Low-voltage power distribution and control systems > Automatic transfer switches >

ATS controllers and remote annunciators

Contents

General Description **25.4-2**
- Overview 25.4-2
- Automatic Transfer Controller Family 25.4-3
- HMi Remote Annunciator Controller 25.4-28

Devices **25.4-34**
- Communication 25.4-34

Layouts and Dimensions **25.4-35**
- Standard Layouts, Dimensions and Weights 25.4-35
- Wiring Diagrams 25.4-40

Application Fundamentals **25.4-43**
- Transfer Switches 25.4-43
- UL 1008 Standard 25.4-50
- NFPA 70 System Installation Types 25.4-52

Powering Business Worldwide

Overview

Eaton's automatic transfer switch (ATS) controller family, transfer switch monitor and HMi remote annunciator controller provide modular intelligence uniquely designed for monitoring and controlling transfer switch equipment in low-voltage and medium-voltage power distribution systems.

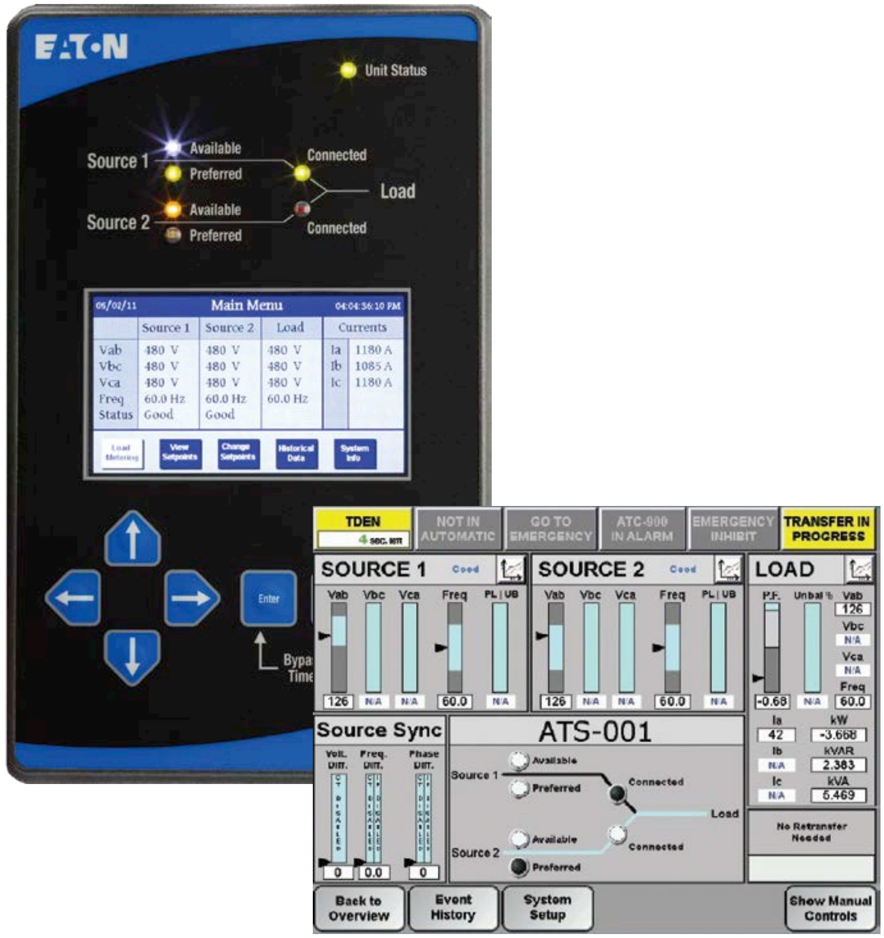
Designs are intended for use in emergency, legally required, optional standby, and critical operation power systems as defined by the National Electrical Code® (NEC®).

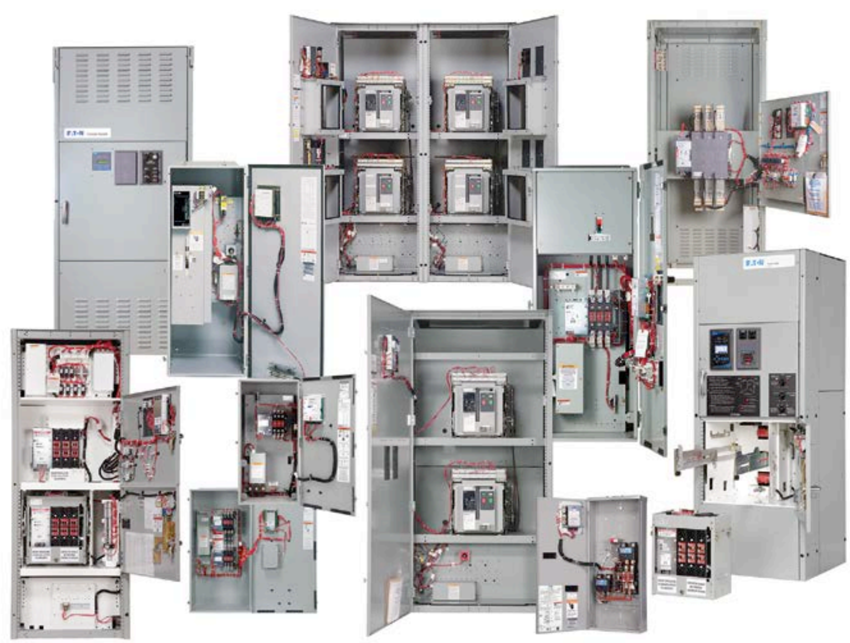
Products

- ATC-100, ATC-300+, ATC-900 automatic transfer controllers
- TSM-900 transfer switch monitor
- HMI remote annunciator controller (RAC)

Design Highlights

- Application flexibility
- Compact footprint
- Ease of installation
- Intuitive operator interface
- Self-acting monitor/control
- Standard microprocessor-based logic and firmware dedicated for use in transfer switch applications
- Communication equipped
- UL® Listed/recognized





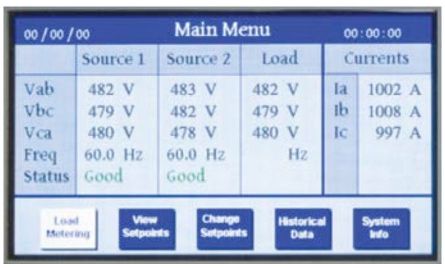
Automatic Transfer Switch Family

Automatic Transfer Controller Family

ATC-900 Automatic Controller

Eaton's ATC-900 brings intelligence, adaptability, enhanced supervisory and programming capabilities to Eaton's low-voltage and medium-voltage transfer switch product family.

The simple yet powerful user interface includes many intuitive features. The color display and mimic bus with LED indication provide enhanced operator visibility of transfer switch status and metering data. Front arrow keys allow for quick screen navigation, removal of codes and abbreviations avoid potential confusion, and refined data screens provide for ease of viewing and programming.



ATC-900 Main Menu Screen

Primary Features

- Monitor voltage and frequency of normal source, emergency source and load
- Self-acting load transfer between power sources
- Display of real-time and historical information
- Programmable setpoints
- User configurable control inputs and relay outputs
- Dual engine start/shutdown signaling
- Dual programmable plant exercisers
- Integral load metering
- Detailed and time-stamped event log and history
- Remote monitoring with HMi RAC
- Advanced diagnostics and trouble-shooting with pre-/post-event data capture
- Download of setpoints, event log, and metering data via USB flash drive
- Upload of setpoints and firmware updates via USB flash drive
- Industry standard communication—serial (RS-485/Modbus® RTU) and ethernet (via optional module)
- Symmetrical component calculation
- Record test data to comply with The Joint Commission, NFPA 99 and NEC (700, 701, 708) requirements
- Generator start contacts (Form C) provide means to comply with 695.14(F) and 700.10(D)(3) of the NEC (2017 and 2020)

Table 25.4-1. ATC-900 Specifications

Description	Specification
Control voltage Nominal voltage Voltage sensing	65–145 Vac and/or 21.6–26.6 Vdc 120–600 Vac (medium voltage with external PT) Source 1 and Source 2
Voltage range Voltage accuracy Nominal frequency	0–720 Vac rms ±1% of nominal voltage 50 or 60 Hz
Frequency sensing Frequency range Frequency accuracy	Source 1 and Source 2 40–80 Hz ±0.2 Hz
Operating temperature range Storage temperature range Operating relative humidity	–20 to +70 °C (–4 to +158 °F) –30 to +80 °C (–22 to +176 °F) Up to 90% (noncondensing)

LED mimic diagram
Color-coded LEDs provide status indication. Source 1 Available (white) and Connected (green), Source 2 Available (amber) and Connected (red), Preferred Source (green).

Display and main menu
Provides status at a glance. Source 1, Source 2, and Load status and metering data are displayed. Additional screens are easily accessed using navigation keys.

Arrow key navigation
Right and left arrow keys are used to navigate menu options and up and down arrow keys are used to scroll screens and change setpoint values.

USB port
Download/upload setpoints, events, statistics, meter data, and firmware.

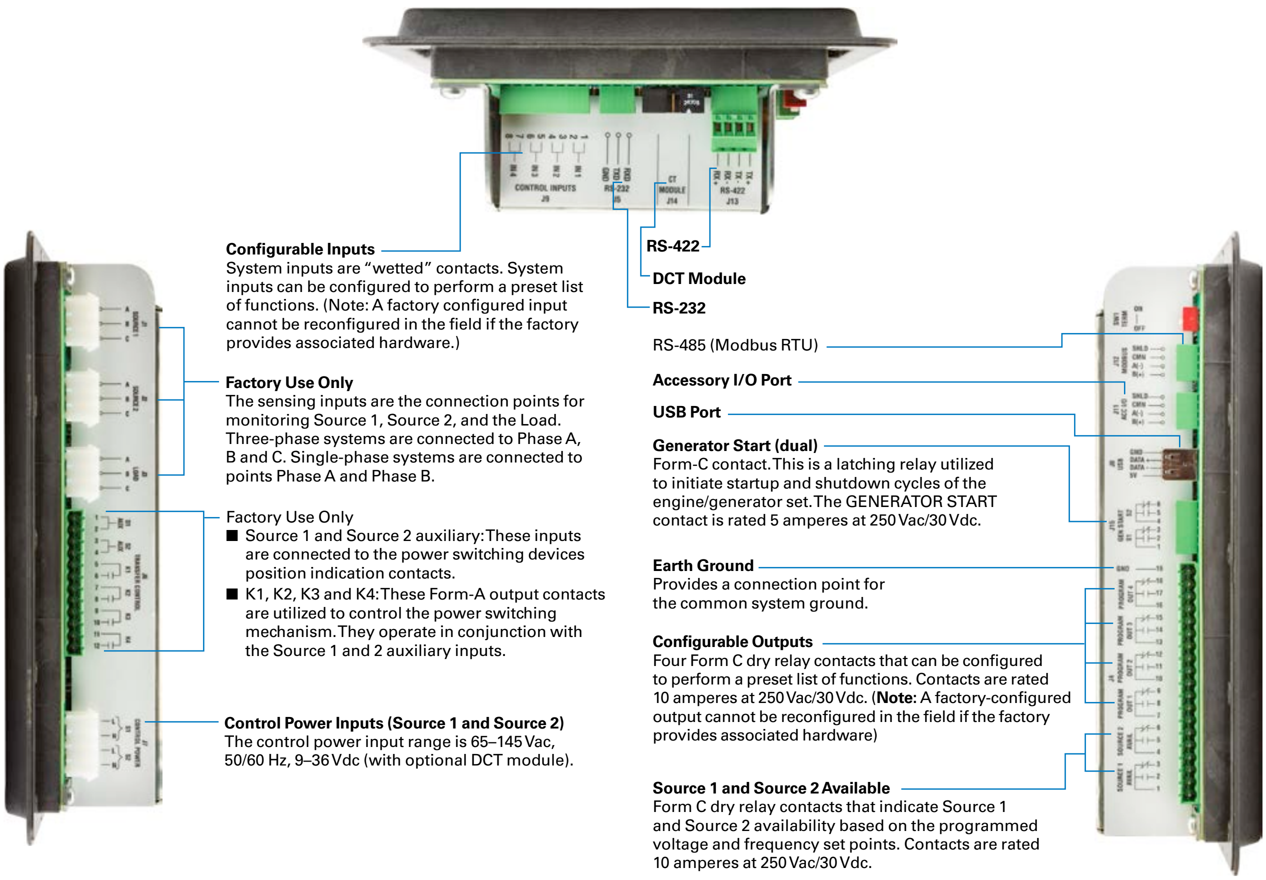
Unit status
LED (green) blinks, indicating that the ATC-900 is operating normally. If the LED is not lit or is on continuously, then a problem condition is indicated.

Help
Displays controller firmware version and user tips.

Lamp test
Pressing the Lamp Test pushbutton lights all LEDs and then displays ATC-900 information.

Engine test
Performs an engine test using the programmed engine run and cool-down times. This is a password-protected feature.

Bypass time delays
Pressing the Enter and Help pushbuttons simultaneously reduces the active programmed time delay to zero.



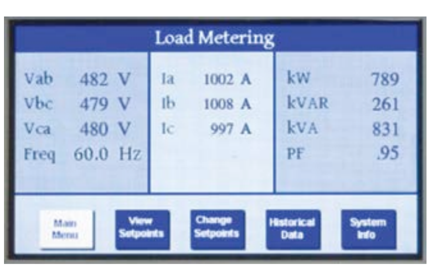
Accessory Modules

The ATC-900 utilizes supporting hardware accessory modules to expand its functionality.

Integral Metering and DC Supply Voltage

An optional DCT module mounts directly to the rear of the ATC-900 and supports the connection of three current transformers (CTs not included) to provide integral power metering (amperes, kW, kVA, kvar, PF) complementing standard ATC-900 voltage and frequency monitoring.

ATC-900 DCT Module



Programmable Inputs/Outputs

The ATC-900 standard offering of four programmable inputs and four programmable outputs is expandable by adding I/O modules.

Each I/O module provides an additional four inputs (wetted, 24 Vdc at 10 mA) and four outputs (Form C rated 10 A at 250 Vac/30 Vdc). A maximum of four I/O modules can be daisy-chained for a total of 20 inputs and 20 outputs.

ATC-900 I/O Module

Programmable Input Functions

- Monitor mode
- Bypass timer
- Lockout
- Manual retransfer
- Enable manual retransfer
- Slave
- Remote engine test
- Preferred source selection
- Go to emergency
- Emergency inhibit/load shed
- ATS on bypass
- Go to neutral position
- Closed transition disable
- Disabled

Programmable Output Functions

- Source 1 available
- Source 2 available
- Source 1 connected
- Source 2 connected
- ATS not in automatic mode
- General alarm
- ATS in test status
- Engine test aborted
- Engine cool-down in process
- Engine 1 start status
- Engine 2 start status
- Emergency inhibit on
- ATS on bypass
- Load sequence
- Selective load shed
- Load bank control
- Pre-/post-transfer
- Pre-transfer
- Post-transfer
- User remote control
- Health
- Waiting for source sync
- Disabled

Fixed Output Functions

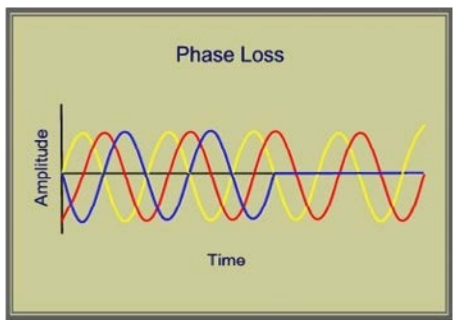
- Source 1 available
- Source 2 available
- Engine start 1
- Engine start 2

Symmetrical Components

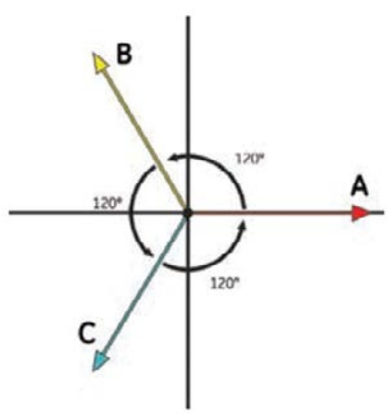
The ATC-900 calculates both positive and negative sequence components for voltage and current to determine when abnormal conditions exist that might otherwise go undetected.

An example is a single-phase loss (e.g., open feeder fuse) at the normal source, which would typically cause a transfer to the alternate source.

Once the normal source is unloaded, a condition can develop whereby the single-phase loss is masked due to an induced or "phantom" voltage. If undetected, this could result in a retransfer back to the normal source. Once the normal source is loaded again, the cycle can repeat itself, resulting in continuous power interruptions until the phase loss condition is corrected.



Through the calculation of symmetrical components, the ATC-900 is capable of detecting this abnormal condition and preventing transfer cycling. To protect mechanical loads from potential damage, the ATC-900 can disconnect the load from the normal source (immediately or after a time delay) until the alternate source becomes available.



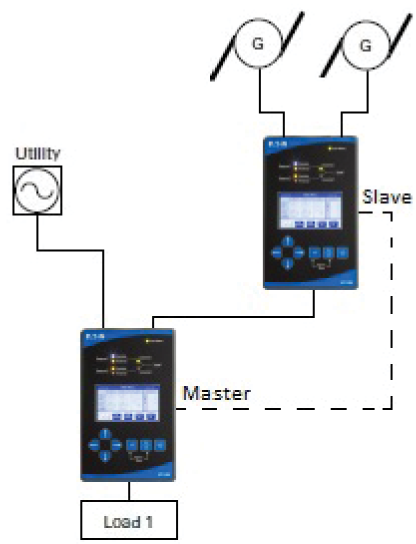
ATC-900 Uses Negative Sequence Components to Detect Abnormal Conditions

Three Source Arrangement with Master-Slave

The master/slave functionality provides the ability to configure two independent automatic transfer switches in a three-source arrangement consisting of a utility and two generator sources (permanent or portable).

In this configuration, the engine start signal from the master ATS is wired directly to a programmed control input at the slave ATS. The engine start 1 and engine start 2 signals at the slave ATS are wired to the generators. The ATC-900 at the slave ATS requires a DCT module (fed by an external 24 Vdc supply) to keep the controller powered.

In the event of a utility power failure, the master ATS engine start relay closes signaling the slave ATS to start either a preferred generator (if designated) or both generators. Generator start and stop is managed by the slave ATS. Upon restoration of utility power, the master ATS engine start relay will open, signaling the slave ATS to begin generator shutdown.



Master-Slave Configuration with ATC-900

Load Management

The ATC-900 offers several standard and optional features, enhancing a user's ability to manage load.

- **Integral load metering:** Monitor load power utilization and compare to baseline measurements
- **Selective load shed:** Drop and pickup non-essential loads when programmed kW threshold levels are reached
- **Emergency inhibit/load shed:** Inhibit or disconnect the load connection to emergency source
- **Pre/post transfer:** Control select loads during the transfer process.
- **Load bank control:** Disengage a load bank connection from the emergency source upon loss of the normal source.
- **Normal source disconnect/reconnect:** When an abnormal power condition is present at the normal source, disconnect the load to prevent potential damage.
- **Emergency source disconnect/ reconnect:** When an abnormal power condition is present at the emergency source, disconnect the load to prevent potential damage.

Integral Power Metering

When fitted with a DCT module, the ATC-900 serves as a multifunction power meter that measures electrical parameters and can be monitored locally using the color display, or remotely via a communication network. Alternatively, data can be monitored using the HMi Remote Annunciator Controller. Metering data can be downloaded to a USB drive for post-event analysis.

Current Inputs

- Range: 0–5 A
- Burden: 0.0115 VA per phase at 5A
- Pickup current: 0.1% of nominal
- Connection: screw terminals
- Input wire gauge: 6–22 AWG (shorting block)
- Fault withstand: 100 A/10 seconds, 300 A/3 seconds, 500 A/1 second

Voltage Inputs

- Range: universal, auto-ranging up to 416 Vac L-N, 720 Vac L-L
- Burden: 0.0022 VA per phase at 120 V
- Input impedance: 2 milli-ohm/phase
- Supported systems: 3-element wye or delta
- Fault withstand: IEEE C37.90.1

Isolation

- All inputs isolated to 2600 Vac

Measurement Methods

- Voltage and current: true rms
- Sampling: 64 samples per cycle, 12-bit A/D conversion

Hi-Speed Capture

Four seconds of event metering data (two seconds before and two seconds after) is captured for waveform display or download. Data is continuously updated every 20 milliseconds and a maximum of 10 events can be stored.

Table 25.4-2. Integral Power Metering

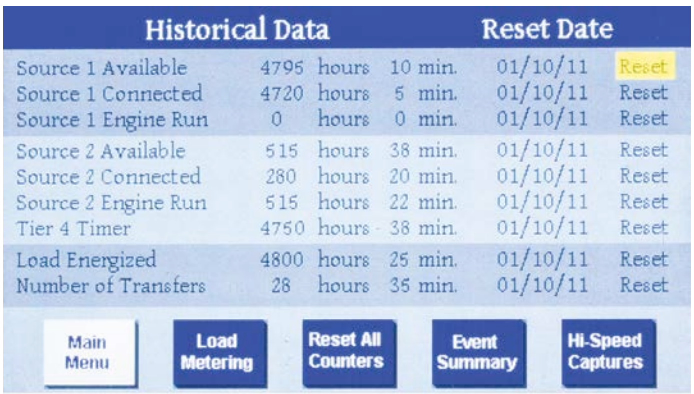
Feature	Location	Units	Accuracy	Measurement Range
Current, phase (I_a, I_b, I_c)	Load	Amperes (A)	±1%	100–5000 A (CT ratio setpoint 100:5 to 5000:5)
Voltage, line-to-line (V_{ab}, V_{bc}, V_{ca})	Source 1, Source 2, Load	Volts (Vac)	±1%	Up to 720 Vac rms
Frequency	Source 1, Source 2, Load	Hertz (Hz)	±0.2 Hz	40–80 Hz
Real power	Load	Kilo Watts (kW)	±2%	
Reactive power	Load	Kilo Volts-Amps Reactive (kvar)	±2%	
Apparent power	Load	Kilo Volts-Amps (kVA)	±2%	
Power factor	Load	PF	0 to ±1.00	

Post-Event Analysis

All historical and event summary data is time/date stamped and can be viewed at a glance via the color display.

Historical counters are cumulative and provide a value in hours; minutes that can be reset individually for diagnostic purposes:

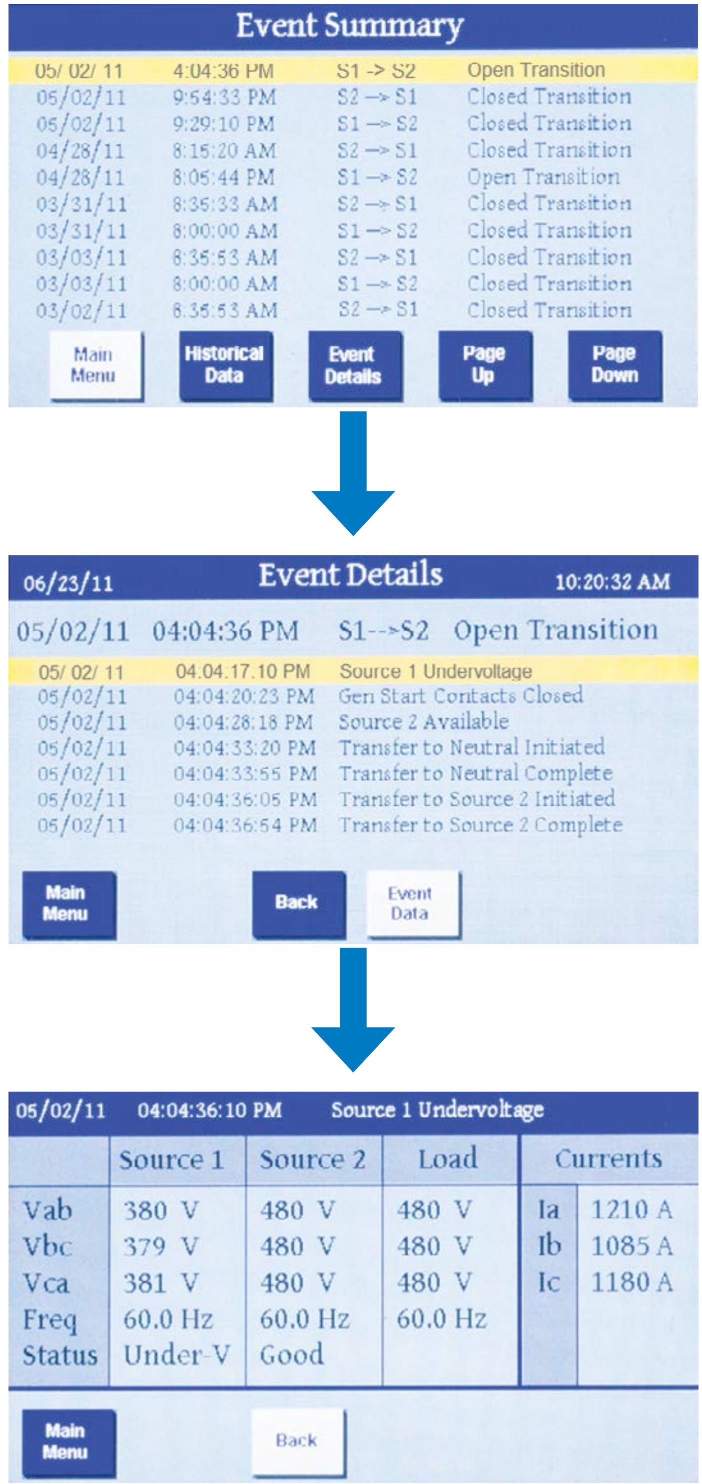
- Source 1 available
- Source 1 connected
- Source 1 engine run
- Source 2 available
- Source 2 connected
- Source 2 engine run
- Tier IV timer
- Load energized
- Number of transfers



A summary list of date/time stamped events allows each individual event to be analyzed in detail by examining the historical sequence of operation and corresponding metering data.

