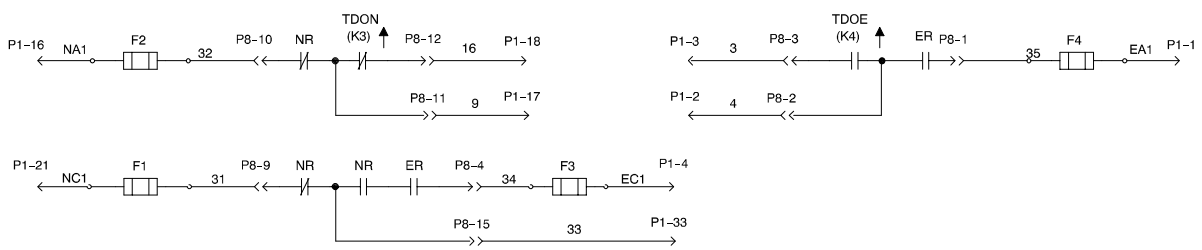
REFER TO POWER SWITCHING SCHEMATIC

LEGEND

CS(E) — EMERGENCY CHANGE STATE SWITCH
CS(N) — NORMAL CHANGE STATE SWITCH
DS — DISCONNECT SWITCH
E — EMERGENCY BREAKER AUX. SWITCH
ER — EMERGENCY RELAY
ET — EMERGENCY TRANSFORMER
ETS — EMERGENCY BREAKER/SWITCH POWER CONTACTS
F — FUSE
J — JUMPER
LED — LIGHT EMITTING DIODE
N — NORMAL BREAKER AUX. SWITCH
NR — NORMAL RELAY
NT — NORMAL TRANSFORMER 1, 2, 3
NTS — NORMAL BREAKER SWITCH POWER CONTACTS
TDON (K3) — DELAY TO NORMAL RELAY
TDOE (K4) — DELAY TO EMERGENCY RELAY
TR — INTERFACE TRANSFORMER

— LEAD
P#–# — PLUG/SOCKET CONNECTOR
○ — COMPONENT CONNECTION
— — — DASHED LINES INDICATE POWER SWITCHING COMPONENTS





ATS SHOWN IN NORMAL POSITION
WITH NORMAL POWER PRESENT

353550-

Schematic Diagram, M340+ Logic, 353550-

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Kohler automatic transfer switches are shipped factory wired and tested, ready for installation. Installation of the transfer switch consists of the following:

- Unpacking and inspecting the switch upon receipt.
- Protecting the switch against damage before and during installation.
- Wiring of normal source (utility), emergency source (generator), and load power circuits.
- Wiring of control connections such as generator start signals and accessories.
- Connecting and initializing the controller.
- Checking voltages and functions.

The transfer switch logic controller operation and installation manual explains the installation and operation of the controller. See the List of Related Materials in the Introduction. Section 3—Accessories and the transfer switch logic controller operation and installation manual explain the installation and operation of accessories.

6.1 Receipt of Unit

6.1.1 Inspection

At the time of delivery, inspect the transfer switch for signs of shipping damage. If damage and/or rough handling is evident, file a damage claim immediately with the transportation company and promptly notify the distributor/dealer.

6.1.2 Lifting

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Use adequate lifting capacity.
Never leave the transfer switch standing upright unless it is securely bolted in place or stabilized.

Figure 1-5 in Section1.6 lists the approximate weight of each automatic transfer switch covered by this manual. Use a spreader bar to lift the transfer switch. Attach the bar only to the enclosure's mounting holes or lifting brackets; do not lift the unit at any other points. Close and latch the enclosure door before moving or mounting the unit.

6.1.3 Unpacking

Unpack the transfer switch immediately after receipt and inspect it for shipping damage. Failure to perform an immediate inspection impedes recovery of losses caused by shipping damage. Use care when unpacking to avoid damaging the transfer switch components. Remove all dirt and packing material that may have accumulated in the transfer switch or any of its components. Record the product identification numbers in the spaces provided in the Service Assistance section of this manual.

If the equipment has been stored at cold temperatures, allow it to warm to room temperature for at least 24 hours before unpacking to prevent condensation on the electrical apparatus.

