

**“WN” Type  
Automatic  
Transfer  
Switches**

**PART 9  
"WN" TYPE  
AUTOMATIC  
TRANSFER  
SWITCHES**

**STANDBY  
ELECTRIC  
POWER  
SYSTEMS**

All Series

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## Section 9.1 MAJOR COMPONENTS

### Introduction

The "Wn" type automatic transfer switch is so named because of the actuating configuration of its main contacts (W) and because it offers a time delay with the main contacts at "Neutral" (n). The transfer switch is rated 600 volts and is available in 100 to 2600 ampere sizes. Components may be housed in a standard NEMA 12 enclosure or in an optional NEMA 3R enclosure.

ITEM	DESCRIPTION
1	Transfer Mechanism ("Wn" Type)
2	Transfer Relay (TR)
3	Time Delay Neutral Relay
4	Grounding Lug
5	Maintenance Disconnect Switch
6	Time Delay Neutral On-Off Switch
7	Neutral Lug
8	Manual Transfer Handle
9	Utility Voltage Sensing Interface
10	Transformer TR4 (480 volts units only)
11	Transformer TR3 (480 volts units only)
12	2-Wire Start Terminal Strip
13	Transformer TR1
14	Transformer TR2
15	Terminal Strip
16	Circuit Board Compartment

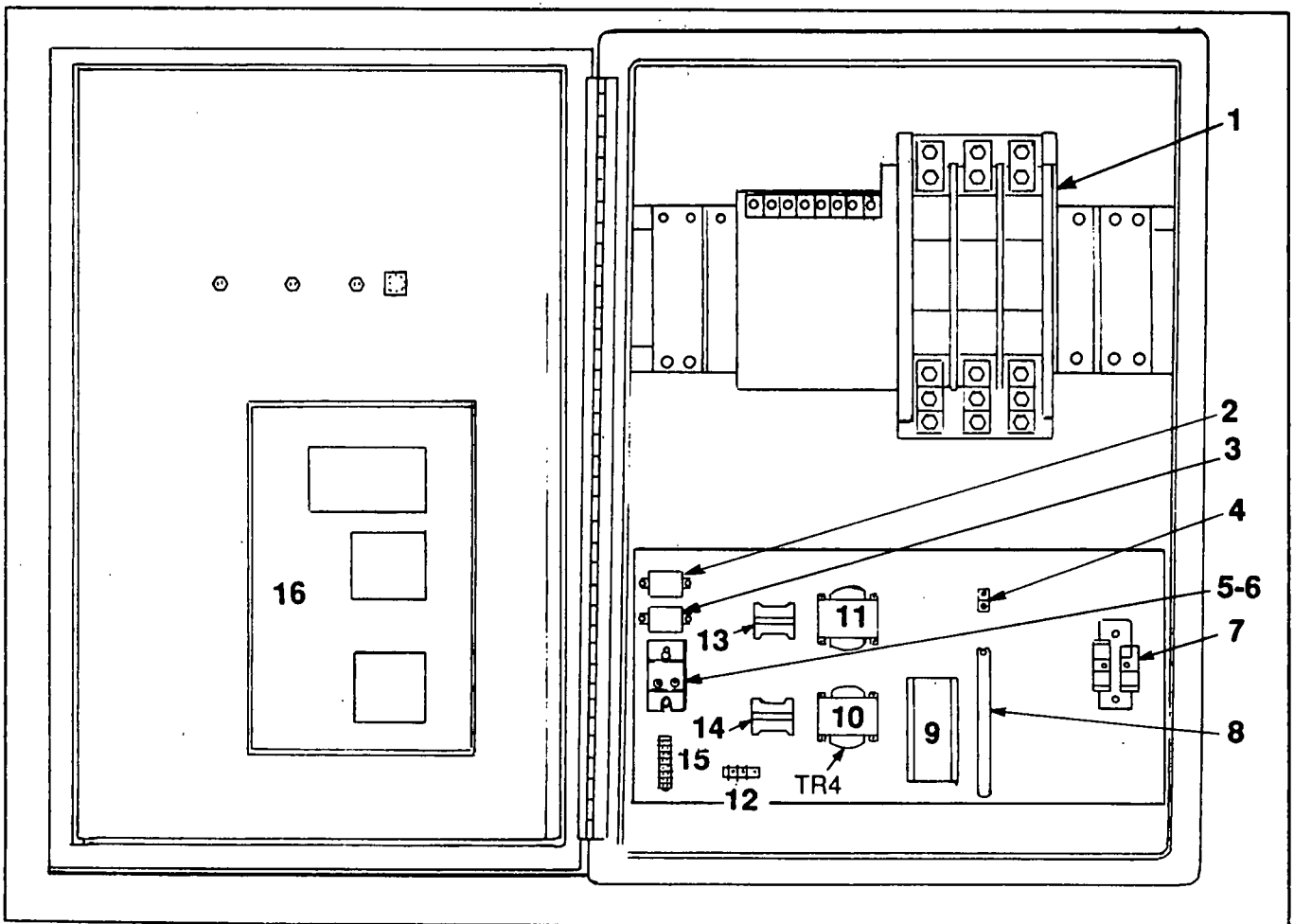


Figure 1. Typical "Wn" Type Transfer Switch

### Transfer Mechanism

The transfer mechanism contains the main load-carrying contacts of the transfer switch, as well as other mechanical and electrical components. Additional information on the transfer mechanism can be found in Section 9.2.

### Transfer Relay

When energized by system control (or CPU) circuit board action, the transfer relay's normally-open contacts close. On closure of those contacts, "Standby" source voltage is delivered to transfer mechanism terminals AT1/AT2 (see Section 9.2). The transfer mechanism main contacts will then actuate to their "Standby" power source side, i.e., loads connected to "Standby" source.

When de-energized by system control (or CPU) board action, the relay's normally-closed contacts close. "Utility" source power is then delivered across the closed contacts to transfer mechanism terminals BT1 and BT2. Transfer mechanism main contacts will then actuate to their "Utility" source side. See "Transfer Mechanism Operational Analysis" in Section 9.2.

### Neutral Lug

"Neutral" lines from the utility, standby and load circuits must be properly connected to the neutral block. The neutral block used must have the same (or greater) amperage rating as the transfer mechanism.

### Maintenance Disconnect Switch

This safety switch should always be set to its "Manual" position before working on the standby system. When set to "Manual", the switch (a) opens the 2-wire start circuit, and (b) opens the transfer signal circuits to the transfer mechanism. Thus, with "Manual" selected, the generator cannot be started in automatic mode and automatic transfer to either power source side will not occur.

The switch should be set to "Automatic" for normal automatic operations, for a "Normal Test" and for a "Fast Test".

### Grounding Lug

The grounding lug provides a convenient way of connecting the transfer switch enclosure to earth ground. In many cases, the enclosure is connected to ground when wiring conduit is installed and grounded. Some installers will simply attach a bare copper wire to the grounding lug and to a bolted junction at the wiring conduit.

*NOTE: Most standby generators have an ungrounded or "floating" neutral line. Be sure to comply with applicable codes pertaining to the grounding of neutral lines in such applications. In most cases, the neutral block can be grounded only at main electrical service entrance.*

### Terminal Strip

This terminal strip provides a convenient method of interconnecting transfer switch components. Most units are equipped with a 7-position terminal strip as shown in Figure 2. However, units rated 480 volts use a 6-position strip.

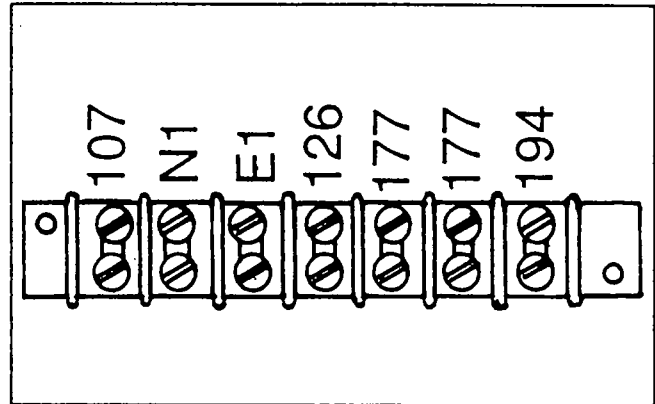


Figure 2. The 7-Position Terminal Strip

### Time Delay Neutral Switch

Some transfer switches may be equipped with an optional "time delay at neutral" feature. The time delay neutral switch (if so equipped) permits that feature to be turned off or on. When the switch is set to "On", the main contacts will be held at "Neutral" for a preset time during transfer to either power source.

The "Neutral" position of the main contacts is that position where the load is disconnected from both power supplies. By allowing the time at "Neutral" to be extended, residual voltages generated by heavy inductive loads can decay to a safe level before the main contacts are reconnected. The feature provides some protection against nuisance tripping of circuit breakers or blowing of fuses that can occur during rapid transfer of motor and other heavy inductive loads.

### Transformer TR1

When the generator is running, generator AC output is delivered to the primary winding of this step-down transformer. A reduced voltage is induced into the transformer secondary winding. The reduced secondary winding output is delivered to (a) a "Standby Operating" lamp on the switch enclosure door, and to (b) the system control (or CPU) circuit board. Transformer nominal input/output voltages are listed below:

PRIMARY WINDING INPUT VOLTAGE	SECONDARY WINDING OUTPUT VOLTAGE
208 volts AC	21 volts AC
240 volts AC	24 volts AC
416 volts AC	21 volts AC
480 volts AC	24 volts AC

The system control (or CPU) circuit board is turned on and starts to operate at the same time the "Standby Operating" lamp turns on.

### Transformer TR2

Load terminal voltage from transfer mechanism terminal lugs T1/T2 is delivered to the primary winding of this step-down transformer. This induces a reduced voltage into the transformer's secondary winding. Secondary winding output is delivered to the 7-day exercise circuit board for operation of the 7-day exercise timer. Input and output voltages are the same as for transformer TR1.

*NOTE: On units with only two circuit boards, the 7-day exercise circuit is incorporated into the CPU circuit board.*

### Transformer TR3

This step-down transformer is employed only on transfer switches rated at 480 volts. The transformer reduces the standby source voltage used for transfer mechanism main contacts operation to a voltage that is compatible with the transfer mechanism's operating voltage. This must be done since the transfer mechanism's actuating coil will respond only to its rated voltage.

A standby source voltage input of 480 volts to the primary winding will result in a 240 volts AC output from the transformer secondary winding.

### Transformer TR4

This step-down transformer is used only on systems rated 480 volts. The transformer reduces utility power source voltage to a voltage that is compatible with that required by the transfer mechanism actuating coil.

### 2-Wire Start Terminal Strip

Terminals 178 and 183 on this terminal strip must be interconnected with identically numbered terminals in the generator's AC connection (lower) panel. Closure of this circuit by transfer switch circuit board action will initiate generator cranking and startup. Opening of the circuit by circuit board action will result in generator shutdown.

*NOTE: Automatic cranking is initiated by closure of the 2-wire start circuit. However, cranking, running and stopping operations are controlled by a DC control/latch-crank board in the generator control console. See Part 5 or 6 as appropriate.*

### Manual Transfer Handle

Use this handle to actuate the transfer mechanism main contacts manually. See Section 9.4, "Operating Instructions".

### Circuit Board Compartment

This compartment, in the transfer switch enclosure door, houses either two or three circuit boards as follows:

- Units with the "Logic" type intelligence system have three circuit boards, i.e., a utility voltage sensor board, a system control board, and a 7-day exercise board.
- Units with "CPU" type intelligence system have only two circuit boards, a utility voltage sensor board and a CPU board. The "exercise" function is controlled by the CPU circuit board.

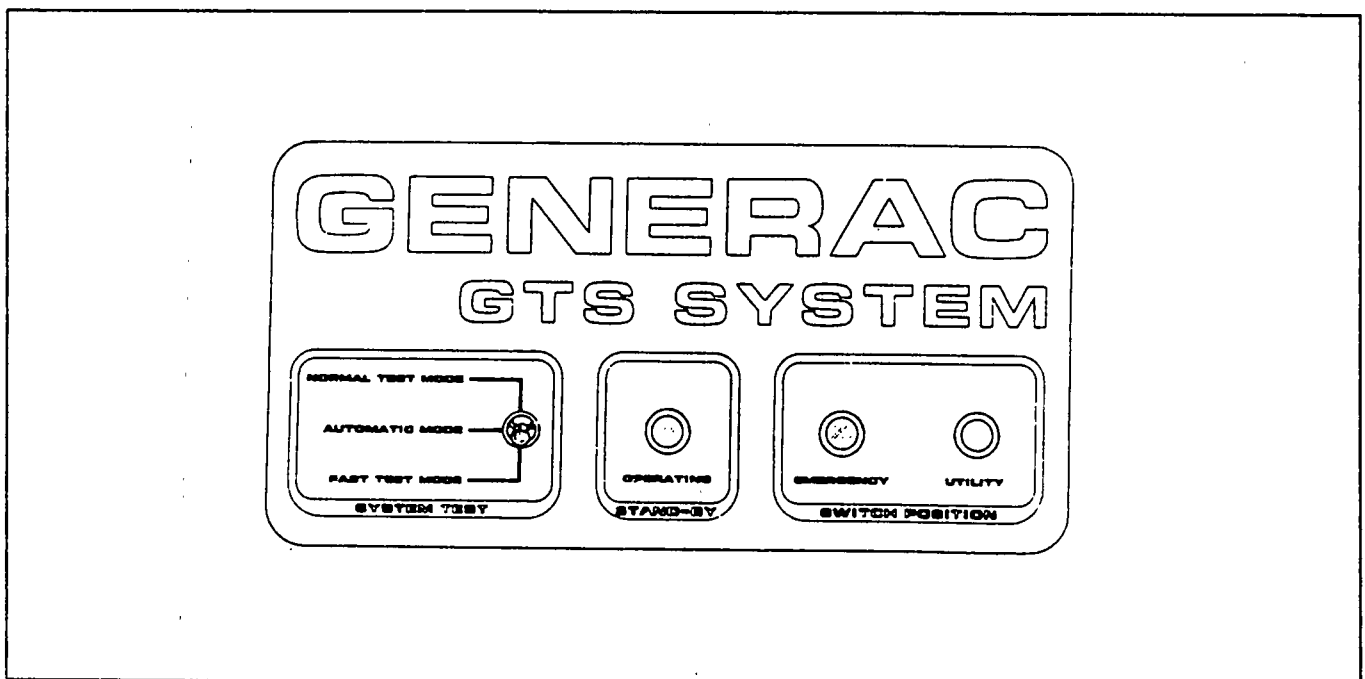


Figure 3. Switches and Lamps on Enclosure Door (Typical)

### ***Utility Voltage Sensing Interface***

Refer to "Utility Sensing Interface" on Page 8.1-4 (Part 8, Section 8.1).

### ***Transfer Switch Enclosure***

Either a NEMA 12 or a NEMA 3R type enclosure may be used.

The NEMA 12 enclosure is intended for INDOOR installation only.

The NEMA 3R enclosure is intended for OUTDOOR installation.

### ***Switches and Lamps on Enclosure Door***

See Figure 3 on previous page. The transfer switch enclosure door mounts the following switches and lamps:

- System Test Switch.
- "Standby Operating" Lamp.
- "Switch Position" Lamps

#### **SYSTEM TEST SWITCH:**

**Automatic Mode:** Set this switch to its "Automatic Mode" position for all normal automatic operations. When "Automatic Mode" is selected, operation will be as follows:

1. A utility voltage sensor circuit board will constantly monitor "Utility" source voltage.
  - a. As long as "Utility" voltage is above the setting of a "voltage dropout sensor", a "Utility On" lamp (LED) on the circuit board will be on.
  - b. Should "Utility" voltage drop below the "voltage dropout sensor" setting, a timer on the circuit board will start timing.
  - c. When the timer has timed out and if "Utility" voltage is still below the "voltage dropout sensor" setting, circuit board action will effect closure of the 2-wire start circuit. The generator will crank and start.
2. On generator startup, an "engine warmup timer" starts timing.
3. When the "engine warmup timer" has timed out and providing generator voltage and frequency are acceptable, transfer to the "Standby" power supply will occur. Load circuits are now powered by generator AC output.
4. On restoration of "Utility" voltage above a preset level, a "return to utility timer" starts timing.
5. When the timer has timed out and if "Utility" voltage is still good, retransfer back to the "Utility" source will occur.
6. Following retransfer, circuit board action will open the 2-wire start circuit. Engine shutdown will then occur.

**Normal Test Mode:** This switch position, when selected, will simulate a "Utility" power source dropout. The generator will crank and start followed by transfer to "Standby" just as though an actual "Utility" source dropout has occurred.

**Fast Test Mode:** Generator starts and transfer to "Standby" occurs in less than five seconds.

#### **SWITCH POSITION LAMPS:**

**Switch Position Utility:** Lamp will turn on when (a) "Utility" source power is available, and (b) when the main contacts are at "Utility" (load connected to the "Utility" side).

**Switch Position-Emergency:** Will turn on when (a) "Standby" power is available to the transfer switch and (b) when the main contacts are at "Standby" (load connected to the "Standby" side).

#### **STANDBY OPERATING LAMP:**

Lamp should turn ON as soon as the standby generator is running.

## Section 9.2 THE TRANSFER MECHANISM

### General

The transfer mechanism houses the main current carrying contacts, along with other components required for switch operation. The main contacts are electrically actuated and mechanically held. They are of silver alloy or silver alloy composition, to resist welding or sticking.

A typical 3-pole transfer mechanism is shown in Figure 1 below. Also available are 4-pole transfer mechanisms.

**NOTE:** At the time of this writing, "Wn" type transfer switches were not available with a 2-pole transfer mechanism. When a transfer switch is ordered, the purchaser must specify (a) the rated voltage, (b) rated phase, and (c) rated current. Units rated 1-phase will include a 3-pole transfer mechanism. However, since the unit is rated "1-phase", factory wiring connections to the third pole (N3, E3, T3) are omitted and a 1-phase utility sensing interface is used.

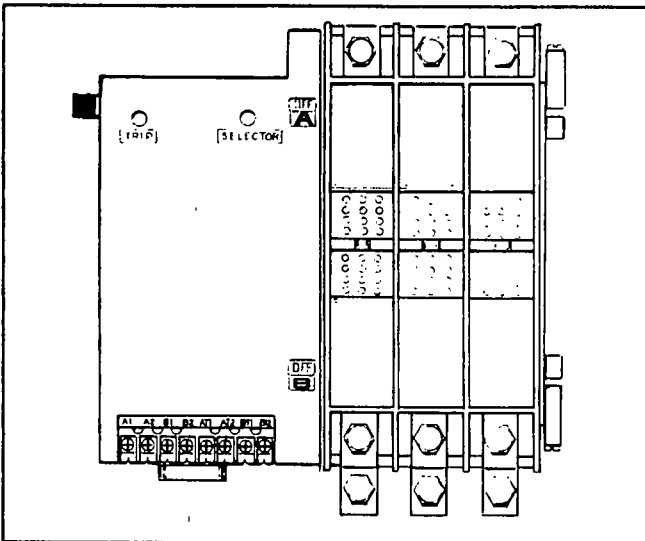


Figure 1. A Typical 3-Pole Transfer Mechanism

### Transfer Mechanism Construction

Figure 6 on next page shows the major components of a typical "Wn" type transfer mechanism.

The LOAD CONTACTS are stationary and are retained to a PLASTIC POLE PIECE. The UTILITY and EMERGENCY CONTACTS are moveable and are actuated by means of a closing coil (in the CONTROL ASSEMBLY) and mechanical linkage. Three or four plastic pole pieces, along with stationary and moveable main contacts, are sandwiched together to form a 3 or a 4-pole mechanism.

### Main Contacts Operation

#### LOAD CONNECTED TO "UTILITY" SOURCE:

Figure 2 shows a set of moveable "Utility" contacts connected to the stationary "Load" contact. The LOAD is connected to the UTILITY power source. On the transfer mechanism cover, window "A" will display the word "ON" and window "B" will display the word "OFF".

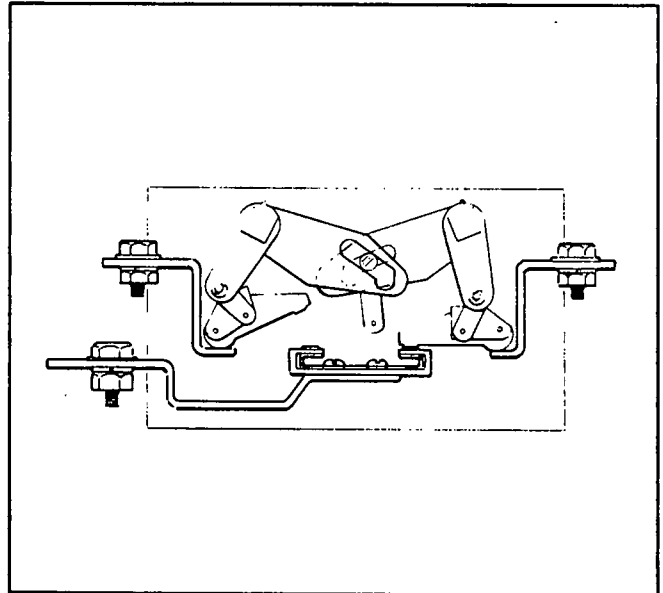


Figure 2. Load Connected to Utility Source

#### NEUTRAL OR "TRIPPED" POSITION:

See Figure 3. The LOAD contacts are disconnected from both the "Utility" and "Standby" power supplies. Windows "A" and "B" will both display the word "OFF".

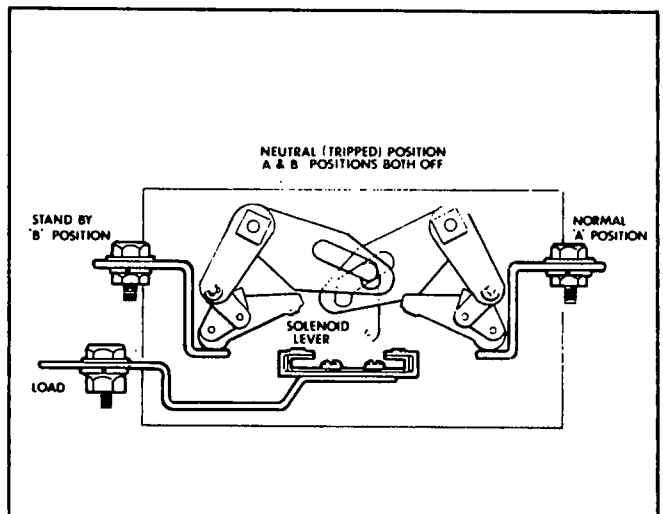


Figure 3. "Neutral" or "Tripped" Position

**Main Contacts Operation (Continued)**

**LOAD CONNECTED TO "STANDBY" SOURCE:**

See Figure 4. The moveable standby contact is connected to the load contact. Window "A" will display the word "OFF"; window "B" the word "ON".

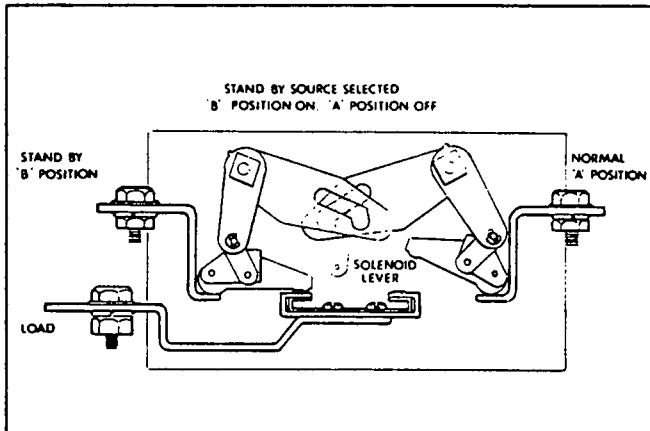


Figure 4. Load Connected to "Standby" Source

**Auxiliary Contacts**

A set of auxiliary contacts may be provided on the transfer mechanism. One auxiliary contacts switch is used to operate "Switch Position" lamps on the door. The second switch may be used by the customer, if desired. A suitable power supply must be connected across the "common" terminal, for operation of customer device(s) such as remote advisory lamps, remote annunciator, etc.

