McGRAW-EDISON

Onan

Operators Manual

TS
Switch

Automatic Control

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SAFETY PRECAUTIONS

This manual includes the following symbols to indicate potentially dangerous conditions to the operator or equipment. Read the manual carefully and know when these conditions exist. Then take the necessary steps to protect personnel and the equipment.

WARNING **Onan uses this symbol throughout the text to warn of possible injury or death.**

CAUTION **This symbol is used to warn of possible equipment damage.**

The Series TS transfer switch has components with high voltages which present serious shock hazards. For this reason, read the following suggestions:

Keep the transfer switch cabinet(s) closed and locked. Make sure authorized personnel only have the cabinet keys.

Always move the operation selector switch on the generator set or automatic transfer switch to "STOP," disconnect the starting batteries of the generator set, and remove AC line power to the automatic transfer switch before performing maintenance or adjustments (unless specified otherwise in the instructions—then only using extreme caution due to danger of shock hazard).

Before removing the disconnect plug, if equipped, for deenergizing the control panel, be sure to place the operation selector switch on the generator set or automatic transfer to the "STOP" position. Neglect of this procedure results in set starting and energization of the transfer switch generator side.

Use rubber insulative mats placed on dry wood platforms over floors which are metal or concrete when working on any electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling any electrical equipment.

Jewelry is a good conductor of electricity and should be removed when working on the electrical equipment.

Do not work on this equipment when mentally or physically fatigued.

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GENERAL INFORMATION

INTRODUCTION

This Operator's Manual provides the information necessary for the successful operation of Onan's Series TS transfer switches. The manual includes installation, description, operation, and adjustment chapters. A troubleshooting guide and service information are also included. Operators should become familiar with this manual and especially the operation procedures that apply to their Series TS transfer switch.

TRANSFER SWITCH APPLICATION

Transfer switches are an essential part of a building's standby or emergency power system. The normal power source, commonly the utility line, is backed up by an emergency power source, often an electric generating set. A transfer switch supplies the electrical load with power from one of these two power sources. The load being served is connected to the common of the transfer switch as in Figure 1. Under normal conditions the load is supplied with power from the normal source as illustrated. Should the normal power source be interrupted, the load is transferred to the emergency power source. When normal power returns, the load is retransferred to the normal power source. The transfer and retransfer of the load are the two most basic functions of a transfer switch.

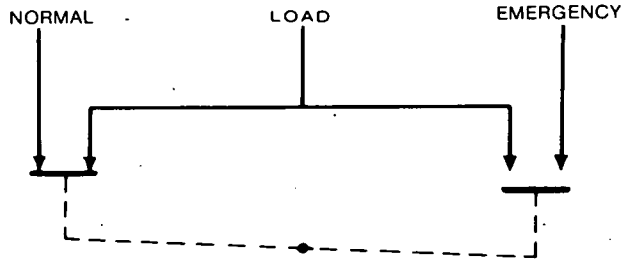


FIGURE 1. TRANSFER SWITCH

AUTOMATIC TRANSFER SWITCHES

Automatic transfer switches are capable of operation without operator involvement. During automatic operation, automatic transfer switches perform the following basic functions:

1. Senses the interruption of the normal power source.
2. Sends a start signal to the electric generating set.
3. Transfers the load to the emergency power source.
4. Senses the return of the normal power source.
5. Retransfers the load to the normal power source.
6. Sends a stop signal to the electric generating set.

Other functions available include the following:

1. Standby-to-standby operation (automatic transfer to a backup generating set if the standby generator fails).
2. Prime power operation with periodic set rotation.
3. Preferred source selection, manual or automatic, for multi-generator installations.
4. A wide variety of metering/indicator options.
5. Protective features to isolate and/or shutdown the affected power source when voltage and/or frequency are out-of-bounds. Load transfer to an alternate source of power occurs automatically when the source becomes available.

INSTALLATION

LOCATION

Locating the transfer switch in the existing electrical circuit varies with application and type of entrance switch. There must be a switch and fuses in the commercial power line before the transfer switch. See the typical installation in Figure 2.

MOUNTING

Choose a vibration-free mounting surface. See Figure 2. Avoid hot, moist, or dusty locations.

Wall Mount

1. Install two top mounting bolts in the wall for the top cabinet mounting keyholes.
2. With the shipping box standing so the cabinet is upright, carefully remove the top and sides of the box.
3. Raise cabinet and mount on the two mounting bolts in the wall (using cabinet keyholes).

WARNING **Be sure to have sufficient manpower for lifting cabinet to prevent serious personal injury.**

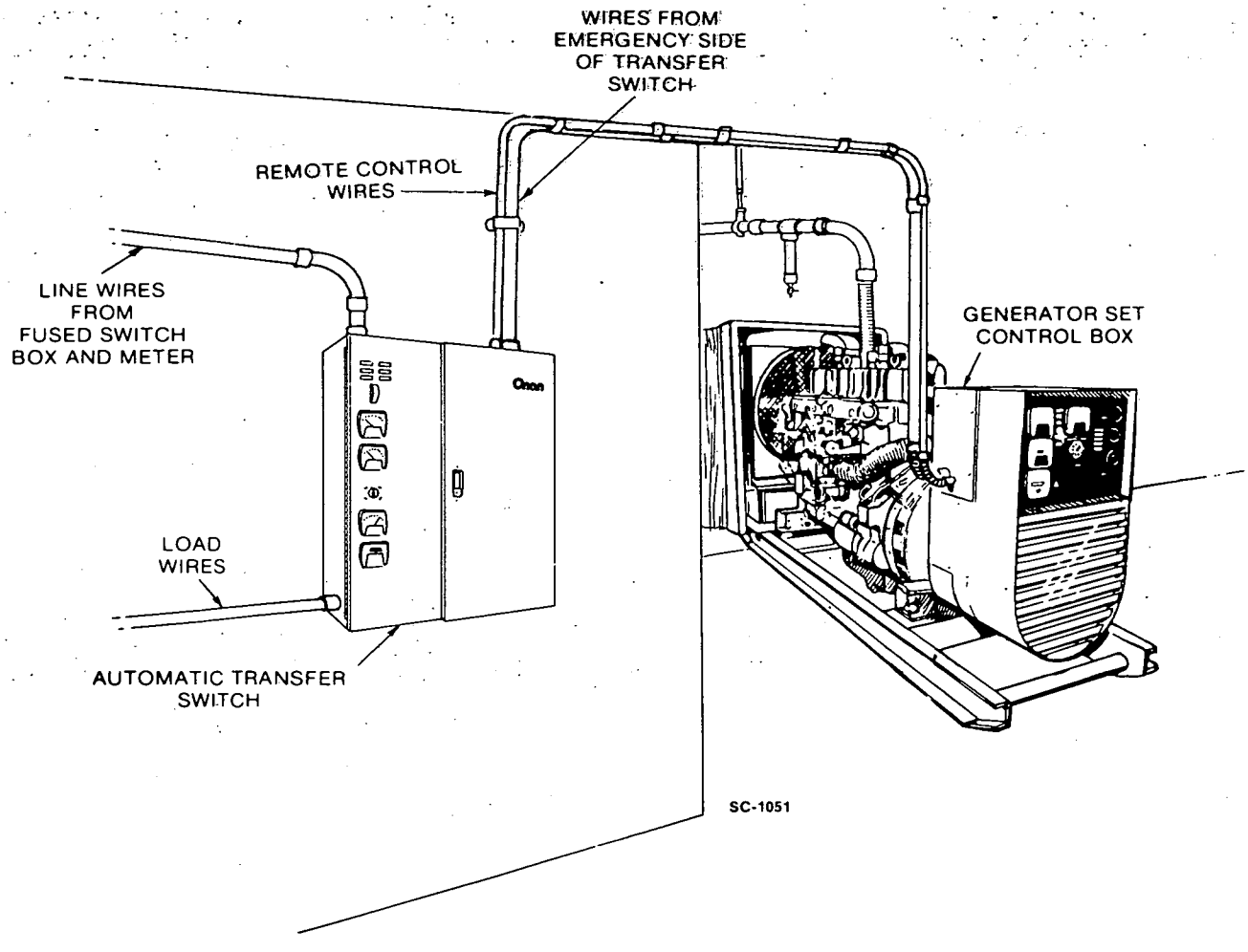


FIGURE 2. TYPICAL AUTOMATIC TRANSFER SWITCH INSTALLATION

4. Open cabinet, remove twist-lock disconnect plug (when used) and open control panel.
5. Remove screws from latch panel and remove panel.
6. Tighten two top mounting bolts.
7. Install two bottom mounting bolts and tighten.

Floor Mount

1. With the shipping box standing so the cabinet is upright, carefully remove the top and sides of the box.
2. Connect a hoist or similar lift to the two lifting eyebolts on the cabinet top.

WARNING **Do not attempt to lift manually because of the danger of serious personal injury.**

3. Carefully raise the cabinet and move it to its installation location. Mounting bolts are usually placed in concrete when floor is poured. Bolts should protrude about one inch (25 mm) from floor. Secure the cabinet to the floor.

WIRING

Onan suggests to the qualified personnel that the wiring be performed in this sequence:

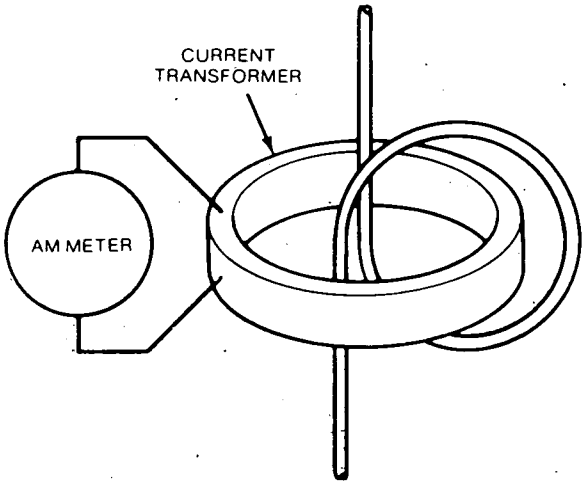
1. Before wiring is started, test the operation of the generator set from its own controls.
2. Put generator set's control switch at "stop" and remove the negative lead from the cranking battery.
3. Connect wires of sufficient size to carry rated current from the line, load, and generator set directly to the transfer switch terminals which are marked A, B, and C (A and B on single-phase switches). Table 1 gives the type and maximum wire size the transfer switch will accept.

On the 800 and 1000 ampere TS cabinets, the bottom cabinet panel can be removed for wire connections.

For TS automatic transfer switches with an AC ammeter, the generator load wires must pass through the transformer twice (two primary turns) for a 100-ampere TS, once (one primary turn) for any 150-through 1000-ampere TS. See Figure 3.

4. Neutral Bar (if used): Connect the neutral wires to the neutral bar (Figure 4). Table 1 lists the wire sizes and types the neutral bar accepts.
5. Area Protection or Remote Test Switch (if used):
   a. Remove terminal jumper located between terminals 4 and 5 of terminal strip TB1 (Figure 5).
   b. Connect the two leads from the normally closed circuit of area protection equipment or single-pole, single-throw remote test switch to terminals TB1-4 and TB1-5. Use number 16 wire up to 800 feet or 244 metres (maximum resistance of 4 ohms per line).

100 AMPERE TS (TWO TURNS)



150 THROUGH 1000 AMPERE TS (ONE TURN)

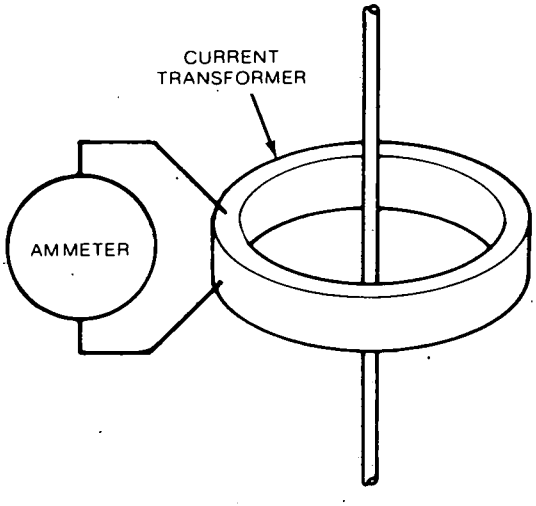


FIGURE 3. CURRENT TRANSFORMER WIRING

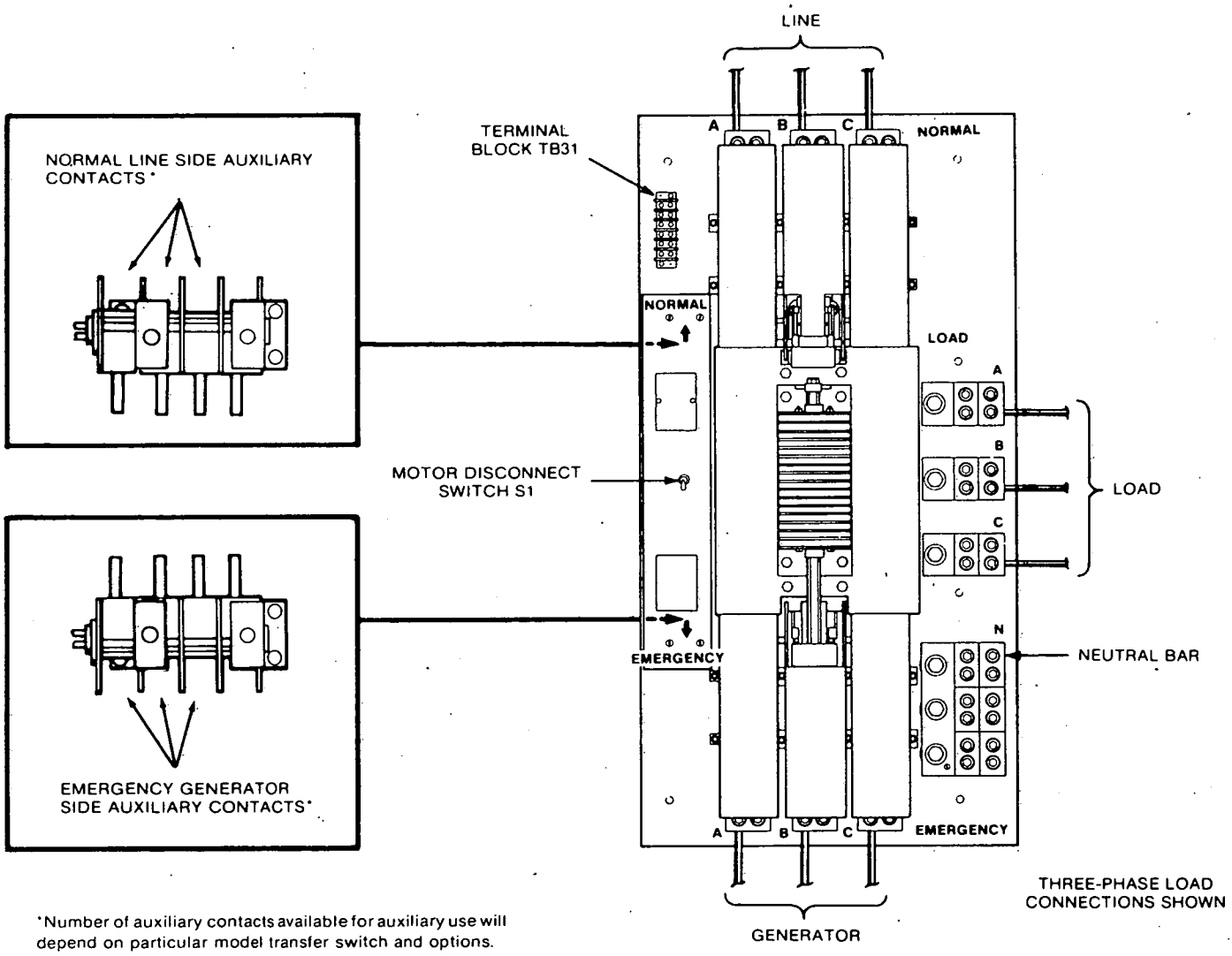


FIGURE 4. TRANSFER SWITCH WIRE CONNECTIONS

TABLE 1. SERIES TSA TRANSFER SWITCH WIRE CAPACITIES

TRANSFER SWITCH (AMPERES)	TERMINAL LUGS Number of Conductors and Size Per Pole	
	Switch Pole*	Neutral Bar*
100	ONE No. 6 - 250 MCM	ONE No. 6 - 250 MCM
150 & 225	ONE No. 6 - 350 MCM	ONE No. 6 - 350 MCM
280	ONE No. 4 - 500 MCM	ONE No. 4 - 500 MCM
400	ONE 350 MCM -1000 MCM	ONE 350 MCM - 1000 MCM
600	TWO No. 2 - 600 MCM	TWO No. 2 - 600 MCM
800 & 1000	FOUR No. 2 - 600 MCM	FOUR No. 2 - 600 MCM

* Connectors compatible with copper and aluminum.

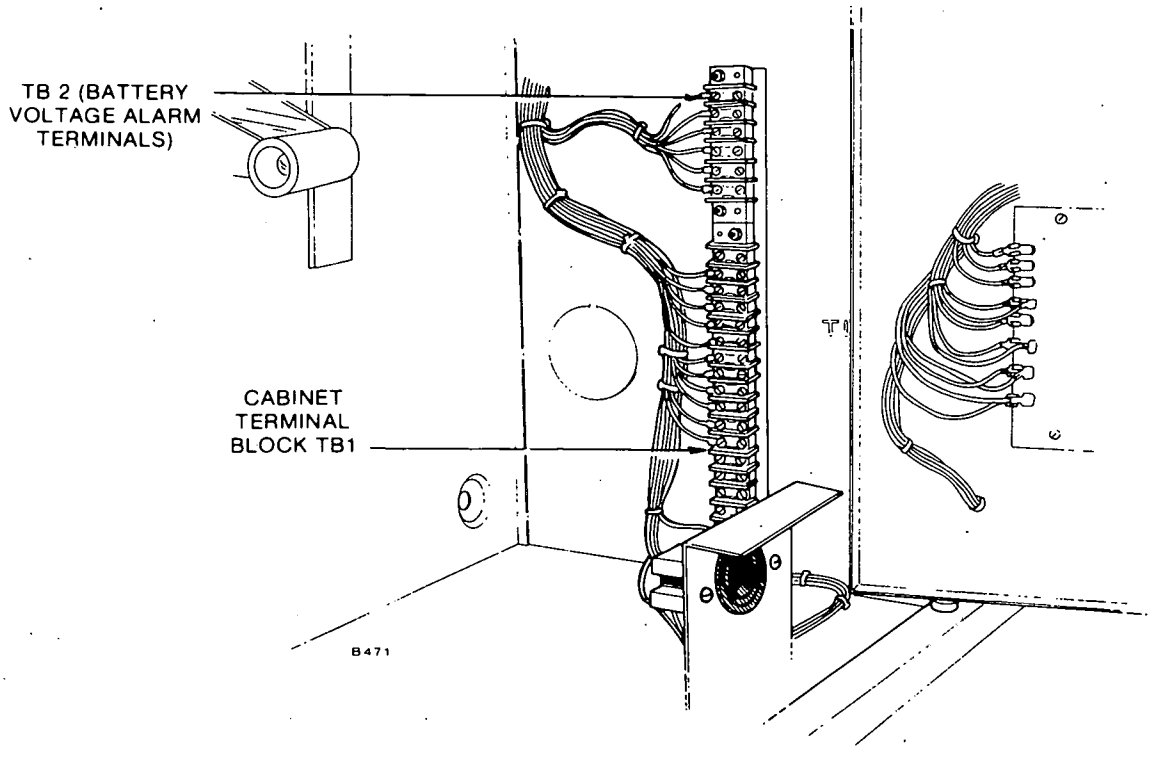


FIGURE 5. CABINET TERMINAL BLOCKS TB1 and TB2 (TYPICAL)

6. Transfer Inhibit Circuit: To inhibit transfer of the automatic transfer switch by another automatic transfer switch (for paralleling systems, priority selection systems, etc.), remove the jumper between TB1-6 and TB1-7. Connect the wire leads from the external equipment to these two terminals. See Figure 5.

7. Diesel Preheat Time Delay (if used): If this delay is used for operation of glow plugs on three-wire start generator sets, connect a wire from terminal TB1-H in the automatic transfer switch (three-wire starting only) to terminal "H" on the generator set. Use number 16 wire for distances up to 100 feet or 31 metres (maximum of 0.5 ohm per line). See Figure 5.

8. Onan Annunciator Connector for Overcrank (if used): Connect a wire from terminal TB1-53 in the automatic transfer switch (three-wire starting only) to terminal 53 on the Onan annunciator panel (Figure 5). Use number 16 wire for distances up to 800 feet or 244 metres (maximum of 4. ohms per line).

The three-wire starting automatic transfer switch supplying the start-stop signals must use the 2 to 3 wire converter 300-0926.

9. Auxiliary Contacts (if used): Auxiliary contacts are located on the normal and emergency sides of the transfer switch for external alarm or control circuitry. To gain access to the auxiliary contacts, remove the transfer switch cover which houses the motor disconnect switch S1 (cover held in place by four screws). See Figure 4. The contacts have ratings of 25 amperes at 125, 250, or 480 VAC; 1 horsepower at 125 VAC; 2 horsepower at 250 VAC or 480 VAC; and a pilot duty rating of 750 VA at 277 VAC maximum.

Run all low voltage DC control wires in a separate conduit from AC wires. Use a flexible conduit between generator set and automatic transfer switch to prevent transmission of vibration.

10. Connect the low voltage DC control wires from the automatic transfer switch to the generator set. Refer to the control interconnection diagram supplied with the equipment.

11. Three-Phase Only: Phase rotation must be checked and corrected before any load can be added to the generator set. Use the following procedures:
    a. Connect an Onan load-test panel, phase rotation meter or three-phase motor to the transfer

switch load terminals. Connect power to the line side (normal) of the transfer switch and observe rotation.

b. Connect the battery and start the generator set. Check the phase rotation of the generator lead connections on the transfer switch. If this phase rotation is different from that of normal power, reverse two of the generator leads on the transfer switch.

CHECKOUT PROCEDURES AFTER INSTALLATION

After the generator set and automatic transfer switch are properly installed, check the various automatic transfer switch functions. Follow the appropriate checkout procedure for the automatic transfer switch, depending on whether it has a solid-state or relay control accessory group.

Solid-State Control Accessory Groups

Check Switch Positions

1. Operation Selector Switch.
   For a two-wire starting automatic transfer switch, move the operation selector switch on the generator set to "STOP." For three-wire starting automatic transfer switches, move operation selector switch to "STOP."
2. Move the load selector switch to "WITHOUT LOAD."
3. Move test transfer switch to "NORMAL."

Connect AC Line

Connect the AC normal line service to the automatic transfer switch. The transfer switch should transfer the load to the line and should light the green "NORMAL" lamp (if equipped with lamps).

Connect the Battery

Charge ammeter should now indicate a charging current (if equipped with battery charger).

Test Overcrank Function

1. Two-wire starting.
   a. Disconnect the positive lead from the starter (insulate lead so it can not touch metal frame).
   b. Move the operation selector switch on the engine control to "RMT".
   c. Move the test transfer switch to "TEST." "Fault" or "overcrank" lamp on engine control should light at the end of crank period (usually factory set at 75, ±15 seconds).
   d. Move test transfer switch to "NORMAL."
   e. Move the generator set operation selector switch to "STOP."
   f. Reconnect positive lead to starter.
   g. Move generator set operation selector switch to "RMT."
2. Three-wire starting.
   a. Disconnect positive start lead from the start solenoid or starter.
   b. Move the operation selector switch to "NORMAL."
   c. Move test transfer switch to "TEST." "Overcrank" lamp on automatic transfer switch should light at end of crank period (usually factory set at 75, ±15 seconds).
   d. Move test transfer switch to "NORMAL."
   e. Move the operation selector switch to "STOP" and push the "PUSH TO RESET" button (overcrank lamp should go out).
   f. Reconnect positive lead to starter or start solenoid.
   g. Move the operation selector switch to "NORMAL."

Starting Test

1. Two-wire starting.
   a. Move selector switch on engine control to "RUN." Generator set should start and run.
   b. Move selector switch to "RMT." Generator set should stop.
2. Three-wire starting
   a. Move the operation selector switch on 2 to 3 wire converter to "HAND CRANK."
   b. Push start button on generator set control. Generator set should start and run.
   c. Move the operation selector switch from "HAND CRANK" to "STOP." Generator set should stop.
   d. Move the operation selector switch to "NORMAL." Generator set should not start.

Test Without Load

1. Make sure the load selector switch is poisitoned at "WITHOUT LOAD."
2. Move test transfer switch to "TEST." Generator set should start and run.
3. Move test transfer switch to "NORMAL." Generator set should stop.

Exercise Without Load (if equipped with exerciser)

1. Make sure the load selector switch is positioned at "WITHOUT LOAD."

2. Align day for exercise on spoked wheel with day pointer.
3. Turn the 24-hour dial clockwise until the pointer is between the two pins. The generator set should start and run, but not assume the load.
4. Turn the dial clockwise until the outside pin passes the pointer. Generator set should stop.
5. Reset the exerciser for the correct time and day.

Test Transfer With Load

1. Move the load selector switch to "WITH LOAD."
2. Move test transfer switch to "TEST." Generator set should start after time delay, (the load will be transferred to the generator), and light the red "emergency" lamp (if equipped with lamps).
3. Check operation of the AC meter(s) on the meter-lamp panel (if equipped with meters).
4. Move the test transfer switch to "NORMAL." Transfer switch should retransfer the load to line and stop engine after duration of time delays.

Battery Voltage Lamps (if equipped)

1. Remove the battery charger module 6. Low battery lamp "LO BAT VOLT" should light within 60 seconds.

   The transfer switch line terminals must be energized and the battery must be connected to the automatic transfer switch.

2. Replace battery charger module 6. Low battery voltage lamp should go out within 60 seconds.

Relay Control Accessory Groups

Check Switch Positions

1. Engine Operation Selector Switch (two-wire starting). Move the operation selector switch on the generator set engine control to "STOP."
2. Move the operation selector switch on the control accessory panel to "NORMAL."
3. Move test transfer switch to "NORMAL."

Connect AC Line

Connect the AC normal line to the automatic transfer switch. The transfer switch should transfer the load to the line and light the green "NORMAL" lamp (if equipped with lamps).

Connect the Battery

Connect the starting battery to the generator set observing correct polarity.

Test Overcrank Function

1. Two-wire starting
   a. Disconnect the positive lead from the starter (insulate lead so it cannot touch metal frame).
   b. Move the engine operation selector switch on the engine control to "RMT."
   c. Move the test transfer switch to "TEST." Fault or overcrank lamp on engine control should light at end of crank period (usually factory set at 75, ±15 seconds).
   d. Move test transfer switch to "NORMAL."
   e. Move the engine operation selector switch on engine control to "STOP."
   f. Reconnect the positive lead to starter.
   g. Move the engine operation selector switch on engine control to "RMT."
2. Three-wire starting
   a. Disconnect positive start lead from the starter or start solenoid (insulate lead so it cannot touch metal frame).
   b. Move operation selector switch on control accessory panel to "NORMAL."
   c. Move test transfer switch to "TEST." Overcrank lamp on automatic transfer switch should light at end of crank period (approximately 45 to 90 seconds).
   d. Move operation selector switch to "STOP."
   e. After about one minute, press the reset button on the cranking limiter. The overcrank lamp should go out.
   f. Reconnect the positive lead to the starter or start solenoid.
   g. Move operation selector switch on control accessory panel to "NORMAL."

