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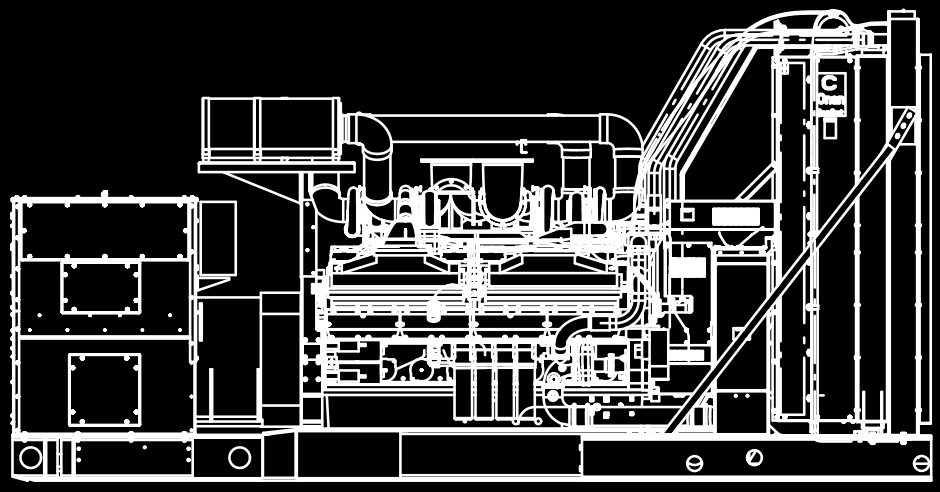
Power Generation

Service Manual

PowerCommand® Control
3200 Series
Generator Sets



Models
DQKB, DQKC

Printed in U.S.A.

960-0512 7-2001

Table of Contents

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS – This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries.

Before operating the generator set (genset), read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠ WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠ CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use zinc coated or copper fuel lines with diesel fuel.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (–) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. Do not operate a genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Cummins Power Generation distributor for more information.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

MEDIUM VOLTAGE GENERATOR SETS

(601V to 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

This manual provides PowerCommand® Control 3200 (PCC) calibration and adjustment procedures, control operation, alternator test and repair procedures and initial startup and test of paralleled generator sets.

Operating and maintenance instructions are in the applicable Operator's Manual. Generator set troubleshooting and repair (control and engine) information is provided in the following manuals.

- Troubleshooting and Repair Manual PowerCommand Control QSK45, QSK60, QSX15 Generator Sets, Bulletin No. 3666394
- Operation and Maintenance Manual QSK 45 and QSK60 Series Engines (engine repair and service) Bulletin No. 3666260

Read ***Safety Precautions*** and carefully observe all instructions and precautions in this manual.

TEST EQUIPMENT

To perform the test procedures in this manual, the following test equipment must be available

- True RMS meter for accurate measurement of small AC and DC voltages. Fluke models 87 or 8060A are good choices.
- Battery Hydrometer
- Powr Factor Indicator
- Jumper Leads
- Tachometer or Frequency Meter
- Wheatstone Bridge or Digital Ohmmeter
- Variac
- Load Test Panel
- Megger or Insulation Resistance Meter

HOW TO OBTAIN SERVICE

Always give the complete Model, Specification and Serial number of the generator set as shown on the nameplate when seeking additional service information or replacement parts. The nameplate is located on the side of the generator output box.

⚠WARNING ***Incorrect service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be trained and experienced to perform electrical and mechanical service. Read and follow Safety Precautions, on pages iii and iv.***

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2. Control Operation

GENERAL

The following describes the function and operation of the PowerCommand generator set control. All indicators, control switches/buttons and graphical display are located on the face of the control panel as illustrated in Figure 2-1.

Normally, generator set configuration options are set at the factory. When a new control is installed on a generator set or when parts are replaced, the control must be configured for that generator set. Setup and calibration procedures are described in *Section 3*.

SEQUENCE OF OPERATION

When the PowerCommand control is in the AUTO mode, it will cause the generator set to start on receiving a signal from a remote device. The control will initiate a starter cranking signal and verify that the engine is rotating. The control will provide sufficient fuel to the engine to accelerate to start disconnect speed. On reaching that speed, the control will ramp the generator set to idle (warm-up) or rated speed and voltage.

On reaching rated speed and voltage, the control checks the system bus voltage. If no bus voltage is present, it will wait for a pulse from a remote Master First Start Sensor. On receiving that pulse, the control will signal the paralleling breaker to close.

If bus voltage is present, the control will check for proper phase rotation, adjust the generator set to the bus voltage and frequency level, and then synchronize the generator set to the system bus. When a synchronous condition is achieved, the control will send a signal to close the paralleling breaker.

When the paralleling breaker is closed, the generator set will assume it's proportional share of the total load on the system bus.

CONTROL PANEL POWER ON/OFF MODES

The power on/off modes of the control panel and operating software are Power On, Screen Saver and Sleep/Awake.

Power On Mode: In this mode, power is continuously supplied to the control panel. The control's operating software and control panel LEDs/graphical display will remain active until the Screen Saver mode is activated.

Screen Saver Mode: Power to the graphical display will be removed after 10 minutes (generator set not running or running). The 10 minute timer resets and begins after each control panel action (any button or switch selection) or signal received by the operating software. The bottom LEDs of the Analog AC Metering Panel (bar graphs) may remain on during Screen Saver mode, indicating that the operating software is active (Awake mode).

When a “Warning” signal is sensed by the PCC (for example, low coolant temp), the control will display the warning message. The control will remain active until the Fault Acknowledge button is pressed to clear the warning message and start the 10 minute timer.

Sleep/Awake Mode: In the Sleep mode, the control’s operating software is inactive and the LEDs and the graphical display on the control panel are all off. Sleep mode is a feature that is used to reduce battery power consumption when the control is in the Auto mode and is not being used.

When all conditions are met (i.e., no unacknowledged faults, Screen Saver Mode is active, and O/Manual/Auto switch is in the Auto position) the Sleep mode will be activated.

The operating software is initialized and the control panel LEDs and graphical display is turned on in response to one of the following:

- moving/pressing any control panel switch/button.
- a remote start input signal (generator set in Auto mode), or
- customer fault 2 or 3 only (shutdown or warning indicator is on).

To activate the control and view the menu display without starting the generator set, press any button on the control panel.

The InPower service tool is required to enable or disable the Sleep mode. When shipped from the factory, the Sleep mode is disabled. When disabled, the operating software will always remain active (Awake mode) when the control is in Auto mode.

InPower service tool is required to selected desired mode.

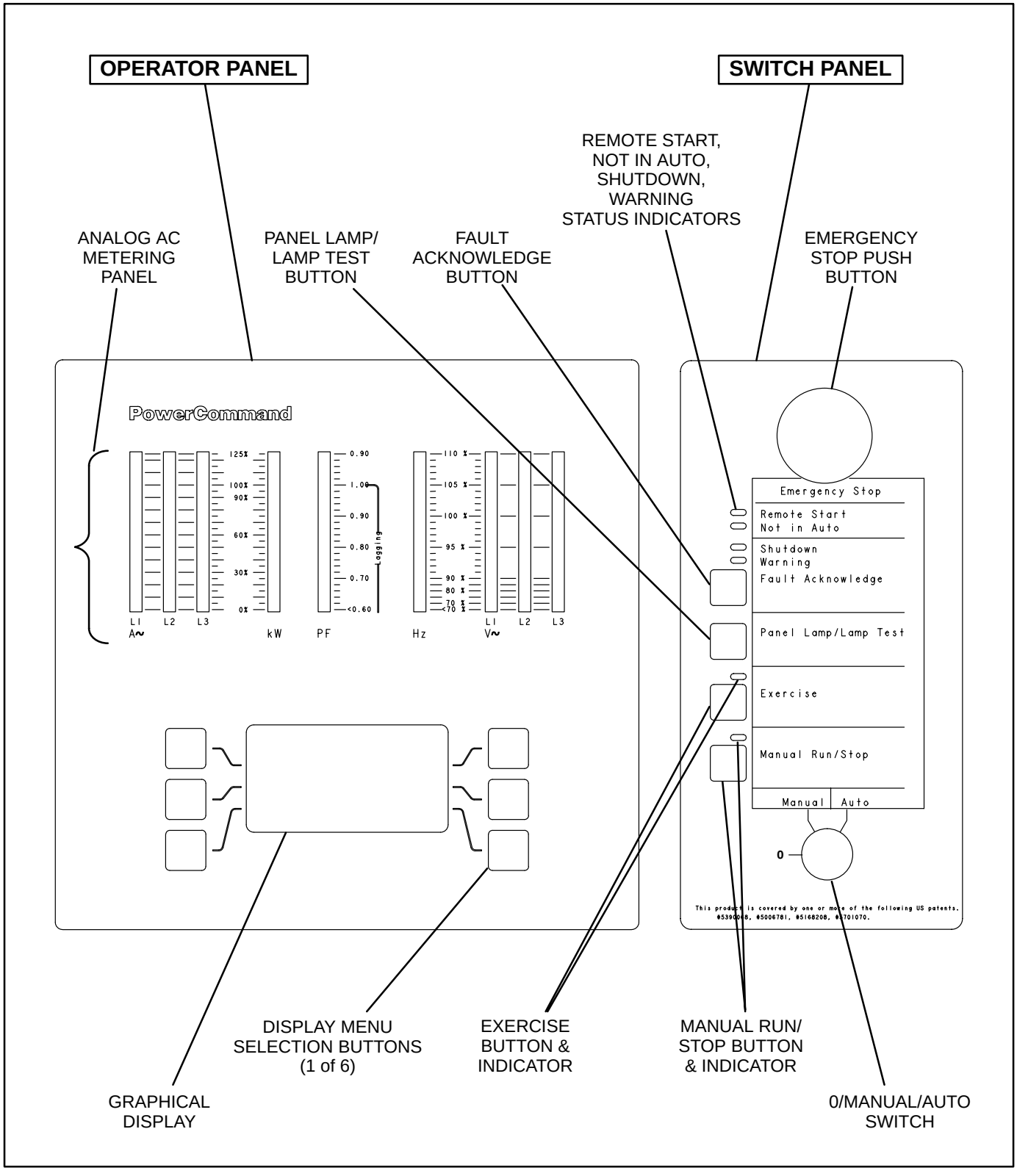

FIGURE 2-1. CONTROL PANEL ASSEMBLY (FULL-FEATURED)

CONTROL PANEL ASSEMBLY

The control panel assembly (Figure 2-1) consist of two panels, the *Operator Panel* and the *Switch Panel*. The control panel assembly can be mounted on the genset or in a freestanding cabinet located near the genset. In either location, the function of the control panel assembly switches and indicators remain the same.

Dependent on site requirements, the *Operator Panel* is either mounted on the control panel assembly (full-featured) as shown in Figure 2-1 or is contained in a separate enclosure and mounted remotely of the control panel assembly.

The function of several buttons on the control panel will vary dependent on the location of the control panel (remote or local of the control panel assembly). If the function differs, it is noted as either "remote" or "local operator panel" in the button description.

Operator Panel

The operator panel contains the following components:

Analog AC Metering Panel: This panel simultaneously displays 3-phase line to line AC volts and current, kW, power factor and frequency.

The meter panel is composed of a series of LEDs, that are configured in bar graphs for each function. The LEDs are color coded, with green indicating normal range values, amber for warning levels and red for shutdown conditions.

Scales for each function are in % of nominal values. Resolution is 1% for values close to nominal, and increases at values further from nominal.

Graphical Display: The graphical display is capable of displaying up to 9-lines of data with approximately 27 characters per line. The display is used to view the menus of the menu-driven operating system.

The top three lines of the graphical display contain the following control information in the order described:

- *State Line* – modes of operation, such as Stopped, Time Delay To Start, Warm Up At Idle, etc. (see Figure 2-2), and paralleling operations, such as Standby, Dead BUS Close, Synchronize, Load Share and Load Govern.
- *Action Line* – system actions, such as Warning, Derate, Shutdown Cool-down and Shutdown, and fault codes.
- *Description Line* – Fault code messages.

Display Menu Selection Buttons: Six momentary buttons—three on each side of the graphical display window—are used to navigate through the system control menus and to adjust generator set parameters. The button is active when the message adjacent to the button is highlighted (displayed in inverse video).

Switch Panel

The switch panel contains the following components:

Emergency Stop Button: Push the button in for emergency shutdown of the engine. If the engine is not running, pushing the button in will prevent the starting of the engine, regardless of the start signal source (local or remote).

To reset:

1. Pull the button out.
2. Move the 0/Manual/Auto switch to 0.
3. Press the front panel Fault Acknowledge button.
4. Select Manual or Auto, as required.

Remote Start Indicator: This green lamp is lit whenever the control is receiving a remote run signal. When flashing, it indicates a load demand stop mode.

Not in Auto Indicator: This red lamp flashes continuously when the 0/Manual/Auto switch is not in the Auto position. (If in Auto position and lamp is flashing, service is required.)

Shutdown Status Indicator: This red lamp is lit whenever the control detects a shutdown condition. The generator set can not be started when this lamp is on. After the condition is corrected, shutdown indicators can be reset by turning the 0/Manual/Auto switch to the 0 position, and pressing the Fault Acknowledge button.

Dependent upon the specific fault that occurs, the engine may or may not shut down immediately. A fault that could cause engine damage, causes an immediate engine shutdown (bypasses engine cool-down sequence). All other faults would allow the engine to run during the cool-down sequence before engine shutdown.

Warning Status Indicator: This yellow lamp is lit whenever the control detects a warning condition. After the condition is corrected, warning indicators can be reset by pressing the Fault Acknowledge button. (It is **not** necessary to stop the generator set if the fault becomes inactive during genset operation.)

Fault Acknowledge: Press this button to acknowledge warning and shutdown messages after the fault has been corrected.

To acknowledge a Warning message, the 0/Manual/Auto switch can be in any position. (It is **not** necessary to stop the generator set to acknowledge an inactive Warning condition.) To acknowledge a shutdown message with this button, the 0/Manual/Auto switch must be in the 0 (Off) position.

This button is also used to blink a fault code if the Shutdown or Warning Status Indicator is lit. (This function is used when the control does not contain a graphical display.) Refer to *Reading Fault Codes* in this section, which describes how to use this button for interpreting fault codes.

Panel Lamp/Lamp Test Button: Press this button to turn on or off the panel lamp. Press and hold down this button for three seconds or more to turn all control panel LEDs on to make sure all lamps illuminate. The illumination will shut off after releasing the button.

Exercise Button: Press this button to initiate a preprogrammed exercise sequence. To start the exercise sequence, press and hold down the Exercise button and move the O/Manual/Auto switch from Auto to Manual and back to Auto or from Manual to Auto.

Manual Run/Stop Button: This button starts and stops the set locally and will bypass Time Delay to Start and Stop sequences. The 0/Manual/Auto switch must be in the Manual position to enable this button.

0/Manual/Auto Switch: Manual position enables the use of the switch panel Manual Run/Stop button.

Auto position enables start/stop control of the engine from a remote location. (Disables the use of the switch panel Manual Run/Stop button.)

0 (Off) position prevents the starting of the set (local or remote). If moved to 0 during set operation, will cause an immediate engine shutdown (bypasses cool-down timers). This hot shutdown should be avoided, if possible, to help prolong the life of the engine. Hot shutdowns are logged by the system software.

