



Powering Business Worldwide

O & M Manual for 1600A (480 Vac) ATC-300 + /900 & Non-Automatic, 3-Position Fixed Mount Contactor Based Transfer Switch

Instruction Booklet

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WARNING

READ AND UNDERSTAND THE INSTRUCTIONS CONTAINED HEREIN AFTER BEFORE ATTEMPTING TO UNPACK, ASSEMBLE, OPERATE, OR MAINTAIN THIS EQUIPMENT.

HAZARDOUS VOLTAGES ARE PRESENT INSIDE TRANSFER SWITCH ENCLOSURES THAT CAN CAUSE DEATH OR SEVERE PERSONAL INJURY. FOLLOW PROPER INSTALLATION, OPERATION, AND MAINTENANCE PROCEDURES TO AVOID THESE VOLTAGES.

TRANSFER SWITCH EQUIPMENT COVERED BY THIS INSTRUCTION BOOK IS DESIGNED AND TESTED TO OPERATE WITHIN ITS NAMEPLATE RATINGS. OPERATION OUTSIDE OF THESE RATINGS MAY CAUSE THE EQUIPMENT TO FAIL RESULTING IN DEATH, SERIOUS BODILY INJURY, AND/OR PROPERTY DAMAGE. ALL RESPONSIBLE PERSONNEL SHOULD LOCATE THE DOOR MOUNTED EQUIPMENT NAMEPLATE AND BE FAMILIAR WITH THE INFORMATION PROVIDED ON THE NAMEPLATE. A TYPICAL EQUIPMENT NAMEPLATE IS SHOWN IN FIGURE 1.

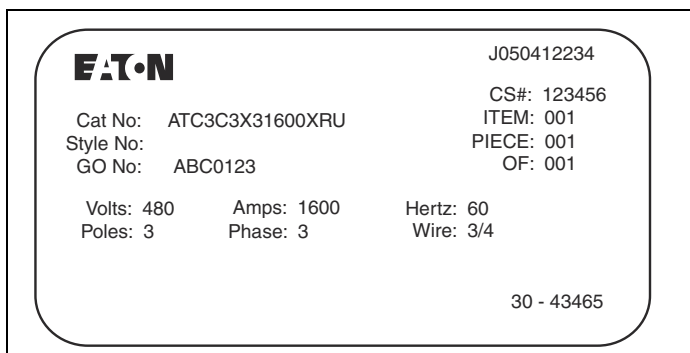


Figure 1. Typical Automatic Transfer Switch (ATS) Equipment Nameplate.

All possible contingencies that may arise during installation, operation, or maintenance, and all details and variations of this equipment do no purport to be covered by these instructions. If further information is desired by the purchaser regarding a particular installation, operation, or maintenance of particular equipment, please contact an authorized Eaton Sales Representative or the installing contractor.

Section 1: Introduction

1.1 Preliminary Comments and Safety Precautions

This technical document is intended to cover most aspects associated with the installation, application, operation, and maintenance of the Automatic Transfer Controller (ATC-300 + /800) controlled contactor based ATS rated at 1600 amperes (A). It is provided as a guide for authorized and qualified personnel only. Please refer to the specific WARNING and CAUTION in Section 1.1.2 before proceeding. If further information is required by the purchaser regarding a particular installation, application, or maintenance activity, please contact an authorized Eaton sales representative or the installing contractor.

1.1.1 Warranty and Liability Information

No warranties, expressed or implied, including warranties of fitness for a particular purpose of merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations and descriptions contained herein. In no event will Eaton be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information and descriptions contained herein.

1.1.2 Safety Precautions

All safety codes, safety standards, and/or regulations must be strictly observed in the installation, operation, and maintenance of this device.



WARNING

THE WARNINGS AND CAUTIONS INCLUDED AS PART OF THE PROCEDURAL STEPS IN THIS DOCUMENT ARE FOR PERSONAL SAFETY AND PROTECTION OF EQUIPMENT FROM DAMAGE. AN EXAMPLE OF A TYPICAL WARNING LABEL HEADING IS SHOWN ABOVE TO FAMILIARIZE PERSONNEL WITH THE STYLE OF PRESENTATION. THIS WILL HELP TO INSURE THAT PERSONNEL ARE ALERT TO WARNINGS, WHICH APPEAR THROUGHOUT THE DOCUMENT. IN ADDITION, WARNINGS AND CAUTIONS ARE ALL UPPER CASE AND BOLDFACE.



CAUTION

COMPLETELY READ AND UNDERSTAND THE MATERIAL PRESENTED IN THIS DOCUMENT BEFORE ATTEMPTING INSTALLATION, OPERATION, OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THIS EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED PRECISELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE.

1.2 General Information

Transfer switches are used to protect critical electrical loads against loss of power. The load's Source 1 power source is backed up by a Source 2 power source. A transfer switch is connected to both the Source 1 and Source 2 power sources and supplies the load with power from one of the two sources. In the event that power is lost from Source 1, the transfer switch transfers the load to the Source 2 power source. This transfer is automatic. Once Source 1 power is restored, the load is automatically transferred back to the Source 1 power source (Figure 2).

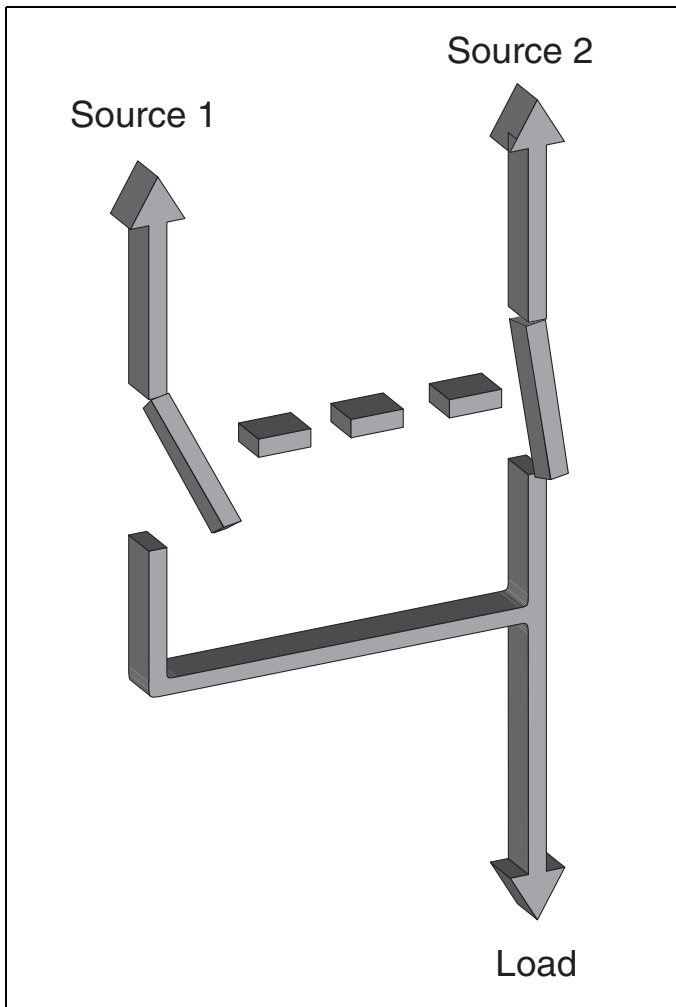


Figure 2. Typical Load Transfer Switch Schematic (Contactor Type).

In ATS equipment, the switch's intelligence system initiates the transfer when the Source 1 power fails, falls below, or rises above a preset voltage. If the Source 2 power source is a standby generator, the ATS initiates generator startup and transfers to the Source 2 power source when sufficient generator voltage is available. When Source 1 power is restored, the ATS automatically transfers back and initiates generator shutdown. In the event the Source 1 power source fails and the Source 2 power source does not appear, the ATS remains connected to the Source 1 power source until the Source 2 power source does appear. Conversely, if connected to the Source 2 power source

and the Source 2 power source fails while the Source 1 power source is still unavailable, the ATS remains connected to the Source 2 power source.

ATSs automatically perform the transfer function and include three basic elements:

1. A power contactor to connect and disconnect the load to and from either power source.
2. Solenoids to make the transfer of the main contacts from source to source.
3. Intelligence/supervisory circuits to constantly monitor the condition of the power sources and thus provide the intelligence necessary for the switch and related circuit operation.

In a Non-Auto transfer switch, the operator will change the position using a three position switch or three push button switches mounted on the front door's device panel. The switches will correspond to Close S1, Trip, Close S21.

2.1 Design Configuration

The Eaton contactor based ATS is a compact design that uses a power contactor to transfer essential loads from one power source to another (Figure 3 [1600A]).

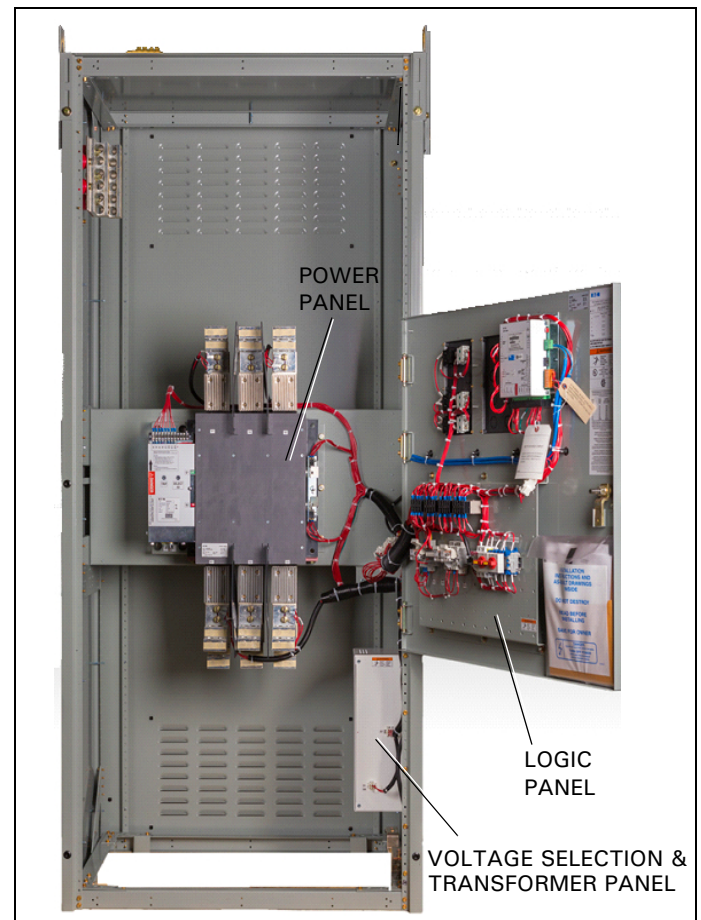


Figure 3. Typical 1600A ATS with an ATC-300+.

1600A (480 Vac) ATC-300 + /900 & Non-Automatic, 3-Position Fixed Mount Contactor Based Transfer Switch

The Eaton contactor based ATS is designed with easy installation and simplified maintenance in mind. Three main panels comprise the contactor based ATS design:

1. Power panel;
2. Voltage selection and transformer panel; and
3. Microprocessor-based logic panel.

Each panel is independently mounted with interconnecting wiring terminated at the connector receptacles on the ATC-300 + /800 Controller.

The 1600A contactor-based fixed-mount transfer switch enclosure is a seismic-approved, free standing design. Refer to Section 4 for specific mounting & modification details.

Table 1. Withstand Ratings.

VOLTAGE V	AMPACITY	FREQUENCY V	# OF PHASES	SHORT CIRCUIT RATING, kA
240	1600	50/60	1	65
480	1600	50/60	3	50, 60#, 200##

- Suitable for use at 65kA when protected by the breakers detailed in Ill. 5 of File E38116 Section General Volume 10, marked with an IR rating of 65kA or greater at 480V with an ampere rating equal to or greater than 125% of the marked maximum transfer switch ampacity rating.

- Suitable for use at 200kA when protected by fuse class and maximum fuse amperage as described in Table 3.

Table 2. 1600A Transfer Switch Catalog Number Explanation.

POSITIONS 1 TO 2 BASIC DEVICE		POSITION 3 SWITCHING DEVICE	POSITION 4 CONTROL PANEL	POSITIONS 5 TO 6 SWITCHING DEVICE	
Automatic Transfer Switch	AT	Contactor	ATC-300+ Controller	3 Position Power Contactor	C3
Non Automatic	NT		ATC-900 Controller	3 Position w In-Phase to TDN	C5
POSITION 7 SWITCHING DEVICE ARRANGEMENT	POSITION 8 NUMBER OF POLES	POSITIONS 9 TO 12 AMPERE RATING	POSITION 13 VOLTAGE/ FREQUENCY	POSITION 14 ENCLOSURE	POSITION 15 LISTING
Fixed Mount	X	1600A – 1600	120 Vac/60 Hz	Type 1	UL/CSA Listing
	Two (2)		208 Vac/60 Hz	Type 3R	No Listing
	Three (3)		240 Vac/60 Hz	Open Type	
	Four (4)		480 Vac/60 Hz	NEMA 12	
			220 Vac/50 Hz	NEMA 4X	
			230 Vac/50 Hz		
			380 Vac/50 Hz		
			415 Vac/50 Hz		

1.3 ATS Catalog Number Identification

Transfer switch equipment catalog numbers provide a significant amount of relevant information that pertains to a particular piece of equipment. The 1600A Catalog Number Identification Table (Table 2) provides the required interpretation information. An example is offered here to initially simplify the process.

Example: Catalog Number (circled numbers correspond to position headings in Table 2).

① to ② ③ ④ ⑤ to ⑥ ⑦ ⑧ ⑨ to ⑫ ⑬ ⑭ ⑮
AT C 3 C3 X 3 1600 X R U

The catalog number ATC3C3X31600XRU describes an ATS with a 3 pole, 3 position Power Contactor mounted on a baseplate within the enclosure. The intelligence represented by the logic panel is ATC-300 + controller. The continuous current rating of this equipment is 1600A and applicable at 480 Vac, 60 Hz. The transfer switch equipment is enclosed in a NEMA 3R enclosure and is listed for UL applications.

1.4 Environmental Conditions

1.4.1 Operational Conditions

Normally, an ATS is applied indoors in an electrical equipment room. In the appropriate enclosure, it can be used for outdoor applications where the equipment is subject to falling rain, freezing temperatures, and no greater than 90% humidity (non-condensing). The ambient temperature range for operation is between -20 and 70°C (-4 to 158°F).