Starting Test

1. Two-wire starting
   a. Move the engine operation selector switch on the engine control to "RUN." Generator set should start and run.
   b. Move the engine operation selector switch to "RMT." Generator set should stop.
2. Three-wire starting
   a. Move operation selector switch on control accessory panel to "OFF."
   b. Push start button on generator set control. Generator set should start and run.
   c. Push stop switch on generator set control. Generator set should stop.
   d. Move operation selector switch on control accessory panel to "NORMAL."

Test Without Load

1. Move operation selector switch to "TEST." Generator set should start and run.
2. Move operation selector switch back to "NORMAL." Generator set should stop.

Exercise Without Load (if equipped with exerciser)

1. Align day for exercise on spoked wheel with day pointer.
2. Turn the 24-hour dial clockwise until the pointer is between the two pins. The generator set should start and run, and the transfer switch should remain in the normal position.
3. Turn the dial clockwise until the outside pin passes the pointer. The generator set should stop.
4. Reset the exerciser for the correct time and day (see ADJUSTMENTS section.

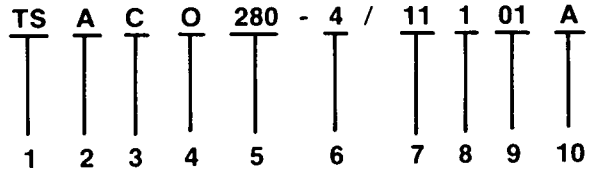
Test Transfer With Load

1. Move test transfer switch to "TEST." The generator set should start (after start time delay if used), run, take over the load, and light the red emergency lamp on the meter-lamp panel (if equipped with normal and emergency lamps).
2. Check operation of AC meter(s) on meter-lamp panel (if equipped with meters).
3. Move the test transfer switch to "NORMAL." The transfer switch should retransfer the load to the normal line and stop the generator set (after duration of time delays if used).

DESCRIPTION

MODEL NUMBER

Onan uses a coded model number to describe the complete transfer switch. When corresponding with Onan concerning your transfer switch, be sure to include its model and serial number. It is also advisable to keep a record of modifications to the transfer switch. A breakdown of a typical transfer switch model number follows:



1. Identifies this model as a TS Series transfer switch.
2. The third letter describes the cabinet configuration (e.g. standby, standby-to-standby, prime power).
3. This letter identifies the starting circuit for automatic transfer switches, or identifies the transfer switch as nonautomatic.
4. This letter identifies the transfer switch mechanism (e.g. O for OT, W for Westinghouse).
5. The current carrying capacity of the transfer switch in continuous amperes. Series TS transfer switches range in size from 30 to 2000 amperes.
6. The number, or number and letter after the dash (-) is a voltage code. For example, a 4 identifies this switch as a 120/208 volt, three phase, four wire switch. This code also contains information on 60 or 50 hertz operation.
7. This number is the controls group designator. For all TS switches, the controls are installed in the box interior and on a swinging panel.
8. This number designates the meter combination.
9. This number designates the lamp combination.
10. This letter is the spec revision designator.

TRANSFER SWITCH

The transfer switch does the work of opening and closing the contacts that transfer the load between normal and emergency power. The transfer switch is a pair of multipole, single throw, electromechanical switches, that are mechanically interlocked to prevent simultaneous closing to both power sources.

The contact assemblies actually make and break the current flow. When closed to either the normal or emergency power source, these contacts are mechanically or electrically held. A mechanical interlock prevents the contact assemblies from closing to both power sources at the same time.

Type "O" TS Switches

The linear actuator moves the contact assemblies from the normal power source to the emergency power source and back again as required. The linear actuator is a linear induction motor that acts upon an actuator rod, which moves the contact assemblies. Operation of the linear actuator is electrical and is initiated automatically with automatic transfer switches. Manual operation of the transfer switch is possible by applying direct manpower to the transfer switch handles. Refer to manual operation in the OPERATION chapter.

MOTOR DISCONNECT SWITCH. The motor disconnect switch opens and closes the power lead to the linear actuator on type "O" TS switches. The switch has two positions; UP for automatic operation and DOWN for manual operation. The motor disconnect switch is located o the auxiliary contact cover as in Figure 4.

Switching Poles

Series TS transfer switches are multipole switches. A multipole switch is one that opens and closes more than one current path, or pole, with a common switching means. Series TS transfer switches are available with the following switching pole combinations:

1. 2 or 3 pole, with a neutral block.
2. 3 pole, single phase, including overlapping-switched neutral.
3. 4 pole, three phase, including overlapping switched neutral.

Switched Neutral

Whenever the neutral, or grounded conductor, is switched in a Series TS transfer switch, it is an overlapping switched neutral. This means that the neutral pole has a make before break switching action.

Programmed Transition

Programmed transition is an optional feature of Onan Series TS transfer switches. Programmed transition is the capability of the transfer switch to assume a mid-transition position, for an adjustable interval of time, when the load is neither connected to the normal power source nor to the emergency power source. This feature allows residual voltages in a motor load to decay to an acceptable level before transition is completed. The length of time that the transfer switch is in the midposition can be adjusted from 0.5 to 5 seconds. The proper adjustment is a function of the motor and its connected load. See the ADJUSTMENTS section.

Auxiliary Contacts

Auxiliary contacts are provided on both the normal and emergency side of the transfer switch. They are located as in Figure 4, and are actuated by the operation of the transfer switch during transfer and retransfer. The auxiliary contact current ratings are: 25 amps at 125, 250, or 480 VAC; 1 horsepower at 125 VAC; 2 horsepower at 250 or 480 VAC; and a pilot duty rating of 750 VA at 277 VAC maximum.

METER LAMP PANEL

Located on the left side of the transfer switch, the meter lamp panel supports a combination of meters and indicating lamps that can be read without opening the cabinet door(s). The specific combination of meters and indicating lamps that are included will vary with the application. A typical meter lamp panel is illustrated in Figure 9. A brief description of all possible individual meters and indicating lamps follow.

STARTING CIRCUITS

One of the basic supervisory functions of an automatic transfer switch is to send start and stop signals to the electric generating set. The standing circuit function requires the automatic transfer switch to be compatible with the starting circuit of the electric generating set. The starting circuits available in Series TS automatic transfer switches are: two-wire twelve volts, two-wire twenty-four volts, and three-wire twelve volts.

Two-Wire Starting Circuits

Although the logic is much more involved, the operation of a two-wire starting circuit can be thought of as a simple single pole, single throw switch. A closed switch signals the electric generating set to start and run. An open switch signals the electric generating set to stop. The starting battery of the electric generating set provides the operating voltage. Accordingly, the TS Series of automatic transfer switches includes twelve and twenty-four volt models with two-wire starting circuits.

Three-Wire Starting Circuits

The end result of the three-wire starting circuit logic is similiar to a single-pole double throw switch. A common is closed to one side to send a start signal. The common is closed to the opposite side to send a stop signal. An automatic transfer switch that is a three-wire starting model will have additional supervisory components.

CONTROL ACCESSORY PANEL

The control accessory panel, in Series TS automatic transfer switches, executes the supervisory functions of sensing, timing, logic, and others. The specific functions that are included in the control accessory panel depend on the requirements of the application. Accordingly, several control accessory groups are possible, each with different combinations of functions and features. A control accessory panel consists of solid-state circuitry, relays, and other control devices.

The control accessory panels in Series TS automatic transfer switches can be divided in two classes: solid-state control and relay control. Both classes, solid-state and relay, can be further subdivided by starting circuits, either two-wire or three-wire. The result is solid-state control for either two-wire or three-wire starting circuits and relay control for either two-wire or three-wire starting circuits. See Figure 7.

(Illustration not available at time of manual publication.)

FIGURE 6. TYPICAL MODEL AUTOMATIC TRANSFER SWITCH

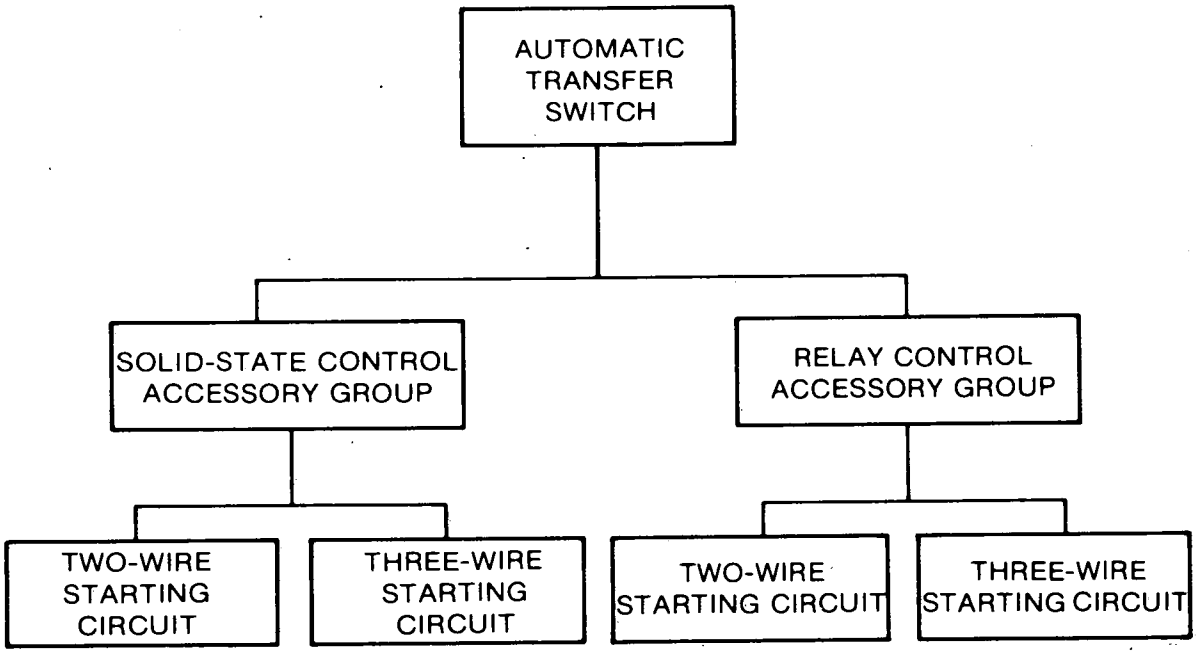


FIGURE 7. CONTROL ACCESSORY GROUPS

Solid-State, Two-Wire Controls

The majority of supervisory functions in the solid-state controls are executed by solid-state plug-in modules. The solid-state controls may include, as the application requires, voltage sensing modules, timing modules, a control voltage module, and starting battery modules. The remaining supervisory functions are provided by control switches, and an exerciser clock. All control components are mounted on the control accessory panel. Figure 6 illustrates a typical solid-state control accessory panel.

AC VOLTAGE SENSORS

Solid-state voltage sensor modules, illustrated in Figure 8, monitor the voltage of both the normal line and the generator output. The normal line may be monitored for both undervoltage and overvoltage conditions. The generator output is monitored for undervoltage conditions only.

Voltage sensor modules have two adjustments. One adjustment sets the pickup voltage. The pickup voltage scale is graduated from 90 to 140 volts, based on a nominal 120 volt system. For other voltage systems, the scale must be corrected using the multiplying factor given in Table 2 (also given on the panel).

The second adjustment is the dropout differential. The dropout differential is a percentage, adjustable from 5 to 20%, of the pickup voltage. The dropout differential is subtracted from the pickup voltage to arrive at the dropout voltage. The dropout voltage is always lower than the pickup voltage by the dropout differential.

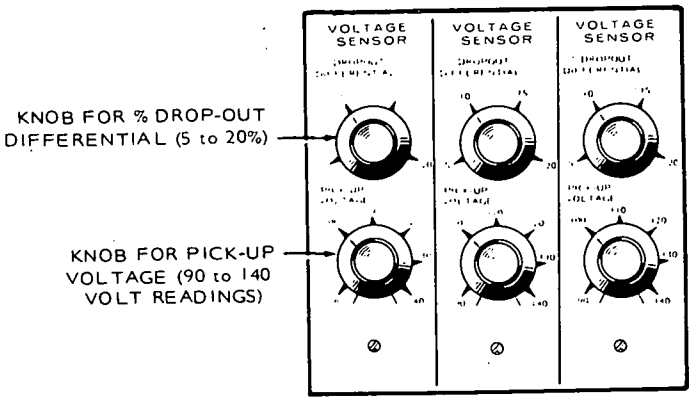


FIGURE 8. VOLTAGE SENSORS

TABLE 2. VOLTAGE FACTORS

VOLTAGE	MULTIPLYING FACTOR
120	1.0
208	1.73
240	2.0
480	4.0
600	5.0

Line Voltage Sensors: The normal line can be sensed for undervoltage and overvoltage using voltage sensor modules. When a line undervoltage or overvoltage condition exists, as defined by the pickup voltage setting and dropout differential, the voltage sensor module initiates the start signal sequence. When line voltage returns to normal, the voltage sensor module initiates the stop signal sequence. Table 3 gives the range of adjustment and function of voltage sensors in both undervoltage and overvoltage applications.

TABLE 3. LINE VOLTAGE SENSING

UNDERVOLTAGE SENSING	
Generator Set Starts (drop-out voltage)	**Generator Set Stops (pick-up voltage)**
5 to 20% below pick-up voltage setting	75 to 100% of normal voltage
OVERVOLTAGE SENSING	
Generator Set Starts (pick-up voltage)	**Generator Set Stops (drop-out voltage)**
101 to 116% of normal voltage	5 to 20% below pick-up voltage

One voltage sensor module is required for each phase of the line being sensed. For example, a three phase line being sensed for undervoltage and overvoltage between all phases would require six voltage sensor modules in the control accessory group.

Generator Voltage Sensor: The generator output voltage is sensed for an undervoltage condition only, across two lines, single phase. One voltage sensor module is used. The pickup voltage setting is the generator output voltage at which transfer of the load to the generator set is allowed to occur. If the generator output voltage falls below the dropout voltage and line voltage is present, the voltage sensor initiates retransfer of the load to the normal power source.

TIMING MODULES

The supervisory functions of the control may include several adjustable time delays before or after an event. For example, to prevent the generator set from starting when power interruptions of very short duration occur, a delay can be timed that disregards the short interruption. The solid-state modules that provide timing functions include: the Transfer-Retransfer module, and the Start-Stop module. Table 4 gives the duration of the time delays and the factory settings.

Transfer-Retransfer Module: The solid-state transfer-retransfer module provides adjustable time delays before the events of transfer and retransfer are allowed to occur. The transfer time delay begins at the moment that the generator output voltage reaches the pickup voltage setting of the generator voltage sensor. At the end of the transfer delay, the transfer switch is allowed to operate, transferring the load to the emergency power source. The purpose of the very brief transfer delay is to allow the electric generating set to stabilize before the load is applied.

The retransfer time delay begins at the moment that normal line voltage returns. At the end of the retransfer time delay, the transfer switch is allowed to retransfer the load to the normal power source. The

TABLE 4. ADJUSTABLE TIME DELAYS

TIME DELAY	TIME RANGE	FACTORY SETTING (if any)
Starting	0.1 to 15 sec. 0.5 to 615 sec.*	2.5 sec. —
Transfer, Retransfer	0.1 to 15 sec. 0.5 to 30 min.	2.5 sec. 10 min.
Stopping	0.1 to 10 min.	5.0 min.
Preheat	5 to 90 sec.	60 sec.

* Programmable start-stop timer.

purpose of the longer retransfer time delay is to allow the normal power source to stabilize before retransfer.

Start-Stop Module: The solid-state start-stop module provides adjustable time delays before the electric generating set is allowed to start or stop. The start time delay begins at the moment of normal power interruption. If the duration of the power interruption exceeds the start time delay, the start signal is sent to the electric generating set. The purpose of the start time delay is to prevent the generator set from starting when power interruptions of very short duration occur. The stop time delay begins timing when the load is retransferred to the normal power source. At the end of the stop time delay, the stop signal is sent to the generator set. The purpose of this time delay is to allow the generator set to cool down while running at no load.

CONTROL VOLTAGE MODULE

A solid-state control voltage module supplies components of the control accessory group with their voltage requirements. There are two possible control voltage modules. Both use the engine starting battery as a source. If the battery is twelve volts, the module will be twelve volts. If the starting battery is twenty-four volts, the module will convert twenty-four to twelve volts.

BATTERY CHARGER MODULE (when used)

The solid-state battery charger module is voltage regulated to float charge the battery continuously without damage to the battery. The maximum output of the charger is two amperes. As the battery approaches full charge, the charging current tapers to zero amperes or to the steady state load on the battery.

The battery charger operates from the normal power source only. It will not charge during emergency operation. The battery charging module is protected by a fuse mounted on the control accessory panel. The battery charger module can be used with either lead acid or nickel cadmium batteries.

BATTERY VOLTAGE SENSOR MODULE (when used)

The solid-state battery voltage sensor, either 12 or 24 volt, monitors the battery charging system. If the battery charger is exceeding a safe float voltage, the sensor lights the high battery voltage indicating lamp. If the battery charger allows the battery voltage to drop below a safe limit, the sensor lights the low battery voltage indicating lamp.

CONTROL SWITCHES

The control switches included in the control accessory group allow the operator to select the different operations as they are required. Solid-state control accessory groups always include the Test Transfer Switch and the With or Without Load Selector Switch. Some solid-state control accessory groups may also include the Retransfer Selector Switch and the Push to Retransfer Switch.

Test Transfer Switch: The test transfer switch is used to simulate a power interruption for test purposes. The test transfer switch has two positions; normal and test. In the NORMAL position, the transfer switch is set for automatic operation. The TEST position sends a start signal to the electric generating set.

With or Without Load Selector Switch: This two position switch determines whether or not the automatic transfer switch will connect the load to the electric generating set during test and exercise periods. The two positions are WITH LOAD and WITHOUT LOAD. The position of the load selector switch does not affect normal operation.

Retransfer Selector Switch (when used): The retransfer selector switch sets the operation of the retransfer function only. The switch has two positions. In the automatic position, AUTO, the transfer switch will retransfer the load to the normal source without operator involvement. In the MANUAL position, the transfer switch will not retransfer until retransfer is initiated manually by the operator.

Push to Retransfer Switch (when used): This momentary switch provides the means to manually initiate retransfer of the load to the normal power source when the retransfer selector switch is in the manual position.

EXERCISER CLOCK

The exerciser clock initiates the starting of the electric generating set at set times. The electric generating set will run, or exercise, for preset intervals. The exerciser clock is a fourteen day, twenty-four hour clock. A large dial divides the twenty-four hour day into intervals of fifteen minutes each. A smaller spoked dial divides two weeks into one day segments. Exercise periods are set by the placement of trip pins in the dial faces. See Adjustments. The normal source powers the exerciser clock. Reset the clock after interruptions of the normal power source.

CONTROL ACCESSORY PANEL

The control accessory panel is the swinging panel directly behind the locking cabinet door. The control devices are mounted on the panel. See Figure 9.

The solid-state control accessory panel has three printed circuit board racks with positions 1 through 18 for plug-in modules. All the following modules used in automatic transfer switches are listed after the number position they occupy in the control accessory panel. Note that some positions list more than one module. If the automatic transfer switch is single-

phase, for example, only one line undervoltage sensor is used and it is located in position 1. Positions 2 and 3 will have blank modules.

Position	Module
1	Line undervoltage sensor (1 phase or 3 phase)
2	Line undervoltage sensor (3 phase), bypass, or blank
3	Line undervoltage sensor (3 phase), bypass, or blank
4	Generator undervoltage sensor (1 phase)
5	12 volt module, or 24 to 12 volt converter
6	12 or 24 volt battery charger or blank
7	Start-Stop or bypass
8	Transfer-Retransfer or bypass
9	2 or 3 wire converter or blank
10	12 or 24 volt battery voltage sensor or blank
11	Blank
12	Blank
13	Line overvoltage sensor (1 phase or 3 phase) or blank
14	Line overvoltage sensor (3 phase) or blank
15	Line overvoltage sensor (3 phase) or blank
16	Preheat or blank
17	Blank
18	Blank

The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The operation selector switch must be moved to STOP, located on the two to three-wire converter module with three-wire starting, or, on the engine control with two-wire starting; and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

Solid-State, Three-Wire Controls (when used)

A solid-state, three-wire control is built on the foundation of a solid-state, two-wire control. As a result, all of the features in the preceding description on two-wire controls can be found in three-wire controls. In addition, solid-state, three-wire controls will always include a two to three wire converter module. If the application requires, a preheat time delay module may also be included.

TWO TO THREE-WIRE CONVERTER MODULE (when used)

This solid-state module is used to convert a two-wire starting control into a three-wire starting control. The major features of the two to three-wire converter are: an operation selector switch, the cranking limiter, and the cranking limiter reset. See Figure 9.

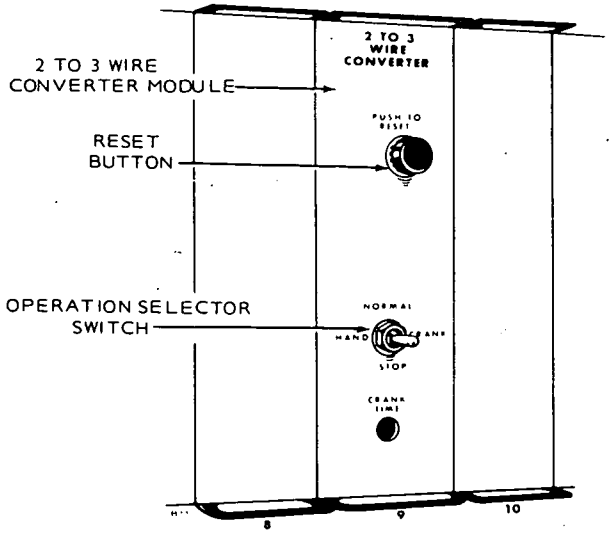


FIGURE 9. 2 TO 3 WIRE CONVERTER MODULE

Operation Selector Switch: The operation selector switch controls the operation of the three-wire starting electric generating set. The operation selector switch has three positions: STOP, HAND CRANK, and NORMAL.

STOP: Shuts down the generator set and prevents it from starting. Use this position when servicing the generator set.

HAND CRANK: Prevents the automatic transfer switch from starting the generator set but allows starting and stopping at the generator set. Use this position for generator set maintenance.

NORMAL: Allows the generator set to start and assume the load if a power interruption occurs. This is the normal operating position.

Cranking Limiter: The cranking limiter is a protective circuit that limits the time the engine starter motor is engaged. If the electric generating set doesn't start within the adjustable time limit, the cranking limiter opens the starting circuit disengaging the engine starter motor. The OVERCRANK indicating lamp will be lit.

Cranking Limiter Reset: When the cranking limiter opens the starting circuit, the cranking limiter reset will restore the cranking limiter, after the engine starting problem has been resolved. See overcrank in the Operation Chapter.

PREHEAT TIME DELAY MODULE (when used)
The solid-state preheat time delay module may be used with three-wire starting diesel engines to provide a preheat function. The preheat module prevents the engine starter motor from engaging until the adjustable preheat time delay is complete.

Relay Two-Wire Controls (when used)

Relay controls use adjustable time delay relays to provide the timing functions required by the application. Relay controls may include, as the application requires: solid-state voltage sensing modules, time delay relays, control switches, a solid-state battery charger, and an exerciser clock. The components of the control are mounted on the hinged control accessory panel as illustrated in Figure 10.

AC VOLTAGE SENSORS

Relay controls use the same solid-state voltage sensor modules for line undervoltage and line overvoltage sensing as the solid-state controls. See the preceding description of AC line voltage sensors.

TIME DELAY RELAYS

Adjustable time delay relays provide the timing functions in relay controls. The time delays that the application may require are: a time delay before starting, a time delay before stopping, a time delay before transfer, and a time delay before retransfer. Table 5 gives the time ranges of the adjustable time delay relays.

TABLE 5. ADJUSTABLE TIME DELAYS

TIME DELAY	TIME RANGE	SUGGESTED SETTING
Starting	1 to 300 sec.	1 to 3 sec.
Transfer	1 to 300 sec.	5 to 10 sec.
Retransfer	2 to 60 min.	10 min.
Stopping	2 to 60 min.	5 min.
Preheat	1 to 300 sec.	60 sec.

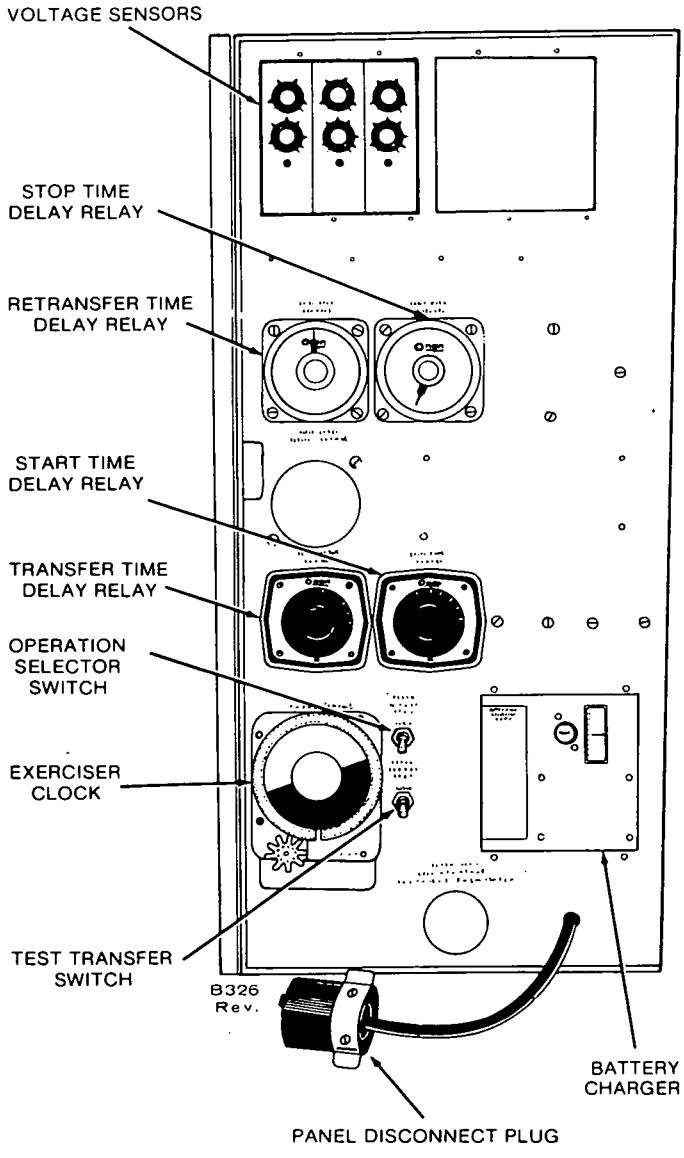


FIGURE 10. RELAY, TWO-WIRE, CONTROL ACCESSORY PANEL

Time Delay Before Starting: This time delay relay is used to prevent the electric generating set from starting when short duration interruptions of the normal power source occur. If the duration of the normal power interruption exceeds the setting of this time delay relay, the start signal will be sent to the electric generating set.

Time Delay Before Stopping: This time delay relay is used to allow the electric generating set to run at no load after retransfer. This running period at no load helps cool the electric generating set. The setting of this time delay relay is the length of time after retransfer that the electric generating set will run before stopping.