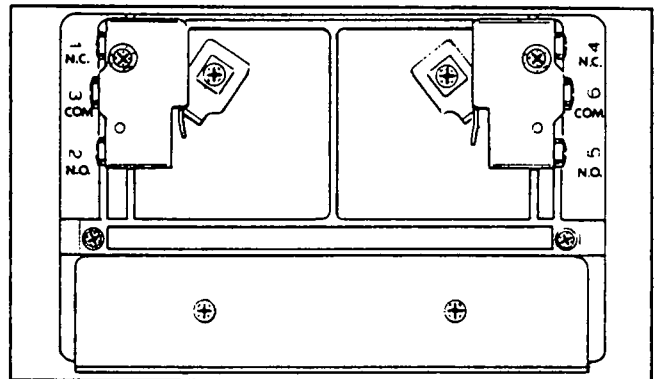


Figure 5. Auxiliary Contacts

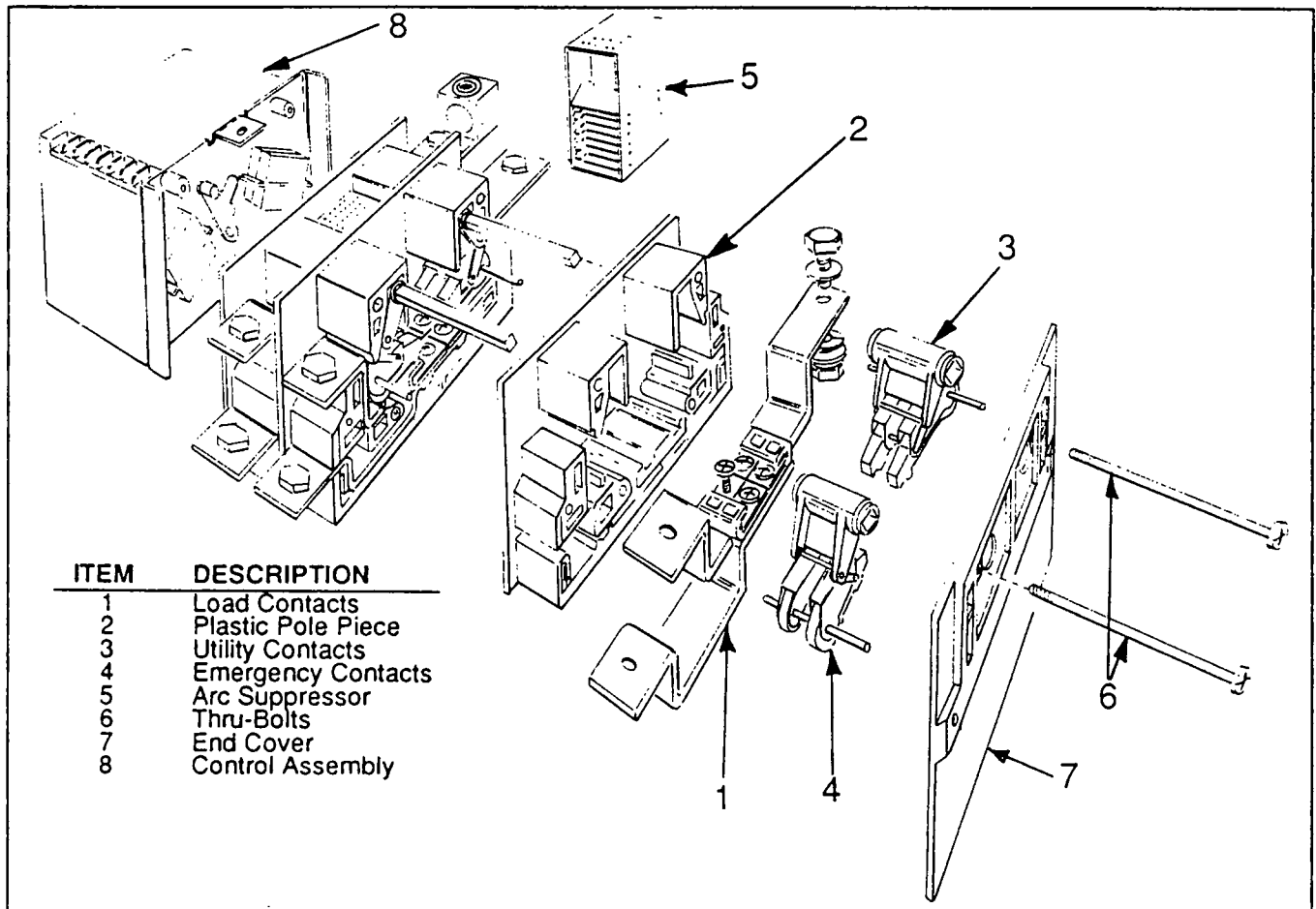


Figure 6. Transfer Mechanism Major Components

## Control Assembly

### GENERAL:

See Figure 7. The control assembly houses the following components:

- A terminal strip.
- A trip coil.
- A selective coil.
- A closing coil.
- A selective switch.
- Control switches.
- Trip control switches.

### TERMINAL STRIP:

The terminal strip (Figure 8) includes the following terminals:

**Terminals A1, A2:** Actuating command to the "Utility" power source side. Transfer to "Utility" cannot occur unless that power source is available.

**Terminals B1, B2:** Actuating command to the "Standby" power source side. Transfer to "Standby" cannot occur unless that power source is available.

**Terminals AT1, AT2:** Power from the "Standby" source is applied here, to provide a "trip to neutral" command from the "Utility" position.

**Terminals BT1, BT2:** Power from the "Utility" source is applied here, to provide a "trip to neutral" command from the "Standby" position.

### TRIP COIL:

During automatic operation, the trip coil (TC) actuates the main contacts to their "tripped" or "neutral" position.

The trip coil is energized by applying "Standby" source power to terminals AT1/AT2, for a "trip to neutral" action from the "Utility" position.

The trip coil is energized by applying "Utility" source power to terminals BT1/BT2, for a "trip to neutral" action from the "Standby" position.

### SELECTIVE COIL:

When energized by rectified (and reduced on 480 volts units) "Utility" or "Standby" voltage, the selective coil acts to reset selective switches (LS).

### CLOSING COIL:

When energized by "Utility" or "Standby" source power, the closing coil actuates the main contacts from their "tripped" (Neutral) position to closed position (closed to either the "Utility" or "Standby" source side).

### SELECTIVE SWITCH:

Actuated by the selective coil (SC), to prepare the circuit for transfer to "Standby" or for retransfer back to "Utility".

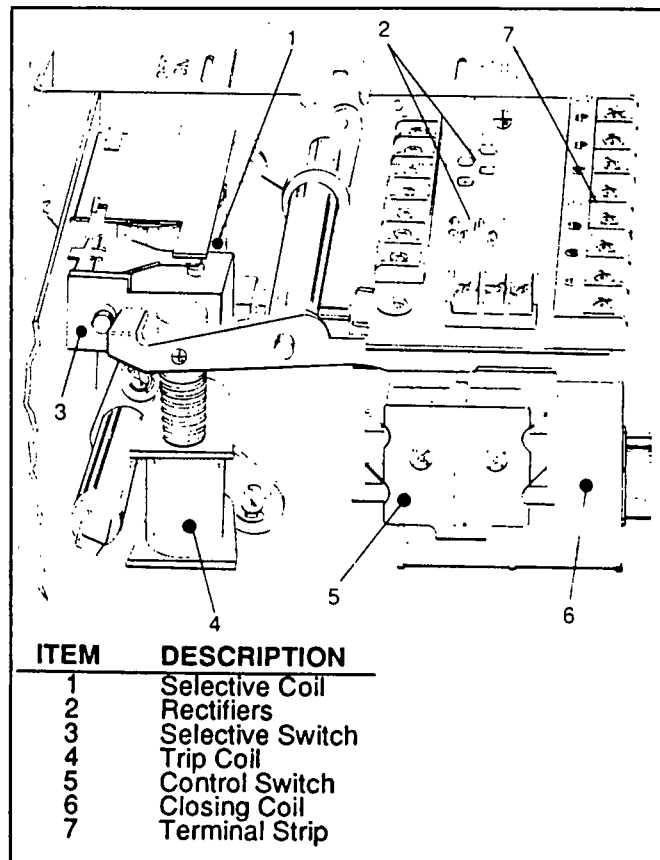


Figure 7. The Control Assembly

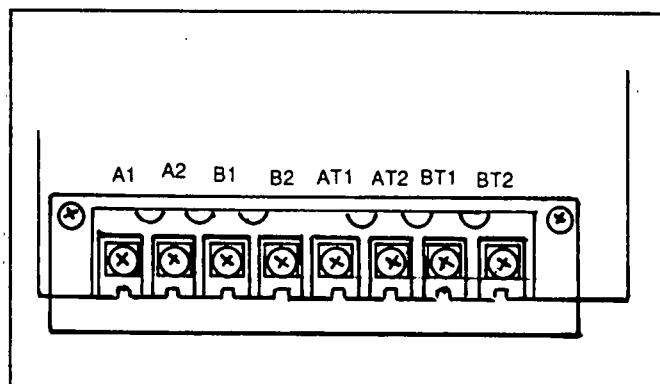


Figure 8. Terminal Strip

### CONTROL SWITCHES:

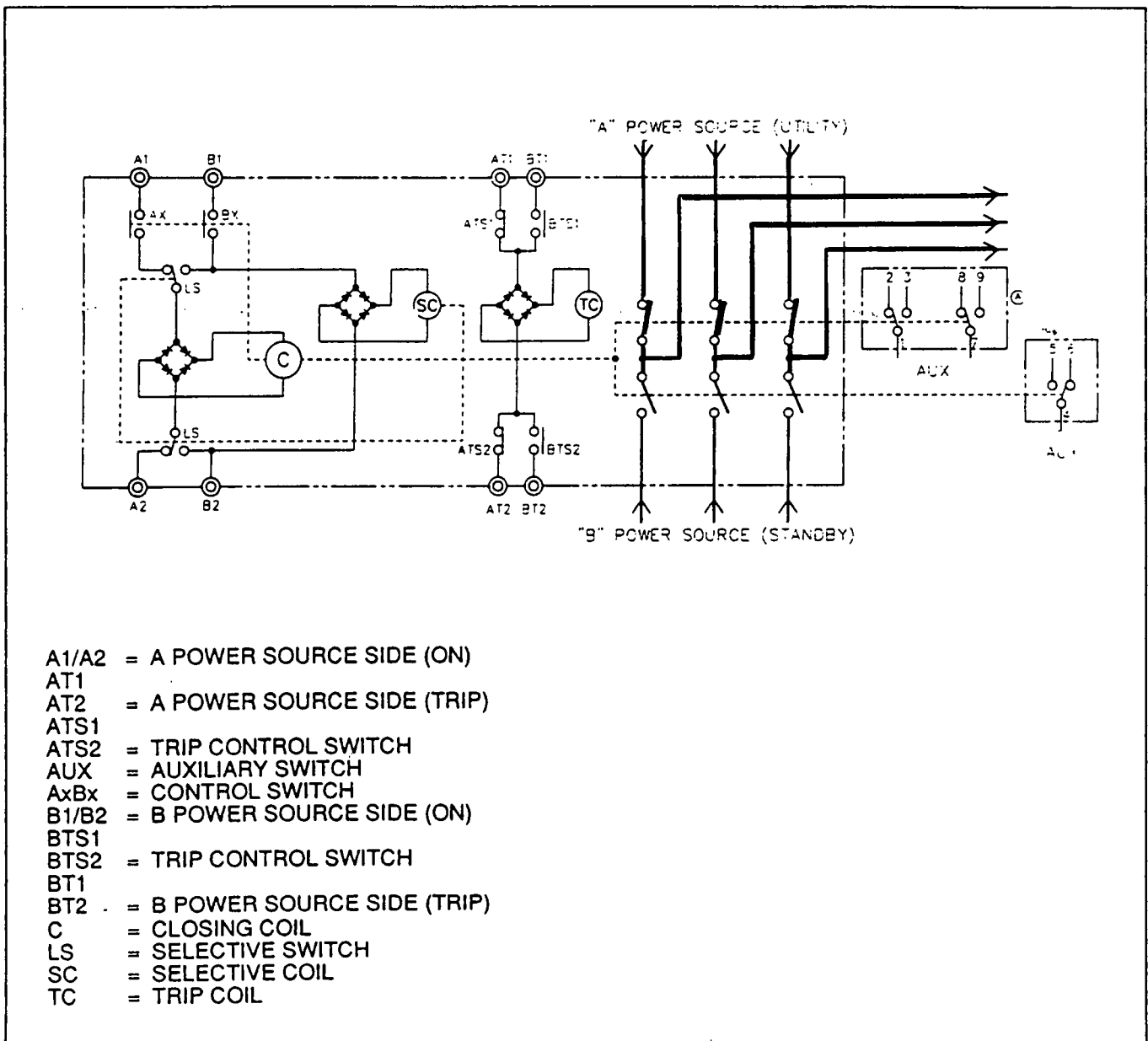
Control switches Ax/Bx are actuated by closing coil action. The following facts apply:

- The control switches will open when the main contacts reach their "Utility" or "Standby" position.
- The control switches will close when "trip to neutral" occurs.

### Transfer Mechanism Operational Analysis

#### PHASE 1- MAIN CONTACTS AT "UTILITY":

- The LOAD is connected to the UTILITY power source side, i.e., LOAD is powered by the UTILITY source ("A" power source).
- Auxiliary contacts (AUX) are positioned as shown.
- Control switches Ax/Bx are open.
- Selective switches (LS) are closed to the terminals A1/A2 side.
- Trip control switches ATS1/ATS2 are closed.
- Trip control switches BTS1/BTS2 are open.

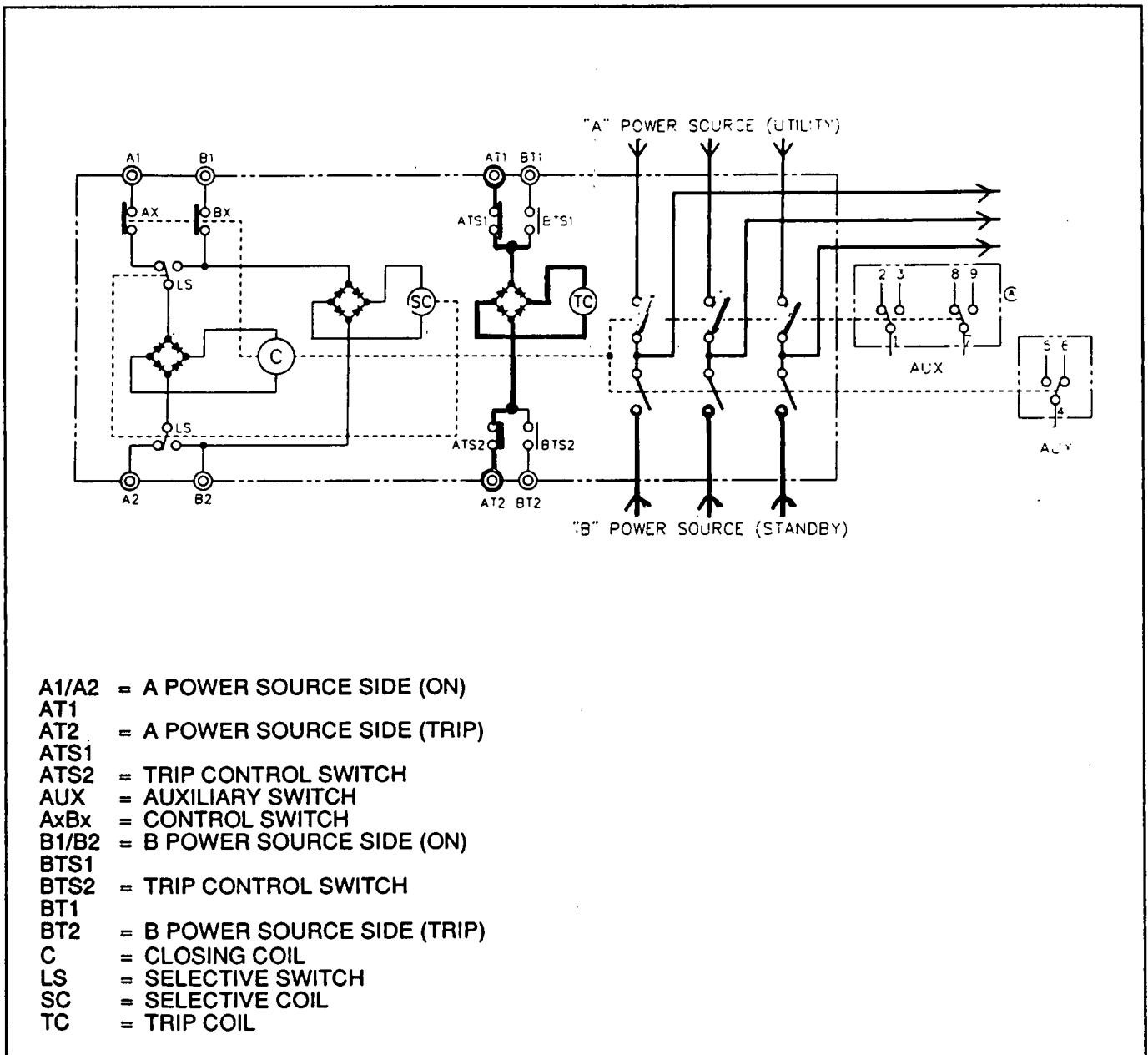


**Transfer Mechanism Operational Analysis (Continued)**

**PHASE 2- TRIP TO "NEUTRAL" FROM "UTILITY":**

On "Utility" failure, the generator engine will crank and start. The following will then take place:

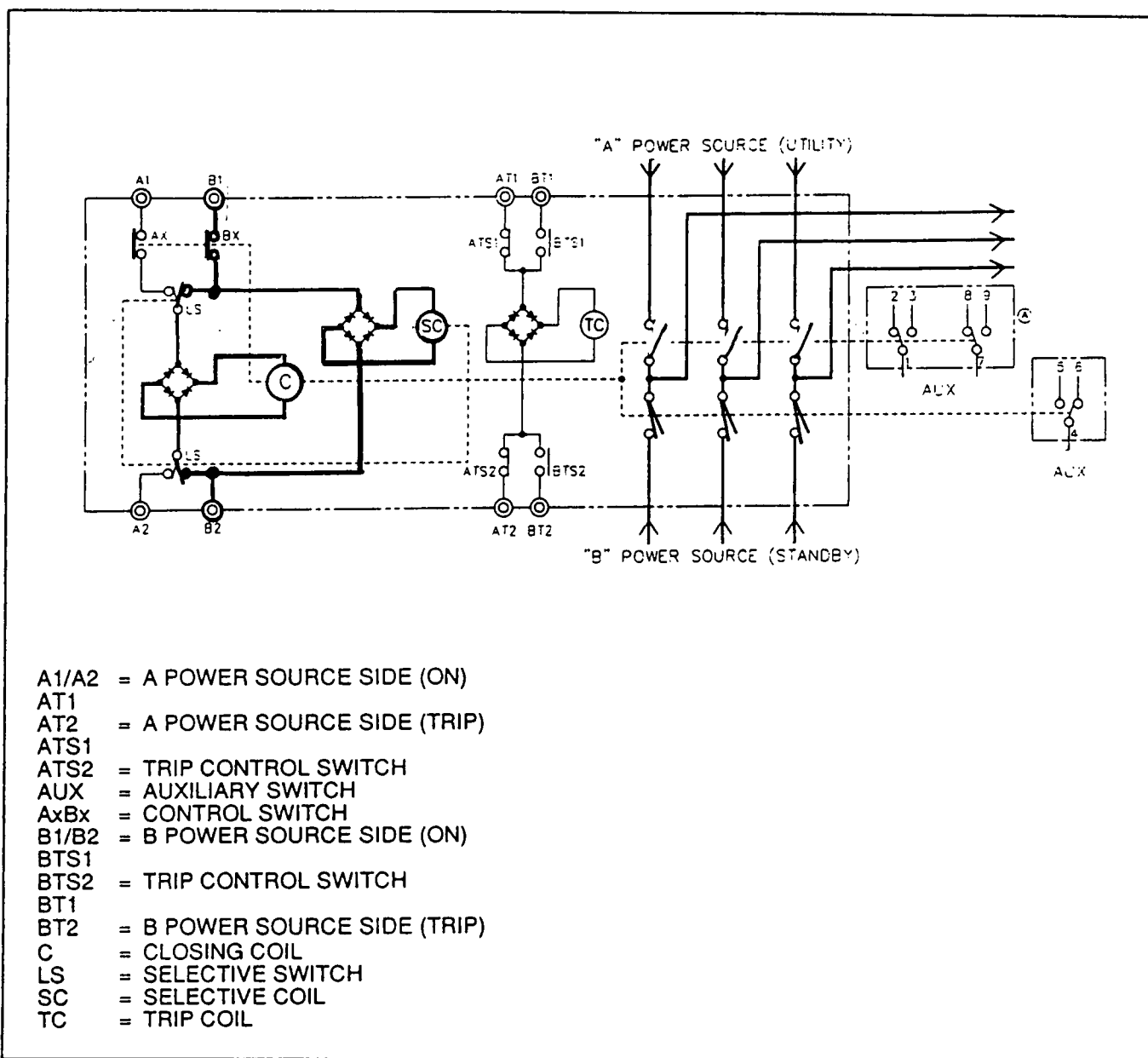
- Generator voltage is applied across terminals AT1/AT2.
- With trip control switches ATS1/ATS2 closed, standby power is delivered to the trip coil (TC), via a bridge rectifier.
- The trip coil energizes to open a mechanical latch on the main contacts, which then actuate to their "tripped" or "neutral" position (customer load disconnected from both power supplies).
- As the main contacts reach "neutral", control switches Ax and Bx close.



### Transfer Mechanism Operational Analysis (Continued)

#### PHASE 3- TRANSFER TO "STANDBY":

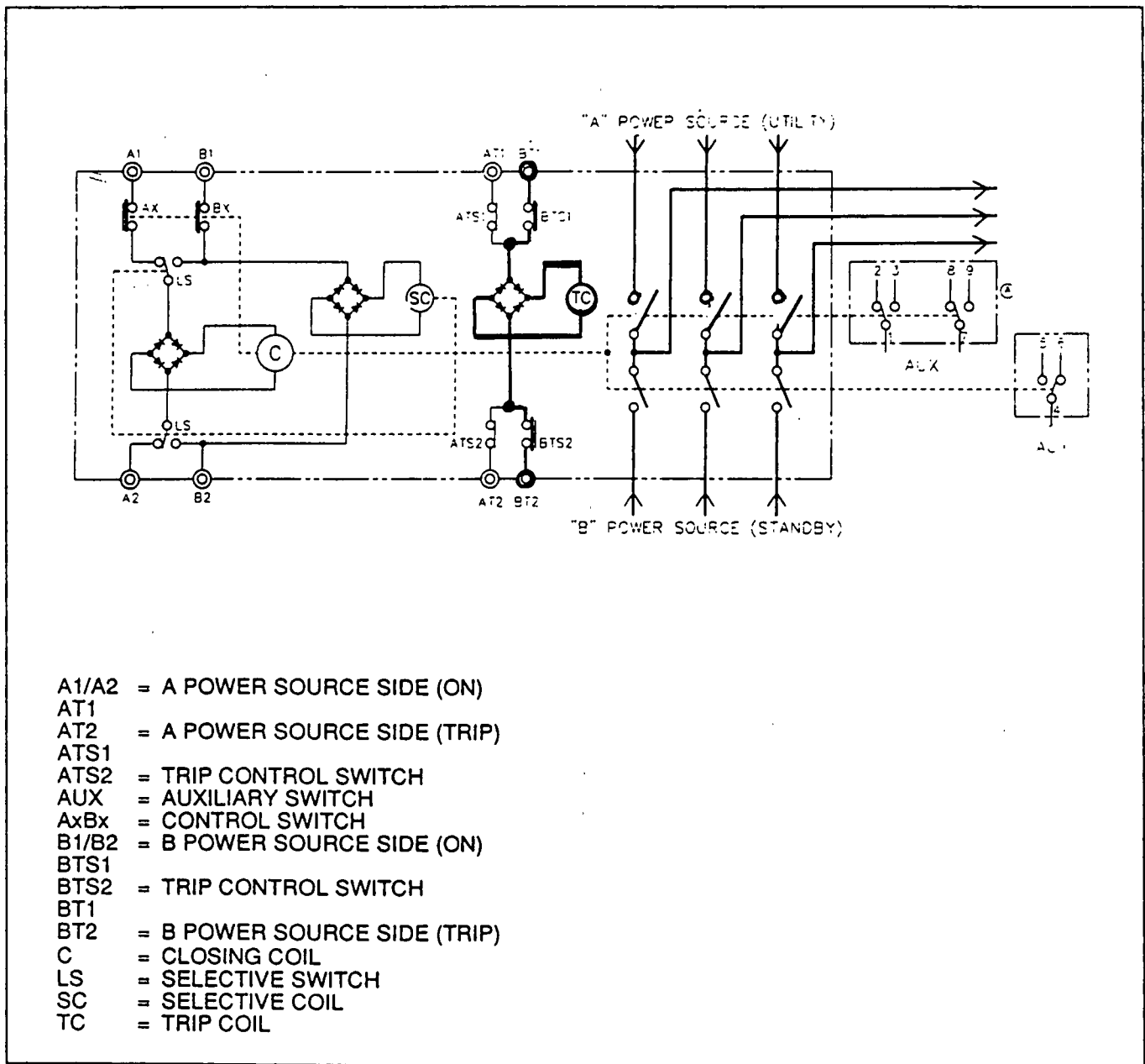
- Standby operating voltage is applied to terminals B1/B2.
- With control switch Bx closed, selective coil SC energizes, causing both selective switches LS to close to the terminals B1/B2 side.
- Closing coil (C) now energizes and the main contacts are actuated to their "Standby" power source side (loads connected to the "B" power source).
- As the main contacts reach their "Standby" position, control switches Ax/Bx open and control switches BTS1/BTS2 close. This prepares the circuit for "return to utility" operations.