1.5 Glossary

With respect to their use within this document and as they relate to transfer switch and controller operation, the following terminology is defined.

Available

A source is defined as "available" when it is within its undervoltage/overvoltage/ underfrequency/overfrequency (if applicable) setpoint ranges for the nominal voltage and frequency setting.

Connected

Connected is defined as when the input is shorted by an external contact or connection.

Failed or Fails

A source is defined as "failed" when it is outside of the applicable voltage and frequency setpoint ranges for the nominal voltage and frequency setting for a time exceeding 0.5 seconds after the time delay emergency fail (TDEF) time delays expires.

Failsafe

Failsafe is a feature that prevents disconnection from the only available power source and also forces a transfer or re-transfer operation to the only available power source.

Re-Transfer

Re-transfer is defined as a change of the load connection from the Source 2 to the Source 1.

Source 1

Source 1 is the primary source (normal source, normal power source, or normal).

Source 2

Source 2 is the secondary source (emergency source, emergency power source, emergency, standby, or backup source).

Source 1: Failed or Fails

Source 1 is defined as "failed" when it is outside of its undervoltage/overvoltage/ underfrequency/overfrequency (if applicable) setpoint ranges for the nominal voltage and frequency setting.

Source 2: Failed or Fails

Source 2 is defined as "failed" when it is outside of its undervoltage/overvoltage/ underfrequency/overfrequency (if applicable) setpoint ranges for the nominal voltage and frequency setting for a time exceeding 0.5 seconds after the Time Delay Emergency Fail (TDEF) time delay expires.

Transfer

Transfer is defined as a change of the load connection from the Source 1 to the Source 2 power source.

Unconnected

Unconnected is defined as when the input is not shorted by an external contact or connection.

Section 2: Receiving, Handling, and Storage

2.1 Receiving

Every effort is made to ensure that the ATS equipment arrives at its destination undamaged and ready for installation. Packing is designed to protect internal components as well as the enclosure. Care should be exercised, however, to protect the equipment from impact at all times. Do not remove the protective packaging until the equipment is ready for installation.

When the ATS equipment reaches its destination, the customer should inspect the shipping container for any obvious signs of rough handling and/or external damage that occurred during transportation. Record any external and internal damage for reporting to the transportation carrier and Eaton, once a thorough inspection is complete. All claims should be as specific as possible and include the catalog and General Order numbers.

A shipping label affixed to the shipping container includes a variety of equipment and customer information, such as General Order Number and catalog numbers. Make certain that this information matches other shipping paper information.

Each transfer switch is packed securely with appropriate shipping materials to prevent damage during shipment. Do not remove or discard the packing material until the equipment is ready for installation.

Once the top packaging is removed from the shipment, the enclosure door can be opened. A plastic bag of documents will be found in the enclosure, usually attached to the inside of the enclosure. Important documents, such as test reports, wiring diagrams, and appropriate instruction leaflets, are enclosed within the bag and should be filed in a safe place.

2.2 Handling

As previously mentioned, ATS equipment is packaged for forklift movement. Protect the equipment from impact at all times and DO NOT double stack.

Once the equipment is at the installation location and ready to be installed, packaging material can be removed and discarded. Once the enclosure is unbolted from the wooden pallet, it can be hand moved to its installation position. Be careful not to damage the top or bottom enclosure mounting flanges. Refer to Section 4 of this manual for specific installation instructions.

2.3 Storage

Although well packaged, this equipment is not suitable for outdoor storage. The equipment warranty will not be applicable if there is evidence of outdoor storage. If the equipment is to be stored indoors for any period of time, it should be stored with its protective packaging material in place. Protect the equipment at all times from excessive moisture, construction dirt, corrosive conditions, and other contaminants.

It is strongly suggested that the package-protected equipment be stored in a climate-controlled environment with temperatures from -30 to 85°C (-22 to 185°F) and with a relative humidity of 80% or less. DO NOT, under any circumstance, stack other equipment on top of a transfer switch equipment enclosure, whether packaged or not.

Section 3: Equipment Description

3.1 General

The ATS consists of three basic panels:

1. The power panel;
2. The voltage selection and transformer panel; and
3. The microprocessor-based logic panel.

These panels are interconnected via connector plugs and mounted in an enclosure (Figure 4).

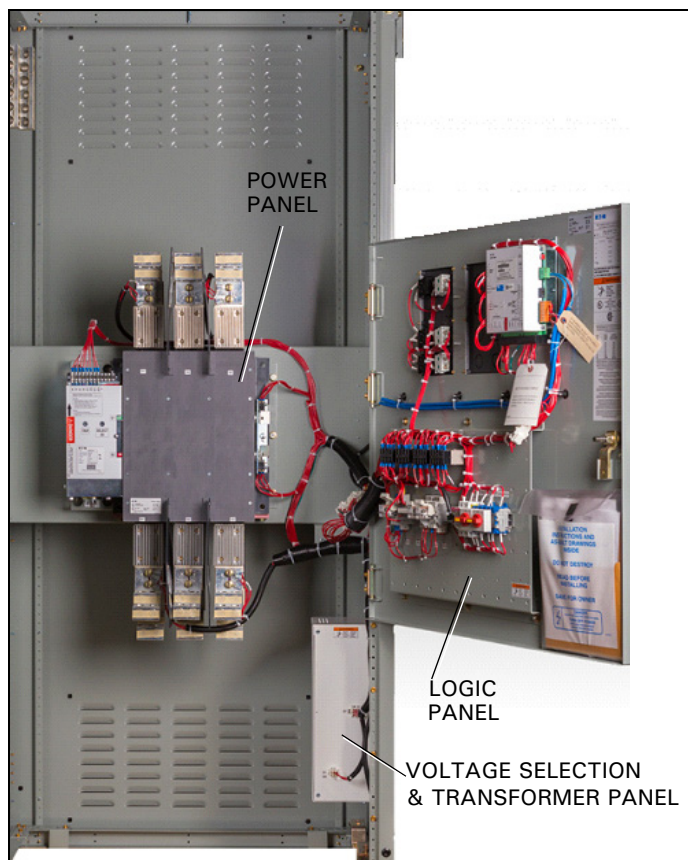


Figure 4. Three Basic Panels of the ATS (1600A).

3.2 Power Panel

The power panel is used for making load, power, and neutral connections. The power contactor is mounted on a steel base-plate (Figure 5).

3.2.1 Main Contacts

This ATS incorporates a power contactor. The main contacts connect and disconnect the load to and from the different power sources. The power contactor is mechanically and electrically interlocked to prevent the two sets of main contacts from being closed simultaneously.

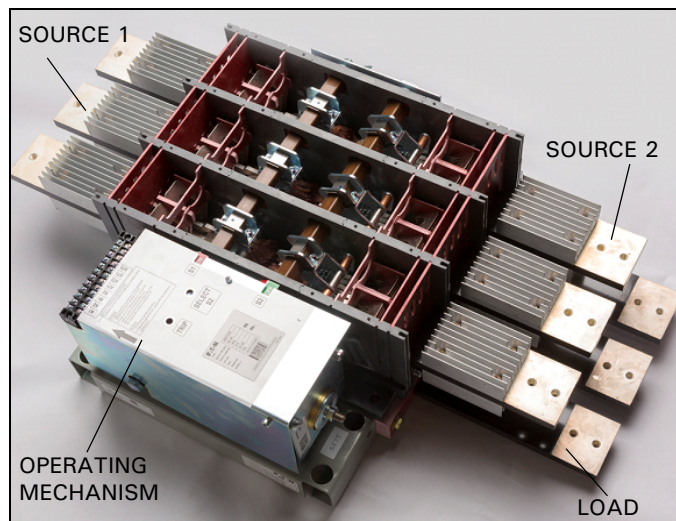


Figure 5. 1600A Contactor Layout.

3.3 Voltage Selection

3.3.1 North American Voltage Selection (120, 208, 240, 480, 60 Hz)

The North American market voltage selection panel consists of multi-tap transformers, contained in a steel case mounted in the transfer switch enclosure (Figure 6). The cover has two connectors on it, with the one on the right being selectable depending on the voltage applied to S1 and S2. The transformer unit is easily removed by removing the two front screws and disconnecting the two plugs. The rear of the transformer enclosure has two flanges that are inserted into two slots. The voltage is selected by simply removing the plug from the default selected voltage on the cover plate and installing the plug to the desired available voltage. Plugs are provided for 120 to 480 Vac to satisfy any required North American market application voltage. The factory default position is 480 Vac. There is a similar selection panel for international voltages.

⚠ DANGER

WHEN CHANGING THE VOLTAGE SELECTION, THE POWER MUST BE REMOVED FROM THE TRANSFER SWITCH. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT ON EQUIPMENT PRIOR TO SERVICING. FAILURE TO FOLLOW THIS WARNING COULD LEAD TO DEATH OR SEVERE INJURY. WHILE ENERGIZED, AN ARC FLASH AND SHOCK HAZARD EXISTS. CONSULT NFPA 70E AND OSHA GUIDELINES FOR OPERATOR SAFETY PRIOR TO SERVICING, INSPECTING OR OPERATING EQUIPMENT.



Figure 6. North American Market Voltage Selection Terminals.

3.4 ATC-300+ Logic Panel

The ATC-300+ is a microprocessor-based transfer switch logic control package. The hardware and software of the controller contain the intelligence/supervisory circuits that constantly monitor the condition of the power sources. It provides the intelligence necessary for the operation of the ATS (Figure 7).



Figure 7. ATC-300+ Logic Control Panel.

The ATC-300+ controller has an operating temperature of -20 to 70°C (-4 to 158°F).

The controller circuit board is protected by an insulating conformal coating.

The specifications, under normal operating conditions, are as follows:

- Tolerance for voltage sensing function: ± 1% of full scale
- Tolerance for frequency sensing function: ± 0.3 Hz of setting

3.5 Features

A variety of standard and optional features are available for Eaton ATs. **All features or combinations of features may not be available on specific ATs.** All features and/or accessories are Underwriters Laboratories (UL) listed unless noted. See specific controller Instruction Booklets for additional options and standards.

3.5.1 Standard Features

The following is a list of the standard features of the ATC-300 + Controller. Please also look at the ATC-300 + Controller instruction booklet. The ATC-900 controller has many new standard features compared to the ATC-300 +. If the ATC-900 is used on the switch, please see the ATC-900's Instruction Booklet for these additional user features.

1. Time Delay Normal to Emergency (TDNE)

This feature provides a time delay when transferring from the Source 1 to the Source 2 power source. Timing begins when Source 2 becomes available. It permits controlled transfer of the load circuit to Source 2.

Adjustable 0 - 1800 Seconds

2. Time Delay on Engine Starting (TDES)

This feature provides a time delay of the signal to initiate the engine/generator start cycle in order to override momentary power outages or voltage fluctuations of Source 1.

Adjustable 0 - 120 Seconds

3. Time Delay Emergency to Normal (TDEN)

This feature provides a time delay of the re-transfer operation to permit stabilization of Source 1. Timing begins when Source 1 becomes available. If Source 2 fails during timing, then re-transfer is immediate, overriding the time delay.

Adjustable 0 - 1800 Seconds

4. Time Delay for Engine Cool-down (TDEC)

This feature provides a time delay of the signal to initiate the engine/generator stop cycle after the re-transfer operation. This allows the engine/generator to cool down by running unloaded. Timing begins on completion of the re-transfer cycle.

Adjustable 0 - 1800 Seconds

5. Source 2 Monitoring and Protection

This feature provides monitoring and protection based on the Source 2 voltage and/or frequency setpoints. All feature 5 functions are "failsafe" operations.

5H. Phase Reversal

For a 3-phase wye source, this feature monitors the phase sequence of the sources. If a source does not have the same ABC or CBA sequence as the setpoint value, that source will be considered "Unavailable."

For a 3-phase delta source, this feature should be turned off via the PHASE REV setpoint.

5J. All Phase Undervoltage and Underfrequency Protection

Adjustable Undervoltage:

Dropout: 78 - 97% of nominal

Pickup: (Dropout + 2%) to 99% of nominal

Adjustable Underfrequency:

Dropout: 90 - 97% of nominal

Pickup: (Dropout + 1Hz) to 99% of nominal

5K. All Phase Overvoltage/Overfrequency

Adjustable Overvoltage:

Dropout: 105 - 110% of nominal

Pickup: 103% to (Dropout - 2%) of nominal

Adjustable Overfrequency:

Dropout: 103 - 105% of nominal

Pickup: 101% to (Dropout - 1Hz) of nominal

5L. Source 2 3-Phase Voltage Unbalance

For a 3-phase wye source, this feature monitors phase voltage ratios. Voltage unbalance (%) is calculated as the difference between the maximum and minimum phase voltage, divided by the minimum phase voltage. User-selectable setpoints are available for dropout and pickup unbalance settings (minimum 2% differential). Dropout is adjustable from 5 to 20%. Pickup is adjustable from 3 to (Dropout - 2%). A setpoint for user-selectable time delay from 10 to 30 seconds is provided. The factory default setpoints are: 5% dropout, 3% pickup, and 30 seconds time delay. A user-selectable setpoint for enable and disable is also provided.

When an unbalance condition is detected on Source 2, the Unbalance Timer (TD UNBAL) starts timing. After TD UNBAL times out, Source 2 is declared "failed".

For a 3-phase delta source, this feature should be turned off via the VOLT UNBAL setpoint.

6. Test Operators

Eaton ATs are provided with a Test Pushbutton that simulates a loss of the Source 1 power source as standard (Feature 6B). All programmed time delays (TDNE, TDEN, etc.) will be performed as part of the Test. Engine run time of the Test is equal to the Plant Exerciser (Feature 23) programmed setpoint. All Tests are Failsafe protected.

6B. Test Pushbutton

Programmable setpoints include:

1. Load, No Load Testing, or Disabled and
2. Engine run time is equal to the Plant Exerciser (Feature 23) setting.

7. Time Delay Emergency Fail (TDEF)

This feature provides a time delay that prevents a connected emergency source from being declared "failed" in order to override momentary generator fluctuations. If the Source 2 power source remains in the failed state then, 0.5 seconds after the TDEF timer expires, the transfer switch will proceed with the programmed sequence for re-transfer. This time delay is only implemented when the Source 2 power source is a generator.

Adjustable 0 - 6 Seconds

8. Time Delay Bypass Pushbutton

This feature provides a way (by pushing the Help and Step pushbutton simultaneously) to bypass the TDNE (Feature 1) and/or TDEN (Feature 2) time delays. The Time Delay Bypass function, when activated by pushing the Help and Step pushbutton simultaneously, will reduce any or all of the programmed time delay to zero.