Time Delay Before Transfer: When the electric generating set reaches pickup voltage, the transfer time delay relay will retard the operation of the transfer switch for the length of time delay setting. This usually brief delay allows the electric generating set to stabilize before load is applied.

Time Delay Before Retransfer: When the normal power source returns after an interruption, it will sometimes fluctuate before it becomes stable. The retransfer time delay relay will keep the transfer switch from retransferring the load to the restored normal source for the duration of its setting.

BATTERY CHARGER (when used)
The solid-state battery charger has a maximum two-ampere output and is voltage regulated to "float charge" the battery continuously without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery (keeping starting batteries fully charged). The battery charger can be used for either lead acid or nickel cadmium batteries.

The battery charger circuit is protected by a fuse. If the battery charger fails to charge, be sure to check the fuse.

CONTROL SWITCHES
The control switches on the control accessory panel allow the operator to select operation functions. The control switches with two-wire starting, relay controls are the operation selector switch and the test transfer switch. See the Operation chapter.

Operation Selector Switch: The operation selector switch is a three position switch: NORMAL, STOP, and TEST.

NORMAL: In this position, the automatic transfer switch will respond to the interruption and return of the normal power source, automatically.

STOP: In this position, the automatic transfer switch will not respond to a normal power interruption.

TEST: This position is used to start the electric generating set without applying the load.

Test Transfer Switch: This two position switch is used to test the electric generating set with the load applied. The two positions are NORMAL and TEST.

EXERCISER CLOCK
The exerciser clock initiates the starting of the electric generating set at set times. The electric generating set will run, or exercise, for preset intervals. The exerciser clock is a fourteen day, twenty-four hour clock. A large dial divides the twenty-four hour day into intervals of fifteen minutes each. A smaller spoked dial divides two weeks into one day segments. Exercise periods are set by the placement of trip pins in the dial faces. See Adjustments.

CONTROL ACCESSORY PANEL
The control accessory panel for a typical two-wire starting, relay control is illustrated in Figure 10. The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The engine operation selector switch (on the engine control) must be moved to STOP, and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the engine operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

Relay, Three-Wire Control (when used)

The three-wire starting relay control is similar to the two-wire control (see the preceding description) except for the operation selector switch and the addition of a cranking limiter. If the application requires, a preheat time delay relay may also be included. See Figure 11.

Operation Selector Switch: The operation selector switch in a three-wire relay control accessory group has four positions: NORMAL, TEST, STOP, and OFF. See the Operation chapter.

NORMAL: In this position, the automatic transfer switch is set for automatic operation.

TEST: This position is used to start the electric generating set without applying the load.

STOP: In this position, the automatic transfer switch will not operate nor will the electric generating set start. The engine starter motor can be engaged using the engine control, but the engine will not start.

OFF: In this position, the electric generating set can be started at the engine control but the automatic transfer switch will not operate.

Cranking Limiter: The cranking limiter in three-wire, relay controls is located in the upper right-hand corner of the control accessory panel as illustrated in Figure 11. The cranking limiter is an electrically operated thermal relay that protects the engine cranking circuit. The relay is energized when the start signal is sent and remains energized until the electric generating set starts. If the engine does not start in forty-five to ninety seconds, the heating element in the relay opens the starting circuit. It can be reset by allowing about one minute to cool, and then pushing the reset.

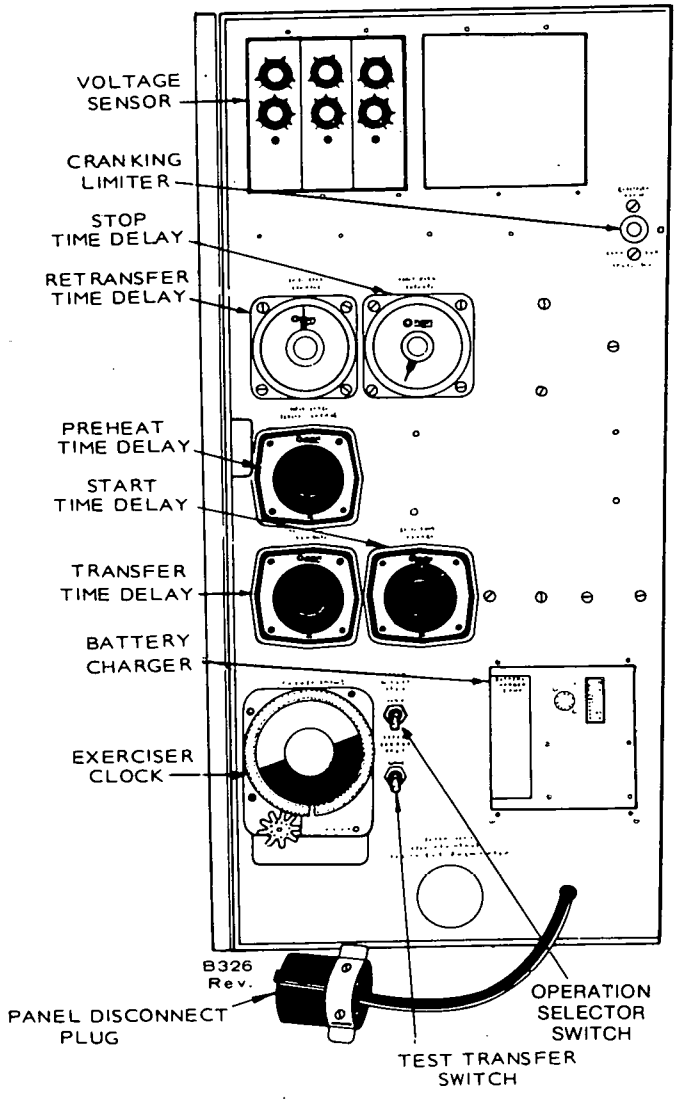


FIGURE 11. RELAY, THREE-WIRE, CONTROL ACCESSORY PANEL

TIME DELAY FOR PREHEAT

If the application requires, a time delay relay may be included that delays cranking of the deisel engine for preheating.

CONTROL ACCESSORY PANEL

A typical control accessory panel for a three-wire, relay control is illustrated in Figure 11. The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The operation selector switch must be moved to STOP, located on the control accessory panel, and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

OPERATION

AUTOMATIC OPERATION

A Series TS automatic transfer switch is set for automatic operation by placing the following control switches in the positions given. The electric generating set must also be set for automatic operation.

SOLID-STATE, TWO-WIRE, CONTROL

Test Transfer Switch - NORMAL
Retransfer Selector Switch - AUTO
Motor Disconnect Switch - UP

SOLID-STATE, THREE-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Retransfer Selector Switch - AUTO
Motor Disconnect Switch - UP

RELAY, TWO-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Motor Disconnect Switch - UP

RELAY, THREE-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Motor Disconnect Switch - UP

RETRANSFER, MANUALLY INITIATED

The retransfer of the load, from the emergency to the normal power source, can be delayed until initiated manually by the operator. This manually initiated retransfer operation is possible only with solid-state controls that include the Retransfer Selector Switch. This procedure allows the operator to plan for the momentary interruption of service to the load on retransfer. The procedure is:

1. Place the Retransfer Selector Switch in the MANUAL position. The automatic transfer switch will not retransfer automatically when the normal power source returns.
2. Manually initiate retransfer by pushing the Push to Retransfer Switch.

If the emergency power source should fail while the Retransfer Selector Switch is in the MANUAL position, a bypass circuit will automatically retransfer the load to the normal power source, if available.

TEST OPERATION

SOLID-STATE CONTROLS

1. Place the With or Without Load Selector Switch in the desired position.
2. Move the Test Transfer Switch to TEST.
3. At end of test period, return the Test Transfer Switch to NORMAL.

During test operation, switching from WITHOUT LOAD to WITH LOAD will cause the electric generating set to stop, go through the start time delay, start, run, and go through the transfer time delay before assuming the load.

RELAY CONTROLS

Test With Load:

1. Move the Test Transfer Switch to TEST.
2. Return the Test Transfer Switch to NORMAL at the end of test period.

Test Without Load:

1. Move the Operation Selector Switch to TEST.
2. Return the Operation Selector Switch to NORMAL at the end of the test period.

EXERCISE

Onan recommends running the electric generating set for a minimum of thirty minutes, with at least fifty percent load if possible, once each week. Automatic transfer switches with an exerciser clock can be set to start and run the electric generating set at selected times automatically, see *Adjustments.* If the normal power source should be interrupted while the electric generating set is exercising without load, the automatic transfer switch will transfer the load.

SOLID-STATE CONTROLS

1. Set the exerciser clock to start the electric generating set at the desired time.
2. Place the With or Without Load Selector Switch in the desired position.

RELAY CONTROLS

1. Set the exerciser clock to start the electric generating set at the desired time. The electric generating set will run without load.

OVERCRANK

An overcrank condition exists when the electric generating set has not started within the time limit set by the cranking limiter. To restore the automatic transfer switch starting circuit:

1. Correct the engine starting problem.
2. Push the cranking limiter reset.

MANUAL OPERATION

An operator can manually transfer or retransfer a Series TS transfer switch using direct manpower. The transfer switch is equipped with manual operator handles for this purpose. Operators must follow the procedure that matches the description of their transfer switch.

WARNING **Use extreme care when operating the transfer switch manually. High voltage on transfer switch terminals presents a serious personal injury hazard.**

When the motor disconnect switch is moved from manual to automatic operation, an automatic transfer switch will return to the active power source in this order of preference: first, the normal power source; second, the emergency power source. The operator must put the transfer switch in its preferred position, manually, before moving the motor disconnect switch to automatic operation position.

WARNING **The rapid movement of the manual operator handles may cause personal injury. An automatic transfer switch must be placed in its preferred position, manually, before moving the motor disconnect switch to automatic operation.**

TS TYPE "O"
Single Actuator, 225-280 Ampere, Transfer Switch Without Programmed Transition

1. Move the motor disconnect switch to the DOWN, manual operation position.
2. Pull either manual operator handle in the desired direction; down for emergency, up for normal.
3. Automatic Transfer Switch - Return the transfer switch to its preferred position.
4. Return the motor disconnect switch to the UP, automatic operation position.

TS TYPE "O"
Single Actuator, 100-1000 Ampere, Transfer Switch, except 225-280 Ampere Without Programmed Transition

1. Move the motor disconnect switch to the DOWN, manual operation position.
2. Transfer or retransfer, following these steps:

   Transfer, from normal power to the emergency power source:

   a. Pull the upper manual operator handle down.
   b. Push the lower manual operator handle down.

   Retransfer, from emergency power to the normal power source:

   c. Pull the lower manual operator handle up.
   d. Push the upper manual operator handle up.
3. Automatic Transfer Switches - Return the transfer switch to its preferred position.
4. Return the motor disconnect switch to the UP, automatic operation position.

TS TYPE "O"
Two Actuator Transfer Switches (Switched Neutral)

Manual operation of a transfer switch with two linear actuators, those having a switched neutral pole, is different than a single actuator transfer switch. The procedure that follows will overcome the mechanical interlock which prevents disconnecting the neutral pole while the power poles are connected to either power source. The mechanical interlock also prevents the power poles from closing to either power source before the neutral pole is closed to that source.

Automatic Transfer Switches - Be sure to return an automatic transfer switch to its preferred position before resuming automatic operation.

TRANSFER, MANUAL

The procedure for manual transfer, from the normal power source to the emergency power source, is:

1. Move the motor disconnect switch to the DOWN, manual operation position. See Figure 12.

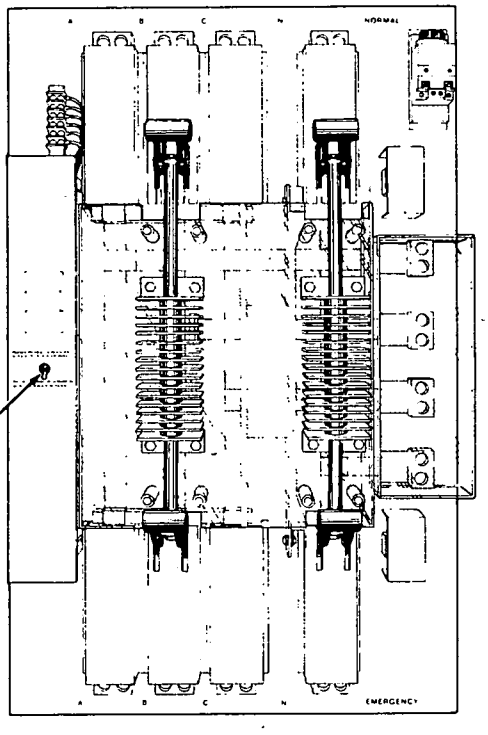


FIGURE 12.

WARNING **Automatic operation of the transfer switch can occur, causing personal injury, if the motor disconnect switch is not in the DOWN, manual operation position.**

2. Pull the top power handle down, as shown in Figure 13, disconnecting the power poles from the normal power source.

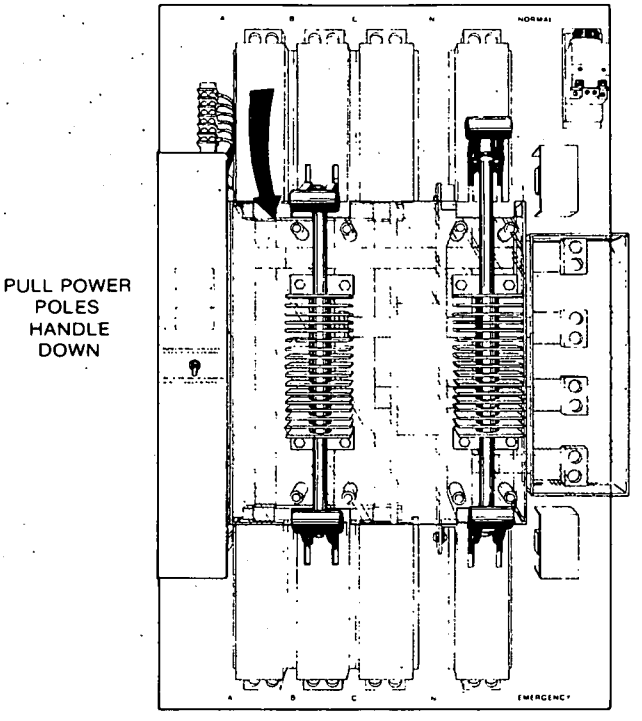


FIGURE 13.

3. Pull the top neutral pole handle all the way down, as shown in Figure 14, connecting the load neutral to the emergency neutral and disconnecting it from the normal power source.

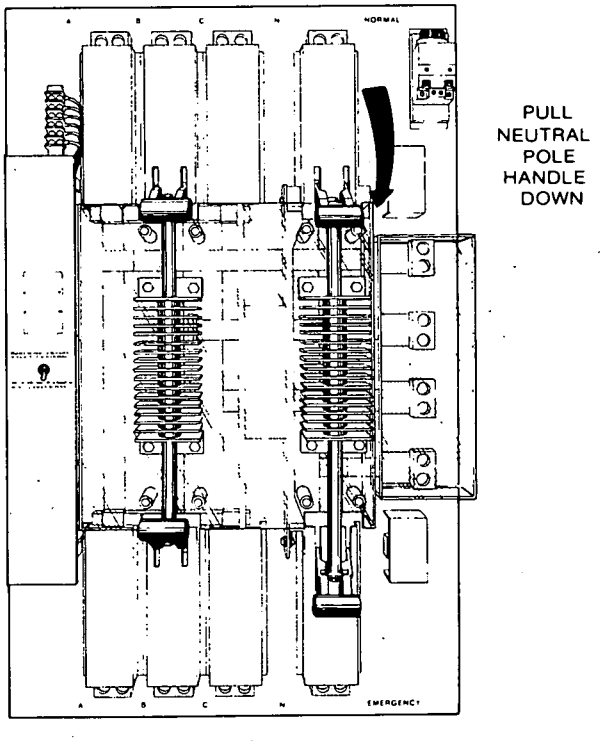


FIGURE 14.

4. Push the lower power pole handle down, as in Figure 15, connecting the load to the emergency power source. This completes the manual transfer switching sequence.

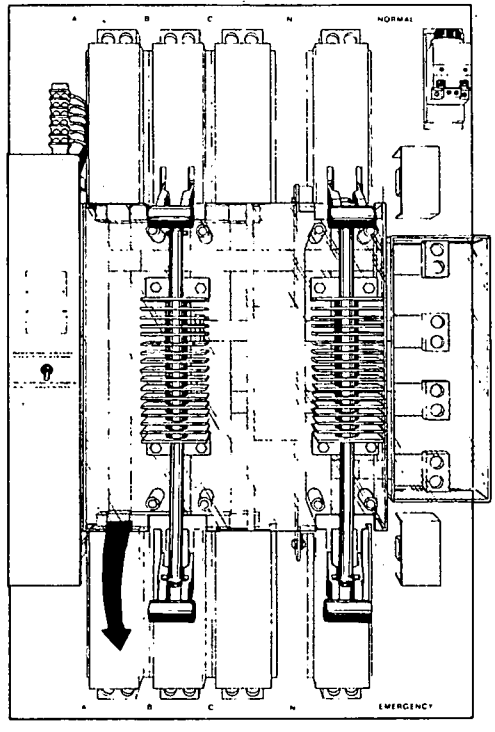


FIGURE 15.

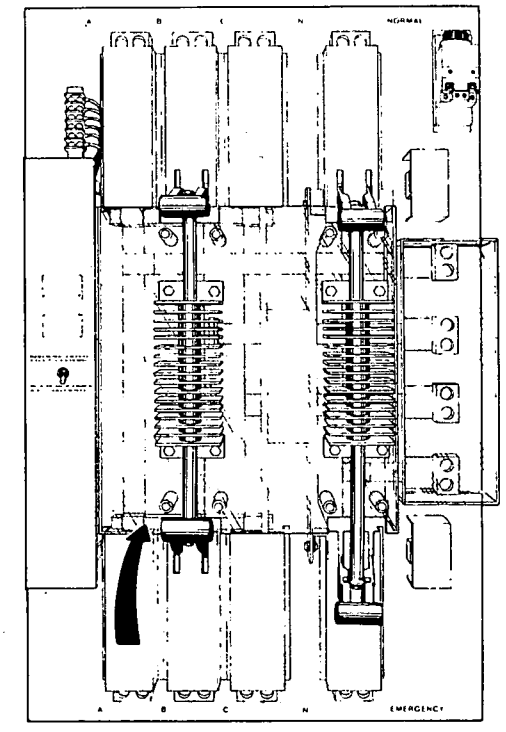


FIGURE 16.

emergency power source.

2. Pull the lower neutral pole handle all the way up, as shown in Figure 17, connecting the load neutral to the neutral of the normal power source and disconnecting it from the emergency power source.

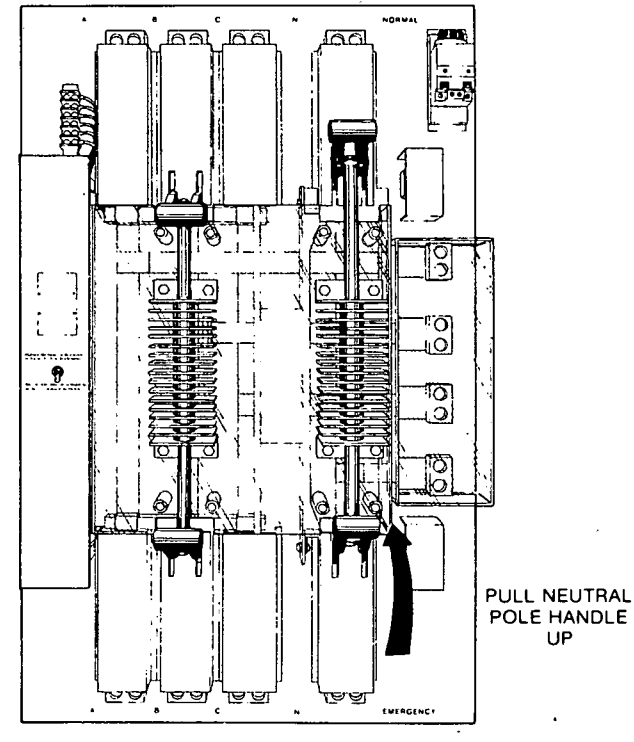


FIGURE 17.

RETRANSFER, MANUAL

The procedure for manual retransfer, from the emergency power source to the normal power source, is:

With the motor disconnect switch in the DOWN, manual position:

1. Pull the lower power pole handle up, as illustrated in Figure 16, disconnecting the load from the

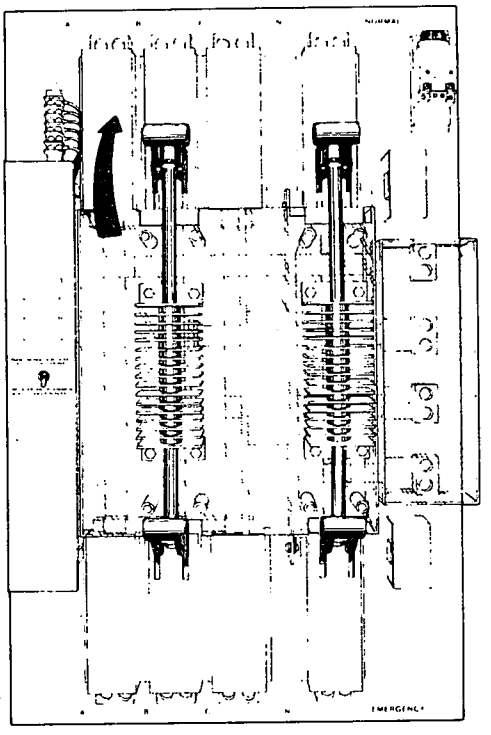


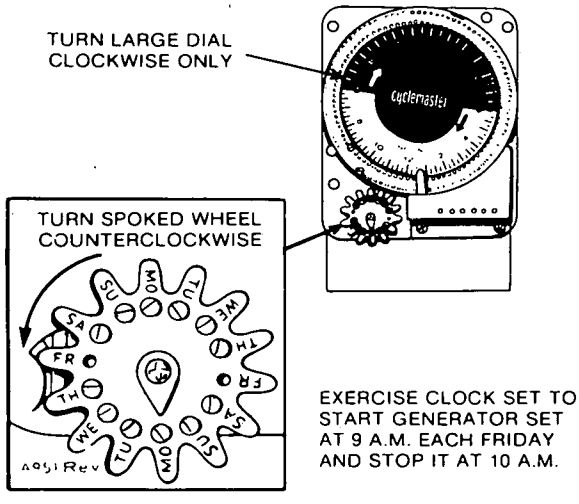
FIGURE 18.

3. Push the lower power pole handle up, as in Figure 18, connecting the load to the normal power source. This completes the manual retransfer switching sequence.
4. Being sure that the transfer switch is in its preferred position, return to automatic operation by moving the motor disconnect switch to the UP position.

ADJUSTMENTS

EXERCISER CLOCK

1. Open the cabinet door of the automatic transfer switch.
2. Move the operation selector switch (on engine control for two-wire starting, in cabinet for three-wire starting) to "STOP."
3. Install a trip pin (**left-hand thread**) in the inside row of holes on the large dial for the time of day you want the generator to start. See Figure 19.



NOTE: Trip pins are left-hand thread.

FIGURE 19. EXERCISER CLOCK

4. Place a trip pin (**left-hand thread**) in the outside row of holes on the large dial to stop the generator set.

   Onan recommends settings which operate the generator set for at least 30 minutes each week. Exercising for one long period is better than several short periods.

5. Install a trip (**left-hand thread**) in the small spoked wheel for every day **no exercise** is desired.
6. Rotate the large dial **clockwise** until the correct time is correctly aligned with the time pointer.
7. Turn the small spoked wheel **counterclockwise** until the correct day aligns with the pointer.

   Sixteen trip pins are supplied with the clock. Store unused pins on the time pointer bracket.

8. Move the operation selector switch to "RMT" (two-wire starting) or "NORMAL" (three-wire starting) whichever applies.
9. Close the cabinet door.

TIME DELAYS

Solid-State Controls

Start-Stop Time Delay: Time delay before start is factory adjusted for 2 to 3 seconds. Time delay before stop is factory adjusted for 4.5 to 5 minutes. If other times are desired, use the following procedure:

1. Open the cabinet door of automatic transfer switch.
2. Move the load selector switch to "WITH LOAD."
3. Move test transfer switch to "TEST."
4. With a stopwatch or watch with a second hand, measure the time until the generator set starts cranking.
5. Insert a small screwdriver through "START" hole in front panel of start-stop time delay module 7. Turn "START" potentiometer clockwise to increase start time delay or counterclockwise to decrease start time delay. Make adjustments in small increments.
6. Move test transfer switch to "NORMAL."
7. Measure time until generator set begins to shut down.
8. Turn "STOP" potentiometer with the small screwdriver clockwise to increase the stop time delay or counterclockwise to decrease the stop time delay. Make adjustments in small increments.
9. Repeat Steps 2 through 8 until desired delay times are obtained.
10. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."

Optional Start-Stop Time Delay: For a time delay change of the programmable timer, pull out the time delay module 7 from the control panel and change the switch settings on the side of the printed circuit board for the desired times. Table 6 lists the switch positions for the available time delays. The illustration following shows the module as viewed from the switch (right) side.

Example: For a start time delay of 2.4 seconds, close switches 1, 2, and 3, and open switch 4. For a 345-second time delay on stopping, close switches 5, 7, and 8, and open switch 6.

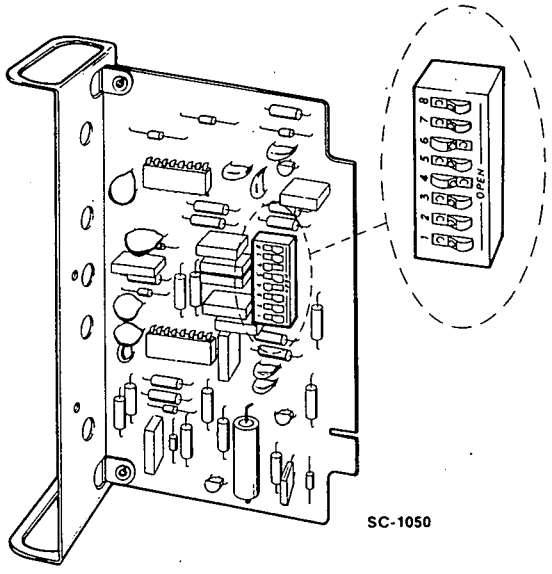


FIGURE 20. START-STOP TIME DELAY (BEGIN SPEC B) (OPTIONAL)

TABLE 6. PROGRAMMABLE TIME DELAY

PROGRAMMABLE START — STOP TIMER

c SWITCH CLOSED
o SWITCH OPEN

SWITCH POSITIONS				
1	2	3	4	TO START
5	6	7	8	TO STOP
				TIME
o	o	c	o	0.5 sec
o	o	o	c	1.0 sec
c	o	c	o	1.4 sec
c	c	c	o	2.4 sec
c	o	o	c	5.5 sec
o	o	o	o	7.9 sec
c	c	o	c	9.6 sec
c	o	o	o	43 sec
o	o	c	c	62 sec
c	c	o	o	76 sec
c	o	c	c	345 sec
c	c	c	c	615 sec

TIME TOL ± 20%

Transfer-Retransfer Time Delay: To change the delay time of transfer-retransfer time delay module 8, use the following procedure and refer to illustration following procedure.