6.1.4 Storage

Store the transfer switch in its protective packing until ready for final installation. Protect the transfer switch at all times from excessive moisture, construction grit, and metal chips. Avoid storage in low-temperature, high-humidity areas where moisture could condense on the unit.

6.2 Mechanical Installation

Check the system voltage and frequency. Do not install a transfer switch if the system voltage and frequency shown on the transfer switch nameplate is different from the nominal normal (utility) source voltage and frequency or the nominal emergency source voltage and frequency shown on the generator set nameplate.

To plan the installation, use the dimensions given on the enclosure dimension drawings in Section 5. Select the mounting site to comply with local electrical code restrictions for the enclosure type. Mount the automatic transfer switch as close to the load and power sources as possible. Allow adequate space to fully open the enclosure door and to service the switch.

Mount the 40- through 630-ampere automatic transfer switches vertically to a wall or other rigid supporting structure. Use the keyhole slots provided in the mounting brackets on the top and bottom of each unit to bolt the unit to the supporting structure. To avoid distortion of the enclosure or door, plumb the enclosure by placing washers behind the keyholes to ensure that the door hinges are vertical.

Mount the 800- through 1250-ampere automatic transfer switches vertically on the floor or on a wall or other rigid supporting structure. When floor mounting these units, shim the mounting feet to plumb the enclosure so that the door hinges are vertical to avoid distortion of the enclosure or door. When wall mounting these units, use the keyhole slots provided in the mounting brackets on the top and bottom of each unit to bolt the unit to the supporting structure. To avoid distortion of the enclosure or door, plumb the enclosure by placing washers behind the keyholes to ensure that the door hinges are vertical.

6.3 Manual Operation Check

Follow the procedure in Section 2 to manually operate the power switching device to verify that it operates smoothly without binding. If the power switching device does not operate smoothly without binding, *STOP*. Call an authorized service center to service the power switching device before proceeding.

6.4 Electrical Wiring

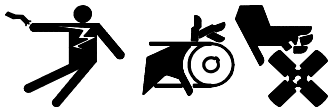
The factory wires all internal electrical connections. The only wiring necessary to install the transfer switch is to connect the transfer switch to external devices and power sources.

Observe all applicable national, state, and local electrical codes during installation.

Install DC, control, and communication system wiring in raceways, cables, or conduit separate from AC power wiring.

Section 5 provides schematic diagrams and enclosure drawings.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before opening the enclosure.

(600 volts and under)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect all power sources before servicing. Install the barrier after adjustments, maintenance, or servicing.

(600 volts and under)

Grounding the transfer switch. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the transfer switch and related equipment and electrical circuits to comply with applicable codes and standards. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

Hazardous voltage can cause severe injury or death. To prevent electrical shock disconnect the harness plug before installing accessories that will be connected to transformer assembly primary terminals 76, 77, 78, and 79. Terminals are at line voltage. *(Models with E33+, S340, S340+, 340, R340, and R33 controls only)*

Installing the battery charger. Hazardous voltage can cause severe injury or death. An ungrounded battery charger may cause electrical shock. Connect the battery charger enclosure to the ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect it to the equipment grounding terminal or the lead on the battery charger. Install the battery charger as prescribed in the equipment manual. Install the battery charger in compliance with local codes and ordinances.

Connecting the battery and the battery charger. Hazardous voltage can cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

Installing accessories to the transformer assembly. Hazardous voltage can cause severe injury or death. To prevent electrical shock disconnect the harness plug before installing accessories that will be connected to the transformer assembly primary terminals on microprocessor logic models. Terminals are at line voltage.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

Hardware damage. The transfer switch may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

NOTE

For easy access during installation wiring, remove the front door of the enclosure. Disconnect the cable plug that connects the front door components to the internal components and then lift the door off its hinge pins.