READING FAULT CODES

If the genset contains the optional graphical display and a fault occurs, the fault code/message will be displayed in the display Description Line (Figure 2-2). If the control does not contain the graphical display, the fault code is read from the Warning and Shutdown status indicators.

Reading Fault codes Using Warning/Shutdown Indicators: If the Warning or Shutdown status indicator is lit, press and hold the Fault Acknowledge button and release after one second or more. After one second, the Shutdown lamp will begin to blink the active fault code(s) as follows.

The Warning lamp is used to indicate the start of a new code. The Warning lamp will remain on for 2 seconds, followed by the Shutdown lamp blinking the fault code. This sequence occurs three times for each code. The fourth flash of the Warning lamp indicates the beginning of the second fault code.

There are distinct pauses between repetitions of the code blink transmissions of the Shutdown lamp.

A three digit fault code is indicated by three sets of blinks separated by a two second pause. The first set corresponds to the hundreds position, the second to the tens position and the third to the ones digit. Example for Code No. 213:

Shutdown LED:
blink-blink-pause-blink-pause-blink-blink-blink

Warning LED:
blink (2 seconds)

The light will display the fault codes (active or inactive) in succession, starting with the most recent. Up to 32 (unacknowledged) fault codes can be stored in control panel memory.

To return the control to the most recent fault code, press and release the Fault Acknowledge button (less than one second) and repeat procedure.

When the fault code is acknowledged and corrected, the recorded fault will be deleted from the LED fault log, but will remain in a data log that maintains a fault code history. (The InPower service tool is required to view this data log.)

MENU DISPLAY AND SWITCHES

Figure 2-2 shows the graphical display and the menu selection buttons.

Graphical Display: The graphical display is capable of displaying up to 9-lines of data with approximately 27 characters per line. The display is used to view the menus of the menu-driven operating system. Refer to the menu trees later in this section. The display is also used to show the following system information:

- *State Line* – modes of operation, such as Stopped, Time Delay To Start, Warm Up At Idle, etc., and paralleling operations, such as Standby, Dead BUS Close, Synchronize, etc.
- *Action Line* – system actions, such as Warning, Derate, Shutdown Cool-down and Shutdown, and fault codes.
- *Description Line* – Fault code/status messages.

Menu Buttons: Six momentary buttons—three on each side of the graphical display window—are used to navigate through the system control menus and to adjust generator set parameters. The button is active when the message or symbol adjacent to the switch is highlighted (displayed in inverse video). The displayed message or symbol indicates the function of the button.

In the graphical display, the "▼" symbol indicates that selecting the adjacent button causes the operating program to go to the next menu display—as shown in the menu diagrams.

In the graphical display, the "▲" symbol indicates that selecting the adjacent button causes the operating program to go back to the previous menu display.

In the graphical display, the " ⇞ " symbol indicates that selecting the adjacent button causes the operating program to go back to Main Menu A (Figure 2-4).

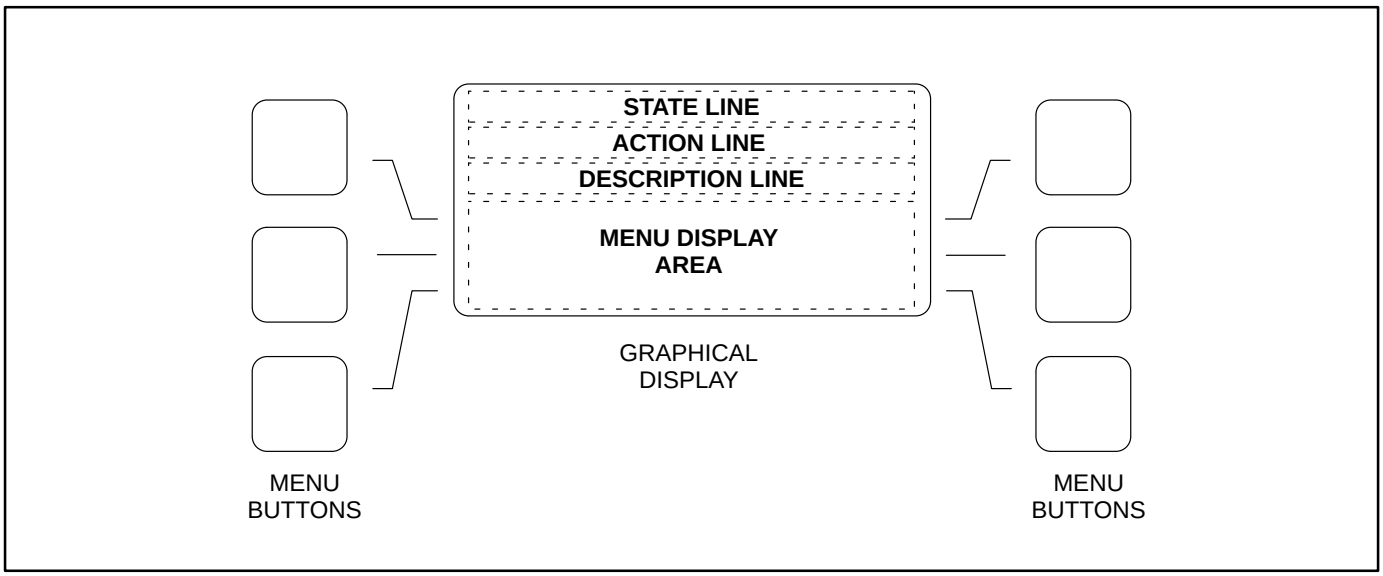

FIGURE 2-2. GRAPHICAL DISPLAY AND MENU SELECTION BUTTONS

MENU UNITS SELECTION

During any control panel operation, you can change how units are displayed by pressing the two lower menu buttons (one on each side of display). When pressing these two buttons simultaneously, the units submenu will appear (Figure 2-3). After selecting the desired units, press the **ENTER** button in this submenu to change and save the selections.

Use the + buttons to select the desired option for each field. Use the arrow (→) button to move to the next field. Selected field is highlighted.

Local/Remote Field: This selection must be set to **Local** when the graphical display is mounted on the generator set front control panel or **Remote** when mounted remotely from the generator set.

The Local/Remote selection determines which buttons in the Control submenu (page 2-12) are active (displayed).

Temp Field: Used to select °F or °C for temperature readings.

Pressure Fluid: Used to select PSI, KPA, BAR or IN for pressure readings.

Pressure Gas: Used to select INHG or MMHG for pressure readings.

Flow Air: Used to select CFM or CMM for air flow readings.

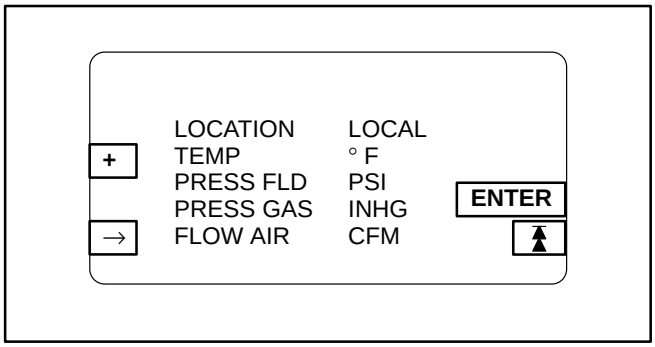

FIGURE 2-3. UNITS SUBMENU

MAIN MENU

Figure 2-4 shows the main menus (Menu A and Menu B) of the system control. The two main menus are used to divide the system submenus into major categories, such as, Engine Data, Alternator Data, Control, etc.

To view system data, simply press the appropriate menu button to select the category. After pressing the desired menu button, refer to the page number shown in Figure 2-4 for detailed information related to the selected category.

Adjust Button: The Adjust submenu is intended for qualified site personnel only. Note that a password may be assigned to allow only authorized operators to modify this data. (Password is not required if not assigned.)

Setup Button: The Setup submenu is described in *Section 3.*

The "Adjust" and "Setup" submenus can be viewed, but not modified without entering the correct passwords.

__ Button: (Paralleling applications only). Used to open and close the generator set circuit breaker (CB). The symbol indicates if the CB is opened or closed. Opened __, push to close. Closed _–_, push to open.

With the control panel **0/Manual/Auto** switch in the **Manual** position, the CB can only be closed by using this button. When manually closed and the CB opens, it must be closed again by using this button. To close the CB, press and hold the button until the symbol indicates a closed CB. (CB close will occur only when setup conditions allow – dead bus or generator synchronized with bus.)

In the **Auto** position, the opening and closing of the CB is controlled by the control system software. The CB symbol will indicate an open or closed CB, but the button will be inactive when the control is in Auto.

In the following figures, the boxed/highlighted field indicates that the adjacent menu button is active. Also, the submenus are shown in the order in which they are displayed when scrolling up ▲ or down ▼.

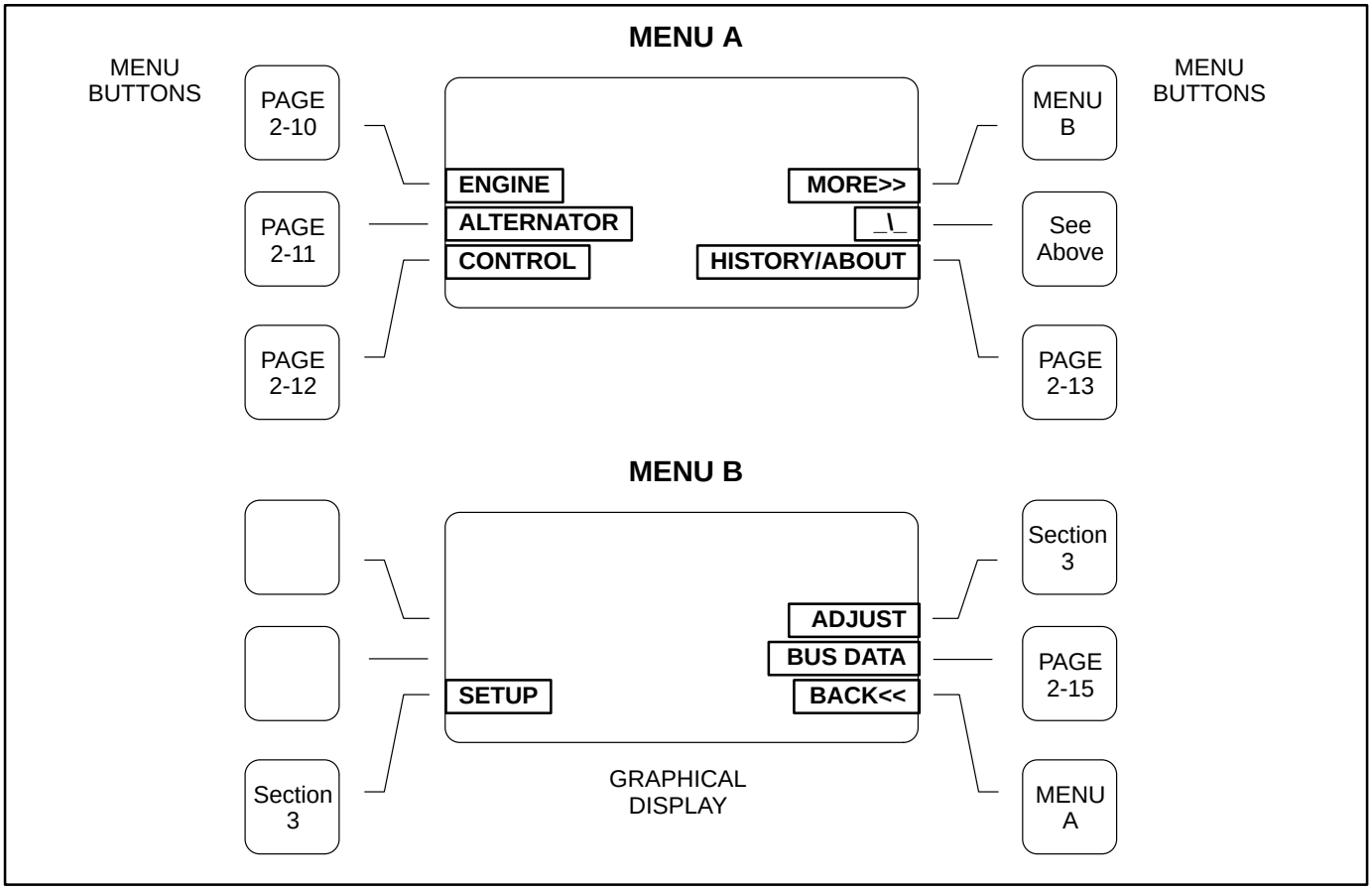

FIGURE 2-4. SYSTEM CONTROL MAIN MENUS A AND B

ENGINE SUBMENUS

If you press the “ENGINE” button in Menu A, the Engine submenus will appear (Figure 2-5).

The first submenu displays general information that applies to all gensets (coolant temp, oil pressure, etc.) The data in the remaining submenu(s) will vary according to the type and number of sensors provided with the engine.

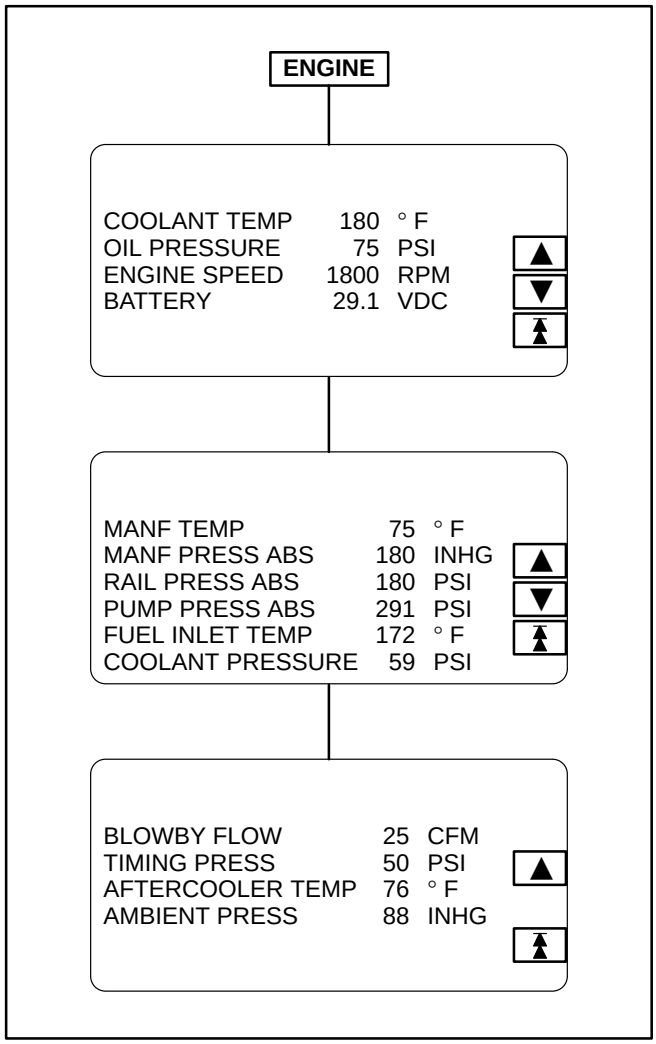

FIGURE 2-5. ENGINE SUBMENUS

ALTERNATOR SUBMENUS

If you press the “ALTERNATOR” button in Menu A, the Alternator Data submenus will appear (Figure 2-6).