**Transfer Mechanism Operational Analysis (Continued)**

**PHASE 4- TRIP TO "NEUTRAL" FROM "STANDBY":**

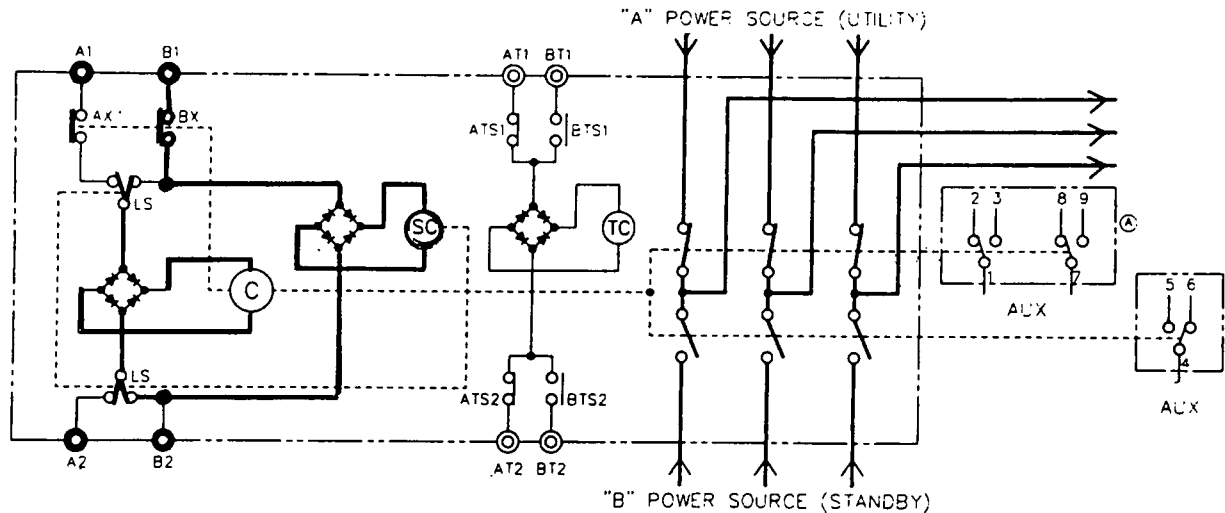
- On restoration of "Utility" source voltage ("B" power source), that voltage is applied across terminals BT1/BT2.
- Since control switches BTS1/BTS2 are closed, trip coil TC energizes.
- With trip coil TC energized, the mechanical latch on the main contacts opens. The main contacts move to their "tripped" or "neutral" position.
- As the main contacts reach "neutral", control switches Ax/Bx close.



**Transfer Mechanism Operational Analysis (Continued)**

**PHASE 5- RETRANSFER BACK TO "UTILITY":**

- "Utility" source voltage is applied across terminals A1/A2.
- With control switches Ax/Bx closed, selective coil SC energizes to reset selective switches LS to the A1/A2 side.
- Closing coil (C) is now energized by "Utility" source voltage. The main contacts actuate to their "Utility" position (load connected to "A" power source).
- As the main contacts close to the "Utility" side, control switches Ax/Bx open and ATS1/ATS2 close (to prepare the circuit for the next "trip to neutral" action).



- A1/A2 = A POWER SOURCE SIDE (ON)
- AT1
- AT2 = A POWER SOURCE SIDE (TRIP)
- ATS1
- ATS2 = TRIP CONTROL SWITCH
- AUX = AUXILIARY SWITCH
- AxBx = CONTROL SWITCH
- B1/B2 = B POWER SOURCE SIDE (ON)
- BTS1
- BTS2 = TRIP CONTROL SWITCH
- BT1
- BT2 = B POWER SOURCE SIDE (TRIP)
- C = CLOSING COIL
- LS = SELECTIVE SWITCH
- SC = SELECTIVE COIL
- TC = TRIP COIL

## Section 9.3 INSTALLATION

### *Transfer Switch Selection*

Because automatic transfer switches are an integral part of a unified, coordinated electrical distribution system, five factors should be considered when selecting the transfer switch to be used. These factors are:

- Distribution system parameters.
- Functional circuit demands.
- System coordination.
- Environmental or unusual operating conditions.
- Safety.

#### DISTRIBUTION SYSTEM PARAMETERS:

Figure 1, below, is a simplified guide for selecting a transfer switch. The "Selection Chart" includes a list of operating system parameters, switch ratings, available enclosures and required options.

#### FUNCTIONAL CIRCUIT DEMANDS:

Automatic transfer switches that monitor all phases of the utility power source are said to offer complete protection, others may offer partial protection.

#### SYSTEM COORDINATION:

The automatic transfer switch must be properly coordinated with the rest of an electrical distribution system. That is, the switch must be carefully selected on the basis of the distribution system's voltage, continuous current, frequency, short circuit capabilities, etc. The continuous current rating of the transfer switch should be determined based on both the "Utility" and "Standby" loads being supplied. Two factors are especially important when coordinating the transfer switch with the rest of the system:

- The switch must be capable of carrying full load currents and must also be able to withstand the thermal and electro-magnetic effects of short circuit currents.
- Transfer equipment and associated wiring must be provided with suitable protective devices (circuit breakers or fuses). These protective devices must be able to clear a fault without extensive damage.

Under abnormal operating conditions where a fault exists between the transfer switch and the load, the switch may be subjected to (a) withstand, (b) closing, and (c) interrupting conditions as follows:

<b>Transfer Switch Selection Chart</b>			
<b>1. SYSTEM DATA</b>	<b>UTILITY</b>	<b>STANDBY</b>	<b>3. TYPE OF ENCLOSURE (CHECK ONE)</b>
Voltage	_____	_____	<input type="checkbox"/> Open
Frequency	_____	_____	<input type="checkbox"/> NEMA 1 General Purpose
Phase	_____	_____	<input type="checkbox"/> NEMA 3R Outdoors
No. of Wires	_____	_____	<input type="checkbox"/> NEMA 12 Industrial
Current Rating	_____	_____	<input type="checkbox"/> Other (Specify)
Available short circuit current at point where transfer switch is to be installed _____			
Interrupting rating of the upstream protective device _____			
<b>2. AUTOMATIC TRANSFER SWITCH RATINGS</b>			
Voltage _____			
Continuous Current _____			
Withstand _____			
Closing _____			
Interrupting _____			
<b>4. OPTIONS OR SPECIAL EQUIPMENT (LIST)</b>			

Figure 1. Transfer Switch Selection Chart

### Transfer Switch Selection (Continued)

- With the switch closed to the "Utility" power source side, it must be able to WITHSTAND the energy let-through of the utility service protective device while that device interrupts the fault.
- When the "Standby" power supply is available, the transfer switch could transfer the load before the utility system's protective device clears the fault. This requires that the transfer switch be capable of INTERRUPTING the protective device's let-through current.
- The transfer switch might "close in" on a fault and, for that reason, it requires a CLOSING rating.

*NOTE: Special circuitry may be required to ensure the transfer switch operates safely under interrupting, closing and withstand conditions. Publications that outline the safe use of automatic transfer switches are (a) The National Electric Code, and (b) UL 1008, "Standard for Safety, Automatic Transfer Switches".*

### Installation Requirements

Generac automatic transfer switches have been factory wired and tested. Transfer switch components have been housed in a sturdy, steel, lockable enclosure. Installation of the transfer switch includes the following:

- Mounting the enclosure.
- Connection of generator start circuit wiring.
- Connection of power source and load lines.
- Installation and connection of any options or accessories.
- Completion of Functional tests and adjustments.

### Mounting the Enclosure

Refer to the appropriate Owner's Manual for the transfer switch to be installed. Comply with mounting instructions in that manual. Some enclosures are designed for wall mounting and should be mounted vertically to a rigid supporting structure. Some larger enclosures require floor mounting.

**CAUTION:** Handle the transfer switch carefully. Protect it against impact at all times. Also protect the unit against metal chips, construction grit, lint, fillings, dust, dirt, etc. Never attempt to use a transfer switch that has been damaged.

### Connection of Start Circuit Wiring

Suitable, approved wiring must be properly connected to the 2-wire start terminal strip in the transfer switch enclosure and to an identically numbered terminal strip in the generator's AC connection (lower) panel. Closure of the Wires 178/183 circuit by transfer switch circuit board action must result in generator engine cranking and startup. Route the start circuit wiring through its own separate conduit. Never run start wiring through the same conduit as any power source or load leads. Recommended wire gauge sizes for this wiring depends on wire run length, as follows:

MAXIMUM WIRE LENGTH	RECOMMENDED WIRE SIZE
460 feet (140m)	No. 18 AWG
730 feet (223m)	No. 16 AWG
1160 feet (354m)	No. 14 AWG
1850 feet (565m)	No. 12 AWG

*NOTE: The preceding procedure applies to connection of a 2-wire start circuit only. An optional 3-wire start circuit is also available. See Part 12, "Transfer Switch Options".*

### Power Source and Load Lines

Power source and load line conductors must be properly supported, of approved insulative qualities, and of the correct wire gauge size.

When connecting power source and load lines, remove surface oxides with a wire brush. Apply joint compound to the stripped end of the conductors. Tighten terminals to the specified torque value, then wipe away excess joint compound. Tighten power source and load terminal lugs on the transfer mechanism as follows:

For units rated 100 amps, tighten to 50 inch-pounds (6 N-m).  
For all other units, tighten to 250 inch-pounds (28 N-m).

**DANGER: ALWAYS TURN OFF ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH BEFORE ATTEMPTING TO CONNECT POWER SOURCE AND LOAD LINES. BOTH THE "UTILITY" AND "STANDBY" POWER SUPPLIES TO THE TRANSFER SWITCH MUST BE POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN DANGEROUS AND POSSIBLY LETHAL ELECTRICAL SHOCK.**

**CAUTION:** Be sure to maintain correct electrical clearance between live metal parts and grounded metal. Allow at least one-half inch of clearance for 100-400 amp circuits; or one inch for circuits over 400 amps.

*NOTE: The transfer switch rated voltage and phase must match the rated voltage and phase of the power sources. Multi-voltage transfer switches (Section 9.7) are available which permit installer selection of transfer switch rated voltage and phase.*

### 3-POLE TRANSFER SWITCH CONNECTIONS:

**For 3-Phase Applications:** Before connecting any 3-phase power supply to the transfer switch, make sure the transfer switch is rated for 3-phase use. To connect a 3-phase system to a 3-pole transfer mechanism, proceed as follows:

1. Connect "Utility" source lines 1, 2 and 3 (A, B and C) to transfer mechanism terminal lugs N1, N2 and N3 respectively.
2. Connect "Standby" source lines E1, E2 and E3 to transfer mechanism terminal lugs E1, E2 and E3.
3. Connect load lines 1, 2 and 3 (A, B and C) to terminal lugs T1, T2 and T3 respectively.

### Power Source and Load Lines (Continued)

4. Connect "Utility", "Standby" and "Load" NEUTRAL lines to the transfer switch neutral block.

**For 1-Phase Applications:** At the time of this writing, "Wn" type transfer switches were available with 3 or 4-pole transfer mechanisms only. Transfer switches rated for 1-phase use are 3-pole type with factory wiring connections to terminal lugs N3, E3 and T3 omitted. The installer must ensure that the switch to be installed is rated for 1-phase use or a multi-voltage transfer switch must be used. Connect the 1-phase power source and load lines to the transfer switch as follows:

1. Connect "Utility" source lines 1 and 2 to transfer mechanism terminal lugs N1 and N2, respectively.
2. Connect "Standby" source lines E1 and E3 to transfer mechanism terminal lugs E1 and E2, respectively.
3. Connect "Load" lines 1 and 2 to terminal lugs T1 and T2.
4. If the "Neutral" line is not to be switched, connect utility, standby and load "Neutral" lines to the transfer switch neutral block.
5. If the "Neutral" line is to be switched during transfer, connect the "Utility" neutral line to terminal N3; the "Standby" source neutral line to terminal E3; and the "Load" neutral line to terminal T3.

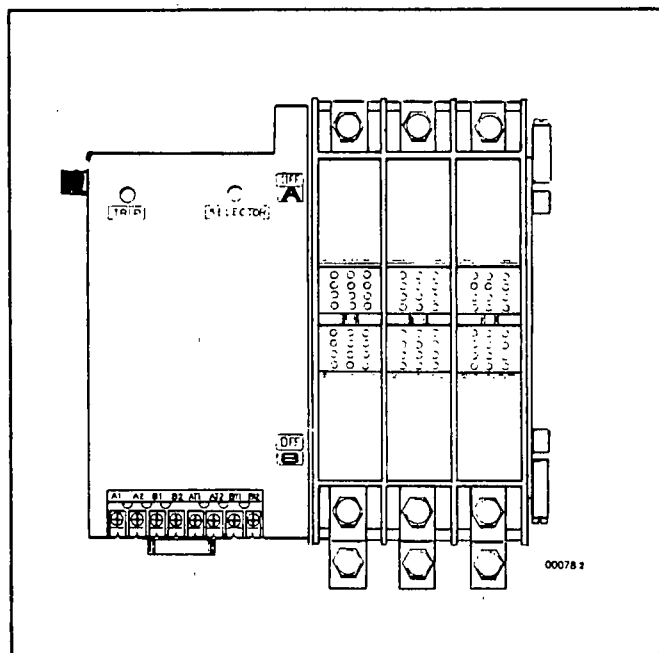


Figure 2. A 3-Pole Transfer Mechanism

#### 4-POLE TRANSFER SWITCH CONNECTIONS:

Typically, a 4-pole transfer mechanism is used in conjunction with a 3-phase system when it is desirable to switch the "Neutral" during a transfer action. Generally, a 4-pole unit is not equipped with a neutral block since "Neutral" will be connected at the transfer mechanism terminal lugs.

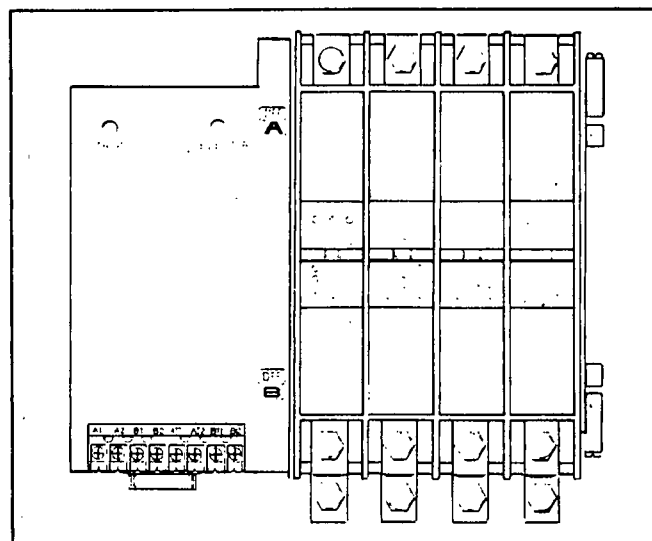


Figure 3. A 4-Pole Transfer Mechanism

Connect a 3-phase system to a 4-pole transfer mechanism as follows, when the "Neutral" is to be switched during transfer:

1. Connect "Utility" lines 1, 2 and 3 (A, B and C) to terminals N1, N2, N3.
2. Connect "Standby" lines E1, E2, E3 to terminal lugs E1, E2, E3 respectively.
3. Connect "Load" lines 1, 2 and 3 (A, B and C) to terminals T1, T2, T3 respectively.
4. Connect the "Utility" source NEUTRAL to terminal lug N4.
5. Connect the "Standby" source NEUTRAL to terminal lug E4.
6. Connect the "Load" NEUTRAL line to terminal lug T4.

### Options and Accessories

Install, connect and test any accessories or options that are to be used. For generator set options and accessories, see Part 7. Transfer switch options and accessories are discussed in Part 12.

### Functional Tests

Before placing the system into service all necessary adjustments and all functional tests should be completed. Refer to Section 9.5, "Functional Tests".

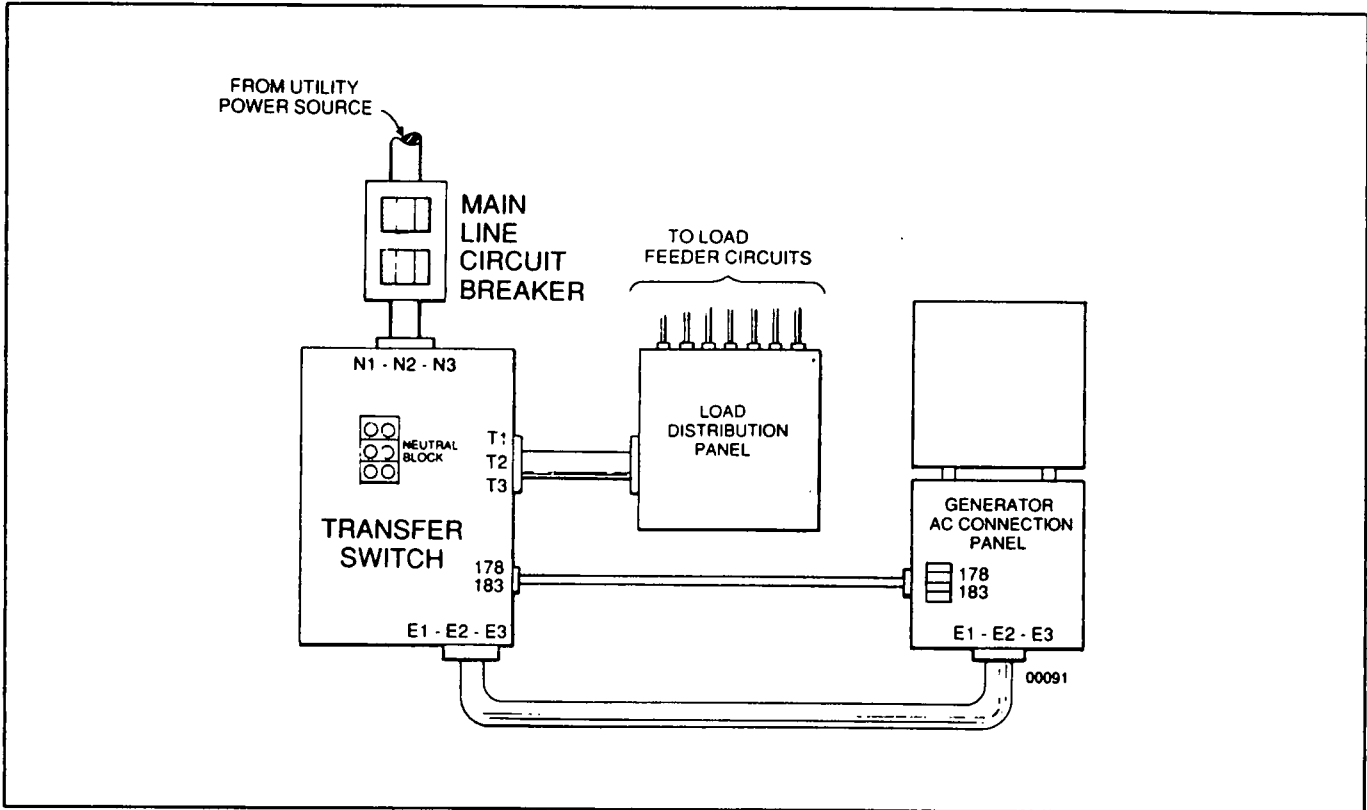


Figure 4. Standby Electric System Interconnections (Typical)

## Section 9.4 OPERATING INSTRUCTIONS

### Normal Automatic Operation

To set the system for normal automatic operation, proceed as follows:

1. On the transfer switch enclosure door, check the switch position advisory lamps. The "Switch Position-Utility" lamp should be on, indicating that "Utility" power is available and the main contacts are at their "Utility" position (load connected to the "Utility" supply).

*NOTE: If necessary, manually actuate the main contacts to their "Utility" power source side. See "Manual Operation" in this section. Also, turn on the "Utility" power supply to the transfer switch, if necessary. The main contacts must be at "Utility" and that power supply must be available to the transfer switch before proceeding.*

*NOTE: On newly installed systems, check the "Utility On" lamp on the utility voltage sensor circuit board. That lamp should be ON, indicating that "Utility" source sensing voltage is available to the board and is above the setting of the board's "voltage dropout sensor". Calibration of the utility voltage sensor board may be necessary, to match the board sensors to actual "Utility" source voltage (see Part 10 or Part 11 as appropriate).*

2. On the transfer switch enclosure door, set the system test switch to its "Automatic Mode".
3. In the transfer switch enclosure, set the maintenance disconnect switch to its "Automatic" position.
4. On the generator control console, set the auto-manual-off switch to "Auto" (if so equipped).
5. Set the generator ("Standby") main line circuit breaker to its "On" or "Closed" position.

When the preceding Steps 1 through 5 are completed, a "Utility" source voltage dropout will result in automatic generator cranking and startup. Following generator startup, transfer of the load to the "Standby" source will occur. See Part 10 or 11 as appropriate for automatic operating sequences and parameters.

**DANGER: WHEN SET FOR AUTOMATIC OPERATION, THE STANDBY GENERATOR CAN CRANK AND START SUDDENLY AT ANY TIME WITHOUT WARNING. TO PREVENT SUCH AUTOMATIC STARTUP AND POSSIBLE INJURY THAT MIGHT BE CAUSED BY SUCH A STARTUP, ALWAYS DISABLE THE 2-WIRE START SYSTEM BEFORE WORKING ON OR AROUND THE SYSTEM. AUTOMATIC STARTUP CAN BE PREVENTED BY SETTING THE MAINTENANCE DISCONNECT SWITCH TO "MANUAL". IF SO EQUIPPED, ALSO SET THE GENERATOR'S AUTO-MANUAL-OFF SWITCH TO "OFF". FINALLY, PLACE A "DO NOT OPERATE" TAG ON THE GENERATOR AND ON THE TRANSFER SWITCH.**

### Manual Operation

#### TRANSFER TO "STANDBY":

To transfer loads to the "Standby" power source and start the generator manually, proceed as follows:

1. In the transfer switch enclosure, set the maintenance disconnect switch to "Manual".
2. On the generator console, set the auto-manual-off switch to "Manual".
3. Turn OFF both the "Utility" and "Standby" power supplies to the transfer switch, using whatever means provided.