8C. Bypass TDEN

This feature provides a membrane pushbutton to bypass the TDEN time delay.

8D. Bypass TDNE

This feature provides a membrane pushbutton to bypass the TDNE time delay.

12. Power Source Annunciation

This feature provides LEDs to give switch position and power source availability indications.

Switch Position

Provides LEDs to indicate the switch position.

12C. Source 1 - Source Connected

This feature provides a green LED that, when lit, indicates the load is connected to Source 1.

12D. Source 2 - Source Connected

This feature provides a red LED that, when lit, indicates the load is connected to Source 2.

Power Source Availability

Provides LEDs to indicate if a power source is available. LEDs may be integral or separate from the controller.

12G. Source 1 - Available

This feature provides a white LED that, when lit, indicates Source 1 is available.

12H. Source 2 - Available

This feature provides an amber LED that, when lit, indicates Source 2 is available.

14. Relay Auxiliary Contacts: This feature provides form "C" relay auxiliary contacts**14G. Source 1 Present:** Provides two (2) normally open and two (2) normally closed contacts. The relay is energized when Source 1 is available.**14H. Source 2 Present:** Provides two (2) normally open and two (2) normally closed contacts. The relay is energized when Source 2 is available.**15. Switch Position Indication Contact**

This feature provides a contact that indicates if the power-switching device is in the "Open" or "Closed" position.

15E. Source 1 Position Indication Contact

This feature provides 1 Dry Form "C" contact that indicates the position of the Source 1 power-switching device.

15F. Source 2 Position Indication Contact

This feature provides 1 Dry Form "C" contact that indicates the position of the Source 2 power-switching device.

23. Plant Exerciser (PE)

This feature provides a means for automatic testing of the engine/generator set or standby power system. All programmed time delays will be performed during plant exerciser operations.

23K. Plant Exerciser Selectable – Disabled/1/7/14/28 Day Interval

This feature provides for automatic test operation of the generator. Available test cycles are daily, 7, 14, or 28 days with duration equal to the programmed engine test time.

Programmable setpoints allow for selection of three test cycles:

- Engine Start/Run Only (No Load);
- Exercise with Load Transfer; or Disabled
- This is a "Failsafe" operation.

26. Source 1 - Monitoring and Protection

This feature provides Source 1 monitoring and protection functions. If the Source 1 power supply fails, then the ATC-300+ will begin the sequence of operations necessary to transfer the load circuit to the Source 2 power source. All Feature 26 monitoring and protection functions are "failsafe" operations.

26D. Go to Source 2

This feature provides the capability for an external contact opening to initiate a load power transfer to the Source 2 power source. This includes starting the engine/generator, performing the programmed time delays, and the transfer operation. Re-transfer will occur when the external contact is closed or under a "failsafe" condition. A connection point on the controller for the connection of an external contact is included.

26H. Phase Reversal Protection

For a 3-phase wye source, this feature monitors the phase sequence of the sources. If a source does not have the same ABC or CBA sequence as the phase reversal setpoint, the source will be considered "Unavailable".

For a 3-phase delta source, this feature should be turned off via the PHASE REV setpoint.

26J. All Phase Undervoltage and Underfrequency Protection**Adjustable Undervoltage:**

Dropout: 78 - 97% of nominal

Pickup: (Dropout + 2%) to 99% of nominal

Adjustable Underfrequency:

Dropout: 90 - 97% of nominal

Pickup: (Dropout + 1Hz) to 99% of nominal

26K. All Phase Overvoltage/Overfrequency**Adjustable Overvoltage:**

Dropout: 105 - 110% of nominal

Pickup: 103% to (Dropout - 2%) of nominal

Adjustable Overfrequency:

Dropout: 103 - 105% of nominal

Pickup: 101% to (Dropout - 1Hz) of nominal

26L. Source 1 3-Phase Voltage Unbalance

For a 3-phase wye source, this feature monitors phase voltage ratios. Voltage unbalance (%) is calculated as the difference between the maximum and minimum phase voltage, divided by the minimum phase voltage. User-selectable setpoints are available for dropout and pickup unbalance settings (minimum 2% differential). Dropout is adjustable from 5 to 20%. Pickup is adjustable from 3 to (Dropout -2%). A setpoint for user-selectable time delay from 10 to 30 seconds is provided. The factory default setpoints are: 5% dropout, 3% pickup, and 30 seconds time delay. A user-selectable setpoint for enable and disable is also provided.

When an unbalance condition is detected on Source 1, the Unbalance Timer (TD UNBAL) starts timing. After TD UNBAL times out, Source 1 is declared "failed".

For a 3-phase delta source, this feature should be turned off via the VOLT UNBAL setpoint.

29. Alternate Transfer Modes of Operation

Provides standard or optional transfer modes, mode selection devices, and operational methods for ATSSs.

29J. Manual Re-Transfer (MANTR) (new feature)

This feature provides for a selection between an automatic transfer and re-transfer mode or a manual pushbutton re-transfer to Normal from the Emergency Source mode. If this option is not selected the factory default selection is automatic.

32. Delayed Transition Transfer Modes for Open Transition Transfer Switches

This feature provides delayed transition transfer modes for an open transition transfer switch. Often used in systems with inductive loads, a delayed transition transfer switch may prevent or reduce in-rush currents due to out of phase switching of inductive loads.

35. Pre-Transfer Signal, Post Transfer Signal

This feature provides a signal to a remote device prior to a re-transfer operation. It provides one Form "C" contact (NO/NC) for interface with other equipment (typically elevator controls). The contacts close/open on a timed basis prior to transfer in either direction. After TDNE/TDEN times out, this relay closes and the Pre-transfer Timer (TPRE) starts timing. After the TPRE times out, the transfer proceeds by starting the TDN timer if enabled. The pre-transfer relay opens after the transfer is complete. A Post Transfer signal is available on the ATC-900 controller

35A. Pre-transfer Signal with 1 N.O. and 1 N.C. Contacts

This feature provides pre-transfer signal and includes 1 N.O. and 1 N.C. contact.

36. Emergency Inhibit

This feature enables the Emergency inhibit control input to inhibit transfers to the Emergency Source. See Control Inputs section for more information.

42. Seismic Withstand Capability

Provides transfer switch with seismic capability exceeding the worst case Zone 4 required per both the Uniform Building Code and the California Building Code.

48F. RS-485 with Modbus Option

Provides communications for the ATC-300+ via Modbus through an integrated RS-485 port. Registers are available to read back status, voltages, frequencies, and historical data. Registers are also available for transfer switch control. Setpoints may be read back and/or programmed via a pass-through command. See the ATC-300+ Modbus Communication Guide pn: 66A7787.

3.5.2 Optional Features

The following is a list of the optional features for the ATC-300+ Controlled ATS. **All features or combinations of features may not be available on specific ATSSs.** The ATC-900 controller has many new features compared to the ATC-300+. Many of the ATC-300+ options are standard in the ATC-900 controller. If the ATC-900 is used on the switch, please see the ATC-900's Instruction Booklet for these additional user features.

9B. Maintenance Selector Switch (MSS)

Marked "OFF", "ON". This feature provides selector switch disconnection of control to transfer thus allowing testing of the transfer switch control logic circuitry without initiating load transfer. Positioning the MSS in the "OFF" position isolates the control circuit, permitting manual operation of the transfer switch or testing of logic circuitry without load transfer. White indication light is lit ON and display on ATC-300+ controller shows "ATS NOT IN AUTOMATIC" when the switch is in maintenance mode.

14. Relay Auxiliary Contacts

This feature provides form "C" relay auxiliary contacts.

14C. Source 1 Present

Provides four (4) normally open and four (4) normally closed contacts. The relay is energized when source 1 is available.

14D. Source 2 Present

Provides four (4) normally open and four (4) normally closed contacts. The relay is energized when source 2 is available.

15. Switch Position Indication Contact

This feature provides a contact that indicates if the power switching device is in the "Open" or "Closed" position.

15G. Source 1 Position Indication Contact

This feature provides 3 Dry Form "C" contacts that indicate the position of the Source 1 power-switching device.

15H. Source 2 Position Indication Contact

This feature provides 3 Dry Form "C" contacts that indicate the position of the Source 2 power-switching device.

18. Metering

This feature includes all required external devices (CTs, shorting blocks, fuses, etc.) for a fully functional metering system.

- 18AN. IQ 250/260 Normal (S1) Only
- 18AE. IQ 250/260 Emergency (S2) Only
- 18AL. IQ 250/260 Load
- 18CN. IQ 110/115 Normal (S1) Only
- 18CE. IQ 110/115 Emergency (S2) Only
- 18CL. IQ 110/115 Load
- 18DN. IQ 130/140/150 Normal (S1) Only
- 18DE. IQ 130/140/150 Emergency (S2) Only
- 18DL. IQ 130/140/150 Load
- 18EN. PXM2250/2260/2270 Normal (S1) Only
- 18EE. PXM2250/2260/2270 Emergency (S2) Only
- 18EL. PXM2250/2260/2270 Load
- 18O. IQ Analyzer Normal (S1) Only
- 18P. IQ Analyzer Emergency (S2) Only
- 18Q. IQ Analyzer Normal (S1) & Emergency (S2) Switch Selectable
- 18V. IQ Analyzer Load
- 18R. IQ DP-4000 Normal (S1) Only
- 18S. IQ DP-4000 Emergency (S2) Only
- 18T. IQ DP-4000 Normal (S1) & Emergency (S2) Switch Selectable
- 18U. IQ DP-4000 Load
- 18W. **Ammeter**

A single ammeter is a true RMS sensing device that displays single phase current only.

The ammeter can be mounted on Source 1, Source 2, or load. The meter can also be configured for 1, 2, or 3-phase sensing by supplying one meter per phase for Source 1, Source 2, or load. Ammeters for both Source 1 and Source 2 can also be grouped together.

23X. Programmable Plant Exerciser

Depending on the controller installed, the plant exerciser offers daily, weekly or annual programming. Depending on the controller installed, the exercisers are different. The ATC-900 has two exercisers. Please see the controller's IB to set this feature.

29G. Auto/Manual Operation

This feature provides 2-position auto/manual selector switch marked "Auto/Manual" which permits the selection of automatic or manual operation. Once the selector switch is transferred to manual mode, manual transfer between Normal (S1), Neutral and Emergency (S2) can be achieved by operating 3-position selector switch marked "Normal-OFF-Emergency". White indication light is lit ON and display on ATC-300+ controller shows "ATS NOT IN AUTOMATIC" when the switch is in manual mode.

32A. Time Delay Neutral (TDN)

This feature provides a time delay in the transfer switch Neutral position when both the source one and source two contacts are open. This delay takes place when the load is transferred in either direction to prevent excessive in-rush currents due to out-of-phase switching of large motor loads. This feature is not available with the Neutral Load Sense Delay (TDNLD) feature.

32D. In-Phase with Default to Time Delay Neutral

This feature provides an in-phase transfer with a default to a time delay neutral transfer which ensures that the ATS will complete a transfer whether or not the two live sources can synchronize. When in-phase with default to time delay in neutral is set and source synchronization does not occur in the specified amount of time, the transfer will default to a time delay in neutral transfer and the Alarm relay will energize and the failure will be logged into the Transfer History as either "Sync Fail - Freq" or "Sync Fail - Phase" depending on whether the frequency difference or the phase difference was excessive. This option allows the user to configure the switch in the field to be In-Phase only, Time Delay Neutral only, or In-Phase with default to TDN (factory setting).

38. Stainless Steel Logic Cover

38A. Stainless Steel Cover for Device Panel

Provides an added level of security by providing a pad lockable stainless steel cover for use with standard transfer switch device panel. The cover is designed for NEMA 1, 3R, 4X, and 12 applications.

38B. Stainless Steel Cover for Controller

Provides an added level of security by providing a pad lockable stainless steel cover for use with standard transfer switch logic controllers and/or associated device panels. These covers function with Eaton's ATC series logic controllers and device panels. The covers are designed for NEMA 1, 3R, 4X, and 12 applications.

41. Space Heater With Thermostat

This feature provides a space heater and non-adjustable thermostat. External control power is not required.

41A. Space Heater With Thermostat - 100 Watt

This feature provides a 100 watt (W) space heater with a non-adjustable thermostat.

49B. Sensing Isolation Transformer (Up to 600 VAC only)

This feature provides 3-phase, 4-wire for Source-1 and Source-2 sensing input on ATC controller for a high resistance grounded delta system.

51D1. 50kA CVX Surge Device

This feature gives protection for surge current capacity rating 50kA, upto 480VAC by providing a low impedance surge path to ground while supporting rated voltage. It provides LED indication.

51F1. 100kA CVX Surge Device

This feature gives protection for surge current capacity rating 100kA, upto 480VAC by providing a low impedance surge path to ground while supporting rated voltage. It provides LED indication.

1600A (480 Vac) ATC-300 + /900 & Non-Automatic, 3-Position Fixed Mount Contactor Based Transfer Switch

3.8 Enclosure

The rugged steel 1600A ATS enclosure is supplied with four door hinges. They ensure proper support of the door and door mounted devices (Figure 8). The hinges have removable hinge pins to facilitate door removal. Certain procedures, such as switch mounting, are simplified with the door removed. The doors are supplied as standard with pad-lockable latches.



Figure 8. Typical Type 1 Enclosure (Door Open).

The door is used to mount a variety of lights, switches, and push-buttons, depending upon the options required for a particular ATS. All lights and switches are mounted in the plastic door-mounted panel.

The bottom of the enclosure is supplied with mounting holes to facilitate standard and seismic rated mounting (see Section 4.3). Cable entry holes are the responsibility of the customer.

ATS enclosures and all internal steel mounting plates, such as the power panel mounting plate, go through a pretreatment cleaning system prior to painting to ensure a durable finish.

The standard ATS enclosure is NEMA Type 1 for general use. However, a variety of enclosures are available to address almost any environmental circumstance (see Table 3).

Table 3. 1600A Transfer Switch Equipment Enclosures.