1. Open the cabinet door of the automatic transfer switch.
2. Move the load selector switch to "WITH LOAD."
3. Move the test transfer switch to "TEST." The generator will start and run.
4. With a stopwatch or watch with a second hand, measure the time the red transfer LED on the transfer-retransfer time delay module 8 remains lit. The red LED will turn off after the time delay is complete. If the time delay is correct or time you desire, proceed to Step 6. If not, proceed to Step 5.
5. Insert a small screwdriver through the "TRANSFER" opening (upper opening) in the front panel of the transfer-retransfer time delay module. Turn clockwise in small increments to increase the time delay, counterclockwise to decrease time delay.
6. Move the test transfer switch to "NORMAL."
7. With a stopwatch or watch with a seconds hand, count the number of flashes the bottom green LED makes in 60 seconds (Onan suggests counting for 60 seconds—shorter intervals would give less accuracy for determing time delays). Once retransfer timing is complete, the retransfer LED will turn off and the green LED will remain on for the duration of the generator set stop delay. The following list gives the correlation of pulses to time delays.

Pulses/60 sec	Time Delay (min)
50	5
25	10
17	15
13	20
10	25
8	30

If time delay is correct or time you want, proceed to Step 10. Otherwise, proceed to Step 8.

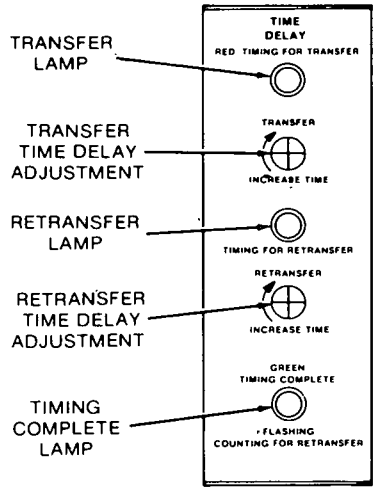


FIGURE 21. TRANSFER-RETRANSFER TIME DELAY

8. Insert a small screwdriver through the "RETRANSFER" hole (lower hole) in the front panel of the transfer-retransfer time delay module. Turn clockwise in small increments to increase the time delay, counterclockwise to decrease the time delay.
9. Repeat Steps 3 through 8 until the desired time delays are obtained.
10. Move the selector switch to "WITH LOAD" if you want the generator set to assume load during exercise or tests.
11. Close the cabinet door.

Preheat Time Delay: The preheat time delay (module 16) for diesel generator sets with 3-wire starting is adjustable from 5 to 60 seconds. To change the delay, follow these instructions:

1. Open the cabinet door of the automatic transfer switch.
2. Move the load selector switch to "WITHOUT LOAD."
3. Move the test transfer switch to "TEST."
4. With a stopwatch or watch with a second hand, measure the amount of time the small lamp on module 16 (preheat time delay module) lights before engine cranks.
5. Move the test transfer switch back to "NORMAL."
6. If time delay for preheat is set as desired, proceed to Step 9. If a different time is desired, proceed to Step 7.
7. Insert a small screwdriver through the "PREHEAT" hole in the front panel of preheat time delay module 16. Turn potentiometer clockwise to increase preheat time, counterclockwise to decrease delay. Make adjustments in small increments.
8. Repeat Steps 3 through 7 until desired preheat time is obtained.
9. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."
10. Close cabinet door of automatic transfer switch.

Relay Controls

Start, Transfer, and Preheat Time Delays: All of these time delays require the same adjustment procedures. Settings can range from 1 to 300 seconds. To make settings, perform the following:

1. Open the cabinet door of the automatic transfer switch.
2. Turn the knob on the time delay clockwise to increase delay time, counterclockwise to decrease the delay time. See Figure 22.
3. Close the cabinet door.

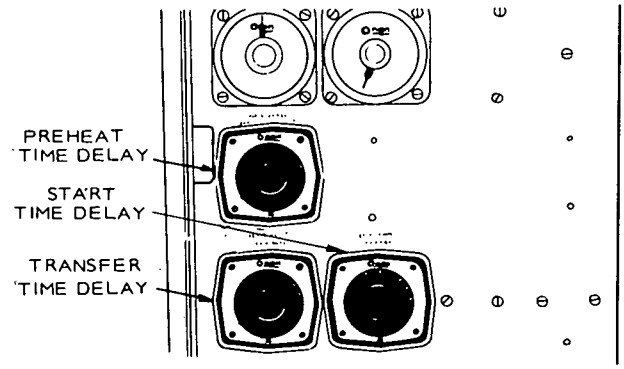


FIGURE 22. START AND TRANSFER TIME DELAY RELAYS

Stop and Retransfer Time Delays: Both of these synchronous motor-driven time delays require the same adjustment procedure. Settings can range from 2 to 60 minutes. To make settings, perform the following:

1. Open the cabinet door of the automatic transfer switch.
2. Set the time delay by turning the adjustment knob in the center of the delay. See Figure 23.

   The black pointer on the face of the time delay indicates the preset delay. The red pointer indicates the delay time left in operation.

3. Close and lock the cabinet door.

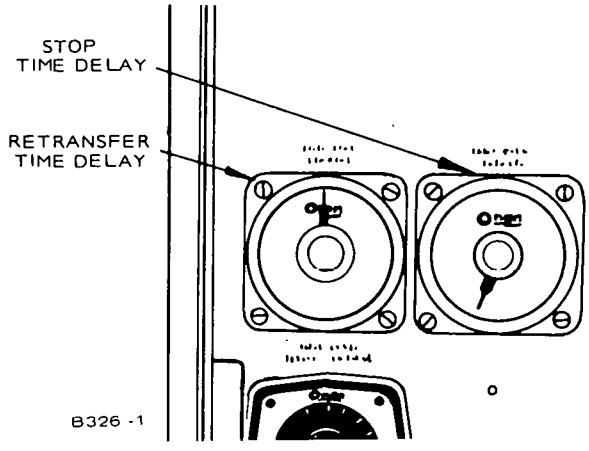


FIGURE 23. STOP AND RETRANSFER TIME DELAY RELAYS

OVERCRANK TIME SOLID-STATE CONTROL ACCESSORY GROUPS (THREE-WIRE STARTING ONLY)

Overcrank settings are made at the factory for approximately 75 ± 10 seconds cranking. To adjust perform the following.

1. Remove the positive lead from the generator set's start solenoid or starter.
2. Open cabinet door of automatic transfer switch.
3. Move the load selector switch to "WITHOUT LOAD."
4. Move the operation selector switch to "NORMAL."
5. Move test transfer switch to "TEST." Overcrank lamp on automatic transfer switch should light at end of crank period. Measure the crank time with a stop watch or watch with a second hand.
6. To change the time, insert a small screwdriver through the "CRANK TIME" hole in the front of the 2 to 3 wire converter module. Turn clockwise to increase the cranking time or counterclockwise to decrease the cranking time. Make adjustments in small increments.
7. Move test transfer switch to "NORMAL."
8. Push the "PUSH TO RESET" button on the 2 to 3 wire converter module.
9. Repeat Steps 5 through 8 until the desired cranking time is obtained.
10. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."
11. Close and lock cabinet door.
12. Reconnect positive lead to generator set's starter or start solenoid.

BATTERY FLOAT CHARGE

For the following adjustments, a fully-charged battery, a hydrometer and an accurate voltmeter (1/2 percent accuracy) are needed. Onan recommends float voltages of: 13.3 volts for nominal 12-volt or 26.6 volts for nominal 24-volt lead-acid batteries; 14.0 to 14.5 volts for 10-cell nickel-cadmium batteries, or 28.0 to 29.0 volts for 20-cell nickel-cadmium batteries.

Lead-acid battery only: During the first few weeks of operation, the batteries should be checked periodically with a hydrometer. A high specific gravity, bubbling of electrolyte and loss of water indicate excessive float voltage. A drop in specific gravity indicates insufficient float voltage.

1. Connect the fully-charged battery (verify charge condition with the hydrometer for lead-acid batteries.)
2. Connect the voltmeter directly to the battery terminals.
3. Measure the battery voltage. If voltage is above the recommended float voltage, proceed to Step 4. If the voltage is below the recommended float voltage, proceed to Step 6.
4. Insert a small screwdriver through the hole in the front panel of battery charger module 6. Turn counterclockwise in small increments to decrease the float voltage.
5. After five minutes, measure the battery terminal voltage again. If voltage is still high, repeat Steps 4 and 5 until voltage stabilizes at the recommended float voltage. Proceed to Step 9.
6. Note charge current rate on charge ammeter on meter-lamp panel.
7. Insert a small screwdriver through hole in front panel of battery charger module 6. Turn clockwise in small increments to increase float voltage. Note increase in the charging current on the charge ammeter on the meter-lamp panel.
8. In approximately one hour or when charge current has decreased to initial value noted in Step 6, recheck battery terminal voltage. Repeat Steps 6 through 8 until the battery terminal voltage stabilizes at the recommended float voltage.
9. Check the battery terminal voltage periodically during the first few weeks of operation (also check a lead-acid battery with a hydrometer). Readjust the float charge rate if necessary.

AC VOLTAGE SENSORS

Voltage sensors can be used for either undervoltage or overvoltage sensing on line side, or undervoltage sensing on generator side. Range of the settings is from 90 to 140 volts for a nominal 120-volt system. For higher voltage systems, the "PICK-UP VOLTAGE" knob readings are multiplied by the following multiplying factors.

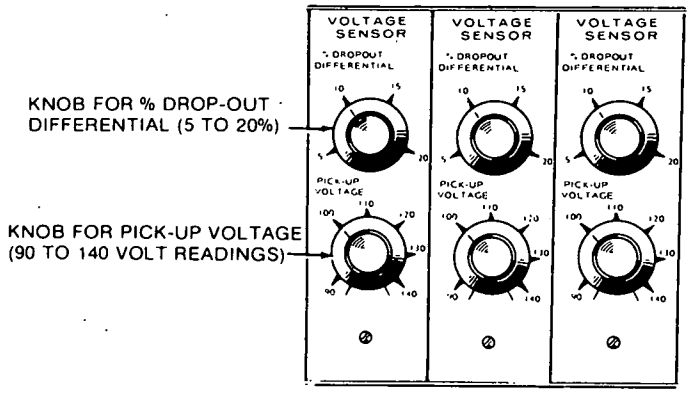


FIGURE 24. VOLTAGE SENSORS

VOLTAGE	MULTIPLYING FACTOR
120	1.0
208	1.73
240	2.0
480	4.0
600	5.0

Undervoltage Sensor Settings
Use the following steps for setting undervoltage sensors. Your settings, however, might vary considerably from the example shown due to your particular application requirements. Use settings which give load protection and yet will avoid "nuisance" load transfers.

1. Open the cabinet door.
2. Move the operation selector switch to STOP, on engine control two-wire starting, or in cabinet for three-wire starting.
3. Turn the PICK-UP VOLTAGE knob to the desired pick-up voltage, voltage at which load is transferred from the generator set to the normal power source. A setting of 108 volts, for example, gives a pick-up voltage which is 90 percent of the nominal voltage for a 120-volt system.
4. Turn the % DROP-OUT DIFFERENTIAL knob to the desired percent deviation below the pick-up voltage. This setting determines the voltage at which load is transferred from the normal power source to the generator set. A setting of 15 percent, for example, would give a 16-volt differential from 108 volts (pick-up voltage from Step 3). Drop-out voltage is then pick-up voltage minus the differential voltage, 108 - 16 = 92 volts.
5. Move the operation selector switch on the engine control to REMOTE for two-wire starting or to NORMAL for three-wire starting, whichever applies.
6. Close the cabinet door.

Overvoltage Sensor Settings
Use the following steps for setting overvoltage sensors. Your settings, however, might vary considerably from the example shown due to your particular application requirements. Use settings which give load protection and yet will avoid "nuisance" load transfers.

1. Open the cabinet door.
2. Move the operation selector switch to STOP, on engine control for two-wire starting, or in cabinet for three-wire starting.
3. Turn the PICK-UP VOLTAGE knob to the desired pick-up voltage, voltage at which load is transferred from the normal power source to the generator set. A setting of 135 volts, for example, gives a pick-up voltage which is 113 percent of the nominal voltage for a 120-volt system.
4. Turn the DROP-OUT DIFFERENTIAL knob to the desired percent deviation below the pick-up voltage. This setting determines the voltage at which load is transferred from the generator set to the normal power source. A setting of 5 percent, for example, would give a 7-volt differential from 135 volts (pick-up voltage from Step 3). Drop-out voltage is then 135 - 7 = 128 volts.
5. Move the operation selector switch on the engine control to REMOTE for two-wire starting, or to NORMAL for three-wire starting, whichever applies.
6. Close the cabinet door.

PROGRAMMED TRANSITION

To change the setting of the time delay relay for programmed transition, use the following procedure.

1. Open cabinet of Series TS Type "O" transfer switch.
2. Move the operation selector switch to "STOP" (on control accessory panel in cabinet for three-wire starting, on engine control panel for two-wire starting) and disconnect the generator set starting battery.

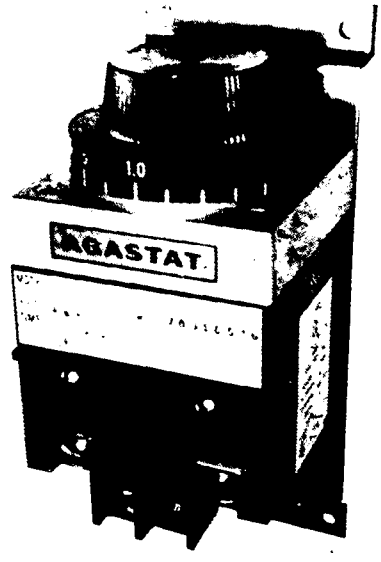


FIGURE 25. PROGRAMMED TRANSITION TIME DELAY RELAY

3. Remove AC line power to the transfer switch.

WARNING **Be sure to move the operation selector switch to "STOP," disconnect starting battery, and remove AC line power before attempting adjustments. Otherwise, the automatic transfer switch presents a serious shock hazard.**

4. With automatic transfer switches, remove the twist-lock disconnect plug and open the control accessory panel.
5. Locate the time delay relay (shown following) in the rear of the cabinet on the transfer switch base assembly.
6. Turn the knob clockwise to increase delay (increments marked on knob), counterclockwise to decrease time delay.
7. With automatic transfer switches, close the control accessory panel and reconnect the twist-lock disconnect plug.

8. Restore AC line power to the transfer switch.
9. Move the operation selector switch to "NORMAL" (in cabinet for three-wire starting) or "RMT" (on engine control for two-wire starting), whichever applies.
10. Reconnect the generator set starting battery.
11. Close the TS transfer switch cabinet door.

ADJUSTMENT OF SERIES TS PROTECTIVE CIRCUIT MODULES AND TIME DELAYS

Refer to the system initial startup and adjustment procedures supplied with each Series TS transfer switch.

TROUBLESHOOTING

POWER OUTAGE OCCURS, BUT GENERATOR SET DOES NOT START

1. Check for overcrank condition.
2. Two-wire starting only: Check position of operation selector switch on engine. Should be at "RMT."
3. Check position of operation selector switch in cabinet. Should be at "NORMAL."
4. Check generator set. Start with start-stop switch on generator set. If it does not crank, check starting batteries. If it cranks but does not start, check fuel supply.

GENERATOR SET STARTS DURING NORMAL SERVICE

1. Two-wire starting only: Check position of operation selector switch on engine control. Should be at "RMT."
2. Check position of operation selector switch in cabinet. Should be at "NORMAL."
3. Check if exerciser clock is turned to exercise period.
4. Check to see if control panel disconnect plug is inserted into receptacle.
5. Check voltage sensor settings (if equipped). If settings are okay, starting may be due to momentary voltage dips. Pick-up voltage settings may have to be reduced.

GENERATOR SET DOES NOT EXERCISE

1. Two-wire starting only: Check position of operation selector switch on engine control. Should be at "RMT."
2. Check position of operation selector switch in cabinet. Should be at "NORMAL."
3. Check exerciser clock to see if it is set correctly and running.
4. Check generator set. Start with start-stop switch on generator set. If it does not crank, check starting batteries. If it cranks but does not start, check fuel supply.

GENERATOR SET STARTS BUT DOES NOT ASSUME LOAD

1. Check output voltage of the generator set.
2. Check generator-side undervoltage sensor (if equipped) pick-up voltage setting. Setting in most cases should be at 100 volts (200 for 240-volt systems).
3. Check position of motor disconnect switch. Should be up.

NO TRANSFER OF LOAD TO COMMERCIAL POWER FROM GENERATOR SET

1. Check disconnect plug in control accessory panel. Must be connected into receptacle.
2. Check retransfer time delay (if used) to see if time delay is still operating. See *OPERATION* section.
3. If automatic transfer switch has battery charging feature, check battery charging fuse. Replace if necessary with correct fuse.
4. Check position of motor disconnect switch. Should be up.
5. Manually initiate retransfer by operating retransfer selector switch and push to retransfer switch (if equipped).
6. Check line voltage to make sure it is above setting of voltage sensor (if equipped).
7. Stop generator set with start-stop switch. When generator set stops, the transfer switch will transfer the load to the normal power line if voltage is normal.

GENERATOR SET CONTINUES TO RUN AFTER RETRANSFER OF LOAD TO COMMERCIAL POWER

Start-stop time delay may be defective. Stop generator set with start stop switch.

BATTERY CHARGER FAILS TO CHARGE

Check battery charger fuse F1 in control accessory panel (if equipped with charger). Replace if necessary with correct fuse.

BATTERY LOSES EXCESS WATER

Battery charger float voltage may be too high (if equipped with charger). See *ADJUSTMENTS* section.

BATTERY LOSES CHARGE

Charge float voltage may be set too low (if equipped with charger). See *ADJUSTMENTS* section.

PARTS AND SERVICE INFORMATION

This Series TS transfer switch is custom engineered and specially constructed. Because of the individuality of each automatic transfer switch, contact the dealer from whom you purchased this equipment for service and parts. Parts catalogs are available through your Onan distributor/dealer. Remember to give the complete model and serial number when requesting service or parts information. The wiring diagrams furnished with your Series TS transfer switch should be kept with your instruction manual in the "pocket" inside the cabinet.

All shipments made are complete. Shipments are properly packed and in good order when delivered to the transportation company. Any claim for loss or damage in transit should be filed promptly against the transportation company making the delivery.

Onan Operators Manual

SERIES TS Switch

Automatic Control

962-0106

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4-80

SYSTEM INSTALLATION, INITIAL STARTUP, AND TEST PROCEDURE - TS SYSTEMS
SECTION 1 Four Gen Set Standby - Page 1
SECTION 11 Single Gen Set Standby - Page 14

SECTION 1 Four Gen Set Standby

This procedure applies to a four generator standby system consisting of the following:

1) One TSACO Spec 14404A - Mains/Generator Bus Selector
2) One TSMCO Spec 15005A - Master Generator Control Switch
3) One TSAFO Spec 10006A - Generator #1/#2 Selector
4) One TSAFO Spec 20006A - Generator #3/#4 Selector and, Two Generator Systems not Utilizing TSAFO Transfer Switches (Refer to 626-5030, 626-5031, 626-5032, and 630-1142)

I. System Operational Description

A. TSACO Spec 14404A

1. Contains sensing equipment to monitor utility voltage and generator bus voltage and frequency.

2. Upon failure of the utility, a mains failure signal is sent to the TSMCO to start a gen set.

3. When generator output is available on the generator bus within operating parameters, the load is then connected to the generator bus.

B. TSMCO Spec 15005A

1. Receives mains failure signal from TSACO and starts the preferred gen set (as determined by the preferred source selector switch).

2. If the preferred gen set fails to start or fails to reach operating voltage, it is shutdown and the next gen set in sequence receives a start signal. The sequence continues until a gen set is available to the generator bus, or all gen sets have failed.

3. Provides time delay start/stop and time delay transfer functions for all gen sets.

4. Provides dry contact for use with customer supplied load bank, for load application control signal.

5. Preferred generator selector switch - Allows manual selection of lead gen set to allow run time equalization of all gen sets.

C. TSAFO Spec 10006A/20006A

1. Connects the gen set selected by the master generator control switch to the generator bus via the TSMCO.

2. In conjunction with the TSMCO, provides electrical and mechanical interlocks to prevent connecting two or more power sources together.

II. Initial System Interconnection

NOTE: At this time, do not connect the utility to the TSACO. Do not connect batteries and chargers into the system until directed to do so. Also, disconnect engine starting batteries at this time.

A. Make control and power circuit interconnections per drawing 630-1138 for Code 8 systems or 630-1139 for Code 7 systems.

B. Temporarily connect one charger to the utility for use in initially charging the control batteries. Charge batteries per battery technical manual procedure for initial charge and installation.

C. Connect the TSMCO battery charger to the generator bus.

D. Connect TSMCO start contacts, located on TB8 to appropriate generator start circuits.

E. Complete charging the TSACO and TSMCO control batteries with the charger used in Step II. B.

III. Function Module, Time Delay, and Control Switch Initial Setting Procedure.

A. TSACO Spec 14404A

1. Control accessory group 626-5009 (Code 7), 626-5012 (Code 8)

a. Voltage sensors A1-A4 and A13-A16

1) Set desired pickup voltage using multipliers listed on the front of the swinging panel.

2) Set percent differential dropout as desired - this is a percentage of the pickup voltage setting.

3) Note that undervoltage sensors A1-A4 will be "picked up" in their normal state, therefore, the differential dropout adjustment will determine when these sensors de-energize or "drop out". The pickup voltage setting then becomes their reset poing.

4) Note that overvoltage sensors A13-A16 are identical modules to A1-A4, but in the overvoltage application the normal state is "dropped out" or de-energized. The pickup voltage setting determines when they will energize to signal the control that an overvoltage condition exists. The differential dropout setting determines the dropout or reset voltage which signals the control that voltage has returned to normal.

5) Refer to the TS operators manual for further explanation of the adjustment of these modules.

b. Transfer/Retransfer Module A8

1) This module is factory set for both transfer and retransfer time delays. Refer to 626-5009 or 626-5012 for adjustment range if further field adjustment is required.

2) Factory settings are approximately 3-5 seconds on transfer and 4-5 minutes on retransfer.

2. Fault Module Time Delay and Frequency Sensor Adjustment.

a. K11 Time Delay Relay - set for 15-20 seconds. This allows ample time delay for the preferred generator to recover from the initial loading transient, before energizing the fault module logic.

b. K12 Frequency Fault Time Delay Relay - Set for approximately 10 seconds. This allows ample delay for the generator to recover from changing load transients without a spurious frequency fault signal.

c. K13 Voltage Fault Time Delay Relay - Set for approximately 10 seconds to allow for transient loading recovery.

d. K10 Start Failure Time Delay Relay - Set for one minute. This relay signals that the preferred generator has encountered a starting problem and either has not started, has not reached operating parameters, or has encountered a long cranking period.

e. K10, K12 and K13 - When energized will illuminate the TSACO fault lamp. This indicates there is a problem in the generator/transfer switch group. The TSMCO and engine control fault lamps should be checked for further fault analysis.

NOTE: Initial settings of time delays are approximate. Optimum time delay settings will be determined by system operational experience and factors such as engine governor response, generator

voltage regulator response, ability of the load to withstand power outages (short or long duration) varying climatic conditions, etc. This note will also apply to control accessory group module adjustments.

B. TSMCO Spec 15005A

1. Control Accessory Group 626-5026 Adjustments.

a. Generator undervoltage sensor adjustments (modules A1-A4): Refer to Step III.A.1.a.1)-3).

b. Generator start-stop modules A7-A10 adjustments.

1) These modules are factory set - refer to note 2 on 626-5026 for adjustment range of these modules if field adjustment is necessary. The delay on stop allows a no load running period for engine cooldown.

c. Generator load transfer modules A13-A16 adjustments.

1) These modules are factory set - refer to note 3 on 626-5026 if further adjustment is necessary.

2. Relay Module - Exerciser time delay relays K42, K44, K46 - Set for 30 minutes. Also set the exerciser clock in the TSACO for a total exercise period of 2 hours - refer to TS operators manual for clock setting procedure.

3. Generator Failure Modules

a. All K11 and K12 relays - set for 5-10 seconds.

1) K11 for each gen set is the voltage fault pilot.

2) K12 for each gen set is the frequency fault pilot.

b. All K13 relays - set for one minute.

1) K13 for each gen set is the fail-to-start pilot.

C. System Control Switch Lineup.

1. TSACO Spec 14404A

a. Control Accessory Panel - Drawing No. 626-5009/626-5012

1) S1 normal - test switch: Place in "NORMAL"

2) S2 with load-without load switch: Place in "WITHOUT LOAD".

b. Transfer switch linear motor cutout switch S1 (located on auxiliary switch cover on left side of transfer mechanism): Place in "OFF" (Down Position), Open both the normal and emergency side main contacts and leave the switch in this "neutral" position.

c. Connect TSACO battery charger input to the load side of the transfer switch.

d. Connect the control batteries positive to the system - do not connect the battery negative to ground at this time. Connect the battery charger output to the batteries.

e. Do not make utility or load connections to the TSACO at this time.

f. Set the exerciser clock to a "no exercise" time of day.

2. TSMCO Spec 15005A

a. Control Accessory Panel - Drawing No. 626-5026.

1) Maintenance cutout switches S11-S14: Place in "NORMAL".

2) Preferred generator selector switch S10: Place in "OFF".

b. Transfer switch linear motor cutout switch S1: Place in the down (OFF) position. Place the transfer mechanism in the "neutral" position (both sets of main contacts open).

3. TSAFO Specs 10006A/20006A

a. Linear motor cutout switch S1: Place in the down (OFF) position.

b. Place the transfer mechanisms in the "NEUTRAL" position (both sets of main contacts open).

4. Engine-Generators

a. Disable each gen set at the engine control panel (i.e., place the start-stop switch in stop).

b. Connect all engine starting batteries.

c. Enable each gen set for remote start capability. No gen set should start when this step is performed. If a gen set starts when this step is performed, stop the set and perform the following:

1) TSMCO - check that the preferred generator selector switch S10 is in "OFF", and that the control batteries have not yet been connected.

2) Engine Control - check that the switch lineup is proper for remote start capability.

3) Check interconnection wiring between gen set and TSMCO.

4) If steps 1-3 do not reveal the problem, a more detailed investigation of the engine and transfer switch controls will be necessary.

IV. GENERATOR SYSTEM TEST

A. Switch Lineup - Verify there are no utility or load connections to the TSACO.

1. In the TSMCO, TSACO, & TSAFO switches - place linear motor cutout switches S1 in the "Normal" (up) position. Leave the transfer mechanisms in the "neutral" position (both sets of main contacts open).

2. Complete interconnection of the batteries and chargers to the TSACO and TSMCO controls. There should be no gen set startup at this time. If a gen set does start, recheck switch lineup, interconnections, and procedure. Verify that preferred generator selector switch S10 is in the "OFF" position (fully counterclockwise with stop screws in positions 1 and 4 on the rear of the switch, and the operating key at the 12:00 O'clock position).

   NOTE: Portions of the TSACO and TSMCO controls are now energized by the batteries. The TSACO fault lamp will energize after approximately one minute. This is normal and it will de-energize once an operating genset has been automatically connected to the generator bus by the TSMCO.