6.4.1 AC Power Connections

All conductors should enter the enclosure at the locations shown on the drawings. See Section 5—Diagrams and Drawings. Cover the transfer switch components for protection from metal chips and construction grit before drilling the holes for the conductors. Remove debris from the transfer switch components or enclosure with a vacuum cleaner or by wiping with a dry cloth or brush. *Do not use compressed air to clean the switch because it can cause debris to lodge in components and damage the switch.*

Before connecting the cables to the terminal lugs, clean the cables with a wire brush to remove surface oxides. If using aluminum conductors, apply a joint compound to the cables.

Connect the normal, emergency, and load conductors to the terminals on the transfer switch. Connection points for the normal power, emergency power, and load are clearly marked on the circuit breaker/switch assembly and the drawings. Be sure to follow the phase markings: A, B, C, and N.

NOTE

Connect source and load phases as indicated by the markings and drawings. Improper connections may cause short circuits or cause phase-sensitive load devices to malfunction or operate in reverse.

NOTE

When making power connections to the power switching device, leave sufficient slack in the power leads to reach all of the power connecting lugs on the power switching device.

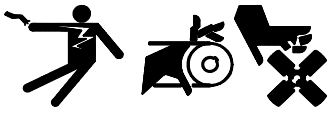
NOTE

On models with M340+ microprocessor logic controls, the power source leads must be phased A-B-C for option DD-34-Z (phase sequence and loss monitoring) to function correctly. If the power source phase sequence is not A-B-C and option DD-34-Z is enabled, the controller considers the source to have failed.

Verify that all connections are consistent with the drawings before tightening the lugs. Tighten all cable lug connections to the torque values shown in Figure 1-9 . After tightening the terminal lugs, carefully wipe off the excess joint compound.

6.4.2 Generator Start Connection

⚠ WARNING



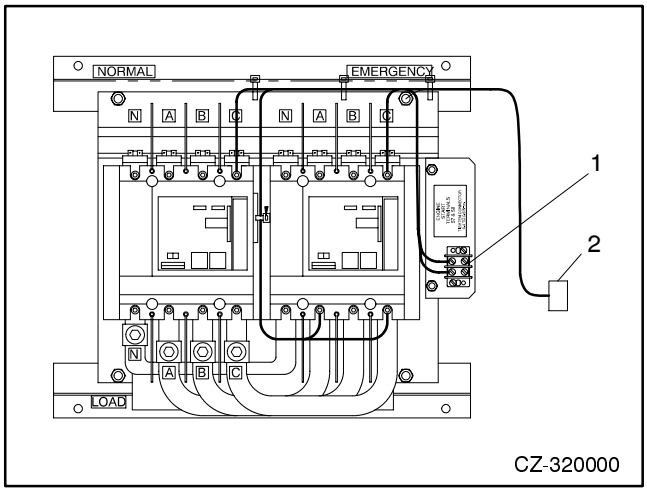
Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

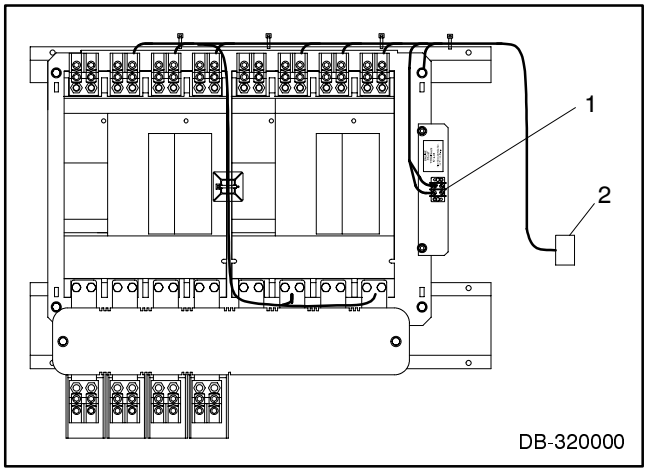
Prevent the emergency power source generator set from starting by moving the generator set master switch to the OFF position; disconnecting power to the generator set battery charger, if installed; and removing the generator set engine start battery cables, negative (-) leads first.

Connect the generator set to the generator start signal connections located on terminals 57 and 58 of the circuit breaker/switch assembly. The controller provides a contact closure through the wire harness to these terminals to signal the generator set to start. A red decal identifies the terminal block; see Figure 6-1 or Figure 6-2 for the terminal block location. Tighten these connections to 4–5 in. lbs. (0.4–0.6 Nm).