NEMA TYPE	DESIGN	PROTECTION
1	Indoor	Enclosed Equipment
3R	Outdoor	Rain, Ice Formation
12	Indoor	Dust, Fibers, Lint, Drippings
4x	Outdoor	Corrosion, Weather resistant

3.9 Standards

Eaton ATS equipment, enclosed in any of the enclosures listed in Table 3, is listed for application by UL and ULC. In addition, Eaton ATSS are listed in File E38116 by Underwriters Laboratories, Inc. under Standard UL 1008. This standard covers requirements for automatic transfer switches intended for use in ordinary locations to provide lighting and power as follows:

- a. In emergency systems, in accordance with articles 517 and 700 in the National Electrical Code, ANSI/ NFPA 70, and the National Fire Protection Association No. 76A; and/or
- b. In standby systems, in accordance with article 702 of the National Electrical Code; and/or
- c. In legally required standby systems in accordance with article 701 of the National Electrical Code.

Eaton ATSS are available to meet NFPA 110 for emergency and standby power systems, and NFPA 99 for health care facilities when ordered with the appropriate options.

Standard UL 1008 for ATSS lists devices under the reexamination program which only require a continual physical reexamination of the components used in the product to ensure consistency with the originally submitted device. Follow-up testing is not required by UL 1008.

Section 4: Installation and Wiring

4.1 General

Eaton ATs are factory wired and tested. Installation requires solidly mounting the enclosed unit and connecting power cables and auxiliary pilot circuits. Physical mounting procedures and power cable connections are covered in this section. All other required wiring or electrical connection references are covered in a separate Customer Wiring Booklet packaged with the ATS.

Locate the wiring schematic, review it, and keep it readily available for reference purposes during installation and testing. Once an ATS is properly installed and wired, it should be mechanically and electrically checked for proper installation and operation. The procedures for these initial mechanical and electrical checks are outlined in Section 6 of this instruction manual.



WARNING

BE CERTAIN THAT THE SOLID STEEL DOOR IS PROPERLY INSTALLED BEFORE THE TRANSFER SWITCH EQUIPMENT IS PUT INTO SERVICE. THE DOOR PROVIDES PROTECTION FROM DANGEROUS VOLTAGES AT THE LINE AND LOAD TERMINALS WHEN THE EQUIPMENT IS IN OPERATION. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY OR DEATH.



WARNING

BE CERTAIN THAT THE PLASTIC COVER ON THE CONTACTOR POWER ASSEMBLY IS PROPERLY INSTALLED BEFORE THE TRANSFER SWITCH EQUIPMENT IS PUT INTO SERVICE. THE COVERS PROVIDE PROTECTION FROM DANGEROUS VOLTAGES AT THE CONTACTS. FAILURE TO DO SO COULD RESULT IN PERSONAL INJURY OR DEATH.

4.2 Mounting Location

Choose a location that offers a flat, rigid mounting surface capable of supporting the weight of the enclosed ATS equipment. For standard ATs, avoid locations that are moist, hot, or dusty. However, Eaton offers optional enclosure designs that can be used in special environments. If there are any doubts as to a location's suitability, discuss them with your Eaton representative.

Check to make certain that there are no pipes, wires, or other mounting hazards in the immediate mounting area that could create a problem.

Carefully remove all packing material from the ATS at the mounting location. Even though an equipment inspection should have been made when the equipment was received, make another careful inspection of the enclosure and the enclosed ATS components as the packing material is removed and the enclosure readied for mounting. Be especially alert for distorted metal, loose wires, or damaged components.

4.3 Mounting Procedure

NOTICE

CABLE ENTRY HOLES ARE NOT PART OF THE ENCLOSURE WHEN SHIPPED FROM THE FACTORY AND MUST BE PROVIDED IN THE FIELD, EITHER BEFORE OR AFTER MOUNTING THE ENCLOSURE.

With the enclosed transfer switch equipment unpacked and ready for mounting, proceed with the following steps:

- Step 1:** Mounting and cabling access is best provided by removing side and rear covers (when applicable).
- Step 2:** Gently maneuver the switch into its location using all of the supplied lift brackets.
- Step 3:** Bolt the enclosure to the base. Use separate cleats (Option 42 only) if Seismic Uniform Building Code (UBC) Zone 4 certification is desired (Figure 9), and secure with 1/2-13 UNC Grade 5 hex bolts.
- Step 4:** Tighten bolts to 50 ft-lbs (68 Nm).
- Step 5:** Double check to ensure that all packing and shipping material has been removed

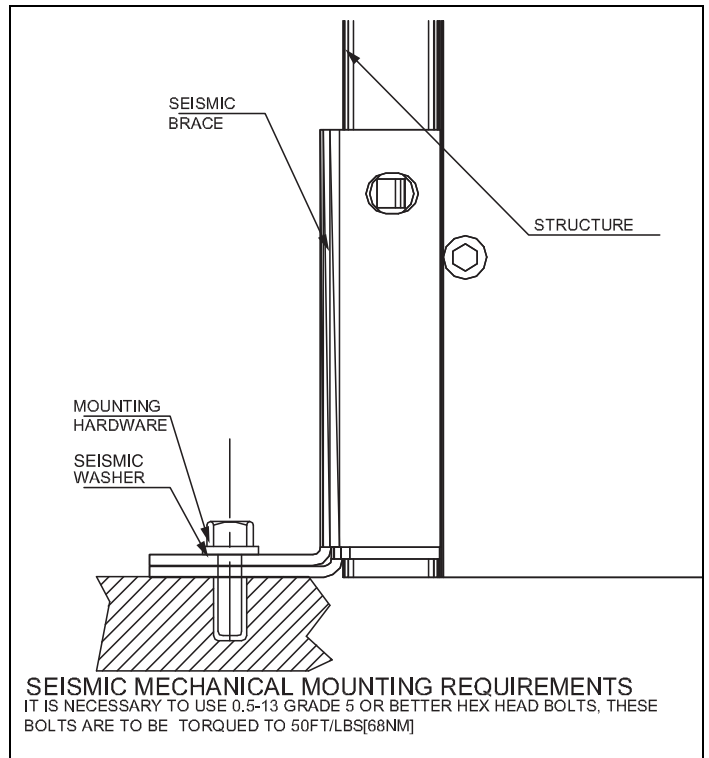


Figure 9. Seismic Tested and Approved Product Mounting Instructions.

4.4 Power Cable Connections

**WARNING**

POWER CONDUCTORS MAY HAVE VOLTAGE PRESENT THAT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. DE-ENERGIZE ALL POWER OR CONTROL CIRCUIT CONDUCTORS TO BE CONNECTED TO THE ATS EQUIPMENT BEFORE BEGINNING TO WORK WITH THE CONDUCTORS AND/OR TERMINATING THEM TO THE EQUIPMENT.

**CAUTION**

USE OF CABLE LUGS NOT DESIGNED FOR THE ATS MAY CAUSE HEATING PROBLEMS.

**CAUTION**

TO HELP PREVENT COMPONENT DAMAGE OR FUTURE MALFUNCTIONS, USE EXTREME CARE TO KEEP CONTAMINANTS OUT OF THE ATS EQUIPMENT WHEN MAKING POWER CABLE CONNECTIONS.

**CAUTION**

RUN THE POWER CABLE THROUGH THE GUTTER SPACE PROVIDED IN THE REAR OF POWER PANEL.

Test all power cables prior to connection to the unit to ensure that the conductors or cable insulation have not been damaged while being pulled into position.

Power cables are to be connected to solderless screw type lugs located on the ATS switching devices. Refer to the separate customer wiring diagram supplied with the ATS equipment for power termination. Verify that the lugs supplied will accommodate the power cables being used. Also verify that the cables comply with local electrical codes. Standard ATS equipment, as supplied from the factory, will accommodate the wire sizes shown in Table 4.

Table 4. Transfer Switch Equipment Wire Sizes.

TRANSFER SWITCH AMPERE RATING	WIRE SIZE RANGES	NUMBER OF CABLES PER PHASE	TERMINAL TEMPERATURE RATING °C (°F)
100	#14-3/0	1	90 (194)*
200	#6-300KCMIL	1	90 (194)*
400	#1/0-750KCMIL	1	90 (194)*
400	#1/0-250KCMIL	2	90 (194)*
1200-1600	#1/0-750KCMIL	4	90 (194)*

* Cable must be 90C rated but size shall be determined based on the ampacity of the wire rated 75C.

Carefully strip the insulation from the power cables to avoid nicking or ringing of the conductor strands. Prepare the stripped conductor termination end by cleaning it with a wire brush. If aluminum conductors are used, apply an appropriate joint compound to the clean conductor surface area.



WARNING

IMPROPER POWER CABLE CONNECTIONS CAN CAUSE EXCESSIVE HEAT AND SUBSEQUENT EQUIPMENT FAILURE.

Tighten the cable lugs to the torque identified on the label affixed to the door of the unit.

4.5 Wiring



WARNING

POWER CONDUCTORS AND CONTROL WIRING MAY HAVE VOLTAGE PRESENT THAT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. DEENERGIZE ALL POWER OR CONTROL CIRCUIT CONDUCTORS BEFORE BEGINNING TO PERFORM ANY WIRING ACTIVITY TO OR WITHIN THE ATS EQUIPMENT.

Power sources, load conductors, and control wiring should be connected to locations as indicated in the customer wiring diagram supplied with the ATS equipment.



CAUTION

ENSURE THE ATS VOLTAGE IS SET CORRECTLY. IT SHOULD BE THE SAME AS THE SOURCE 1 AND SOURCE 2 LINE VOLTAGES. OPERATING THE EQUIPMENT ON IMPROPER VOLTAGE CAN CAUSE EQUIPMENT DAMAGE.

Once the ATS equipment has been installed and wired, perform the initial mechanical and electrical procedures as outlined in Section 6 to verify that the equipment is installed and operating properly.

4.6 Engine Start Connection

The engine control contact connections are located on the logic panel of the ATS. Connect the engine start wires to the terminals marked 13 and 14 on J-5 connector on the ATC-300+ Controller (see Figure 10A). Figure 10B shows the ATC-900 controller's I.O. connections. See the switches drawings for locations of the generator start outputs. Many of the ATC-900's I/Os are connected to a terminal block on the door and are Red. A contact closes between these terminal when an engine start signal is provided by the ATS logic. The wiring diagram provides additional engine start connection information. Use the proper wire size as listed by the generator set (Genset) manufacturer.

NOTICE

PRIOR TO MAKING THE ENGINE START CONNECTION TO THE SWITCH, SET THE ENGINE GENERATOR CONTROLS SELECTOR SWITCH IN THE OFF POSITION TO PREVENT AN UNWANTED ENGINE START. CONTROL WIRING, SUCH AS THE ENGINE START WIRES, MUST BE RUN IN A SEPARATE CONDUIT FROM THE POWER CABLES.

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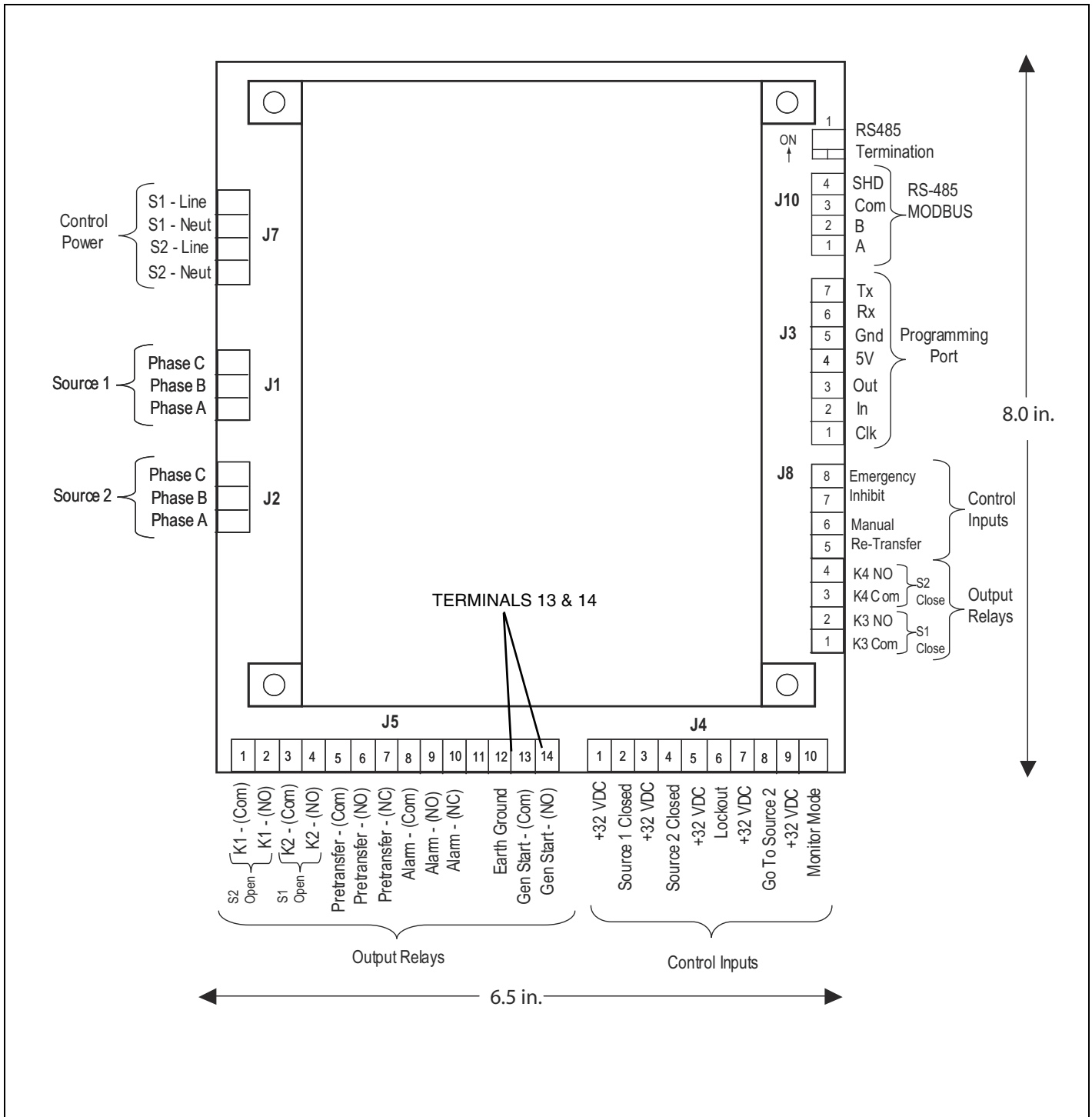


Figure 10A. Location of Terminals 13 and 14 on the J-5 Connector of ATC-300+ Controller.