The ATC-900 is capable of storing 100 event summaries, 350 event details, 100 alarms and 20 time adjustments. Events include:

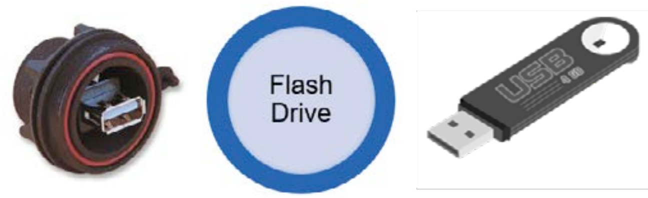
- Actions of the transfer sequence
- Alarms
- Change to setpoints
- Change to time/date
- Reset of historical counter
- Engine run test



USB Port

The ATC-900 includes a USB port to perform the following actions:

- Download metering data for post-event analysis
- Download existing setpoint configuration file for editing with the EASE tool, uploading into other ATC-900 transfer switch equipment or to share with Eaton's dedicated ATS technical support team
- Download detailed event data
- Download historical counter data
- Download high-speed capture waveform data
- Upload a setpoint configuration file
- Upload an ATC-900 firmware file (later/earlier version) to field update



When an engine-test is initiated, or the connected power source becomes unavailable, the ATC-900 calculates the "transfer time" to the alternate power source.

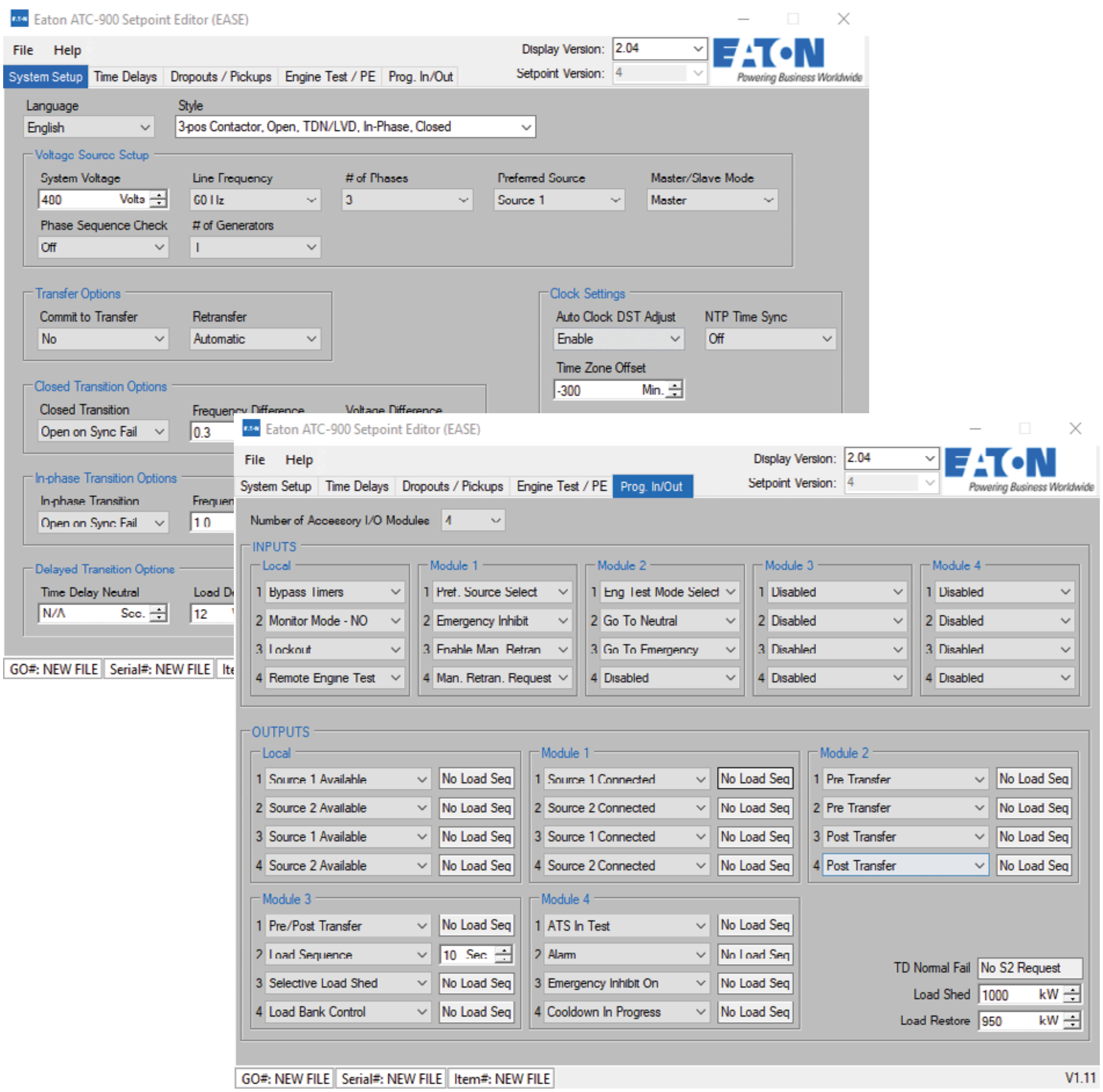
Timestamp	Event ID	Event Code	Event Description	Transfer ID	Transfer Code	Transfer Description	Source 1 Vab (V)	Source 1 Vbc (V)	Source 1 Vca (V)	Source 1 Freq (Hz)	Source 2 Vab (V)	Source 2 Vbc (V)	Source 2 Vca (V)	Source 2 Freq (Hz)	Load Vab (V)	Load Vbc (V)	Load Vca (V)	Load Freq (Hz)	Load Ia (A)	Load Ib (A)	Load Ic (A)	Status Source 1	Status Source 2
2019-11-11 T15:53:30.140	931	0x14	Source 2 Unavailable				482	482	484	60	0	0	0	0	482	482	484	60	321	291	262	Good	Under-V
2019-11-11 T15:53:29.410	930	0x39	Generator Start Relay 2 OFF																				
2019-11-11 T15:53:24.360	929	0x1D	Open Transition to Source 1 Complete	76	0x13	Transfer to Source 1 Complete	482	482	484	60	482	479	481	60	482	482	484	60	321	291	262	Good	Good
2019-11-11 T15:53:24.260	928			76	0x12	Transfer to Source 1 Initiated	487	486	488	60	482	479	481	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:53:21.250	927			76	0x0F	Transfer to Neutral Complete	488	486	488	60	482	479	481	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:53:21.150	926			76	0x0E	Transfer to Neutral Initiated	488	486	488	60	480	476	478	60	480	476	478	60	325	297	272	Good	Good
2019-11-11 T15:53:16.100	925			76	0x08	Preferred Source Available	487	486	488	60	480	476	478	60	480	476	478	60	325	297	272	Good	Good
2019-11-11 T15:53:16.70	924	0x11	Source 1 Available				487	486	488	60	480	476	478	60	480	476	478	60	325	297	272	Good	Good
2019-11-11 T15:52:48.850	923	0x1C	Open Transition to Source 2 Complete	75	0x11	Transfer to Source 2 Complete	0	0	0	0	480	476	478	59.8	480	476	478	59.8	325	297	272	Under-V	Good
2019-11-11 T15:52:48.850	922	0x35	Transfer Time (sec) 8.64																				
2019-11-11 T15:52:48.750	921			75	0x10	Transfer to Source 2 Initiated	0	0	0	0	482	479	481	60	0	0	0	0	0	0	0	Under-V	Good
2019-11-11 T15:52:45.750	920			75	0x0F	Transfer to Neutral Complete	0	0	0	0	482	479	481	60	0	0	0	0	0	0	0	Under-V	Good
2019-11-11 T15:52:45.650	919			75	0x0E	Transfer to Neutral Initiated	0	0	0	0	482	479	481	60	0	0	0	0	0	0	0	Under-V	Good
2019-11-11 T15:52:42.500	918	0x12	Source 2 Available				0	0	0	0	482	479	481	60	482	0	0	0	0	0	0	Under-V	Good
2019-11-11 T15:52:42.410	917	0x00	Power Up - Time OK																				
2019-11-11 T15:52:40.240	916			75	0x0B	Gen Start Contacts Closed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Under-V	Under-V
2019-11-11 T15:52:40.240	915			75	0x00	Undervoltage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Under-V	Under-V
2019-11-11 T15:52:40.210	914	0x13	Source 1 Unavailable				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Under-V	Under-V
2019-11-11 T15:42:21.370	913	0x14	Source 2 Unavailable				487	486	488	60	0	0	0	0	487	486	488	60	320	290	261	Good	Under-V
2019-11-11 T15:42:20.900	912	0x39	Generator Start Relay 2 OFF																				
2019-11-11 T15:42:10.300	911	0x1D	Open Transition to Source 1 Complete	74	0x13	Transfer to Source 1 Complete	482	482	484	60	482	479	481	60	482	482	484	60	321	291	262	Good	Good
2019-11-11 T15:42:09.930	910			74	0x12	Transfer to Source 1 Initiated	488	486	488	60	482	479	481	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:42:06.930	909			74	0x0F	Transfer to Neutral Complete	488	486	488	60	482	479	481	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:42:06.830	908			74	0x0E	Transfer to Neutral Initiated	487	486	488	60	480	476	478	60	480	476	478	60	322	292	263	Good	Good
2019-11-11 T15:42:01.780	907			74	0x2A	Test Transfer	487	486	488	60	480	476	478	60	480	476	478	60	323	292	266	Good	Good
2019-11-11 T15:42:01.730	906	0x19	Engine Test Successful																				
2019-11-11 T15:40:01.720	905	0x1C	Open Transition to Source 2 Complete	73	0x11	Transfer to Source 2 Complete	487	486	488	60	480	476	478	59.8	480	476	478	59.8	325	297	272	Good	Good
2019-11-11 T15:40:01.720	904	0x35	Transfer Time (sec) 9.66																				
2019-11-11 T15:40:01.620	903			73	0x10	Transfer to Source 2 Initiated	487	486	488	60	480	476	478	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:39:58.610	902			73	0x0F	Transfer to Neutral Complete	488	486	488	60	482	479	481	60	0	0	0	0	0	0	0	Good	Good
2019-11-11 T15:39:58.460	901			73	0x0E	Transfer to Neutral Initiated	484	484	486	60	482	479	481	60	484	484	486	60	321	291	262	Good	Good
2019-11-11 T15:39:53.410	900			73	0x2A	Test Transfer	482	482	484	60	482	479	481	60	482	482	484	60	321	291	262	Good	Good
2019-11-11 T15:39:53.350	899	0x12	Source 2 Available				482	482	484	60	482	479	481	60	482	482	484	60	321	291	262	Good	Good
2019-11-11 T15:39:52.710	898	0x38	Generator Start Relay 2 ON																				
2019-11-11 T15:39:52.000	897	0x18	Engine Test Request																				
2019-11-11 T15:39:16.990	892	0x11	Source 1 Available				482	482	484	60	0	0	0	0	482	482	484	60	321	291	262	Good	

Example of event log with metering data (downloaded via USB port) showing initiation and completion of an engine-generator test followed by a Source 1 unavailable condition. Both events result in a transfer to the alternate power source and calculation of "transfer time".

EASE

Eaton's Setpoint Editor Tool (EASE) can be downloaded from Eaton's website (www.eaton.com/ATS) and allows you to easily create, edit and save configuration files for upload to your ATC-900 controller or Transfer Switch Monitor 900 via a USB flash drive.

- Create a single configuration file to simplify startup when commissioning one or more transfer switches
- Download an existing configuration file to make setpoint edits, reproduce for use with new transfer switch equipment, create a backup copy or forward to the Eaton technical support team for assistance with troubleshooting



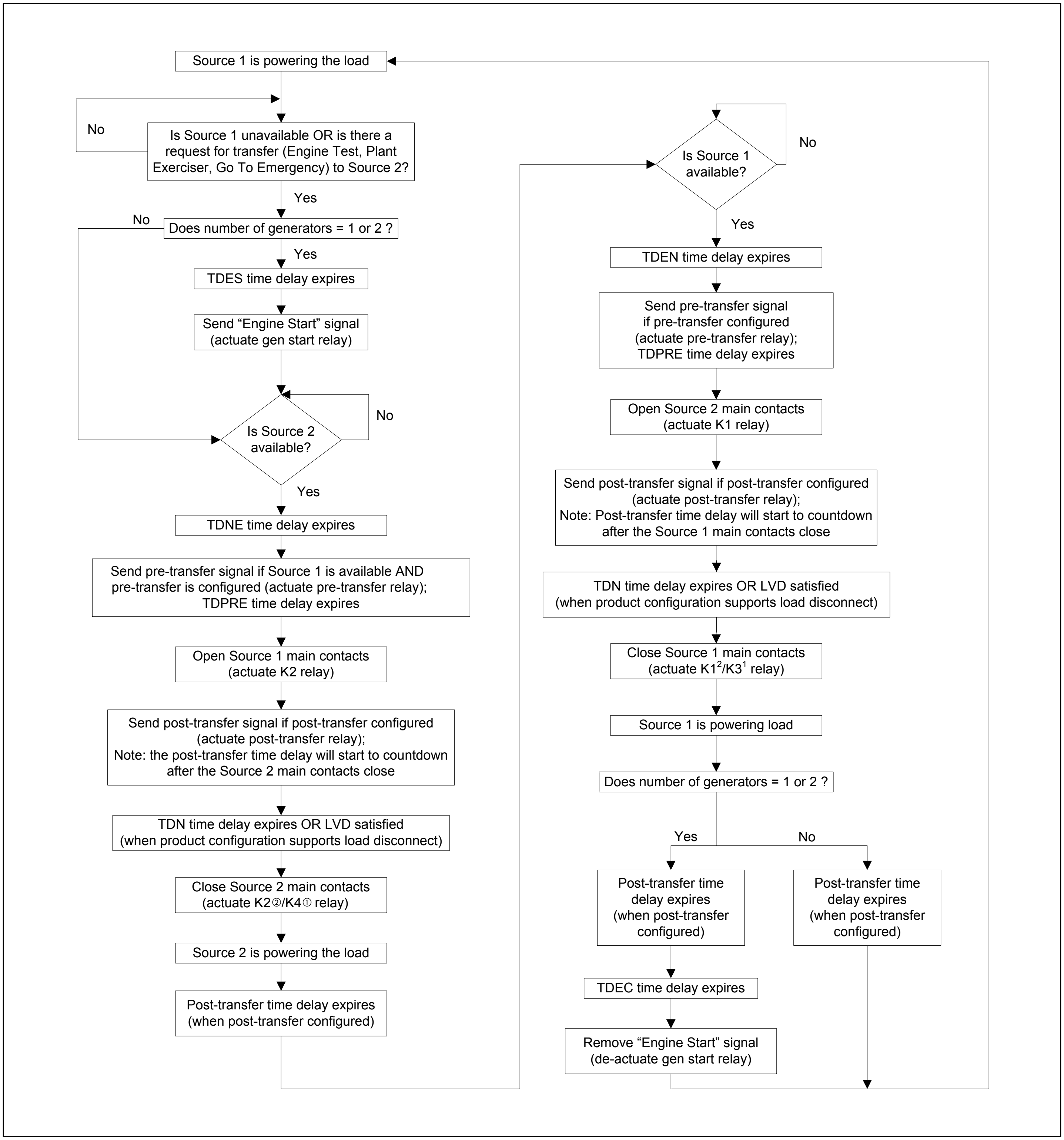


Figure 25.4-1. ATC-900: Open Delayed Transition Sequence of Operation Flowchart (Source 1 Configured as Preferred Source)

① Applicable for contactor and power frame type transfer switches with support for time delay in load disconnect ("neutral") position.

② Applicable for molded case type transfer switches.

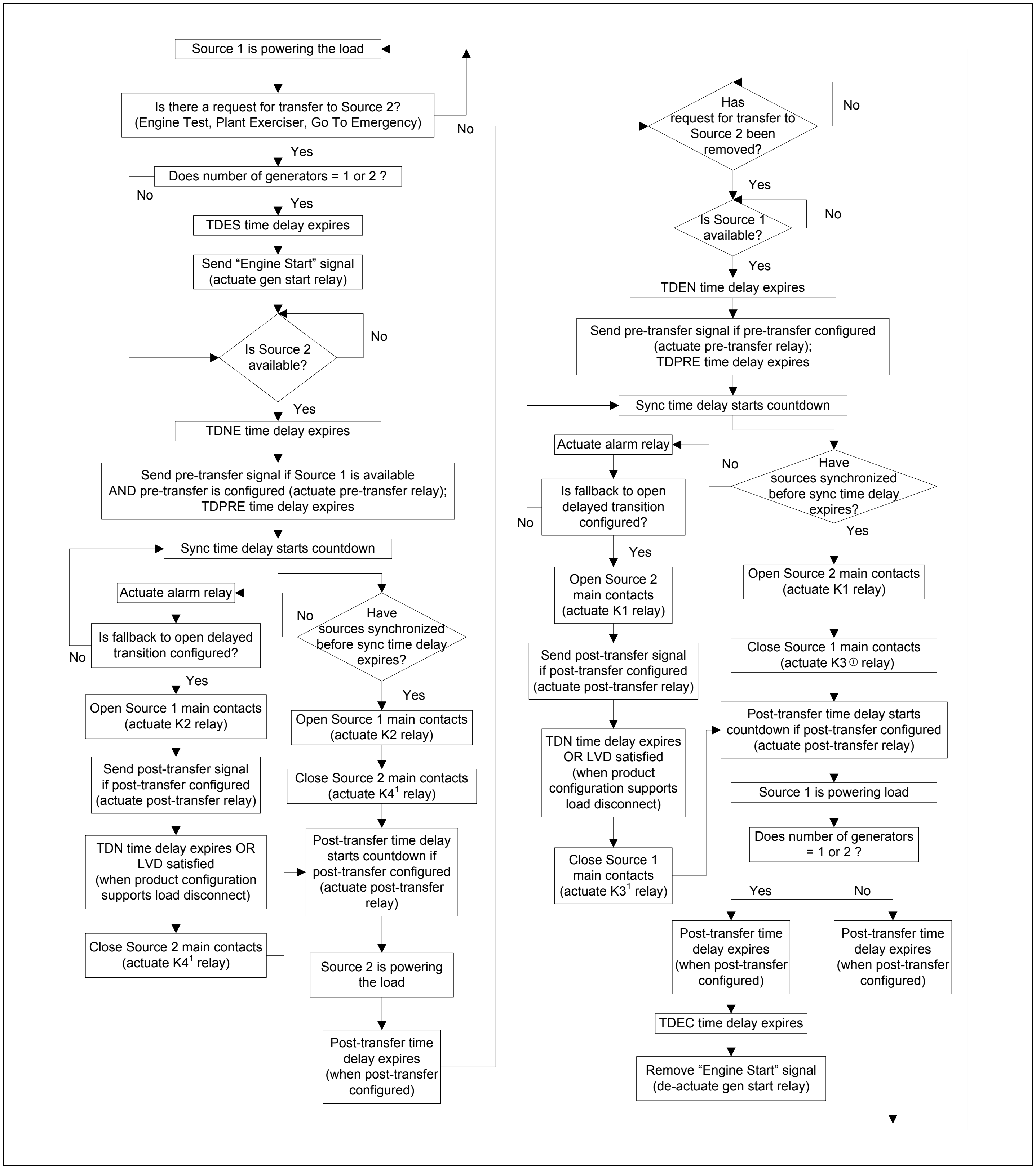


Figure 25.4-2. ATC-900: Open In-Phase Transition Sequence of Operation Flowchart (Source 1 Configured as Preferred Source)

① Applicable for contactor and power frame type transfer switches with support for time delay in load disconnect (“neutral”) position.

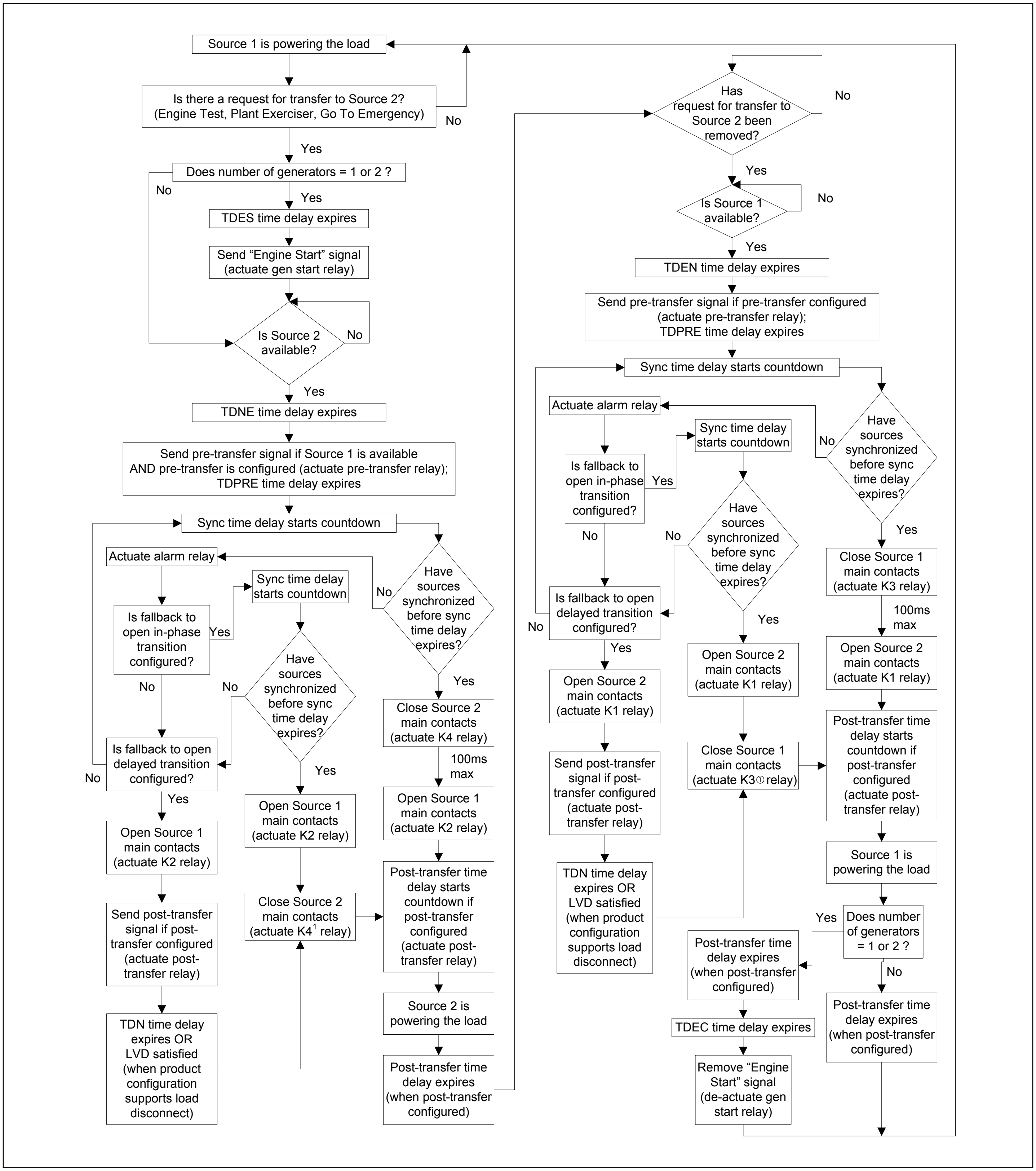


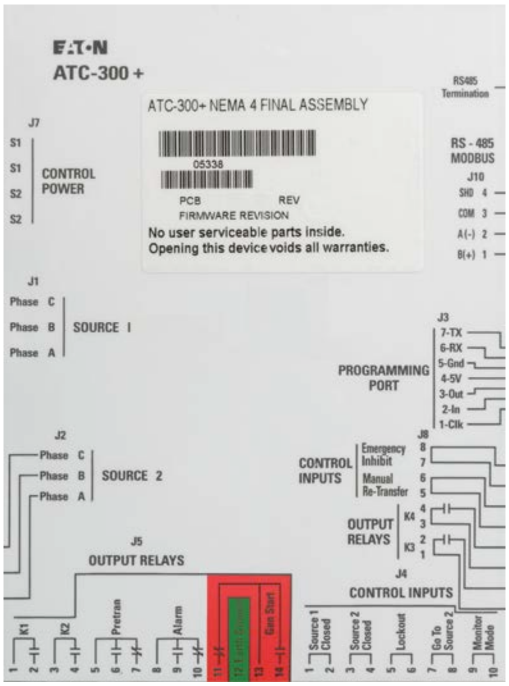
Figure 25.4-3. ATC-900: Closed Transition Sequence of Operation Flowchart (Source 1 Configured as Preferred Source)

① Applicable for contactor and power frame type transfer switches with support for time delay in load disconnect ("neutral") position.

