SERVICE BULLETIN

THERMO KING

488

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Service Bulletin: TT488

Subject: Thermo King TriPac Power Inverter Diagnostics

Units Covered: All Thermo King TriPac Power Inverters

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Summary: This bulletin will assist the technician in operating and diagnosing the Thermo King Power Inverter. It includes important operating information and notes, diagnostic routines, fault code diagnostics and diagnostic flowcharts.

Inverter Operation: It is important to understand the basic operation of the Thermo King Power Inverter. This will help achieve quick and accurate diagnostic results and help prevent unnecessary warranty returns.

- During operation, if the Ground Fault Circuit Interrupter (GFCI) trips, the reset button on the GFCI receptacle will pop out and output power will be removed from the GFCI receptacle. If the power inverter was operating on DC power the control panel will remain on and the DC input voltage will appear normal, but the input current and output power will both read “0”.
- If the power inverter is not supplying AC output power, press the RESET button on the GFCI receptacle all the way in to be sure the GFCI is not tripped. Be sure to press the RESET button all the way in.
- The Ground Fault Circuit Interrupter (GFCI) should be installed in a manner that protects all AC branch circuits.
- The Thermo King Power Inverter control panel only operates when DC power is connected to the inverter. If the power inverter is operating on AC standby power without a DC power source connected to the power inverter, then the control panel LEDs will not light and the control panel will not function.
- If the power inverter is operating on AC standby power and the inverter control panel is turned on the control panel voltage display will indicate tractor battery voltage in Vdc, not the input AC voltage.
- If AC standby power is connected to the power inverter and the inverter control panel is switched on, the power inverter will automatically transfer from DC operation to AC operation to save battery power. If AC standby power is removed or falls below 90 Vac then the power inverter will automatically transfer back to DC operation.
- If AC standby power is connected to the power inverter and the inverter control panel is switched off, erratic operation may occur if the AC standby power falls below approximately 107 Vac.
- There are two cooling fans located on the bottom of the power inverter. Be sure airflow to the cooling fans is not obstructed.
- Be sure the ambient temperature is not excessive in the compartment where the power inverter is installed.

- Disconnect all sources of supply power, both DC and AC, before servicing the power inverter. Turning the power inverter off using the control panel will not remove the risk of electrical shock or burns.

- Observe all Warnings and Cautions shown in the Thermo King Power Inverter Operators Manual and Installation Manual.

Status LED

There is a three color status LED on the power inverter control panel as shown below. The LED color indicates if the power inverter is running from external AC power or batteries and if a fault condition exists. The power inverter control panel only operates when DC power is connected to the inverter.

- **Green LED** If the LED glows green the power inverter is turned on and is connected to and using external AC standby power to operate the connected loads.

- **Yellow LED** If the LED glows yellow the power inverter is turned on and is using the tractor batteries to operate the connected loads.

- **Red LED** If the LED glows red the power inverter is turned on and a fault condition exists. The power inverter output is shut down. See the Power Inverter Fault Codes on page 4 of this bulletin.