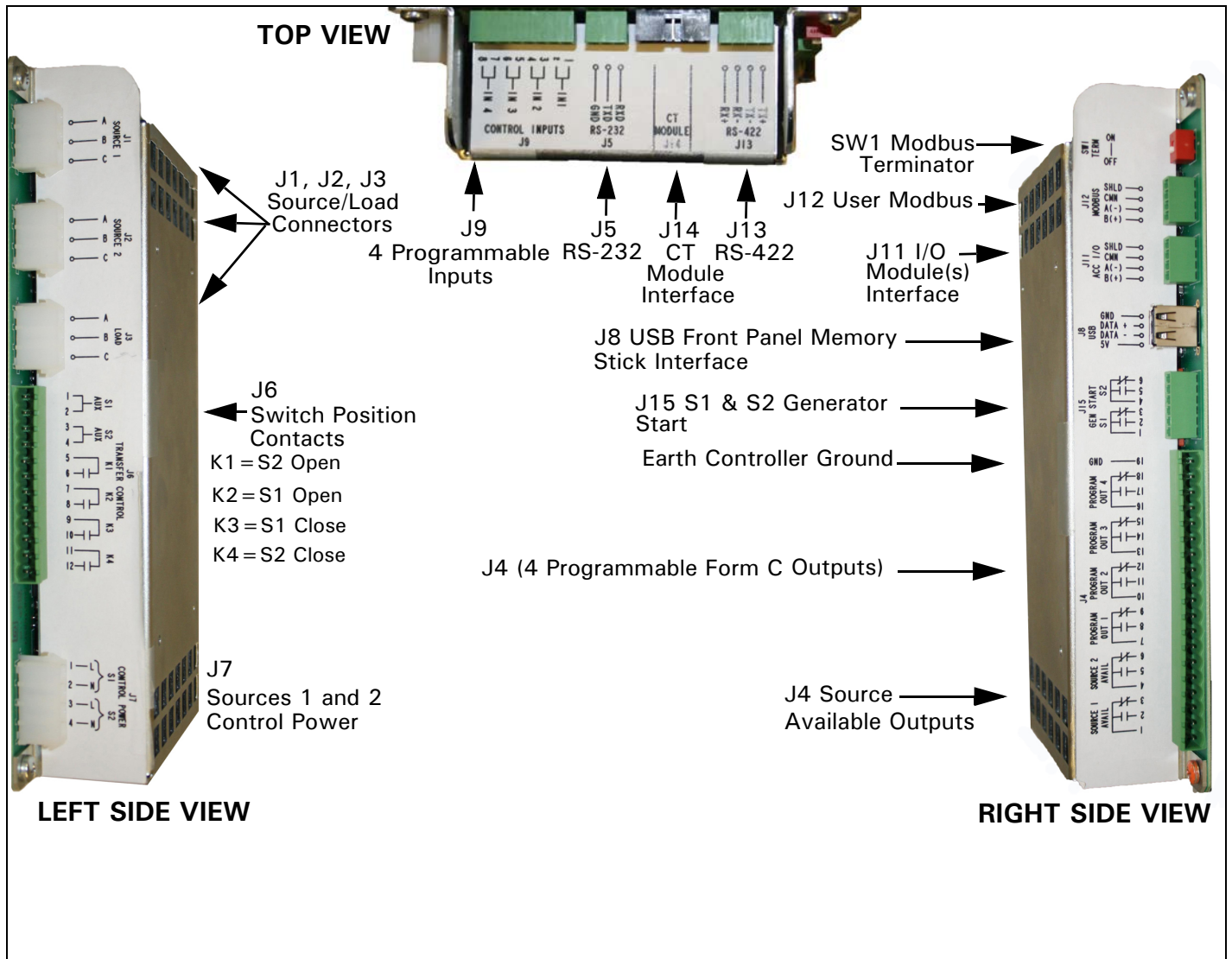


Figure 10B. ATC-900 (Top Left, and Right Side Views).

4.7 Voltage Selection Adjustments

Certain devices, such as the Voltage Selection Panel, sensing relays, and timers, need to be set and/or calibrated prior to placing the ATS equipment in service. Adjustments for logic devices are described in the separate instructional document dedicated to the specific logic being used. Voltage selection adjustments are described in this section.

⚠ CAUTION

BE SURE THAT THE CORRECT VOLTAGE IS SELECTED TO MATCH THE SYSTEM VOLTAGE. AN IMPROPER SELECTION AND/OR CONNECTION COULD RESULT IN EQUIPMENT DAMAGE.

4.7.1 North American Market Voltage Selection Panels (120, 208, 240, 480, - 60 Hz)

The North American market voltage selection panel consists of multi-tap transformers, contained in a steel case mounted in the transfer switch enclosure (Figure 11). The cover has two connectors on it, with the one on the right being selectable depending on the voltage applied to S1 and S2. The transformer unit is easily removed by removing the two front screws and disconnecting the two plugs. The rear of the transformer enclosure has two flanges that are inserted into two slots. The voltage is selected by simply removing the plug from the default selected voltage on the cover plate and installing the plug to the desired available voltage. Plugs are provided for 120 to 480 Vac to satisfy any required North American market application voltage. The factory default position is 480 Vac. There is a similar selection panel for international voltages.

⚠ DANGER

WHEN CHANGING THE VOLTAGE SELECTION, THE POWER MUST BE REMOVED FROM THE TRANSFER SWITCH. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT ON EQUIPMENT PRIOR TO SERVICING. FAILURE TO FOLLOW THIS WARNING COULD LEAD TO DEATH OR SEVERE INJURY. WHILE ENERGIZED, AN ARC FLASH AND SHOCK HAZARD EXISTS. CONSULT NFPA 70E AND OSHA GUIDELINES FOR OPERATOR SAFETY PRIOR TO SERVICING, INSPECTING OR OPERATING EQUIPMENT.



Figure 11. North American Market Voltage Selection Terminals.

Section 5: Operation

5.1 General

An ATS provides a power contactor to connect and disconnect the load to and from the Source 1 and Source 2 power sources (Section 3.2.1).

5.2 Manual Operation

⚠ WARNING

DO NOT ATTEMPT TO MANUALLY OPERATE THE ATS WITH SOURCE 1 OR SOURCE 2 AVAILABLE.

⚠ WARNING

HIGH VOLTAGES ARE PRESENT IN AND AROUND TRANSFER SWITCH EQUIPMENT. BEFORE ATTEMPTING TO MANUALLY TRANSFER, DISCONNECT THE LINE POWER FROM THE EQUIPMENT BEING SERVICED BY OPENING AND LOCKING OUT, IF POSSIBLE, THE NEXT HIGHEST DISCONNECT DEVICE. FAILURE TO FOLLOW THIS PROCEDURE COULD CAUSE SEVERE PERSONAL INJURY AND/OR DEATH.

ALWAYS TURN THE SOURCE 1 POWER OFF AND TURN THE SOURCE 2 (IF A GENERATOR) CONTROL SELECTOR SWITCH TO THE "OFF" POSITION BEFORE ATTEMPTING A MANUAL TRANSFER.

To manually operate:

1. Disconnect all sources of power.
2. Disconnect the J7 connector from the ATC-300 + /900 controller.
3. Depress the "trip" button located on the operating mechanism of the contactor to bring the contactor to neutral (trip) position (Figure 12).



Figure 12. Trip Button on Contactor Operating Mechanism.

4. Locate the manual lever on the left side of the contactor.
5. Locate the handle used to manually transfer the switch.
6. Attach the handle to the manual lever.
7. Rotate the lever up to go to Source 1.
8. Depress the "trip" button located on the operating mechanism of the contactor to bring the contactor to neutral (trip) position.
9. Depress the "select" button located on the operating mechanism of the contactor and rotate the lever up keeping the "select" button depressed to go to Source 2 (Figure 13).

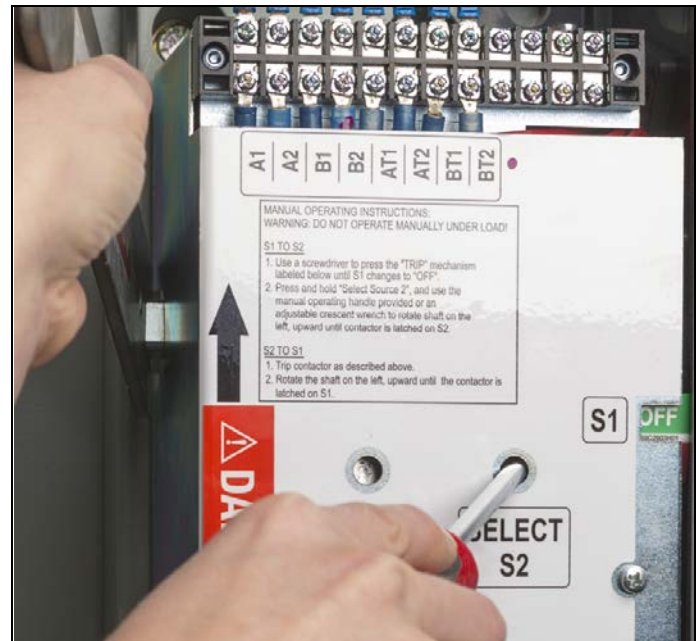


Figure 13. Select Button on Contactor Operating Mechanism.

10. Once the manual operation is complete and automatic operation is desired, connect the sources of power.
11. If Source 1 is available, check for 120VAC at J7-4 to J7-3 on an ATC-300 +. Check for 120VAC at J7-1 to J7-2 on an ATC-900.
12. If Source 2 is available, check for 120VAC at J7-2 to J7-1 on an ATC-300 +. Check for 120VAC at J7-3 to J7-4 on an ATC-900. See Troubleshooting Guide (Table 3, Section 7 of ATC-300 + Controller Instruction Booklet IB01602009E) or Table 3, Section 6 of ATC-900 Controller Instruction Booklet I.B. ATS-C103) if values are above 130 Vac or below 110 Vac.
13. Insert the J7 connector into the controller.
14. Follow the testing procedure in Section 6 to ensure proper automatic operation.

5.3 Automatic Transfer

The operating sequence of an ATS is dictated by the switch's standard features and selected options. Operation of an ATS during Source 1 power source failure and Source 1 power source restoration will be described here with only standard options included on the switch. Additional options, as described in Sections 3.5.2 and 3.7.2, can change sequences and timing, depending upon the options selected. It is strongly suggested that you become familiar with additional options selected with the particular ATS and their effect on the normal operation of an ATS.

5.3.1 Source 1 Power Source Failure

Standard Source 1 power source failure is defined as a reduction or loss of voltage. If this occurs, the sequence of operation is as follows.

1. Failure of Source 1 is detected by the controller intelligence.
2. When the controller detects a failure, the engine contacts close (after delay if programmed) and start the engine-driven generator.
3. When the Source 2 voltage reaches its operation rating, the K2 and K4 relays inside ATC-300 + /900 controller operate to start transfer operation to Source 2. This operating sequence causes the contactor to open Source 1 and close on Source 2.
4. The load is now transferred to the Source 2 power source.

5.3.2 Source 1 Power Source Restoration

1. A return to the Source 1 power source begins when the voltage in all phases of a 3-phase sensing unit, or phase-to-phase in a single sensing unit, is restored to a preset value.
2. At the preset voltage, K1 and K3 relays inside the ATC-300 + /900 controller operate to start transfer operation to Source 1.
3. During this sequence, the contactor opens Source 2 and closes on Source 1.
4. Simultaneously, the engine cool-down timer initiates the shut down of the engine driven generator.
5. Transfer of the load back to the Source 1 power source is now complete.

5.4 Non-Automatic Operation (Electrically Operated)

A non-automatic (electrically operated) transfer switch functions similarly to the non-automatic (manually operated) transfer switch except for the addition of an electrical operating device panel on the door. This permits the main contacts to be opened and closed electrically. There is, however, no intelligence associated with this design.

Automatic Operation	With Controller
Non-Automatic Operation	With Switches and no Controller
Manual	Uses Lever (wrench) and no Electrical

Electrical operation is accomplished by adding required indication lights and push buttons (located on the front device panel) to the operating mechanism of the 3-position contactor.

With the transfer switch connected to Source 1, to transfer from Source 1 to Source 2 first press "TRIP" push button and release. Then press "S2 Close" push button. Conversely, with the transfer switch connected to Source 2, to transfer from Source 2 to

Source 1 first press "TRIP" push button and release. Then press "S1 Close" push button. The switch's operating position (S1 and S2 Connected) and Source Present can be visually indicated via indication lights installed on the front device panel without opening the door (Figure below). Source Present is different than Source Available in that Source Present shows that there is a voltage on the source. Source Available is only from the ATC-900 or ATC-300+ and it shows that the source's are good with respect to voltage and frequency. The measures of an Available Source can be set in the controller. There is not a controller in a Non-Automatic Switch.

Since an intelligence circuit is not part of the non-automatic transfer switch design, operation of the push buttons mentioned above is required each time an electrical transfer is required.



Figure 14. Non-Automatic Controls.

Section 6: Testing and Problem Solving

6.1 Testing

After the ATS equipment is initially installed or during planned outages, the installation should be tested to ensure that all equipment operates properly. This attention to detail will help avoid unexpected malfunctions. Mechanical and/or electrical tests should be performed as described in this section.

The frequency of subsequent testing should be based on recommendations of the Genset manufacturer. Use the test pushbutton on the ATC-300 + /800 controller to check the electrical operation of the switch.



WARNING

HIGH VOLTAGES ASSOCIATED WITH OPERATIONAL TRANSFER SWITCH EQUIPMENT PRESENT A SHOCK HAZARD THAT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. USE EXTREME CAUTION TO AVOID TOUCHING ELECTRICAL CONNECTIONS WHENEVER INSPECTING OR TESTING THE EQUIPMENT.

IN ADDITION, IMPROPER OPERATION OF THE GENERATOR SET PRESENTS A HAZARD THAT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. OBSERVE ALL SAFETY PRECAUTIONS IN YOUR GENERATOR SET OPERATIONS AND INSTALLATION MANUALS.

6.1.1 Mechanical and/or Electrical Testing

NOTICE

SINCE FEATURE 4 (TIME DELAY ENGINE COOL-OFF), AS DESCRIBED IN SECTION 3, IS A STANDARD FEATURE, AN ENGINE START SIGNAL WILL BE PRESENT FOR A PERIOD OF TIME WHEN THE SWITCH IS FIRST ENERGIZED. THE PERIOD OF TIME IS EQUAL TO THE TIMER SETTING. TO AVOID STARTING THE ENGINE DURING THIS TIME PERIOD, TURN THE GENERATOR CONTROLS TO THE OFF POSITION.