ATC-300+ Automatic Controller

Eaton's ATC-300+ is a comprehensive, multi-function, microprocessor-based automatic transfer switch (ATS) controller.

It is equipped with a two-line LCD menu and integrated keypad for displaying monitored parameters, programming setpoints, viewing messages and accessing help prompts in an easy to read format.



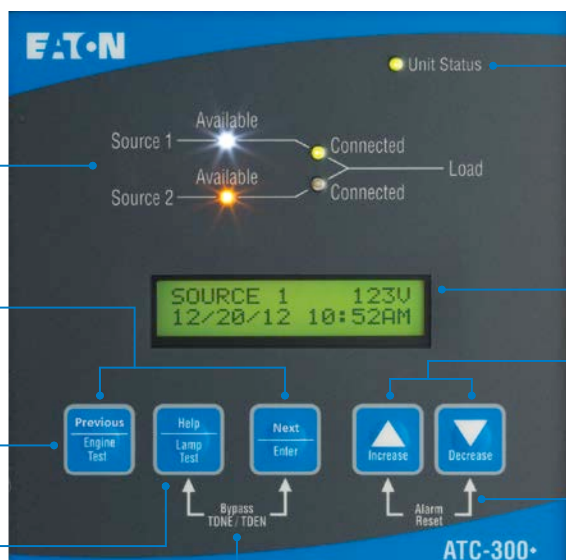
ATC-300+ Controller (Rear View)

Primary Features

- Monitor voltage and frequency of normal source and emergency source
- Self-acting load transfer between power sources
- Display of real-time and historical information
- Programmable setpoints
- Control inputs and relay outputs
- Engine start/shutdown signaling (Form C contacts) provide means to comply with 695.14(F) and 700.10(D)(3) of the NEC (2017 and 2020)
- Programmable plant exerciser
- Detailed and time-stamped event log and history
- Diagnostics and troubleshooting with pre-/post-event data capture
- Industry standard communication—serial (RS-485/ Modbus RTU) and ethernet (via optional module)
- Remote monitoring with HMi RAC

Table 25.4-3. ATC-300+ Specifications

Description	Specification
Control voltage Nominal voltage Voltage sensing	65–145 Vac 120–600 Vac Source 1 and Source 2
Voltage range Voltage accuracy Nominal frequency	0–790 Vac rms ±1% of nominal voltage 50 or 60 Hz
Frequency sensing Frequency range Frequency accuracy	Source 1 and Source 2 40–70 Hz ±0.3 Hz
Operating temperature range Storage temperature range Operating relative humidity	–20 to +70 °C (–4 to +158 °F) –30 to +85 °C (–22 to +185 °F) Up to 95% (noncondensing)



LED mimic diagram
Color-coded LEDs indicate Source 1 Available (white) and Connected (green), Source 2 Available (amber) and Connected (red) status.

Scroll keys
Previous and Next keys are used to scroll screens.

Engine test
Performs an engine test using programmed engine run and cool-down times. Password protected.

Help/Lamp test
Display firmware version and feature code. Test functionality of all LEDs.

Unit status
LED (green) indicates ATC-300+ is operating normally.

Display
Provides system status at a glance.

Increment/decrement keys
Program setpoints to desired value.

Alarm reset
Reset an active alarm condition.

Bypass timers
Reduces the active programmed time delay to zero.

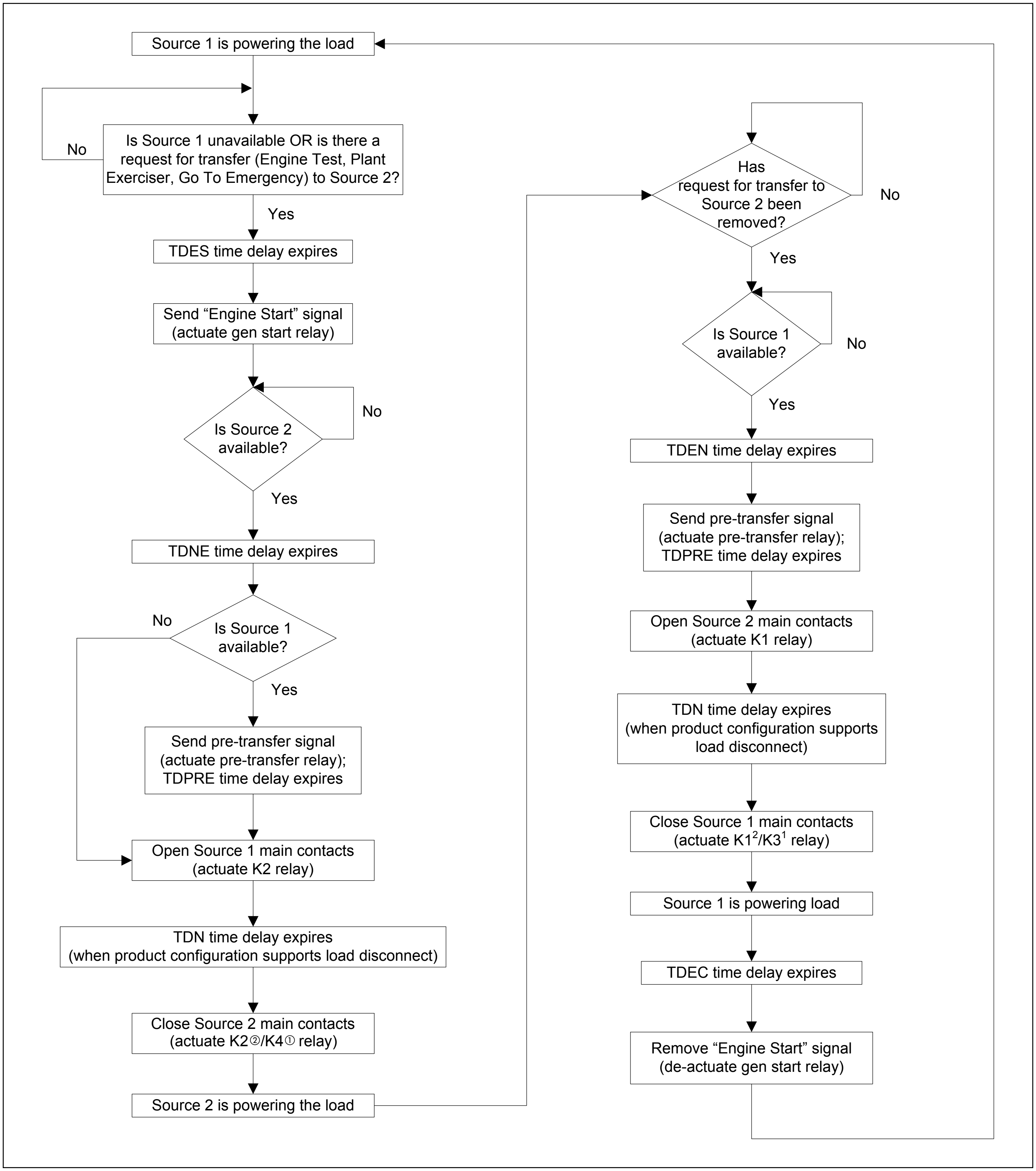


Figure 25.4-4. ATC-300+: Open Delayed Transition Sequence of Operation Flowchart

① Applicable for contactor type transfer switches with support for time delay in load disconnect (“neutral”) position.
② Applicable for molded case type transfer switches.

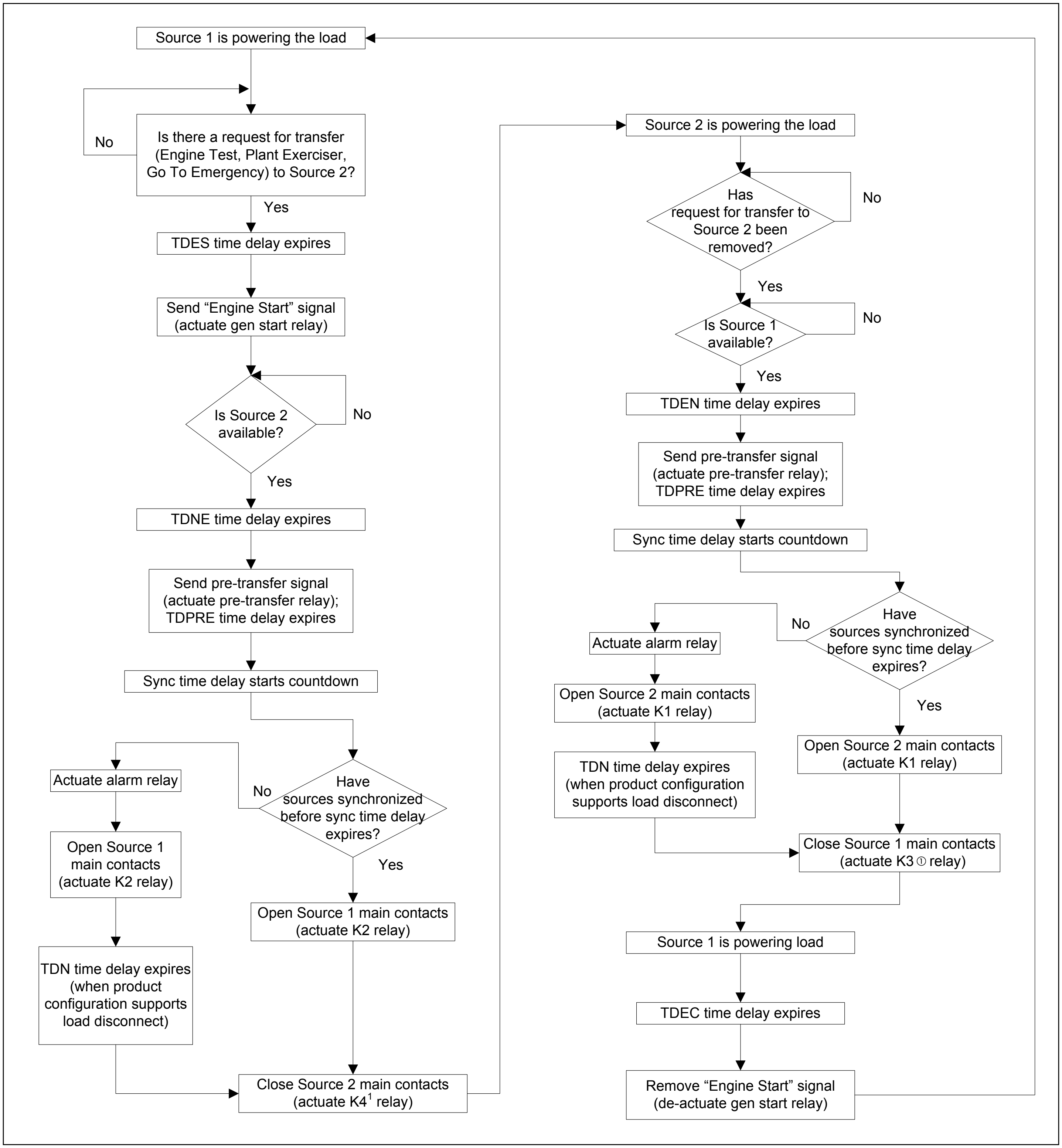


Figure 25.4-5. ATC-300+: Open In-Phase Transition Sequence of Operation Flowchart

① Applicable for contactor type transfer switches with support for time delay in load disconnect ("neutral") position.

ATC-100 Automatic Controller

Eaton's ATC-100 is a compact, self-contained, panel-mounted microprocessor-based automatic transfer switch (ATS) controller.

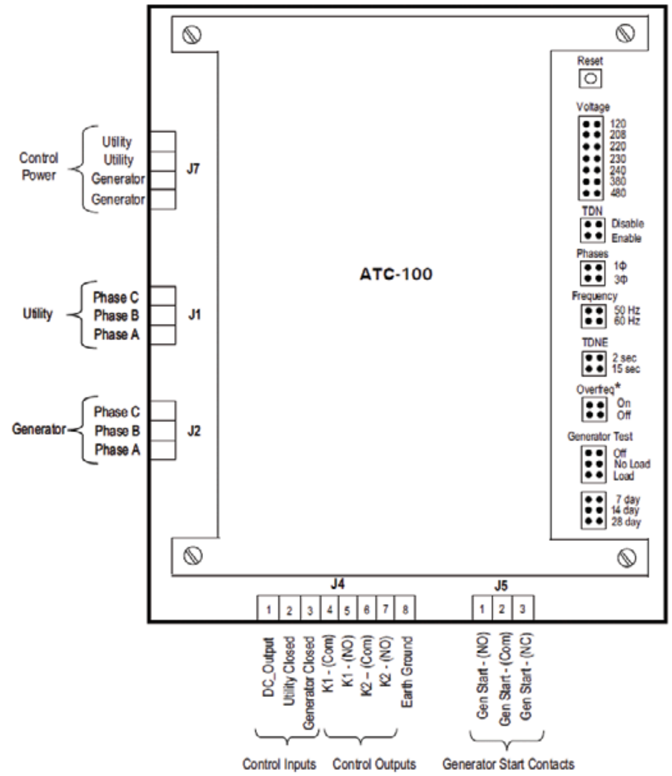
It is equipped with an LED mimic diagram to indicate source availability and load connected status. Pushbutton keys are provided to program and initiate an engine-generator test. Rear-mounted DIP switches allow the user to configure setpoints.

Primary Features

- Monitor voltage and frequency of normal source and emergency source
- Self-acting load transfer between power sources
- Display of real-time status information
- Configurable setpoints
- Engine start/shutdown signaling (Form C contacts)
- Programmable plant exerciser

Table 25.4-4. ATC-100 Specifications

Description	Specification
Control voltage Nominal voltage Voltage sensing	95–145 Vac 120, 209, 220, 230, 240, 390,480 Vac Source 1 and Source 2
Voltage range Voltage accuracy Nominal frequency	0–575 Vac rms ±1% of nominal voltage 50 or 60 Hz
Frequency sensing Frequency range Frequency accuracy	Source 1 and Source 2 40–70 Hz ±0.3 Hz
Operating temperature range Storage temperature range Operating relative humidity	–20 to +70 °C (–4 to +158 °F) –30 to +85 °C (–22 to +185 °F) Up to 95% (noncondensing)

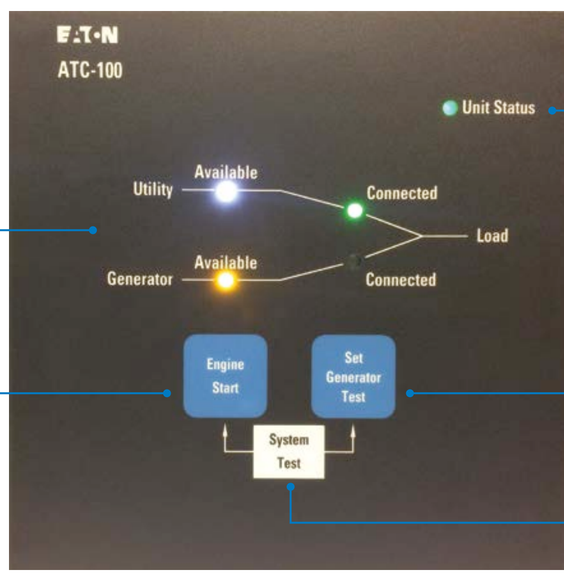


* Overfrequency available with molded case type transfer switches

ATC-100 Controller (Rear View)

LED mimic diagram
Color-coded LEDs indicate Source 1 Available (white) and Connected (green), Source 2 Available (amber) and Connected (red) status.

Engine start
Press and hold to start and stop an unloaded engine-generator test.



Unit status
LED (green) indicates ATC-100 is operating normally.

Set generator test
Press and hold to schedule an automated engine-generator test (loaded or unloaded) that occurs every 7, 14, or 28 days.

System text
Press and hold to start and stop a loaded engine-generator test.

ATC-100 Controller (Front View)

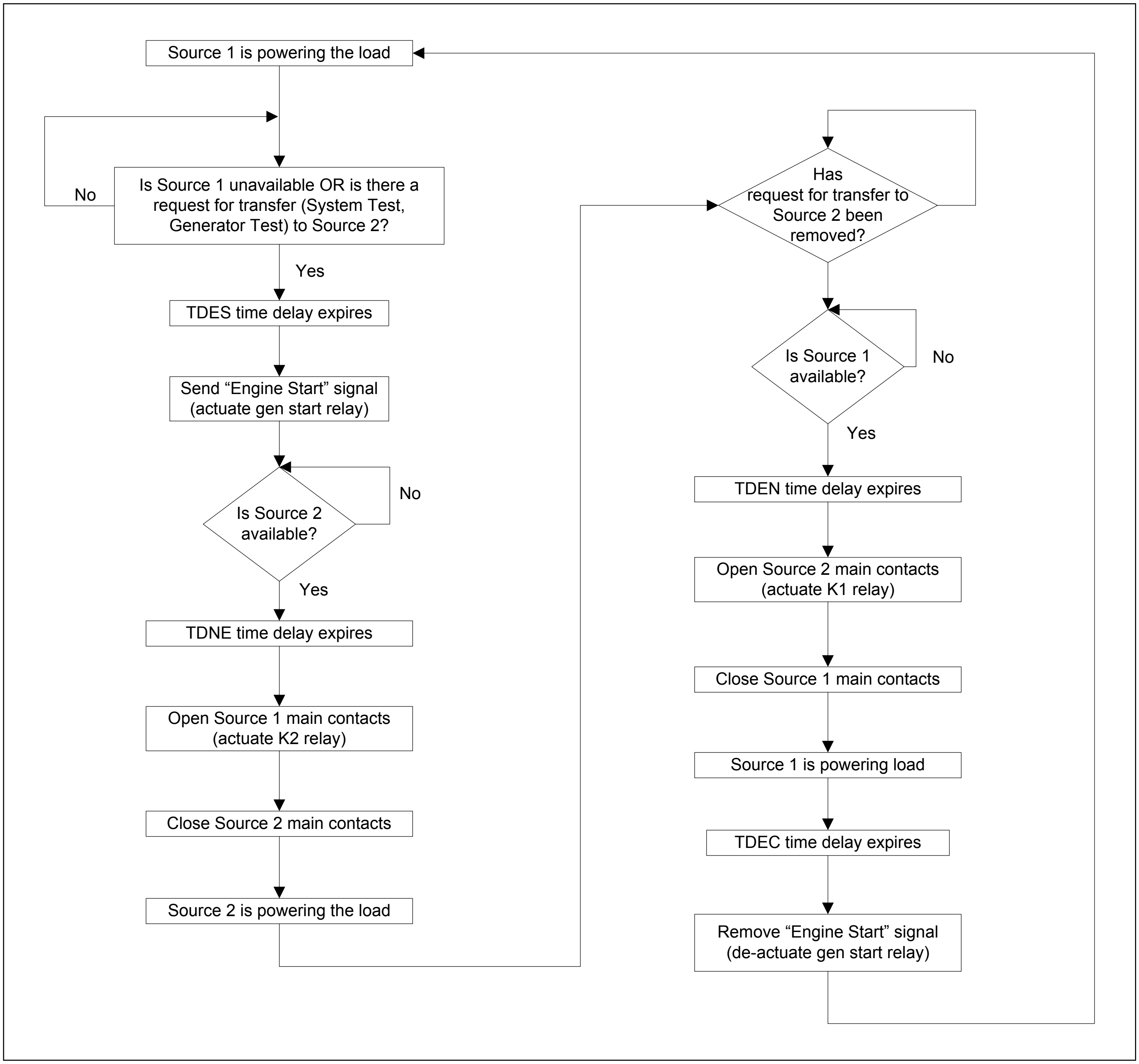


Figure 25.4-6. ATC-100 Open Transition ① Sequence of Operation Flowchart

① Applicable for contactor type transfer switches **without** support for time delay in load disconnect (neutral) position.

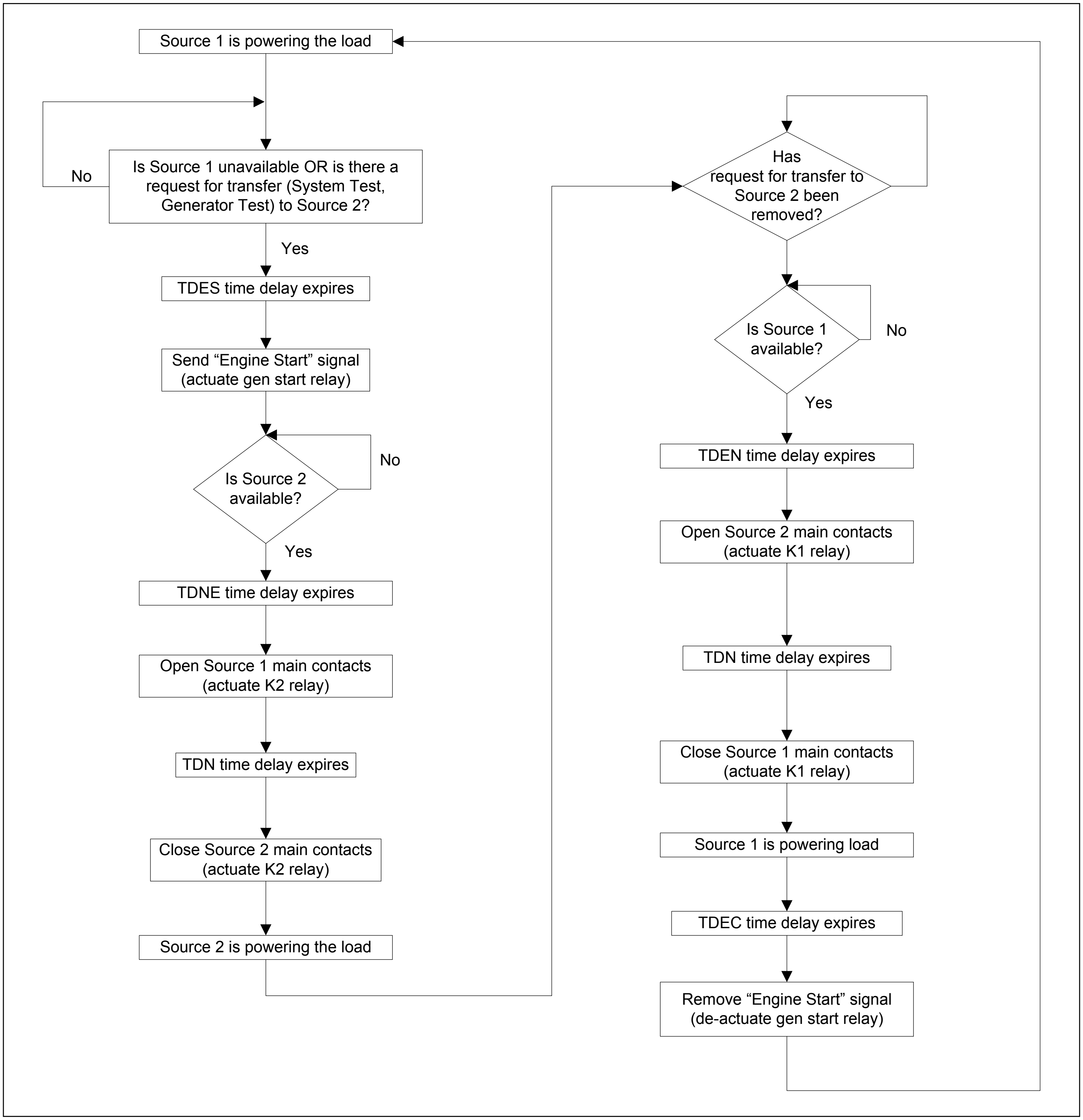


Figure 25.4-7. ATC-100: Open Delayed Transition ① Sequence of Operation Flowchart

① Applicable for molded case type transfer switches.