**DANGER: DO NOT ATTEMPT MANUAL TRANSFER SWITCH OPERATION UNTIL AFTER ALL POWER VOLTAGE SUPPLIES TO THE SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN HAZARDOUS AND POSSIBLY DEADLY ELECTRICAL SHOCK.**

4. Use the manual transfer handle to manually actuate the main contacts to their "Standby" source side (LOAD connected to the "Standby" supply). The word "ON" must be visible in window B of the transfer mechanism; the word "OFF" in window A. Refer to Section 9.5, "Functional Tests" for manual operating procedures.
5. Start the generator engine manually, using the start/stop switch on the generator control console. Let the engine stabilize and warm up.
6. Set the generator's main line circuit breaker to "On" or "Closed". Loads are now powered by the standby generator.

#### RETRANSFER TO "UTILITY" AND SHUTDOWN:

To retransfer loads back to the "Utility" source and shut the generator down, proceed as follows:

1. Check that the maintenance disconnect switch (in transfer switch enclosure) is set to "Manual".
2. If so equipped, set the auto-manual-off switch (on generator console) to "Manual".
3. Turn OFF both the "Utility" and "Standby" power supplies to the transfer switch, using whatever means available (such as the "Utility" and "Standby" main line circuit breakers).
4. Use the engine-start/stop switch on generator console to shut down the generator engine.
5. See Section 9.5, "Functional Tests". Use the manual transfer handle to manually actuate the main contacts back to their "Utility" position (load connected to the utility power supply). On the transfer mechanism, window A should display the word "On" and window B the word "Off".
5. Turn ON the "Utility" power supply to the transfer switch. Then, set the system for normal automatic operation (see "Normal Automatic Operation").

### ***Normal Test***

To perform a "Normal Test" of the system, refer to Section 9.5, "Functional Tests".

### ***Fast Test***

To conduct a "Fast Test" of the system, refer to Section 9.5, "Functional Tests".

### ***System Exercise***

Once every seven days, on a day and at a time of day selected by the owner, the standby generator will start and run for a preset time period. During this exercise, transfer to the "Standby" source may or may not occur as selected by means of a circuit board switch.

*NOTE: On units equipped with three circuit boards, system exercise is controlled by a 7-day exercise circuit board. An optional programmable exercise board is also available which provides an exercise runup on selected day or days of the week. On transfer switches having only two circuit boards, the exercise feature is part of the CPU circuit board.*

## Section 9.5 FUNCTIONAL TESTS

### General

Following installation, the standby electric system should be inspected and tested. All required adjustments should be completed.

Functional testing of the system includes (a) manual operation, (b) voltage checks, (c) electrical operation, and (d) completing required adjustments.

Read and make sure you understand all instructions before proceeding. Also read instructions on tags and labels that might be affixed to the transfer switch. Note any options or accessories that might be installed and review their operation.

**DANGER: DO NOT ATTEMPT MANUAL TRANSFER SWITCH OPERATION UNTIL ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY LETHAL ELECTRICAL SHOCK.**

### Manual Operation

Both a manual transfer handle and an actuating pin are included with the "Wn" type automatic transfer switch. Following installation, manual operation should be checked before the switch is operated electrically. To operate the transfer switch manually, proceed as follows:

**CAUTION: Do NOT apply excessive force when operating the main contacts manually, or the manual transfer handle may be damaged. Always set the contacts to their "tripped" or "neutral" position before selecting either "Utility" or "Standby". The main contacts are at "tripped" or "neutral" when the word "Off" appears in both windows A and B.**

1. In the transfer switch enclosure, set the maintenance disconnect switch to its "Manual" position.
2. Turn off both the "Utility" and "Standby" power supplies to the transfer switch, using whatever means provided.
3. Note the position of the transfer mechanism main contacts by observing the display in windows A and B.
  - a. When window A reads "ON" and window B reads "OFF", load is connected to the "Utility" power source.
  - b. When window B reads "ON" and window A reads "OFF", the load is connected to the "Standby" power source.
  - c. When windows A and B both read "OFF", the load is disconnected from both power sources ("tripped" or "neutral").

4. If window A or B reads "ON": Go to Step 6. The switch must be "tripped" to "Neutral" before it is reset to "Manual" or "Utility".
5. If windows A and B Both Read "OFF": Switch is already "tripped" to "Neutral". Go to Step 7.
6. To "trip" the contacts (set them to "Neutral"), proceed as follows:
  - a. Insert the actuating pin (shipped with unit) into Hole "T" (see Figure 1 below). Push the trip lever in.
  - b. The main contacts should "trip" to "Neutral" and the word "OFF" should appear in windows A and B.

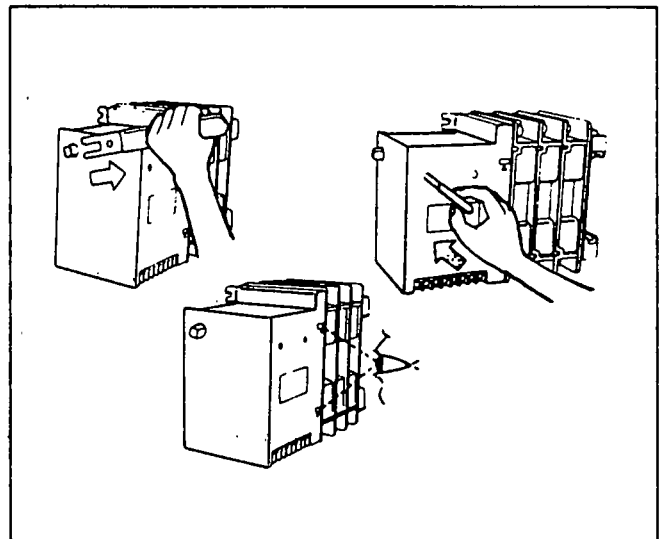


Figure 1. Trip to "Neutral"

7. To close the main contacts to the "Utility" power source side, proceed as follows:
  - a. Attach the manual transfer handle to the square shaft at upper corner of transfer mechanism (Figure 2).
  - b. Move the handle upward. The word "ON" should appear in window A, the word "OFF" in window B. This indicates the "Load" is connected to the "Utility" power source side.
8. To close the main contacts to their "Standby" power source side, proceed as follows:
  - a. Attach manual transfer handle to square shaft.
  - b. Operate the handle upward and, at the same time, use the actuating pin to push in on trip lever through Hole "S". The main contacts should actuate.
  - c. The word "ON" should appear in window B; the word "OFF" in window A. This indicates the "Load" is connected to the "Utility" source side.
9. Repeat Steps 6, 7 and 8 several times, until you are certain that manual operation is correct.

**NOTE: Before proceeding to "Voltage Checks", "LOad" must be connected to the "Utility" source. Window A must display the word "ON", window B must display the word "OFF".**

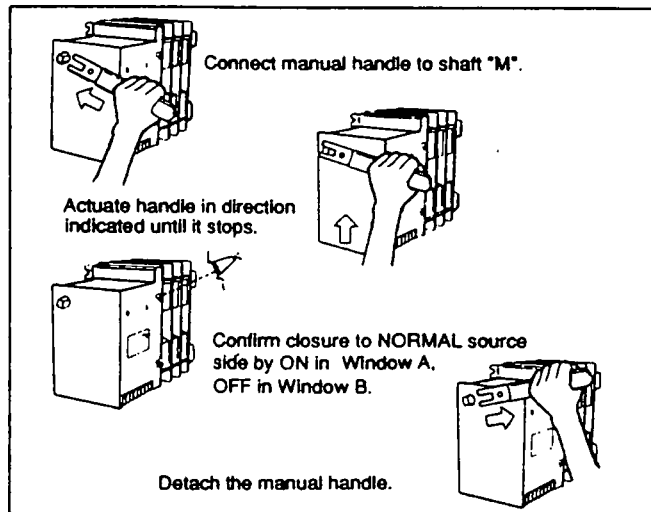
**Manual Operation (Continued)**

Figure 2. Closing to "Utility" Source Side

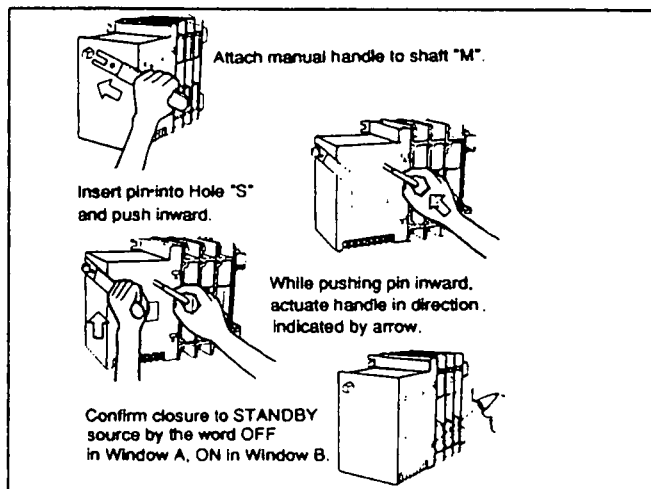


Figure 3. Closing to "Standby" Source Side

**Voltage Checks**

Before proceeding, check the transfer switch data plate for rated voltage. Both "Utility" and "Standby" voltage must be compatible with the data plate voltage.

**DANGER: FOR SAFETY, SET THE MAINTENANCE DISCONNECT SWITCH TO "MANUAL" BEFORE PERFORMING VOLTAGE CHECKS.**

**DANGER: USE EXTREME CAUTION WHEN PERFORMING VOLTAGE CHECKS. POWER TERMINALS AND WIRES ARE ELECTRICALLY HOT. DO NOT TOUCH LIVE ELECTRICAL PARTS. DO NOT PERFORM VOLTAGE CHECKS WHILE BAREFOOT, WHILE HANDS OR FEET ARE WET, OR WHILE STANDING IN WATER. IF POSSIBLE STAND ON INSULATIVE MATS WHILE PERFORMING THE VOLTAGE CHECKS.**

Perform voltage checks as follows:

1. In the transfer switch enclosure, set the maintenance disconnect switch to "Manual".
2. If so equipped, set the generator's auto-manual-off switch to "Off" position.
3. On the switch enclosure door, set the system test switch to "Automatic Mode".
4. Check that the main contacts are actuated to their "Utility" position, i.e., "Load" connected to the "Utility" source. Window A should display the word "ON"; window B the word "OFF".

**CAUTION: DO NOT proceed until the preceding Steps 1 through 4 have been completed.**

5. Turn ON the "Utility" power supply to the transfer switch using whatever means provided (such as the "Utility" main line circuit breaker).
  - a. Check that the "Switch Position-Utility" lamp is ON. "Lamp ON" condition indicates that (a) "Utility" voltage is available to the transfer switch and (b) the "Load" is connected to the "Utility" side.
  - b. Inside the transfer switch enclosure door, locate the utility voltage sensor circuit board. The board's "Utility On" lamp (LED) should be ON. Lamp illuminates to indicate that (a) "Utility" sensing voltage is available to the circuit board, and (b) the "Utility" sensing voltage is above the setting of a "voltage dropout sensor".

*NOTE: It is recommended that the utility voltage sensor circuit board be calibrated to match the local "Utility" power source voltage. Refer to Part 10 or 11 as appropriate for circuit board calibration procedures.*

6. Use an AC voltmeter to check line-to-line (phase-to-phase) voltages across transfer switch terminal lugs N1, N2, N3. Also check line-to-neutral voltage across terminal lug N1 and neutral; N2 and neutral; N3 and neutral. Supplied voltage must be compatible with transfer switch rated voltage and phase.

*NOTE: For MULTI-VOLTAGE transfer switches, see Section 9.7.*

7. Refer to the appropriate Owner's Manual for the specific standby generator set.
  - a. Make sure the generator and its engine have been properly serviced and are completely ready for use.
  - b. On the generator control console, set the auto-manual-off switch to "Manual".
  - c. Use the start/stop switch on generator console to crank and start the generator engine. Let the engine stabilize and warm up.
  - d. Turn on the "Standby" power supply to the transfer switch, using whatever means provided (such as the generator main line circuit breaker).
8. On the transfer switch enclosure door, check that the "Standby Operating" lamp is lighted.
9. Use an AC voltmeter to check voltage across terminal lugs E1, E2, E3 (line-to-line), and across each terminal lug and the neutral block (line-to-neutral).

### *Voltage Checks (Continued)*

10. Use an AC frequency meter to check generator AC frequency. If necessary, adjust the engine speed governor to supply correct frequency.
11. When all tests and adjustments have been completed, shut the generator down.

### *Electrical Operation*

#### PERFORM A "NORMAL TEST":

1. On the utility voltage sensor circuit board, check that the "Utility On" lamp is ON.
2. On the switch enclosure door, check that the "Switch Position-Utility" lamp is ON.
3. In the transfer switch enclosure, set the maintenance disconnect switch to "Automatic".
4. If so equipped, set the generator's auto-manual-off switch to "Auto".
5. Make sure the standby generator and its engine have been properly serviced and are completely ready for use.
6. Set the "Standby" main line circuit breaker to "On" or "Closed".
7. Set the system test switch to its "Normal Test Mode" position.
  - a. The standby generator engine should crank and start. The "Standby Operating" lamp on transfer switch door should illuminate.
  - b. Following generator startup, transfer to the "Standby" source should occur. The "Switch Position-Emergency" lamp should illuminate.
8. With the generator running and with loads powered by generator output, reset the system test switch back to "Automatic Mode".
  - a. After a brief pause, retransfer back to the "Utility" power source should occur.
  - b. Following retransfer, an "engine cooldown timer" and an "engine minimum run timer" will time out. When those timers have finished timing, the generator should shut down.

*NOTE: On units equipped with a "logic type" intelligence system (3 circuit boards), advisory lamps on the system control (logic) circuit board will turn on to indicate operation of the various sensors and timers that control automatic operation. By observing these lamps (LED's), automatic operation sequences and times can be verified. See Part 11, "The Logic Type Intelligence System".*



## Section 9.6 OPERATIONAL ANALYSIS

**NOTE:** The transfer switch used in this operational analysis is a 3-pole, 1-phase, 240 volts unit equipped with (a) a "Logic" type intelligence system having 3 circuit boards, and (b) with the time delay neutral feature.

### Circuit Condition- Utility Power Available

"Utility" source voltage is delivered to transfer mechanism (GTS) terminals N1, N2, N3 via customer supplied wiring. From the transfer mechanism (GTS), "Utility" voltage is delivered to terminals N1, N2 and N3 of a utility sensing interface. Step-down transformers in the interface reduce the voltage signal to about 18-25 volts, depending on the actual "Utility" source voltage. The reduced voltage is then delivered to a utility voltage sensor circuit board via Wires 224-227. A "Utility On" lamp (LED) on that circuit board should be ON.

From terminal lug N1, "Utility" source power is delivered to transfer mechanism terminal A1, via Wire N1, the safety disconnect switch ("Automatic" selected), Wire 125, the normally-closed transfer relay (TR) contacts, Wire 126, normally-closed time delay relay (TD) contacts. From terminal lug N2, "Utility" power is available to transfer mechanism terminal A2, via wire N2. With the main contacts at "Utility", the A1/A2 circuit to the closing coil (C) is held open by control switch Ax action.

Power from terminal lugs N1/N2 is also available to transfer mechanism terminals BT1 and BT2. However, trip control switches BTS1/BTS2 are held open by transfer mechanism action and trip coil (TC) is de-energized.

From load terminals T1/T2, "Utility" source voltage is delivered to the primary coil of transformer TR2. A reduced voltage is induced into the TR2 secondary coil. This reduced (step-down) voltage is available to the 7 day exerciser board via wires 185 and 0. The step-down voltage is also delivered to a "Switch Position-Utility" lamp (CL), via the normally-closed auxiliary contacts and the lamp is ON.

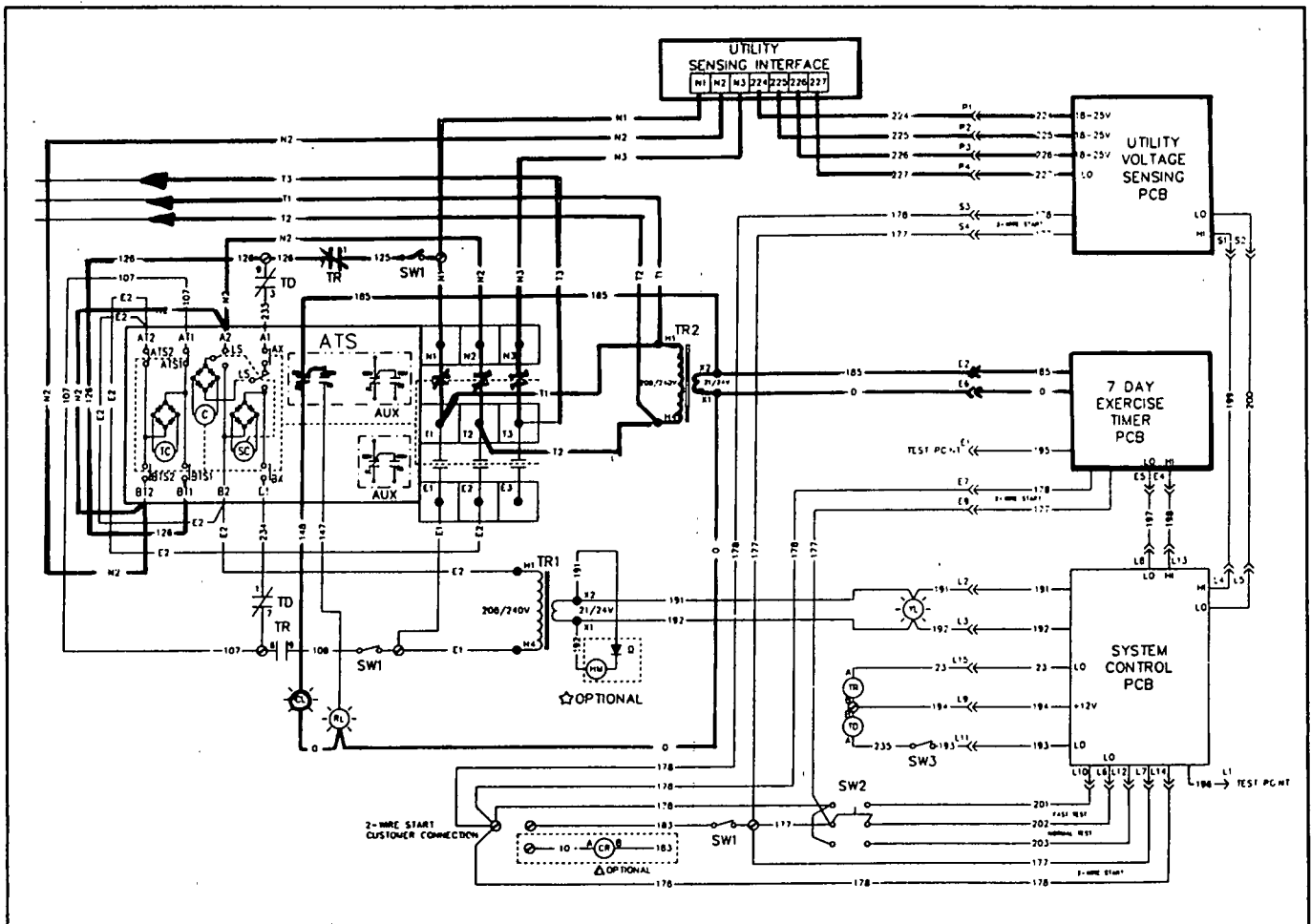


Figure 1. Circuit Condition- Utility Source Power Available

### Circuit Condition- Utility Power Source Dropout

The utility voltage sensor monitors the "Utility" power source voltage from the utility sensing interface, via Wires 224-227. Should that source voltage drop below the setting of a "voltage dropout sensor" on the circuit board, a timer on the circuit board will start. Should the sensing voltage remain low after the timer has finished timing, circuit board action will close the wires 178/183 circuit. The generator will then crank and start as controlled by a dc control/latch-crank board in the generator console.

The utility voltage sensor board will also open the wires 199/202 circuit between its connector and the system control (logic or CPU) circuit board, to "tell" the system control board that "Utility" voltage is low. If the circuit is not opened by circuit board action when in automatic mode, transfer to "Standby" will not occur.

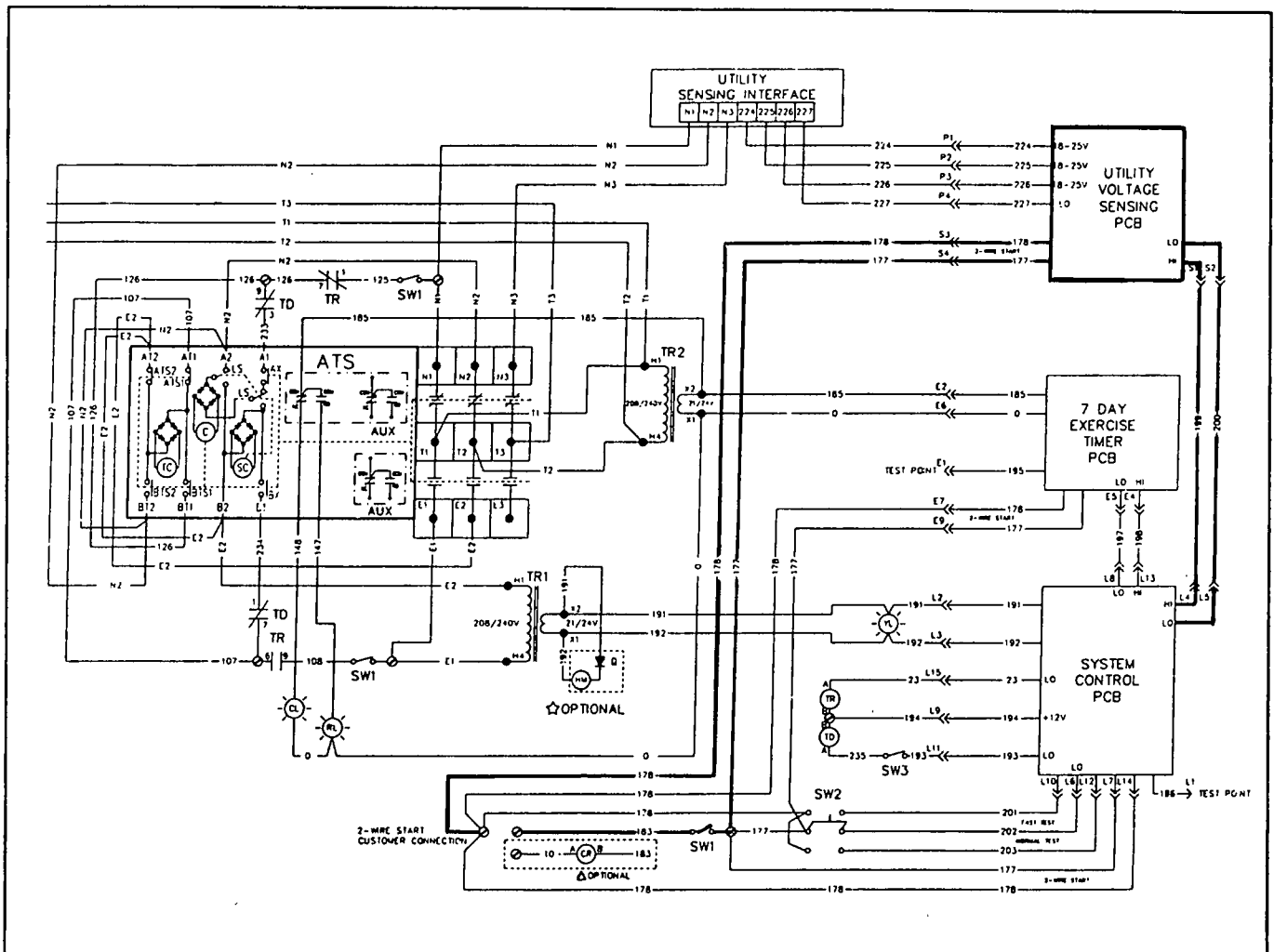


Figure 2. Circuit Condition- Utility Power Source Dropout

### Circuit Condition- Standby Generator Running

With the standby generator running, generator AC output voltage is delivered to transfer mechanism terminal lugs E1, E2, E3. Standby current flows through the primary coil of transformer TR1, to induce a step-down voltage into the transformer secondary coil. Secondary coil output is then delivered to a "Standby Operating" lamp and to the system control circuit board.