Ground Fault Circuit Interrupter (GFCI) Receptacle

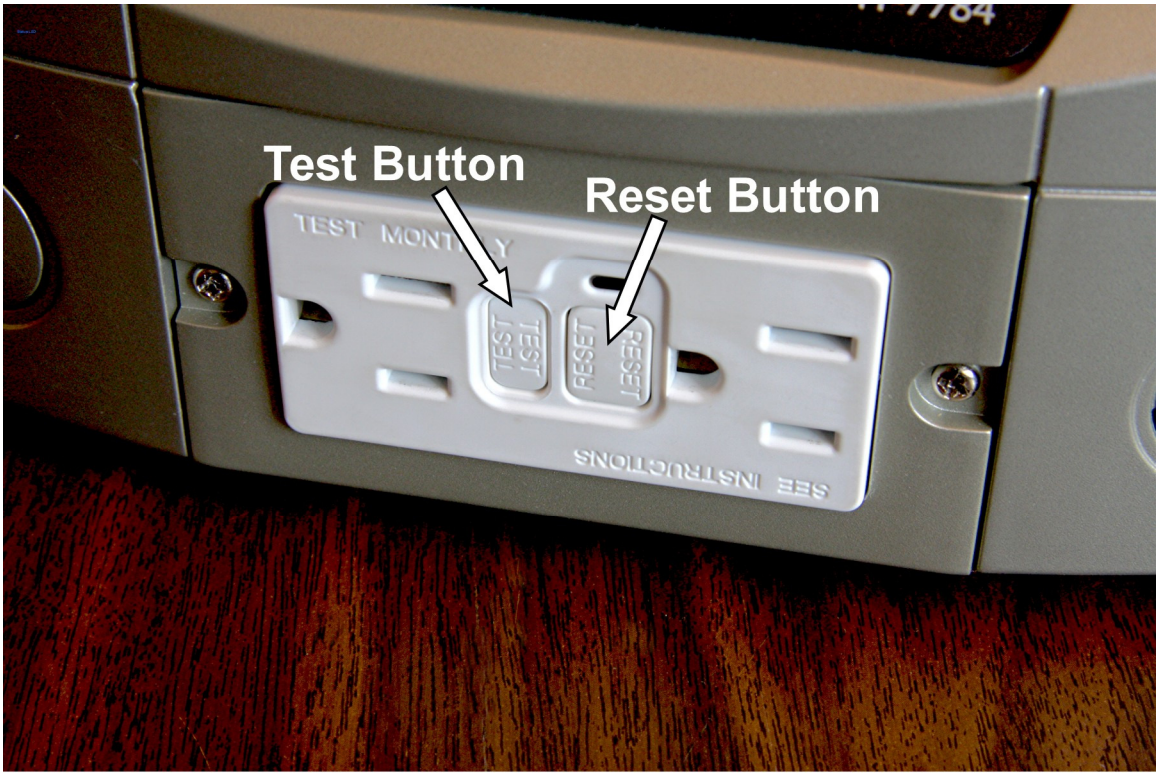
There is a Ground Fault Circuit Interrupter receptacle located on the front panel of the power inverter as shown above. The power inverter output loads are normally connected to this GFCI receptacle. There are TEST and RESET buttons located in the center of the receptacle as shown here and on the next page. The GFCI receptacles on some power inverters also feature a red LED that glows if the GFCI is tripped.

IMPORTANT: If the Ground Fault Circuit Interrupter (GFCI) trips, the reset button on the GFCI will pop out. The power inverter control panel will remain on and the DC input voltage will appear normal, but the input current and output power will both read “0”.

IMPORTANT: If the power inverter is not supplying AC output power, press the RESET button on the GFCI receptacle all the way in to be sure the GFCI is not tripped. Be sure to press the RESET button all the way in.

IMPORTANT: The Ground Fault Circuit Interrupter (GFCI) protects only loads that are plugged into it. If AC loads are connected to the inverter AC output terminal board then GFCI protect must be supplied for those AC loads in accordance with all National, State and local electrical code requirements.

IMPORTANT: Use only Ground Fault Circuit Interrupter (GFCI) types specified in the Installation Instructions. Other types may fail to operate properly when connected to this inverter equipment.



Testing the GFCI Receptacle

GFCI receptacles should be tested once a month to make sure they are working properly. They should also be tested after installation to make sure they are wired correctly. To test a GFCI receptacle proceed as follows.

1. Plug a test light into the outlet and be sure it is on.
2. Press the TEST button on the GFCI receptacle all the way in. The GFCI RESET button should pop out, and the test light should go out.
3. If the RESET button pops out but the test light does not go out, the GFCI receptacle has been improperly wired. Check and repair wiring as required.
4. If the RESET button does not pop out, the GFCI receptacle is defective and must be replaced.
5. If the GFCI receptacle is functioning properly, press the RESET button all the way in to reset the GFCI and restore power to the outlet.

Checking Inverter Input Voltage, Input Current and Output Power.

When the power inverter is connected to a source of DC power, the display on the power inverter control panel can be used to display the input voltage, input current and output power. With the power inverter turned on, press the Select key to scroll through the input voltage from the battery (in volts), the current flowing to the inverter from the battery (in amps) and the instantaneous power output of the inverter (in kilowatts). If the power inverter is operating on AC standby power and the inverter control panel is turned on the control panel display will indicate tractor battery voltage, not AC input voltage.