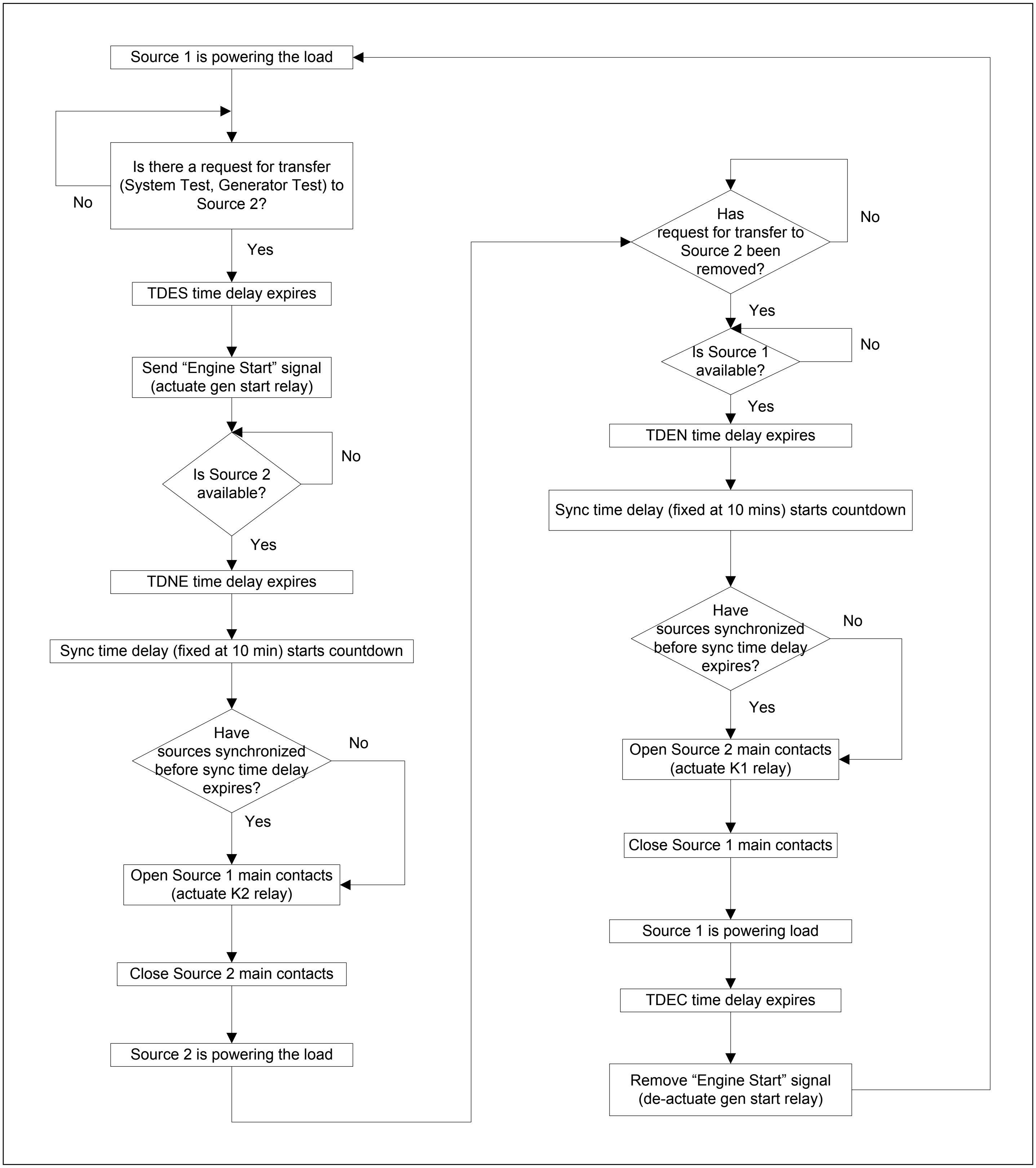


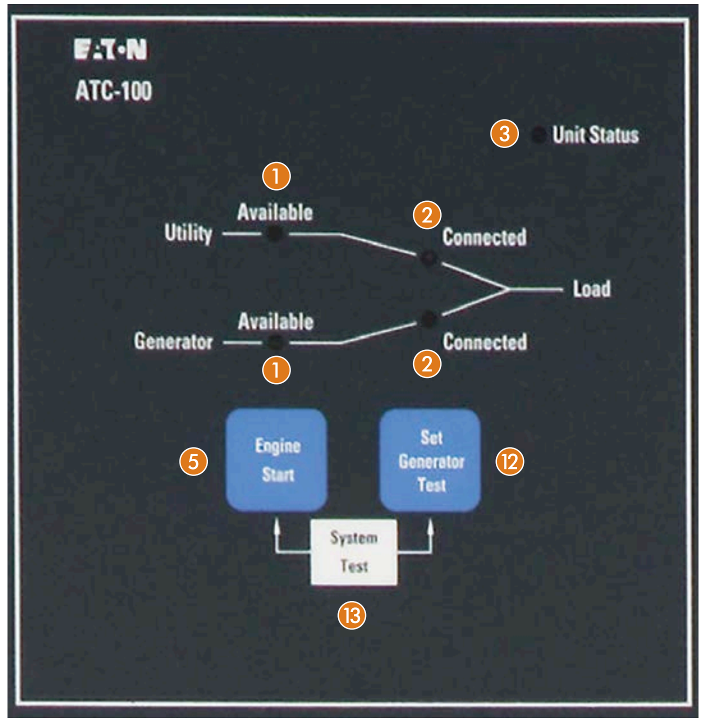
Figure 25.4-8. ATC-100: Open In-Phase Transition ① Sequence of Operation Flowchart

① Applicable for contactor type transfer switches without support for time delay in load disconnect ("neutral") position.

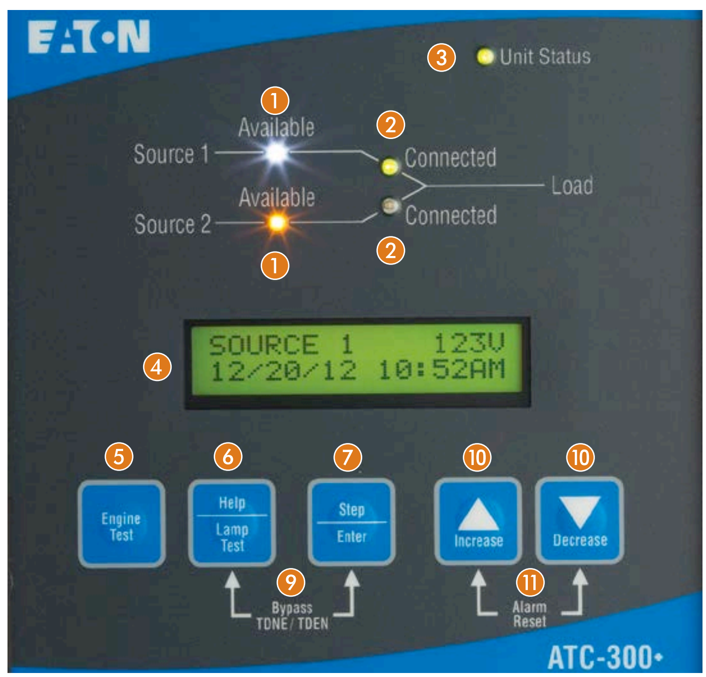
Feature and Specification Comparison

ATS Controller Features

1. Source availability indication
2. Source position indication
3. Diagnostic status indication
4. Liquid crystal display (LCD)
5. Engine start pushbutton
6. Help/lamp test pushbutton
7. Step/enter pushbutton
8. Navigation pushbuttons
9. Bypass timer pushbuttons
10. Increase/decrease pushbuttons
11. Alarm reset pushbuttons
12. Set generator test pushbutton
13. System test pushbutton



ATC-100



ATC-300+

ATC-900

Table 25.4-5. Controller Comparison
Note: Specifications are subject to change without notice.

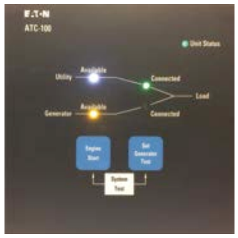
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Application			
Market segment	Residential, light commercial	Commercial, industrial	Mission critical, commercial, industrial
System arrangement	Utility-generator	Utility-generator, dual-utility	Utility-generator, dual-utility, dual-generator, three-source
Transition			
Open	Yes	Yes	Yes
Open (delayed)	Yes (molded case type only)	Yes	Yes
Open (in-phase)	Yes	Yes	Yes
Open (load voltage decay)	—	—	Yes
Closed (without fallback to open)	—	—	Yes
Closed (with fallback to open in-phase)	—	—	Yes
Closed (with fallback to open in-phase/ open delayed)	—	—	Yes
Closed (with fallback to open in-phase/ open load voltage decay)	—	—	Yes
Transfer Switch Product Type			
Contactor	Yes	Yes	Yes
Contactor, service entrance	—	Yes	Yes
Molded case	Yes	Yes	Yes
Molded case, service entrance	—	Yes	Yes
Power frame	—	—	Yes
Power frame, service entrance	—	—	Yes
Bypass isolation contactor	—	Yes	Yes
Bypass isolation contactor, service entrance	—	Yes	Yes
Bypass isolation power frame	—	—	Yes
Bypass isolation power frame, service entrance	—	—	Yes
Electrical			
Voltage (nominal)	120, 208, 220, 230, 240, 380, 480 Vac	120–600 Vac	120–600 Vac (medium voltage per PT ratio)
Potential transformer (PT) ratio	—	—	2:1-500:1
Voltage (range)	Up to 575 Vac rms	Up to 790 Vac rms	Up to 720 Vac rms
Voltage (measurement)	V_{ab}, V_{bc}, V_{ca}	V_{ab}, V_{bc}, V_{ca}	V_{ab}, V_{bc}, V_{ca}
Voltage (accuracy)	± 1%	± 1%	± 1%
Voltage (unbalance)	—	Yes	Yes—negative and positive sequence detection
Voltage (sensing)	Source 1, Source 2	Source 1, Source 2	Source 1, Source 2, Load
Frequency (nominal)	50 or 60 Hz	50 or 60 Hz	50 or 60 Hz
Frequency (range)	40–70 Hz	40–70 Hz	40–80 Hz
Frequency (accuracy)	± 0.3 Hz	± 0.3 Hz	± 0.2 Hz
Frequency (sensing)	Source 1, Source 2	Source 1, Source 2	Source 1, Source 2, Load
Current (range)	—	—	Up to 5000 A
Current transformer (CT) ratio	—	—	100:5–5000:5
Current transformer (CT) connection	—	—	Normal or reversed
Current (measurement)	—	—	I_a, I_b, I_c
Current (unbalance)	—	—	Yes—negative and positive sequence detection

Table 25.4-5. Controller Comparison (Continued)

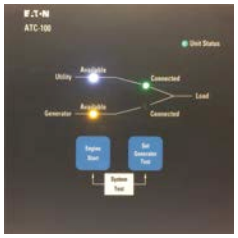
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Electrical (continued)			
Power (kW, kvar, kVA)	—	—	Yes
Power (accuracy)	—	—	± 2%
Power factor (PF)	—	—	Yes
Power factor lead/lag sign	—	—	IEEE or Alt. IEEE
AC power systems	Single- or three-phase	Single- or three-phase	Single- or three-phase
Three-phase rotation sequence check	—	ABC, CBA, Off	ABC, CBA, Off
Service connection	Delta, hi-leg delta, wye	Delta, hi-leg delta, wye	Delta, hi-leg delta, wye
Wire configuration	3- or 4-wire	3- or 4-wire	3- or 4-wire
Power poles	2, 3, 4	2, 3, 4	2, 3, 4
Solid neutral	Yes	Yes	Yes
Switched neutral	Yes	Yes	Yes
General			
Source 1 and source 2 condition status	—	Yes	Yes
Preferred source	Fixed —Source 1	Fixed —Source 1	Programmable—none, Source 1, Source 2, external (control input)
Number of generators	—	—	0, 1, 2
Master/slave control	—	—	Yes
Commit to transfer (preferred to alternate source)	—	—	Yes
Set time/date	—	Yes	Yes
Daylight savings time	—	Enable/disable	Enable/disable
Time zone offset	—	—	Hours (± 12), min (15, 30,45)
Network time synchronization	—	—	Yes—Modbus, meter, PLC
Language	English	English, French, Spanish	English, French, Spanish
Password	—	Yes—4 digit	Yes—4 digit
Program/configure setpoints	Yes (via jumper)	Yes (via faceplate, HMi or serial/ethernet)	Yes (via faceplate, USB flash, HMi or serial/ethernet)
Controller Interface			
Mimic diagram	Yes	Yes	Yes
Status indication (LED)	Unit status, Source 1 and 2 available, Source 1 and 2 connected	Unit status, Source 1 and 2 available, Source 1 and 2 connected	Unit status, Source 1 and 2 available, Source 1 and 2 connected, Source 1 and 2 preferred
Display	—	Monochrome LCD, 2-line	4.3-inch color TFT LCD, 480 x 272 pixels
Start/abort engine test pushbutton	Yes	Yes	Yes
Set engine test pushbutton	Yes	—	—
Help/Lamp test pushbutton	—	Yes	Yes
Bypass timer pushbutton	—	Yes	Yes
Screen/menu navigation pushbuttons	—	Yes	Yes
Enter pushbutton	—	Yes	Yes
Engine Test via Pushbutton, Control Input or Communication			
Test mode	Load, no load	Load, no load	Disabled, load, no load, external (control input select)
Run time	15 minutes	0–600 minutes	0–600 minutes
USB Flash Memory Port (Type A)			
Metering data (download)	—	—	Yes
Setpoint configuration (download/upload)	—	—	Yes
Event data (download)	—	—	Yes

Table 25.4-5. Controller Comparison (Continued)

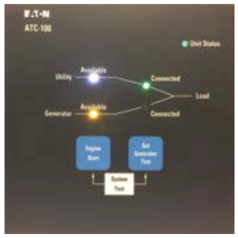
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
USB Flash Memory Port (Type A) (continued)			
Historical counter data (download)	—	—	Yes
High-speed capture data (download)	—	—	Yes
Firmware (upload)	—	—	Yes
Connectivity			
Serial communication (RS-485/Modbus)	—	Yes	Yes (enable/disable)
Serial network termination resistance	—	Open, 120 ohm	Open, 120 ohm
Modbus read/write (monitor/control) functionality	—	Read/write	Read only, read/write, read (write date/time only)
Modbus address	—	1–247	1–247
Modbus baud rate	—	9600, 19200	9600, 19200
Modbus parity	—	—	None, even, odd
Ethernet communication	—	Yes (via optional external module)	Yes (via optional external module)
Control Power			
AC voltage (nominal)	120 Vac	120 Vac	120 Vac
AC voltage (range)	95–145 Vac	65–145 Vac	65–145 Vac
AC power source	Source 1 or Source 2	Source 1 or Source 2	Source 1, Source 2, External
DC voltage (nominal)	—	—	24 Vdc
DC voltage (range)	—	—	21.6–26.4 Vdc
DC power source	—	—	External
Power consumption	4 VA	18 VA	20 VA
Plant Exerciser (PE)—Self Acting, Automated Engine Test			
Plant exerciser 1 (automatic)	Yes	Yes	Yes
Plant exerciser 2 (automatic)	—	—	Yes
PE test mode	Disabled, load, no load	Load, no load	Disabled, load, no load, external (control input select)
PE run time	15 minutes	0–600 minutes	0–600 minutes
PE scheduled start	7-day, 14-day, 28-day	Daily, 7-day, 14-day, 28-day, Off	Daily, 7-day, 14-day, 28-day, calendar date (up to 12)
PE calendar date	—	—	Month (1–12), Day (1–31)
PE day of week	—	Day (1–7)	Day (1–7)
PE start time	—	Hour (0–23), minute (0–59)	Hour (0–23), minute (0–59)
PE normal to emergency time delay	—	—	0–9999 sec
PE emergency to normal time delay	—	—	0–9999 sec
PE engine cooldown time delay	—	—	0–9999 sec
Engine Generator Start Contacts (5 A at 250 Vac/30 Vdc)			
Engine generator 1	Yes (Form-C)	Yes (Form C)	Yes (Form C)
Engine generator 2	—	—	Yes (Form C)
Programmable Inputs/Outputs			
Control inputs	—	—	(4)—expandable up to 20
Relay outputs	—	—	(4)—expandable up to 20
Control Input Functions (Wetted—10 mA at 24 Vdc)			
Source 2 inhibit / load shed	—	Yes	Yes—programmable
Go to source 2	—	Yes	Yes—programmable
Lockout	—	Yes	Yes—programmable
Monitor mode	—	Yes	Yes—programmable
Manual retransfer (request)	—	Yes	Yes—programmable

Table 25.4-5. Controller Comparison (Continued)

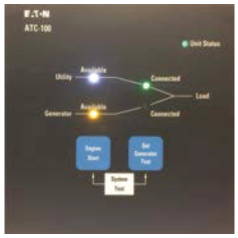
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Control Input Functions (Wetted—10 mA at 24 Vdc) (continued)			
Manual retransfer (enable/disable)	—	—	Yes—programmable
Preferred source selection (source 1 or source 2)	—	—	Yes—programmable
Bypass time delay (countdown)	—	—	Yes—programmable
Remote engine test	—	—	Yes—programmable
Engine test mode selection (load or no load)	—	—	Yes—programmable
Go to neutral (load disconnected)	—	—	Yes—programmable
ATS bypassed	—	—	Yes—programmable
Slave (3 source system)	—	—	Yes—programmable
Safety interlock (bypass isolation)	—	—	Yes—programmable
Closed transition disable	—	—	Yes—programmable
Disabled (general purpose use)	—	—	Yes—programmable
Source 1—position of main contacts (factory use)	Yes	Yes	Yes—programmable
Source 2—position of main contacts (factory use)	Yes	Yes	Yes—programmable
Relay Output Functions (Form C contacts—10 A at 250 Vac/30 Vdc)			
Pre-transfer	—	Yes	Yes—programmable
Post-transfer	—	—	Yes—programmable
Pre/Post-transfer	—	—	Yes—programmable
Source 1 available	—	—	Yes—programmable
Source 2 available	—	—	Yes—programmable
Source 1 connected	—	—	Yes—programmable
Source 2 connected	—	—	Yes—programmable
Selective load shed (with kW drop out and pickup)	—	—	Yes—programmable
Alarm (general)	—	—	Yes—programmable
Monitor mode	—	—	Yes—programmable
ATS in test	—	—	Yes—programmable
Engine test aborted	—	—	Yes—programmable
Cooldown in progress	—	—	Yes—programmable
ATS not in automatic	—	—	Yes—programmable
Engine generator 1 start contact	—	—	Yes—programmable
Engine generator 2 start contact	—	—	Yes—programmable
Source 2 inhibit / load shed	—	—	Yes—programmable
ATS in bypass	—	—	Yes—programmable
Load bank control	—	—	Yes—programmable
Remote I/O	—	—	Yes—programmable
Health	—	—	Yes—programmable
Disabled (general purpose use)	—	—	Yes—programmable
K1—open/close main contacts (Form A, factory use)	Yes	Yes	Yes
K2—open/close main contacts (Form A, factory use)	Yes	Yes	Yes
K3—close main contacts (Form A, factory use)	—	Yes	Yes
K4—close main contacts (Form A, factory use)	—	Yes	Yes

Table 25.4-5. Controller Comparison (Continued)

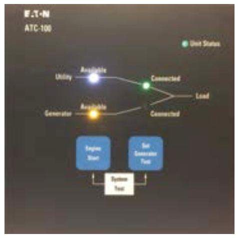
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Source 1 and Source 2 Voltage and Frequency Settings			
Undervoltage (dropout)	80% of nominal	70–97% of nominal	70 –97% of nominal
Undervoltage (pickup)	90% of nominal	(Dropout plus 2%) 99%	(Dropout plus 2%) 99%
Overvoltage (dropout)	—	105–120% of nominal	105–120% of nominal
Overvoltage (pickup)	—	103% (dropout minus 2%)	103% (dropout minus 2%)
Overvoltage (enable/disable)	—	Yes	Yes
Underfrequency (dropout)	90% of nominal (source 2 only)	90–97% of nominal	90–97% of nominal
Underfrequency (pickup)	95% of nominal (source 2 only)	(Dropout plus 1 Hz) 99%	(Dropout plus 1 Hz) 99%
Underfrequency (enable/disable)	—	Yes	Yes
Overfrequency (dropout)	115% of nominal (source 2 only)	103–110% of nominal	103–110% of nominal
Overfrequency (pickup)	110% of nominal (source 2 only)	101% (dropout minus 1Hz)	101% (dropout minus 1Hz)
Overfrequency (enable/disable)	Yes	Yes	Yes
Voltage unbalance/phase loss (dropout)	—	5–20% of nominal	—
Voltage unbalance/phase loss (pickup)	—	3% (dropout minus 2%)	—
Voltage unbalance/phase loss (enable/disable)	—	Yes	—
Voltage unbalance (dropout)	—	—	5–20% of nominal
Voltage unbalance (pickup)	—	—	3% (dropout minus 2%)
Voltage unbalance (enable/disable)	—	—	Yes
Voltage phase loss (dropout)	—	—	20–60%
Voltage phase loss (pickup)	—	—	18% (dropout minus 2%)
Voltage phase loss (enable/disable)	—	—	Yes
Voltage unbalance/phase loss time delay	—	10–30 sec	0–30 sec
Load Current Settings			
Current unbalance (dropout)	—	—	5–60% / disabled
Current unbalance (pickup)	—	—	3% (dropout minus 2%)
Current unbalance (enable/disable)	—	—	Yes
Current unbalance (enable threshold)	—	—	1–100% of rated current
Delay Settings			
Time delay engine-generator 1 start	3 sec	0–120 sec	0–120 sec (0–259 min with DCT module)
Time delay engine-generator 2 start	—	—	0–120 sec (0–259 min with DCT module)
Time delay normal source to emergency source	2 or 15 sec	0–1800 sec	0–9999 sec
Time delay emergency source to normal source	5 min	0–1800 sec	0–9999 sec
Time delay emergency source fail	6 sec	0–6 sec	0–60 sec
Time delay engine cooldown	5 min	0–1800 sec	0–9999 sec
Time delay neutral (load disconnected from sources)	0 or 2 sec	0–120 sec	0–600 sec
Load voltage decay (load disconnected from sources)	—	—	2–30% of nominal voltage
Time delay pre-transfer	—	0–120 sec	0–600 sec
Time delay post-transfer	—	—	0–600 sec
Time delay normal source disconnect	—	—	1–10 sec
Time delay normal source reconnect	—	—	0–60 sec