Energize the ATS equipment as described in Sections 6.1.2 through 6.1.6. Insure that all safety precautions are taken and that all **WARNINGS** and **CAUTIONS** are observed.

6.1.2 No Voltage Steps

With no voltage available on either power source, proceed as follows.

Step 1: The generator engine start controls should be in the OFF position to prevent an undesired start.

Step 2: Ensure that the ATS has been set to the proper applied system voltage (See Section 4.7).

Step 3: Check all ATS loads to ensure that they are ready to be energized.

6.1.3 Connecting the Power Sources

Step 1: Close the Source 1 power source upstream protection device.

Step 2: Connect the engine start battery cable.

Step 3: With the emergency generator in the OFF position, close the Source 2 power source upstream protective device, assuming such a device used.

NOTICE

AT THIS POINT, AND PRIOR TO MAKING ANY ATTEMPT TO ENERGIZE THE ATS EQUIPMENT, THE ENGINE-DRIVEN GENERATOR SHOULD BE OPERATED. IF NECESSARY, THE VOLTAGE REGULATOR ON THE GENERATOR SHOULD BE ADJUSTED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS. THE ATS EQUIPMENT WILL RESPOND ONLY TO THE RATED VOLTAGE AND FREQUENCY PROGRAMMED INTO THE CONTROLLER.

Step 4: Close any generator engine-start controls opened as a result of actions taken in Step 1, Section 6.1.2.

Step 5: Where required, use an accurate voltmeter to check phase-to-phase and phase-to-neutral voltages present at the transfer switch Source 1, Source 2, and/or load terminals.

6.1.4 Operational Checks

Step 1: Check to ensure that Source 1 switching device is in the CLOSED position. This should have been done in Section 6.1.3, Step 1.

Step 2: Initiate an automatic transfer operation from the Source 1 to the Source 2 power source by pressing the **<Engine Test>** pushbutton on the ATC-300 + /800 Controller two times.

Note: The ATC-300 + /800 Logic Controller provides the capability to set the Engine Test function to:

0. No Load Engine Test;
1. Load Engine Test; or
2. Disabled.

The factory default is set to 0 - No Load Engine Test

1. Load Engine Test
 - a. After the Time Delay Engine Starting (TDES) has timed out, the engine should start, run, and build up to normal voltage and frequency.
 - b. The transfer switch will transfer to the Source 2 power source after the Time Delay Normal to Emergency (TDNE) times out.

Step 3: Initiate an automatic transfer operation back to the Source 1 power source by pressing the **<Engine Test>** pushbutton on the ATC-300 + /800 Controller one time.

1. After the Time Delay Emergency to Normal timer (TDEN) has timed out, the transfer switch will transfer back to the Source 1 power source.
2. The Time Delay for Engine Cool-Off (TDEC - Feature 4) will allow the engine to run unloaded for a preset time after transfer to the Source 1 power source is completed.

6.1.5 Alternate Tests

1. Alternate operational tests may be possible depending upon the options provided with any given ATS. Refer to the schematic diagram provided with the ATS equipment, along with the specification nameplate, to determine the exact options provided.

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! WARNING

DO NOT ATTEMPT TO MANUALLY OPERATE THE ATS WITH THE SOURCE 1 POWER SOURCE CONNECTED AND AVAILABLE.

DO NOT ATTEMPT TO MANUALLY OPERATE THE ATS WITH THE SOURCE 2 POWER SOURCE CONNECTED AND AVAILABLE.

6.2 Problem Solving

! WARNING

HAZARDOUS VOLTAGES IN AND AROUND NON-AUTOMATIC TRANSFER SWITCH EQUIPMENT DURING THE PROBLEM SOLVING PROCESS CAN CAUSE SEVERE PERSONAL INJURY AND/OR DEATH. AVOID CONTACT WITH ANY VOLTAGE SOURCE WHILE PROBLEM SOLVING.

! WARNING

ONLY PROPERLY TRAINED PERSONNEL, FAMILIAR WITH THE NON-AUTOMATIC TRANSFER SWITCH EQUIPMENT AND ITS ASSOCIATED EQUIPMENT, SHOULD BE PERMITTED TO PERFORM THE PROBLEM SOLVING FUNCTION. IF AN INDIVIDUAL IS NOT QUALIFIED TO PERFORM THE PROBLEM SOLVING FUNCTION, THE INDIVIDUAL SHOULD NOT ATTEMPT ANY OF THESE PROCEDURES.

A basic problem solving effort is the first step to take prior to calling for assistance. Frequently, the effort will successfully address most problems encountered. In addition, several problem solving procedures are presented here which are specific to the type of switches or contactors used in this equipment.

If a problem persists after having completed the problem solving procedure, contact an Eaton representative for further assistance. When calling for assistance, the following is the minimum information required to properly address the need:

1. General Order Number (GO#) of transfer switch, plus related Item Number.
2. Catalog and/or Style Number of transfer switch.
3. Actual location of transfer switch (type of facility, address, etc.).
4. Company name.
5. Name and position of individual representing company.
6. Basic description of situation as it exists.
7. Any results of problem solving steps taken and/or readings taken.

Eaton Care for Assistance
877-386-2273 option 2, option 4, and then option 3

6.2.1 Transfer Switch Appears Inoperative (Manual Operation or Non-Automatic Operation)

- Step 1:** Initially verify that there is no voltage on any source (Source 1 or Source 2) inside the transfer switch.
- Step 2:** Depress the "TRIP" button located on the operating mechanism of the contactor to bring the contactor to neutral (trip) position.
- Step 3:** Attach the lever to the manual operating handle (see Figure 15) and rotate the lever up to go to Source 1.
- Step 4:** Depress the "TRIP" button located on the operating mechanism of the contactor to bring the contactor to neutral (trip) position.
- Step 5:** Depress the "SELECT" button located on the operating mechanism of the contactor and rotate the lever up keeping the "SELECT" button depressed to go to Source 2.

Following above steps, if the transfer switch does not transfer between two sources, contact factory personnel

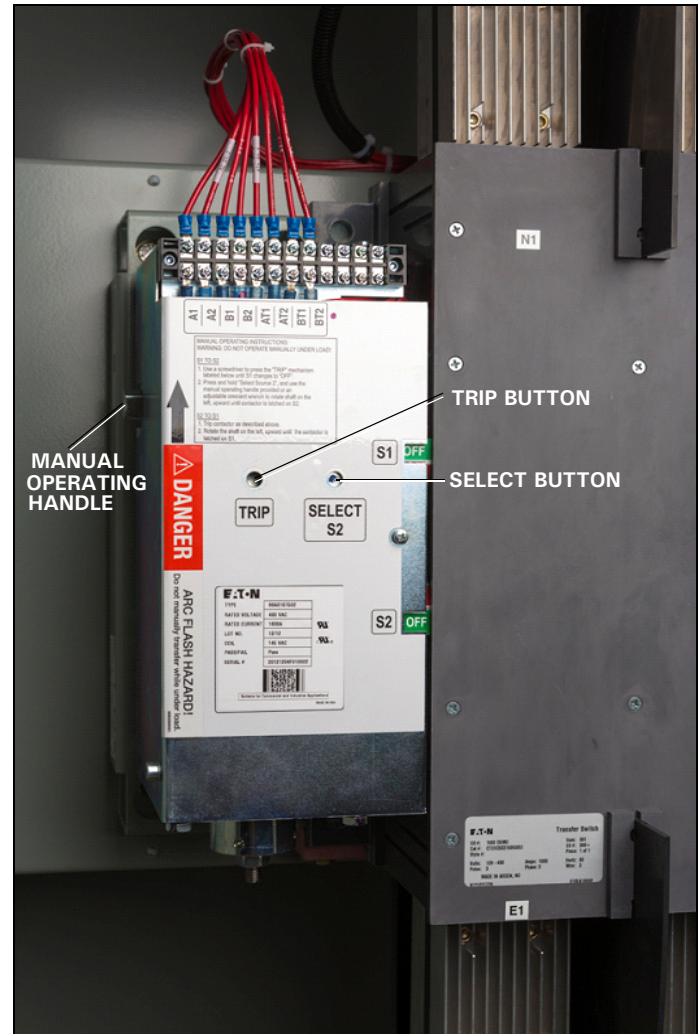


Figure 15. Troubleshooting Manual Operation of the Transfer Switch

6.2.2 Transfer Switch Appears Inoperative (Non-Automatic Electrical Operation)

- Step 1:** Initially verify that there is no voltage on any source (Source 1 or Source 2) inside the transfer switch.
- Step 2:** Verify that the 3-position contactor is in neutral position. If not, depress the "TRIP" button located on the operating mechanism of the contactor to bring the contactor to neutral (trip) position.
- Step 3:** Verify that all plugs and sockets are properly interconnected.
- Step 4:** Apply sufficient voltage and frequency on Source 1 (or Source 2) and verify that correct system voltage appears on Source 1 (or Source 2) side of the transfer switch. Measure and confirm correct voltage at Source 1 (or Source 2) lugs.
- Step 5:** Verify that the voltage selection plug is in proper position to match the system voltage.
- Step 6:** Look for any obviously overheated components. Determine the cause and rectify, if possible. Replace defective components after the cause is determined.
- Step 7:** Verify that correct source available light is "ON" on the front device panel.
- Step 8:** Press "Source 1 Close" push button (or "Source 2 Close" push button) and verify that correct position indication light is "ON".

Section 7: Adjustments**7.1 General****WARNING**

HAZARDOUS VOLTAGES IN AND AROUND ATS EQUIPMENT DURING THE PROBLEM SOLVING PROCESS CAN CAUSE SEVERE PERSONAL INJURY AND/OR DEATH. AVOID CONTACT WITH ANY VOLTAGE SOURCE WHILE PROBLEM SOLVING.

Refer to I.B. 01602009E, supplied with the ATS for ATC-300 + Controller adjustments and programming. Refer to I.B. ATS-C103, supplied with the ATS for ATC-800 Controller adjustments and programming.

Section 8: Maintenance

8.1 Introduction



WARNING

HIGH VOLTAGES ARE PRESENT IN AND AROUND ATS EQUIPMENT. BEFORE INSPECTING OR MAINTAINING THIS EQUIPMENT, DISCONNECT THE LINE POWER FROM, THEN LOCK OUT, IF POSSIBLE, THE NEXT HIGHEST DISCONNECT DEVICE. FAILURE TO FOLLOW THIS PROCEDURE COULD CAUSE SEVERE PERSONAL INJURY AND/OR DEATH.

In general, ATS switch equipment is designed to be relatively maintenance free under normal usage. However, because of the variability of application conditions and the importance placed on dependable operation by this type of equipment, inspection and

maintenance checks should be made on a regularly scheduled basis. Since equipment maintenance will consist mainly of keeping the equipment clean, the frequency of maintenance will depend to a large extent on the cleanliness of the equipment's surroundings. If a significant amount of dust or foreign matter is present, a more frequent maintenance schedule should be followed.

It is suggested that visual inspections of the equipment be made on a regular basis, not just during scheduled periods. Always be alert for an accumulation of dirt in and around the structure; loose parts; and/or hardware, cracks, and/or discoloration to insulation; and damaged or discolored components.

8.2 Procedures

A suggested maintenance procedure is outlined in Table 5.

Table 5. Periodic Maintenance Procedures.

STEP	ACTION
a. Make the ATS equipment safe for inspection and/or maintenance.	Disconnect the line power from equipment being serviced by opening the next highest disconnect device. Make certain that any accessory control power is switched off by disconnecting all control plugs.
b. Inspect the structure area for safety hazards or potential maintenance problems.	Inspect the area, especially where switching device is installed, for any safety hazards, including personnel safety and fire hazards. Exposure to certain chemical vapors can cause deterioration of electrical connections. Inspect for accumulated dirt, loose hardware, or physical damage. Examine the primary insulation for evidence of cracking or overheating. Overheating will show as discoloration, melting, or blistering of conductor insulation, or as pitting or melting of conductor surfaces due to arcing. Inspect the secondary control connections for damage and the control wiring for insulation integrity.
c. Inspect the power contactor for dust, dirt, soot, grease, moisture, or corrosion.	Remove dust, dirt, soot, grease, moisture, and corrosion contamination from the surface of the switching device using a dry soft lint-free cloth, dry soft bristle brush, and vacuum cleaner. Do not blow debris into the power contactor. If contamination is found, look for the source and fix the problem.
d. Check for material integrity, uneven wear, discoloration, or loose hardware.	Severe material cracking will require replacement and loose hardware will need to be tightened.
e. Check the terminals and connectors for looseness or signs of overheating.	Overheating will show as discoloration, melting, or blistering of the conductor insulation. Connections that do not have signs of looseness or overheating should not be disturbed.
f. Contact Inspection Procedure	Remove all the screws on the molded cover over the power assembly. Inspect the contacts. Contact Eaton Care (1-877-ETN-CARE, Option-2) if the contacts have excessive wear. Reinstall the molded cover and tighten screws to 17 in-lbs.
g. Exercise the power contactor if it is not often exercised while in operation. This will permit a "wiping" action by the contacts.	If the power contactor is used for frequent switching during normal operation, this step can be disregarded.
h. Return the ATS equipment to service.	Make certain all barriers are in place and doors closed. Reapply secondary and primary power.
i. Contact Resistance Testing	Contact resistance should not be considered a reliable measure of a contactor's ability to carry rated current. Contact resistance is usually measured with low currents from a low voltage supply flowing through the contacts, and the resistance value is heavily dependent on transient contact surface conditions. The millivolt drop procedure outlined in NEMA Standards Publication AB 4 can be used to assess the electrical integrity of connections and contacts within a contactor. Again, the millivolt drop can be affected by contact surface conditions which can change with contactor operation and arcing. The millivolt drop is only one factor in determining the thermal loading of a contactor, and the total system must be considered prior to judging a contactor to be unacceptable. If resistance and millivolt drop test data raises concerns with regard to contactor integrity, a proper thermal test must be performed.

**Eaton Care for Assistance
877-386-2273 Option2, Option 4, and then Option3**

Section 9: Renewal Parts Guide

9.1 General

Refer to Figure 16 for assistance with selecting and ordering selected ATS renewal parts. For more information please see Renewal Parts Publication (RP01603002E)

Example: To order the transformer pack for an **ATC3C3X31600XRU** transfer switch, order Catalog Number as shown in Figure 16.