In the photograph below the yellow status LED indicates the Power Inverter is turned on and is operating from DC power supplied by the tractor batteries. The display is showing an input voltage from the tractor batteries of 12.8 Vdc.



IMPORTANT: If AC voltage and current measurements are taken using a hand-held multi-meter, be sure a high quality true RMS multi-meter such as a Fluke 87 or 112 is used. Inexpensive multi-meters may not be capable of accurately reading the modified sine wave output supplied by the power inverter when running on battery power.

WARNING: Dangerous electrical voltage and current levels are present any time the power inverter is connected to a source of battery DC power or external AC input power. To reduce the risk of electrical shock, disconnect both AC and DC power from the power inverter before working on the power inverter or attached circuits. Turning the power inverter off will not reduce this risk.



Power Inverter Fault Codes and Corrective Actions

If a power inverter fault condition occurs, the fault code will appear in the control panel display alternating with additional information as shown in the table below. When checking a fault code, also check the color of the Status LED. Consult the table below for fault code descriptions and corrective actions.

Turn the power inverter off and back on to clear a fault code. Some Fault Codes such as E02 Under-Voltage Shutdown will clear automatically if the supply voltage returns to acceptable levels.

Fault Code Display	Status LED & Beeper	Description	Corrective Action
[E01] Alternating with [Battery Voltage]	Yellow - Beeps every two seconds	Under-voltage Warning (Battery voltage is less than 11.0 Vdc)	1. Check the battery cables and connections to be sure they are clean and secure. 2. Check the battery charge and recharge if necessary. 3. Reduce the load on the inverter. 4. Monitor the battery voltage at the power inverter when the loads are turned on. If the voltage falls below 11.0 VDC when the loads are turned on the battery cables may be undersize or loose or a battery may be defective. It is also possible that the loads may have excessive startup current draw.
[E02] Alternating with [Battery Voltage]	Red - Beeps every second	Under-voltage Shutdown (Battery voltage is less than 10.5 Vdc)	1. Check the battery cables and connections to be sure they are clean and secure. 2. Check the battery charge and recharge if necessary. 3. Reduce the load on the inverter. 4. Monitor the battery voltage at the power inverter when the loads are turned on. If the voltage falls below 10.5 VDC when the loads are turned on the battery cables may be undersize or loose or a battery may be defective. It is also possible that the loads may have excessive startup current draw.
[E03] Alternating with [Battery Voltage]	Red - Beeps every second	Over-voltage Shutdown (Battery voltage is greater than 15.5 Vdc)	1. Make sure the power inverter is connected to a <u>12 volt</u> battery supply. 2. Check the voltage regulation of the battery charging system. This fault code is set if battery voltage exceeds 15.5 VDC. Note that voltage in excess of 16 VDC may damage the power inverter. Damage caused by excessive input power voltage is not covered by the power inverter warranty.
[E04]	Yellow - Beeps every two seconds	Overload Warning	1. Check to be sure the connected load does not exceed the power inverters rating. 2. Reduce the connected load if necessary. 3. Check the load connections for short circuits or loose wires. 4. Check to be sure the loads are not drawing excessive starting current.

Power Inverter Fault Codes and Corrective Actions - continued

Fault Code Display	Status LED & Beeper	Description	Corrective Action
[E05] Alternating with [OL] (Overload)	Red - Beeps every second	Overload Shutdown or Short Circuit	1. Check to be sure the connected load does not exceed the power inverters rating. 2. Reduce the connected load if necessary. 3. Check the load connections for short circuits or loose wires. 4. Check to be sure the loads are not drawing excessive starting current.
[E06]	Not Used	Not Used	Not Used
[E07] Alternating with [OtA] (Overtemp Approach)	Yellow - Beeps every two seconds	Over-temperature Warning	1. Allow the power inverter to cool down. 2. Reduce the connected load if continuous operation is required. 3. Improve the power inverter ventilation. Be sure the power inverter ventilation openings and fans at the bottom of the power inverter are not obstructed. 4. Be sure there is ample air flow in the area surrounding the power inverter. 5. Reduce the ambient temperature at the power inverter location.
[E08] Alternating with [Ot] (Overtemp)	Red - Beeps every second	Over-temperature Shutdown	1. Allow the power inverter to cool down. 2. Reduce the connected load if continuous operation is required. 3. Improve the power inverter ventilation. Be sure the power inverter ventilation openings and fans at the bottom of the power inverter are not obstructed. 4. Be sure there is ample air flow in the area surrounding the power inverter. 5. Reduce the ambient temperature at the power inverter location.