The "Standby Operating" lamp turns on.

The system control circuit board turns on and delivers 12 volts DC to (a) a transfer relay (TR) coil and (b) a time delay relay (TD) coil. The TR coil circuit is completed back to the system control board via Wire 23; the TD coil circuit via Wire 193. Circuit board action holds these circuits open and both relays remain de-energized.

An "engine warmup timer" and a "minimum run timer" on the system control board start timing.

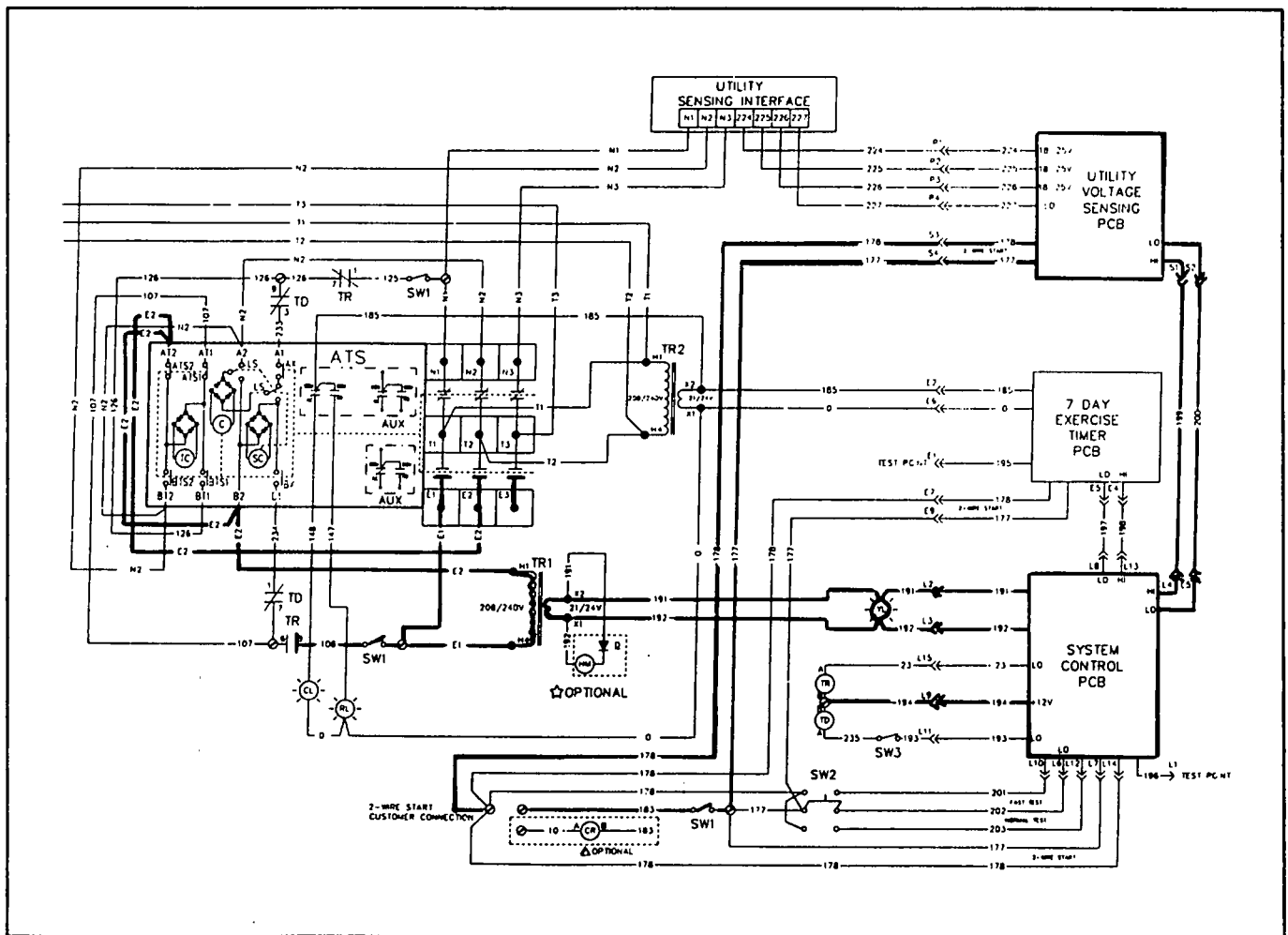


Figure 3. Circuit Condition- Generator Running

### Circuit Condition- Transfer to Standby

When the "engine warmup timer" has timed out and providing standby source voltage and frequency are at an acceptable (preset) level, the system control board will complete the transfer relay (TR) circuit and the time delay neutral relay (TD) circuits to ground. Both relays will then energize simultaneously. Standby power will then be delivered across the closed transfer relay (TR) contacts and to transfer mechanism terminals AT1/AT2. The time delay relay (TD) normally-closed contacts have opened and no power is available to transfer mechanism terminals B1/B2.

Power from terminals AT1/AT2 is delivered to a trip contactor (TC). TC energizes to unlatch the main contacts. The main contacts then actuate to their "tripped" or "neutral" position.

Main contacts movement to the "tripped" position closes control switches Ax and Bx.

When a time delay timer on the system control board times out, the circuit board opens the Wire 193 circuit and the time delay relay (TD) de-energizes. That relay's normally-closed contacts close to deliver power to terminals A1/A2. This energizes a selective coil (SC) which, in turn, closes selective switches (LS) to the B1/B2 side.

Closure of the selective switches (LS) delivers power to the closing coil (C). The closing coil energizes to complete the transfer action to the "Standby" power source side.

As the main contacts actuate to their "Standby" side, control switches Ax and Bx are opened.

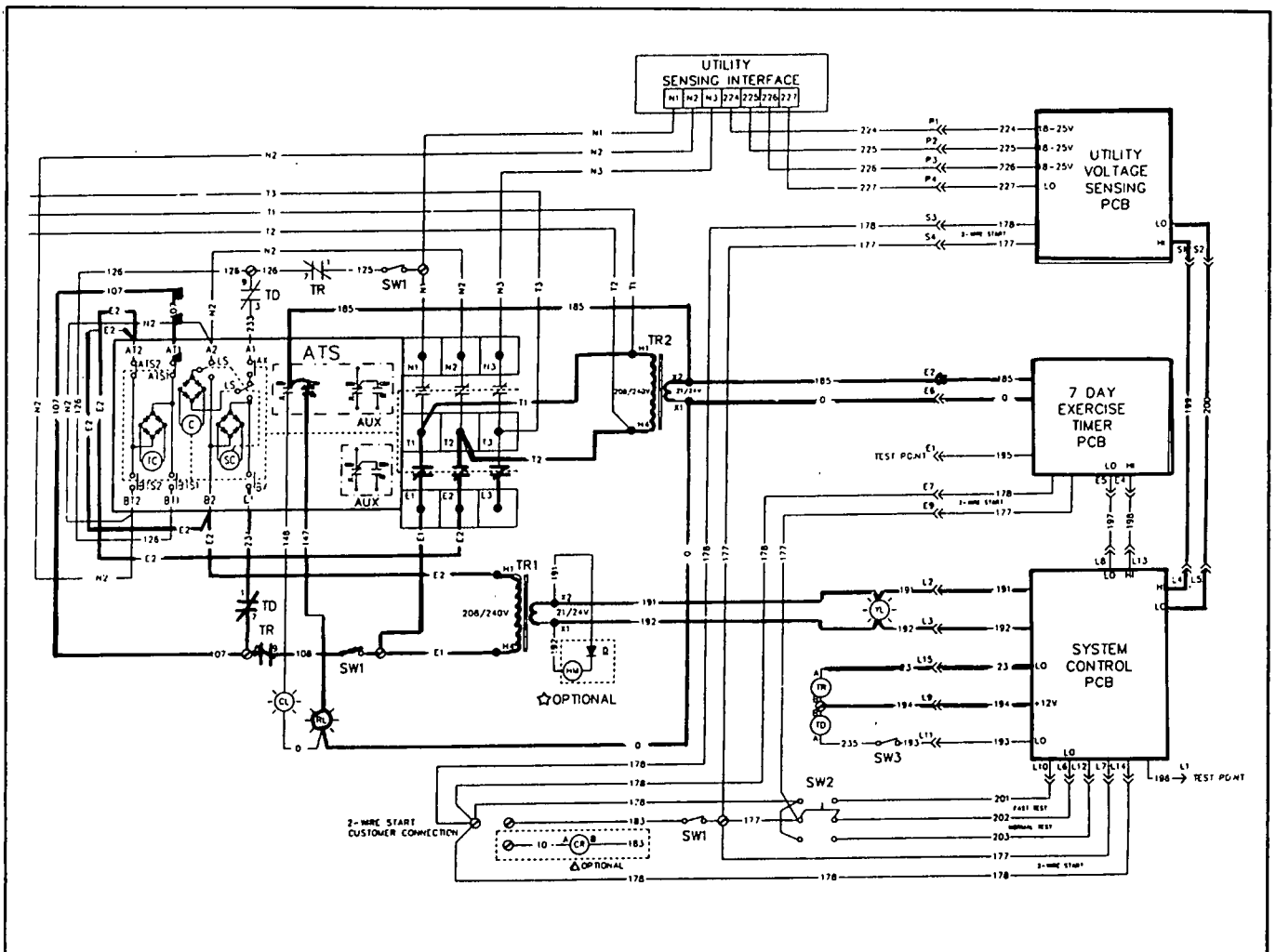


Figure 4. System Condition- Transfer to Standby



**Circuit Condition- Retransfer Back to Utility Source**

With a preset utility sensing voltage available to the utility voltage sensor board, that board closes the 199/200 circuit to "tell" the system control board that utility voltage is now available. A "return to utility timer" on the system control board starts timing. After a preset time interval, the system control board opens the transfer relay's wire 23 circuit and closes the time delay relay (TD) circuit to ground. The transfer relay (TR) de-energizes and its normally-closed contacts close. The time delay relay energizes and its normally-closed contacts open.

Utility source voltage is now available to transfer mechanism terminals BT1/BT2. A trip coil (TC) energizes to unlatch the main contacts and allow them to move to their "tripped" or "neutral" position. Main contacts movement to "neutral" closes control switches Ax/Bx in the transfer mechanism. Utility power is then delivered to a selective coil (SC). The selective coil (SC) energizes and closes selective switches (LS) to their A1/A2 side.

When a "time delay neutral timer" on the system control board has timed out, circuit board action de-energizes the time delay relay (TD). The relay's normally-closed contacts then close to deliver utility source power to closing coil (C). Closing coil (C) then energizes to actuate the main contacts to their utility power source side.

Main contacts movement to the utility power source side opens control switches Ax/Bx.

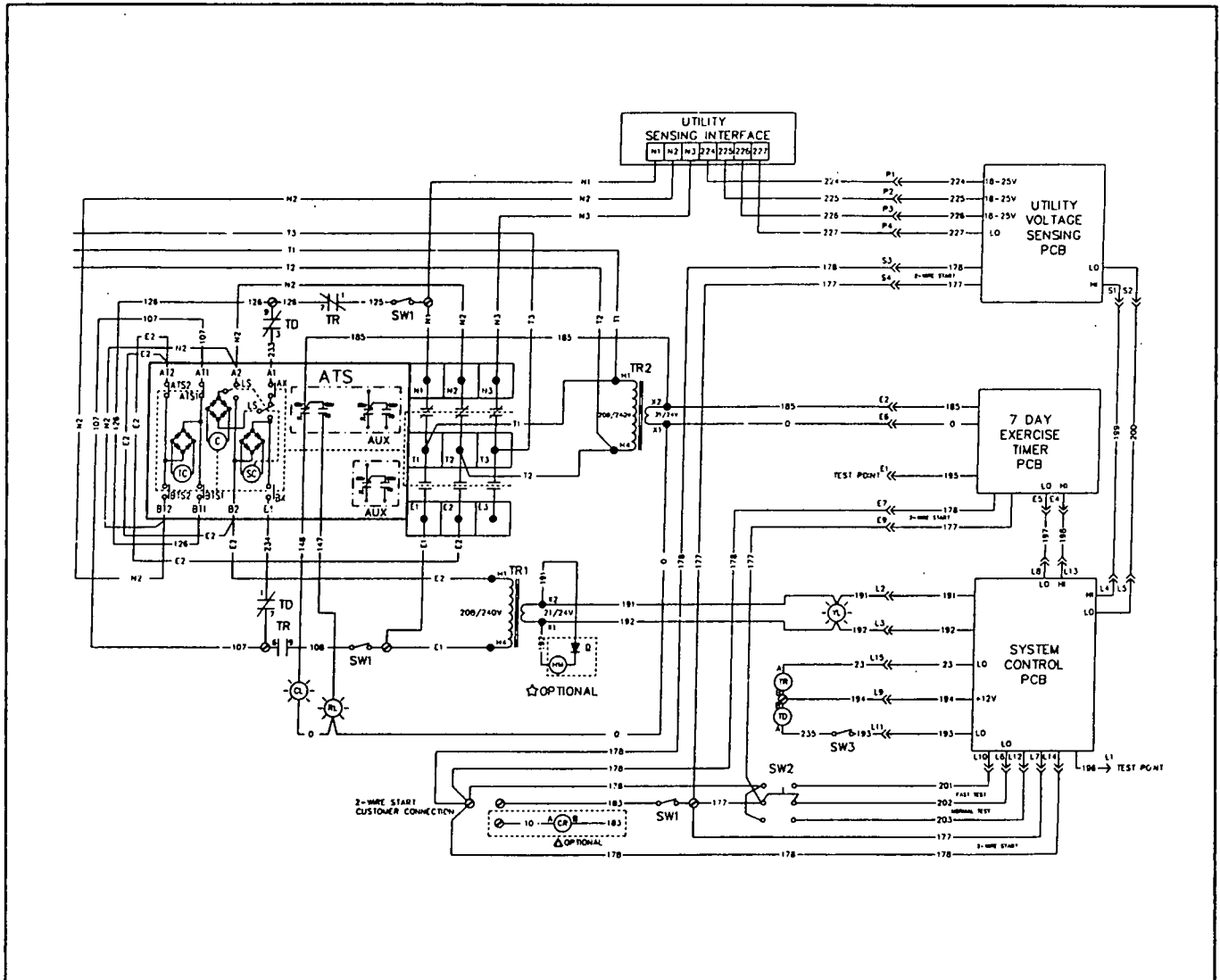


Figure 6. Circuit Condition- Retransfer Back to Utility Source

## Section 9.7 MULTI-VOLTAGE TRANSFER SWITCHES

### General

Standard GTS transfer switches must be installed and used with a power source voltage and phase that is compatible with the transfer switch rated voltage and phase (as stated on the transfer switch data plate).

The "multi-voltage" type transfer switch permits greater flexibility of use since it permits several different voltage and phase selections to be made by the installer. The installer must make sure the selected voltage and phase is compatible with the power source voltage and phase.

### Voltage Selections

A multi-voltage interface panel is shown in Figure 1 at right. A typical multi-voltage interface panel will permit selection of the following:

- 240 volts, 1-phase.
- 208 volts, 3-phase.
- 240 volts, 3-phase.
- 416 volts, 3-phase.
- 480 volts, 3-phase.

To select a voltage and phase, simply plug the connector into the interface panel receptacle indicated by the correct voltage and phase.

*NOTE: The utility voltage sensor circuit board should be calibrated to match the actual utility power source voltage. See Part 10 or 11 of this manual as appropriate.*

### Using 3-pole Transfer Mechanisms in 1-Phase Applications

A special procedure may be required when connecting a 1-phase power supply to a 3-pole transfer mechanism on multi-voltage units. See Section 8.8, "Multi-Voltage Transfer Switches".

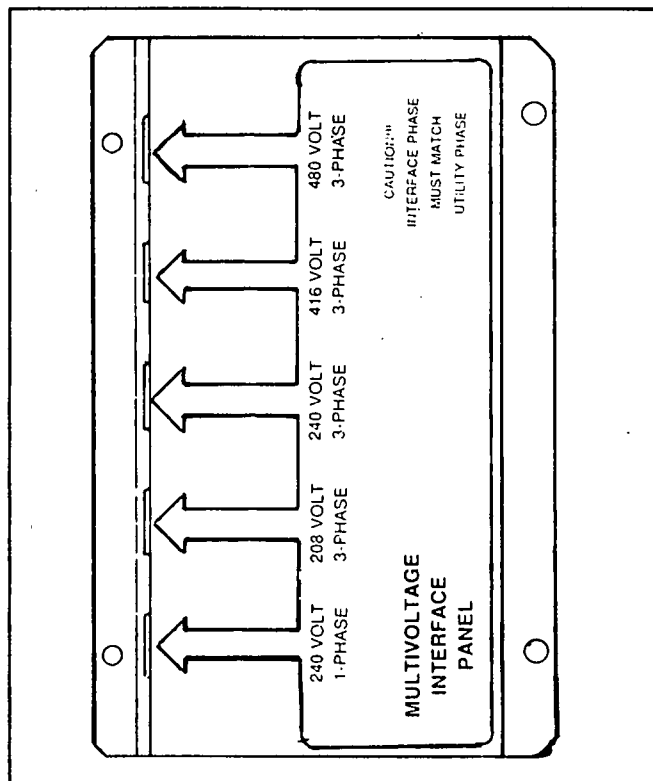


Figure 1. Multi-Voltage Interface Panel (Typical)

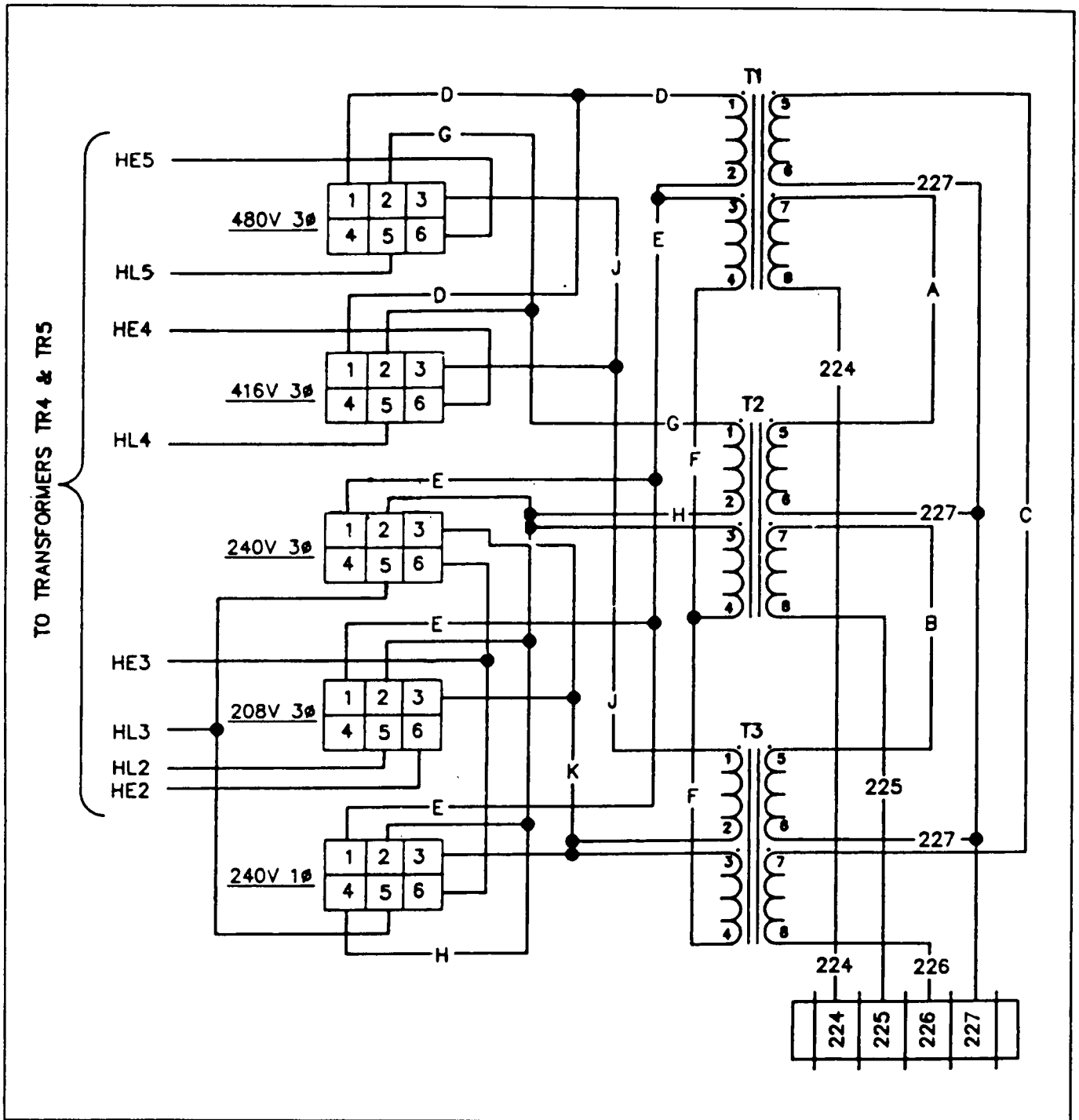
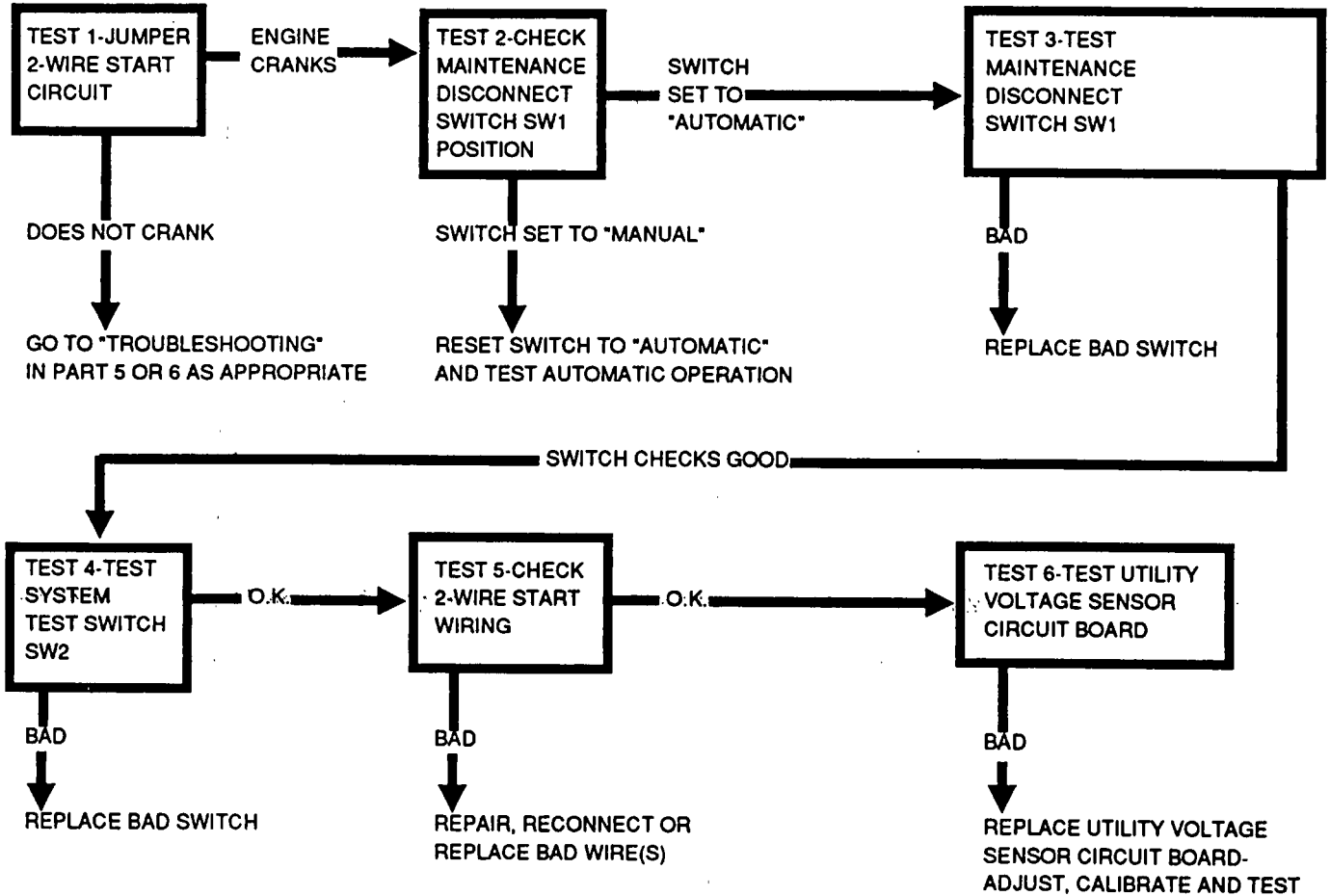