3. At the TSMCO, perform the following:

   a. Open the right hand door to allow the operator to observe the LED's on the TD START/STOP and TD TRANSFER modules. These modules are located in the control accessory panel on the rear of the right hand door.

   b. Place switch S10 in the Generator No. 1 Position - No. 1 gen set should receive a start signal after completion of the A7 module timing sequence. (Observe the A7 module TD Start LED).

c. After the generator has reached operating voltage, the TD transfer module (A13) should time out and the gen set should then be connected to the generator bus by the #1 Auxiliary Generator Control (TSAF0/10006A) and the Master Generator Control (TSMC0).

4. At the TSAC0:

a. The TSAC0 Time Delay Transfer function will commence timing if the generator voltage and frequency are within the operating window. Observe the timing for transfer LED on module A8.

NOTE: The frequency sensor relay (A31) has not yet been adjusted and should be set for the maximum "window".

b. Following completion of the A8 module timing cycle, the TSAC0 will connect the generator to the load side of the transfer switch. Check the TSAC0 voltmeter to verify this has occurred.

c. Setting the A31 frequency sensor:

CAUTION: Follow all electrical safety precautions for work on energized equipment when working inside the transfer switch cabinets. Both AC and DC power are now applied to the controls.

1) Remove relay K12 from its' socket and connect a a 24V DC test lamp from terminal "A" of the socket to ground. The lamp should remain de-energized.

2) Remove the capscrew from the underfrequency adjustment potentiometer on A31. Check that the adjustment is at the low limit (adjustment screw fully counter-clockwise). The low limit is ≈ 50 Hz.

3) Reduce the speed of #1 gen set to the desired under-frequency set point.

4) Carefully turn the adjustment screw in the clockwise direction until the test lamp just energizes. Then return gen set speed to normal.

5) Raise and lower gen set speed to check the under-frequency adjustment and readjust as necessary. Re-install the capscrew removed in Step 2) when completed.

6) Remove the capscrew on the overfrequency adjustment of A31 and check that the adjustment screw is at the fully clockwise or maximum setting (this will be ≈ 70 Hz).

7) Increase the speed of #1 gen set to the desired overfrequency set point.

8) Carefully turn the overfrequency adjustment screw in the counterclockwise direction until the test lamp just energizes. Then return gen set speed to normal.

9) Raise and lower gen set speed to check the over-frequency set point and re-adjust as necessary. Re-install the adjustment capscrew when completed.

10) Remove the test lamp and re-install the K12 relay. This completes the A31 adjustment procedure.

B. Maintenance Cutout Function Test

1. Initial conditions

a. No. 1 gen set running and connected to the load side of the TSACO.

b. Switch S10 at the TSMCO (preferred generator selector switch) in the No. 1 Generator postiion.

c. Maintenance cutout switches S11-S14 on 626-5026 in the "NORMAL" position.

2. Test

a. Place switch S11 in the maintenance cutout position.

b. Following the TD Start function, No. 2 gen set should start.

c. No. 1 auxiliary generator control (TSAFO/10006A) should transfer to No. 2 gen set following the TD transfer function.

d. No. 1 gen set should shutdown following the time delay stop function.

e. Place switch S10 in the No. 2 gen set position and return switch S11 to "NORMAL". No. 1 gen set should not start. No. 2 gen set should remain running and be connected to the TSACO load side.

f. Place switch S12 in the maintenance cutout position.

g. Following all applicable time delays, No. 3 gen set should start and be connected to the load side of the TSACO. No. 2 gen set should shutdown following the TD stop function.

h. Place switch S10 in the No. 3 gen set position and return switch S12 to "NORMAL". No. 2 gen set should not start and No. 3 gen set should be running.

i. Place switch S13 in the maintenance cutout position. Observe that No. 4 gen set starts, is connected to the load side of the TSACO, and No. 3 gen set is shutdown.

j. Place switch S10 in the No. 4 gen set position and return S13 to "NORMAL".

k. Place switch S14 in the maintenance cutout position. Observe that No. 1 gen set starts, is connected to the load side of the TSACO, and No. 4 gen set is shutdown.

l. Place switch S10 in the No. 1 gen set position and return S14 to "NORMAL".

m. Simultaneously place switches S11, S12, and S13 in the maintenance cutout position. Observe that No. 4 gen set starts, is connected to the load side of the TSACO, and No. 1 gen set is shutdown.

n. Return S11 only to the normal position. Observe that the system returns to No. 1 gen set running, connected to the load side of the TSACO, and No. 4 gen set is shutdown.

o. Return all maintenance cutout switches (S11-S14) to "NORMAL".

p. Test all S10 switch positions by selecting each gen set in turn. Observe that the selected set is started, connected to the load side of the TSACO, and the preceeding gen set is shutdown. Observe all applicable time delay functions (Start/Stop, Transfer) and adjust as desired.

q. Place S10 in "OFF". Observe that the running gen set is shut down following the time delay stop function and no gen set is running. This completes the maintenance cutout function test and also tests the preferred generator selector switch.

C. Generator Failure Logic Test

1. Initial Conditions

a. All maintenance cutout switches in "NORMAL".

b. Preferred generator selector switch S10 in the No. 1 gen set position.

c. No. 1 gen set running and connected to the load side of the TSACO.

2. At the No. 1 gen set engine control panel, reduce the generator voltage to a point below the drop out setting of the TSACO A4 module (refer to Step III.A.1.a.)

   a. Following the cumulative time delays of the TSACO K13 relay and the TSMCO 1K11 relay, the Volts Hi/Lo lamp for No. 1 gen set should energize. The No. 1 generator failure relay will initiate a start-up of No. 2 gen set and it should be connected to the load side of the TSACO. No. 1 gen set should shutdown following the time delay stop function. Return the voltage adjustment of No. 1 generator to its original position.

      NOTE: DO NOT PRESS ANY RESET SWITCHES (S21-S24) UNTIL DIRECTED TO DO SO.

3. Repeat Step 2 for each generator until No. 4 gen set is running and connected to the load side of the TSACO.

   a. At this time, place preferred generator selector switch S10 in the No. 4 gen set position. Then press the S21 reset switch for No. 1 gen set. Note that No. 1 gen set should be the only unit operating.

4. Reduce the voltage of No. 4 gen set to initiate a low voltage fault function.

   a. No. 1 gen set should start and be connected to the load side of the TSACO. No. 4 gen set should be shutdown.

   b. Return the No. 4 generator voltage adjustment to its normal position.

   c. Press the S24 reset switch for No. 4 gen set. Switch S10 should still be in the No. 4 gen set position. The gen set should start and be connected to the load side of the TSACO. No. 1 gen set should be shutdown.

   d. Return switch S10 to the No. 1 gen set position. Note the system operation to return to No. 1 gen set running, connected to the load side of the TSACO, and all other units shutdown.

5. Repeat Steps 2 through 4, with the following changes:

   a. Reduce gen set speed rather than voltage to check the frequency fault circuits.

b. Note that the fault time delay will be the sum of the TSACO K12 relay, and the associated gen set K12 relay (1K12, 2K12, 3K12, or 4K12).

6. Start Failure Test - Initial conditions as obtained in Step IV.C.4.d.

a. With No. 1 gen set running, raise the pickup voltage setting of the A1 module (626-5026 Control Accessory panel in the TSMCO) to maximum. After approximately one minute, the No. 1 gen set fail-to-start clamp should energize, No. 2 gen set should receive a start signal and the load transferred to No. 2 gen set once it is at operating parameters.

b. Each, in turn, increase the pick voltage settings of the A2 and A3 modules (ref: 626-5026) to test the start failure functions of No. 2 and No. 3 gen sets. At the completion of this step, No. 4 gen set should be running and connected to the load side of the TSACO. No. 1 - No. 3 gen sets should be shutdown and the fail-to-start lamp for each of these units should be energized.

c. Place switch S10 (preferred generator selector switch) in the No. 4 gen set position.

d. Press switch S21 to reset No. 1 gen set failure monitor and return the pickup voltage setting of the A1 module to its normal position.

e. Raise the pickup voltage setting of the A4 module (626-5026) to its maximum point. Note the system operation to shut-down No. 4 gen set and return to No. 1 gen set operating and connected to the load side of the TSACO.

f. Return switch S10 to the No. 1 gen set position, return the pickup voltage settings of modules A2-A4 to normal, and press reset switches S22 - S24 to reset the fault modules of No. 2 - No. 4 gen sets. The system should now be in a normal lineup with No. 1 gen set operating.

D. This completes the system no load testing. To complete the system interconnection, proceed as follows:

1. Shutdown/disable all gen sets.

2. Make all utility, load, and load bank connections per interconnection drawings 630-1138 or 630-1139 as applicable.

3. Energize the utility to the TSACO and note that the utility is supplying the load.

E. Exerciser Function Test

1. At the TSACO

   a. Initial conditions

      1) Utility supplying the load.

      2) Normal-Test Switch S1 in "NORMAL".

      3) With load-Without Load switch S2 in "WITHOUT LOAD".

   b. Manually rotate the exerciser clock wheel to initiate the system exercise function (refer to TS operator's manual for clock operation), after checking that the clock is set for a two hour exercise period. Note the following:

      1) The load bank test lamp energizes.

      2) The load remains connected to the utility.

2. At the TSMCO, note that No. 1 gen set is operating and is connected to the customer's load bank. Gen set change over should occur at $\approx$ 1/2 hour intervals. Allow the exerciser clock to run through the full exercise period.

3. At the completion of the exercise period, note that all gen sets are shutdown, the load bank test lamp is de-energized and the load remains connected to the utility.

4. Place with load-without load switch S2 in the "WITH LOAD" position at the TSACO. Then place normal-test switch S1 in "TEST" to manually initiate system exercise. Note the following:

   a. No. 1 gen set receives a start signal.

   b. The load bank test lamp does not energize.

   c. When No. 1 gen set has reached operating parameters, the TSACO transfers the system load to the generator bus.

   d. The customer's load bank is not energized.

5. Return the normal-test switch S1 to "NORMAL" and note the following:

   a. Following the time delay on retransfer function, the TSACO transfers the system load to the utility.

   b. Following the applicable time delay on stop function, the operating generator is shutdown.

6. This completes the exerciser system function test. Ensure that all module adjustments are in their normal positions. Select the desired lead gen set with the TSMCO preferred generator selector switch S10 and remove the key for safe-keeping. At this time, other testing as described in the TS operators manual may be performed as desired. This completes the system installation test. Place switch S2 in the "WITHOUT LOAD" position.

7. If additional charge time is necessary for the control batteries utilized in this system, proceed as follows:

   a. At the TSACO, place the with load-without load switch S2 in "WITHOUT LOAD". Place normal-test switch S1 in "TEST".

   b. This will start the system exercise function with No. 1 gen set.

   c. Each gen set will run for approximately 1/2 hour until No. 4 gen set is connected to the generator bus. This gen set will then be in operation as long as the normal-test switch is in the "TEST" position. Allow No. 4 gen set to run as long as necessary to charge batteries. If another gen set is desired for battery charging, this set may be selected by placing the TSMCO maintenance cutout switches for the other three gen sets in the "CUTOUT" position (ref: 626-5026).

SECTION 11 Single Gen Set Standby

This procedure applies to a single generator system consisting of one TSACO Spec 17407A.

I. System Operational Description

A. TSACO Spec 14404A

1. Contains sensing equipment to monitor utility voltage and generator voltage and frequency.

2. Time delays on generator start, stop, load transfer, and load retransfer are included.

3. Upon failure of the utility, a start signal is sent to the gen set.

4. When generator output is within normal operating parameters, the load is transferred to the gen set.

II. System Interconnection - disable the gen set before starting this procedure.

A. Make all system interconnections per Drawing 630-1134.

B. Place linear motor cutout switch S1 in the "OFF" (down) position. This switch is located on the auxiliary switch cover of the transfer mechanism. (Refer to the TS Operators Manual). Manually close the transfer switch on the normal side and energize the utility feeder.

C. Check the TSACO meters to verify the utility is supplying the load. Note that the control battery charger (305-0651) should now be supplying charging current to the control batteries.

CAUTION: AC and DC power are now applied to the transfer switch cabinet and controls. Follow all electrical safety precautions for working on energized equipment. This caution applies throughout this procedure.

D. Set the transfer switch exerciser clock to a "no exercise" time of day and select the desired exercise time period. (Refer to the TS Operators Manual).

III. Initial Switch Lineup

A. The transfer mechanism should be in the condition as stated in Step II. B.

B. Control Accessory Panel 626-5009 and/or 5012.

1. Normal-test switch S1: Place in "NORMAL".

2. With load-without load switch S2: Place in "WITHOUT LOAD".

3. Voltage sensor modules A1-A4 (undervoltage).

   a. Set desired pickup voltage using multipliers listed on the front of the swinging panel.

   b. Set the percent differential dropout as desired - this is a percentage of the pickup voltage setting.

   c. The pickup voltage setting is the point at which the sensor energizes and for A1-A4, this is their normal state.

   d. The differential dropout setting determines the point at which A1-A4 will dropout to signal an undervoltage condition.

4. Voltage sensor modules A13-A16 (overvoltage): These modules are identical to A1-A4, but the adjustment procedure changes for the overvoltage application.

   a. The normal state of A13-A16 is de-energized (dropped out), therefore, the differential dropout setting determines the point at which the sensor will revert to its' normal state. Note again that this setting is a percentage of the pickup voltage setting.

   b. It is recommended the pickup voltage setting be adjusted to $\geq$ 110% of the system voltage. This will be the point at which the sensor signals the control that an over-voltage condition exists. Also, this allows ease of setting the reset point at approximately 105% of the system voltage. System operational experience will dictate all final settings of these sensors depending on gen set voltage regulator response, governor response of the engine, and extent of fluctuations in the utility system.

      NOTE: For voltage codes 4, 5D, and 8, these sensors will sense system voltage from line to line. For voltage codes 7 and 7X, they will sense system voltage from line to neutral. This must be kept in mind when selecting a multiplier from the front of the panel. All multipliers are based on 120 volt as being 1:1.

5. Start-stop module A7 and transfer-retransfer module A8 are factory set. Refer to 626-5009/5012 for adjustment range and the TS Operators Manual if field adjustment is required.

6. Set the start failure relay K10 for approximately one minute.

C. TSACO Spec 17407A Fault Module Adjustments

1. Set time delay relay K11 for 15-20 seconds. This delays energizing the fault module until the generator has recovered from the initial loading transient.

2. Set time delay relays K12 (frequency fault) and K13 (voltage fault) for approximately 10 seconds. This allows ample time for the generator to recover from a transient loading condition without fault initiation.

3. System operational experience will dictate the final settings of the K11-K13 relays.

4. Frequency sensor A1 - remove the capscrews to check adjustments.

a. Underfrequency adjustment - check that this setting is at minimum (fully counterclockwise).

b. Overfrequency adjustment - check that this setting is at maximum (fully clockwise).

IV. System Test

A. Frequency sensor A31 adjustment/test.

1. Check that the transfer mechanism is in the condition as stated in Step II.B. Remove the adjustment capscrews from the A31 frequency sensor.

2. Disable the load bank (when used) such that the TSACO will apply the load bank control signal but the load will not be applied to the generator.

3. Verify that control accessory group switches S1 and S2 are in the positions required by Steps III.B.1.&2.

4. Enable the gen set for remote start capabilities. The gen set should not start when this step is performed, if the utility is within the operating window.

5. In the transfer switch cabinet, remove the K12 relay and connect a 24V DC test lamp from the K12 relay socket terminal "A" to ground.

6. Place normal-test switch S1 in "TEST" to start the gen set.

NOTE: With S1 in "TEST" and S2 in "WITHOUT LOAD", the start-stop function time delay is by-passed. This also applies to the system exercise function when S2 is in "WITHOUT LOAD". To test the Start-Stop time delay function, the test or exercise function must be done in the "WITH LOAD" position of S2, and the system load is used rather than the customer's load bank.

7. Once the gen set has obtained operating voltage and frequency, proceed as follows:

   a. Reduce gen set speed to obtain the desired underfrequency set point.

   b. Adjust the A31 underfrequency potentiometer until the 24V DC test lamp installed in Step IV. A.5. just energizes (Turn the adjustment screw in the clockwise direction)

   c. Increase the gen set speed to the desired overfrequency set point. Also, note the frequency at which the test lamp de-energizes.

   d. Adjust the A31 overfrequency potentiometer until the test lamp just energizes. (counterclockwise rotation of the adjustment screw).

   e. Reduce the gen set speed to normal, noting the frequency at which the test lamp de-energizes.

   f. Raise and lower gen set speed to check the A31 set points and re-adjust as necessary. Return gen set speed to normal when this step is completed.

B. Generator over/under voltage test.

   1. With the gen set and control in the condition as obtained in Step IV.A.7.f., reduce the generator voltage below the drop-out point of the A4 module (refer to 626-5009/5012) and note the following:

      a. At the completion of the K13 relay timing period, the TSACO FAULT and VOLTS HI/LO lamps should illuminate.

      b. The gen set should shutdown after the TD stop function is completed.

   2. Return the generator voltage adjustment to normal, press reset switch S12, and note that the gen set restarts. All fault lamps

should now be de-energized.

3. Repeat Step 1, except increase generator voltage above the pick-up point of the A16 module. Repeat Step 2, after the gen set has shutdown.

4. Return normal-test switch S1 to the normal position to stop the gen set.

C. Generator Fail-To-Start Test.

1. Set the A16 module pick-up voltage adjustment at maximum. (This simulates the generator has not built up voltage.)

2. Place normal-test switch S1 in "TEST". Note that the gen set starts.

3. After approximately one minute, the TSACO fault lamp will illuminate and the gen set should be shutdown.

4. Place the S1 switch in "NORMAL".

5. Return the A16 module voltage adjustment to normal.

D. Exerciser Clock Function Test

1. Refer to the TS manuals' checkout procedures for this test.

2. Step IV.A.6 should be referred to for additional information regarding this test.

3. The linear motor cutout switch S1 (located on the transfer mechanism auxiliary switch cover) should be placed in the "NORMAL" (up) position at this time.

4. This completes the installation checkout procedure.

SAFETY PRECAUTIONS

This manual includes the following symbols to indicate potentially dangerous conditions to the operator or equipment. Read the manual carefully and know when these conditions exist. Then take the necessary steps to protect personnel and the equipment.

WARNING **Onan uses this symbol throughout the text to warn of possible injury or death.**

CAUTION **This symbol is used to warn of possible equipment damage.**

The Series TS transfer switch has components with high voltages which present serious shock hazards. For this reason, read the following suggestions:

Keep the transfer switch cabinet(s) closed and locked. Make sure authorized personnel only have the cabinet keys.

Always move the operation selector switch on the generator set or automatic transfer switch to "STOP," disconnect the starting batteries of the generator set, and remove AC line power to the automatic transfer switch before performing maintenance or adjustments (unless specified otherwise in the instructions—then only using extreme caution due to danger of shock hazard).

Before removing the disconnect plug, if equipped, for deenergizing the control panel, be sure to place the operation selector switch on the generator set or automatic transfer to the "STOP" position. Neglect of this procedure results in set starting and energization of the transfer switch generator side.

Use rubber insulative mats placed on dry wood platforms over floors which are metal or concrete when working on any electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling any electrical equipment.

Jewelry is a good conductor of electricity and should be removed when working on the electrical equipment.

Do not work on this equipment when mentally or physically fatigued.

TABLE OF CONTENTS

GENERAL INFORMATION

INTRODUCTION

This Operator's Manual provides the information necessary for the successful operation of Onan's Series TS transfer switches. The manual includes installation, description, operation, and adjustment chapters. A troubleshooting guide and service information are also included. Operators should become familiar with this manual and especially the operation procedures that apply to their Series TS transfer switch.

TRANSFER SWITCH APPLICATION

Transfer switches are an essential part of a building's standby or emergency power system. The normal power source, commonly the utility line, is backed up by an emergency power source, often an electric generating set. A transfer switch supplies the electrical load with power from one of these two power sources. The load being served is connected to the common of the transfer switch as in Figure 1. Under normal conditions the load is supplied with power from the normal source as illustrated. Should the normal power source be interrupted, the load is transferred to the emergency power source. When normal power returns, the load is retransferred to the normal power source. The transfer and retransfer of the load are the two most basic functions of a transfer switch.

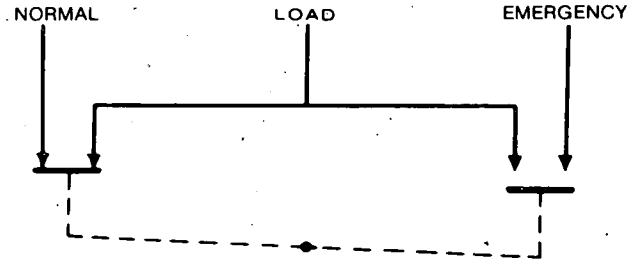


FIGURE 1. TRANSFER SWITCH

AUTOMATIC TRANSFER SWITCHES

Automatic transfer switches are capable of operation without operator involvement. During automatic operation, automatic transfer switches perform the following basic functions:

1. Senses the interruption of the normal power source.
2. Sends a start signal to the electric generating set.
3. Transfers the load to the emergency power source.
4. Senses the return of the normal power source.
5. Retransfers the load to the normal power source.
6. Sends a stop signal to the electric generating set.

Other functions available include the following:

1. Standby-to-standby operation (automatic transfer to a backup generating set if the standby generator fails).
2. Prime power operation with periodic set rotation.
3. Preferred source selection, manual or automatic, for multi-generator installations.
4. A wide variety of metering/indicator options.
5. Protective features to isolate and/or shutdown the affected power source when voltage and/or frequency are out-of-bounds. Load transfer to an alternate source of power occurs automatically when the source becomes available.

INSTALLATION

LOCATION

Locating the transfer switch in the existing electrical circuit varies with application and type of entrance switch. There must be a switch and fuses in the commercial power line before the transfer switch. See the typical installation in Figure 2.

MOUNTING

Choose a vibration-free mounting surface. See Figure 2. Avoid hot, moist, or dusty locations.

Wall Mount

1. Install two top mounting bolts in the wall for the top cabinet mounting keyholes.
2. With the shipping box standing so the cabinet is upright, carefully remove the top and sides of the box.
3. Raise cabinet and mount on the two mounting bolts in the wall (using cabinet keyholes).

WARNING **Be sure to have sufficient manpower for lifting cabinet to prevent serious personal injury.**

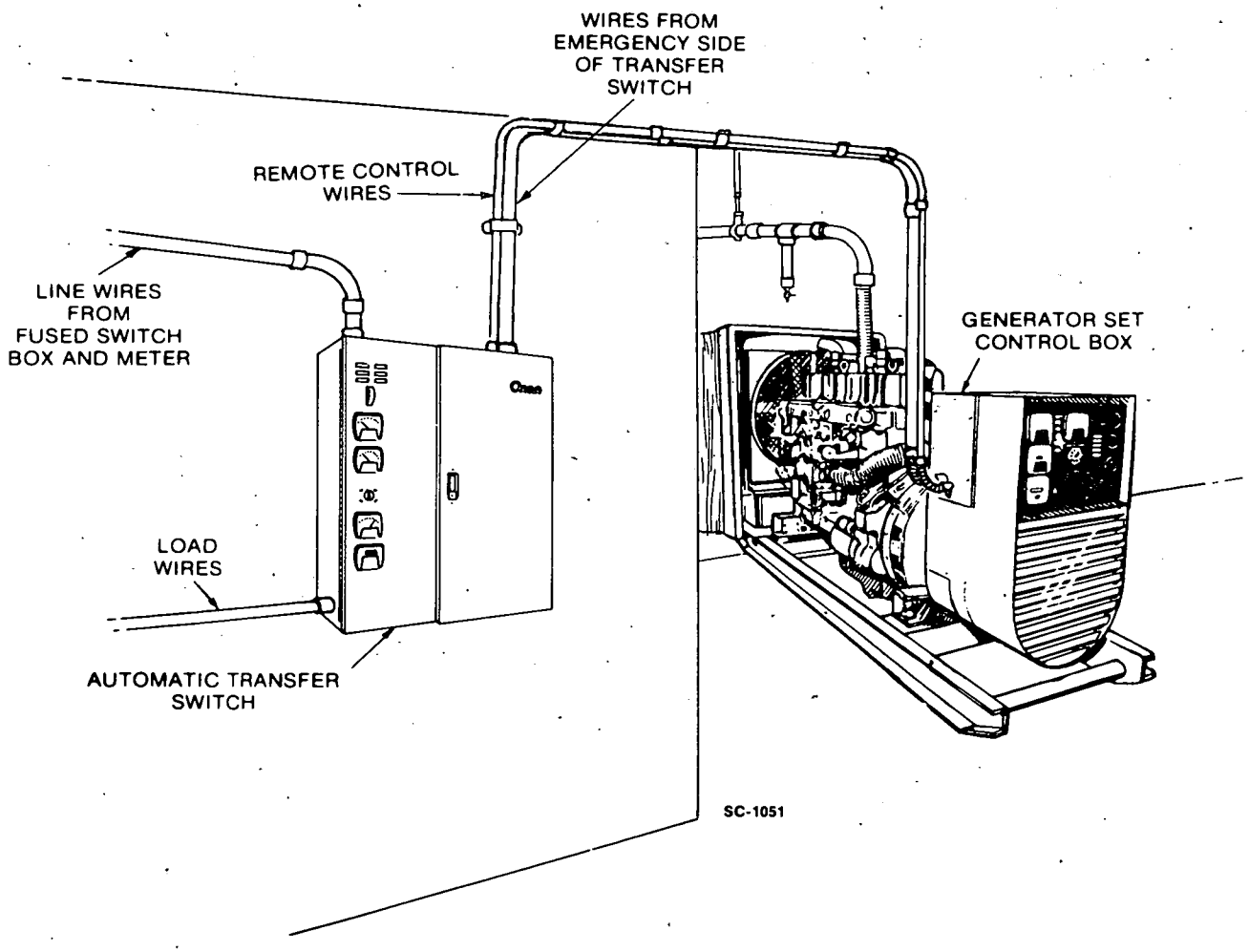


FIGURE 2. TYPICAL AUTOMATIC TRANSFER SWITCH INSTALLATION

4. Open cabinet, remove twist-lock disconnect plug (when used) and open control panel.
5. Remove screws from latch panel and remove panel.
6. Tighten two top mounting bolts.
7. Install two bottom mounting bolts and tighten.

Floor Mount

1. With the shipping box standing so the cabinet is upright, carefully remove the top and sides of the box.
2. Connect a hoist or similar lift to the two lifting eyebolts on the cabinet top.

WARNING **Do not attempt to lift manually because of the danger of serious personal injury.**

3. Carefully raise the cabinet and move it to its installation location. Mounting bolts are usually placed in concrete when floor is poured. Bolts should protrude about one inch (25 mm) from floor. Secure the cabinet to the floor.