Table 25.4-5. Controller Comparison (Continued)

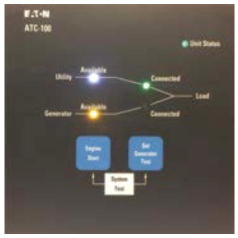
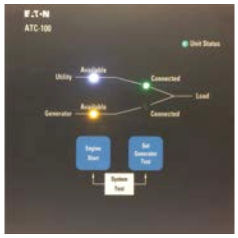
			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Delay Settings (continued)			
Time delay emergency source disconnect	—	—	1–10 sec
Time delay emergency source reconnect	—	—	0–60 sec
Source Synchronization Settings			
Synchronization timer (in-phase and closed transition)	10 min (fixed)	1–60 min	1–60 min
Open in-phase transition	—	Disable / enable	Disable / enable (alarm or fallback upon sync fail)
Open in-phase transition frequency difference	—	0.0–3.0 Hz	0.0–3.0 Hz
Closed transition	—	—	Disable / enable (alarm or fallback upon sync fail)
Closed transition voltage difference	—	—	1–5 %
Closed transition frequency difference	—	—	0.0–0.3 Hz
Historical Counters			
Source 1 available	—	Hours	Hours : minutes
Source 1 connected	—	Hours	Hours : minutes
Engine 1 run (source 1)	—	—	Hours : minutes
Source 2 available	—	Hours	Hours : minutes
Source 2 connected	—	Hours	Hours : minutes
Engine 2 run (source 2)	—	Hours	Hours : minutes
Tier 4 timer	—	—	Hours : minutes
Load energized	—	Hours	Hours : minutes
Number of transfers (S1 ≥ S2 or S2 ≥ S1)	—	Number	Number
Reset historical counter	—	Yes	Yes
Date of historical counter reset	—	—	Yes
Event Summary (Date/Time Stamped)			
Historical log	—	Yes (16 events)	Yes (100 events)
Transfer transition type and cause	—	Yes	Yes
Engine-generator test	—	Yes	Yes
Transfer time (preferred source to alternate source)	—	—	Yes
Control input change	—	—	Yes
Source availability change	—	—	Yes
Setpoint change	—	—	Yes
Programmable I/O change	—	—	Yes
Time/date change	—	—	Yes
Historical counter reset	—	—	Yes
Alarm	—	—	Yes
Event Summary Details (Date/Time Stamped)			
Historical log	—	—	Yes
Source unavailability cause	—	—	Yes
Transfer sequence of events	—	—	Yes
Source 1 voltage, frequency and status	—	—	Yes
Source 2 voltage, frequency and status	—	—	Yes

Table 25.4-5. Controller Comparison (Continued)

			
Features and Specifications	**ATC-100**	**ATC-300+**	**ATC-900**
Event Summary Details (Date/Time Stamped) (continued)			
Load voltage and frequency	—	—	Yes
Load current	—	—	Yes
Environmental			
Operating temperature range	–20 to +70 °C (–4 to +158 °F)	–20 to +70 °C (–4 to +158 °F)	–20 to +70 °C (–4 to +158 °F)
Storage temperature range	–30 to +85 °C (–22 to +185 °F)	–30 to +85 °C (–22 to +185 °F)	–30 to +85 °C (–22 to +185 °F)
Operating relative humidity	Up to 95% (noncondensing)	Up to 95% (noncondensing)	Up to 90% (noncondensing)
UV resistance (faceplate)	Yes	Yes	Yes
Chemical resistantance (faceplate)	Ammonia, methane, nitrogen, hydrogen, hydrocarbons	Ammonia, methane, nitrogen, hydrogen, hydrocarbons	Ammonia, methane, nitrogen, hydrogen, hydrocarbons
Enclosure compatibility	NEMA 1, 3R, 12	NEMA 1, 3R, 4/4X, 12	NEMA 1, 3R, 4/4X (with gasket), 12
Physical			
Dimensional in inches (millimeters)	6.5 (165.1) width x 8.5 (215.9) height x 2.23 (59) depth	6.5 (165.1) width x 8.5 (215.9) height x 2.84 (72.1) depth	6.72 (170.7) width x 10.25 (260.4) height x 2.61 (66.4) depth
Weight in pounds (kilograms)	2.85 (1.29)	4.10 (1.86)	2.70 (1.22)
Testing and Certification			
Safety	UL recognized	UL recognized	UL recognized
Electromagnetic compatibility (EMC)	IEC 61000-4-2 (ESD immunity)	IEC 61000-4-2 (ESD immunity)	IEC 61000-4-2 (ESD immunity)
	IEC 61000-4-3 (radiated immunity)	IEC 61000-4-3 (radiated immunity)	IEC 61000-4-3 (radiated immunity)
	IEC 61000-4-4 (fast transient/burst immunity)	IEC 61000-4-4 (fast transient/burst immunity)	IEC 61000-4-4 (fast transient/burst immunity)
	IEC 61000-4-5 (surge immunity)	IEC 61000-4-5 (surge immunity)	IEC 61000-4-5 (surge immunity)
	IEC 61000-4-6 (conducted immunity)	IEC 61000-4-6 (conducted immunity)	IEC 61000-4-6 (conducted immunity)
	IEC 61000-4-11 (voltage dips/ interruptions/variations)	IEC 61000-4-11 (voltage dips/ interruptions/variations)	IEC 61000-4-11 (voltage dips/ interruptions/variations)
	FCC Part 15 subpart B (class B), CISPR 11 (class B)	FCC Part 15 subpart B (class B), CISPR 11 (class B)	FCC Part 15 subpart B (class B), CISPR 11 (class B)

HMi Remote Annunciator Controller

Tightening arc flash regulations and requirements for personal protective equipment are driving more and more end users toward the use of remote monitoring and control devices.

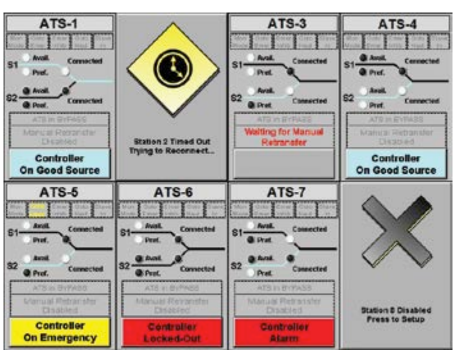
Eaton's HMi Remote Annunciator Controller offers a simple and cost-effective means of remotely monitoring and controlling up to eight automatic transfer switches (with ATC-300+ or ATC-900 controller) via serial or ethernet communication.

Using one intuitive touch screen interface, users can:

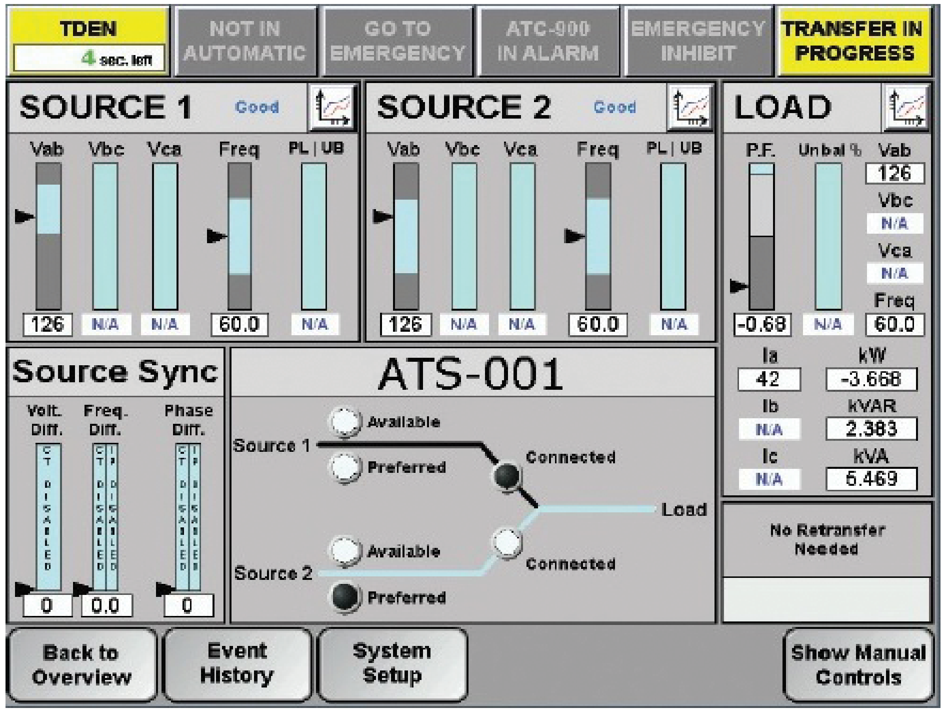
- Monitor source vitals and health
- Analyze metering and trend data of sources and load
- View and program transfer switch controller set points, control inputs and relay outputs
- Start and stop a generator engine test
- Initiate a transfer to the alternate source
- Bypass a time delay countdown
- Initiate a manual retransfer
- View and silence alarms
- Perform basic troubleshooting
- Monitor source synchronization during in-phase or closed transition
- View event history
- View the status of up to eight transfer switches on a single overview screen

Overview Screen

- View an abbreviated status of up to eight transfer switches on a single overview screen



Overview Screen (Eight Transfer Switches)



Status Screen (Single Transfer Switch)

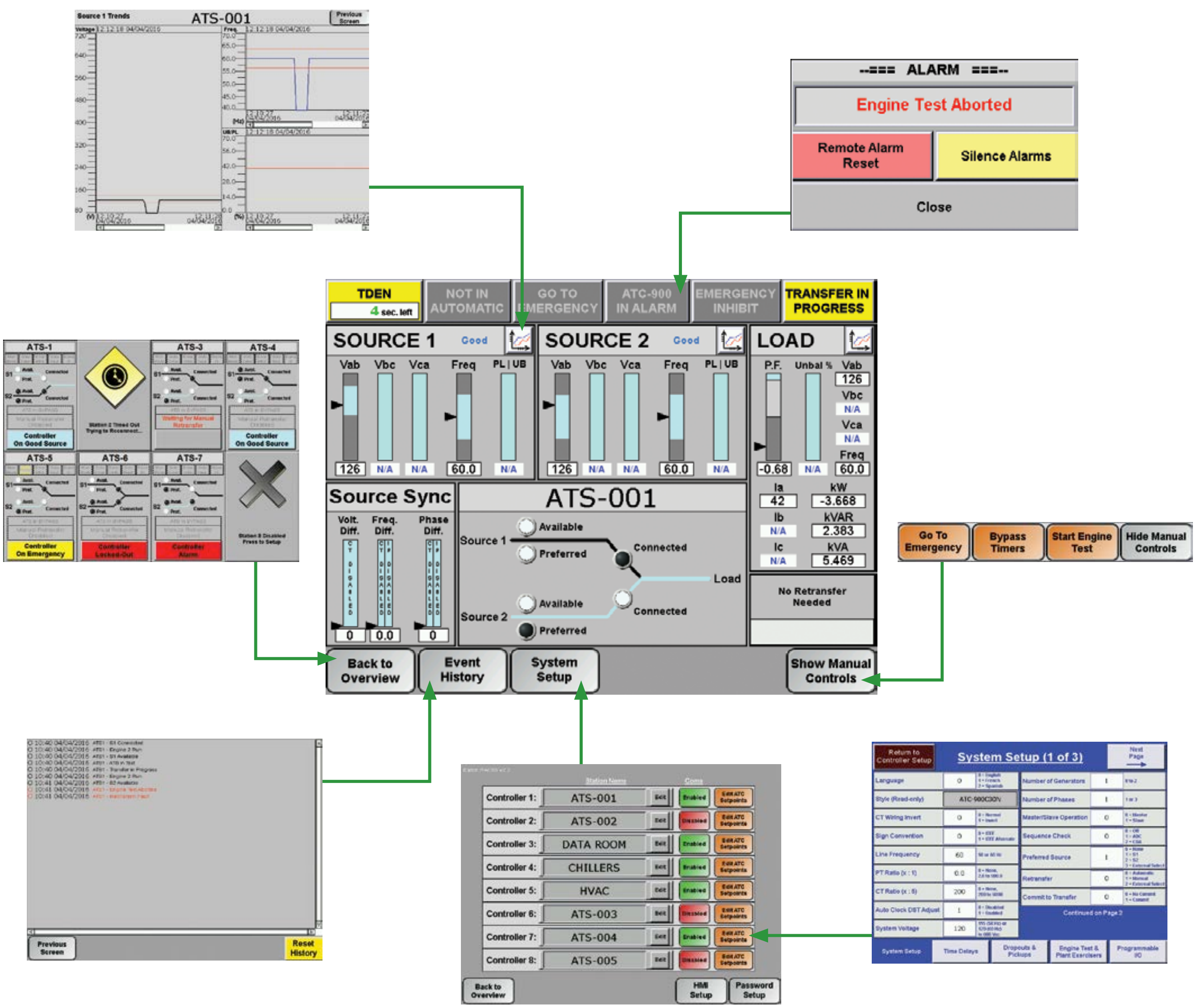
Table 25.4-6. Specifications

Note: Specifications are subject to change without notice.

Specifications	**HMi RAC**
Interface	
Display with touchscreen	7-inch color TFT LCD, 800 x 600 pixels, LED backlight
Control Power	
Operation voltage	DC +24 V (–10% ~ +15%)
Power consumption	7.8 W
Connectivity	
Serial (RS-485)	Yes
Ethernet	Yes—10/100 Mbps
Sound	
Alarm buzzer	85 dB, multi-tone frequency
Environmental	
Operating temperature	0–50 °C (32–122 °F)
Storage temperature	–20 to +60 °C (–4 to +140 °F)
Humidity	10%–90% RH (0–40C), 10%–55% RH (41–50C)
Waterproof degree	IP65 / NEMA 4X (indoor use only)
Certification	
Safety	UL / CE
Physical	
Dimensions in inches (millimeters)	7.24 (184) width x 5.67 (144) height x 1.97 (50) depth
Panel cutout in inches (millimeters)	6.79 (172.4) width x 5.21 (132.4) height
Weight in pounds (grams)	1.76 (800)

HMi RAC View Screens

- Status indication of a single ATS including limited control functionality
- Time delay countdown
- Source available, preferred and connected indication
- Metering and health vitals for Source 1, Source 2 and Load
- Manual controls for:
  - Go To Emergency
  - Bypass Timers
  - Start Engine Test
  - Manual Retransfer
- System setup
- Event history
- Alarm status
- Real-time trend data graphic for Source 1, Source 2 and Load
- Source synchronization status
- Mimic bus diagram
- Silence audible alarm
- Status indication for:
  - Not in Automatic
  - Go To Emergency
  - Emergency Inhibit
- Return to overview screen



TSM-900 Transfer Switch Monitor Logic Panel

Eaton's Transfer Switch Monitor 900 (TSM-900) is a compact, microprocessor-based, enclosed monitoring device that can be used to retrofit legacy transfer switch equipment with current technologies, including communication, power metering and status monitoring.

The versatile design allows the TSM-900 to be retrofitted with a wide array of manufacturer's transfer switch equipment that is already installed and operational for integration into an existing building management system (BMS) or power management system (PMS).

A retrofit permits an existing transfer switch to be updated in-place and provide information for The Joint Commission, NFPA 99 and NEC (700, 701, 708) maintenance requirements.

User interface:

- UV resistant faceplate
- Unit operation status
- LED mimic bus with source available and source connected indication
- Color display for system status, metering data, programming, diagnostics, help and troubleshooting
- Arrow pushbuttons for quick menu navigation
- Engine test, help, lamp test, enter and bypass timer pushbuttons
- USB drive port for uploading/downloading metering data, setpoint profile and firmware

Configurable features and options:

- 120 Vac or 24 Vdc control power
- Loaded/unloaded engine test
- Serial Modbus RTU communication
- Ethernet communication (multiple protocols)
- Time synchronization (network time protocol)
- Up to 20 programmable inputs and outputs
- Load power metering
- NEMA 1 or 3R enclosure with internal/external mounting points and left/right door hinge orientation
- Keyed door latch

LED mimic diagram

Color-coded LEDs provide status indication. Source 1 Available (white) and Connected (green), Source 2 Available (amber) and Connected (red).

Display and main menu

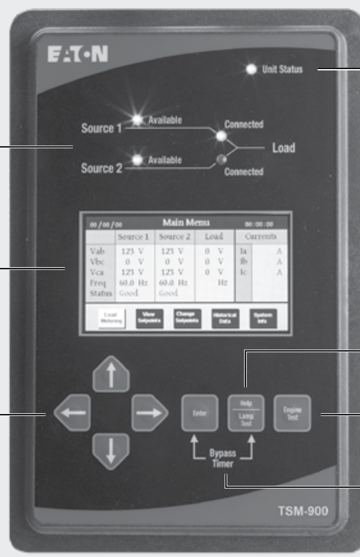
Provides status at a glance. Source 1, Source 2, and Load status and metering data are displayed. Additional screens are easily accessed using navigation keys.

Arrow key navigation

Right and left arrow keys are used to navigate menu options and up and down arrow keys are used to scroll screens and change setpoint values.

USB port

Download/upload setpoints, events, statistics, meter data, and firmware.



TSM-900 Logic Panel Faceplate

Unit status

LED (green) blinks, indicating that the TSM-900 is operating normally. If the LED is not lit or is on continuously, then a problem condition is indicated.

Help

Displays controller firmware version and user tips.

Lamp test

Pressing the Lamp Test pushbutton lights all LEDs and then displays TSM-900 information.

Engine test

Performs an engine test using the programmed engine run and cool-down times. This is a password-protected feature.

Bypass time delays

Pressing the Enter and Help pushbuttons simultaneously reduces the active programmed time delay to zero.

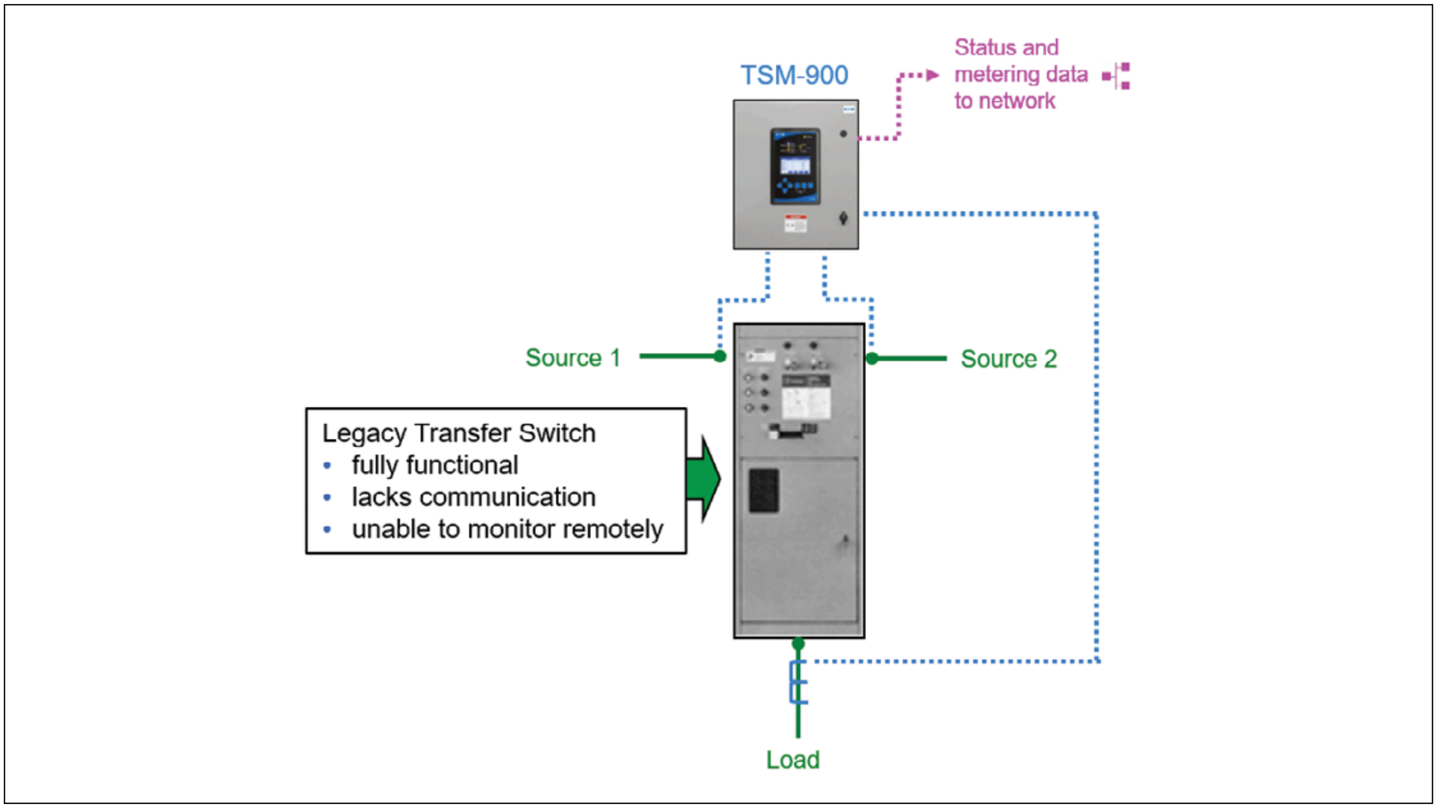


Figure 25.4-9. Retrofitting a Functional, Legacy Transfer Switch with a TSM-900

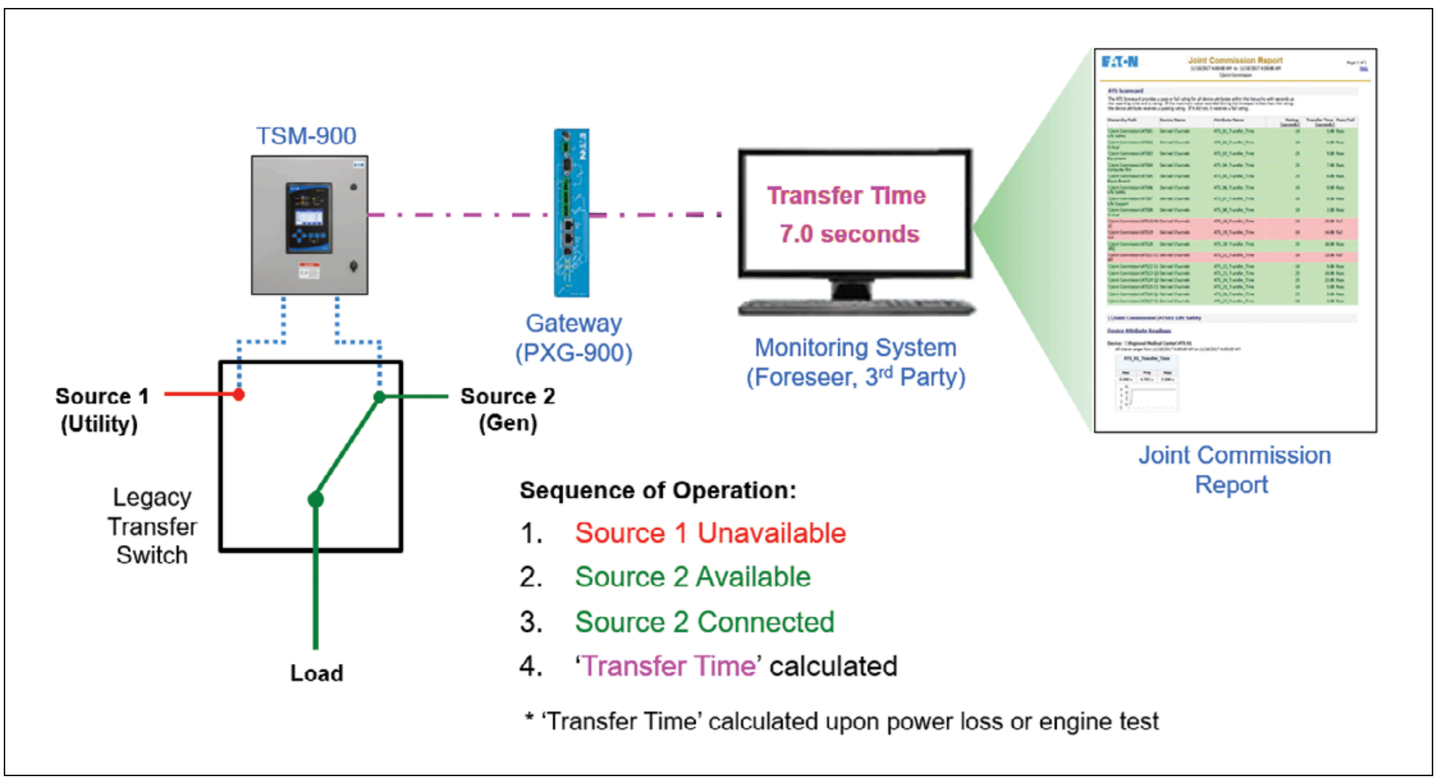


Figure 25.4-10. Transfer Time Calculation Upon a Source Unavailability Condition or Initiation of an Engine-Generator Test can be Used for Reporting