Turn the power inverter off and back on to clear a fault code. Some Fault Codes such as E02 Under-Voltage Shutdown will clear automatically if the supply voltage returns to acceptable levels.

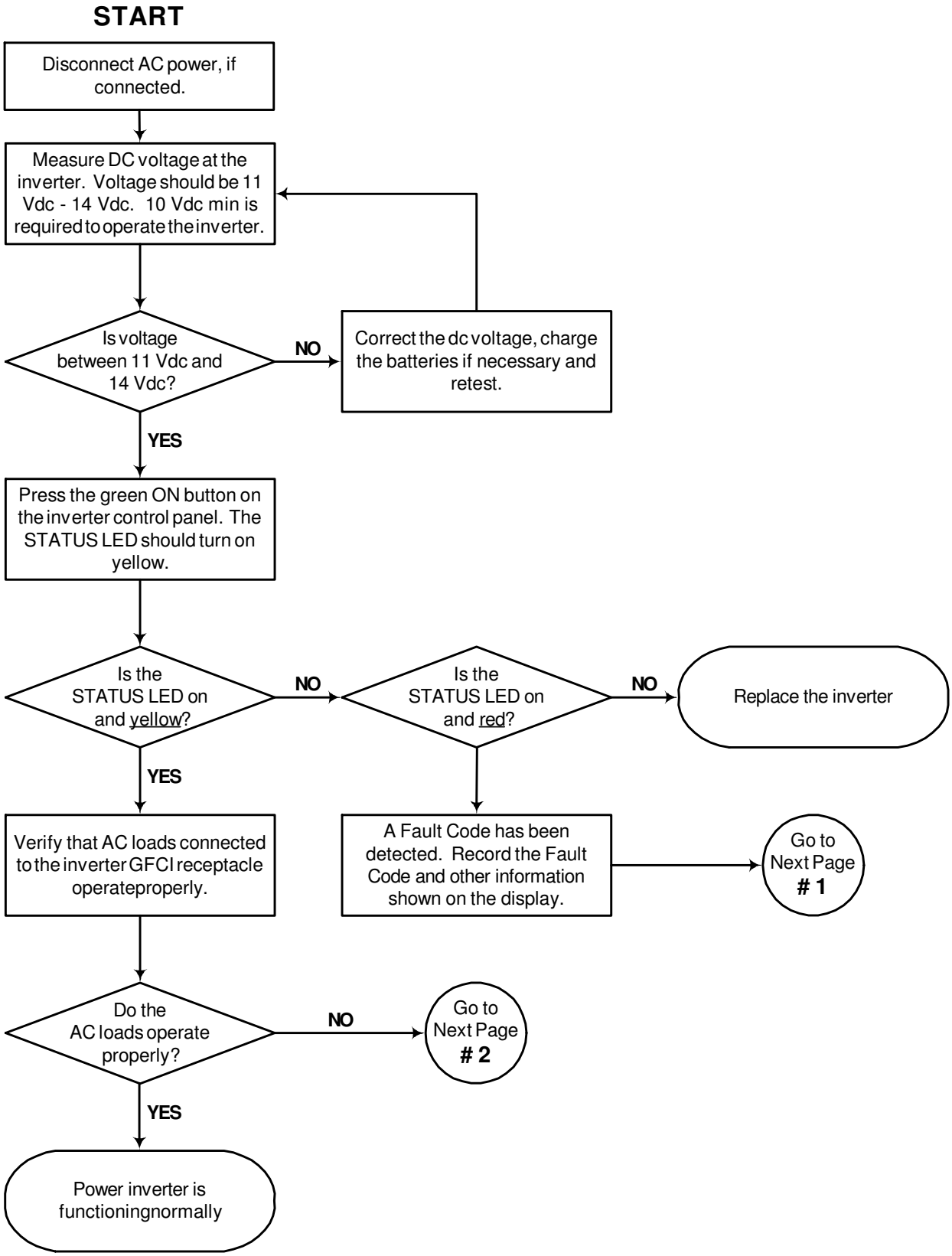
Power Inverter Diagnostics – External Battery Power Operation

The table below shows suggested diagnostic actions when the power inverter is being operated from an external battery. Be sure to use a high quality true RMS multi-meter such as a Fluke 87 or 112 to take AC voltage and current measurements. Also see the External Battery Power Operation Diagnostic Flowchart at the back of this bulletin.