WIRING

Onan suggests to the qualified personnel that the wiring be performed in this sequence:

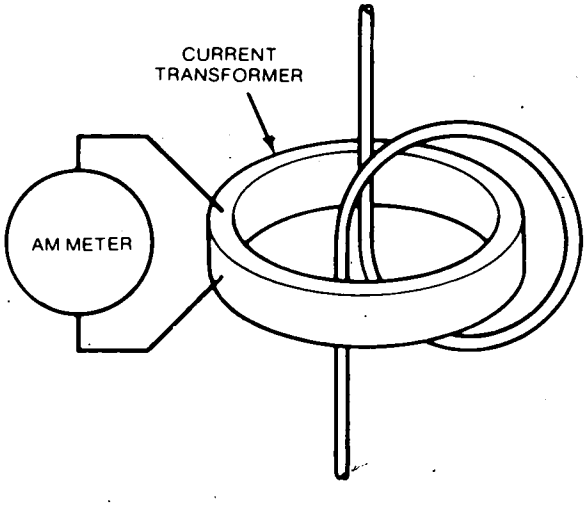
1. Before wiring is started, test the operation of the generator set from its own controls.
2. Put generator set's control switch at "stop" and remove the negative lead from the cranking battery.
3. Connect wires of sufficient size to carry rated current from the line, load, and generator set directly to the transfer switch terminals which are marked A, B, and C (A and B on single-phase switches). Table 1 gives the type and maximum wire size the transfer switch will accept.

On the 800 and 1000 ampere TS cabinets, the bottom cabinet panel can be removed for wire connections.

For TS automatic transfer switches with an AC ammeter, the generator load wires must pass through the transformer twice (two primary turns) for a 100-ampere TS, once (one primary turn) for any 150-through 1000-ampere TS. See Figure 3.

4. Neutral Bar (if used): Connect the neutral wires to the neutral bar (Figure 4). Table 1 lists the wire sizes and types the neutral bar accepts.
5. Area Protection or Remote Test Switch (if used):
   a. Remove terminal jumper located between terminals 4 and 5 of terminal strip TB1 (Figure 5).
   b. Connect the two leads from the normally closed circuit of area protection equipment or single-pole, single-throw remote test switch to terminals TB1-4 and TB1-5. Use number 16 wire up to 800 feet or 244 metres (maximum resistance of 4 ohms per line).

100 AMPERE TS (TWO TURNS)



150 THROUGH 1000 AMPERE TS (ONE TURN)

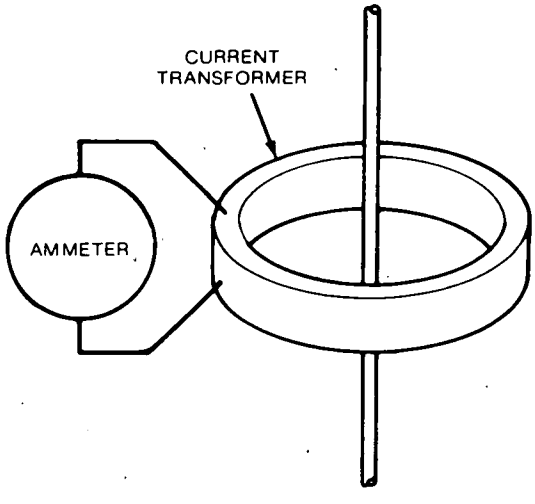
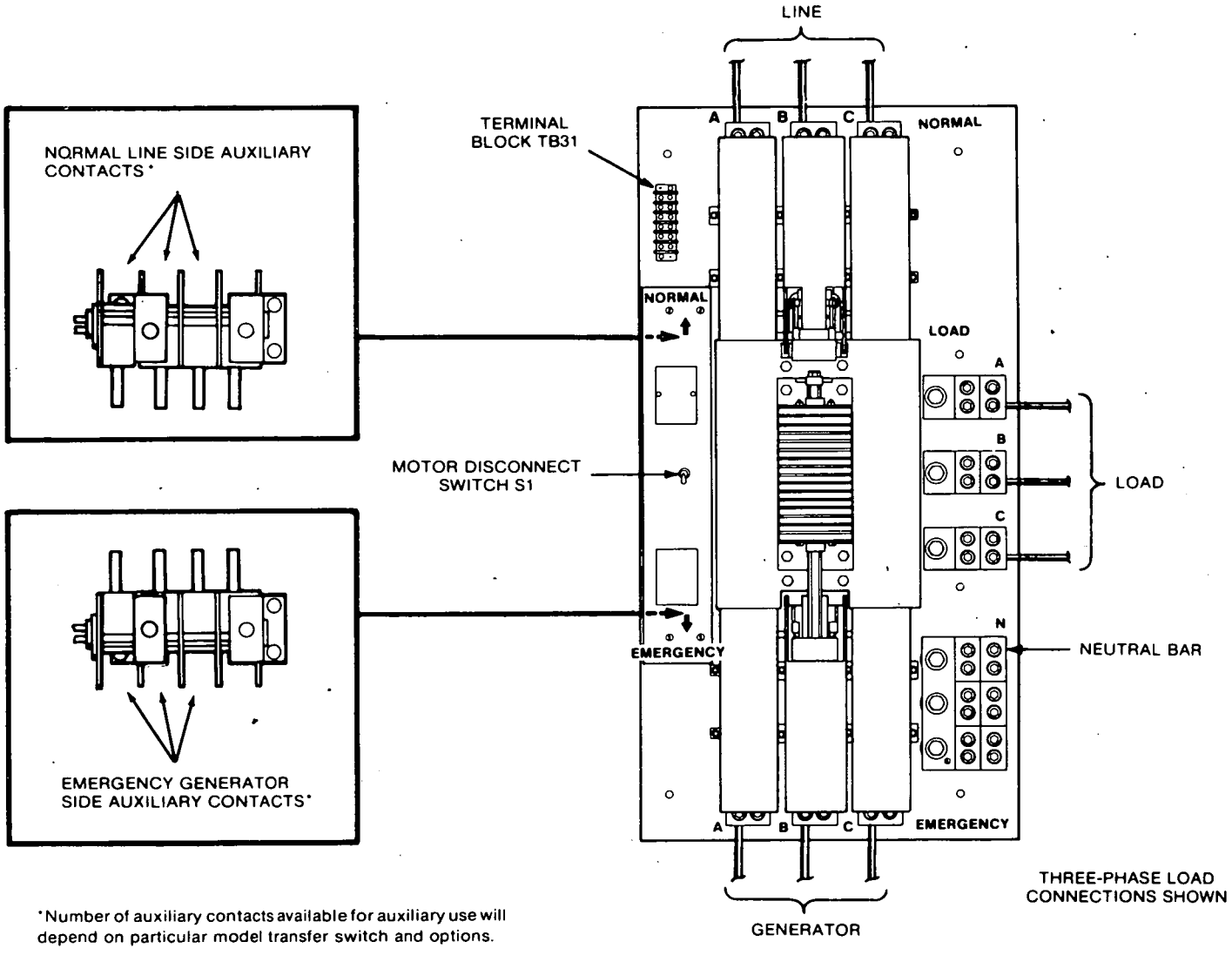


FIGURE 3. CURRENT TRANSFORMER WIRING



*Number of auxiliary contacts available for auxiliary use will depend on particular model transfer switch and options.

FIGURE 4. TRANSFER SWITCH WIRE CONNECTIONS

TABLE 1. SERIES TSA TRANSFER SWITCH WIRE CAPACITIES

TRANSFER SWITCH (AMPERES)	TERMINAL LUGS Number of Conductors and Size Per Pole	
	Switch Pole*	Neutral Bar*
100	ONE No. 6 - 250 MCM	ONE No. 6 - 250 MCM
150 & 225	ONE No. 6 - 350 MCM	ONE No. 6 - 350 MCM
280	ONE No. 4 - 500 MCM	ONE No. 4 - 500 MCM
400	ONE 350 MCM -1000 MCM	ONE 350 MCM - 1000 MCM
600	TWO No. 2 - 600 MCM	TWO No. 2 - 600 MCM
800 & 1000	FOUR No. 2 - 600 MCM	FOUR No. 2 - 600 MCM

* Connectors compatible with copper and aluminum.

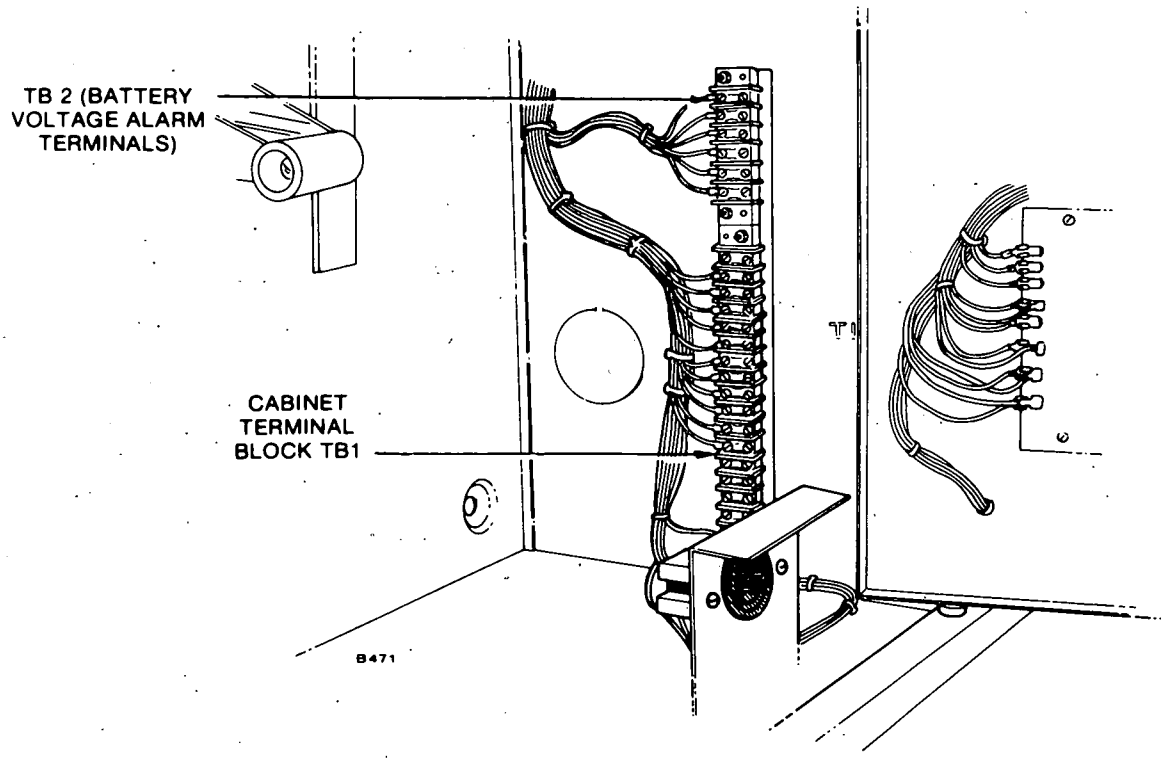


FIGURE 5. CABINET TERMINAL BLOCKS TB1 and TB2

6. Transfer Inhibit Circuit: To inhibit transfer of the automatic transfer switch by another automatic transfer switch (for paralleling systems, priority selection systems, etc.), remove the jumper between TB1-6 and TB1-7. Connect the wire leads from the external equipment to these two terminals. See Figure 5.

7. Diesel Preheat Time Delay (if used): If this delay is used for operation of glow plugs on three-wire start generator sets, connect a wire from terminal TB1-H in the automatic transfer switch (three-wire starting only) to terminal "H" on the generator set. Use number 16 wire for distances up to 100 feet or 31 metres (maximum of 0.5 ohm per line). See Figure 5.

8. Onan Annunciator Connector for Overcrank (if used): Connect a wire from terminal TB1-53 in the automatic transfer switch (three-wire starting only) to terminal 53 on the Onan annunciator panel (Figure 5). Use number 16 wire for distances up to 800 feet or 244 metres (maximum of 4 ohms per line).

The three-wire starting automatic transfer switch supplying the start-stop signals must use the 2 to 3 wire converter 300-0926.

9. Auxiliary Contacts (if used): Auxiliary contacts are located on the normal and emergency sides of the transfer switch for external alarm or control circuitry. To gain access to the auxiliary contacts, remove the transfer switch cover which houses the motor disconnect switch S1 (cover held in place by four screws). See Figure 4. The contacts have ratings of 25 amperes at 125, 250, or 480 VAC; 1 horsepower at 125 VAC; 2 horsepower at 250 VAC or 480 VAC; and a pilot duty rating of 750 VA at 277 VAC maximum.

Run all low voltage DC control wires in a separate conduit from AC wires. Use a flexible conduit between generator set and automatic transfer switch to prevent transmission of vibration.

10. Connect the low voltage DC control wires from the automatic transfer switch to the generator set. Refer to the control interconnection diagram supplied with the equipment.

11. Three-Phase Only: Phase rotation must be checked and corrected before any load can be added to the generator set. Use the following procedures:

    a. Connect an Onan load-test panel, phase rotation meter or three-phase motor to the transfer

switch load terminals. Connect power to the line side (normal) of the transfer switch and observe rotation.

b. Connect the battery and start the generator set. Check the phase rotation of the generator lead connections on the transfer switch. If this phase rotation is different from that of normal power, reverse two of the generator leads on the transfer switch.

CHECKOUT PROCEDURES AFTER INSTALLATION

After the generator set and automatic transfer switch are properly installed, check the various automatic transfer switch functions. Follow the appropriate checkout procedure for the automatic transfer switch, depending on whether it has a solid-state or relay control accessory group.

Solid-State Control Accessory Groups

Check Switch Positions

1. Operation Selector Switch.
   For a two-wire starting automatic transfer switch, move the operation selector switch on the generator set to "STOP." For three-wire starting automatic transfer switches, move operation selector switch to "STOP."
2. Move the load selector switch to "WITHOUT LOAD."
3. Move test transfer switch to "NORMAL."

Connect AC Line

Connect the AC normal line service to the automatic transfer switch. The transfer switch should transfer the load to the line and should light the green "NORMAL" lamp (if equipped with lamps).

Connect the Battery

Charge ammeter should now indicate a charging current (if equipped with battery charger).

Test Overcrank Function

1. Two-wire starting.
   a. Disconnect the positive lead from the starter (insulate lead so it can not touch metal frame).
   b. Move the operation selector switch on the engine control to "RMT".
   c. Move the test transfer switch to "TEST." "Fault" or "overcrank" lamp on engine control should light at the end of crank period (usually factory set at 75, ±15 seconds).
   d. Move test transfer switch to "NORMAL."
   e. Move the generator set operation selector switch to "STOP."
   f. Reconnect positive lead to starter.
   g. Move generator set operation selector switch to "RMT."
2. Three-wire starting.
   a. Disconnect positive start lead from the start solenoid or starter.
   b. Move the operation selector switch to "NORMAL."
   c. Move test transfer switch to "TEST." "Overcrank" lamp on automatic transfer switch should light at end of crank period (usually factory set at 75, ±15 seconds).
   d. Move test transfer switch to "NORMAL."
   e. Move the operation selector switch to "STOP" and push the "PUSH TO RESET" button (overcrank lamp should go out).
   f. Reconnect positive lead to starter or start solenoid.
   g. Move the operation selector switch to "NORMAL."

Starting Test

1. Two-wire starting.
   a. Move selector switch on engine control to "RUN." Generator set should start and run.
   b. Move selector switch to "RMT." Generator set should stop.
2. Three-wire starting
   a. Move the operation selector switch on 2 to 3 wire converter to "HAND CRANK."
   b. Push start button on generator set control. Generator set should start and run.
   c. Move the operation selector switch from "HAND CRANK" to "STOP." Generator set should stop.
   d. Move the operation selector switch to "NORMAL." Generator set should not start.

Test Without Load

1. Make sure the load selector switch is poisitoned at "WITHOUT LOAD."
2. Move test transfer switch to "TEST." Generator set should start and run.
3. Move test transfer switch to "NORMAL." Generator set should stop.

Exercise Without Load (if equipped with exerciser)

1. Make sure the load selector switch is positioned at "WITHOUT LOAD."

(Illustration not available at time of manual publication.)

FIGURE 6. TYPICAL MODEL AUTOMATIC TRANSFER SWITCH

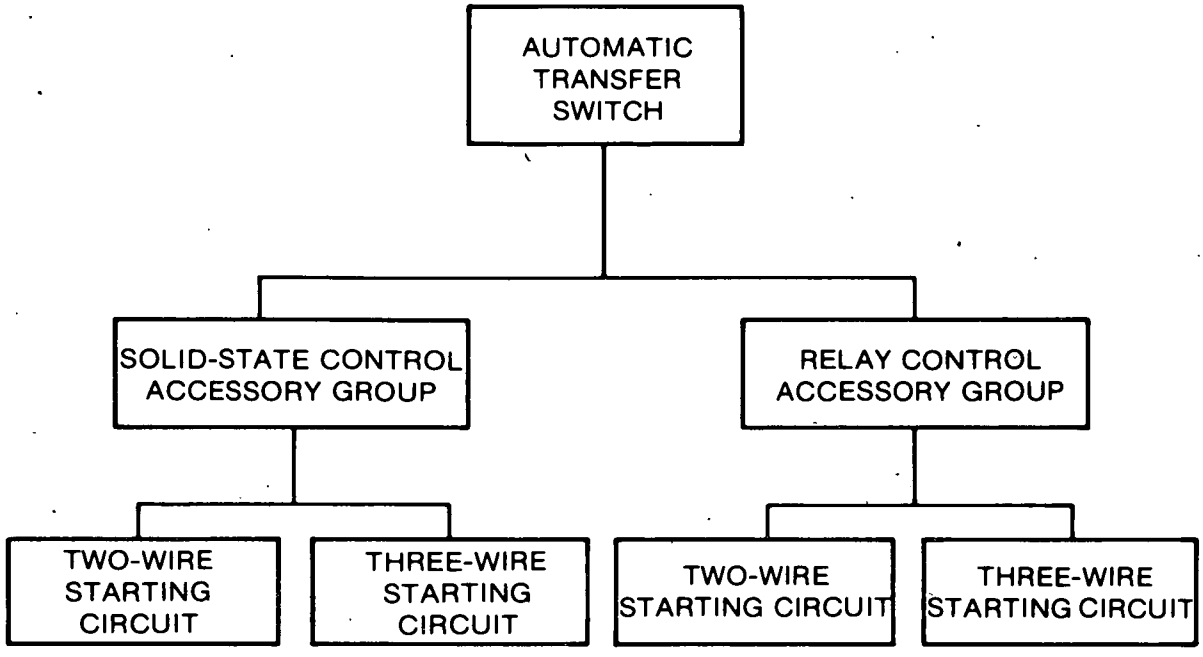


FIGURE 7. CONTROL ACCESSORY GROUPS

Solid-State, Two-Wire Controls

The majority of supervisory functions in the solid-state controls are executed by solid-state plug-in modules. The solid-state controls may include, as the application requires, voltage sensing modules, timing modules, a control voltage module, and starting battery modules. The remaining supervisory functions are provided by control switches, and an exerciser clock. All control components are mounted on the control accessory panel. Figure 6 illustrates a typical solid-state control accessory panel.

AC VOLTAGE SENSORS

Solid-state voltage sensor modules, illustrated in Figure 8, monitor the voltage of both the normal line and the generator output. The normal line may be monitored for both undervoltage and overvoltage conditions. The generator output is monitored for undervoltage conditions only.

Voltage sensor modules have two adjustments. One adjustment sets the pickup voltage. The pickup voltage scale is graduated from 90 to 140 volts, based on a nominal 120 volt system. For other voltage systems, the scale must be corrected using the multiplying factor given in Table 2 (also given on the panel).

The second adjustment is the dropout differential. The dropout differential is a percentage, adjustable from 5 to 20%, of the pickup voltage. The dropout differential is subtracted from the pickup voltage to arrive at the dropout voltage. The dropout voltage is always lower than the pickup voltage by the dropout differential.

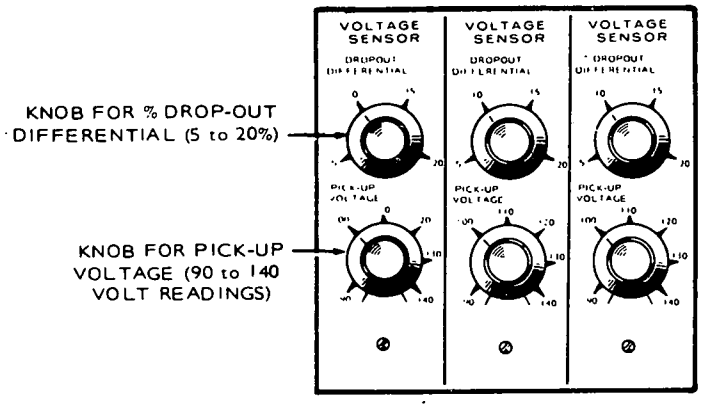


FIGURE 8. VOLTAGE SENSORS

TABLE 2. VOLTAGE FACTORS

VOLTAGE	MULTIPLYING FACTOR
120	1.0
208	1.73
240	2.0
480	4.0
600	5.0

Line Voltage Sensors: The normal line can be sensed for undervoltage and overvoltage using voltage sensor modules. When a line undervoltage or overvoltage condition exists, as defined by the pickup voltage setting and dropout differential, the voltage sensor module initiates the start signal sequence. When line voltage returns to normal, the voltage sensor module initiates the stop signal sequence. Table 3 gives the range of adjustment and function of voltage sensors in both undervoltage and overvoltage applications.

TABLE 3. LINE VOLTAGE SENSING

UNDERVOLTAGE SENSING	
Generator Set Starts (drop-out voltage)	**Generator Set Stops (pick-up voltage)**
5 to 20% below pick-up voltage setting	75 to 100% of normal voltage
OVERVOLTAGE SENSING	
Generator Set Starts (pick-up voltage)	**Generator Set Stops (drop-out voltage)**
101 to 116% of normal voltage	5 to 20% below pick-up voltage

One voltage sensor module is required for each phase of the line being sensed. For example, a three phase line being sensed for undervoltage and overvoltage between all phases would require six voltage sensor modules in the control accessory group.

Generator Voltage Sensor: The generator output voltage is sensed for an undervoltage condition only, across two lines, single phase. One voltage sensor module is used. The pickup voltage setting is the generator output voltage at which transfer of the load to the generator set is allowed to occur. If the generator output voltage falls below the dropout voltage and line voltage is present, the voltage sensor initiates retransfer of the load to the normal power source.

TIMING MODULES

The supervisory functions of the control may include several adjustable time delays before or after an event. For example, to prevent the generator set from starting when power interruptions of very short duration occur, a delay can be timed that disregards the short interruption. The solid-state modules that provide timing functions include: the Transfer-Retransfer module, and the Start-Stop module. Table 4 gives the duration of the time delays and the factory settings.

Transfer-Retransfer Module: The solid-state transfer-retransfer module provides adjustable time delays before the events of transfer and retransfer are allowed to occur. The transfer time delay begins at the moment that the generator output voltage reaches the pickup voltage setting of the generator voltage sensor. At the end of the transfer delay, the transfer switch is allowed to operate, transferring the load to the emergency power source. The purpose of the very brief transfer delay is to allow the electric generating set to stabilize before the load is applied.

The retransfer time delay begins at the moment that normal line voltage returns. At the end of the retransfer time delay, the transfer switch is allowed to retransfer the load to the normal power source. The

TABLE 4. ADJUSTABLE TIME DELAYS

TIME DELAY	TIME RANGE	FACTORY SETTING (if any)
Starting	0.1 to 15 sec. 0.5 to 615 sec.*	2.5 sec. —
Transfer, Retransfer	0.1 to 15 sec. 0.5 to 30 min.	2.5 sec. 10 min.
Stopping	0.1 to 10 min.	5.0 min.
Preheat	5 to 90 sec.	60 sec.

* Programmable start-stop timer.

purpose of the longer retransfer time delay is to allow the normal power source to stabilize before retransfer.

Start-Stop Module: The solid-state start-stop module provides adjustable time delays before the electric generating set is allowed to start or stop. The start time delay begins at the moment of normal power interruption. If the duration of the power interruption exceeds the start time delay, the start signal is sent to the electric generating set. The purpose of the start time delay is to prevent the generator set from starting when power interruptions of very short duration occur. The stop time delay begins timing when the load is retransferred to the normal power source. At the end of the stop time delay, the stop signal is sent to the generator set. The purpose of this time delay is to allow the generator set to cool down while running at no load.

CONTROL VOLTAGE MODULE

A solid-state control voltage module supplies components of the control accessory group with their voltage requirements. There are two possible control voltage modules. Both use the engine starting battery as a source. If the battery is twelve volts, the module will be twelve volts. If the starting battery is twenty-four volts, the module will convert twenty-four to twelve volts.

BATTERY CHARGER MODULE (when used)

The solid-state battery charger module is voltage regulated to float charge the battery continuously without damage to the battery. The maximum output of the charger is two amperes. As the battery approaches full charge, the charging current tapers to zero amperes or to the steady state load on the battery.

The battery charger operates from the normal power source only. It will not charge during emergency operation. The battery charging module is protected by a fuse mounted on the control accessory panel. The battery charger module can be used with either lead acid or nickel cadmium batteries.

BATTERY VOLTAGE SENSOR MODULE

The solid-state battery voltage sensor, either 12 or 24 volt, monitors the battery charging system. If the battery charger is exceeding a safe float voltage, the sensor lights the high battery voltage indicating lamp. If the battery charger allows the battery voltage to drop below a safe limit, the sensor lights the low battery voltage indicating lamp.

CONTROL SWITCHES

The control switches included in the control accessory group allow the operator to select the different operations as they are required. Solid-state control accessory groups always include the Test Transfer Switch and the With or Without Load Selector Switch. Some solid-state control accessory groups may also include the Retransfer Selector Switch and the Push to Retransfer Switch.

Test Transfer Switch: The test transfer switch is used to simulate a power interruption for test purposes. The test transfer switch has two positions; normal and test. In the NORMAL position, the transfer switch is set for automatic operation. The TEST position sends a start signal to the electric generating set.

With or Without Load Selector Switch: This two position switch determines whether or not the automatic transfer switch will connect the load to the electric generating set during test and exercise periods. The two positions are WITH LOAD and WITHOUT LOAD. The position of the load selector switch does not affect normal operation.

Retransfer Selector Switch: The retransfer selector switch sets the operation of the retransfer function only. The switch has two positions. In the automatic position, AUTO, the transfer switch will retransfer the load to the normal source without operator involvement. In the MANUAL position, the transfer switch will not retransfer until retransfer is initiated manually by the operator.

Push to Retransfer Switch: This momentary switch provides the means to manually initiate retransfer of the load to the normal power source when the retransfer selector switch is in the manual position.

EXERCISER CLOCK

The exerciser clock initiates the starting of the electric generating set at set times. The electric generating set will run, or exercise, for preset intervals. The exerciser clock is a fourteen day, twenty-four hour clock. A large dial divides the twenty-four hour day into intervals of fifteen minutes each. A smaller spoked dial divides two weeks into one day segments. Exercise periods are set by the placement of trip pins in the dial faces. See Adjustments. The normal source powers the exerciser clock. Reset the clock after interruptions of the normal power source.

CONTROL ACCESSORY PANEL

The control accessory panel is the swinging panel directly behind the locking cabinet door. The control devices are mounted on the panel. See Figure 9.

The solid-state control accessory panel has three printed circuit board racks with positions 1 through 18 for plug-in modules. All the following modules used in automatic transfer switches are listed after the number position they occupy in the control accessory panel. Note that some positions list more than one module. If the automatic transfer switch is single-

phase, for example, only one line undervoltage sensor is used and it is located in position 1. Positions 2 and 3 will have blank modules.