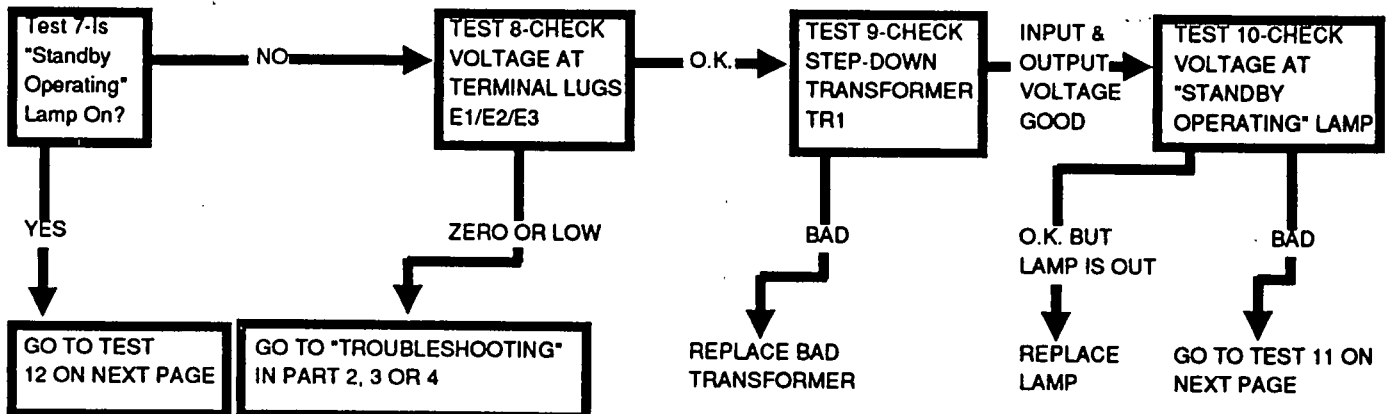
Figure 2. Schematic Diagram- Multivoltage Interface

## Section 9.8 TROUBLESHOOTING FLOW CHARTS

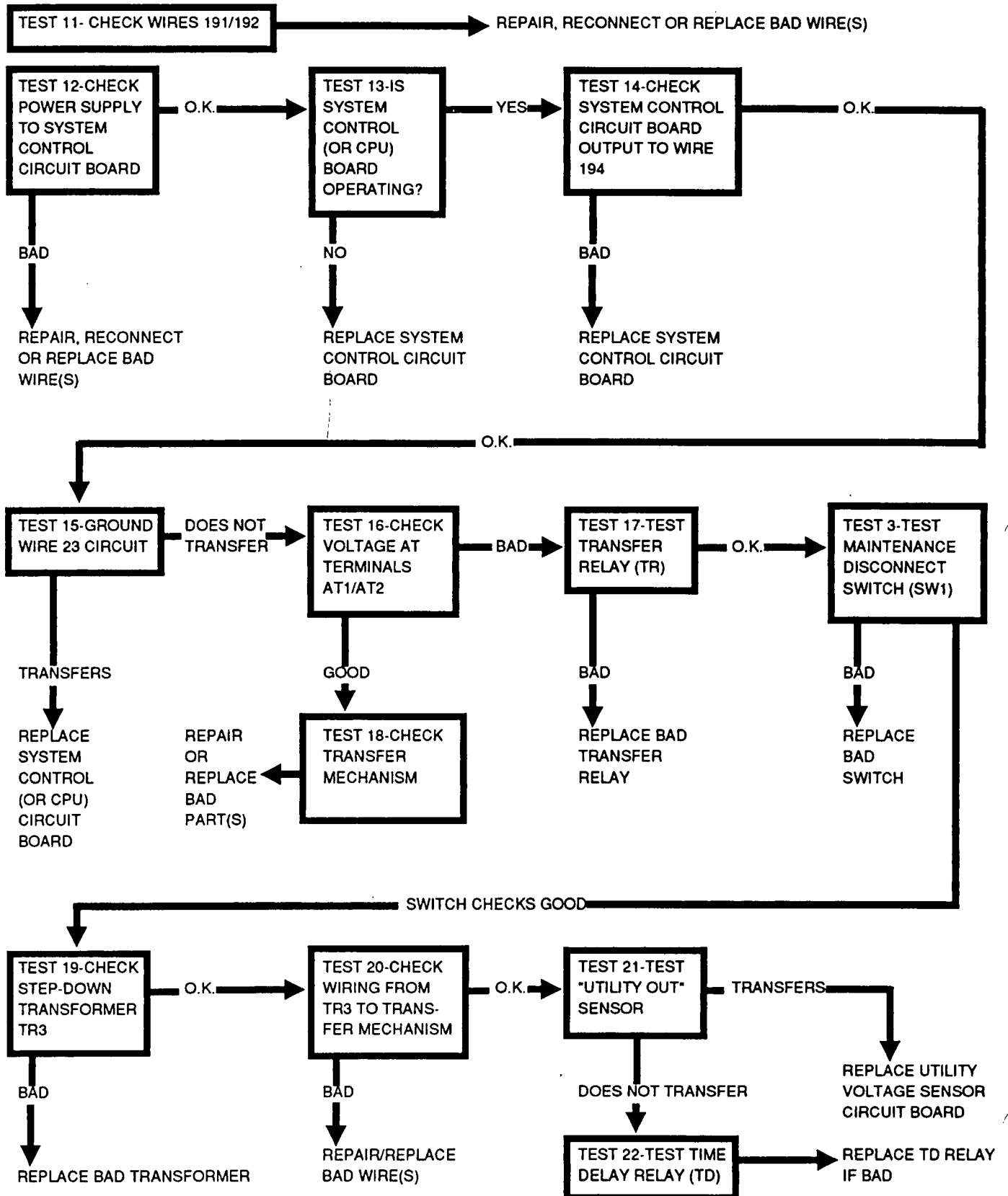
### Problem 1- Generator Engine Does Not Crank in Automatic Mode (On Utility Failure or "Normal Test")



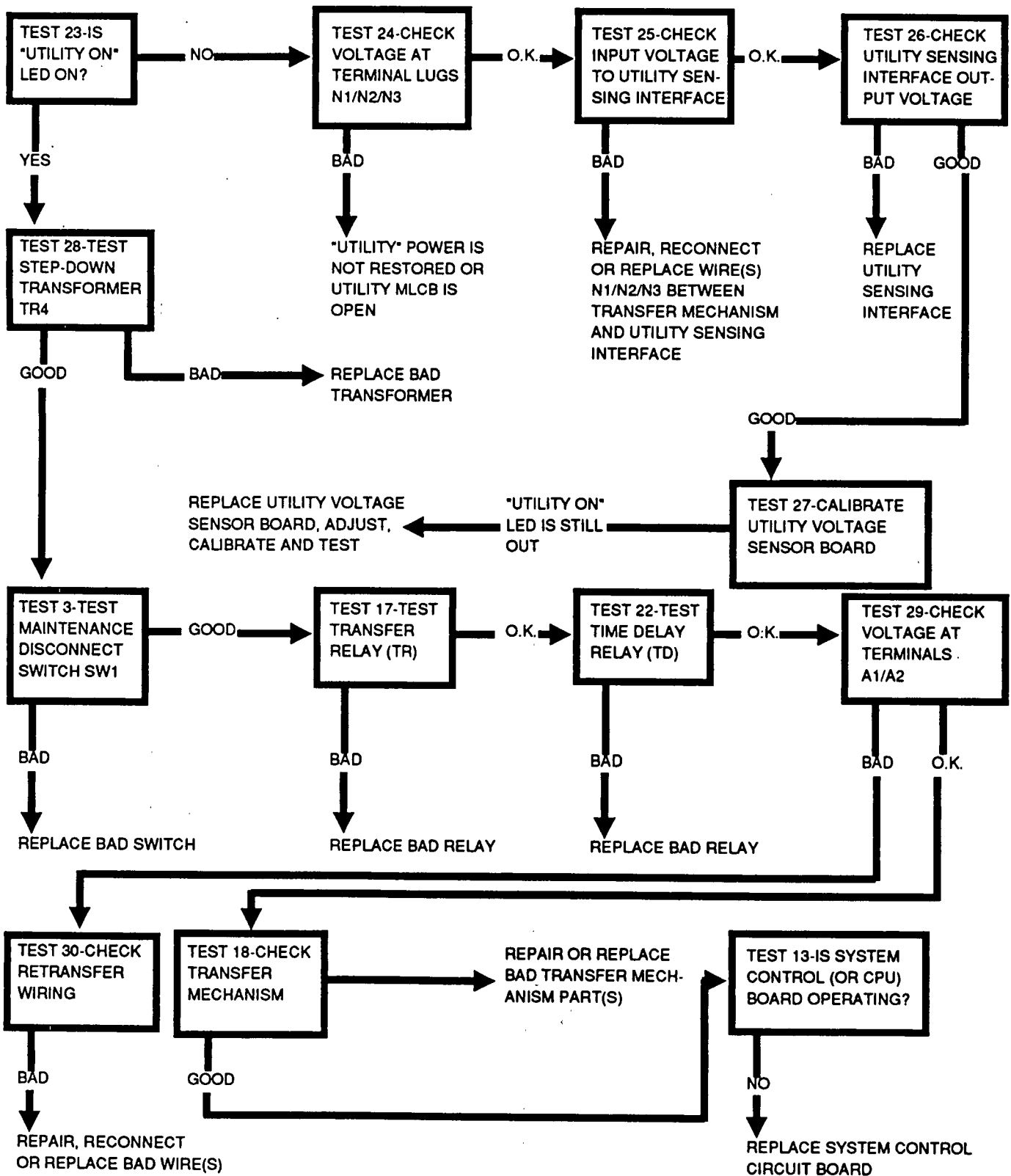
### Problem 2- Does Not Transfer to "Standby" in Automatic Mode



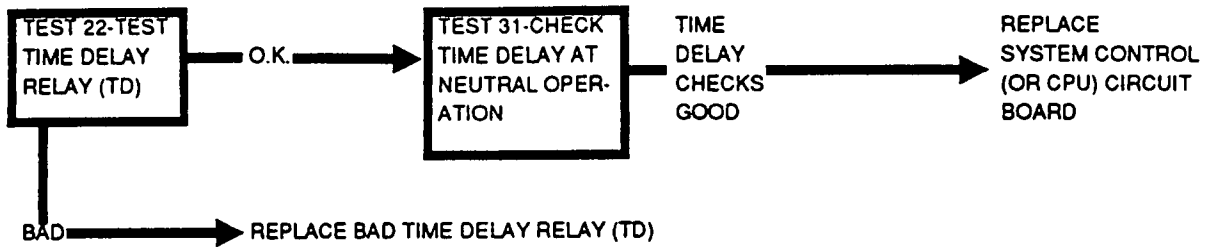
**Problem 2- Does Not Transfer to "Standby" in Automatic Mode (Continued)**



**Problem 3- Does Not Retransfer Back to "Utility" When That Power Supply is Restored  
(In Automatic Mode or During "Normal Test")**



**Problem 4- Transfer and Retransfer Occurs But No Time Delay at Neutral Function  
(If So Equipped)**



## Section 9.9 DIAGNOSTIC TESTS

### Introduction

Perform the diagnostic tests in this section in conjunction with the "Troubleshooting Flow Charts" of Section 9.8. The numbered tests in Section 9.8 correspond to test numbers in this section.

### Test 1- Jumper 2-Wire Start Circuit

**DISCUSSION:**

Following a "Utility" power outage, utility voltage sensor board action should close the 2-wire start circuit (Wires 178/183). On closure of that circuit, a DC control/latch-crank circuit board in the generator console should crank and start the engine. The same events should take place during performance of a "Normal Test". If engine does not crank during a "Normal Test" or on "Utility" power failure, this test will determine if the problem is in the automatic transfer switch or in the standby generator.

**PROCEDURE:**

Connect a jumper wire across terminals 178 and 183 in the transfer switch enclosure (Figure 1). The engine should crank and start, as controlled by a DC control/latch-crank board in the generator control console.

**RESULTS:**

1. If engine does NOT crank, a problem exists in the 2-wire start leads to the generator or in the generator DC control system. Refer to troubleshooting in Part 5 or 6 as appropriate.
2. If engine cranks when jumper wire is attached but not during automatic operation, go on to Test 2. The problem is in the transfer switch.

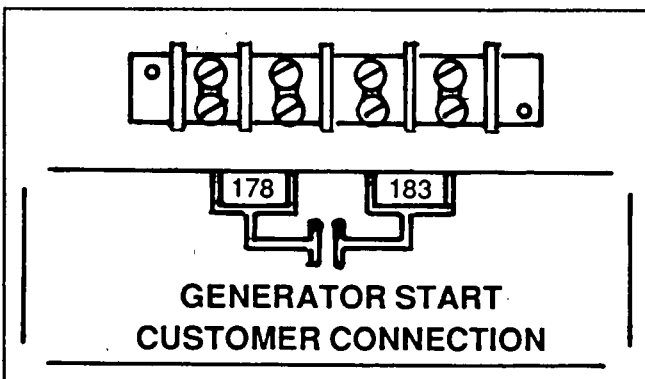


Figure 1. The 2-Wire Start Terminals

### Test 2- Check Maintenance Disconnect Switch Position

**DISCUSSION:**

This switch must be set to its "Automatic" position for all operations in the automatic mode. When the switch is set to "Manual", neither automatic engine startup or automatic transfer will occur.

**PROCEDURE:**

Check that the maintenance disconnect switch (in transfer switch) is set to its "Automatic" position.

**RESULTS:**

1. If necessary, reset switch to "Automatic" and test automatic operation.
2. If automatic cranking and operation cannot be obtained with switch set to "Automatic", go to Test 3.

### Test 3- Test Maintenance Disconnect Switch

**DISCUSSION:**

A defective maintenance disconnect switch can prevent (a) engine cranking in automatic mode, (b) transfer to the "Standby" source side, and (c) retransfer to the "Utility" side.

**PROCEDURE:**

Test the maintenance disconnect switch as follows (see Figure 2):

- Turn OFF all power voltage supplies to the transfer switch.
- Set the switch to "Automatic". Use an ohmmeter to test the switch as indicated in the following chart.
- Set the switch to "Manual". Again test the switch as indicated in the following chart.

SWITCH POSITION	TEST POINTS	METER READING
"Automatic"	Terminals 1 and 2	Continuity
	Terminals 2 and 3	Infinity
	Terminals 4 and 5	Continuity
	Terminals 5 and 6	Infinity
	Terminals 7 and 8	Continuity
	Terminals 8 and 9	Infinity
	Terminals 10 and 11	Continuity
"Manual"	Terminals 11 and 12	Infinity
	Terminals 1 and 2	Infinity
	Terminals 2 and 3	Continuity
	Terminals 4 and 5	Infinity
	Terminals 5 and 6	Continuity
	Terminals 7 and 8	Infinity
	Terminals 8 and 9	Continuity
"Manual"	Terminals 10 and 11	Infinity
	Terminals 11 and 12	Continuity

**Test 3- Test Maintenance Disconnect Switch (Continued)**

**RESULTS:**

1. If the switch checks good, go to Test 4.
2. Replace switch if defective.

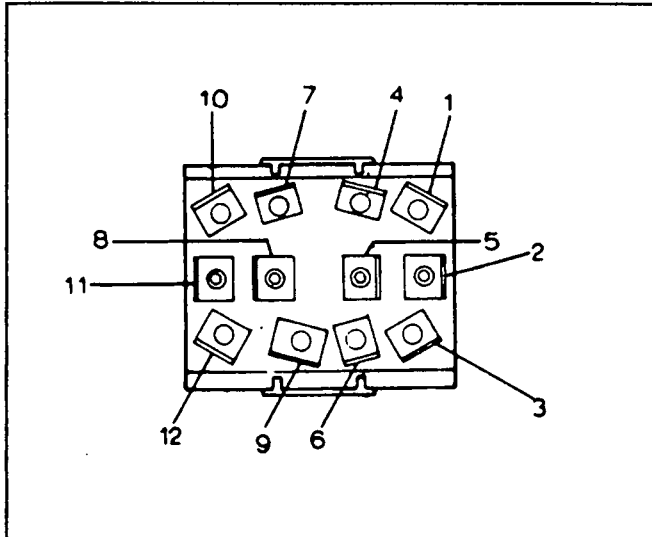


Figure 2. Maintenance Disconnect Switch Test Points

**Test 4- Test System Test Switch SW2**

**DISCUSSION:**

This switch is used to select either (a) automatic operation, (b) a "Normal Test", or (c) a "Fast Test".

**PROCEDURE:**

Test the system test switch with a VOM as follows (Figure 3):

- Set the VOM to its "Rx1" scale and zero the meter. Disconnect leads from the switch, to prevent interaction.
- Connect the VOM test leads across switch terminals as indicated in the chart that follows.

**RESULTS:**

1. If switch checks good, go to Test 5.
2. Replace switch if defective.

SWITCH POSITION	TEST POINT	METER READING
"AUTOMATIC"	Terminals 3 & 5	"Infinity"
	Terminals 1 & 3	"Infinity"
	Terminals 4 & 6	"Infinity"
	Terminals 2 & 4	"Infinity"
"FAST TEST"	Terminals 2 & 4	"Continuity"
	Terminals 1 & 3	"Continuity"
	Terminals 3 & 5	"Infinity"
	Terminals 4 & 6	"Infinity"
"NORMAL TEST"	Terminals 2 & 4	"Infinity"
	Terminals 1 & 3	"Infinity"
	Terminals 3 & 5	"Continuity"
	Terminals 4 & 6	"Continuity"

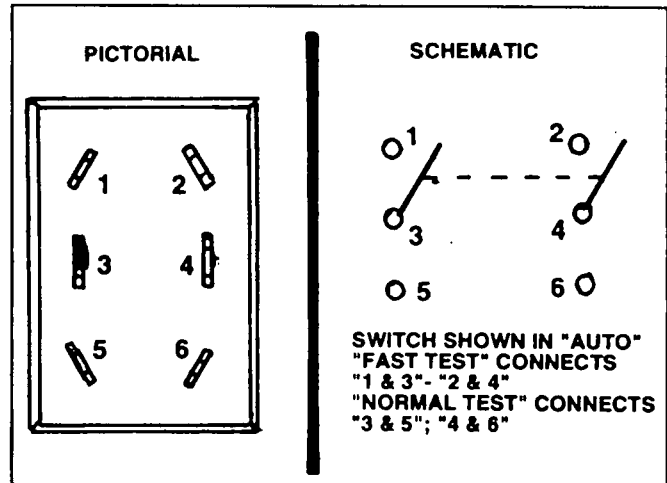


Figure 3. System Test Switch Test Points

**Test 5- Check 2-Wire Start Wiring**

**DISCUSSION:**

Any open condition in the 2-wire start wiring will prevent automatic cranking following a "Utility" power outage or during a "Normal Test" or "Fast Test".

**PROCEDURE:**

Carefully inspect Wires 177, 178 and 183 in the transfer switch. Look for damaged or disconnected wires. Refer to appropriate wiring diagram. Also check wires 201, 202 and 203 (between the system test switch and the system control board).

**RESULTS:**

1. Repair, reconnect or replace and bad wire(s).
2. If all wiring checks good, go to Test 6.

**Test 6- Test Utility Voltage Sensor Circuit Board**

**DISCUSSION:**

If automatic engine cranking does not occur following a "Utility" power source loss, the utility voltage sensor circuit board could be the cause.

**PROCEDURE:**

Unplug the connector plug from the utility voltage sensor board to which Wires 177, 178, 199 and 200 attach. Connect a jumper wire across connector plug Pins No. 3 and 4 to which Wires 178 and 177 connect. The generator engine should crank.

**RESULTS:**

If engine cranks now but did not on "Utility" outage, replace the utility voltage sensor circuit board. Calibrate and adjust the new board as necessary.

### Test 7- Is "Standby Operating" Lamp On?

#### DISCUSSION:

Transfer to the "Standby" power source cannot occur until that power supply is available to the transfer switch. One quick method of determining whether "Standby" power is available is to observe the "Standby Operating" lamp on the transfer switch door. The lamp is powered by transformer reduced "Standby" source voltage. Perform this test when transfer of the load to "Standby" does not occur in automatic mode.

#### PROCEDURE:

Perform a "Normal Test". The generator should crank and start. On generator startup, the "Standby Operating" lamp should illuminate. After a short engine warmup period, transfer to the "Standby" side should occur and the "Switch Position-Emergency" lamp should light, indicating that transfer to the "Standby" side has occurred.

#### RESULTS:

1. If the "Standby Operating" lamp comes on but the "Switch Position-Emergency" lamp does not, transfer to "Standby" has NOT occurred. Go to Test 12.
2. If the "Standby Operating" lamp does NOT come on, go to Test 8.

### Test 8- Check Voltage at Terminal Lugs E1/E2/E3

#### DISCUSSION:

As previously stated, transfer to "Standby" cannot occur unless that power supply is available to the transfer switch. This test is a positive method of determining whether "Standby" source voltage is available to the transfer switch.

The system control (or CPU) circuit board incorporates a standby voltage and a standby frequency sensor. Transfer to the "Standby" source side cannot occur unless generator AC output voltage is above the setting of the voltage sensor and unless frequency is above the setting of the frequency sensor.

#### PROCEDURE:

Perform a "Normal Test". With the generator running, use an AC voltmeter to test line-to-line voltage across terminal lugs E1/E2/E3. Normal rated generator AC output voltage should be indicated.

Now, use an AC frequency meter to test AC frequency across terminal lugs. Normal rated AC frequency should be indicated.

#### RESULTS:

1. If voltage/frequency is zero or low, go to "Troubleshooting" in Part 2, 3 or 4 as appropriate.
2. If volts and frequency are good, go to Test 9.

### Test 9- Check Step-Down Transformer TR1

#### DISCUSSION:

"Standby" source power is delivered to the primary winding of transformer TR1. As alternating current flows through the primary winding, a step-down voltage is induced into the transformer's secondary winding. This reduced voltage is delivered to (a) a "Standby Operating" lamp and (b) the system control (or CPU) circuit board for the operation of that board. If reduced "Standby" voltage is not available to turn the "Standby On" lamp on, one possible cause is a defective transformer TR1.

#### PROCEDURE:

1. Perform a "Normal Test".
2. With the generator running, use an AC voltmeter to test the line-to-line voltage across terminals H1 and H4 of transformer TR1, to which wires E1 and E2 connect. Normal rated generator AC output voltage should be indicated.
3. Now, check the step-down voltage across terminals X1 and X2 of transformer TR1. Transformer reduced voltage (about 24 volts) should be indicated.

#### RESULTS:

1. If voltage readings across terminal lugs E1/E2/E3 were good, but readings in Step 2 of this test are bad, check wires E1 and E2 between the transfer mechanism and transformer TR1. Repair, reconnect or replace defective wire(s).
2. If voltage readings in Step 2 are good, but readings in Step 3 are bad, replace transformer TR1.
3. If transformer TR1 input and output voltages are both good, go to Test 10.