ATC-300+ Controller - 3-Position Contactor Type ATC-900 Controller	Cat# 8160A00G108 Call Factory
Transformer Pack	1600A, 480VAC, 2-Pole - Cat# 68C8241G03 1600A, 480VAC, 3-Pole - Cat# 68C8241G03 1600A, 480VAC, 4-Pole - Cat# 68C8241G03
Contactor	1600A, 480VAC, 2-Pole - Cat# 66A8167G01 1600A, 480VAC, 3-Pole - Cat# 66A8167G02 1600A, 480VAC, 4-Pole - Cat# 66A8167G03
Wire Harness	Domestic Switch, up to 480VAC, 2-Pole - Cat# 68C8492G03 + 68C8492G04 Domestic Switch, up to 480VAC, 3-Pole - Cat# 68C8492G03 + 68C8492G06 Domestic Switch, up to 480VAC, 4-Pole - Cat# 68C8492G03 + 68C8492G06
100W Space Heater	Domestic Switch, up to 480VAC - Cat# 8160A41G54
Lugs	1600A - Cat# 4ABV-750

Figure 16. Typical ATC-300 + /900 Controlled Contactor Type 1600A ATS.

**Section 10: ATC-300 + Controlled ATS
Quick Start Instructions**

! WARNING

THESE QUICK START INSTRUCTIONS ARE NOT A COMPLETE SOURCE OF INFORMATION ON THE ATC-300+ CONTROLLED ATS EQUIPMENT. INSTALLATION SHOULD NOT BE STARTED UNTIL THE ENTIRE INSTRUCTION BOOK HAS BEEN REVIEWED AND UNDERSTOOD. FAILURE TO FOLLOW THE FULL INSTRUCTIONS CAN RESULT IN DEATH, SEVERE PERSONAL INJURY, OR PROPERTY DAMAGE.

! WARNING

THESE QUICK START INSTRUCTIONS ARE PROVIDED FOR USE ONLY BY TECHNICIANS HIGHLY FAMILIAR AND EXPERIENCED WITH ATC-300+ CONTROLLED ATS EQUIPMENT INSTALLATION, SET UP, AND TESTING. IT IS STRONGLY SUGGESTED THAT THE FULL INSTRUCTIONS BE FOLLOWED FOR ALL INSTALLATIONS, SET UP, AND TESTING.

Step 1: Mount the ATS on a flat rigid surface (Figure 17). Shim if necessary.

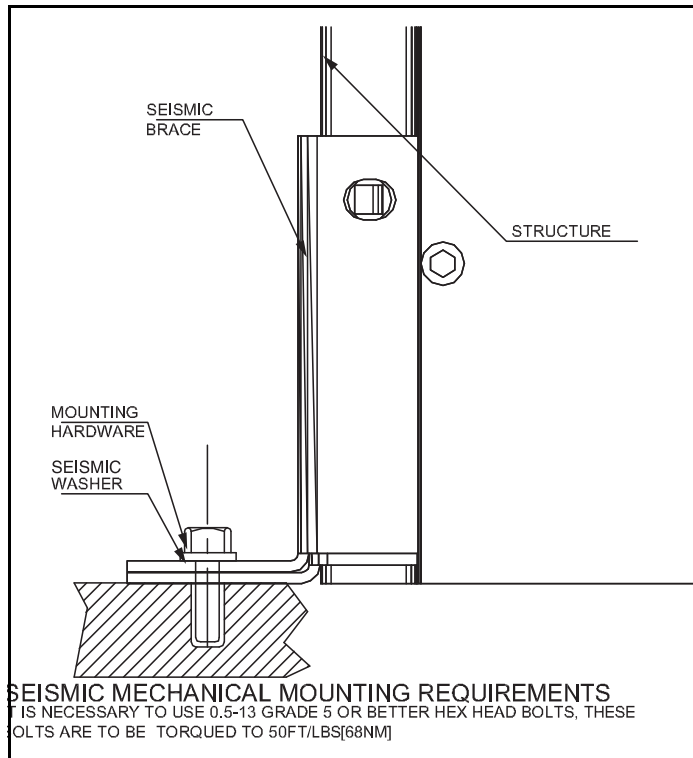


Figure 17. Mounting Details.

Step 2: Install the power cables. Cables must be sized and installed per National Electrical Code, refer to NFPA70. The cables must be sized within the specified cable size range on the side of the cable connectors.

Connect the cables and torque to the correct value indicated on the label on the door in the following order:

1. Load Cables* (T1, T2, T3);
2. Source 1 or Utility Supply (N1, N2, N3); and
3. Source 2 or Generator Supply (E1, E2, E3).

For 4 pole transfer switches, connect the load cables (TN), Source 1 or utility supply (NN), and Source 2 or generator supply (EN). Refer to Figure 18 for the location of all parts discussed in this document.

*Load cables MUST be connected and torqued BEFORE installing the SUPPLY cables (Figure 18).

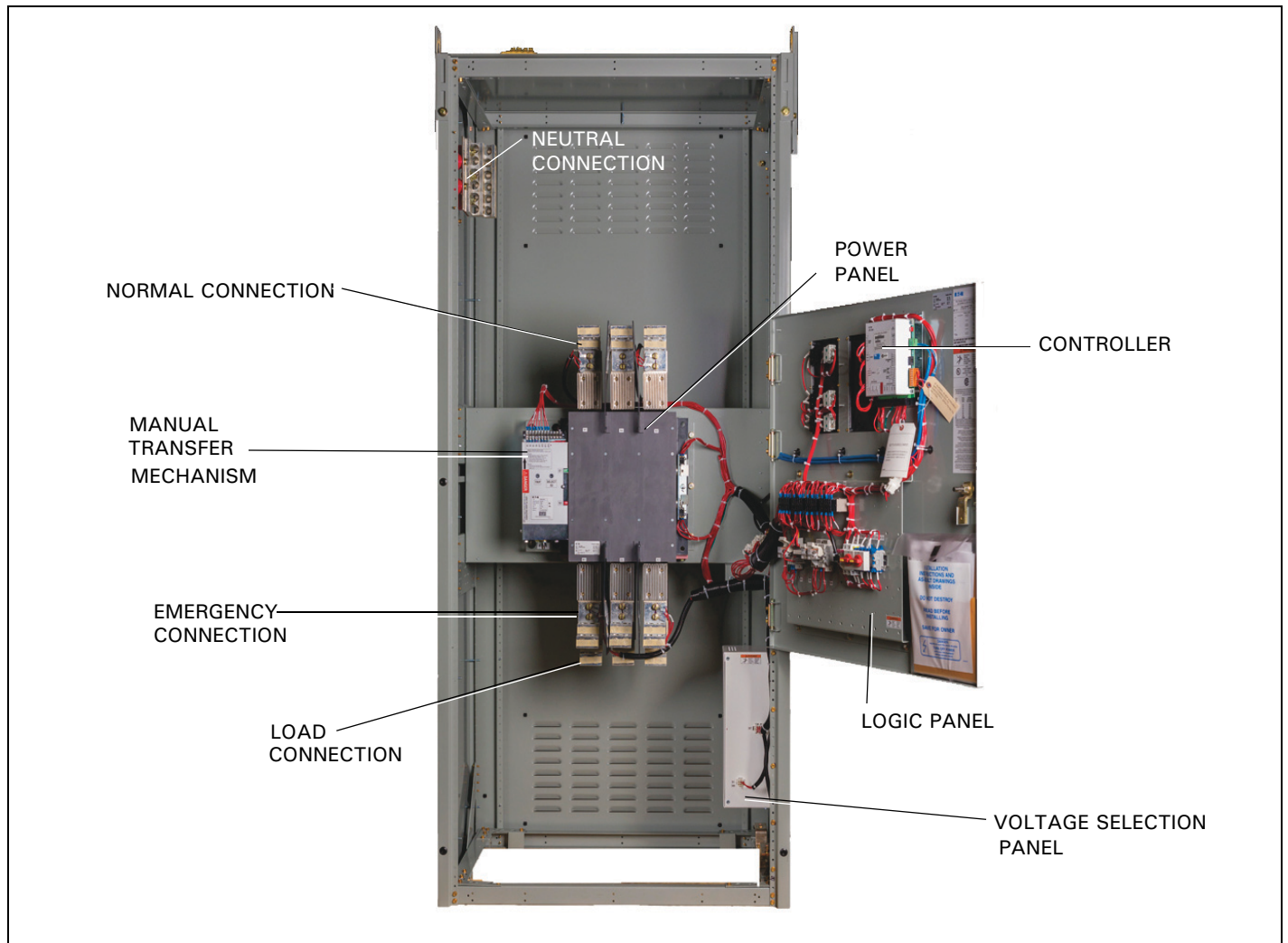


Figure 18. 1600A, 3-Pole, ATS Interior Components Shown with (ATC-300).

1600A (480 Vac) ATC-300 + /900 & Non-Automatic, 3-Position Fixed Mount Contactor Based Transfer Switch

- Step 3:** Turn the generator OFF at the generator control panel. This will prevent unexpected activation of the generator.
- Step 4:** Connect the Engine Generator Start wires to terminals 13 and 14 on the J-5 connector on the ATC-300+ Controller (Figure 19). This contact is CLOSED whenever

the engine generator is needed, and should be connected to a generator controller. **NEVER** connect directly to a starter solenoid or ignition system. See the Genset manufacturer instruction leaflet for recommended wire sizes and location procedures.

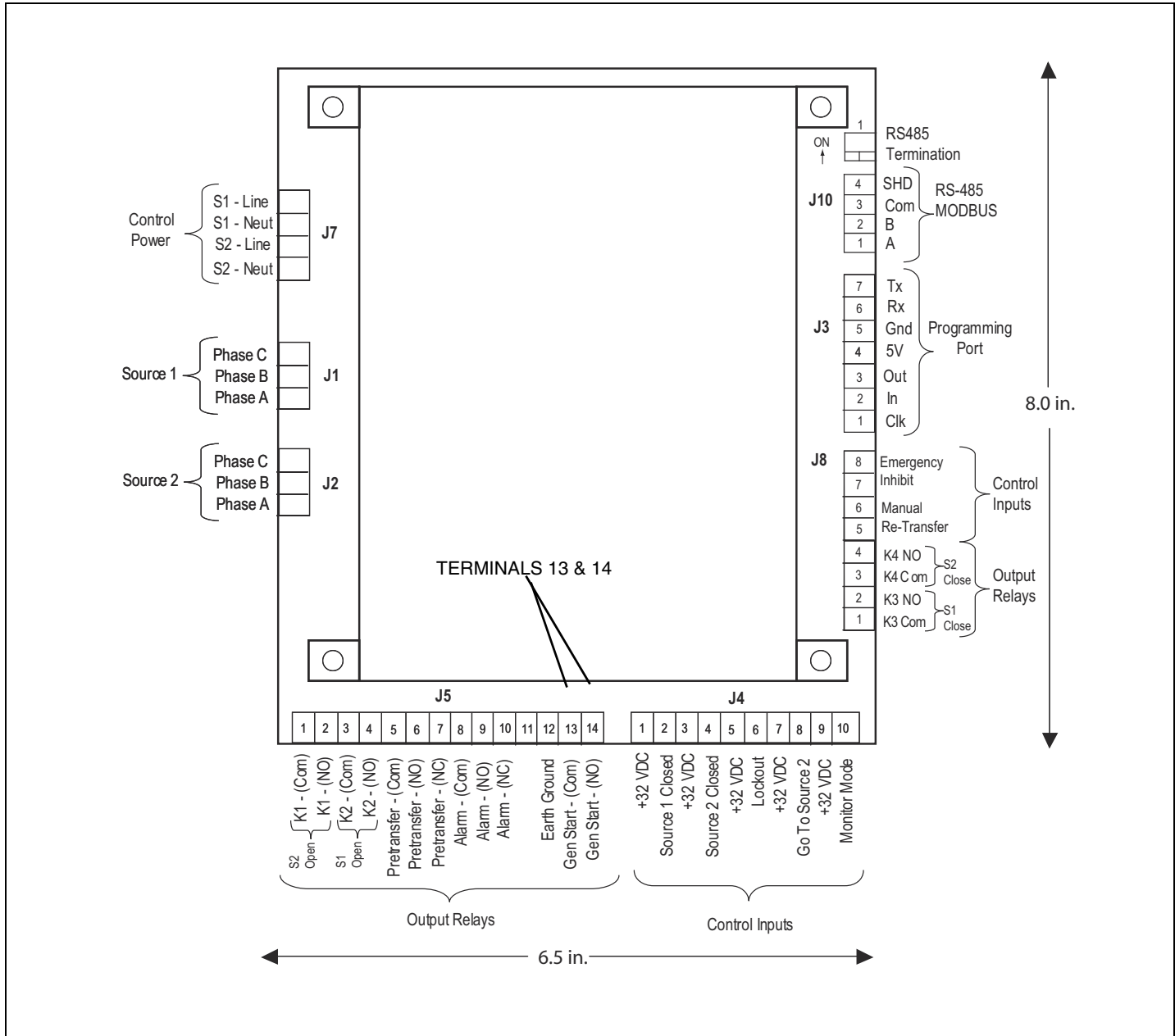


Figure 19. Engine Generator Control Connection (ATC-300+).

- Step 5:** Apply Utility (Source 1) power. If the switch is properly applied for the system voltage ordered, the display should work and the Source 1 Available white LED should light (Figure 20). Using a voltmeter, check for proper system voltage on Source 1 and load terminals. Check all phases on a 3-phase switch. Voltage measurements should be taken phase to phase and phase to neutral.

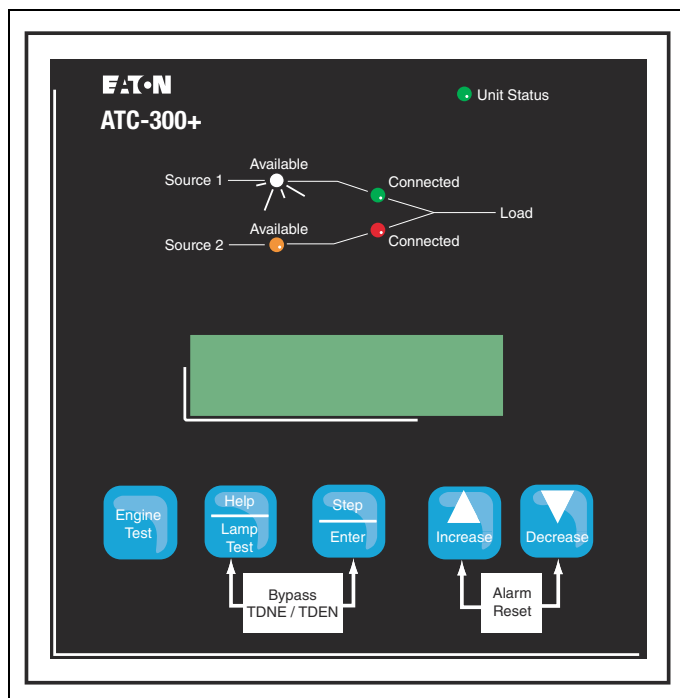


Figure 20. ATC-300+ Logic (Utility Supplying Load).