Position	Module
1	Line undervoltage sensor (1 phase or 3 phase)
2	Line undervoltage sensor (3 phase), bypass, or blank
3	Line undervoltage sensor (3 phase), bypass, or blank
4	Generator undervoltage sensor (1 phase)
5	12 volt module, or 24 to 12 volt converter
6	12 or 24 volt battery charger or blank
7	Start-Stop or bypass
8	Transfer-Retransfer or bypass
9	2 or 3 wire converter or blank
10	12 or 24 volt battery voltage sensor or blank
11	Blank
12	Blank
13	Line overvoltage sensor (1 phase or 3 phase) or blank
14	Line overvoltage sensor (3 phase) or blank
15	Line overvoltage sensor (3 phase) or blank
16	Preheat or blank
17	Blank
18	Blank

The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The operation selector switch must be moved to STOP, located on the two to three-wire converter module with three-wire starting, or, on the engine control with two-wire starting; and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

Solid-State, Three-Wire Controls

A solid-state, three-wire control is built on the foundation of a solid-state, two-wire control. As a result, all of the features in the preceding description on two-wire controls can be found in three-wire controls. In addition, solid-state, three-wire controls will always include a two to three wire converter module. If the application requires, a preheat time delay module may also be included.

TWO TO THREE-WIRE CONVERTER MODULE

This solid-state module is used to convert a two-wire starting control into a three-wire starting control. The major features of the two to three-wire converter are: an operation selector switch, the cranking limiter, and the cranking limiter reset. See Figure 9.

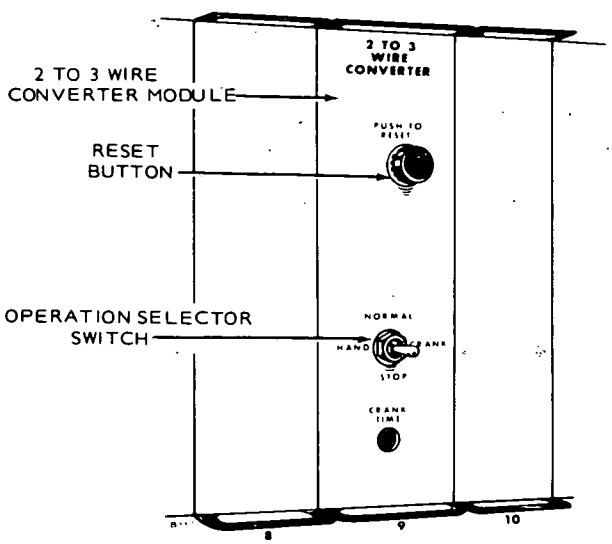


FIGURE 9. 2 TO 3 WIRE CONVERTER MODULE

Operation Selector Switch: The operation selector switch controls the operation of the three-wire starting electric generating set. The operation selector switch has three positions: STOP, HAND CRANK, and NORMAL.

STOP: Shuts down the generator set and prevents it from starting. Use this position when servicing the generator set.

HAND CRANK: Prevents the automatic transfer switch from starting the generator set but allows starting and stopping at the generator set. Use this position for generator set maintenance.

NORMAL: Allows the generator set to start and assume the load if a power interruption occurs. This is the normal operating position.

Cranking Limiter: The cranking limiter is a protective circuit that limits the time the engine starter motor is engaged. If the electric generating set doesn't start within the adjustable time limit, the cranking limiter opens the starting circuit disengaging the engine starter motor. The OVERCRANK indicating lamp will be lit.

Cranking Limiter Reset: When the cranking limiter opens the starting circuit, the cranking limiter reset will restore the cranking limiter, after the engine starting problem has been resolved. See overcrank in the Operation Chapter.

PREHEAT TIME DELAY MODULE

The solid-state preheat time delay module may be used with three-wire starting diesel engines to provide a preheat function. The preheat module prevents the engine starter motor from engaging until the adjustable preheat time delay is complete.

Relay Two-Wire Controls

Relay controls use adjustable time delay relays to provide the timing functions required by the application. Relay controls may include, as the application requires: solid-state voltage sensing modules, time delay relays, control switches, a solid-state battery charger, and an exerciser clock. The components of the control are mounted on the hinged control accessory panel as illustrated in Figure 10.

AC VOLTAGE SENSORS

Relay controls use the same solid-state voltage sensor modules for line undervoltage and line overvoltage sensing as the solid-state controls. See the preceding description of AC line voltage sensors.

TIME DELAY RELAYS

Adjustable time delay relays provide the timing functions in relay controls. The time delays that the application may require are: a time delay before starting, a time delay before stopping, a time delay before transfer, and a time delay before retransfer. Table 5 gives the time ranges of the adjustable time delay relays.

TABLE 5. ADJUSTABLE TIME DELAYS

TIME DELAY	TIME RANGE	SUGGESTED SETTING
Starting	1 to 300 sec.	1 to 3 sec.
Transfer	1 to 300 sec.	5 to 10 sec.
Retransfer	2 to 60 min.	10 min.
Stopping	2 to 60 min.	5 min.
Preheat	1 to 300 sec.	60 sec.

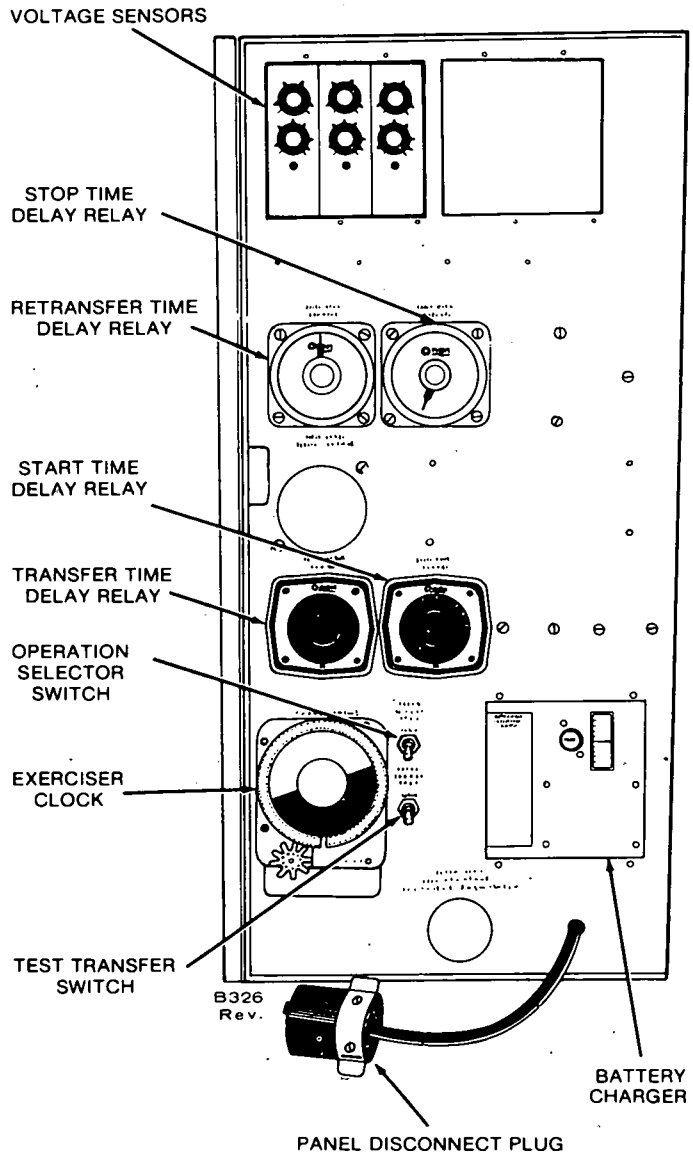


FIGURE 10. RELAY, TWO-WIRE, CONTROL ACCESSORY PANEL

Time Delay Before Starting: This time delay relay is used to prevent the electric generating set from starting when short duration interruptions of the normal power source occur. If the duration of the normal power interruption exceeds the setting of this time delay relay, the start signal will be sent to the electric generating set.

Time Delay Before Stopping: This time delay relay is used to allow the electric generating set to run at no load after retransfer. This running period at no load helps cool the electric generating set. The setting of this time delay relay is the length of time after retransfer that the electric generating set will run before stopping.

Time Delay Before Transfer: When the electric generating set reaches pickup voltage, the transfer time delay relay will retard the operation of the transfer switch for the length of time delay setting. This usually brief delay allows the electric generating set to stabilize before load is applied.

Time Delay Before Retransfer: When the normal power source returns after an interruption, it will sometimes fluctuate before it becomes stable. The retransfer time delay relay will keep the transfer switch from retransferring the load to the restored normal source for the duration of its setting.

BATTERY CHARGER

The solid-state battery charger has a maximum two-ampere output and is voltage regulated to "float charge" the battery continuously without damage to the battery. As the battery approaches full charge, the charging current automatically tapers to zero amperes or to steady-state load on the battery (keeping starting batteries fully charged). The battery charger can be used for either lead acid or nickel cadmium batteries.

The battery charger circuit is protected by a fuse. If the battery charger fails to charge, be sure to check the fuse.

CONTROL SWITCHES

The control switches on the control accessory panel allow the operator to select operation functions. The control switches with two-wire starting, relay controls are the operation selector switch and the test transfer switch. See the Operation chapter.

Operation Selector Switch: The operation selector switch is a three position switch: NORMAL, STOP, and TEST.

NORMAL: In this position, the automatic transfer switch will respond to the interruption and return of the normal power source, automatically.

STOP: In this position, the automatic transfer switch will not respond to a normal power interruption.

TEST: This position is used to start the electric generating set without applying the load.

Test Transfer Switch: This two position switch is used to test the electric generating set with the load applied. The two positions are NORMAL and TEST.

EXERCISER CLOCK

The exerciser clock initiates the starting of the electric generating set at set times. The electric generating set will run, or exercise, for preset intervals. The exerciser clock is a fourteen day, twenty-four hour clock. A large dial divides the twenty-four hour day into intervals of fifteen minutes each. A smaller spoked dial divides two weeks into one day segments. Exercise periods are set by the placement of trip pins in the dial faces. See Adjustments.

CONTROL ACCESSORY PANEL

The control accessory panel for a typical two-wire starting, relay control is illustrated in Figure 10. The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The engine operation selector switch (on the engine control) must be moved to STOP, and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the engine operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

Relay, Three-Wire Control

The three-wire starting relay control is similar to the two-wire control (see the preceding description) except for the operation selector switch and the addition of a cranking limiter. If the application requires, a preheat time delay relay may also be included. See Figure 11.

Operation Selector Switch: The operation selector switch in a three-wire relay control accessory group has four positions: NORMAL, TEST, STOP, and OFF. See the Operation chapter.

NORMAL: In this position, the automatic transfer switch is set for automatic operation.

TEST: This position is used to start the electric generating set without applying the load.

STOP: In this position, the automatic transfer switch will not operate nor will the electric generating set start. The engine starter motor can be engaged using the engine control, but the engine will not start.

OFF: In this position, the electric generating set can be started at the engine control but the automatic transfer switch will not operate.

Cranking Limiter: The cranking limiter in three-wire, relay controls is located in the upper right-hand corner of the control accessory panel as illustrated in Figure 11. The cranking limiter is an electrically operated thermal relay that protects the engine cranking circuit. The relay is energized when the start signal is sent and remains energized until the electric generating set starts. If the engine does not start in forty-five to ninety seconds, the heating element in the relay opens the starting circuit. It can be reset by allowing about one minute to cool, and then pushing the reset.

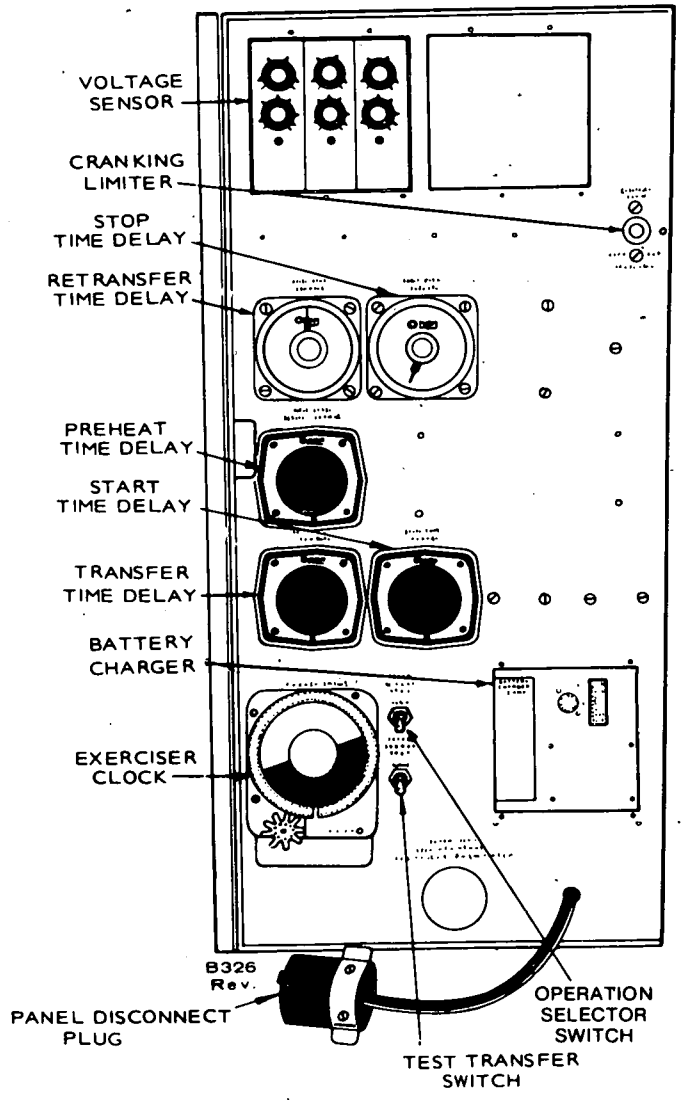


FIGURE 11. RELAY, THREE-WIRE, CONTROL ACCESSORY PANEL

TIME DELAY FOR PREHEAT

If the application requires, a time delay relay may be included that delays cranking of the deisel engine for preheating.

CONTROL ACCESSORY PANEL

A typical control accessory panel for a three-wire, relay control is illustrated in Figure 11. The control accessory panel can be swung open to allow access to the transfer switch. Before opening the control accessory panel: (1) The operation selector switch must be moved to STOP, located on the control accessory panel, and (2) The control accessory panel disconnect plug must be removed (when used), removing AC line voltage from the control accessory panel.

WARNING **If the operation selector switch is not moved to "STOP" before the disconnect plug is removed, the generator set will start and energize the transfer switch's generator side. Because the disconnect plug does not deenergize the transfer switch, the transfer switch presents a serious shock hazard unless AC power is removed from the automatic transfer switch.**

OPERATION

AUTOMATIC OPERATION

A Series TS automatic transfer switch is set for automatic operation by placing the following control switches in the positions given. The electric generating set must also be set for automatic operation.

SOLID-STATE, TWO-WIRE, CONTROL

Test Transfer Switch - NORMAL
Retransfer Selector Switch - AUTO
Motor Disconnect Switch - UP

SOLID-STATE, THREE-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Retransfer Selector Switch - AUTO
Motor Disconnect Switch - UP

RELAY, TWO-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Motor Disconnect Switch - UP

RELAY, THREE-WIRE, CONTROL

Operation Selector Switch - NORMAL
Test Transfer Switch - NORMAL
Motor Disconnect Switch - UP

RETRANSFER, MANUALLY INITIATED

The retransfer of the load, from the emergency to the normal power source, can be delayed until initiated manually by the operator. This manually initiated retransfer operation is possible only with solid-state controls that include the Retransfer Selector Switch. This procedure allows the operator to plan for the momentary interruption of service to the load on retransfer. The procedure is:

1. Place the Retransfer Selector Switch in the MANUAL position. The automatic transfer switch will not retransfer automatically when the normal power source returns.
2. Manually initiate retransfer by pushing the Push to Retransfer Switch.

If the emergency power source should fail while the Retransfer Selector Switch is in the MANUAL position, a bypass circuit will automatically retransfer the load to the normal power source, if available.

TEST OPERATION

SOLID-STATE CONTROLS

1. Place the With or Without Load Selector Switch in the desired position.
2. Move the Test Transfer Switch to TEST.
3. At end of test period, return the Test Transfer Switch to NORMAL.

During test operation, switching from WITHOUT LOAD to WITH LOAD will cause the electric generating set to stop, go through the start time delay, start, run, and go through the transfer time delay before assuming the load.

RELAY CONTROLS

Test With Load:

1. Move the Test Transfer Switch to TEST.
2. Return the Test Transfer Switch to NORMAL at the end of test period.

Test Without Load:

1. Move the Operation Selector Switch to TEST.
2. Return the Operation Selector Switch to NORMAL at the end of the test period.

EXERCISE

Onan recommends running the electric generating set for a minimum of thirty minutes, with at least fifty percent load if possible, once each week. Automatic transfer switches with an exerciser clock can be set to start and run the electric generating set at selected times automatically; see *Adjustments*. If the normal power source should be interrupted while the electric generating set is exercising without load, the automatic transfer switch will transfer the load.

SOLID-STATE CONTROLS

1. Set the exerciser clock to start the electric generating set at the desired time.
2. Place the With or Without Load Selector Switch in the desired position.

RELAY CONTROLS

1. Set the exerciser clock to start the electric generating set at the desired time. The electric generating set will run without load.

OVERCRANK

An overcrank condition exists when the electric generating set has not started within the time limit set by the cranking limiter. To restore the automatic transfer switch starting circuit:

1. Correct the engine starting problem.
2. Push the cranking limiter reset.

MANUAL OPERATION

An operator can manually transfer or retransfer a Series TS transfer switch using direct manpower. The transfer switch is equipped with manual operator handles for this purpose. Operators must follow the procedure that matches the description of their transfer switch.

WARNING **Use extreme care when operating the transfer switch manually. High voltage on transfer switch terminals presents a serious personal injury hazard.**

When the motor disconnect switch is moved from manual to automatic operation, an automatic transfer switch will return to the active power source in this order of preference: first, the normal power source; second, the emergency power source. The operator must put the transfer switch in its preferred position, manually, before moving the motor disconnect switch to automatic operation position.

WARNING **The rapid movement of the manual operator handles may cause personal injury. An automatic transfer switch must be placed in its preferred position, manually, before moving the motor disconnect switch to automatic operation.**

TS TYPE "O"
Single Actuator, 225-280 Ampere, Transfer Switch Without Programmed Transition

1. Move the motor disconnect switch to the DOWN, manual operation position.
2. Pull either manual operator handle in the desired direction; down for emergency, up for normal.
3. Automatic Transfer Switch - Return the transfer switch to its preferred position.
4. Return the motor disconnect switch to the UP, automatic operation position.

TS TYPE "O"
Single Actuator, 100-1000 Ampere, Transfer Switch, except 225-280 Ampere Without Programmed Transition

1. Move the motor disconnect switch to the DOWN, manual operation position.
2. Transfer or retransfer, following these steps:

   Transfer, from normal power to the emergency power source:

   a. Pull the upper manual operator handle down.

   b. Push the lower manual operator handle down.

   Retransfer, from emergency power to the normal power source:

   c. Pull the lower manual operator handle up.

   d. Push the upper manual operator handle up.
3. Automatic Transfer Switches - Return the transfer switch to its preferred position.
4. Return the motor disconnect switch to the UP, automatic operation position.

TS TYPE "O"
Two Actuator Transfer Switches (Switched Neutral)

Manual operation of a transfer switch with two linear actuators, those having a switched neutral pole, is different than a single actuator transfer switch. The procedure that follows will overcome the mechanical interlock which prevents disconnecting the neutral pole while the power poles are connected to either power source. The mechanical interlock also prevents the power poles from closing to either power source before the neutral pole is closed to that source.

Automatic Transfer Switches - Be sure to return an automatic transfer switch to its preferred position before resuming automatic operation.

TRANSFER, MANUAL

The procedure for manual transfer, from the normal power source to the emergency power source, is:

1. Move the motor disconnect switch to the DOWN, manual operation position. See Figure 12.

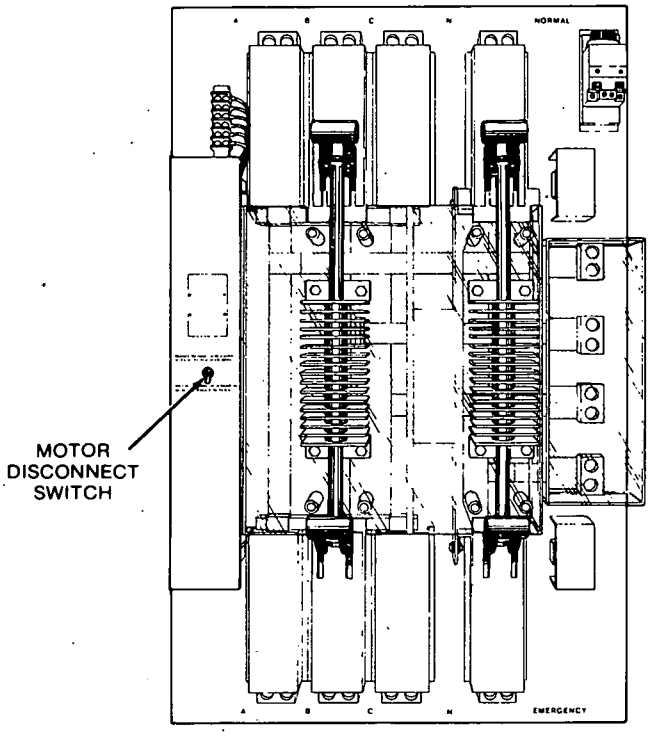


FIGURE 12.

WARNING **Automatic operation of the transfer switch can occur, causing personal injury, if the motor disconnect switch is not in the DOWN, manual operation position.**

2. Pull the top power handle down, as shown in Figure 13, disconnecting the power poles from the normal power source.

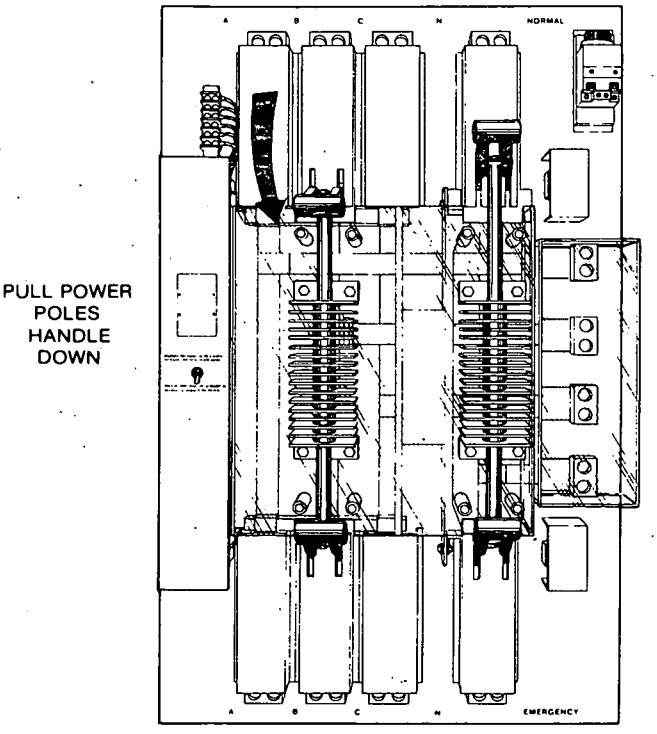


FIGURE 13.

3. Pull the top neutral pole handle all the way down, as shown in Figure 14, connecting the load neutral to the emergency neutral and disconnecting it from the normal power source.

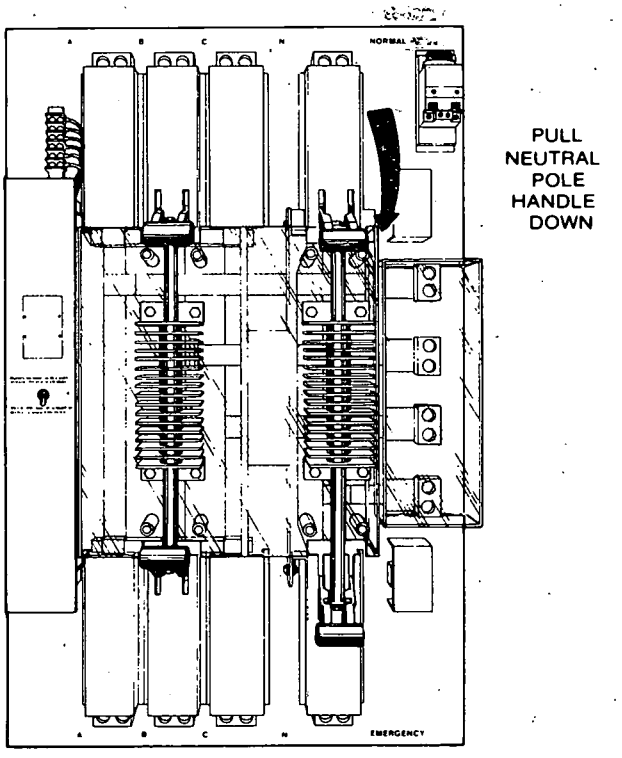
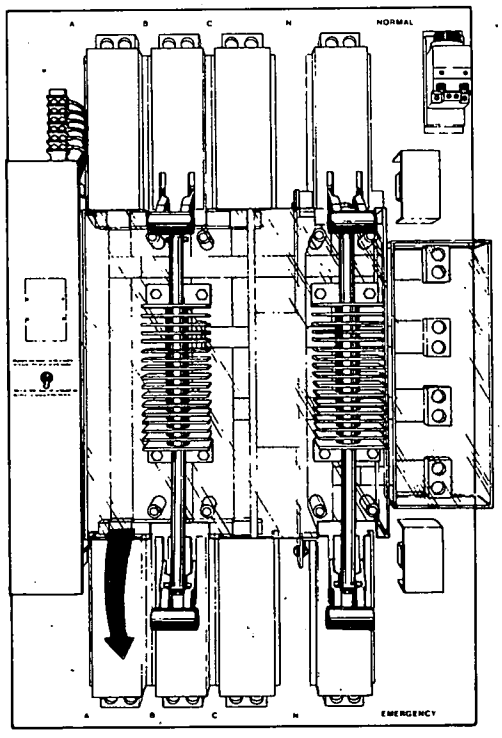


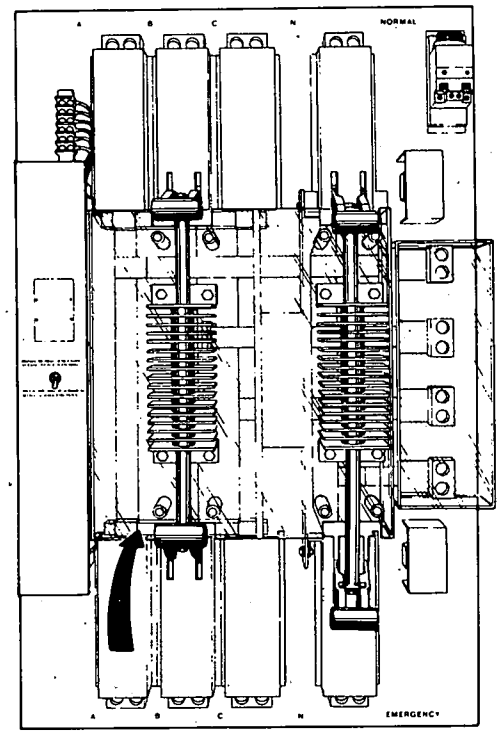
FIGURE 14.

4. Push the lower power pole handle down, as in Figure 15, connecting the load to the emergency power source. This completes the manual transfer switching sequence.