1. Engine start terminals 57 and 58
2. Inline plug, P1

Figure 6-1. Typical Circuit Breaker/Switch Assembly, 40–630 Amps



1. Engine start terminals 57 and 58
2. Inline plug, P1

Figure 6-2. Typical Circuit Breaker/Switch Assembly, 800-1250 Amps

6.4.3 Accessory and Control Connections

Complete external connections for accessories. Section 3—Accessories and the transfer switch logic controller operation and installation manual explain the installation and operation of accessories. See Sections 1.3 and 1.4 of this manual for nameplate and model number information to identify the type of logic controller. See the List of Related Materials in the Introduction of this manual for the logic controller manual part number.

Perform the voltage check procedure in Section 6.6 before connecting the power switching device wire harness to the controller wire harness at the inline plug shown in Figure 6-1 or Figure 6-2. See the logic controller operation and installation manual for additional control connection information.

6.5 Generator Set Preparation

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Disconnect all power sources to the transfer switch by opening upstream circuit breakers or switches to the transfer switch.

Prepare the generator set that provides the emergency power source to the transfer switch for operation. Check the oil level, coolant level, fuel supply, batteries, and items specified by the generator set installation or operation checklist or manual.

Move the generator set master switch to the OFF position; reconnect generator engine start battery cables, negative (–) leads last; and reconnect power to the generator engine start battery chargers, if installed.

6.6 Functional Tests

6.6.1 Voltage Check

Perform a voltage check to verify that the voltages and phasing of all power sources are compatible with the transfer switch before energizing the load or connecting the power switching device wire harness to the controller wire harness.

The nominal voltage and frequency of the normal (utility) source, the transfer switch nameplate, and the generator set output and nameplate should all be the same to avoid damage to loads and the transfer switch.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Only authorized personnel should open the enclosure.

(600 volts and under)

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove rings, wristwatch, and jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Read and understand all instructions on installation drawings and labels affixed to the switch. Note any optional accessories that have been furnished with the switch and review their operation.

Voltage Check Procedure

NOTE

Perform voltage checks in the order given to avoid damaging the transfer switch.

1. Disconnect all power sources before opening the transfer switch enclosure by opening the upstream circuit breakers or switches leading to the transfer switch.

2. Disconnect the power switching device and logic controller wire harnesses at the inline disconnect plug (P1). See Figure 6-1 or Figure 6-2.
3. Move the generator set master switch to the OFF position to inhibit generator set starting.
4. Manually transfer the load to the emergency source. See Section 2.4.
5. Reapply the normal source by closing the circuit breakers or switches.
6. Use an accurate voltmeter to check the normal source phase-to-phase and phase-to-neutral terminal voltages. Use accurate test equipment to check the phase rotation at the normal source terminals. If the nominal normal source voltage or frequency does not match the value shown on the transfer switch nameplate, *STOP.* Do not continue the installation because the transfer switch is not designed for the application. Call a local service distributor to order the correct transfer switch. Rewire the transfer switch normal source terminals to obtain a phase sequence of A-B-C if required on transfer switches with microprocessor controls.

NOTE

The power source leads must be phased A-B-C for option DD-34-Z (phase sequence and loss monitoring) to function correctly on microprocessor-based controls. If the power source phase sequence is not A-B-C and option DD-34-Z is enabled, the controller considers the source to have failed.