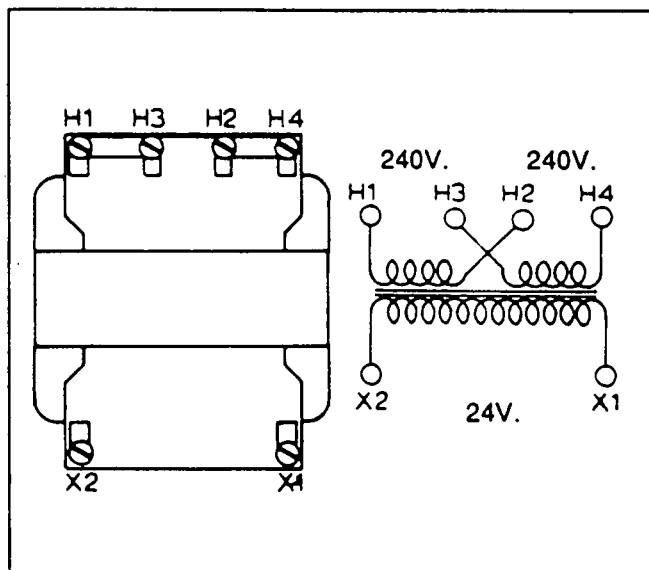


Figure 4. Transformer TR1 Test Points

**Test 10- Check Voltage at "Standby Operating" Lamp****DISCUSSION:**

This test will determine if (a) the "Standby Operating" lamp is out, or (b) if wires 191/192 are good.

**PROCEDURE:**

On the transfer switch door interior, locate the "Standby Operating" lamp. With the generator running, connect the test leads of an AC voltmeter across the lamp terminals. The meter should indicate transformer reduced voltage.

**RESULTS:**

1. If voltage reading is good, but lamp is out, replace the lamp.
2. If voltage reading is bad, go to Test 11.

**Test 11- Check Wires 191/192****DISCUSSION:**

Since the "Standby Operating" lamp is not illuminated, wires 191 and 192 are suspect.

**PROCEDURE:**

If voltage reading at terminals X1/X2 of transformer TR1 was good, but reading was bad in Test 10, Wires 191/192 are suspect. Test the wires for an open or grounded condition.

**RESULTS:**

Repair, replace or reconnect wire(s) 191/192 as necessary.

**Test 12- Check Power Supply to System Control Circuit Board****DISCUSSION:**

If transfer to "Standby" does not occur during automatic operation, but the generator starts and the "Standby Operating" lamp is ON, this test should be performed. The system control (or CPU) circuit board is powered by the same transformer reduced power supply that operates the "Standby Operating" lamp.

**PROCEDURE:**

Check AC voltage supply to the system control (or CPU) circuit board (wires 191/192). Refer to appropriate wiring diagram/schematic.

**RESULTS:**

1. If operating voltage is not available to the system control (or CPU) board, check wires 191/192 between the "Standby Operating" lamp and the circuit board connector.

2. If normal operating voltage is available to the system control (or CPU) circuit board, go to Test 13.

**Test 13- Is System Control (or CPU) Board Operating?****DISCUSSION:**

You should have already verified that normal operating voltage is available to the system control board. During automatic operation (or "Normal Test"), various LED's on the circuit board should turn on to indicate that circuit board timers and sensors are functioning.

**PROCEDURE:**

Perform a "Normal Test" and observe lamps on system control board. See Part 10 or 11 of manual for operating sequences and times. If unit has a CPU board, red LED will flash a few times and go out (if CPU is normal).

**RESULTS:**

1. If the system control (or CPU) board is not functioning, replace the circuit board.
2. If the circuit board sensors and timers appear to be functioning normally, go to Test 14.

**Test 14- Check System Control Circuit Board Output to Wire 194****DISCUSSION:**

During automatic operation and with an operating voltage available to the system control (or CPU) board, a 12 volts DC output should be delivered from the circuit board to a transfer relay and to a time delay relay, via wire 194. If this voltage is not available, neither the transfer relay or the time delay relay can become energized and transfer to "Standby" cannot occur. This test will verify that a 12 volts DC output is available to energize the transfer relay and initiate transfer to "Standby".

**PROCEDURE:**

Connect the positive (+) test lead of a DC voltmeter to the transfer relay's wire 194 terminal. Connect the meter's common (-) test lead to ground. With the generator running, the meter should read approximately 12 volts DC.

**RESULTS:**

1. If 12 volts DC is NOT indicated, replace the system control (or CPU) circuit board.
2. If 12 volts DC is indicated, go to Test 15.

**Test 15- Ground Wire 23 Circuit****DISCUSSION:**

During automatic operation and following generator startup, system control circuit board action should deliver 12 volts DC to the transfer relay via wire 194.

### Test 15- Ground Wire 23 Circuit (Continued)

You should have already verified that 12 volts DC is available to the transfer relay, in Test 14. That circuit is completed back to the system control (or CPU) board via wire 23. Circuit board action will hold the circuit open until (a) an engine warmup timer has timed out, (b) standby voltage is above the setting of a "standby voltage sensor", and (c) standby frequency is above the setting of a "standby frequency sensor". When the three requirements are met, circuit board action will complete the wire 23 circuit to ground. The transfer relay should then energize and transfer to "Standby" should occur.

#### PROCEDURE:

Locate the circuit board connector pin to which Wire 23 connects (Pin 15). Perform a "Normal Test". If the unit starts and runs but transfer to "Standby" does not occur, connect Wire No. 23 (Pin 15) to terminal 177 of the terminal strip (terminal 177 is grounded). The transfer relay should energize and transfer to "Standby" should occur.

#### RESULTS:

1. If transfer to "Standby" occurs when wire 23 is grounded but does not otherwise occur, replace the system control (or CPU) circuit board.
2. If transfer to "Standby" does NOT occur, go to Test 16.

### Test 16- Check Voltage at Terminals AT1/AT2

#### DISCUSSION:

When the transfer relay is energized, its normally open contacts close to deliver "Standby" source voltage to transfer mechanism terminals AT1 and AT2. If that voltage is available to those terminals, but transfer to "Standby" does not occur, a transfer mechanism failure is suspect.

#### PROCEDURE:

Connect the test leads of an AC voltmeter across transfer mechanism terminals AT1 and AT2. Repeat Test 15 and note the voltage reading across AT1/AT2. The meter should read rated generator voltage.

*NOTE: On 480 volts units, generator system voltage is reduced to approximately 240 volts AC by a step-down transformer (TR3). It is this reduced voltage that is delivered to terminals AT1/AT2 of the transfer mechanism.*

#### RESULTS:

1. If voltage reading is good but transfer to "Standby" does not occur, go to Test 18.
2. If voltage reading is bad, go to Test 17.

### Test 17- Test Transfer Relay

#### DISCUSSION:

This is a test of the transfer relay itself, to determine if it is functioning properly. If transfer to "Standby" is to occur, the relay must energize and its normally-open contacts must close. For retransfer to "Utility", the relay must de-energize and its normally-closed contacts must close.

#### PROCEDURE:

See Figure 5. Test the transfer relay (TR) for proper operation as follows:

- In the transfer switch enclosure, set the maintenance disconnect switch to "Manual". This must be done to prevent standby generator startup when the "Utility" power supply is turned off.
- Turn OFF all power voltage supplies to the transfer switch, using whatever means available (such as the "Utility" and "Standby" main line circuit breakers).
- Disconnect all wires from the transfer relay terminals, to prevent interaction. Note wire numbers and the terminals to which they connect.
- Connect the positive (+) side of a 12 volts DC power source to relay terminal B and the negative (-) side to relay terminal A. The relay should energize.
- Set a volt-ohm-milliammeter (VOM) to its "Rx1" scale and zero the meter.
- With the relay energized, connect the VOM test leads across relay terminals 6 and 9; then across relay terminals 1 and 7. In each case, note the resistance reading.
- Disconnect the 12 volts DC power source from the relay. The relay should de-energize.
- With the relay de-energized, connect the VOM test leads across relay terminals 1 and 7; and across terminals 6 and 9. In each case, note the reading.

Correct readings are shown in the following chart. Be sure to reconnect all wires to the relay terminals before proceeding.

TRANSFER RELAY CONDITION	TEST ACROSS TERMINAL	DESIRED READING
ENERGIZED	1 AND 7	INFINITY
	6 AND 9	CONTINUITY
	4 AND 7	CONTINUITY
DE-ENERGIZED	1 AND 7	CONTINUITY
	6 AND 9	INFINITY
	4 AND 7	INFINITY

#### RESULTS:

1. If transfer relay tests bad, replace it.
2. If transfer relay tests good, and automatic transfer to "Standby" does not occur, perform Test 3, "Test Maintenance Disconnect Switch". See "Problem 2" in Section 9.8.
3. If transfer relay tests good and automatic retransfer back to "Utility" does not occur, perform Test 22, "Test Time Delay Relay". See "Problem 3" in Section 9.8.

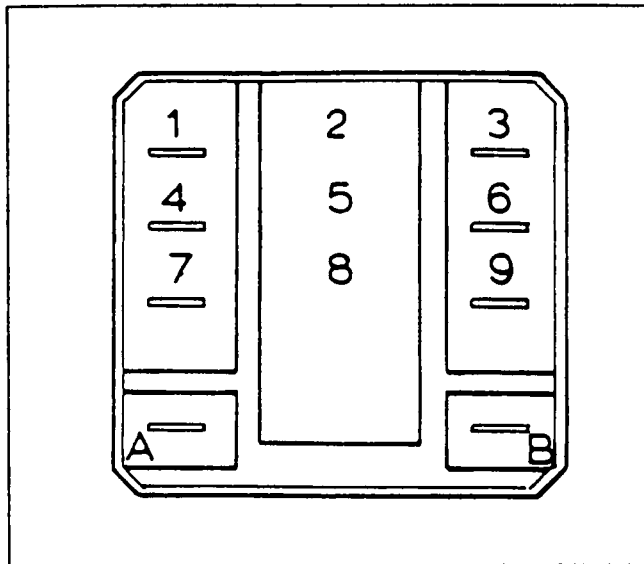
**Test 17- Test Transfer Relay (Continued)**

Figure 5. Transfer Relay Test Points

**Test 18- Check Transfer Mechanism****DISCUSSION:**

For additional information on the transfer mechanism, refer to Section 9.2, "The Transfer Mechanism". Also see Section 9.10, "Transfer Mechanism Disassembly".

**DANGER: BEFORE ATTEMPTING TO WORK ON THE TRANSFER MECHANISM, TURN OFF ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH. EXTREMELY HIGH AND DANGEROUS VOLTAGES ARE DELIVERED TO TRANSFER MECHANISM TERMINALS. FAILURE TO TURN OFF POWER VOLTAGE SUPPLIES MAY RESULT IN HAZARDOUS AND POSSIBLY LETHAL ELECTRICAL SHOCK.**

**PROCEDURE:**

**A. Visual Inspection:** In many cases, transfer mechanism problems can be detected by conducting a close visual inspection of the unit.

1. Remove the transfer mechanism cover.
2. Inspect the transfer mechanism carefully. Look for burning, charring, hot spots, evidence of arcing, etc.
3. Remove arc suppressors and inspect main contacts for burning, scoring, pitting, evidence of arcing, etc. Check arc suppressors for damage caused by arcing.

**B. Check Manual Operation:** See Section 9.5, "Functional Tests". Check manual operation as outlined in that section.

**C. Preliminary Electrical Tests:** The following "preliminary" tests will help determine if all transfer

mechanism electrical components are functioning properly.

1. Refer to the "Transfer Mechanism Test Chart" on next page.
2. Manually trip the main contacts to "Neutral" first ("OFF" appears in both window A and B). Then, perform resistance tests across the terminals indicated in the chart. Meter readings should be as indicated in the chart.
3. Actuate the main contacts to their "Utility" position and perform tests indicated in the chart.
4. Actuate the contacts to "Standby" and complete tests indicated in the chart.

**RESULTS:**

If any meter reading is not as indicated in the chart on next page, a fault exists in the transfer mechanism. Further testing of individual transfer mechanism electrical components will be necessary. Refer to Section 9.10, "Transfer Mechanism Disassembly".

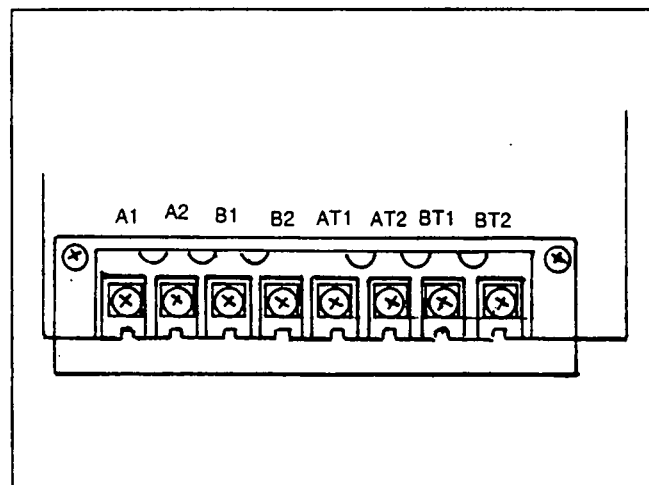


Figure 6. Transfer Mechanism Terminal Strip







**Test 19- Check Step-Down Transformer TR3****DISCUSSION:**

Step-down transformer TR3 is used only on 480 volts transfer switches. The transformer reduces line E1 to line E2 voltage to about 240 volts AC. The reduced voltage is then delivered to the transfer mechanism terminals. Use of transformer TR3 allows a transfer mechanism rated 240 volts to be used in 480 volts system applications. A defective transformer TR3 will prevent "Standby" source voltage from reaching the transfer mechanism terminals and transfer to the "Standby" side will not occur in automatic mode.

**PROCEDURE:**

1. With the standby generator running, check for correct AC voltage across terminals H1 and H4 of the transformer. The meter should indicate normal rated generator voltage (about 480 volts AC).

*Transfer Mechanism Test Chart*

MAIN CONTACTS POSITION	WINDOWS INDICATIONS	TEST CONNECTIONS	DESIRED METER READING
<p>Tripped to "Neutral"</p> 	<p>Windows A and B both read "OFF"</p> 	<p>Positive test lead at "A1" Common (-) test lead at "A2"</p> <p>Positive test lead at "A2" Common (-) test lead at "A1"</p> <p>Positive test lead at "B1" Common (-) test lead at "B2"</p> <p>Positive test lead at "B2" Common (-) test lead at "B1"</p> <p>Positive test lead at "AT1" Common (-) test lead at "AT2"</p> <p>Positive test lead at "AT2" Common (-) test lead at "AT1"</p> <p>Positive test lead at "BT1" Common (-) test lead at "BT2"</p> <p>Positive test lead at "BT2" Common (-) test lead at "BT1"</p>	<p>A small resistance (About 1-1/2 ohms)</p> <p>A small resistance (About 1-1/2 ohms)</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p>
<p>"Utility" Power Source Side</p> 	<p>Window A reads "ON" Window B reads "OFF"</p> 	<p>Positive test lead at "A1" Common (-) test lead at "A2"</p> <p>Positive test lead at "A2" Common (-) test lead at "A1"</p> <p>Positive test lead at "B1" Common (-) test lead at "B2"</p> <p>Positive test lead at "B2" Common (-) test lead at "B1"</p> <p>Positive test lead at "AT1" Common (-) test lead at "AT2"</p> <p>Positive test lead at "AT2" Common (-) test lead at "AT1"</p> <p>Positive test lead at "BT1" Common test lead at "BT2"</p> <p>Positive test lead at "BT2" Common (-) test lead at "BT1"</p>	<p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Small resistance (about 1.8-2.0 ohms)</p> <p>Small resistance (About 1.8-2.0 ohms)</p> <p>Infinity</p> <p>Infinity</p>
<p>"Standby" Power Source Side</p> 	<p>Window A reads "OFF" Window B reads "ON"</p> 	<p>Positive test lead at "A1" Common (-) test lead at "A2"</p> <p>Positive test lead at "A2" Common test lead at "A1"</p> <p>Positive test lead at "B1" Common test lead at "B2"</p> <p>Positive test lead at "B2" Common (-) test lead at "B1"</p> <p>Positive test lead at "AT1" Common (-) test lead at "AT2"</p> <p>Positive test lead at "AT2" Common (-) test lead at "AT1"</p> <p>Positive test lead at "BT1" Common (-) test lead at "BT2"</p> <p>Positive test lead at "BT2" Common (-) test lead at "BT1"</p>	<p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Infinity</p> <p>Small resistance (About 1.8-2.0 ohms)</p> <p>Small resistance (About 1.8-2.0 ohms)</p>

**Test 19- Check Step-Down Transformer TR3 (Continued)**

2. Now, check the transformer AC output voltage at terminals X1 and X4. Meter should indicate about 240 volts AC.

**RESULTS:**

1. If voltage reading across terminals H1 and H4 is bad, check wires E1/E2 between the transformer and the transfer mechanism (Test 20).

2. If voltage reading across terminals H1/H4 is good but reading across X1/X4 is bad, replace sensing transformer TR3.

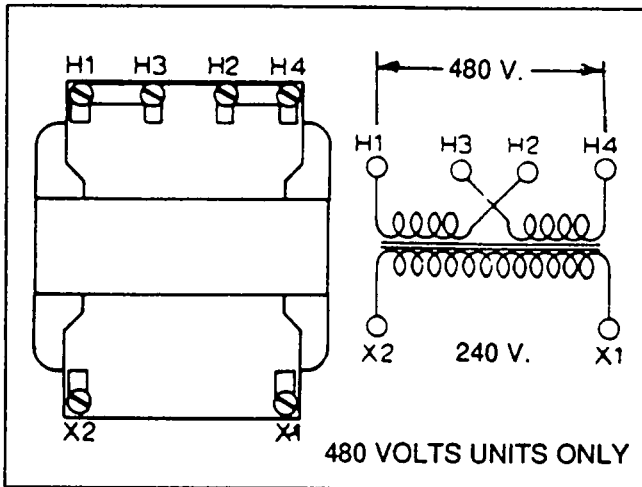


Figure 7. Transformer TR3 and TR4

**Test 20- Check Wiring From TR3 to Transfer Mechanism**

**DISCUSSION:**

"Standby" source power from the transfer mechanism is delivered to the transformer's primary winding via Wires E1 and E2. If the voltage reading at transformer terminals H1/H4 was bad, wires E1/E2 may be open or grounded.

**PROCEDURE:**

Inspect Wires E1 and E2 carefully. Turn OFF all power voltage supplies to the transfer switch and use a VOM to test the wires for an open or grounded condition.

**RESULTS:**

Repair, reconnect or replace wires E1 and/or E2 as necessary.

**Test 21- Test "Utility Out" Sensor**

**DISCUSSION:**

Wires 199 and 200 are routed from the utility voltage sensor circuit board to the system control (or CPU) circuit board. Wire 199 connects a transistor in the utility voltage sensor board to the transfer circuit in the system control (or CPU) board. Wire 200 is a grounded connection, i.e., grounded in the system control (or CPU) board. When "Utility" source sensing voltage is available to the utility voltage sensor board, that circuit board applies a small voltage to the base of a transistor. This causes the transistor to act much like a "switch". The transistor becomes a conductor and closes the wire 199 circuit to ground. As long as the circuit is closed to ground, the system control board will not initiate transfer to the "Standby" source side. That is, transfer to "Standby" cannot occur while "Utility" source power is available.

On dropout of "Utility" source voltage, the voltage signal to the transistor base is removed. Transistor action then opens the 199/200 circuit. Transfer to "Standby" can now occur.

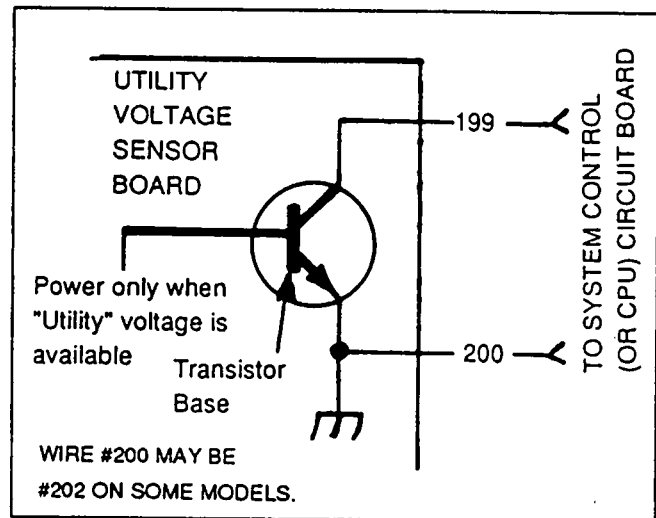


Figure 8. Wires 199/200 (or 199/202) Circuit

If transfer to the "Standby" source does not occur in automatic mode, the "Utility Loss Sensor" circuit may be tested as follows:

**PROCEDURE:**

1. At the utility voltage sensor circuit board, disconnect the connector to which wires 177, 178, 199 and 200 attach.
2. Set the maintenance disconnect switch (in transfer switch enclosure) to "Automatic".
3. Start the engine manually, using the start/stop switch on the generator console.

### Test 21- Test "Utility Out" Sensor (Continued)

*NOTE: If the transfer switch is equipped with three circuit boards, LED's on the system control circuit board should turn on when the generator has started. LED's that will turn on include (a) a "Standby On" lamp, (b) an "Engine Minimum Run" lamp, (c) an "engine warmup timer" lamp, and finally (d) a "transfer to standby" lamp. When the "transfer to standby" lamp illuminates, transfer to that power source should occur. On units with two circuit boards, the CPU board is not equipped with advisory lamps (LED's).*

4. Following generators startup, transfer to "Standby" should occur.

#### RESULTS:

1. If transfer to "Standby" occurs with the utility voltage sensor board connector unplugged, but does not occur in normal automatic operating modes, replace the utility voltage sensor board. Calibrate, adjust and test the new circuit board.
2. If transfer to "Standby" does not occur, go to Test 22.

*NOTE: On 3 circuit board units having a "programmable" system control board, illumination of that board's "transfer to standby" lamp indicates the "Utility Out Sensor" on the utility voltage sensor board is functioning properly. If the "transfer to standby" lamp turns on but transfer to "Standby" does not occur, repeat all tests under Problem 2 in Section 9.8.*

### Test 22- Test Time Delay Relay

#### DISCUSSION:

In order for a "transfer to standby" operation to occur, "Standby" source power must be available to transfer mechanism terminals B1 and B2. That power source will not be available to those terminals unless the time delay relay's normally-closed contacts (1 and 7) are closed.

For a "retransfer to utility" operation, "Utility" source power must be available to transfer mechanism terminals A1 and A2. That power supply will not be available to those terminals unless the time delay relay's normally-closed contacts (3 and 9) are closed.

Failure of the time delay relay's normally-closed contacts to close can result in a failure to transfer loads to either power source side while in automatic mode.

#### PROCEDURE:

The time delay relay is identical to the transfer relay. Refer to Test 17 (Pages 9.9-5 and 9.9-6).

#### RESULTS:

Replace the time delay relay (TD) if it fails the test.

### Test 23- Is "Utility On" LED On?

#### DISCUSSION:

Perform this test if retransfer back to "Utility" does not occur in automatic mode or during "Normal Test". The "Utility On" lamp is located on the utility voltage sensor circuit board. The lamp should illuminate when "Utility" power source voltage is above the setting of that circuit board's "voltage dropout sensor".

#### PROCEDURE:

Observe the "Utility On" lamp (LED). If the lamp is ON, "Utility" source voltage sensing is available to the utility voltage sensor board and is above the setting of the "voltage dropout sensor". If the lamp is OUT, "Utility" sensing voltage is not available to the board or is below the setting of a "voltage pickup sensor".

#### RESULTS:

1. If the LED is ON, go to Test 28.
2. If the LED is OUT, go to Test 24.

### Test 24- Check Voltage at Terminal Lugs N1/N2/N3

#### DISCUSSION:

This test should be performed if the "Utility On" lamp on the utility voltage sensor board is not lighted. The purpose of the test is to determine if "Utility" voltage is actually available to the transfer switch.

**DANGER: USE EXTREME CARE DURING THE TEST. POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH ARE HIGH AND DANGEROUS.**

#### PROCEDURE:

Use an AC voltmeter to test line-to-line voltage across transfer mechanism terminal lugs N1, N2 and N3. Normal rated "Utility" source voltage should be indicated.

#### RESULTS:

1. If voltage readings are bad, check the "Utility" source main line circuit breaker. Perhaps that power source has not been restored.
2. If voltage readings are good, go to Test 25.