Voltage L-L and L-N: Indicates voltage Line-to Line and Line-to-Neutral. Note that the Line-to-Neutral column will not be displayed for a 3 phase/3 wire system. Accuracy 1%.

The voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.

Amps: All phases. Accuracy 1%.

Frequency: Generator set output frequency.

AVR DUTY CYCLE: Displays voltage regulator (drive) level in percentage of maximum.

kW, kVA and PF: Displays generator set kW and kVA output (average and individual phase, and direction of flow) and power factor with leading/lagging indication. Accuracy 5%.

The PF reading will contain an asterisk if the power factor is leading (for example, *.30).

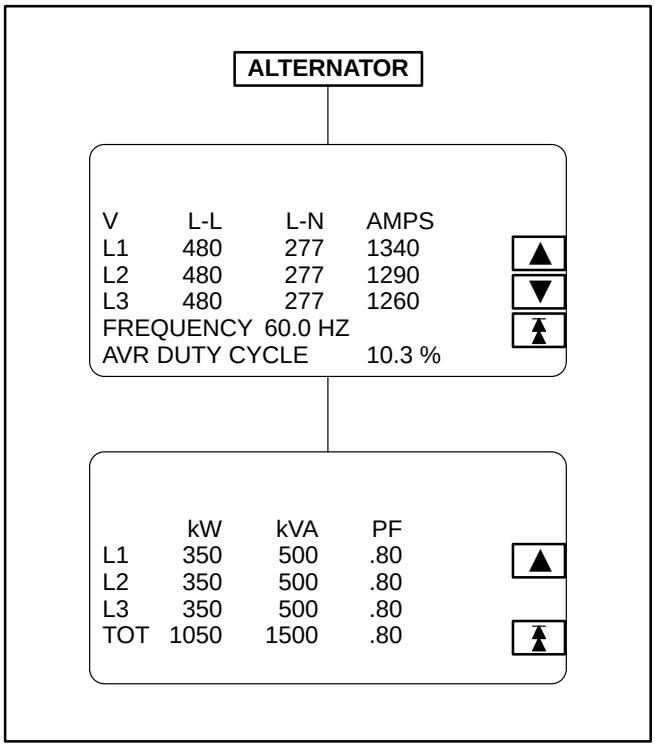

FIGURE 2-6. ALTERNATOR SUBMENUS

CONTROL SUBMENU

If you press the “CONTROL” button in Menu A, the Control submenu will appear (Figure 2-7).

Local CONTROL Submenu Function

When the operator panel is mounted on the control panel assembly, the Run Mode Idle/Rated button is active (displayed). Note in Figure 2-7 that this button is not displayed in remote applications.

The shaded area in Figure 2-7 displays the selected/active mode of operation, either IDLE or RATED.

Remote CONTROL Submenu Functions

When the operator panel (Figure 2-1) is mounted remotely of the control panel assembly, the menu buttons in the Control submenu are used to perform the following remote operations. (To activate these menu buttons for remote/local use, refer to page 2-8.)

The 0/Manual/Auto switch must be in the Auto position to activate the Remote Menu Buttons of the Control submenu.

Remote START or STOP Button: This button is used to start and stop the generator set when the operator panel is mounted in a remote location.

When the generator set is operating, **Stop** will be displayed for this button and **Start** will be displayed when not operating.

Fault Acknowledge Button: Used to reset inactive Warning messages, not Shutdown messages.

Local/Remote CONTROL Submenu Function

Bargraph Test: The function of this button remains the same and is not dependent on operator panel location. This button sequentially lights the LEDs to test the bar graph display.

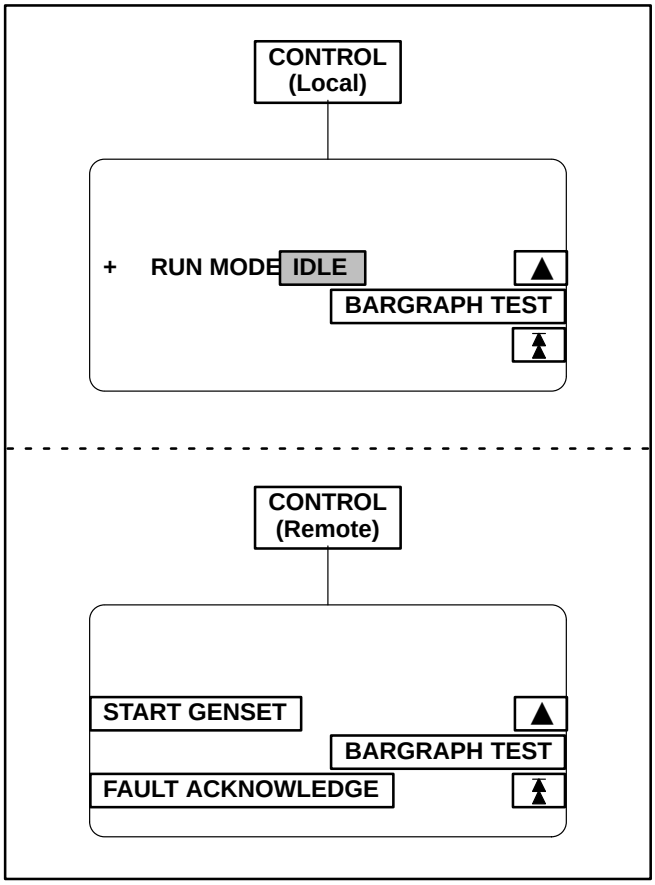

FIGURE 2-7. CONTROL SUBMENU

HISTORY/ABOUT SUBMENUS

If you press the “HISTORY/ABOUT” button in Menu A, the History/About submenus will appear (Figure 2-8).

HISTORY: The control maintains a data log of the number of engine starts and number of operating hours for the engine and control, and the megawatt and maximum torque hours of the generator set. This information is stored in non-volatile memory and will not be deleted due to loss of battery power.

ABOUT: The About submenus provide the following generator set information.

- Genset model and wattage (kW/MW)
- Output voltage and WYE, DELTA or SINGLE
- Frequency 50 or 60 Hz
- Rating: Standby, Prime or Base
- Version level of the controller and panel operating software.

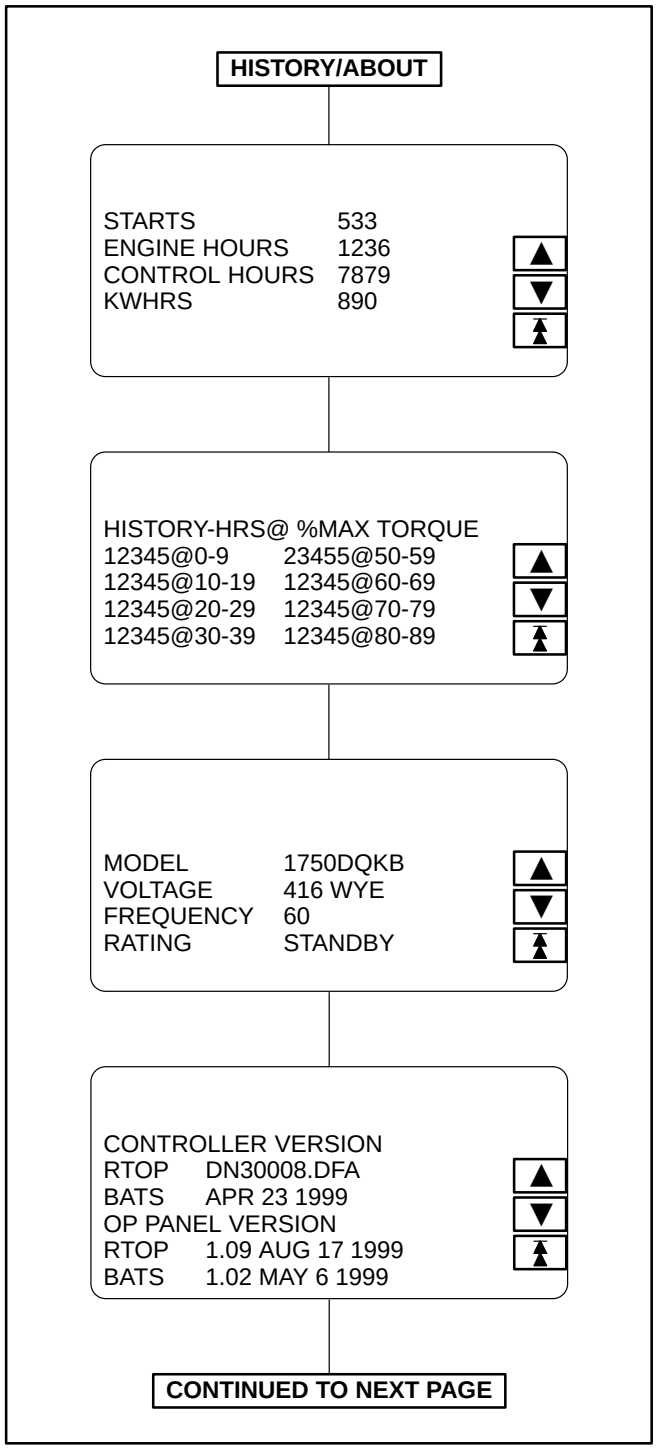

FIGURE 2-8. HISTORY/ABOUT SUBMENUS

FAULT HISTORY: The control maintains a data log of all fault conditions as they occur, and time stamps them with the control and engine operating hours.

Up to 32 (unacknowledged) fault codes can be stored in control panel memory. After the fault is acknowledged and corrected, the recorded fault will be deleted from the control panel memory, but will remain in a data log that maintains a fault code history. (The InPower service tool is required to view this data log.)

The *Fault History* display line: 1 of 24 indicates that 24 faults are recorded and that the most recent fault (1) detected by the controller is displayed.

The *Occurrences* display line: In this example, 5 indicates that this is the fifth occurrence of this fault. (The InPower service tool is required to review the last four faults of this code.)

The Occurrences number is incremented for each new occurrence of the same fault. The controller must detect that the original sensed fault is corrected before it will increment the occurrence number for that fault.

For example, when a Low Oil Pressure fault is detected, the controller will increment the Occurrences number by 1. This fault will remain active until the fault is acknowledged and the controller detects that the fault is corrected. An active fault will prevent the controller from incrementing the Occurrences number each time the engine is started. When the controller detects that the oil pressure is normal the fault will become inactive, allowing the occurrences number to be incremented for the next detected Low Oil Pressure fault.

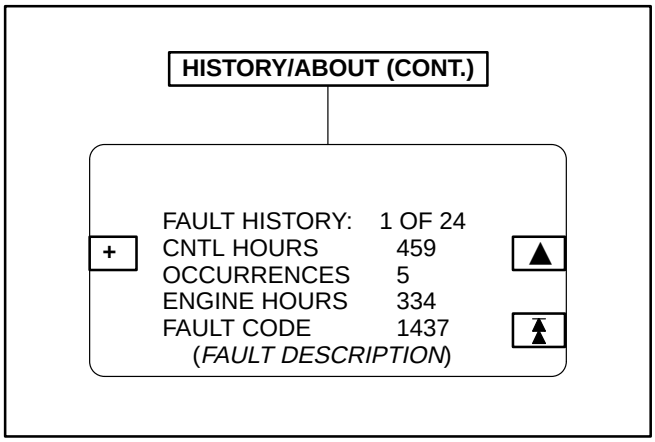

FIGURE 2-8. HISTORY/ABOUT SUBMENUS (CONT.)

BUS DATA SUBMENU

If you press the “BUS DATA” button in Menu B, the Bus Data submenu will appear (Figure 2-9) (paralleling applications only).

BUS DATA STATUS LINE: The top line of the graphical display is used to indicate the following BUS DATA status:

- STANDBY
- DEAD BUS CLOSE: Indicates first genset in system to close to bus.
- SYNCHRONIZE: Genset is synchronizing to bus.
- LOAD SHARE: Genset has closed to bus and is sharing load with other gensets in system.
- LOAD GOVERN: Genset closed to bus in parallel with utility (mains).

BUS Voltage L-L: The BUS voltage Line-to-Line (L1, L2 and L3) are measured between L1 to L2, L2 to L3 and L3 to L1, respectively.

BUS/GEN HZ: BUS and genset frequency.

BUS/GEN SYNC STATUS: The bottom line of the graphical display is used to indicate the following BUS/GEN Sync status:

- NOT SYNCHRONIZING: Genset is in service mode that does not allow auto sync feature. (Selected via InPower service tool – deactivate to allow synchronization.)
- SYNCHRONIZING: Genset is synchronizing to bus.
- READY TO CLOSE: In manual mode, push circuit breaker close button to close breaker.

__ Button: Used to open and close the genset circuit breaker (CB) when the **0/Manual/Auto** switch is in Manual position. The symbol indicates if the CB is opened or closed. Opened __, push to close. Closed _–_, push to open.

In the **Manual** position, the CB must be closed by this button. When manually closed and the CB opens, it must be closed again by using this button. To close the CB, press and hold the button until the symbol indicates a closed CB. (CB close will occur only when setup conditions allow – dead bus or generator synchronized with bus.)

In the **Auto** position, the opening and closing of the CB is controlled by the control system software. The CB symbol will indicate an open or closed CB, but the button will be inactive when the control is in **Auto**.

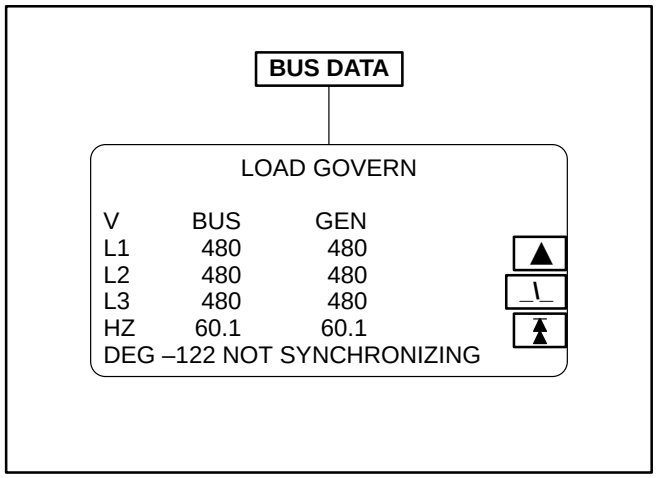

FIGURE 2-9. BUS DATA SUBMENU

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3. Control Calibration and Adjustment

GENERAL

This section contains calibration and adjustment procedures for the generator set control.

MODIFYING SETUP/ADJUST SUBMENUS

The Setup and Adjust submenus allow you to calibrate the graphical display meters and to adjust system parameters, customer defined faults, generator set voltage/frequency and paralleling applications.

⚠ CAUTION ***Improper calibration or adjustment of the control can cause equipment malfunction or damage. Calibration and adjustment must be performed by technically qualified personnel only.***

The Setup submenus are intended for qualified service personnel only. The Adjust submenu is intended for qualified service and site personnel only. For this reason, a password must be entered before this data can be modified. The Setup and Adjust submenus can be viewed, but not modified without entering the correct password.

Saving Menu Changes

Changes are automatically saved when the menu is exited.

PASSWORD Menu

To allow the site personnel to modify only the Adjust submenu and not the Setup submenus, two passwords are assigned within the system software. An **Application** password is used for the Setup submenus and a **User** password is used for the Adjust submenu.