7. Disconnect the normal power source by opening the upstream circuit breakers or switches leading to the transfer switch.
8. Manually transfer the load to the normal source. See Section 2.4.
9. Reapply the emergency source by closing the circuit breakers or switches.
10. Move the generator set master switch to the RUN position. The generator set should start.
11. Use an accurate voltmeter to check the emergency source phase-to-phase and phase-to-neutral terminal voltages. Use accurate test equipment to check the phase rotation at the emergency-source terminals. Rewire the transfer switch emergency source terminals if the emergency source phase rotation is not the same as the normal source.
12. Follow the generator set manufacturer's instructions to adjust the generator output voltage and frequency to match the nominal system voltage and frequency shown on the transfer switch nameplate if they are different. The automatic transfer switch will operate correctly only to the rated system voltage and frequency specified on the nameplate.
13. Move the generator set master switch to the AUTO position.
14. Disconnect the emergency power source by opening the upstream circuit breakers or switches to the transfer switch.
15. Set both circuit breakers/switches for automatic operation. See Section 2.4.
16. Connect the power switching device and controller wiring harnesses together at the inline disconnect plug. See Figure 6-1 or Figure 6-2.
17. Close and lock the transfer switch enclosure door.
18. Reconnect power sources by closing the circuit breakers or switches.

NOTE

When initially applying power to the transfer switch, the engine start contacts remain closed, signaling the generator to run until the ATS's Time Delay Engine Cooldown (TDEC), if equipped, ends.

Installation of the transfer switch's power switching device is complete.

6.6.2 Automatic Operation Test

Test the transfer switch's automatic control system. See the logic controller operation and installation manual for the test procedure.

6.7 Controller Setup

See the logic controller operation and installation manual for controller startup and setup procedures.

6.8 Warranty Registration

The transfer switch seller must complete a Startup Notification Form and submit it to the manufacturer within 60 days of the initial startup date. A Startup Notification Form is included with generator sets and covers all equipment in the standby system. Standby systems not registered within 60 days of the initial date are automatically registered using the manufacturer's ship date as the startup date.

Appendix A. Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally in the text they will appear in complete form with the abbreviation following in parenthesis the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below.

AC	alternating current
AISI	American Iron and Steel Institute
Amp	ampere
Amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
aux.	auxiliary
AWG	American Wire Gauge
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective pressure
Btu	British thermal unit
°C	Celsius degree
cc	cubic centimeter
CCA	cold cranking Amps.
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch, cubic inches
cyl.	cylinder
dB	decibel
dBA	decibels (A weighted)
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
e.g.	example given
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPA	Environmental Protection Agency
etc.	et cetera (and so forth)
ext.	external
°F	Fahrenheit degree
fl. oz.	fluid ounce, fluid ounces
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
ga.	gauge (meters, wire size)
gal./ gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
gnd.	ground
HCHT	high cylinder head temperature
HET	high exhaust (or engine) temperature
Hg	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronic Engineers
in.	inch(es)
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms
kg/cm^2	kilograms per square centimeter
kgm	kilogram meter(s)
kJ	kilojoules (btu cal)
km	kilometer, kilometers
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
LxWxH	length x width x height
LED(s)	light emitting diode
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minutes
LOP	low oil pressure
LP	liquefied petroleum
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
meggar	megohmmeter
MHz	megahertz
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
mJ	millijoule, millijoules
MJ	mega joule, mega joules
mm	millimeter, millimeters
m^3/min	cubic meters per minute
MPa	megaPascal
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available or not applicable
NBS	National Bureau of Standards
N.C.	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	Newton meter, Newton meters
no., nos	number, numbers
NPT	National Standard taper pipe thread per general use
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed, oversize
O/S	oversize
OSHA	Occupational Safety and Health Act
OV	overvoltage
oz.	ounce, ounces
PF	power factor
PMG	permanent magnet generator
pot.	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
PVC	polyvinyl chloride
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
r.h.m.	round-head machine (screw)
rms	root mean square
RPM	revolutions per minute
RTV	room temperature vulcanization
SAE	Society of Automotive Engineers
SCR	silicon-controlled rectifier
sec.	second, seconds
spec.	specs, specification
sq.	square
sq. cm	square centimeters
sq. in.	square inch, square inches
tach	tachometer
TDC	top dead center
tech. pub.	technical publications
temp.	temperature
TIF	telephone influence factor
TP, TPs	technical publications
turbo	turbocharger
UHF	ultrahigh frequency
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter's Laboratories, Inc.
U/S	undersize
U.S.A.	United States of America
V	volt, volts
vac	volts alternating current
vdc	volts direct current
VHF	very high frequency
W	watt, watts

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