Table 25.4-7. Specifications

Features	Description
System application	Three-phase or single-phase Low-voltage: up to 600 Vac Medium-voltage: up to 46 kVac (external PT required) Frequency: 50 or 60 Hz
Supply power	120 Vac (65–160 Vac, 50/60 Hz) or 24 Vdc (±20%) Power consumption (maximum): 48 VA (120 Vac) / 20 W (24 Vdc) ① 30 or 60 second supply power ride-through (optional)
User interface	4.3 inch color display (TFT LCD, 480 x 272), LED mimic bus (source available, source connected), pushbutton control (navigation, enter, help, engine test, bypass timer, lamp test), USB port (type A)
Display language	English
Setpoints	User programmable (local or remote)
Access control	Password protection (system setpoints and engine test)
Voltage	Source 1, Source 2, load line-line (Vab, Vbc, Vca) and phase-ground (Vag, Vbg, Vcg) Range: up to 720 Vac rms Accuracy: ±1%
Frequency	Source 1, Source 2, load Range: 40 Hz to 80 Hz Accuracy: ±0.2 Hz
Current (optional)	Load Range: 100 to 5000 A (CT ratio setpoint 100:5 to 5000:5) Accuracy: ±1%; burden: 0.0115 VA (per phase at 5 A) Current input: 0–5 A (CTs not included), wire range 6–22 AWG
Power (optional)	Load Accuracy: ±2 % kW, kvar, kVA, power factor (PF)
Demand averaging (optional)	Measured at fixed 15 minute intervals. Present and peak values (kW, kvar, kVA, power factor, phase current)
Maximum/minimum	Source 1, Source 2: voltage (L-L, L-G) and frequency Load (optional): current and power (total and phase)
Sampling	64 samples per cycle (frequency measured every cycle; voltage, current, and power measured every third cycle)
Data logging	Logging interval setpoint. Non-volatile, on-board memory stores up to 150 time-stamped data sets.
Phase rotation	Three-phase sequence check
Symmetrical components	Positive and negative sequence detection (voltage and current)
Serial port	USB 2.0 (download: setpoints, events, statistics, metering data; upload: setpoints, firmware)
Serial communication (native)	Modbus RTU
Ethernet communication (optional)	CAENET (protocols supported ICMP, IP, TCP, UDP, DHCP, HTTP, ModbusTCP, EtherNet/IP)
Ethernet communication (optional)	PXG-900 (protocols supported ModbusTCP/IP, BACnet/IP, SMTP, DHCP, HTTP)
Time synchronization (optional)	Network time protocol (NTP) with resolution to 0.01 seconds
Inputs (fixed)	Source 1 auxiliary, source 2 auxiliary (wetted, 24 Vdc at 6 mA)
Inputs (field programmable)	Four inputs standard. Expandable up to 20 (wetted, 24 Vdc at 6 mA) 1. Disabled 2. Source 1 available 3. Source 2 available 4. Transfer switch on bypass 5. Bypass auxiliary (Source 1) 6. Bypass auxiliary (Source 2) 7. Generator start contact 8. Door open 9. General alarm 10. ATS not in automatic 11. Lockout 12. Enable manual retransfer 13. Manual retransfer request 14. Go to emergency 15. Emergency inhibit 16. Go to neutral 17. Bypass timers 18. Remote engine test 19. Engine test mode select 20. Test status 21. Remote input/output
Outputs (fixed)	Source 1 and Source 2 available (Form C, rated 10 A at 250 Vac/30 Vdc) Load-transfer test, run-only test (Form C rated 5 A at 250 Vac/30 Vdc)
Outputs (field programmable)	Four outputs are standard. Expandable up to 20 (Form C, rated 10 A at 250 Vac/30 Vdc). 1. Disabled 2. Source 1 available 3. Source 2 available 4. Transfer switch on bypass 5. Source 1 connected 6. Source 2 connected 7. Generator start 8. Door open 9. Alarm 10. ATS not in automatic 11. Lockout 12. Enable manual retransfer 13. Manual retransfer request 14. Go to emergency 15. Emergency inhibit 16. Go to neutral 17. ATS in test 18. Transfer test contact status 19. Run-only test contact status 20. Engine test aborted 21. Selective load shed 22. Load bank control 23. Cool-down in progress 24. Remote input/output
Source availability	Indication and status determined by programmable input or programmable setpoints.

① Excludes ac-dc power supply (not required) and I/O expansion modules (not available).

Table 25.4-7. Specifications (Continued)

Features	Description
Drop-outs and pick-ups	Source 1 and Source 2: undervoltage, overvoltage, under-frequency, over-frequency, voltage unbalance, phase loss Load: current unbalance
Time delays	Time delay engine fail, time delay normal emergency, time delay emergency normal, time delay engine cool-down, time delay negative sequence drop-out.
Engine/plant exerciser	Two, independent exercisers with programmable start and run times. Test modes: run only, load transfer, external select, disabled. Schedule: off, daily, 7-14-28 day, up to 12 specific calendar dates.
Historical counters	Source 1 available time Source 2 available time Source 1 connected time Source 2 connected time Tier 4 timer Load energized time Number of transfers Number of run-only tests Number of transfer tests Counter resets are time-stamped and logged as events
Event logging	Up to 100 time-stamped event summaries and 350 event details. Time-stamping resolution of 0.01 seconds
Event recording (hi-speed capture)	4 seconds of metered data (stored every 20 msec) for certain events. Data is captured 2 seconds before and 2 seconds after an event (except for power failure which stores 4 seconds before event) Oscillographic data for 10 events is stored and can be downloaded via USB or displayed graphically.
Time/date	User programmable. Supports automatic DST (daylight saving time) and time zone offset.
System information	General order number, serial number, firmware revision level
Environmental	Storage temperature: –30° to +80 °C (–22 to +176 °F) Operating temperature: –20° to +70 °C (–4 to +158 °F) Relative humidity: up to 90% (noncondensing)
Safety	UL 508A standard for industrial controls panels
Emissions	FCC Part 15 (Subpart B, Class A); CISPR 11 (Class A)
Electromagnetic compatibility (EMC)	IEC 61000-4-2: electrostatic discharge immunity IEC 61000-4-3: radiated immunity IEC 61000-4-4: fast transient/burst immunity IEC 61000-4-5: surge immunity IEC 61000-4-6: conducted immunity IEC 61000-4-11 (voltage dips/interruptions/variations)

Communication

Eaton's ATC-300+ and ATC-900 transfer switch controllers include native support for serial communication and a Modbus register map is available for interfacing with a building management or power management system.

When ethernet communication is desired, there are several modular options available. Modules are typically DIN rail mounted within the enclosure assembly but can be shipped loose for installation elsewhere.

The Power Xpert PXG 900 is a full-featured gateway and includes an embedded web server. Eaton technical document TD152008EN can be referenced for details.

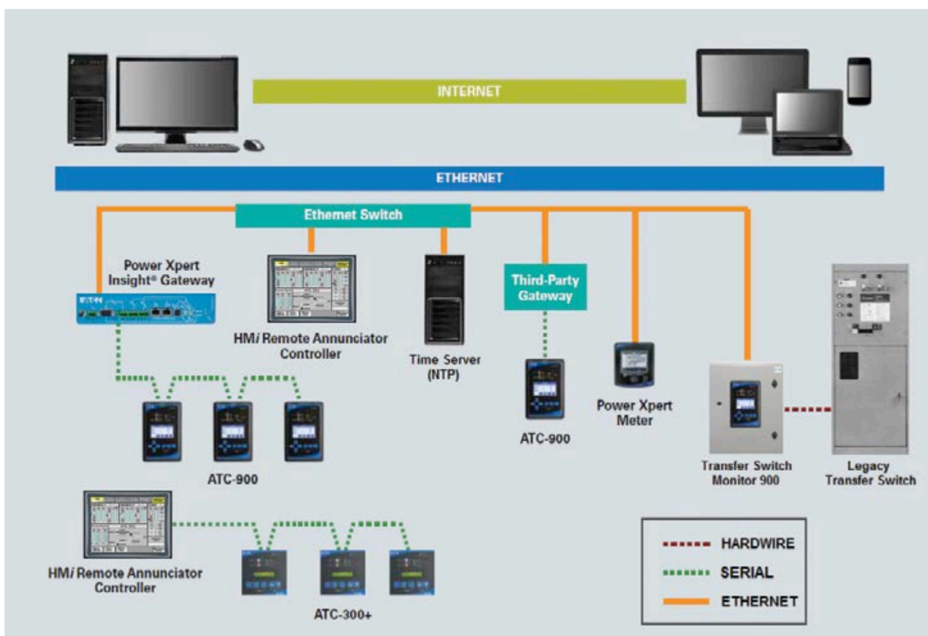
Network protocols:

- ModbusTCP/IP
- HTTP and HTTPS
- DHCP
- BACnet/IP

The ELC-CAENET module is a basic serial to ethernet adapter and supports a variety of protocols. Eaton document MN05002003E can be referenced for details.

Network protocols:

- ModbusTCP/IP
- HTTP and HTTPS
- DHCP
- BACnet/IP



System Architecture with PXG-900 Gateway

Standard Layouts, Dimensions and Weights

Table 25.4-8. Automatic Transfer Controller Dimensions

Description	Width Inches (mm)	Height Inches (mm)	Depth Inches (mm)	Weight lb (kg)
ATC-100	6.50 (165.1)	8.50 (215.6)	2.23 (59.0)	2.85 (1.29)
ATC-300+	6.50 (165.1)	8.50 (215.6)	2.84 (72.1)	4.10 (1.86)
ATC-900	6.72 (17.07)	10.25 (260.4)	2.61 (66.4)	2.70 (1.22)
HMi RAC	7.24 (184.0)	5.67 (144.0)	1.97 (50.0)	1.76 (0.80)