The two passwords are assigned during the initial installation of the generator set (via InPower) and will vary between sites. The installer must make sure that the passwords are available to the appropriate personnel.

When the generator set is first installed, the *Application* password is set to GENSET to allow initial modification of the Setup submenus. The *User* password is initially left blank and does not require a password to modify the Adjust submenu. The entering of the *User* password is not required unless a password is assigned to this field. (*User* password is site dependent.) Assign the password(s) when site installation is complete.

When viewing the Adjust menu, pressing the **+** or **–** button will display the User Password menu *if a user password has been installed with InPower software.* If a password is not assigned to the Adjust menu, changes can be made without entering a password.

When viewing a Setup menu, pressing the **+** or **–** button will always display the Application Password menu.

After entering the correct password, the system will allow you to modify the submenus. To help prevent unauthorized adjustment, the entered password is valid for only 10 minutes after the last button is pressed.

Entering Password

To enter the password:

1. Display submenu to modify.
2. Press either the **+** or **–** button within the displayed submenu. The Password menu appears.
3. Press the **+** and **–** button to select the first character of the password (A–Z or 0–9). (Enter **Application** password for Setup submenus; Enter **User** password for Adjust submenu.)
4. Press the → button to select the next character field. Selected character field is highlighted.
5. Repeat steps 3 and 4 to enter remaining password characters.
6. Press the **Enter** button after entering the password. The submenu selected in step 1 will reappear.
7. After making desired changes to submenu, exit submenu to save changes.

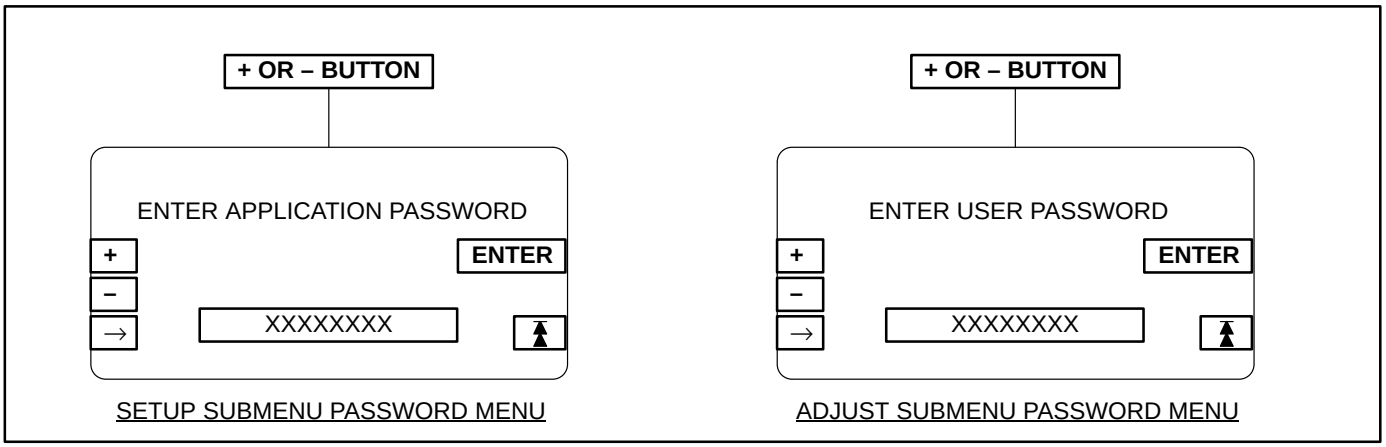

FIGURE 3-1. PASSWORD MENUS

SETUP MENUS

Figure 3-2 shows the main menus (Menu A and Menu B) of the system control and the two Setup menus.

The Setup procedure is intended for qualified service personnel only. The **APPLICATION** password must be entered to modify the Setup submenu fields. Refer to *Modifying Setup/Adjust Submenus* in this section to enter password and to save menu changes.

To display the two Setup menus, press the **MORE>>** button in Menu A and then the **SETUP** button in Menu B.

To view system data or to adjust system parameters, press the appropriate Setup menu button to display the desired Setup submenu(s). Refer to the page number shown in Figure 3-3 for detailed information related to the selected submenu(s).

⚠ CAUTION ***Improper calibration or adjustment of the control can cause equipment malfunction or damage. Calibration and adjustment must be performed by technically qualified personnel only.***

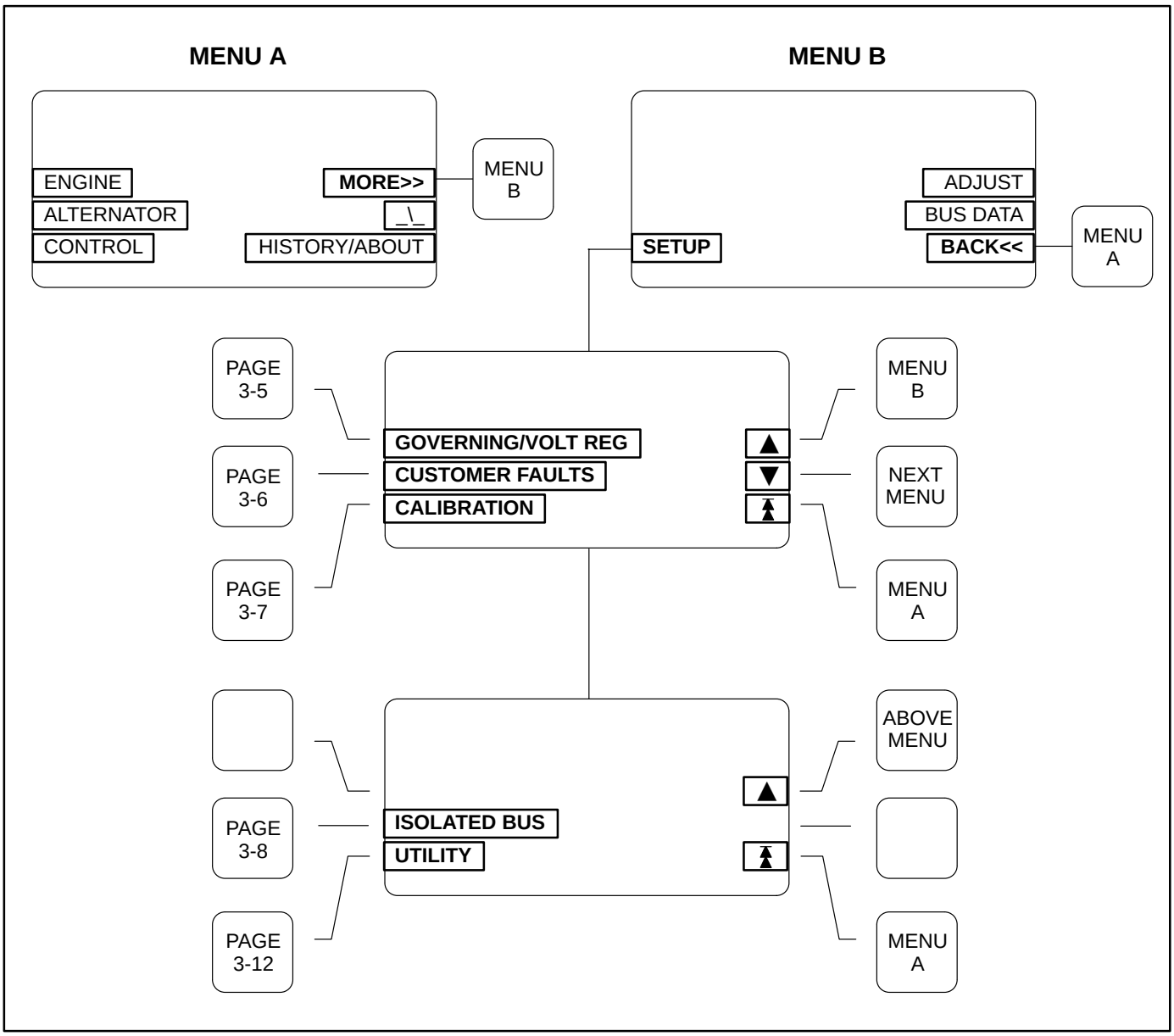

FIGURE 3-2. SETUP SUBMENUS

GOVERNING/VOLT REG Submenu

If you press the “GOVERNING/VOLT REG” button in the Setup menu, the Governing/Volt Regulator submenu will appear (Figure 3-3).

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Exit menu to safe changes.

GOV GAIN: If the gain adjustment is set too high, engine speed will “hunt” or oscillate. If gain is set too low, the engine will respond too slowly to changes in load and overspeed may result. (Gain should be reduced to 80% for paralleling installations.)

AVR GAIN: If the gain adjustment is set too high, output voltage will be unstable. If gain is set too low, the output voltage will respond sluggishly to changes in load and overshoot may result.

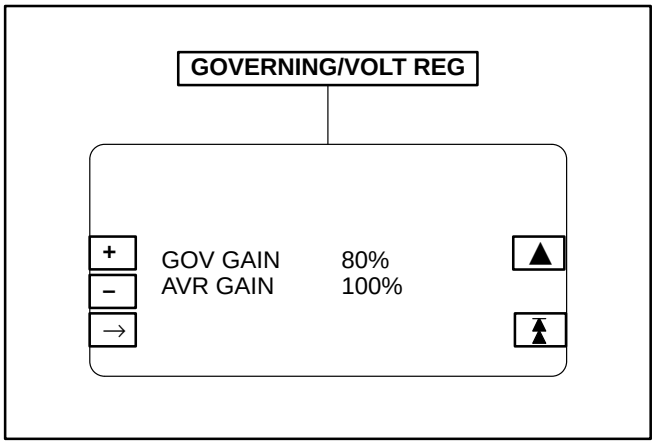

FIGURE 3-3. GOVERNING/VOLT REG SUBMENU

CUSTOMER FAULTS Submenus

If you press the “CUSTOMER FAULTS” button in the Setup menu, the Customer Faults submenus will appear (Figure 3-4).

There are a total of four customer fault inputs. (*Faults 3 and 4 paralleling only.*) The message displayed at the bottom of the menu can be modified for each of these faults in addition to selecting the following operating parameters for each fault.

- Enable – On or Off
- Active – Closed or Open
- Response – Shutdown, Cooldown, Derate or Warning

  Shutdown: Genset will immediately shut down. Normally used for engine faults.

  Cooldown: Cooldown sequence will be initiated before shutdown. Should not be used for engine faults.

  Derate: Used to lower kW output of genset for warnings such as pre-high coolant temperature, etc. Paralleling application – controller will reduce precentage of kW load sharing on the set. Non-paralleling application – controller will lower percentage of kW load by operating load shed relay contacts.

  Warning: Display message, genset continues to operate.

The Enable and the Active fields apply to the Fault 1 and 4 submenus only.

With the Active field selected, pressing the **+** or **–** buttons will toggle the selection between CLOSED and OPEN. Use same operation for remaining field selections.

To enter the desired customer fault message, press the ▼ or ▲ button to display the submenu that contains the customer fault message (1 through 4) to be changed. Use the → button to scroll down through the menu selections to the editable fault message (bottom menu line).

Use the → button to move to each character position within the fault message line.

With the desired character position selected, use **+** or **–** buttons to select the appropriate character.

If these messages are changed, you should note these changes in the *Troubleshooting* section of the Operator’s manual for this generator set.

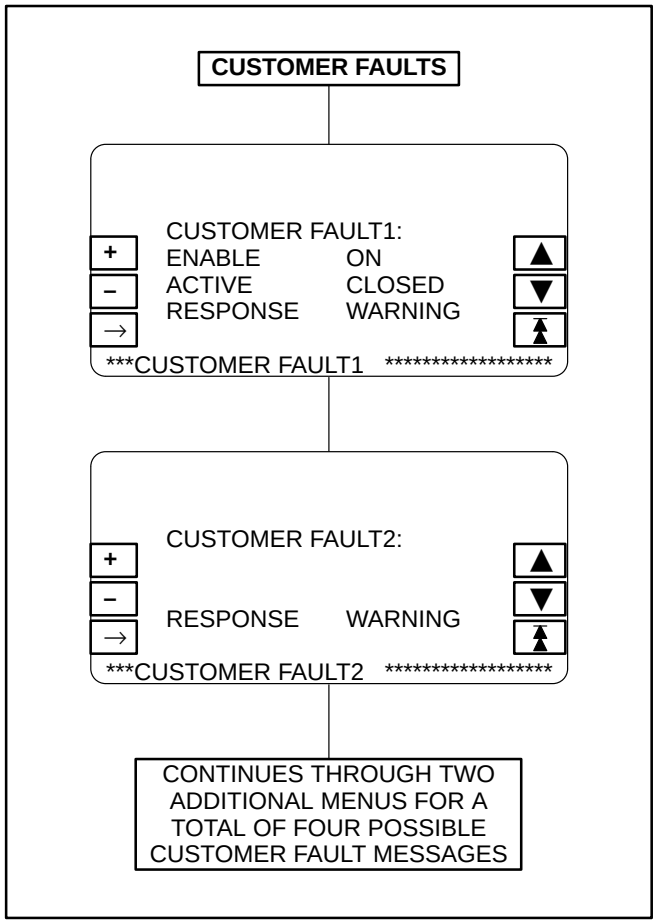

FIGURE 3-4. CUSTOMER FAULTS SUBMENUS

CALIBRATION Submenus

If you press the “CALIBRATION” button in the Setup menu, the Calibration submenus will appear (Figure 3-5).

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Exit menu to safe changes.

The Calibration submenus allow you to calibrate the control with the reading from a calibrated meter. Calibration is accomplished by using this section of the menu software to adjust the display so that it matches the reading taken on an accurate, recently calibrated meter.

Calibration is normally only required when replacing certain circuit cards. Refer to the *Calibration Procedure* in this section which contains a list of the cards that require control calibration.

When performing Bus Voltage Calibration from the graphical display, the genset must be off and the Bus live. If the genset is running, it will synchronize to the Bus.