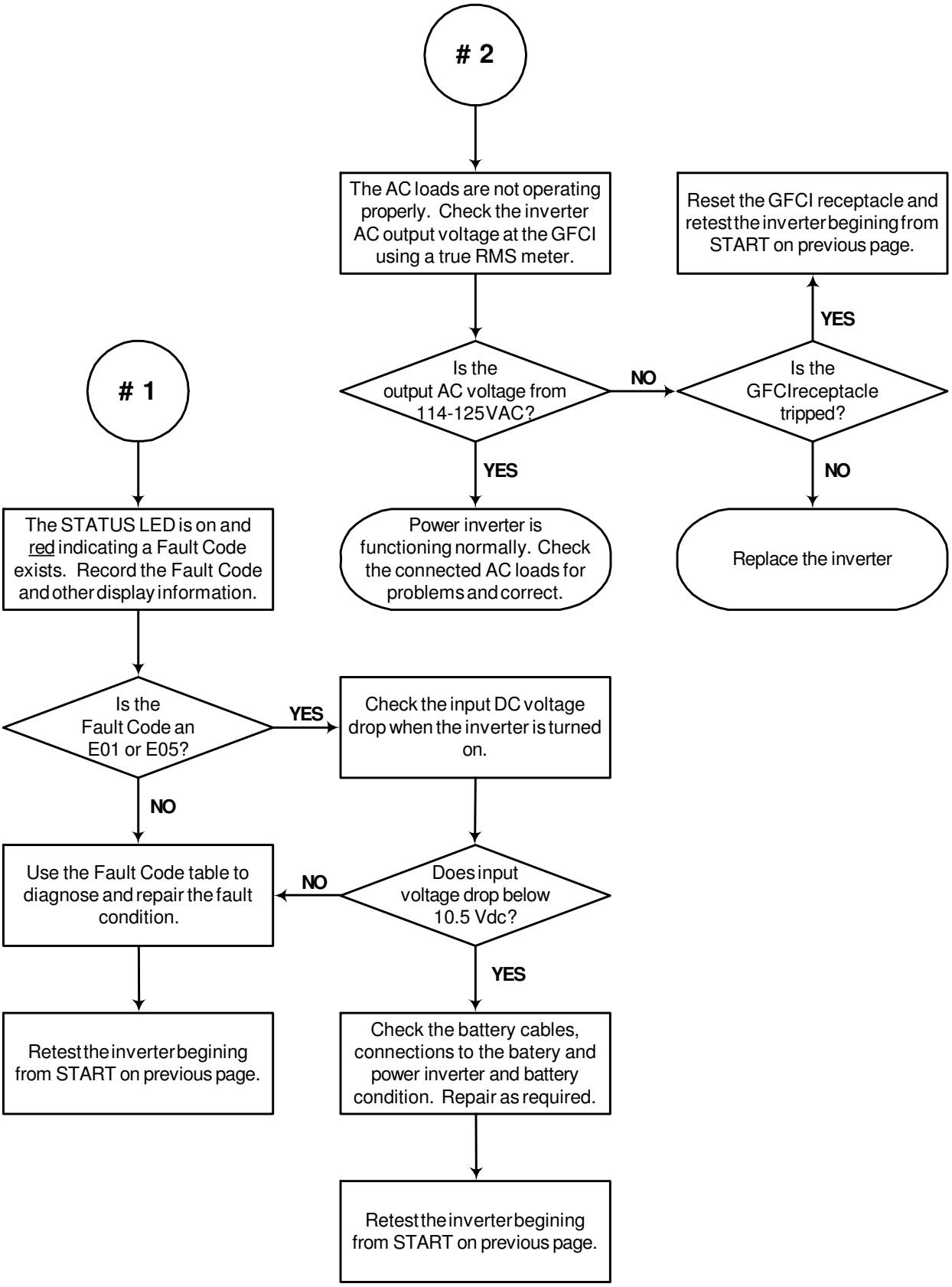
If any fault codes are present, check and correct the cause of the fault code as shown on the following pages.