PUSH POWER POLES HANDLE DOWN

FIGURE 15.

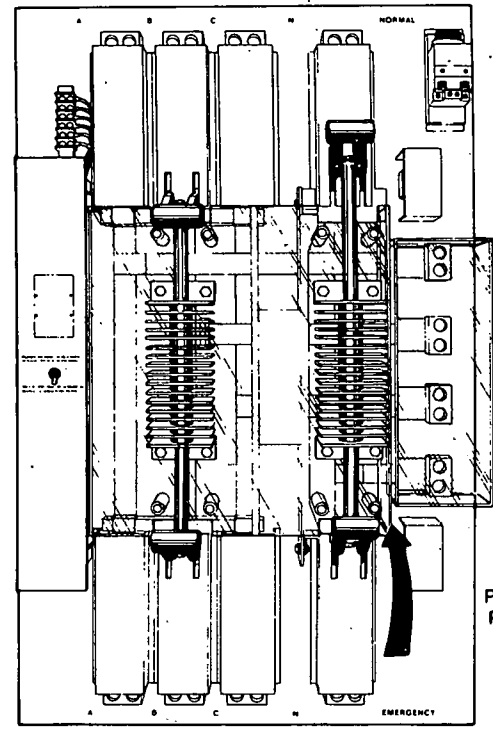


PULL POWER POLES HANDLE UP

FIGURE 16.

emergency power source.

2. Pull the lower neutral pole handle all the way up, as shown in Figure 17, connecting the load neutral to the neutral of the normal power source and disconnecting it from the emergency power source.



PULL NEUTRAL POLE HANDLE UP

FIGURE 17.

RETRANSFER, MANUAL

The procedure for manual retransfer, from the emergency power source to the normal power source, is:

With the motor disconnect switch in the DOWN, manual position:

1. Pull the lower power pole handle up, as illustrated in Figure 16, disconnecting the load from the

PUSH POWER POLES HANDLE UP

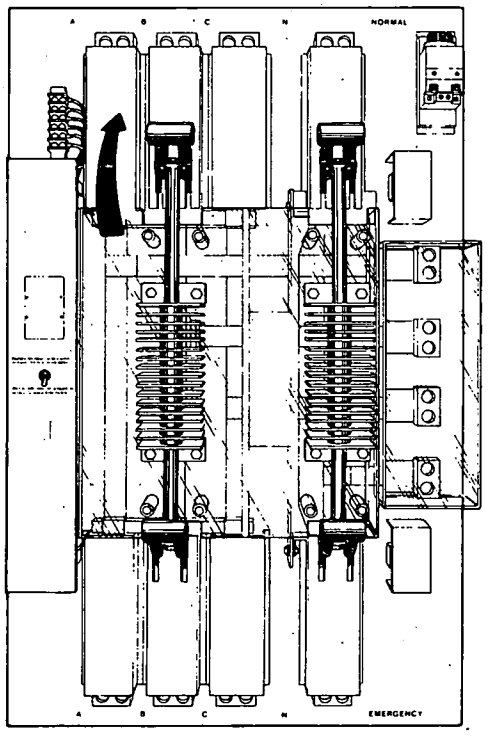


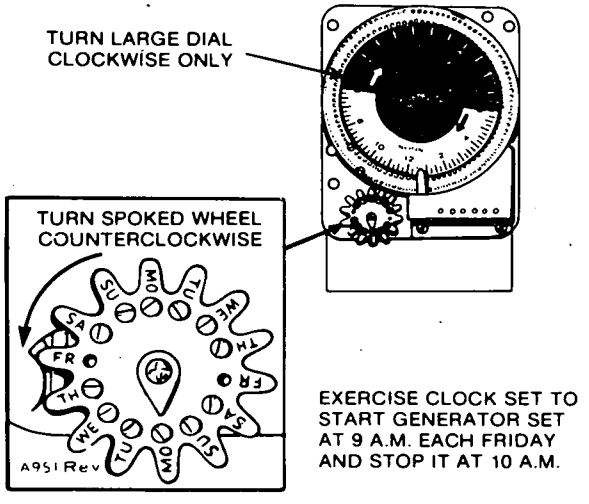
FIGURE 18.

3. Push the lower power pole handle up, as in Figure 18, connecting the load to the normal power source. This completes the manual retransfer switching sequence.
4. Being sure that the transfer switch is in its preferred position, return to automatic operation by moving the motor disconnect switch to the UP position.

ADJUSTMENTS

EXERCISER CLOCK

1. Open the cabinet door of the automatic transfer switch.
2. Move the operation selector switch (on engine control for two-wire starting, in cabinet for three-wire starting) to "STOP."
3. Install a trip pin (**left-hand thread**) in the inside row of holes on the large dial for the time of day you want the generator to start. See Figure 19.



NOTE: Trip pins are left-hand thread.

FIGURE 19. EXERCISER CLOCK

4. Place a trip pin (**left-hand thread**) in the outside row of holes on the large dial to stop the generator set.

   Onan recommends settings which operate the generator set for at least 30 minutes each week. Exercising for one long period is better than several short periods.

5. Install a trip (**left-hand thread**) in the small spoked wheel for every day **no exercise** is desired.
6. Rotate the large dial **clockwise** until the correct time is correctly aligned with the time pointer.
7. Turn the small spoked wheel **counterclockwise** until the correct day aligns with the pointer.

   Sixteen trip pins are supplied with the clock. Store unused pins on the time pointer bracket.

8. Move the operation selector switch to "RMT" (two-wire starting) or "NORMAL" (three-wire starting) whichever applies.
9. Close the cabinet door.

TIME DELAYS

Solid-State Controls

Start-Stop Time Delay: Time delay before start is factory adjusted for 2 to 3 seconds. Time delay before stop is factory adjusted for 4.5 to 5 minutes. If other times are desired, use the following procedure:

1. Open the cabinet door of automatic transfer switch.
2. Move the load selector switch to "WITH LOAD."
3. Move test transfer switch to "TEST."
4. With a stopwatch or watch with a second hand, measure the time until the generator set starts cranking.
5. Insert a small screwdriver through "START" hole in front panel of start-stop time delay module 7. Turn "START" potentiometer clockwise to increase start time delay or counterclockwise to decrease start time delay. Make adjustments in small increments.
6. Move test transfer switch to "NORMAL."
7. Measure time until generator set begins to shut down.
8. Turn "STOP" potentiometer with the small screwdriver clockwise to increase the stop time delay or counterclockwise to decrease the stop time delay. Make adjustments in small increments.
9. Repeat Steps 2 through 8 until desired delay times are obtained.
10. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."

Optional Start-Stop Time Delay: For a time delay change of the programmable timer, pull out the time delay module 7 from the control panel and change the switch settings on the side of the printed circuit board for the desired times. Table 6 lists the switch positions for the available time delays. The illustration following shows the module as viewed from the switch (right) side.

Example: For a start time delay of 2.4 seconds, close switches 1, 2, and 3, and open switch 4. For a 345-second time delay on stopping, close switches 5, 7, and 8, and open switch 6.

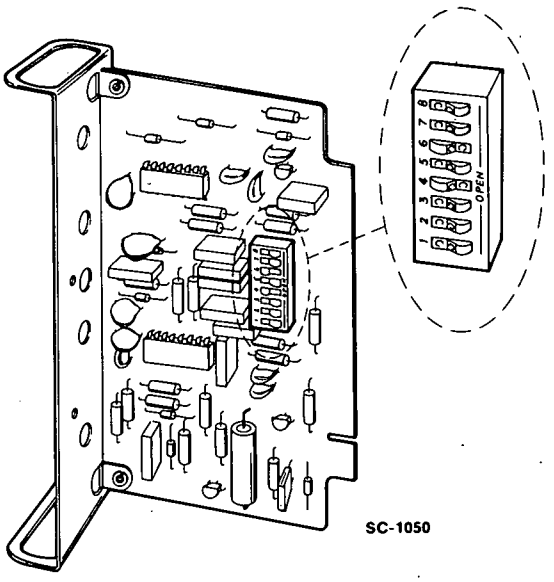


FIGURE 20. START-STOP TIME DELAY (BEGIN SPEC B)

TABLE 6. PROGRAMMABLE TIME DELAY

PROGRAMMABLE START — STOP TIMER

c = SWITCH CLOSED
o = SWITCH OPEN

SWITCH POSITIONS				
1	2	3	4	TO START
5	6	7	8	TO STOP
				TIME
o	o	c	o	0.5 sec
o	o	o	c	1.0 sec
c	o	c	o	1.4 sec
c	c	c	o	2.4 sec
c	o	o	c	5.5 sec
o	o	o	o	7.9 sec
c	c	o	c	9.6 sec
c	o	o	o	43 sec
o	o	c	c	62 sec
c	c	o	o	76 sec
c	o	c	c	345 sec
c	c	c	c	615 sec

TIME TOL ± 20%

Transfer-Retransfer Time Delay: To change the delay time of transfer-retransfer time delay module 8, use the following procedure and refer to illustration following procedure.

1. Open the cabinet door of the automatic transfer switch.
2. Move the load selector switch to "WITH LOAD."
3. Move the test transfer switch to "TEST." The generator will start and run.
4. With a stopwatch or watch with a second hand, measure the time the red transfer LED on the transfer-retransfer time delay module 8 remains lit. The red LED will turn off after the time delay is complete. If the time delay is correct or time you desire, proceed to Step 6. If not, proceed to Step 5.
5. Insert a small screwdriver through the "TRANSFER" opening (upper opening) in the front panel of the transfer-retransfer time delay module. Turn clockwise in small increments to increase the time delay, counterclockwise to decrease time delay.
6. Move the test transfer switch to "NORMAL."
7. With a stopwatch or watch with a seconds hand, count the number of flashes the bottom green LED makes in 60 seconds (Onan suggests counting for 60 seconds—shorter intervals would give less accuracy for determing time delays). Once retransfer timing is complete, the retransfer LED will turn off and the green LED will remain on for the duration of the generator set stop delay. The following list gives the correlation of pulses to time delays.

Pulses/60 sec	Time Delay (min)
50	5
25	10
17	15
13	20
10	25
8	30

If time delay is correct or time you want, proceed to Step 10. Otherwise, proceed to Step 8.

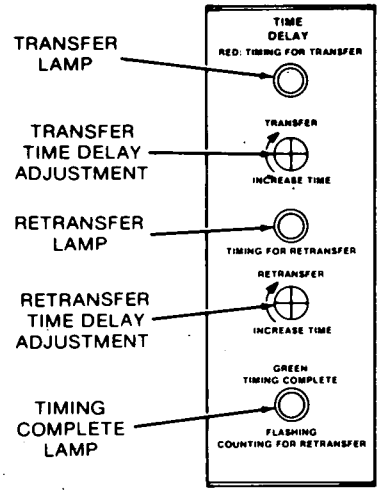


FIGURE 21. TRANSFER-RETRANSFER TIME DELAY

8. Insert a small screwdriver through the "RETRANSFER" hole (lower hole) in the front panel of the transfer-retransfer time delay module. Turn clockwise in small increments to increase the time delay, counterclockwise to decrease the time delay.
9. Repeat Steps 3 through 8 until the desired time delays are obtained.
10. Move the selector switch to "WITH LOAD" if you want the generator set to assume load during exercise or tests.
11. Close the cabinet door.

Preheat Time Delay: The preheat time delay (module 16) for diesel generator sets with 3-wire starting is adjustable from 5 to 60 seconds. To change the delay, follow these instructions:

1. Open the cabinet door of the automatic transfer switch.
2. Move the load selector switch to "WITHOUT LOAD."
3. Move the test transfer switch to "TEST."
4. With a stopwatch or watch with a second hand, measure the amount of time the small lamp on module 16 (preheat time delay module) lights before engine cranks.
5. Move the test transfer switch back to "NORMAL."
6. If time delay for preheat is set as desired, proceed to Step 9. If a different time is desired, proceed to Step 7.
7. Insert a small screwdriver through the "PREHEAT" hole in the front panel of preheat time delay module 16. Turn potentiometer clockwise to increase preheat time, counterclockwise to decrease delay. Make adjustments in small increments.
8. Repeat Steps 3 through 7 until desired preheat time is obtained.
9. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."
10. Close cabinet door of automatic transfer switch.

Relay Controls

Start, Transfer, and Preheat Time Delays: All of these time delays require the same adjustment procedures. Settings can range from 1 to 300 seconds. To make settings, perform the following:

1. Open the cabinet door of the automatic transfer switch.
2. Turn the knob on the time delay clockwise to increase delay time, counterclockwise to decrease the delay time. See Figure 22.
3. Close the cabinet door.

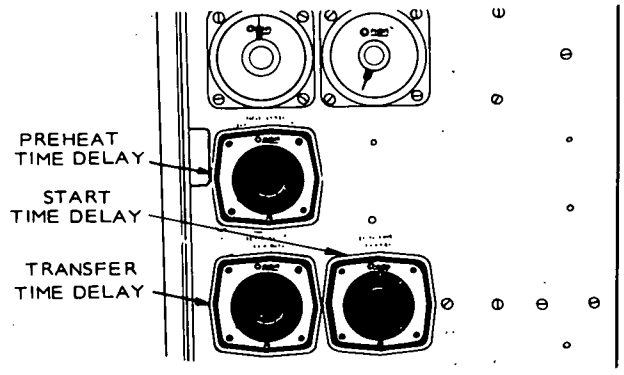


FIGURE 22. START AND TRANSFER TIME DELAY RELAYS

Stop and Retransfer Time Delays: Both of these synchronous motor-driven time delays require the same adjustment procedure. Settings can range from 2 to 60 minutes. To make settings, perform the following:

1. Open the cabinet door of the automatic transfer switch.
2. Set the time delay by turning the adjustment knob in the center of the delay. See Figure 23.

   The black pointer on the face of the time delay indicates the preset delay. The red pointer indicates the delay time left in operation.

3. Close and lock the cabinet door.

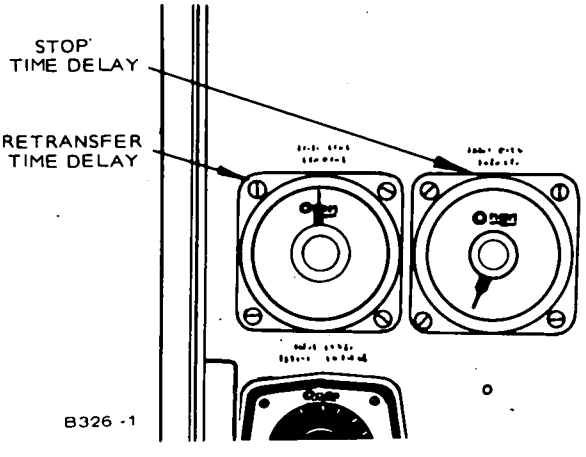


FIGURE 23. STOP AND RETRANSFER TIME DELAY RELAYS

OVERCRANK TIME SOLID-STATE CONTROL ACCESSORY GROUPS (THREE-WIRE STARTING ONLY)

Overcrank settings are made at the factory for approximately 75 ± 10 seconds cranking. To adjust perform the following.

1. Remove the positive lead from the generator set's start solenoid or starter.
2. Open cabinet door of automatic transfer switch.
3. Move the load selector switch to "WITHOUT LOAD."
4. Move the operation selector switch to "NORMAL."
5. Move test transfer switch to "TEST." Overcrank lamp on automatic transfer switch should light at end of crank period. Measure the crank time with a stop watch or watch with a second hand.
6. To change the time, insert a small screwdriver through the "CRANK TIME" hole in the front of the 2 to 3 wire converter module. Turn clockwise to increase the cranking time or counterclockwise to decrease the cranking time. Make adjustments in small increments.
7. Move test transfer switch to "NORMAL."
8. Push the "PUSH TO RESET" button on the 2 to 3 wire converter module.
9. Repeat Steps 5 through 8 until the desired cranking time is obtained.
10. Move the load selector switch to desired position, "WITHOUT LOAD" or "WITH LOAD."
11. Close and lock cabinet door.
12. Reconnect positive lead to generator set's starter or start solenoid.

BATTERY FLOAT CHARGE

For the following adjustments, a fully-charged battery, a hydrometer and an accurate voltmeter (1/2 percent accuracy) are needed. Onan recommends float voltages of: 13.3 volts for nominal 12-volt or 26.6 volts for nominal 24-volt lead-acid batteries; 14.0 to 14.5 volts for 10-cell nickel-cadmium batteries, or 28.0 to 29.0 volts for 20-cell nickel-cadmium batteries.

Lead-acid battery only: During the first few weeks of operation, the batteries should be checked periodically with a hydrometer. A high specific gravity, bubbling of electrolyte and loss of water indicate excessive float voltage. A drop in specific gravity indicates insufficient float voltage.

1. Connect the fully-charged battery (verify charge condition with the hydrometer for lead-acid batteries.)
2. Connect the voltmeter directly to the battery terminals.
3. Measure the battery voltage. If voltage is above the recommended float voltage, proceed to Step 4. If the voltage is below the recommended float voltage, proceed to Step 6.
4. Insert a small screwdriver through the hole in the front panel of battery charger module 6. Turn counterclockwise in small increments to decrease the float voltage.
5. After five minutes, measure the battery terminal voltage again. If voltage is still high, repeat Steps 4 and 5 until voltage stabilizes at the recommended float voltage. Proceed to Step 9.
6. Note charge current rate on charge ammeter on meter-lamp panel.
7. Insert a small screwdriver through hole in front panel of battery charger module 6. Turn clockwise in small increments to increase float voltage. Note increase in the charging current on the charge ammeter on the meter-lamp panel.
8. In approximately one hour or when charge current has decreased to initial value noted in Step 6, recheck battery terminal voltage. Repeat Steps 6 through 8 until the battery terminal voltage stabilizes at the recommended float voltage.
9. Check the battery terminal voltage periodically during the first few weeks of operation (also check a lead-acid battery with a hydrometer). Readjust the float charge rate if necessary.

AC VOLTAGE SENSORS

Voltage sensors can be used for either undervoltage or overvoltage sensing on line side, or undervoltage sensing on generator side. Range of the settings is from 90 to 140 volts for a nominal 120-volt system. For higher voltage systems, the "PICK-UP VOLTAGE" knob readings are multiplied by the following multiplying factors.

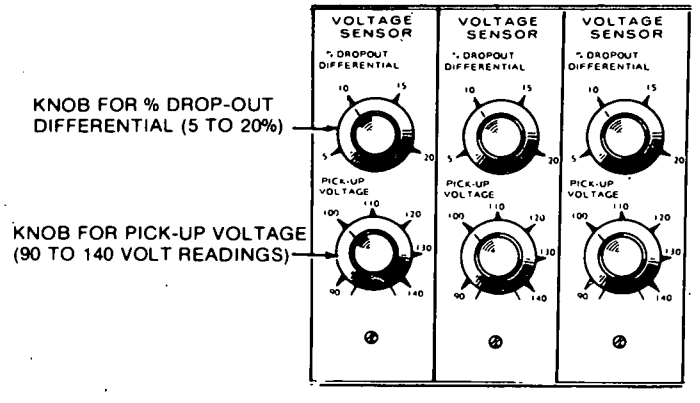


FIGURE 24. VOLTAGE SENSORS

VOLTAGE	MULTIPLYING FACTOR
120	1.0
208	1.73
240	2.0
480	4.0
600	5.0

Undervoltage Sensor Settings
Use the following steps for setting undervoltage sensors. Your settings, however, might vary considerably from the example shown due to your particular application requirements. Use settings which give load protection and yet will avoid "nuisance" load transfers.

1. Open the cabinet door.
2. Move the operation selector switch to STOP, on engine control two-wire starting, or in cabinet for three-wire starting.
3. Turn the PICK-UP VOLTAGE knob to the desired pick-up voltage, voltage at which load is transferred from the generator set to the normal power source. A setting of 108 volts, for example, gives a pick-up voltage which is 90 percent of the nominal voltage for a 120-volt system.
4. Turn the % DROP-OUT DIFFERENTIAL knob to the desired percent deviation below the pick-up voltage. This setting determines the voltage at which load is transferred from the normal power source to the generator set. A setting of 15 percent, for example, would give a 16-volt differential from 108 volts (pick-up voltage from Step 3). Drop-out voltage is then pick-up voltage minus the differential voltage, 108 - 16 = 92 volts.
5. Move the operation selector switch on the engine control to REMOTE for two-wire starting or to NORMAL for three-wire starting, whichever applies.
6. Close the cabinet door.

Overvoltage Sensor Settings
Use the following steps for setting overvoltage sensors. Your settings, however, might vary considerably from the example shown due to your particular application requirements. Use settings which give load protection and yet will avoid "nuisance" load transfers.

1. Open the cabinet door.
2. Move the operation selector switch to STOP, on engine control for two-wire starting, or in cabinet for three-wire starting.
3. Turn the PICK-UP VOLTAGE knob to the desired pick-up voltage, voltage at which load is transferred from the normal power source to the generator set. A setting of 135 volts, for example, gives a pick-up voltage which is 113 percent of the nominal voltage for a 120-volt system.
4. Turn the DROP-OUT DIFFERENTIAL knob to the desired percent deviation below the pick-up voltage. This setting determines the voltage at which load is transferred from the generator set to the normal power source. A setting of 5 percent, for example, would give a 7-volt differential from 135 volts (pick-up voltage from Step 3). Drop-out voltage is then 135 - 7 = 128 volts.
5. Move the operation selector switch on the engine control to REMOTE for two-wire starting, or to NORMAL for three-wire starting, whichever applies.
6. Close the cabinet door.

PROGRAMMED TRANSITION

To change the setting of the time delay relay for programmed transition, use the following procedure.

1. Open cabinet of Series TS Type "O" transfer switch.
2. Move the operation selector switch to "STOP" (on control accessory panel in cabinet for three-wire starting, on engine control panel for two-wire starting) and disconnect the generator set starting battery.

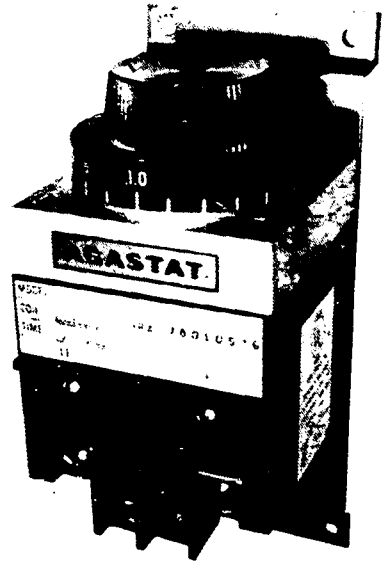


FIGURE 25. PROGRAMMED TRANSITION TIME DELAY RELAY

3. Remove AC line power to the transfer switch.

WARNING **Be sure to move the operation selector switch to "STOP," disconnect starting battery, and remove AC line power before attempting adjustments. Otherwise, the automatic transfer switch presents a serious shock hazard.**

4. With automatic transfer switches, remove the twist-lock disconnect plug and open the control accessory panel.
5. Locate the time delay relay (shown following) in the rear of the cabinet on the transfer switch base assembly.
6. Turn the knob clockwise to increase delay (increments marked on knob), counterclockwise to decrease time delay.
7. With automatic transfer switches, close the control accessory panel and reconnect the twist-lock disconnect plug.

8. Restore AC line power to the transfer switch.
9. Move the operation selector switch to "NORMAL" (in cabinet for three-wire starting) or "RMT" (on engine control for two-wire starting), whichever applies.
10. Reconnect the generator set starting battery.
11. Close the TS transfer switch cabinet door.

ADJUSTMENT OF SERIES TS PROTECTIVE CIRCUIT MODULES AND TIME DELAYS

Refer to the system initial startup and adjustment procedures supplied with each Series TS transfer switch.

TROUBLESHOOTING

POWER OUTAGE OCCURS, BUT GENERATOR SET DOES NOT START

1. Check for overcrank condition.
2. Two-wire starting only: Check position of operation selector switch on engine. Should be at "RMT."
3. Check position of operation selector switch in cabinet. Should be at "NORMAL."
4. Check generator set. Start with start-stop switch on generator set. If it does not crank, check starting batteries. If it cranks but does not start, check fuel supply.

GENERATOR SET STARTS DURING NORMAL SERVICE

1. Two-wire starting only: Check position of operation selector switch on engine control. Should be at "RMT."
2. Check position of operation selector switch in cabinet. Should be at "NORMAL."
3. Check if exerciser clock is turned to exercise period.
4. Check to see if control panel disconnect plug is inserted into receptacle.
5. Check voltage sensor settings (if equipped). If settings are okay, starting may be due to momentary voltage dips. Pick-up voltage settings may have to be reduced.

GENERATOR SET DOES NOT EXERCISE

1. Two-wire starting only: Check position of operation selector switch on engine control. Should be at "RMT."
2. Check position of operation selector switch in cabinet. Should be at "NORMAL."
3. Check exerciser clock to see if it is set correctly and running.
4. Check generator set. Start with start-stop switch on generator set. If it does not crank, check starting batteries. If it cranks but does not start, check fuel supply.

GENERATOR SET STARTS BUT DOES NOT ASSUME LOAD

1. Check output voltage of the generator set.
2. Check generator-side undervoltage sensor (if equipped) pick-up voltage setting. Setting in most cases should be at 100 volts (200 for 240-volt systems).
3. Check position of motor disconnect switch. Should be up.

NO TRANSFER OF LOAD TO COMMERCIAL POWER FROM GENERATOR SET

1. Check disconnect plug in control accessory panel. Must be connected into receptacle.
2. Check retransfer time delay (if used) to see if time delay is still operating. See *OPERATION* section.
3. If automatic transfer switch has battery charging feature, check battery charging fuse. Replace if necessary with correct fuse.
4. Check position of motor disconnect switch. Should be up.
5. Manually initiate retransfer by operating retransfer selector switch and push to retransfer switch (if equipped).
6. Check line voltage to make sure it is above setting of voltage sensor (if equipped).
7. Stop generator set with start-stop switch. When generator set stops, the transfer switch will transfer the load to the normal power line if voltage is normal.

GENERATOR SET CONTINUES TO RUN AFTER RETRANSFER OF LOAD TO COMMERCIAL POWER

Start-stop time delay may be defective. Stop generator set with start stop switch.

BATTERY CHARGER FAILS TO CHARGE

Check battery charger fuse F1 in control accessory panel (if equipped with charger). Replace if necessary with correct fuse.

BATTERY LOSES EXCESS WATER

Battery charger float voltage may be too high (if equipped with charger). See *ADJUSTMENTS* section.

BATTERY LOSES CHARGE

Charge float voltage may be set too low (if equipped with charger). See *ADJUSTMENTS* section.

PARTS AND SERVICE INFORMATION

This Series TS transfer switch is custom engineered and specially constructed. Because of the individuality of each automatic transfer switch, contact the dealer from whom you purchased this equipment for service and parts. Parts catalogs are available through your Onan distributor/dealer. Remember to give the complete model and serial number when requesting service or parts information. The wiring diagrams furnished with your Series TS transfer switch should be kept with your instruction manual in the "pocket" inside the cabinet.

All shipments made are complete. Shipments are properly packed and in good order when delivered to the transportation company. Any claim for loss or damage in transit should be filed promptly against the transportation company making the delivery.

Onan Corporation
1400 73rd Avenue Northeast
Minneapolis Minnesota 55432

612 574 5000
Telex 29 0476
TWX 910 576/2833