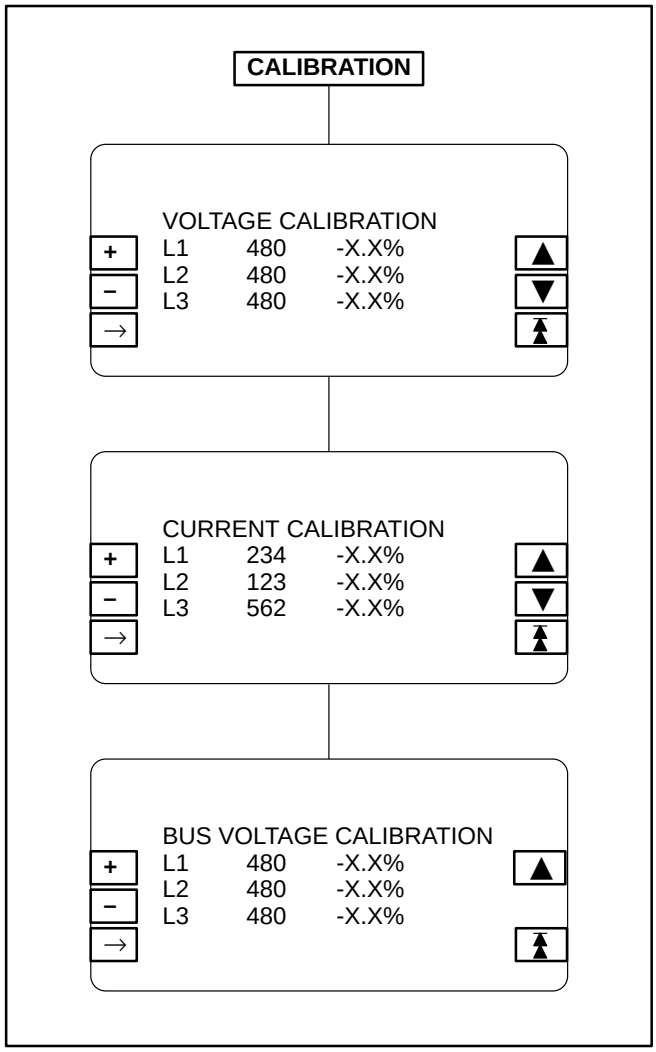

FIGURE 3-5. CALIBRATION SUBMENUS

ISO BUS / UTILITY Submenus (Paralleling Application)

The Isolated BUS submenus (Figure 3-6) and the Utility submenus (Figure 3-7) adjust the control parameters for generator set protection, synchronizing and load sharing for both isolated bus and utility (mains) paralleling applications. Utility (mains) parallel applications may require adjustment of both the Isolated BUS and Utility submenus.

Always perform ISO BUS calibration before Utility BUS calibration.

The sync check (permissive) function is operational in both automatic and manual (RUN) modes. The control will make sure that the generator set is at proper voltage, within the defined sync check window for the defined period of time and that phase rotation is correct. When all criteria are met, the paralleling breaker is closed automatically by the control (auto mode), or by operation of the breaker close switch by the operator (manual mode).

The synchronizing function of the control is enabled when the control has brought the generator set to 90% of rated speed and voltage, and has sensed that bus voltage is available. The control automatically adjusts the generator set speed and voltage to match the bus frequency and voltage. The control can force the generator set to match bus voltage and frequency in a range of minus 40% to plus 10% of normal bus conditions. When the paralleling breaker has closed, the control will bring the generator set back to normal voltage and frequency.

When the generator set is paralleled to another generator set, the control provides automatic load sharing functions for both real (kW) and reactive (kVAR) loads. Load sharing is proportional between generator sets based on their standby ratings. If two generator sets of different sizes are paralleled, they will assume the same percentage of the system load automatically. This can easily be verified on the kW Load LED bar graph on the front of the control panel.

When the utility paralleling mode is enabled and the generator set paralleling breaker is closed, the generator set will assume load based on external analog input signal. The input signal must be calibrated from 0–5 VDC. When the signal is at 0.5 to 1 VDC, the control will operate the generator at no load in parallel with the utility (mains) source. At 4.5 VDC and greater, the control will operate the generator set at 110% of the generator set base load setting. When the load govern signal is between 1 VDC and 4.5 VDC the control will operate the generator set at a load level which is determined by a linear relationship between the kW reference and the load govern signal.

ISO BUS Submenus

If you press the “ISO BUS” button in the Setup menu, the Isolated BUS submenus will appear (Figure 3-6).

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Exit menu to safe changes.

SYNC TIME LIMIT: This parameter adjusts the time delay in seconds before the Fail To Synchronize alarm will operate.

REVERSE PWR LMT: Adjusts the reverse power set point. For PowerCommand generator sets, a typical set point is 10-15%.

REVERSE PWR TIME: Adjusts the reverse power function time delay. A typical time delay which is suitable for PowerCommand generator sets is 3 seconds.

Lower reverse power set points can result in nuisance reverse power shutdown faults.

PERM WIN-PHASE: Adjusts the width of the permissive (sync-check) acceptance window. The adjustment range is from five to twenty electrical degrees. Recommended set point is 20 degrees for isolated bus applications, and 15 degrees for utility (mains) paralleling applications.

PERM WIN-TIME: Adjusts the time period (in seconds) for which the generator set must be synchronized with the system bus, before a breaker close signal is issued by the PowerCommand control. Available range is 0.5 to 5 seconds. Recommended value for PowerCommand generator sets is 0.5 seconds for isolated bus applications.

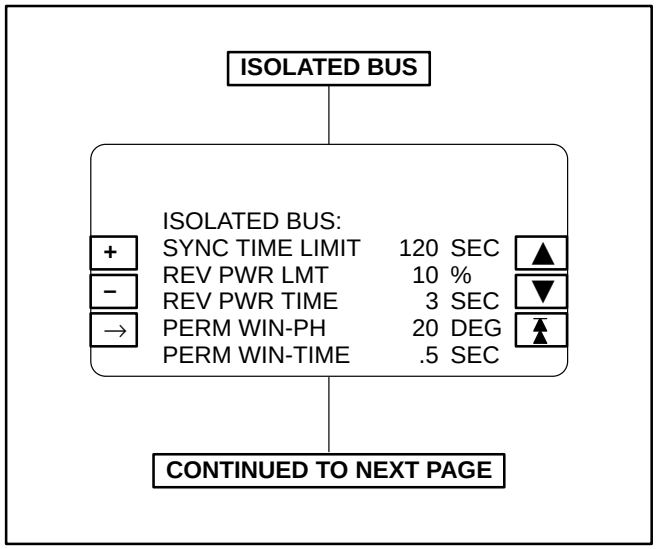

FIGURE 3-6. ISO BUS SUBMENUS

Adjusting the control for a smaller sync-check window or longer time delay will cause synchronizing time to be extended.

SYNC GAIN: The sync gain adjustment controls how quickly the governor will respond to try to minimize the bus/generator phase difference. Increasing the gain speeds up the response. If the gain is too high instability can result.

KW Balance and KVAR Balance changes should be equally shared among all generator sets.

KW BALANCE: This function adjusts the kW load sharing function of the generator set. Before adjusting this value, all generator set calibrations should be performed. If the total load on the system is not shared proportionately, the kW Balance can be used to adjust the generator set for more precise load sharing. Increasing the kW Balance value will cause the generator set to reduce the percentage of the total kW load on that set.

KVAR BALANCE: This function adjusts the kVAR load sharing function of the generator set. Before adjusting this value, all generator set calibrations should be performed. If the total load on the system is not shared proportionately, the kVAR balance can be used to adjust the generator set for more precise load sharing. Increasing the kVAR balance value will cause the generator set to reduce the percentage of the total kVAR load on that set.

KW GAIN: Adjusts the rate of change of kW load on the generator set. With a constant load on the system, if the generator set load is constantly changing, reduce the gain adjustment on the generator set. This also allows modification of the rate of load assumption on transient load change.

KVAR GAIN: Adjusts the rate of change of kVAR load on the generator set. With a constant load on the system, if the generator set load is constantly changing, reduce the gain adjustment on the generator set. This also allows modification of the rate of load assumption on transient load change.

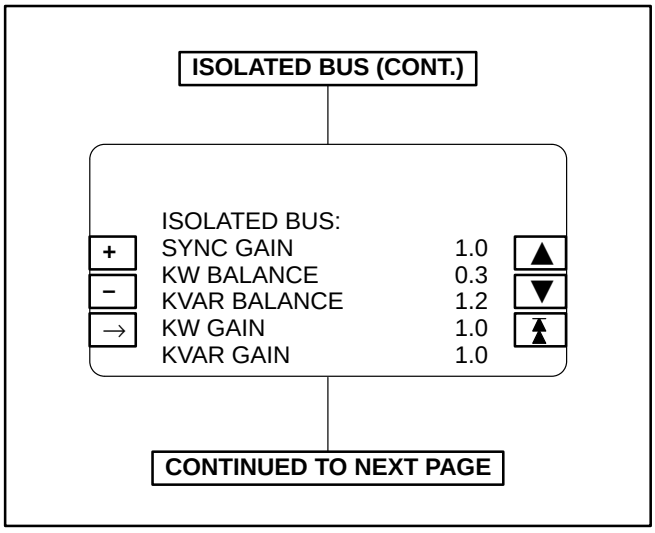

FIGURE 3-6. ISO BUS SUBMENUS (CONT.)

1ST FAIL TIME: Time delay in seconds after a signal from the first start master is not sensed by the PCC that a FIRST START FAIL warning is displayed.

RAMP UNLOAD TIME: When a load demand stop input is sensed the load is ramped down from the present load level on the set to the ramp unload level in the time specified in seconds.

RAMP UNLOAD LEVEL: The load demand ramp unload function will ramp the load down from the present level on the set to this level before opening the set circuit breaker. Value shown is in % of genset standby rating.

RAMP LOAD TIME: When the load demand stop signal is removed the load is ramped from 0kW to the load share level in the specified time after the circuit breaker closes.

LOSS FIELD TIME: Adjusts the loss of field function time delay. A typical delay which is suitable for PowerCommand generator sets is 2 seconds.

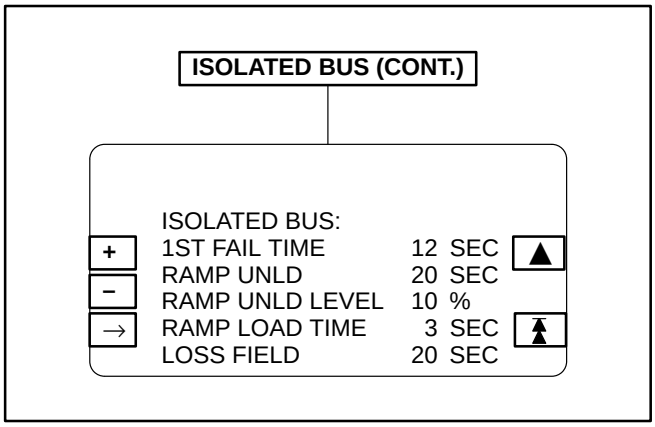

FIGURE 3-6. ISO BUS SUBMENUS (CONT.)

UTILITY Submenus

If you press the “UTILITY” button in the Setup menu, the Utility submenus will appear (Figure 3-7).

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Exit menu to safe changes.

BASE LOAD (%): This controls the maximum kW load level that the generator set will operate at when paralleled with the utility (mains). The value shown indicates the steady state load on the generator as a percent of the generator set standby rating.

Check generator set ratings for maximum load level at which the generator set should operate when paralleled with the utility (mains). Extended operation at load levels in excess of the generator set rating can cause abnormal engine wear or premature engine failure.

PF LEVEL: Adjusts the power factor that the generator set will run at when paralleled to the utility (mains). Recommended setting is 1.0.

RAMP LOAD TIME: This is the ramp time from present set load to level determined by the load set analog input. This is active when the control first enters the load govern mode.

RAMP UNLOAD TIME: This is the ramp time from present set load to 0 kW. This ramp is active when the load set analog input is less than 0.5 volts.

MODE – MULTIPLE/SINGLE: This controls whether the set is to operate as part of a multiple set or single set (PLTE or PLTF) system. (Refer to “LOAD DEMAND SHUTDOWN” and “SINGLE MODE VERIFY” function descriptions in wiring diagram, page 5-6.)

KW GOVERN GAIN: This controls the rate that the generator set kW load is increased after the generator set has closed to the system bus when utility (mains) paralleled. Decreasing this value will result in slower loading of the generator set.

KVAR GOVERN GAIN: This controls the rate that the generator set kVAR load is increased after the generator set has closed to the system bus when utility (mains) paralleled. Decreasing this value will result in slower loading of the generator set.

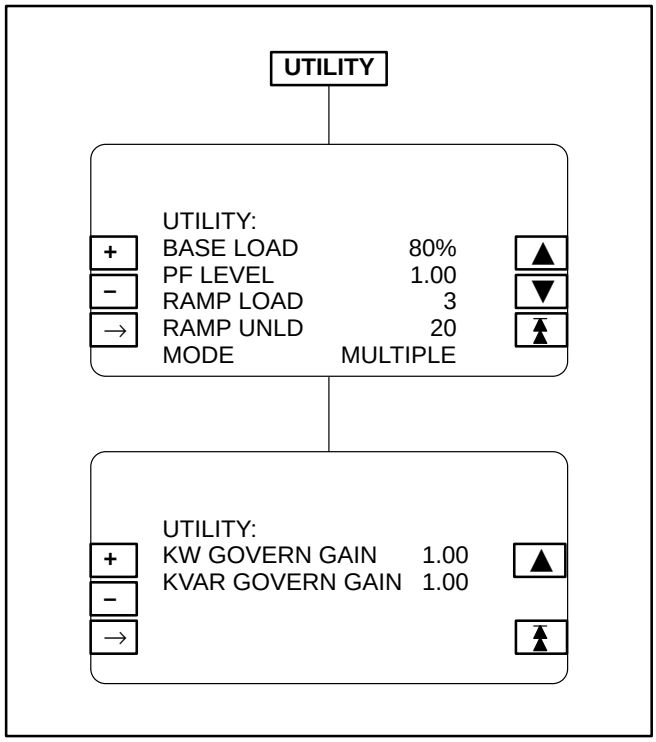

FIGURE 3-7. UTILITY SUBMENUS

ADJUST SUBMENU

Figure 3-8 shows the main menus (Menu A and Menu B) of the system control and the Adjust submenu.

To display the Adjust submenu, press the **MORE>>** button in Menu A and then the **ADJUST** button in Menu B.

The Adjust procedure is intended for qualified service personnel and site personnel only. The **USER** password must be entered to modify the Adjust submenu fields. Refer to *Modifying Setup/Adjust Submenus* in this section to enter password and to save menu changes.

If the generator set is operating in parallel with a system bus, the voltage and frequency adjustments are disabled to prevent inadvertent misadjustment of the paralleling load sharing functions.

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Exit menu to safe changes.

VOLTAGE: Used to adjust the output voltage ±5%.

FREQUENCY: Used to adjust the frequency ±3 Hz.

START DELAY: This delay applies only to remote starting in the Auto mode (0/Manual/Auto switch in Auto). The Start Delay adjustment range is 0 to 300 seconds.

STOP DELAY: This delay applies only to remote stopping in the Auto mode (0/Manual/Auto switch in Auto). The Stop Delay adjustment range is 0 to 600 seconds.