Symptom	Cause	Corrective Action
Low output voltage (96 – 104 Vac)	The voltmeter being used to check the output voltage cannot accurately read the modified sine wave output of the power inverter.	Use a true RMS reading voltmeter such as a Fluke Model 87 or 112 for AC voltage and current measurements.
No output voltage (Status LED and display are off)	The power inverter is turned off.	Turn the power inverter on. The Status LED should be yellow and the display showing battery voltage should appear.
	No input power to the power inverter from the batteries. The DC voltage at the power inverter input should be 11-14 Vdc. 10 Vdc minimum is required to operate the power inverter.	Check and charge the batteries as required. Check the input power connections. Check the 250 A input power fuse located near the batteries.
	Battery input power polarity is reversed.	If battery power polarity is reversed when connected to the power inverter the power inverter may be damaged. Damage caused by reversed input power polarity is not covered by the power inverter warranty.
No AC output voltage. The Status LED is yellow and display appears normal but input current and output power are both “0”.	The GFCI receptacle has tripped.	Press the reset button on the GFCI receptacle. If the GFCI continues to trip check the connected AC loads for a short to ground.
No output voltage (Status LED is red)	Low input voltage from the battery (Fault Code E02 set).	See Fault Code E02 corrective actions.
	High input voltage from the battery (Fault Code E03 set).	See Fault Code E03 corrective actions.
	High temperature shutdown (Fault Code E08 set).	See Fault Code E08 corrective actions.
	Unit overload or output short circuit (Fault Code E05 set).	See Fault Code E05 corrective actions.

Diagnostic Flowchart – External Battery Power Operation (Page 1)



Diagnostic Flowchart – External Battery Power Operation (Page 2)



Power Inverter Diagnostics – External AC Standby Power Operation

The table below shows suggested diagnostic actions when the power inverter is being operated from a source of external AC standby power. Be sure to use a high quality true RMS multi-meter such as a Fluke 87 or 112 to take AC voltage and current measurements. Also see the External Battery Power Operation Diagnostic Flowchart at the back of this bulletin.

IMPORTANT: The power inverter must be connected to a source of DC power and the inverter control panel must be turned on in order to properly transfer to DC operation if the AC standby supply falls below 90 Vac or is removed.

IMPORTANT: If AC standby power is connected to the power inverter and the inverter control panel is switched off, erratic operation may occur if the AC standby power falls below approximately 107 Vac.

IMPORTANT: If the power inverter is connected to AC standby power, the built in transfer switch will automatically switch the power inverter to AC operation.

IMPORTANT: If the power inverter is connected to AC standby power and the AC power source falls below 90 VAC or is removed, the built in transfer switch will automatically switch the power inverter to battery operation.

IMPORTANT: If the power inverter is connected to a source of AC standby power, that AC power will flow thru the power inverter even if the power inverter is turned off.

IMPORTANT: The Ground Fault Circuit Interrupter (GFCI) protects only loads that are plugged into it. If AC loads are connected to the inverter AC output terminal board then GFCI protect must be supplied for those AC loads in accordance with all National, State and local electrical code requirements.

Symptom	Cause	Corrective Action
No output voltage (Status LED and display are off and will not turn on).	No input power to the power inverter from the external AC power supply and no DC power is connected to the power inverter. The AC voltage at the power inverter input should be 100-130 Vac.	Check and correct the external AC power source as necessary. Check the input power connections.
No output voltage	The GFCI breaker located on the front of the power inverter has tripped. The 15 amp supplemental circuit breaker located on the side of the power inverter has tripped.	Press the reset button on the GFCI. If the GFCI continues to trip check the connected AC loads for a short to neutral or ground. Reset the 15 amp supplemental circuit breaker.
Erratic operation or the transfer relay short cycles off and on.	The inverter is operating on AC standby power, the inverter control panel is not turned on and the AC voltage has fallen to approximately 107 Vac or lower.	Turn the inverter control panel on.

Diagnostic Flowchart – Standby Power Operation