Step 6: To view the setpoints, press the <Step/Enter> pushbutton and enter the Password.

Note: The factory default Password is 0300. The factory default password on the ATC-900 is 0900. See the instruction booklet for instructions on the ATC-900 menus and operation.

After entering the password, press the <Step/Enter> pushbutton until the VIEW SETPOINTS menu appears. Select YES. Press the <Step/Enter> pushbutton to scroll through the setpoints (Figures 21 and 22).

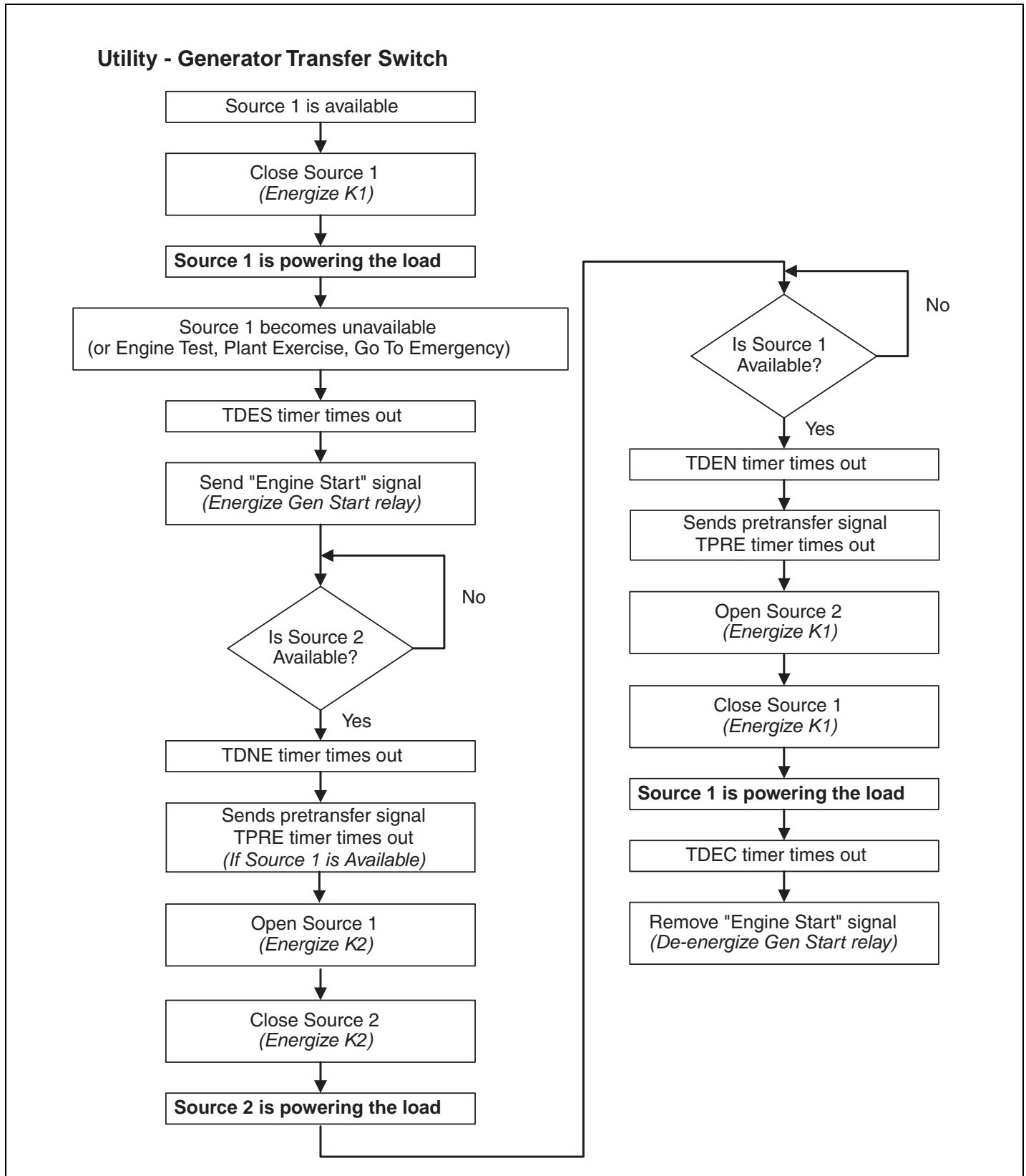


Figure 21. Utility - Generator Transfer Switch (ATC-300+).

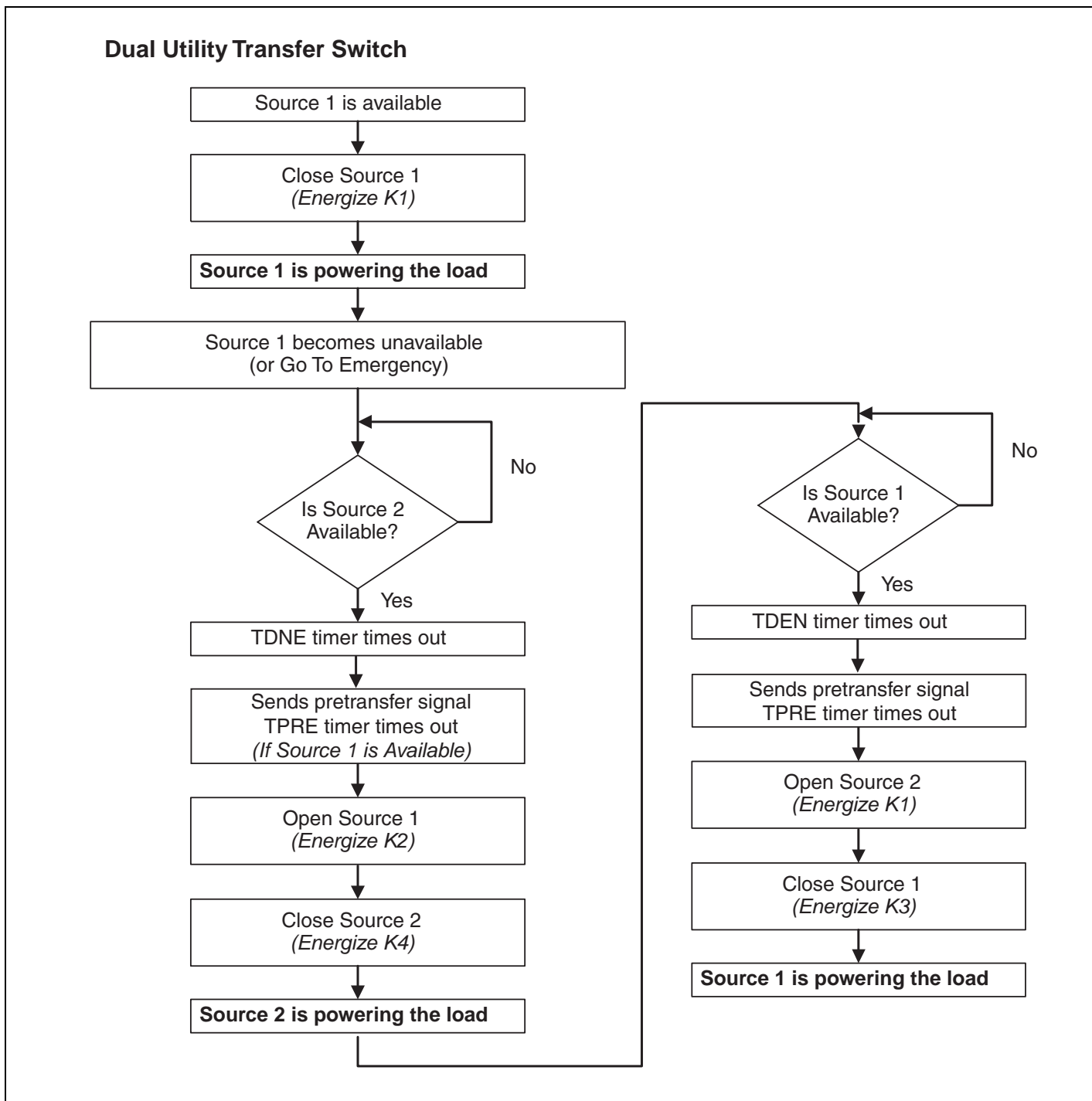


Figure 22. Dual Utility Transfer Switch (ATC-300 +).

For factory setpoints, please see the ATC type controller Instruction Booklets furnished with the switch.

Step 7 : To change or add a setpoint, select **Yes** when the “Change Setpoints” message appears on the screen. Use the **<Step/Enter>** pushbutton to step through the setpoints.

Use the **<Increase>** and **<Decrease>** pushbuttons to change the setpoint.

When finished scrolling through and changing the desired setpoints, answer **Yes** when the “Save Setpoints?” question appears on the screen. The display will return to the default screen.

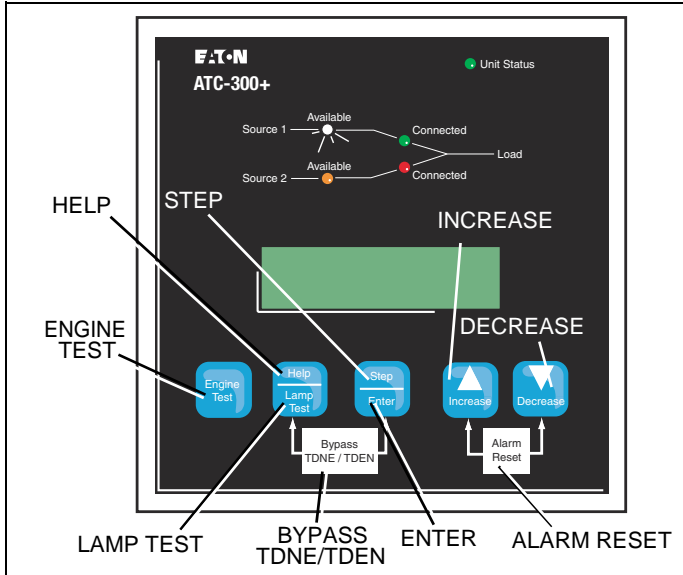


Figure 23. ATC-300 + Pushbuttons.

WARNING

THE GENERATOR SHOULD BE MANUALLY STARTED AND THE OUTPUT CHECKED AND VERIFIED BEFORE PROCEEDING TO STEP 8. IF IMPROPER VOLTAGE/FREQUENCY IS APPLIED TO THE LOAD, THE ATS MAY BE DAMAGED.

Step 8: Manually start the engine generator at the generator controller. Check that the generator is running and the *Source 2 Available* amber LED is lit. Press the **<Step/Enter>** pushbutton, step through the phase voltages, frequency, and message display. If the source message indicates that the source is Good, shut down the generator and place the Genset controller in the Auto-operating position. If the message indicates a problem with the source, the setpoints should be reviewed and the generator checked for proper voltage and frequency output.

Step 9: Initiate a Load Test from the front panel of the ATC-300+ (Figure 24). This may be done by setting the engine test mode setpoint to:

- 1 Load Test

then saving the setpoints. Once the engine test setpoint has been changed and saved, press the **<Engine Test>** pushbutton twice. The generator should start, the ATS should transfer and run on the generator for the set test interval, then proceed to a TDEN countdown and return to Source 1. While the ATS is connected to Source 2, use a voltmeter to check for correct system voltage on

the load terminals of the ATS. Check all phases on a 3-phase system. Voltage measurements should be taken phase to phase and phase to neutral. A load test will cause a momentary power outage during transfer.

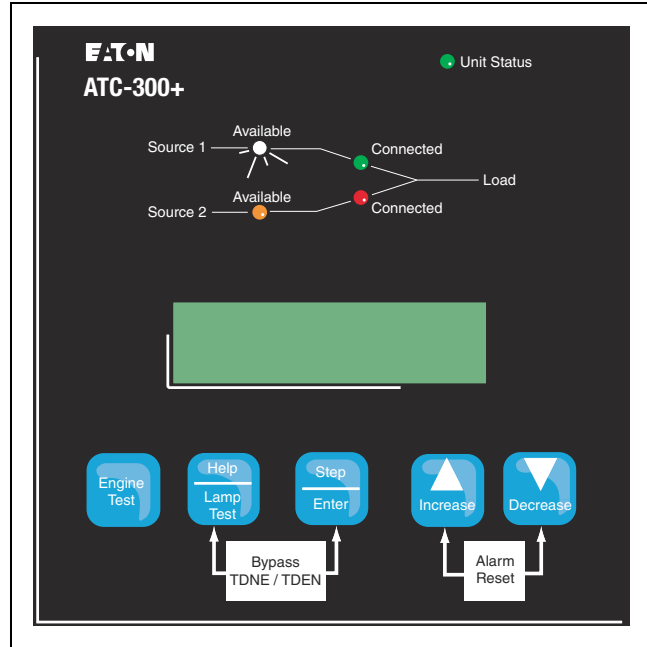


Figure 24. ATC-300 + Logic.

Step 10: ATC-3 Controlled ATS Power Failure Test - Initiate a Load Test by simulating an actual power failure.

1. This should be done by opening the upstream breaker or fused disconnect switch.
2. The generator should start and the ATS should transfer to Source 2.
3. After transfer, close the upstream breaker, or close the Source 1 Control Circuit Fused Disconnect. The TDEN timer should begin counting, and, when complete, the ATS should transfer to Source 1. The TDEC should time out and shut the Source 2 power unit down.

NOTICE

WHILE PERFORMING TESTING, IF AN UNDESIRABLE OR UNDOCUMENTED RESULT OCCURS, FIRST CONTACT THE LOCAL GENSET DEALER. IF THE RESULT IS NOT CORRECTED, CONTACT THE EATON POWER QUALITY TECHNICAL SUPPORT CENTER AT 1-800-354-2070.



**1600A (480 Vac) ATC-300 + /900 & Non-Automatic,
3-Position Fixed Mount Contactor Based Transfer Switch**

Notes:

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For Transfer Switches:
877-ETN CARE (877-366-2273)
option 2, option 4, and then option 3