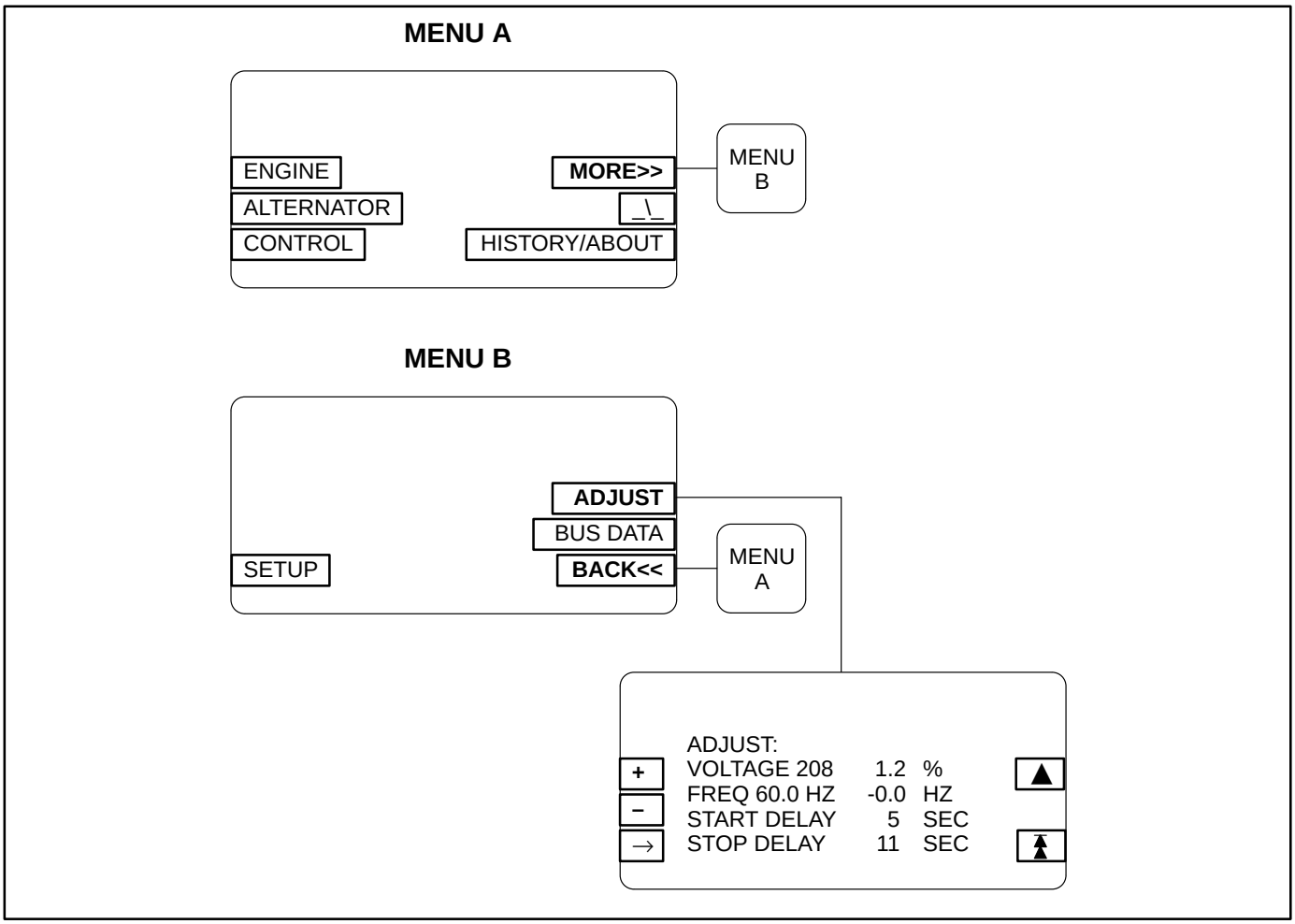

FIGURE 3-8. ADJUST SUBMENU

CALIBRATION PROCEDURE

There are several circuit cards/modules that, when removed and replaced, require you to recalibrate the control panel display for genset voltage and current and bus voltage.

Note that the type of calibration to perform varies for each card. The letters A, B and C are used to designate which of the following three calibration procedures are required for each card/module.

- Genset board (**A, B** & **C**) No adjustments required for Genset board if controller contains the Parallel board.
- Parallel board (**A, B** & **C**)
- PT/CT board (**A** & **B**)
- Bus PT (**C**)
- CT's (**B**)

⚠WARNING ***Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Calibration and adjustment must be performed by technically qualified personnel only. Read and observe all WARNINGS and CAUTIONS in your generator set manuals.***

⚠ CAUTION ***Improper calibration or adjustment of the PowerCommand control can cause equipment malfunction or damage. Calibration and adjustment must be performed by technically qualified personnel only.***

Use a calibrated RMS multimeter for accurate measurements. Fluke models 87 or 8060A are good choices.

(A) Genset Voltage Display Calibration

The PowerCommand control automatically synchronizes to the system bus when bus voltage is available and the genset is running. Consequently, it is not possible to calibrate the genset output voltage display of the genset that is running when the bus is energized. If it is necessary to adjust the output voltage display of the genset that is running, the InPower service tool must be used to switch off the synchronizer function of the control.

1. Display the *Voltage Calibration* submenu (Page 3-7).
2. With the genset OFF, attach a calibrated voltmeter to the AC output from L1 to L2. (L1 to Neutral for single phase alternators.)
3. Start the genset and allow it to reach normal operating speed.
4. Calibrate voltage reading for *L1* so that the reading on the display agrees with the calibrated voltmeter.
5. Shut the generator set OFF.
6. Repeat steps 2 through 5 for L2 and L3. (In step 2 attach meter to the AC output from L2 to L3 to calibrate *L2* and L3 to L1 to calibrate *L3*.)
7. Exit menu to safe changes.

(B) Genset Ammeter Display Calibration

1. Display the Current Calibration submenu (Page 3-7).
2. With the genset OFF, attach a calibrated ammeter to L1.
3. Start the genset and allow it to reach normal operating speed.
4. Load the genset to maximum rated kVA at rated voltage.
5. Calibrate the reading for *L1* current so that the reading on the display agrees with calibrated ammeter.
6. Repeat steps 2 through 5 for *L2* and *L3*. (In step 2, attach meter to L2 to calibrate *L2* current and L3 to calibrate *L3* current.)
7. Exit menu to safe changes.

(C) Bus Voltage Calibration

The PowerCommand control automatically synchronizes to the system bus when bus voltage is available and the genset is running. Consequently, it is not possible to calibrate the genset bus voltage display of the genset that is running when the bus is energized. If it is necessary to adjust the bus voltage display of the genset that is running, the InPower service tool must be used to switch off the synchronizer function of the control.

1. Display the Bus Voltage Calibration submenu (Page 3-7).
2. With all gensets OFF, attach a calibrated voltmeter to TB1-A (L1) and TB1-B (L2) of the bus PT module (Figure 3-9).
3. Start another genset and allow it to reach normal operating speed and voltage. Connect operating genset to the bus.
4. Calibrate the voltage reading for Bus Volts *L1* so that the reading on the display matches the reading on the calibrated meter.
5. Shut the generator set OFF.
6. Repeat steps 2 through 5 for Bus Volts L2 and L3. (In step 2 attach meter to the AC output from L2 to L3 to calibrate *L2;* L3 to L1 to calibrate *L3*.)
7. Exit menu to safe changes.

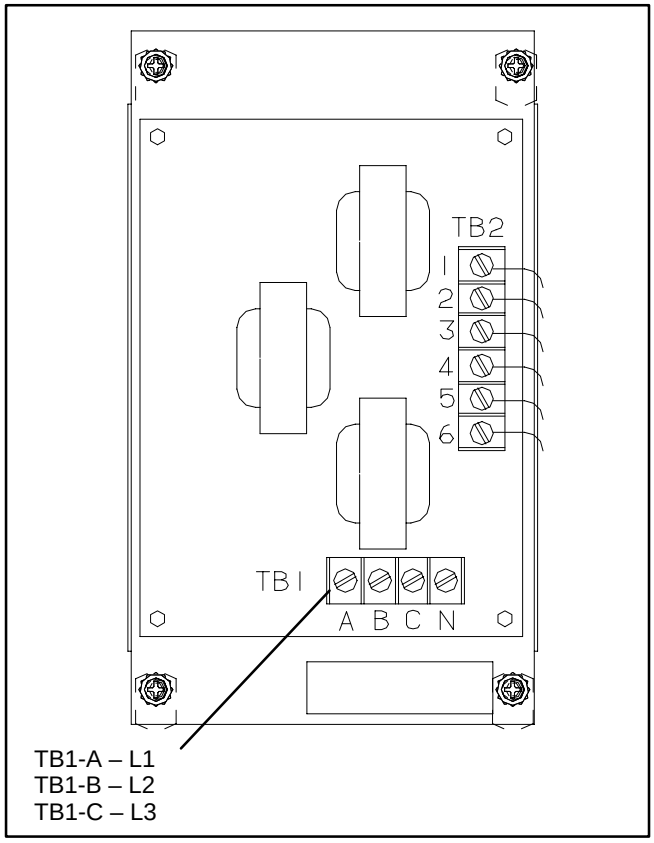

FIGURE 3-9. BUS PT MODULE

ELECTRONICS BOX CONTROL WIRING

The generator set electronics box, which is located on the engine side of the control housing, contains connection points for remote control and monitor options. These connection points are located in two different locations within the electronics box as shown in Figure 3-10.

Customer monitor/control connections are attached to terminal blocks TB3, TB4 TB5 and TB8. Optional equipment such as sensing devices used to monitor genset operation, remote start/stop switches, control box heater, battery charger and etc. are attached to these terminal blocks. Refer to Customer Connections diagram in Section 5.

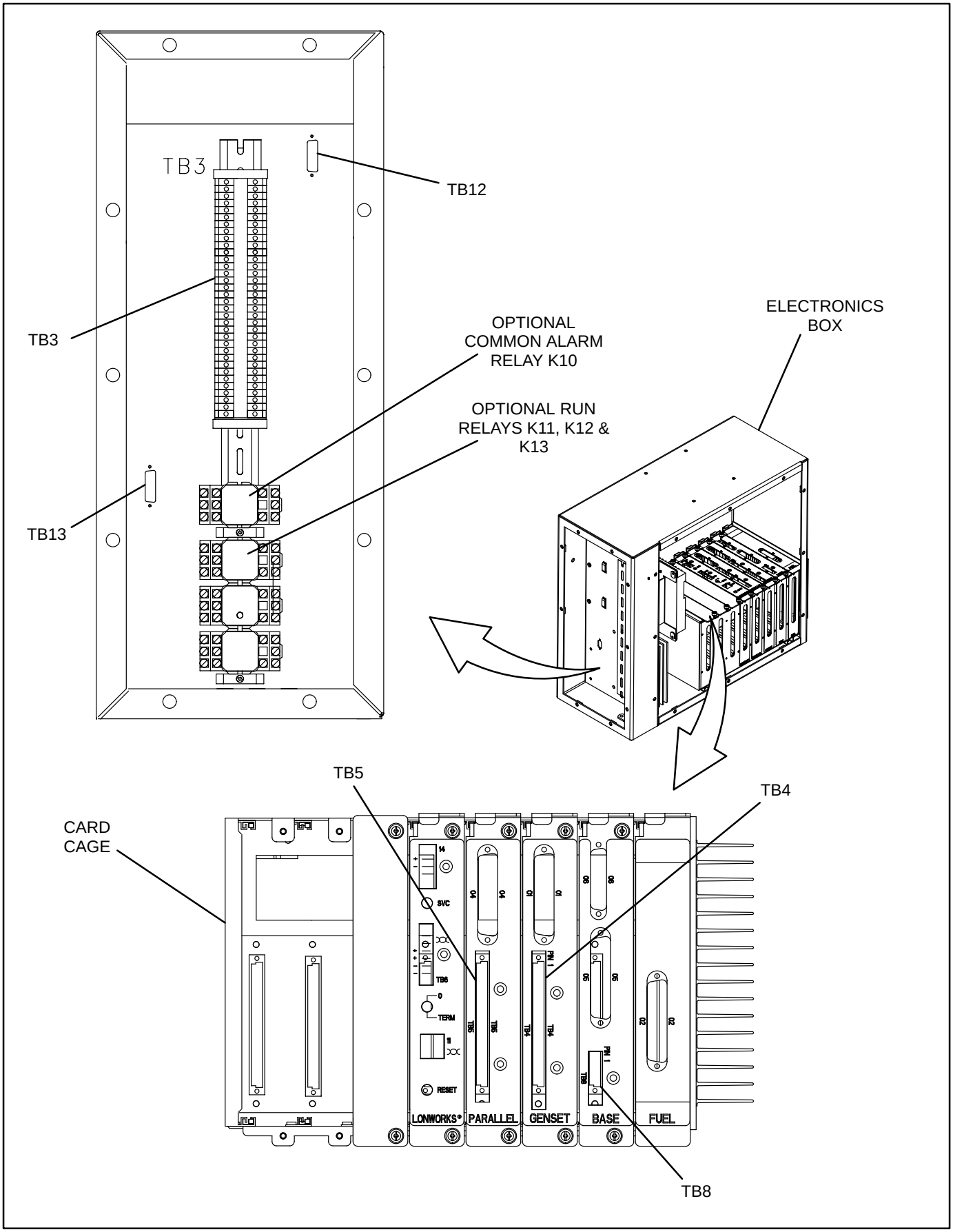

FIGURE 3-10. ELECTRONICS BOX

TB3, TB4, TB5, and TB8 Customer Connections

Refer to pages 5-6 and 5-7 for typical connections to TB3, TB4, TB5, and TB8.

Run Relays (K11, K12, 13)

The optional run relays are rail mounted inside the electronics box (Figure 3-10). The rail mount allows you to easily remove and replace the snap-on relays. The generator set can be equipped with one, two or three run relays.

The three-pole, double-throw run relays (Figure 3-11) are used to control auxiliary equipment such as fans, pumps and motorized air dampers. The run relays are energized when the generator set reaches operating speed.

The contacts are rated:

- 10 amps at 28 VDC or 120 VAC, 80%PF
- 6 amps at 240 VAC, 80%PF
- 3 amps at 480/600 VAC, 80%PF

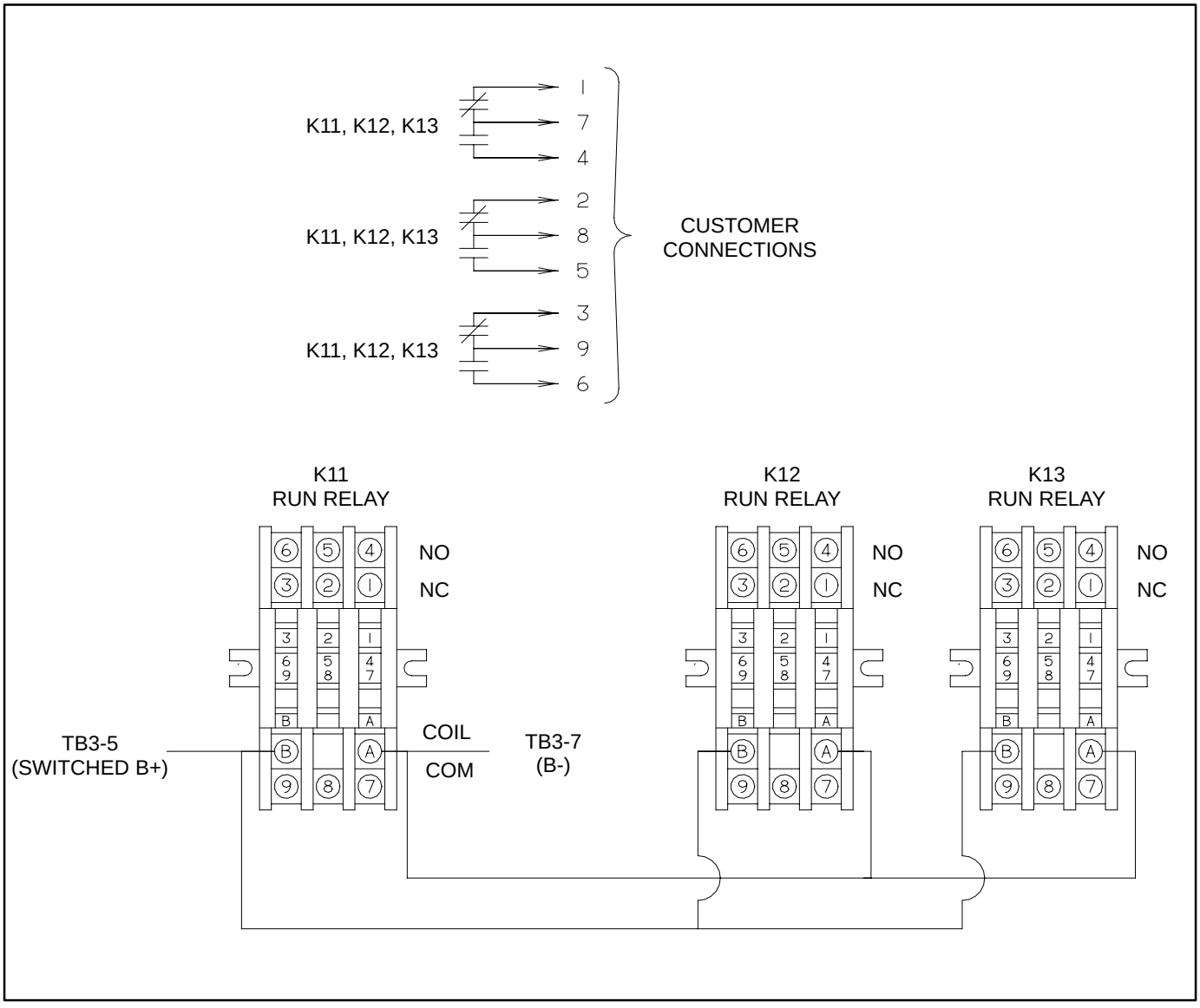

FIGURE 3-11. OPTIONAL RUN RELAYS (K11, K12, K13)

Alarm Relay (K10)

The optional alarm relay is rail mounted inside the electronics box (Figure 3-10). The rail mount allows you to easily remove and replace the snap-on relay.