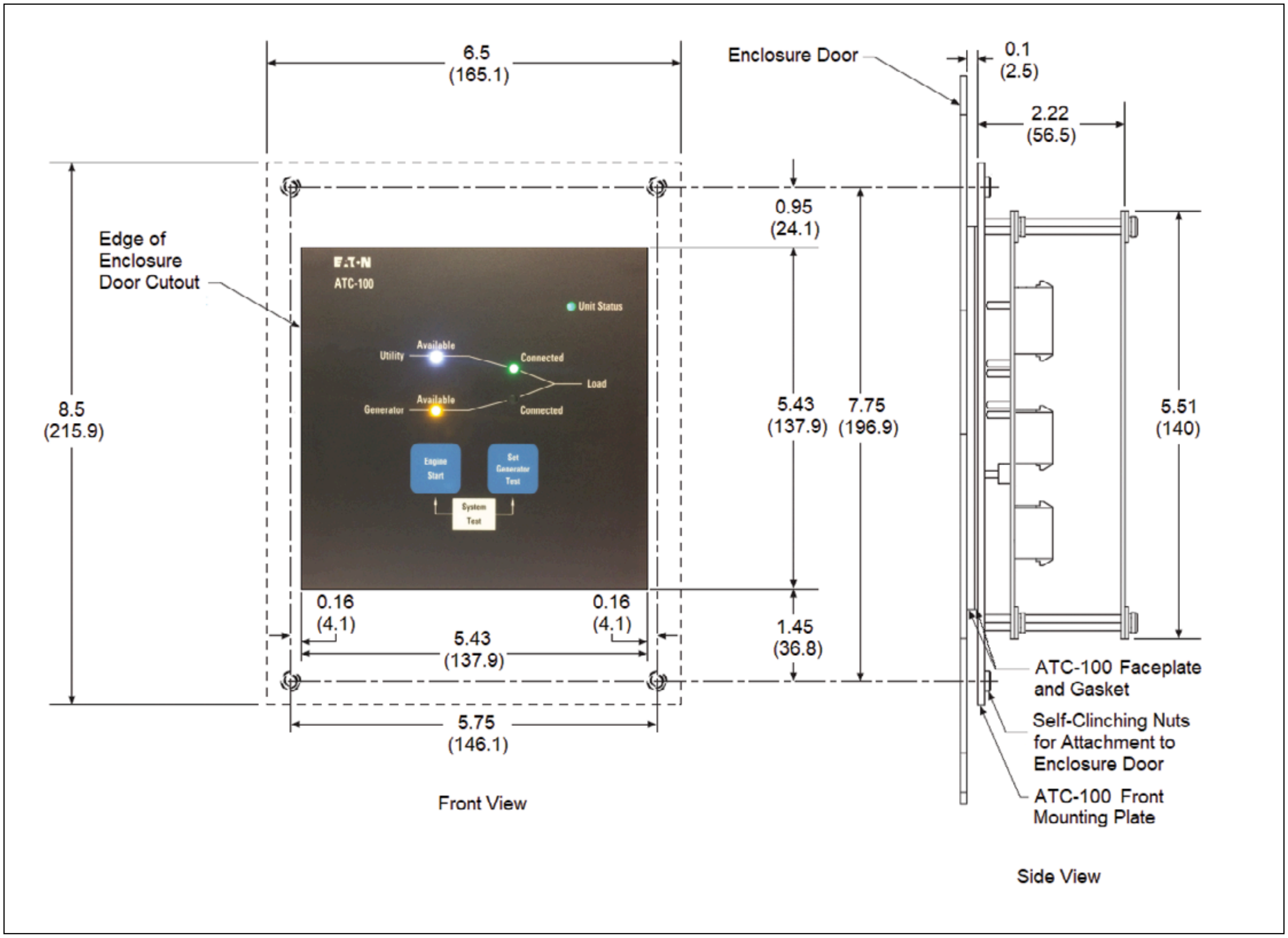


Figure 25.4-11. ATC-100 Automatic Transfer Controller

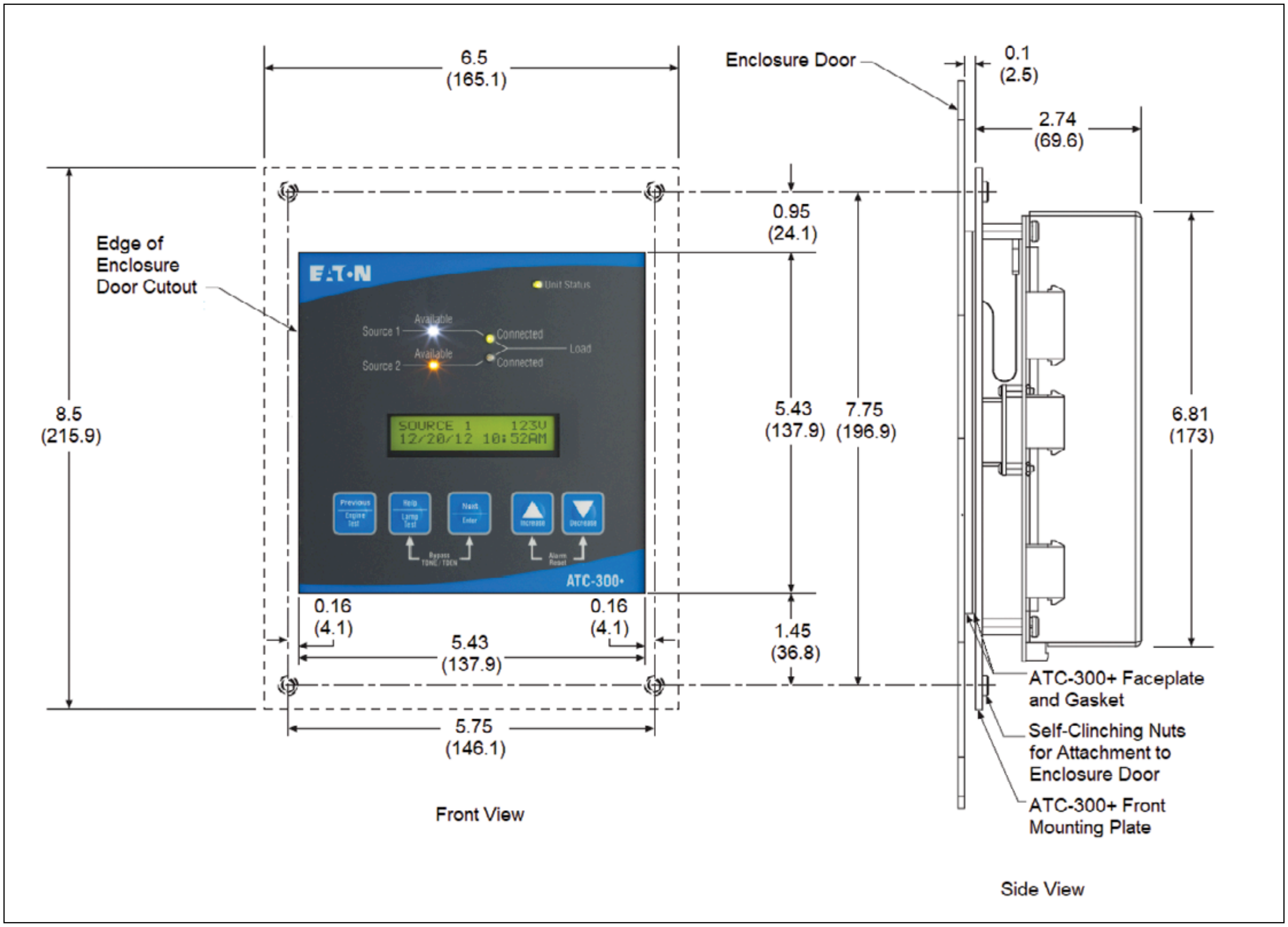


Figure 25.4-12. ATC-300+ Automatic Transfer Controller

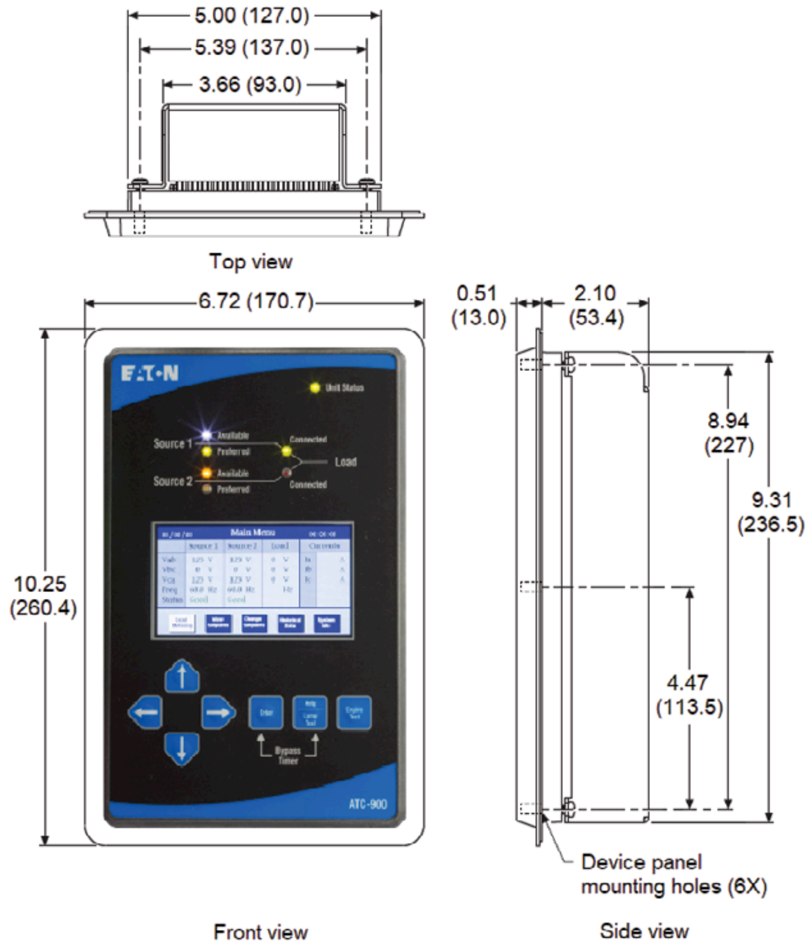


Figure 25.4-13. ATC-900 Automatic Transfer Controller

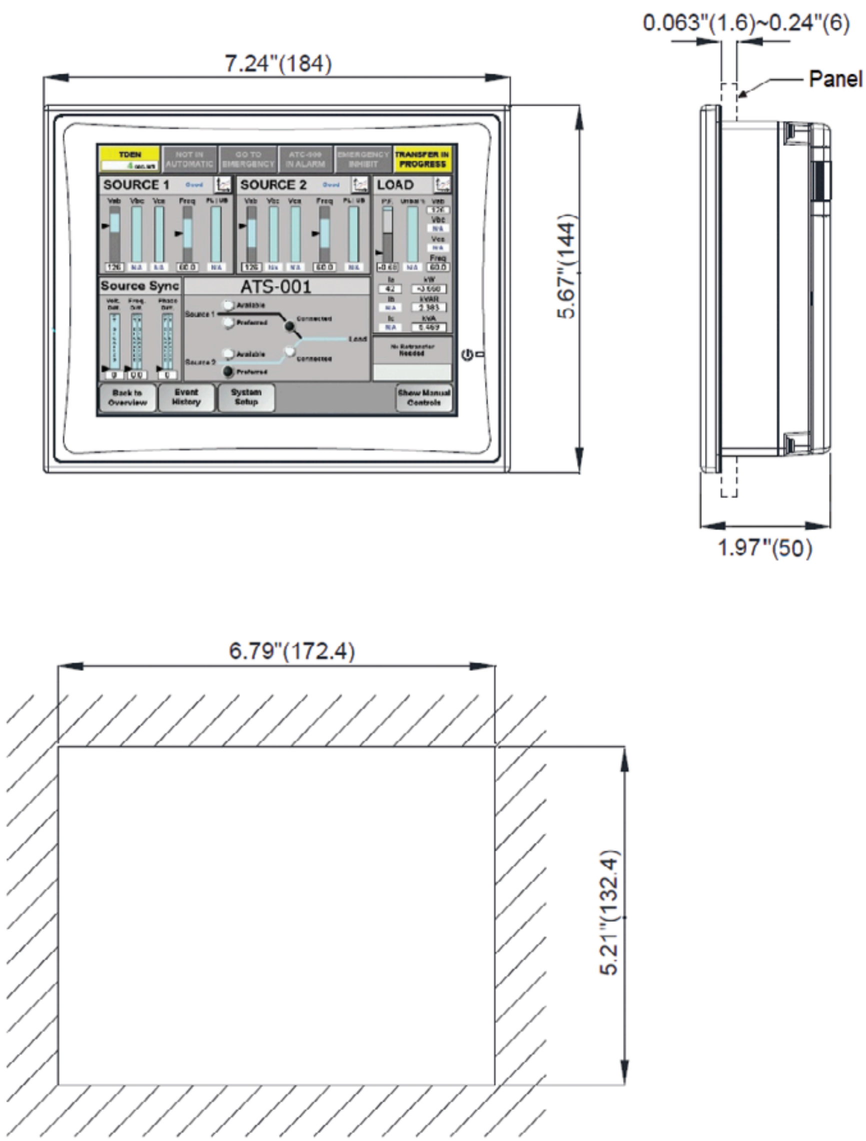


Figure 25.4-14. HMi Remote Annunciator Controller

Figure 25.4-15. TSM-900 Transfer Switch Monitor Logic Panel

Wiring Diagrams

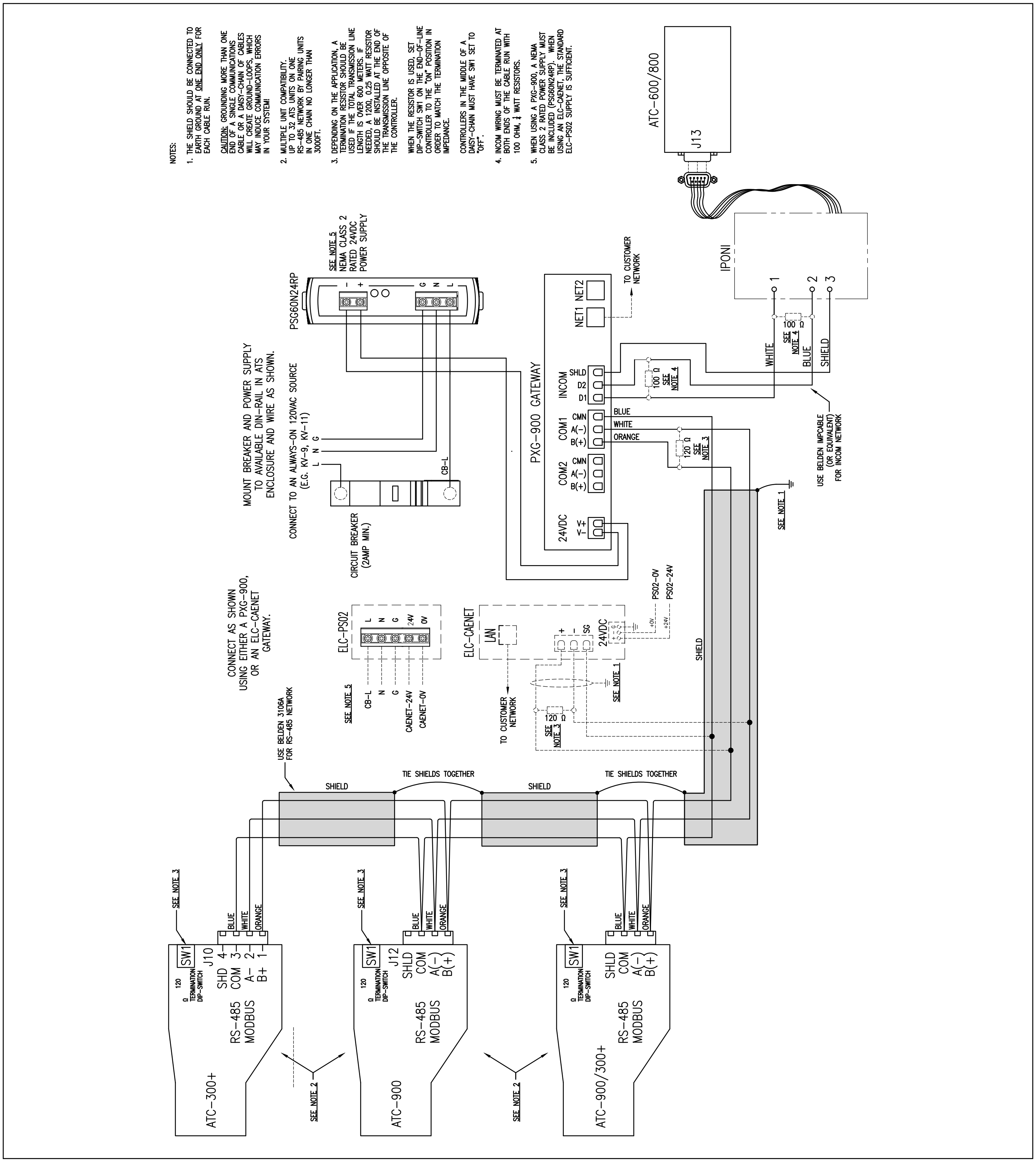


Figure 25.4-16. ATC-300+ and ATC-900 Communication Wiring Diagram

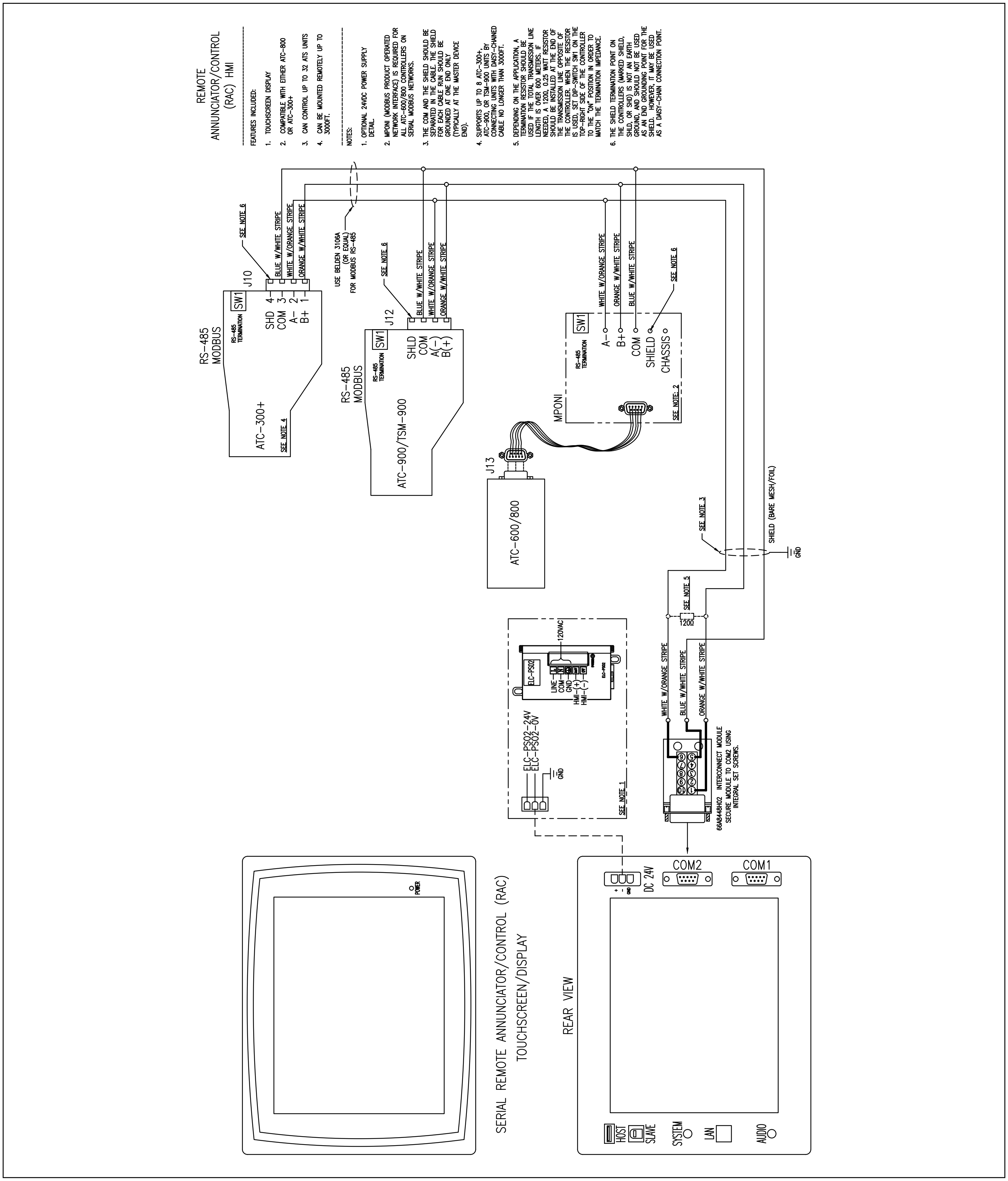


Figure 25.4-17. HMi RAC Serial Wiring Diagram

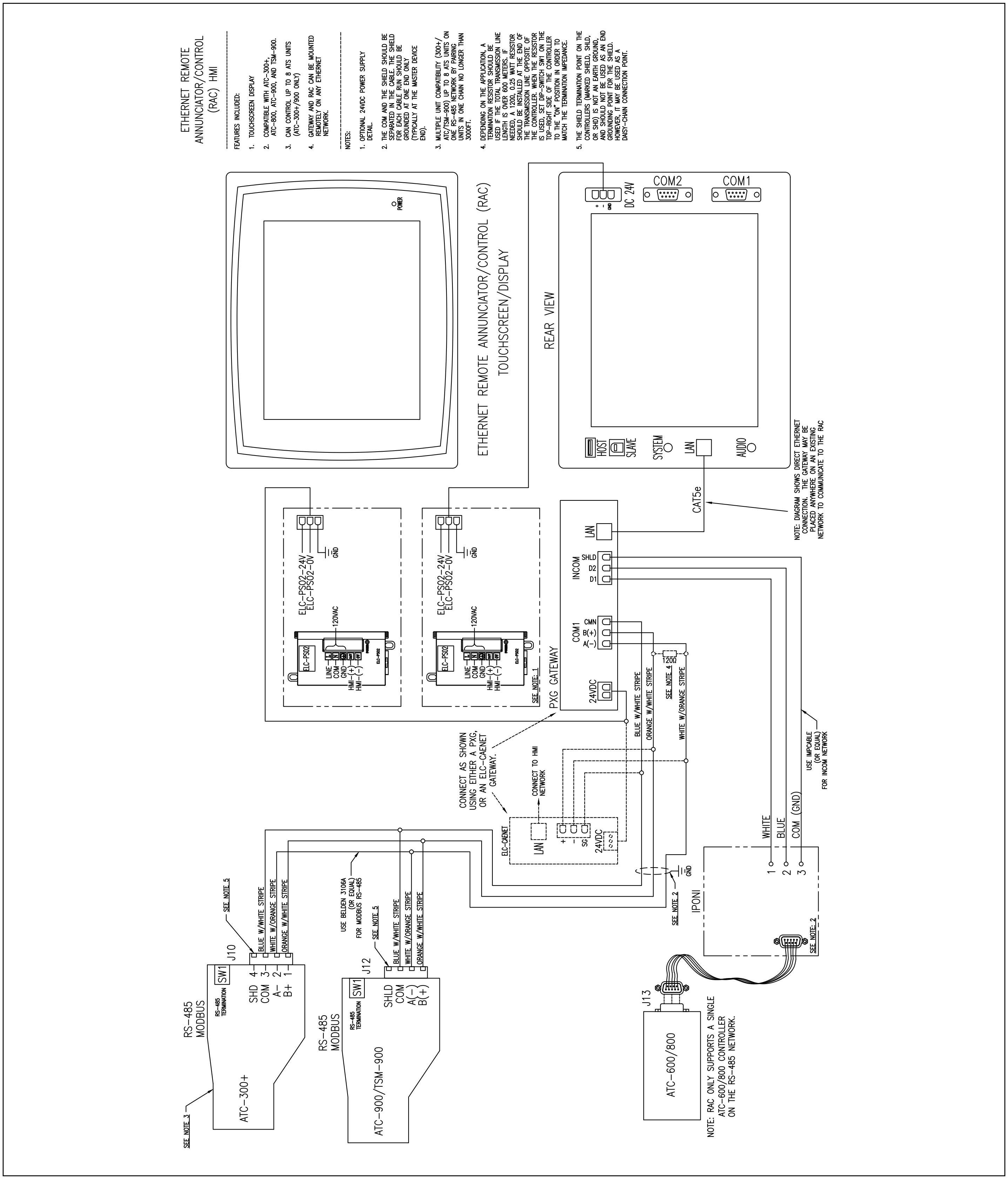
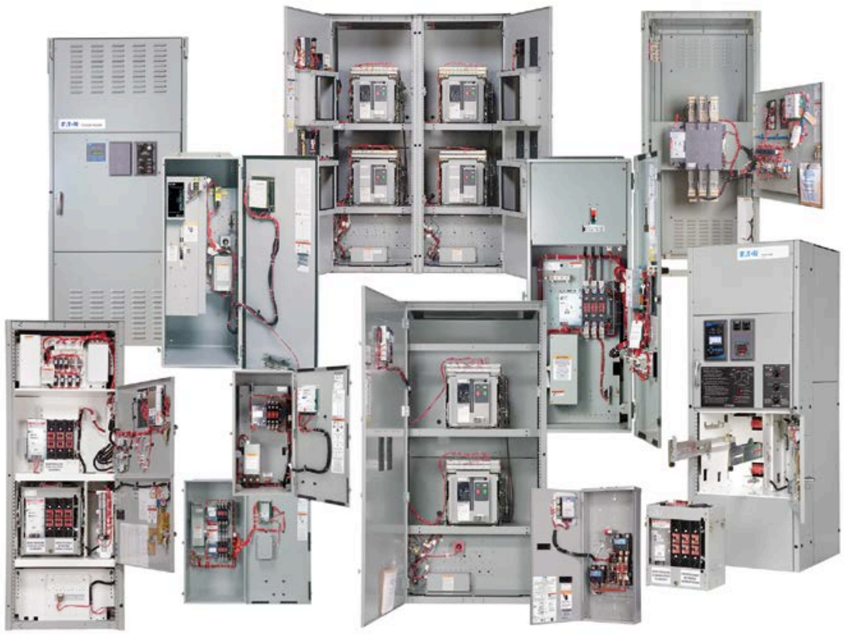


Figure 25.4-18. HMi RAC Ethernet Wiring Diagram

Transfer Switches



Automatic Transfer Switch Family

General Description

Eaton's low-voltage automatic transfer switch assemblies provide a reliable means of transferring essential load connections between primary and alternate sources of electrical power.

Data centers, hospitals, factories and a wide range of other facility types that require continuous or near continuous uptime typically utilize an emergency (alternate) power source, such as a generator or a backup utility feed, when their normal (primary) power source becomes unavailable.

When the normal power source fails, the transfer switch quickly and safely transitions the load connections to the emergency power source allowing critical loads to continue running with minimal or no interruption. All electrical power consumed by the circuit, equipment or system connected to the transfer switch output is defined as the load.

A typical transfer sequence includes these steps:

1. The normal utility power source fails.
2. When power from the generator or backup utility feed is stable and within prescribed voltage and frequency tolerances, the transfer switch shifts the load to the emergency power source. Depending on a facility's needs and preferences, the transfer process is self-acting or manually initiated.
3. When utility power is restored, the transfer switch returns the load from the emergency power source to the normal power source. The retransfer process is self-acting or manually initiated.

Arrangements

Two Power Sources

Utility—Generator

The standard transfer switch use case includes an electric utility service and an engine-generator set (generator) providing the normal and emergency power sources. This system arrangement is typically referred to as an emergency standby generator system. The single generator shown may be several engine-generator sets operating in parallel.

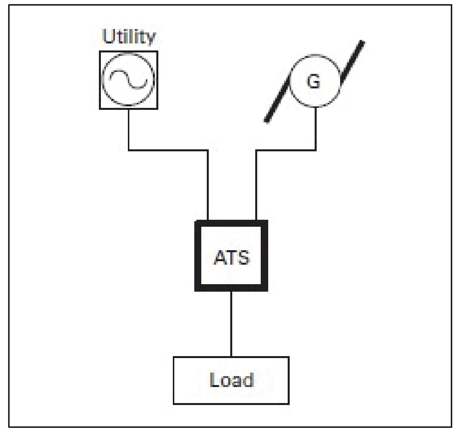


Figure 25.4-19. Utility—Generator

Utility—Utility

This use case employs two utility sources providing some level of redundancy in the distribution system and allows for quick restoration of service to the load if an upstream equipment failure occurs.

The two sources can be independent of each other, requiring the public utility company to provide dual electric services, or they can originate from a single electric service that is distributed through redundant paths within the facility.

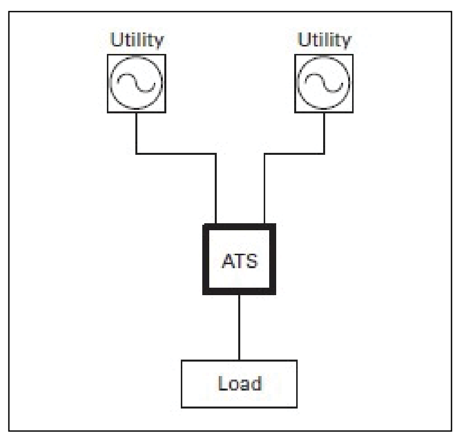


Figure 25.4-20. Utility—Utility

Generator—Generator

Transfer switches are sometimes applied between two generator sets for prime power use, often at remote installations. In such cases, the generator may be required to provide continuous power 24/7. As a means to equally share run-time, source power is periodically alternated between the generator sets.

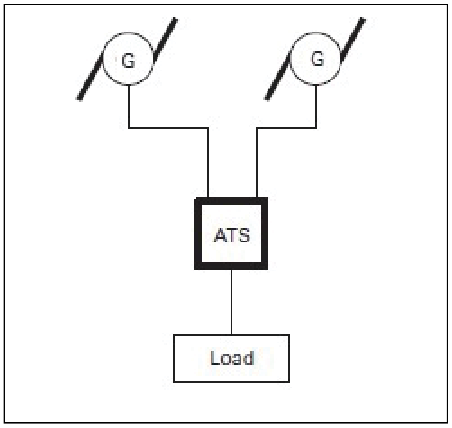


Figure 25.4-21. Generator—Generator

Three Power Sources

Utility—Generator—Generator

Critical facilities with an emergency standby generator system will often include provisions for a second generator connection to serve as a redundant emergency backup that can be used during periods of inclement weather or when scheduled maintenance is being performed on the first generator.

In some cases, the first generator is permanently installed onsite whereas the second generator will be a portable roll-up type that is deployed when needed. Two variations of this arrangement are shown. When configured as shown in the first example, the generator start circuits must be managed to prevent unnecessary running when the utility source is available.

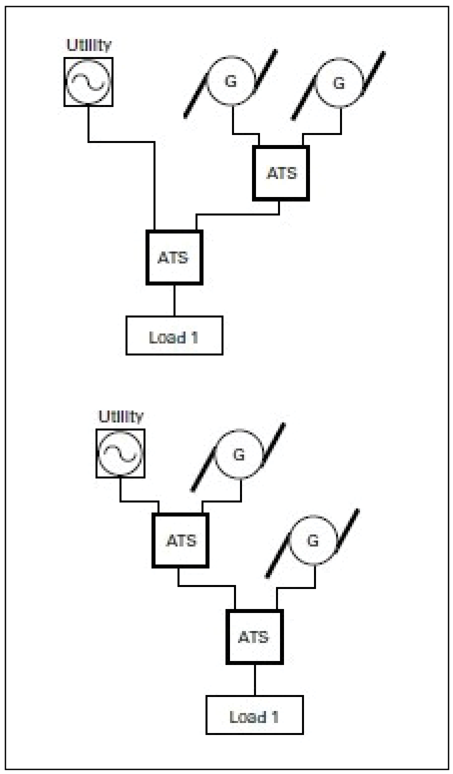


Figure 25.4-22. Utility—Generator—Generator

Utility—Utility—Generator

This use case expands on the redundancy provided by dual utility arrangement and includes an emergency standby generator source. The generator can be dedicated for use by a single transfer switch or shared among multiple transfer switches employing a priority control scheme. Two variations of this arrangement are shown.

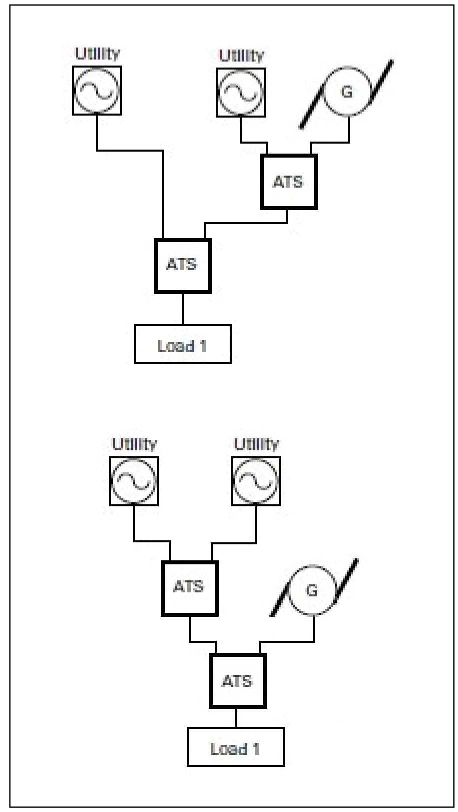


Figure 25.4-23. Utility—Utility—Generator

Transition Types

Transfer switches can transition loads between normal and emergency power sources in two basic ways: open or closed.

The specific functions performed by a given load and the importance of those functions to safety or security play an important role in determining which kind of transition is required.

Open Transition

An open transition is a "break before make" transfer. That is, the transfer switch breaks its connection to one power source before making a connection to the other. For some period of time between disconnection and connection, neither the normal power source nor the emergency source is providing electricity to downstream loads.

There are two kinds of open transition: open delayed and open in-phase.

Open Delayed Transition

For an open delayed transition, the transfer switch pauses in-between disconnecting the load from one power source and connecting it to the other power source. The delay typically lasts either a pre-set amount of time (fixed or programmed time delay) or however long it takes the load voltage to decay below a pre-specified level (programmed threshold). The load voltage decay approach is more precise.

Open In-Phase Transition

With open in-phase transition, an automatic controller uses built-in intelligence to execute an open transition at the precise moment it expects the normal and emergency power sources to be synchronized in phase, voltage and frequency.

In-phase transitions are typically completed in 150 milliseconds or less to ensure that inrush current is equal to or less than the normal starting current of any inductive load(s).

If synchronization doesn't occur within this time span, the transfer switch may have the ability to default automatically to a delayed transition that serves as a failsafe.

Closed Transition

A closed transition is a "make before break" transfer, in that the transfer switch makes a connection to a second power source before breaking its connection with the first power source.

As there's no gap between disconnection and connection, downstream loads receive continuous power throughout the transfer process.

Switches configured for closed transition transfer power automatically as soon as both power sources are closely synchronized in phase, voltage, and frequency. The overlap period during which both sources are simultaneously connected, or "paralleled," usually lasts no more than 100 milliseconds to comply with local utility interconnect requirements.

Modes of Operation

Power transfers involve two processes: initiation and operation. Initiation is what starts the transfer. Operation is what completes it. Most transfer switches can support multiple operation modes through the addition of configurable options.

Manual Mode

In manual mode, both initiation and operation are performed manually, typically by pushing a button or moving a handle. Initiation occurs locally.

Non-Automatic Mode

In non-automatic mode, the operator manually initiates a transfer by pressing a button or rotating a switch that causes an internal electromechanical device to electrically operate the switching mechanism. Initiation can occur locally or remotely.

Automatic Mode

In automatic mode, the transfer switch controller is self-acting and completely manages both initiation and operation. Initiation is triggered when the automatic controller senses an unavailability or loss of source power followed by operation of the switching mechanism.

Switching Mechanism

The switching mechanism is the part of a transfer switch that is physically responsible for carrying the rated electrical current and shifting the load connection from one power source to another.

Low-voltage switching mechanism technology comes in two basic varieties, commonly referred to as "contactor type" and "circuit breaker type". Circuit breaker switching mechanisms can be further divided into two sub-types: molded case and power frame.

Contactor Switching Mechanisms

Contactor Type

This is the most common and typically most economical switching mechanism type. Contactors are constructed as an electrically controlled, double-throw switch where a single operator opens one set of power contacts while closing a second set. In an open transition design, a mechanical interlock is often employed to prevent simultaneous closure of both contact sets. In a closed transition design, the mechanical interlock is absent. Unlike a circuit breaker, a contactor is not designed to provide overcurrent protection or interrupt short-circuit fault current.

Power Frame Switching Mechanisms are Available up to 5000 A and Utilize Stored Energy Technology

Molded Case Type

Routinely used for closing and interrupting a circuit between separable contacts under both normal and abnormal conditions, molded case switches feature simple designs and are capable of supporting either a mechanically operated, over-center toggle or a motor operator. They are typically assembled in an enclosed housing constructed of insulating material.

When configured for use in a transfer switch, a pair of molded case switches are operated via a common, interlocking mechanical linkage. The linkage can be driven manually or automatically. When overcurrent protection is needed, molded case circuit breakers equipped with a thermal-magnetic or electronic trip element are used.

Molded case switching mechanisms provide a compact, cost-effective and service entrance-rated solution, as they eliminate the need for additional upstream protective devices. Each molded case mechanism individually complies with industry standard UL 489, which covers low-voltage molded case switches and circuit breakers.