### Test 25- Check Input Voltage to Utility Sensing Interface

#### DISCUSSION:

If the utility voltage sensor board's "Utility On" lamp does not light and you have determined that "Utility" source voltage is available to the transfer mechanism terminal lugs, the next step is to determine if that source voltage is available to the utility sensing interface.

**Test 25- Check Input Voltage to Utility Sensing Interface (Continued)**

**PROCEDURE:**

- In the transfer switch, set the maintenance disconnect switch to "Manual".
- Use an AC voltmeter to check line-to-line voltage across terminals N1, N2 and N3 of the utility sensing interface. See Figure 9.
- Normal rated "Utility" source voltage should be indicated.

**RESULTS:**

1. If voltage reading is bad, but readings in Test 24 were good, repair, reconnect or replace wires N1, N2, or N3 between the transfer mechanism and the utility sensing interface.
2. If voltage readings are good, go to Test 26.

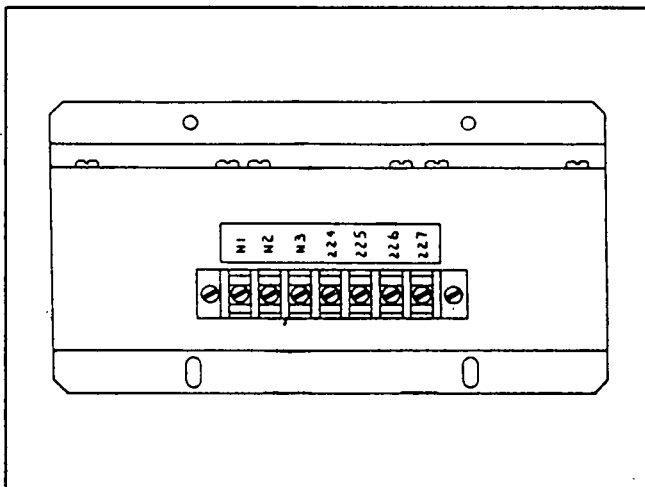


Figure 9. Utility Sensing Interface Test Points

**Test 26- Check Utility Sensing Interface Output Voltage**

**DISCUSSION:**

Step-down transformers in the utility sensing interface are used to reduce the actual "Utility" source voltage to a proportional sensing voltage that is delivered to the utility voltage sensor circuit board. The interface transformers provide a fixed ratio reduction in voltage. This test, in conjunction with Test 25, will determine if the utility sensing interface is in good condition.

You may also wish to review the information on multi-voltage utility sensing interface systems. Refer to Section 9.7, "Multi-Voltage Transfer Switches".

**PROCEDURE:**

Use an AC voltmeter to test for correct voltage across interface terminals 224 through 227. Test connections and acceptable interface output voltages are listed in the following chart.

TEST ACROSS TERMINALS	224-225	224-227
	225-226	225-227
LINE TO LINE RATED VOLTS	OUTPUT VOLTS	
600 volts AC	40-43 VAC	22.5-25.0 VAC
480 volts AC	40-43 VAC	22.5-25.0 VAC
400 volts AC	40-43 VAC	22.5-25.0 VAC
240 volts AC	40-43 VAC	22.5-25.0 VAC
208 volts AC	36.5-39.0 VAC	20.5-23.0 VAC
240 volts, 1-Phase	41-46 VAC	20.5-23.0 VAC*

\* 226 not used on 1-phase units.

**RESULTS:**

1. If voltage readings in Test 25 were good, but readings taken in Test 26 were bad, replace the utility sensing interface.
2. If voltage readings are good, go to Test 27.

**Test 27- Calibrate Utility Voltage Sensor Board**

**DISCUSSION:**

The utility sensing interface transformers reduce utility power source voltage at a fixed ratio. For that reason, if the "Utility" voltage varies from the nominal rated voltage, the sensing voltage to the utility voltage sensor board will also vary a proportional amount. In some cases, calibration of the circuit board may be required.

**CAUTION:** The installed transfer switch must be rated at a voltage and phase that is compatible with the "Utility" and "Standby" power supplies. Do NOT attempt to calibrate a utility voltage sensor board on a non-compatible unit in an attempt to make the unit compatible with supplied voltages.

Once the circuit board has been properly calibrated, the voltage that was present during calibration establishes 100 percent "Utility" voltage for "dropout" and "pickup" settings. "Utility" source power must be available during calibration.

**PROCEDURE:**

1. In the transfer switch enclosure, set the maintenance disconnect switch to "Manual". Make sure rated "Utility" source voltage is available to the unit.
2. On the utility voltage sensor board, locate Test Points "TP3" and "TP4" (Figure 10). Connect a jumper wire across these two test points.
3. Locate the small potentiometer "R10". Turn the potentiometer fully counterclockwise (CCW).
4. Now, turn the potentiometer SLOWLY clockwise until the circuit board's "Utility On" lamp (LED) just turns on.
5. Remove the jumper wire from "TP3" and "TP4".
6. Reset the maintenance disconnect switch to "Automatic".

**RESULTS:**

If "Utility On" lamp is still out even though the sensing voltage to the board is good, replace the utility voltage sensor circuit board.

**Test 27- Calibrate Utility Voltage Sensor Board (Continued)**

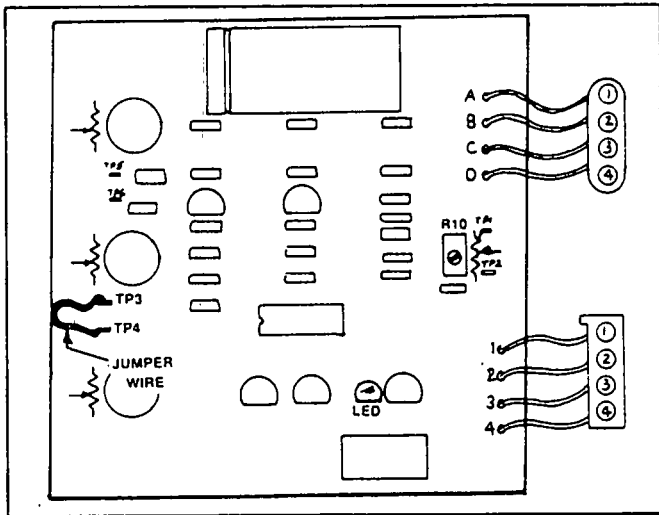


Figure 10. Utility Voltage Sensor Board Calibration

**Test 28- Test Step-Down Transformer TR4**

**DISCUSSION:**

Transformers TR3 and TR4 are used only on transfer switches rated 480 volts. The two transformers act to reduce the 480 volts power supply to a voltage that is compatible with transfer mechanism requirements (about 240 volts). Transformer TR3 reduces "Standby" source voltage; transformer TR4 reduces "Utility" source voltage.

An open or shorted condition in transformer TR4 can prevent retransfer back to the "Utility" side.

**PROCEDURE:**

1. See Figure 11. Turn ON the "Utility" power supply to the transfer switch.
2. Use an AC voltmeter to check voltage across transformer terminals H1 and H4. Approximately 480 volts AC should be indicated.
3. Now, check the voltage across terminals X1 and X2 of the transformer. About 240 volts should be read.

**NOTE:** The transformer provides a fixed step-down ratio. For that reason, voltage reading across terminals X1 and X2 may not read exactly 240 volts.

**RESULTS:**

1. If voltage reading in Step 2 is bad, check wires N1/N2 between transformer and transfer mechanism.
2. If reading in Step 2 is good, but Step 3 reading is bad, replace transformer TR4.
3. If readings in both Step 2 and Step 3 are good, go to Test 3.

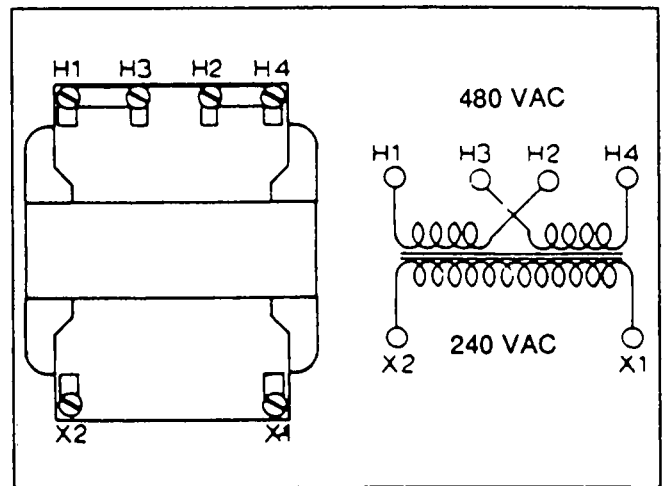


Figure 11. Transformer TR4 Test Points

**Test 29- Check Voltage at Terminals A1/A2**

**DISCUSSION:**

If retransfer back to the "Utility" power source is to occur, that power source voltage must be delivered to transfer mechanism terminals A1 and A2. The following requirements must be met to deliver "Utility" voltage to those terminals:

- "Utility" voltage must be available to transfer mechanism terminal lugs N1 and N2.
- A transfer relay (TR) must be energized by system control (or CPU) circuit board action and the relay's normally-open contacts must close.
- If so equipped, a time delay relay (TD) must be de-energized by system control (or CPU) circuit board action and the relay's normally-closed contacts must be closed.

This test will determine if "Utility" source voltage is available to terminals A1/A2 of the transfer mechanism during a retransfer action. You should have already tested the transfer relay (Test 17) and the time delay relay (Test 22). If the unit is a 480 volts unit, you should have tested transformer TR4 (Test 28). If "Utility" power is still not available to terminals A1/A2, the wiring between terminal lugs N1/N2 and terminals A1/A2 must be bad.

**PROCEDURE:**

1. Connect the test leads of an AC voltmeter across transfer mechanism terminals A1 and A2.
2. Perform a "Normal Test". Carefully monitor automatic operation during the test.
3. When the generator has started, wait for the system to transfer loads to the "Standby" power source side.
  - a. Check that the utility voltage sensor board's "Utility On" lamp is lighted.
  - b. On the transfer switch door, check that the "Standby Operating" lamp is lighted and that the "Switch Position-Emergency" lamp is on.
4. Set the system test switch back to "Automatic Mode" and monitor the AC voltmeter.

**Test 29- Check Voltage at Terminals  
A1/A2 (Continued)**

5. After an "engine cooldown timer" on the system control (or CPU) board has timed out, the following should be observed:

- a. On the system control board, a time delay neutral timer lamp (LED) should illuminate (if the unit is equipped with the time delay neutral feature).
- b. When the time delay neutral timer has timed out, the AC voltmeter previously connected across A1/A2 should indicate "Utility" voltage. Retransfer back to "Utility" should then occur.

**RESULTS:**

1. If normal rated "Utility" source voltage is indicated at A1/A2, but retransfer back to "Utility" does not occur, go to Test 18. The problem appears to be in the transfer mechanism.
2. If normal rated "Utility" voltage is NOT indicated at A1/A2, go to Test 30.

**Test 30- Check Retransfer Wiring****DISCUSSION:**

An open or grounded condition in the retransfer circuit can prevent retransfer back to "Utility" from occurring.

**PROCEDURE:**

Carefully inspect and test wires between terminal lugs N1/N2 and transfer mechanism terminals A1/A2. Trace the circuit on an appropriate wiring diagram and inspect and test all wires.

**RESULTS:**

Repair, reconnect or replace any defective wire(s).

**Test 31- Check Time Delay at Neutral  
Operation****DISCUSSION:**

During automatic operation and after the standby generator has started the following timers on the system control (or CPU) board will start timing: (a) engine minimum run timer, (b) engine warmup timer.

*NOTE: On units with programmable system control board, LED's on the circuit board will turn on to indicate the timers or sensors are operating.*

Also on the system control (or CPU) circuit board, a standby voltage and a standby frequency sensor will be activated when generator voltage and frequency have reached a preset level. LED's are provided on the programmable system control board to indicate that standby voltage and frequency are acceptable.

When the engine warmup timer has timed out, and when standby voltage and frequency have reached a

preset level, system control (or CPU) board action will energize both the transfer relay and the time delay relay simultaneously. When the transfer relay energizes, its normally-open contacts close. However, when the time delay relay energizes its normally-closed contacts open. This opens the circuit to transfer mechanism terminals B1/B2 and transfer to "Standby" cannot occur.

The time delay relay will remain energized until a "time delay neutral timer" on the system control board has timed out. When that timer has timed out, circuit board action will de-energize the relay, its normally-closed contacts will close, and transfer to "Standby" will occur.

This test will determine if the system control (or CPU) circuit board is (a) energizing the time delay relay and (b) de-energizing the relay as programmed.

**PROCEDURE:**

1. Connect an AC voltmeter across transfer mechanism terminals B1/B2.
2. Perform a "Normal Test" with the time delay switch set to "On".
3. When the generator has started and after a preset time interval, the AC voltmeter should indicate "Standby" source voltage. At the same time, transfer to "Standby" should occur.
4. If voltage is not indicated at terminals B1/B2 after a preset time, turn the time delay neutral switch "Off" and observe the voltmeter.

**RESULTS:**

1. If the AC voltmeter indicates "Standby" voltage, but transfer does not occur, a problem exists in the transfer mechanism.
2. If the voltmeter does not read "Standby" voltage with the time delay neutral switch at "On", but does when the switch is set to "Off", replace the system control (or CPU) circuit board.

*NOTE: In Result 2 above, transfer should occur when the time delay neutral switch is turned "Off" since power is available to transfer mechanism terminals B1/B2.*

Section 9.10

**TRANSFER MECHANISM DISASSEMBLY**

**Introduction**

The transfer mechanism houses the main current carrying contacts, along with other mechanical and electrical components required for switch operation. The main contacts are actuated by a single solenoid and are electrically operated and mechanically held. The contacts are silver plated or silver alloy, to provide resistance against welding or sticking. Contacts shape provides concentrated contact pressure for positive circuit continuity.

The main contacts assembly consists of three or four pole assemblies. Each pole assembly houses and supports a dual set of moveable contactis (utility and emergency contactis) and a stationary load contactis assembly. The pole assemblies are sandwiched together and retained to the control assembly by means of thru-bolts. Arc suppressors are retained in each pole assembly.

*NOTE: You may wish to review main contacts operation in Section 9.2, "The Transfer Mechanism".*

**Main Contacts Assembly**

Figure 1, below, shows the transfer mechanism with the main contacts assembly separated from the control assembly.

**DANGER: DO NOT ATTEMPT TO REMOVE THE TRANSFER MECHANISM FROM THE TRANSFER SWITCH ENCLOSURE UNTIL ALL POWER VOLTAGE SUPPLIES TO THE TRANSFER SWITCH SWITCH HAVE BEEN TURNED OFF.**

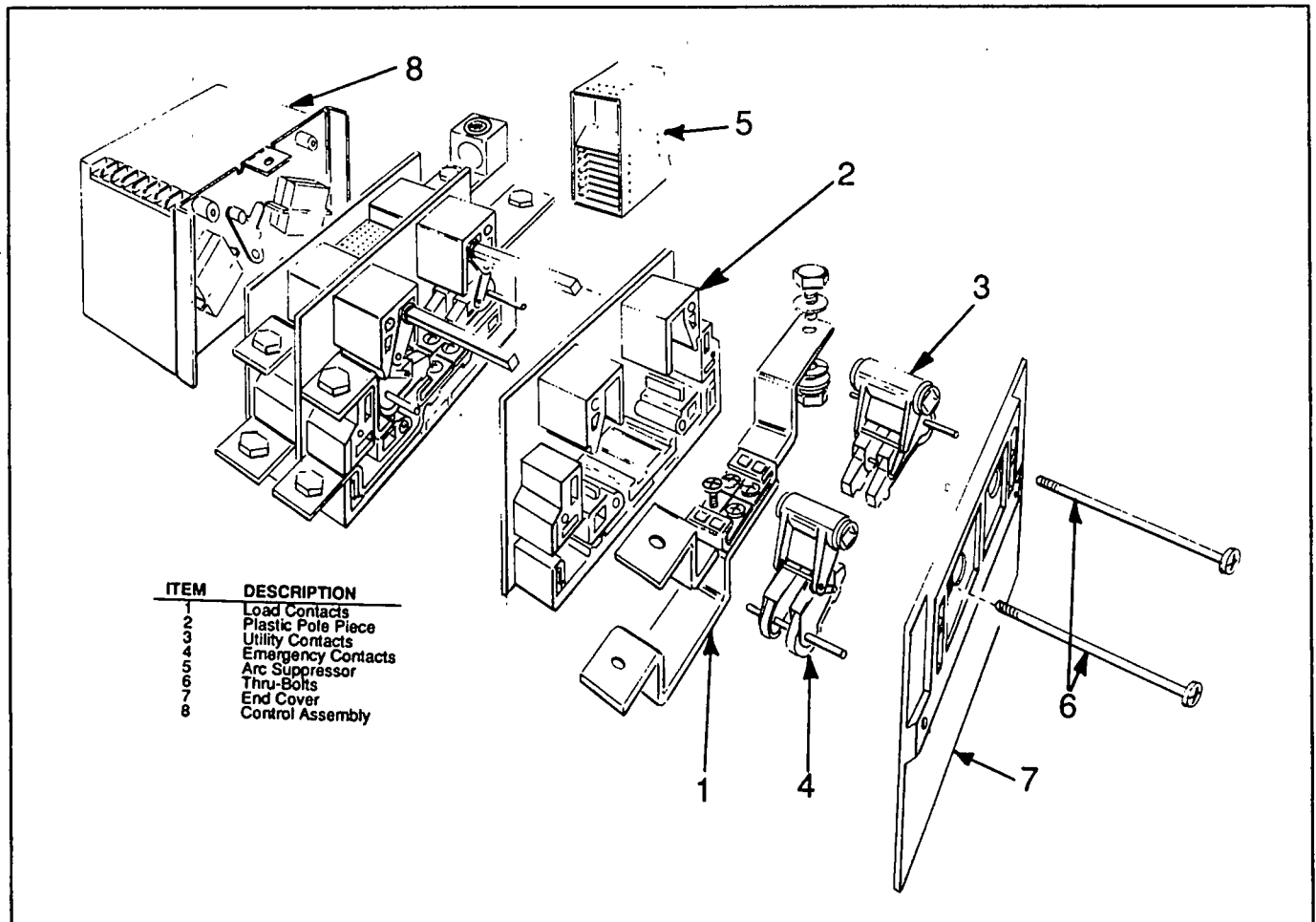


Figure 1. Transfer Mechanism Major Components

**Auxiliary Contacts Removal**

Each set of auxiliary contacts (Figure 2) is retained to the main contacts assembly side cover by means of a single screw. The auxiliary contacts are rated 10 amps at 125 or 250 volts AC.

**Main Contacts Assembly Removal**

The main contacts assembly can be removed from the control assembly by first removing the thru-bolts which retain the pole pieces to the control assembly. The side cover can then be removed, followed by the utility, emergency and load contacts in one plastic pole piece.

After removing the side cover, slide the utility and emergency contacts off their square shafts. Then remove the first plastic pole piece, along with the stationary load contacts. The second and third (and fourth, if required) pole piece components can then be removed in similar fashion.

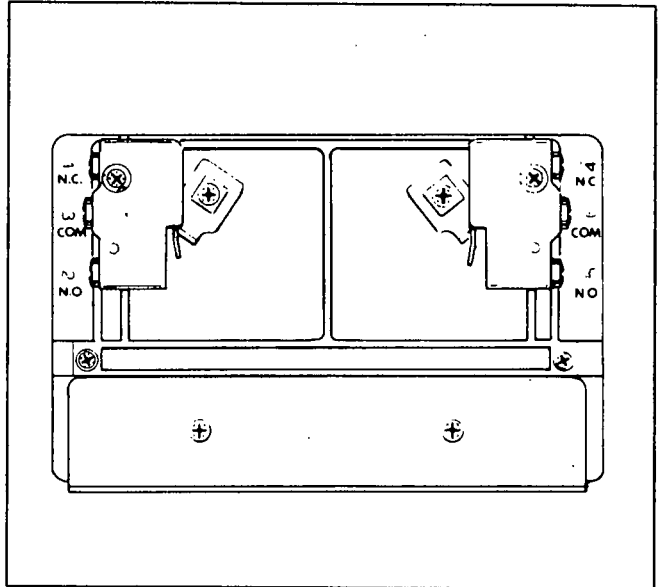


Figure 2. Auxiliary Contacts

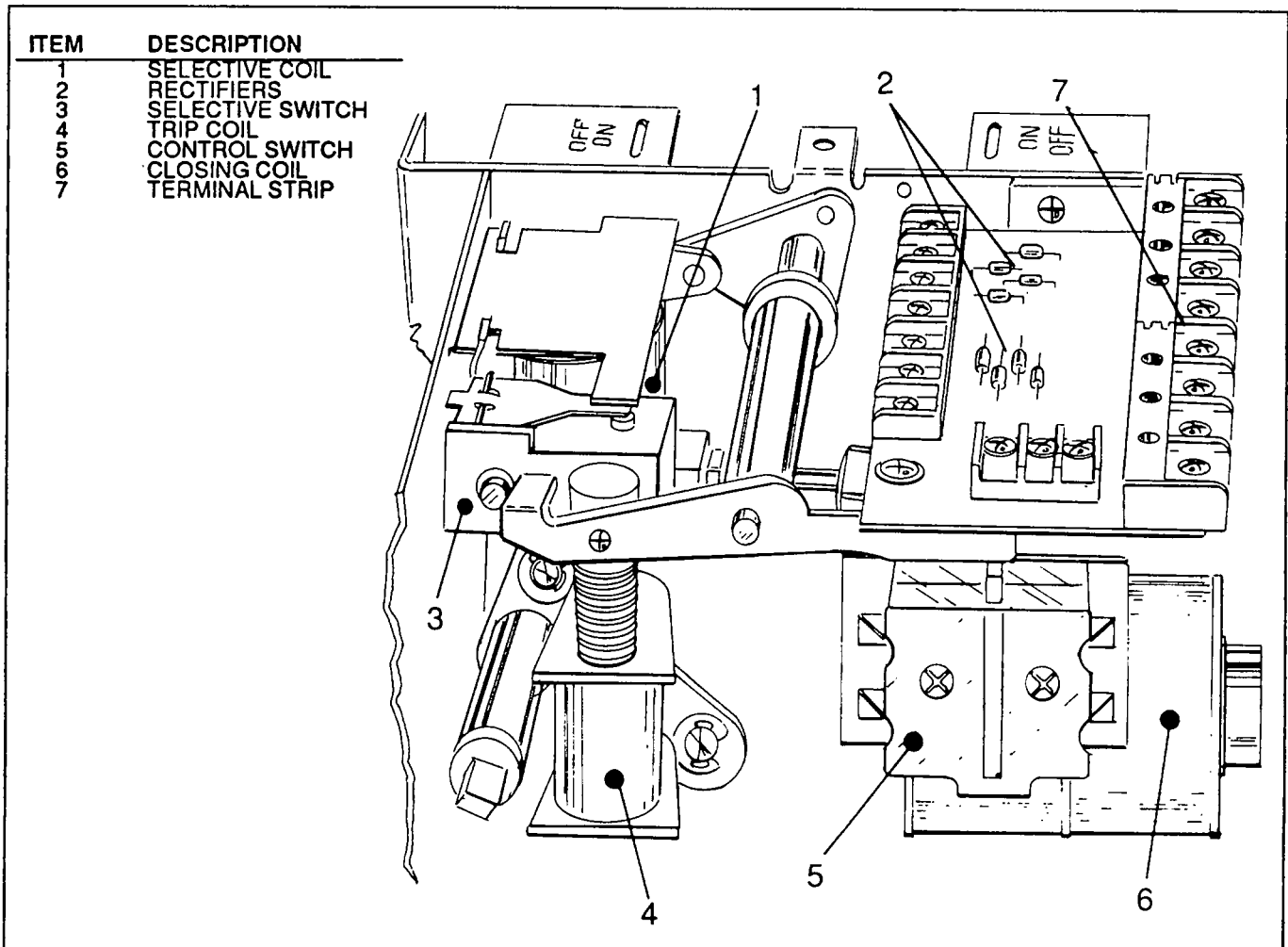


Figure 3. Control Assembly Components