The three-pole, double-throw alarm relay (Figure 3-12) is often used to energize warning devices such as audible alarms. Any generator set warning or shutdown will energize the alarm relay.

The contacts are rated:

- 10 amps at 28 VDC or 120 VAC, 80%PF
- 6 amps at 240 VAC, 80%PF
- 3 amps at 480/600 VAC, 80%PF

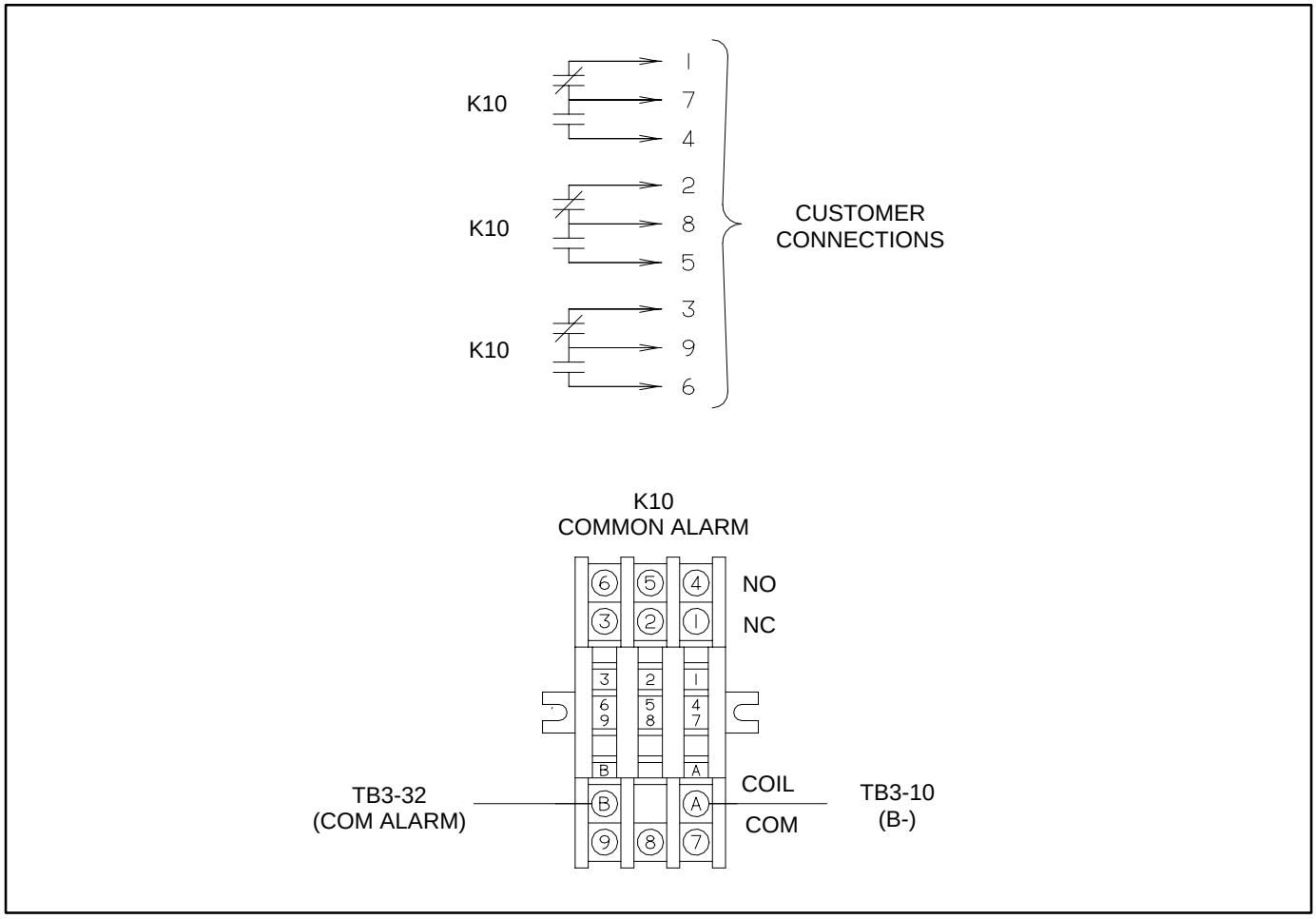

FIGURE 3-12. OPTIONAL ALARM RELAY (K10)

MAGNETIC SPEED PICKUP UNIT (MPU) INSTALLATION

To install the MPU sensor, bar the engine until a gear tooth on the flywheel lines up in the center of the mounting hole. Thread the sensor in gently by hand until it just touches the gear tooth. Back it out one quarter turn and set the locknut.

⚠ CAUTION ***Do not use fan blade to bar over engine. That can damage blades and cause property damage and personal injury.***

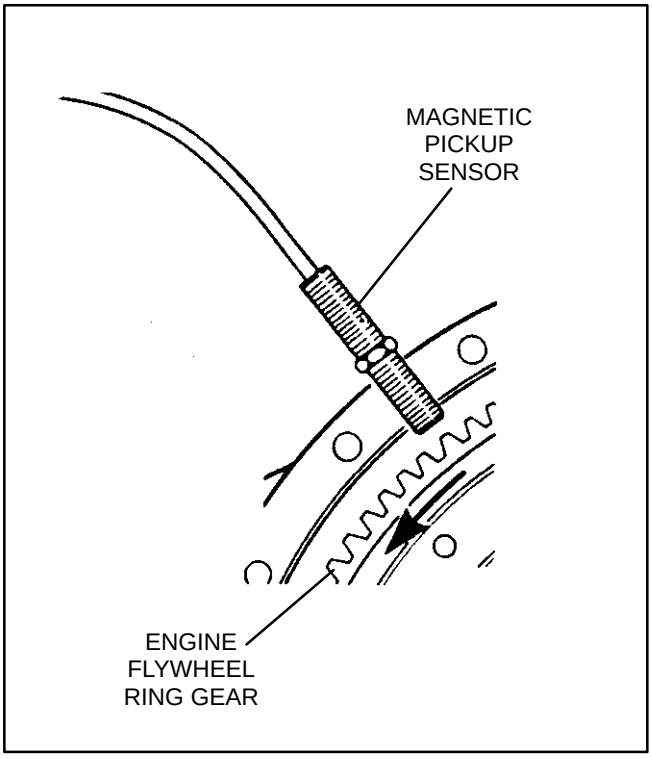

FIGURE 3-13. MPU SENSOR

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4. Servicing the Generator

TESTING THE GENERATOR

These tests can be performed without removing the generator. Before starting tests, disconnect the starting battery cables (negative [–] first) to make sure the engine will not start while performing these tests.

⚠ CAUTION ***Always disconnect battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.***

⚠ WARNING ***Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).***

Make certain battery area has been well-ventilated before servicing battery. Arcing can ignite explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur when cable is removed or re-attached, or when negative (–) battery cable is connected and a tool used to connect or disconnect positive (+) battery cable touches frame or other grounded metal part of the set. Always remove negative (–) cable first, and reconnect it last. Make certain hydrogen from the battery, engine fuel, and other explosive fumes are fully dissipated. This is especially important if battery has been connected to a battery charger.

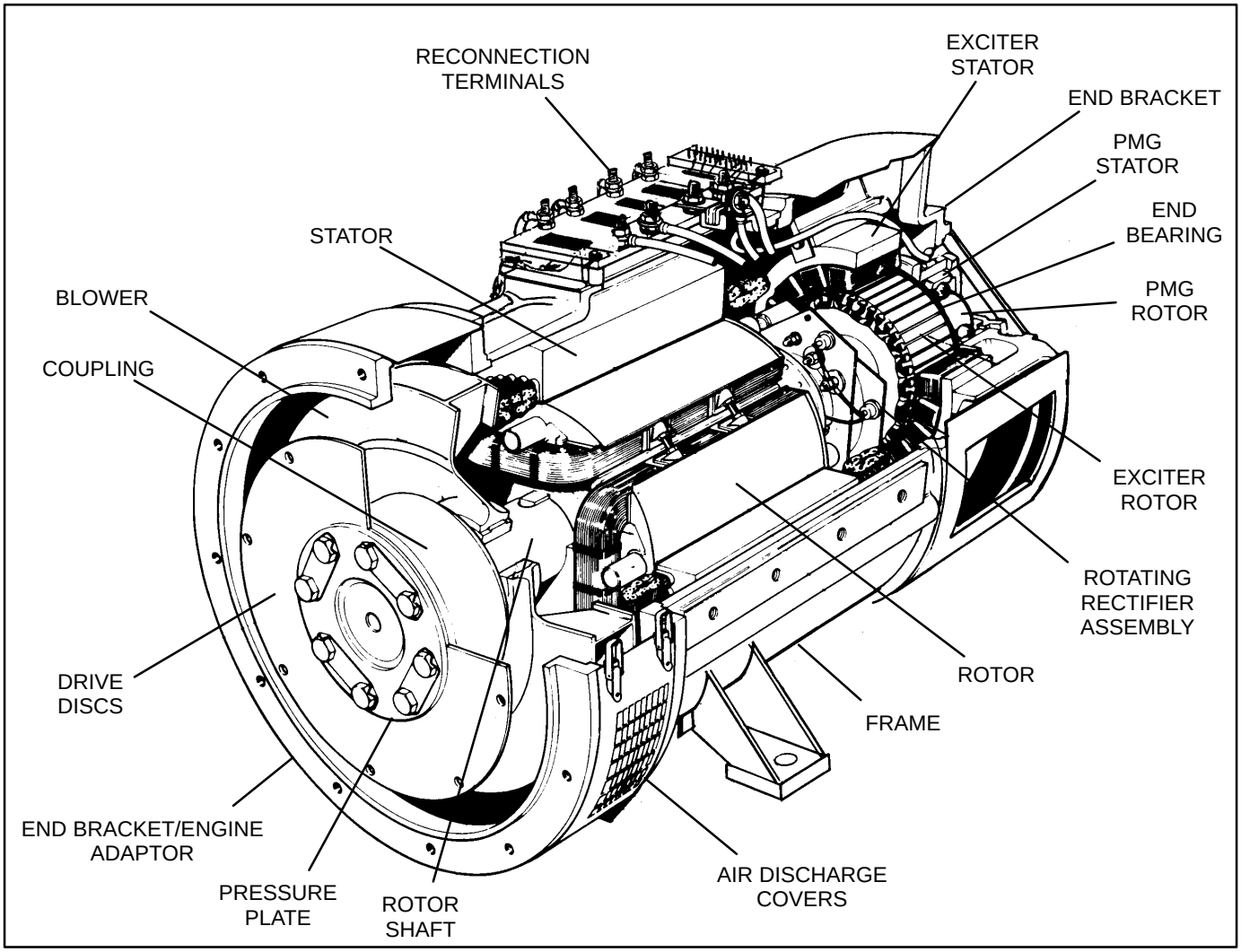

FIGURE 4-1. GENERATOR

INSULATION RESISTANCE (MEGGER) & POLARIZATION INDEX (PI) TESTING

Megger and PI testing **must** be performed on all medium voltage (601 through 15,000 volts) generator sets before initial start-up. PI testing for low voltage (less than 600 volts) generator sets is recommended by Onan.

These tests are used to verify that the windings are dry before the generator set is operated and develops a base line for future test comparison.

Before these tests can be performed on medium voltage generator sets, you must first perform the generator grounding procedure.

Generator Set Grounding Procedure

Prior to performing service or inspection procedures that may expose personnel to conductors normally energized with voltages greater than 600 volts, the following generator set grounding procedure must be followed.

⚠ DANGER ***Do not perform these procedures unless fully trained in medium voltage grounding procedures and have necessary safety equipment. Severe injury or death due to high voltage electrical shock may result.***

1. Open, lock-out and tag-out all sources of power to the immediate work area.
2. Disable the starting system of the generator set:
   a. Move the 0/Manual/Auto switch to the 0 (Off) position and wait for the controller to power down (approximately 10 minutes).
   b. Disconnect the battery charger from its AC source.
   c. Remove the negative battery cable from the battery.
   d. Install a lockout device on the battery cable end. (For engines equipped with an air-powered starting system, close air valve and install valve locking device.)
3. Put on high voltage gloves with leather protectors.
4. Using two pre-tested voltage detection devices (of the proper rating), verify de-energized condition in the work area. (Retest voltage detection devices immediately after verification of de-energized condition.)
5, Remove the metal cover from the generator output box to gain access to generator load terminals.
6. Securely install the Grounding Cluster ground clamp to a verified “grounded” conductor.

   ⚠WARNING ***Hazardous voltage. Can cause severe personal injury or death. After DC voltage from the test equipment has been applied to the windings and ground, there will be a definite static charge on the windings. Reconnect Grounding Cluster to remove static charge from the winding after each generator test.***

7. With the Grounding Cluster in place, you are protected from static and/or induced charges that may have been present in the generator stator.

   Leave grounds connected for at least one minute so static charge can dissipate. Remove ground cluster and perform PI and/or any other tests required on the stator winding. Reconnect grounds if additional generator service is necessary.
8. When work on the generator set is complete, remove the Grounding Cluster in the reverse order of installation.
9. After getting clearance from all personnel involved in the lock-out/tag-out procedure, remove all lock-out devices in reverse order of installation.