Molded case switching mechanisms are ideal for applications that require integral overcurrent protection

Power Frame Type

Power frame switches are larger, faster and more powerful than molded case switches, and are capable of handling up to 5000 A.

A two-step stored energy technology is utilized that permits manual and electrical operation under load.

When an application requires integral overcurrent protection, power circuit breakers are configured with an electronic trip unit that facilitates selective coordination.

Power frame switching mechanisms are a good fit for applications vulnerable to large fault currents.

Each power frame switch or circuit breaker individually complies with industry standard UL 1066, which covers low-voltage power circuit breakers.

Note: For more detail, reference Eaton Publication WP140001EN.

Mounting

Drawout

The use of drawout construction permits the switching mechanism to be levered into three different positions (connected, disconnected, withdrawn) within a cassette or cell structure facilitating safety, testing and serviceability. Drawout is typically achieved using rail slides or rollers.

When in the disconnected position, the switching mechanism is isolated from the main power bus or cabling. Some designs may allow the switching mechanism to be manually or electrically (via control power) exercised to satisfy preventive maintenance requirements. Placing the switching mechanism in the disconnected position can also be used during a lockout/tagout procedure.

Removing the switching mechanism from the transfer switch allows for bench testing or replacement.

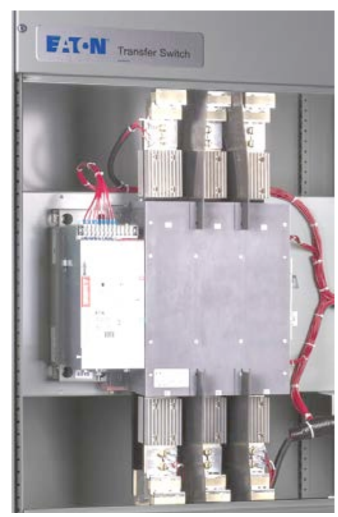
Drawout construction is often employed in bypass isolation type transfer switches used in mission-critical applications.

Drawout Mounting

Fixed

Switching mechanisms with a fixed mounting configuration are simple and economic because there are no drawout system components.

The switching mechanism bolts directly to the main power bus or cable conductors and may result in a reduced enclosure depth when compared to drawout.



Fixed Mounting

Power Poles

Every transfer switch includes a specific number of power poles. 2-pole and 3-pole designs are commonly employed in locations fed by single-phase power whereas 3- and 4-pole designs are utilized in places supplied with three-phase power.

Each power pole is constructed with two sets of main contacts (momentary and stationary components) that are interconnected to form a three-terminal, single-pole switch. This arrangement allows the load terminal to be connected with one or both power source terminals.

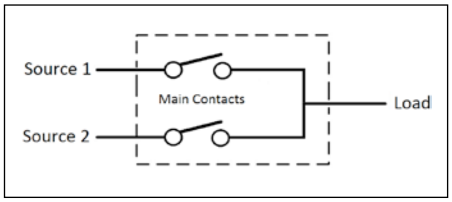


Figure 25.4-24. Power Pole

Power poles are used to switch individual phase conductors of the power source and where required, the neutral conductor.

When multiple power poles are combined with an operator device(s), a switching mechanism is formed.

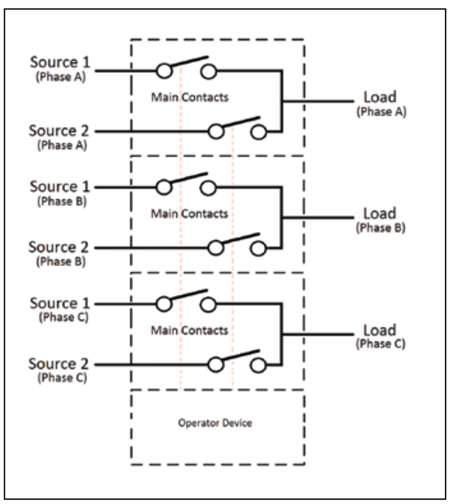


Figure 25.4-25. Switching Mechanism

For simplicity, multiple power poles are eliminated from the common transfer switch symbol used in one-line drawings.

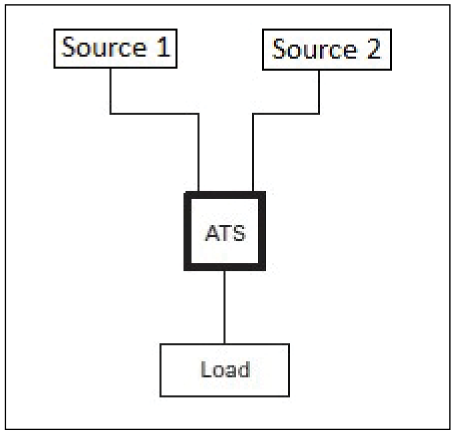


Figure 25.4-26. Transfer Switch Schematic Drawing

In open transition transfer switches, the main contacts are mechanically interlocked, preventing both sets from being closed at the same time. This action prevents the inadvertent electrical paralleling of the two power sources that can differ in voltage, frequency and phase.

Closed transition designs do not include a mechanical interlock and will permit simultaneous paralleling of the power sources when they are electrically synchronized, however, an electrical interlock is used to limit the paralleling time (typically 100 ms) to comply with public utility interconnect specifications.

Power poles also include features to mitigate arcing and erosion of the main contacts such as arcing contacts, arc runners and arc chutes.

Arc Chutes

Switching mechanisms include arc chutes, housed within an arc chamber constructed of high-dielectric high-strength material, that are mounted over each set of main contacts. Arc chutes are constructed of metal plates designed to extinguish an electrical arc and protect the main contacts.

Arc Chutes

Operator Device

The operator device drives the power pole main contacts open or closed. Depending on the switching mechanism type, this is accomplished using an electric solenoid, electric motor or a spring stored energy mechanism.

Some operator device designs allow the source 1 main contacts to be driven independently of the source 2 main contacts. This permits the load to remain disconnected from either of the power sources for a programmed time delay or until the residual load voltage decays below a programmed threshold. When the load is disconnected in this manner, the transfer switch is said to be in a center-off or "neutral-position".

Contactor type switching mechanisms that provide a "neutral-position" are referred to as 3-position, otherwise, they are termed 2-position. All molded case and power frame type switching mechanisms provide a "neutral-position".

Applications (e.g., inductive loads) specifying open-delayed transition will require a transfer switch with a "neutral-position".

Switched Neutral

For three-phase power applications requiring that the neutral conductor be switched, transfer switches can be configured with a fully rated 4th pole that performs identical to the individual phase (A,B,C) power poles. For single-phase applications, a fully rated third pole can be configured.

A switched neutral is commonly used when the transfer switch is fed by separately derived power sources. The benefits of using a switched neutral include the following:

- Inhibits circulating ground current from flowing between power sources on the neutral conductor that can cause nuisance tripping of the ground fault relay at the de-energized or unconnected source
- Prevents de-sensitizing the ground fault relay at the energized or connected source
- Eliminates the need for complex ground fault sense wiring

Note: For more detail, reference Eaton White Paper IA08700002E.

For closed transition transfer switches, the switched neutral pole operates as "make-before-break" and simultaneous closure or overlapping of the neutral contacts is limited to 100 ms.

For open transition transfer switches, the switched neutral pole operates in a "break-before-make" fashion and eliminates potential problems that can occur with a three-pole solid neutral or three-pole overlapping neutral (not offered by Eaton) configuration.

The likelihood of a ground fault occurring during the time period that neutral contacts are simultaneously closed or overlapped is just as likely as any other time but perhaps slightly more. When transferring between power sources, dynamic changes are introduced into the system such as moving contacts, vibration and energizing previously de-energized conductors that may push and pull equipment and cables in different directions.

Configuration	Advantages	Disadvantages
Three-pole	Lower cost	Nuisance tripping of ground fault (GF) relay on de-energized or unconnected source. De-sensitizing the ground fault relay at the energized or connected source. Added complexity to implement ground fault relay circuit to prevent nuisance tripping of ground fault relay at de-energized or unconnected source.
Four-pole (switched neutral)	No circulating ground current (eliminates nuisance tripping of ground fault relay at de-energized or unconnected source and desensitizing ground fault relay at energized or connected source).	Higher cost
Three-pole (overlapping neutral)	May be less expensive than four-pole if overlapping neutral is not fully rated.	During the time when both neutrals are connected, the same disadvantages as a three-pole switch exists.

Bypass Isolation Automatic Transfer Switches

For simplified maintenance and improved uptime, bypass isolation automatic transfer switches provide dual switching functionality and redundancy for critical applications. The primary switching mechanism (automatic transfer switch) handles the day-to-day distribution of electrical power to the load, while the secondary switching mechanism (bypass switch) serves as a backup or redundant device. During repair or maintenance procedures, service personnel can bypass power around the automatic transfer switch through the bypass to ensure that critical loads remain powered without interruption.

In some bypass isolation transfer switch designs, the bypass switch is fully automatic and self-acting, providing increased redundancy. When in the automatic bypass mode of operation, the control logic continues to monitor the normal power source and will automatically initiate a transfer to the alternate source should the normal source fail.

A bypass isolation transfer switch is frequently selected for use in healthcare, as well as in other critical applications, because it allows the automatic transfer switch (ATS), and in some cases the bypass switch, to be drawn out and isolated from the power source(s) to facilitate regular maintenance, inspection and testing as prescribed by code (NFPA 110).

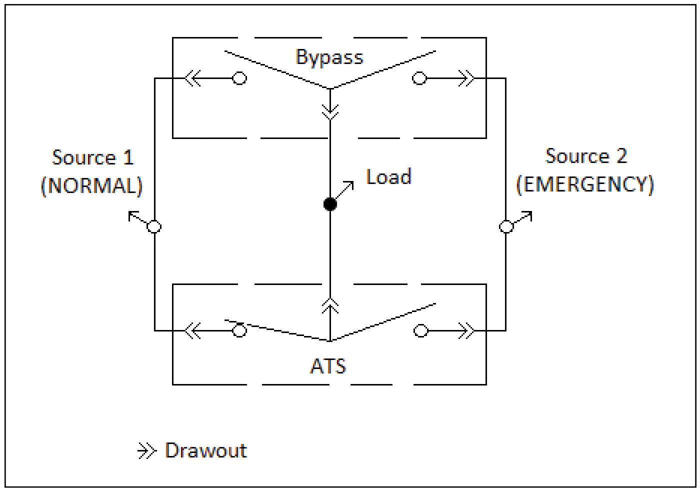


Figure 25.4-27. Bypass Isolation ATS Schematic Drawing

Service Entrance Rated Transfer Switches

Facilities with a single utility connection and a single emergency power source will often have an automatic transfer switch located at the service entrance to ensure that critical loads can quickly and safely shift to emergency power (generator) if utility power is interrupted. Non-critical loads are often inhibited or shed from connection to the emergency power source to avoid capacity overload.

Service entrance rated transfer switches include integral overcurrent protection and a disconnect means allowing them to be installed directly at the point of service entrance, which eliminates the need for separate upstream device(s), including additional power connections. As required, they can also include ground fault protection.

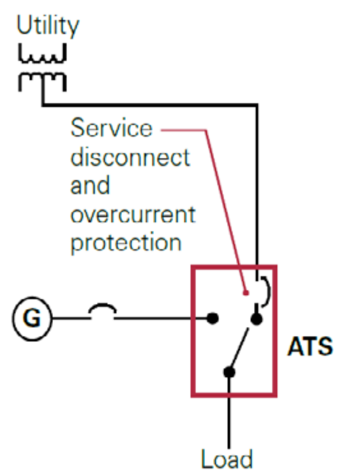


Figure 25.4-28. Service Entrance Rated Transfer Switch with Integral Overcurrent Protection Saves Space and Cost

Arc Flash Reduction

When required by the National Electrical Code (NEC), integral overcurrent protection can be configured with technology to reduce clearing time, such as an Arcflash Reduction Maintenance System™ (ARMS), resulting in lower incident energy at all downstream work locations.

A circuit breaker equipped with ARMS can improve worker safety by providing a simple and reliable method to reduce fault clearing time. For applications where the highest continuous current trip setting of the overcurrent device in a circuit breaker is rated (or can be adjusted to) 1200 A or higher, a method to reduce clearing time is required per NEC 240.87.

When the ARMS maintenance mode is enabled, an integral analog trip circuit provides an accelerated instantaneous trip. To facilitate maximum arc flash reduction while avoiding nuisance tripping, the ARMS pickup level is adjustable.

Service entrance transfer switch construction can vary in the marketplace and care should be taken by the consulting engineer to consider when the transfer equipment needs to be "fully UL 1008 Listed" and marked for use at 100% of rated current.

The phrase "fully UL 1008 listed" is used to describe the entire transfer switch enclosure assembly—including the integral circuit breaker and power bus—which has passed rigorous temperature rise performance testing required by the UL 1008 standard for transfer switch equipment.

Table 25.4-9. Incident Energy Level Decreases with ARMS

Service Entrance Transfer Switch Rating (A)	Available Fault Current (kA)	Arcing Fault Current (kA)	Without ARMS		With ARMS	
			Maximum Clearing Time (sec)	Incident Energy (cal/cm³)	Maximum Clearing Time (sec)	Incident Energy (cal/cm³)
4000	64	32	0.5	58.4	0.04	4.7
3000	51	26.4	0.5	47.3	0.04	3.8
2000	39	21	0.5	37	0.04	3.0
1600	28	15.8	0.5	27.2	0.04	2.2
1200	19	11.3	0.5	19	0.04	1.5

Note: Overcurrent protection device modeled is Eaton Magnum DS circuit breaker (520MC or 1150+ trip). When Eaton MCCB (310+ trip) is used as the protection device, maximum clearing time (ARMS) is 0.03 sec. Arcing fault current and incident energy values derived using SKM System Analysis software. Incident energy is calculated immediately downstream of transfer switch load.

UL 1008 standard

The industry safety standard governing the construction and performance criteria for transfer switch equipment, having a maximum voltage rating of 1000 V, is UL 1008.

To ensure a minimum level of reliability, the standard requires that all transfer switch equipment, listed to apply the UL 1008 mark, meet rigorous performance testing—regardless of the design type.

Performance Tests

Undervoltage

A voltage sensing relay coil shall be capable of withstanding 95% of rated pull-in voltage without damage.

Overvoltage

An electromagnetic coil shall be capable of withstanding 110% of rated voltage without damage.

Overload

The transfer switch must operate for a number of operation cycles, with a non-unity power factor, at a multiple of its rated current.

Dielectric

The transfer switch shall be capable of withstanding 1000 Vac, plus twice its maximum rated voltage, without breakdown.

Temperature Rise

While operating at 100% of its rated current, the transfer switch temperature shall not exceed a maximum value, sustain material damage or pose a fire risk.

Endurance

The transfer switch must operate for thousands of operation cycles without fail.

Withstand and Closing

With the transfer switch closed into a test circuit, it must "withstand" a short-circuit current, at a specific voltage, for a specified time period or until a specific overcurrent protective device opens. The same transfer switch sample must then "close-into" a test circuit, with a short-circuit current applied, for a specified time period or until a specific overcurrent protective device opens. At the conclusion of each test, a set of operational, physicaland electrical criteria must be met.

An optional short-time variant of the test can be performed at the request of the manufacturer but is not a requirement to obtain a UL 1008 mark.

Withstand Closing Current Ratings

When applying a transfer switch for use in a power distribution system, consideration must be given to the withstand closing current rating (WCR) to ensure system integrity and reliability.

The UL 1008 standard permits transfer switches to be marked with one or more short-circuit and/or short-time WCRs specific to an overcurrent protection (OCP) device type. Transfer switches with multiple ratings provide greater application flexibility.

The WCR represents a transfer switch's capability to ride-out a fault condition until the overcurrent protective device (a circuit breaker or fuse that is integral to the transfer switch assembly or is located externally upstream) opens and clears the fault. The WCR, applicable up to a maximum voltage, is given in thousands of amperes and must be equal to or greater than the available fault current calculated at the location of the transfer switch in the electrical circuit. In some instances, a WCR may be further qualified by a maximum time duration.

Short-Circuit Withstand Closing Rating

Applied in electrical circuits where the overcurrent protection (OCP) device, a fuse or circuit breaker, is equipped with an instantaneous trip response capable of clearing a fault quickly without intentional delay.

Various transfer switch short-circuit WCR examples are as follows:

- When the overcurrent protection device is an external circuit breaker, of any type, a "time-based" short-circuit WCR can be applied. An important caveat is that the maximum clearing time of the circuit breaker's instantaneous trip response must be equal to or less than the maximum time duration of the marked short-circuit WCR
- When the overcurrent protection device is an external circuit breaker, of a specific type that appears on a manufacturer's list, a "specific circuit breaker" short-circuit WCR can be applied and offers a higher current rating compared to a time-based rating
- When the overcurrent protection device is a fuse, of a specific type or classification, a "fuse" short-circuit WCR can be applied and offers the highest current rating
- When the overcurrent protection (OCP) device is integral to the transfer switch assembly, an "integral OCP" short-circuit WCR can be applied. A typical use is a service entrance transfer switch that is fed directly from the utility

A transfer switch short-circuit withstand closing current rating (WCR) is frequently utilized in circuits where the overcurrent protective device is a UL 489 circuit breaker. A common example is a molded case circuit breaker installed in UL 891 switchboard, serving as a feeder to a transfer switch.

When applying a transfer switch short-circuit WCR it's important to note that UL 489 Listed circuit breakers include a magnetic, built-in instantaneous override that can't be defeated or disabled. For molded case breakers, the override is fixed at approximately 10–12 times the nominal trip or frame rating. For insulated case breakers, the override is fixed at approximately 13–18 times the nominal trip or frame rating.

For many years, fuses and thermal-magnetic circuit breakers (UL 489) have successfully been used to provide overcurrent protection for short-circuit rated transfer switches. Today, circuit breakers are more commonly configured with an electronic trip unit having a short-time element (LS, LSI, LSG, LSIG) allowing the short-time pick-up/delay to be adjusted.

When a circuit breaker's short-time element adjustments are set to maximum, the protection provided can be similar to that of a fuse or thermal-magnetic circuit breaker. However, adjusting the settings to something less than maximum can provide shorter clearing times and increased protection at lower level faults when compared to a fuse (reference **Figure 25.4-29**) or a thermal-magnetic circuit breaker. As a result, UL 489 breakers equipped with a short-time element have the ability to provide "better protection" compared to a fuse or a circuit breaker without a short-time element.

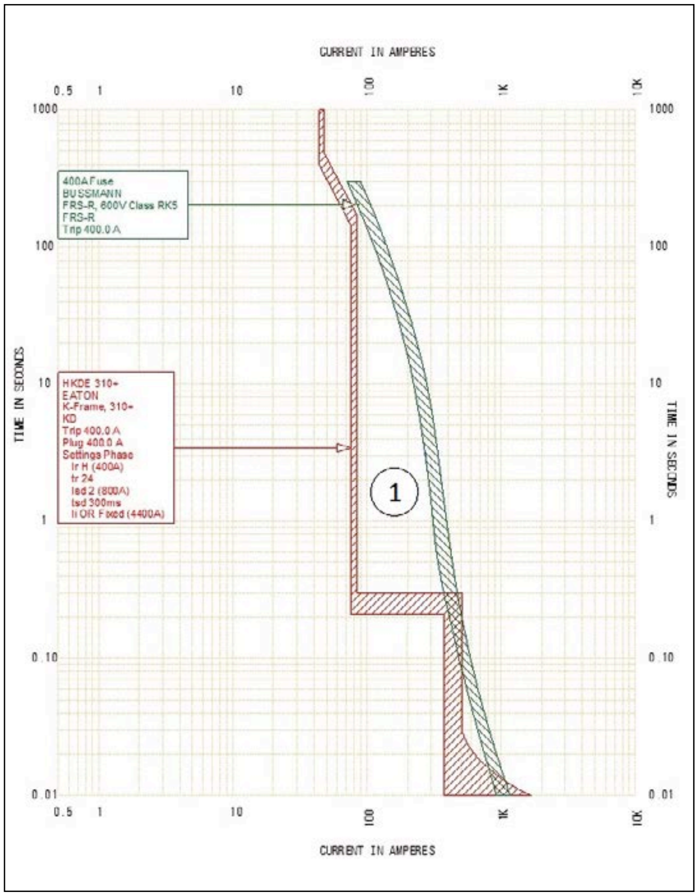


Figure 25.4-29. Time-current characteristic curve showing that a UL 489 circuit breaker with LSI trip (red curve) can clear the same level of fault current more quickly (region 1) than a fuse (green curve)

Short-Time Withstand Closing Rating

Typically applied in critical electrical circuits where the overcurrent protection device is a circuit breaker, equipped with an adjustable electronic trip capable of providing intentional delay, that allows for selective coordination within the distribution system. In many cases, the instantaneous response of the circuit breaker is disabled.

When a transfer switch carries an optional short-time WCR, it will always be qualified by a maximum time duration. Values typically range between 0.1 and 0.5 seconds correlating with a circuit breaker's short-time response. To ensure proper protection, the circuit breaker short-time settings must be coordinated with the maximum time duration of the marked short-time WCR.

Short-time WCRs are frequently utilized in circuits where the overcurrent protective device is a UL 1066 circuit breaker, such as UL 1558 switchgear.

Transfer switches with a short-time WCR and maximum time duration of 0.5 seconds offer the greatest flexibility to the specifying engineer when designing a selectively coordinated system.

Life Expectancy

Transfer switches are periodically exercised upon a loss of normal power or when conducting routine testing. Many designs include control logic with a plant exerciser capable of initiating a test automatically based on a programmed schedule (weekly, biweekly, monthly).

Assuming a transfer switch is exercised once a week through scheduled testing or a power outage condition, an approximation of life expectancy can be made based on UL 1008 endurance test criteria that is conducted with and without rated current.

Table 25.4-10. UL 1008 Endurance Testing

Transfer Switch Rating (Amperes)	Number of Operation Cycles		Total
	With Current	Without Current	
0–300	6000	—	6000
301–400	4000	—	4000
401–800	2000	1000	3000
801–1600	1500	1500	3000
1601 and above	1000	2000	3000

Table 25.4-11. Estimated Transfer Switch Life Expectancy

Transfer Switch Rating (Amperes)	52 Transfer/Retransfer Operations per Year		
	With Current (Years)	Without Current (Years)	Total (Years)
0–300	115	—	115
301–400	76	—	76
401–800	38	19	57
801–1600	28.5	28.5	57
1601 and above	19	38	57

NFPA 70 System Installation Types

Transfer switches are employed in a variety of special conditions that typically fall into one of four categories defined by the National Electrical Code (NFPA 70): emergency systems, legally required systems, critical operations power systems and optional standby systems.

Emergency Systems

Emergency systems supply, automatically distribute and control electricity used by systems essential to life safety during fires and other disasters. They include fire detectors, alarms, emergency lights, elevators, fire pumps, public safety communication systems and ventilation systems, and are commonly found in hotels, theaters, sports arenas and hospitals.

Emergency systems are regulated by a municipal, state, federal or other government agency. Transfer from the normal power source to the emergency source must complete within 10 seconds and meet the requirements of Article 700 of the National Electrical Code (NFPA 70). In addition, overcurrent devices must be selectively coordinated with all supply-side overcurrent protective devices.

Legally Required Systems

Legally required systems automatically supply power to a selected set of regulated loads not classified as emergency systems when normal power is unavailable. They serve critical heating, refrigeration, communication, ventilation, smoke removal, sewage disposal and lighting functions that could create hazards or hamper rescue or fire-fighting operations if denied electrical power.

As with emergency systems, legally required systems are regulated by municipal, state, federal and other governmental agencies. Transfer from the normal power source to the emergency source must complete within 60 seconds and meet the requirements of Article 701 of the National Electrical Code (NFPA 70). Overcurrent devices must be selectively coordinated with all supply-side overcurrent protective devices.

Special Occupancies

In addition to the special conditions previously discussed, transfer switches are utilized in the critical, life safety and equipment branches of an essential electrical system located within a healthcare facility and subject to Article 517 of the National Electrical Code (NFPA 70).

Other Standards

Other relevant industry standards for transfer switches are NFPA 99 (Health Care Facilities Code) and NFPA 110 (Emergency and Standby Power Systems).

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Printed in USA
Publication No. CA140004EN / Z23678
December 2019

Powering Business Worldwide