Megger and PI Test

⚠ DANGER ***Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator or cables. Service personnel must be well-trained/qualified to work with distribution voltages. (See Generator Set Grounding Procedures, Page 4-2.)***

⚠WARNING ***The windings of medium-voltage (601 through 15,000 volts) generator sets must be dry before the generator is operated. Failure to make sure windings are dry before start-up may result in catastrophic equipment failure, severe personal injury or death.***

Megger Test: The megger test consists of applying voltage for up to one minute (Figure 4-2, 4-4, 4-5 and 4-6. The highest resistance values shown in Table 4-1 should be obtained for a new generator with dry windings. For a set that has been in service, the resistance reading should not be less than the lower value shown.

PI Test: The PI test consists of applying a voltage between the winding and ground for ten mInutes and recording resistance values at one minute and at ten minutes. The PI is the ratio of a ten minute reading in megohms divided by a one minute reading in megohms. A ratio of two or greater is considered good for new and in service sets.

1. Perform the *Generator Set Grounding Procedure*.
2. Remove the housing cover of the electronics box and remove connector **10** from the regulator output module. See Figure 3-10.
3. Disconnect the AC control input leads from the generator output terminals. The AC control leads are marked 5, 6, 7 and 8. Refer to the appropriate *Reconnection Diagram* in *Section 6*.
4. If the RTD (resistive thermal device) option is installed, ground all six RTD temperature leads. Each RTD has three leads, one red and two white leads. Total of 18 leads must be grounded.
5. Perform the *Winding Resistance Test* procedure for the desired windings as noted in this section.
6. Perform the *Insulation Resistance Test* and *PI Test* procedures for the desired windings as noted in this section.

If low readings are obtained, the cause should be investigated and corrected before the generator set is returned to service.

If moisture is determined to be the cause of low test readings, a winding drying process will be required.

TABLE 4-1. GENERATOR WINDING RESISTANCE

GENERATOR VOLTAGE	MEGGER VDC SETTING	MINIMUM RESISTANCE (MEGOHMS)		
		MAIN STATOR	MAIN ROTOR	EXCITOR STATOR/ ROTOR
600 VAC or less	500	5.0 – 1.0	5.0 – 1.0	5.0 – 1.0
601 thru 5000 VAC	2500	400 – 50		
	1000		5.0 – 1.0	5.0 – 1.0
5001 thru 15000 VAC	5000	1000 – 200		
	1000		5.0 – 1.0	5.0 – 1.0

DRYING THE WINDINGS

If low readings are obtained and moisture is determined to be the problem, the windings should be dried out and the test repeated. Use the generator heaters or blow warm air through the generator with a fan.

A more effective way is to run the genset without excitation to use the generator fan to blow air over the windings or use a bolted 3-phase short across the generator terminals to heat the windings. This procedure must be done as described or equipment damage can result. To do this:

1. Remove the housing cover of the electronics box and remove connector **10** from the regulator output module. See Figure 3-10.
2. Disable generator excitation using the InPower service tool. In the *Test/Manual Operation* group, set the parameter *Excitation Disable Override* to *Excitation Off*. (Note that this parameter will return to *Excitation On* whenever the controller powers down.)

   Without disabling excitation, the controller will shutdown the genset and display Low AC Voltage.

Skip steps 3, 4 and 5 if using the generator fan to dry the windings.

3. Bolt the generator three phase output terminals together.
4. Connect the positive and negative leads of a variable 12 VDC source to connector **10** as follows:

   Positive lead – Red wire of connector **10-6** (X)

   Negative lead – Brown wire of connector **10-3** (XX)

   ⚠ CAUTION ***Voltage must begin at zero volts and be gradually increased or equipment damage will result. The current will increase rapidly and it must be monitored to prevent exceeding the generator rating.***
5. Attach a clamp-on ammeter to the generator leads to measure generator current, adjust the 12 VDC source for zero voltage, start the set and very slowly increase the excitation voltage. Obtain the highest current possible without exceeding generator rating.
6. Run the genset for approximately one hour, then repeat the insulation resistance tests. If further drying time is indicated, continue the drying process.

GENERATOR/PCC CONTROL ISOLATION PROCEDURE

The following procedure is used to determine if the generator or the PCC control circuitry is causing a high AC voltage shutdown fault.

1. Throw the line circuit breaker **OFF** and shut down the set.

⚠ CAUTION ***This test involves unregulated excitation of the generator. To prevent damage to the generator due to overcurrent, make sure that all loads have been disconnected and that all faults have been cleared from the power output terminals of the generator.***

2. Remove the housing cover of the electronics box and remove connector 10 from the regulator output module. See Figure 3-10.
3. Prepare to measure output voltage across the generator terminals while the set is running.
4. Bring two jumpers from a 12 volt battery for connection to the **X** (Field +) and **XX** (Field –) pins of plug P10.

   X = Red wire of connector **10-6**
   XX = Brown wire of connector **10-3**

   Connect the jumper from the positive (+) post of the battery to the **X** pin (red wire) of connector **10-6**. Be prepared to connect the jumper from the negative (–) post of the battery to the **XX** pin (brown wire) of connector **10-3**. If one of the 12 volt cranking batteries is used, bring the jumpers from the battery connected on the grounded side of the system to avoid inadvertently imposing 24 volts on the system.
5. Check polarity again. Polarity must be correct or this test will be inconclusive because the induced and residual magnetic polarities in the exciter stator will be opposed.

⚠ WARNING ***HIGH VOLTAGE. Touching uninsulated high voltage parts inside the control box can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.***

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and wear elbow length insulating gloves intended for hazardous voltages.

6. Start the set and connect the jumper from the battery negative (–) terminal to the **XX** lead.
7. The generator circuitry is probably okay if rated output voltage or higher is obtained and the voltages for all phases are balanced when the exciter is powered by a 12 volt battery. Refer to *Troubleshooting and Repair PCC Manual* to troubleshoot the PCC control circuitry. (Normal excitation voltage ranges from approximately 10 VDC at no-load to approximately 40 VDC at full–load.)
8. If the voltages are unbalanced, troubleshoot the main stator first. If the voltages are uniformly low, troubleshoot the exciter and field circuits first.

EXCITER STATOR

Testing Winding Resistance: Measure winding resistance with a Wheatstone bridge or digital ohmmeter. Replace the stator if winding resistance is not as specified in Tables 4-2/4-3.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Testing Winding Insulation Resistance: Disconnect exciter stator leads **F1** and **F2** from their connectors in the AC generator wiring harness and isolate them from ground.

Connect the megger between one of the leads and ground and conduct the test. Refer to Table 4-1 for megger voltage selection and required resistance values.

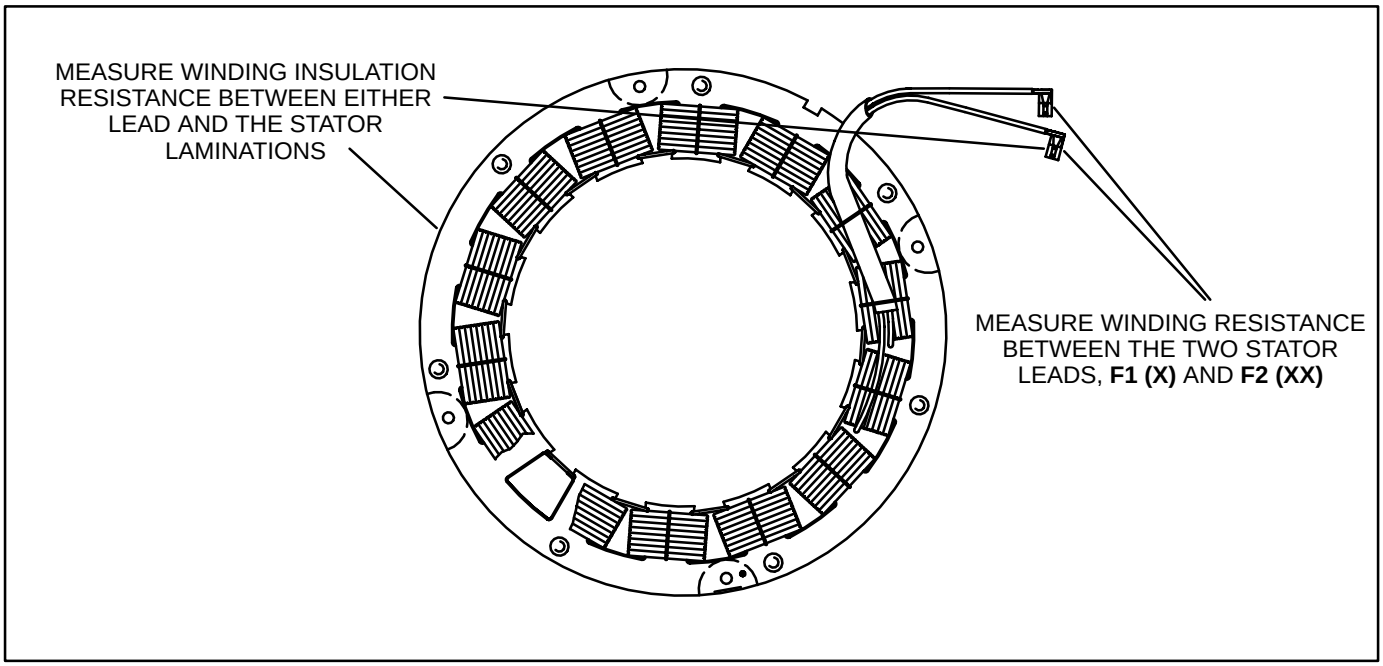

FIGURE 4-2. TESTING THE EXCITER STATOR

EXCITER RECTIFIER BRIDGE (ROTATING RECTIFIER ASSEMBLY)

The exciter rectifier bridge is mounted on the exciter rotor, inboard, facing the main rotor. It consists of a positive plate and a negative plate, split diametrically. Each carries three diodes, three terminal posts for connecting exciter rotor leads to the diode pigtails and a terminal for the main rotor (generator field) lead. A surge suppresser is connected across the two plates to prevent transient voltages that could damage the diodes.

Testing Diodes: Disconnect the diode pigtails from the terminal posts. Using an ohmmeter, measure electrical resistance between each diode pigtail and the plate on which the diode is mounted. Reverse the meter test probes and repeat the tests. The electrical resistance across each diode should be high in one direction and low in the other. If the resistance is high or low in both directions, replace the diode.

Replacing Diodes: Make sure the replacement diode is of the correct polarity. Disconnect the pigtail from the terminal post and unscrew the old diode. Apply heat-sink compound under the head of the diode. Make sure the compound does not get on the threads. Torque the diodes to 36 to 42 in-lbs (4 to 4.8 N•m) and the pigtail terminals to 24 in-lbs (2.7 N•m) when reassembling.

Surge Suppresser Testing and Replacement: Remove the suppresser. Replace the suppresser if it appears to have overheated or if ohmmeter readings indicate less than infinite resistance (end of scale) in both directions. Torque the terminals to 24 in-lbs (2.6 N•m) when reassembling.

⚠ CAUTION ***Layers of dust can cause diodes to overheat and fail. Brush dust off regularly.***

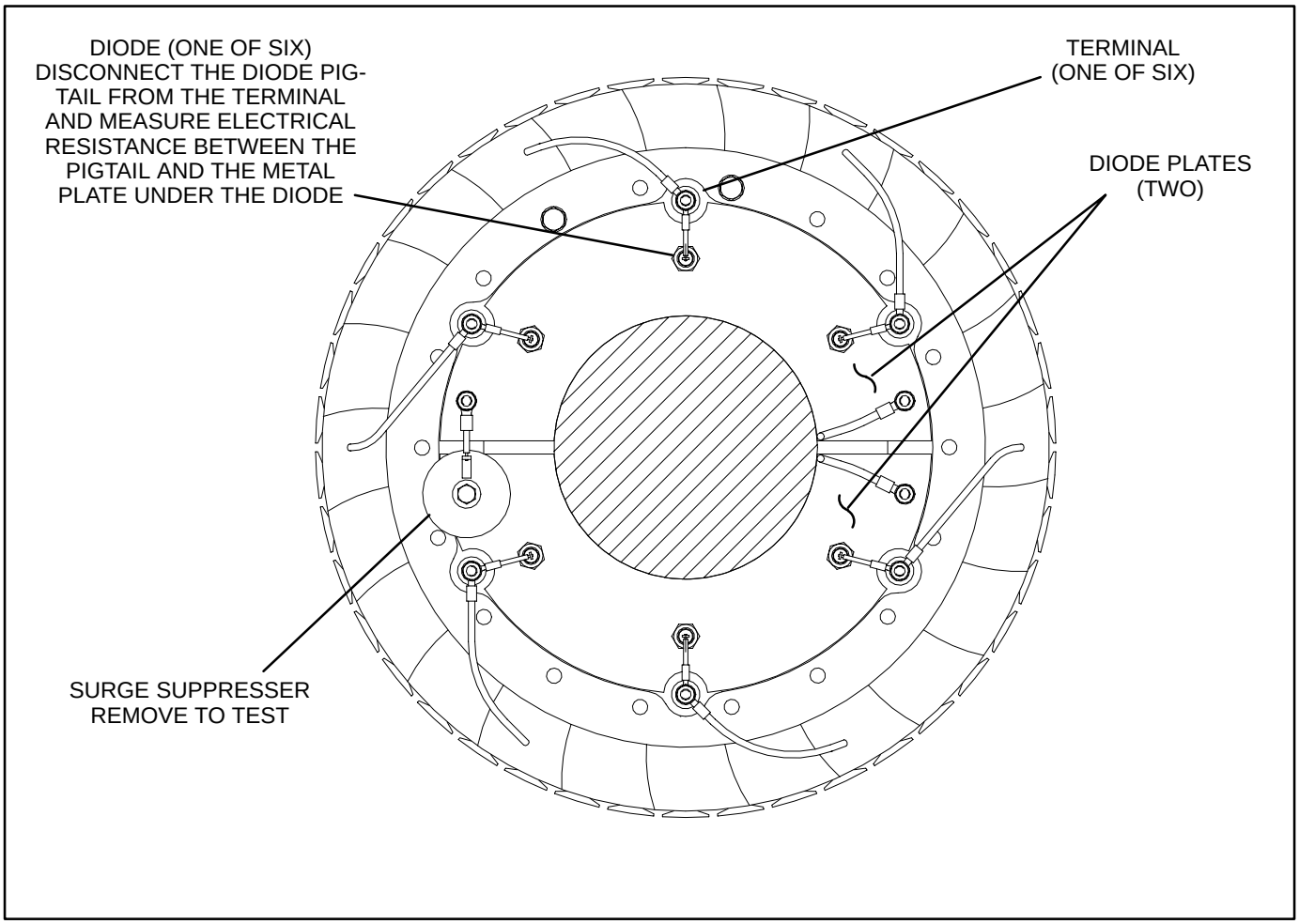

FIGURE 4-3. TESTING THE ROTATING RECTIFIER ASSEMBLY

EXCITER ROTOR

Testing Winding Resistance: Disconnect the six rotor winding leads from the terminal posts on the rectifier assembly. With a Wheatstone bridge, measure electrical resistance across each pair of rotor windings: **U** (CR1 or CR4) and **V** (CR2 or CR5), **V** (CR2 or CR5) and **W** (CR3 or CR6), **W** (CR3 or CR6) and **U** (CR1 or CR4). See the winding schematic. Replace the whole rotor shaft assembly if the resistance of any winding is not as specified in Tables 4-2/4-3.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Testing Winding Insulation Resistance: Disconnect all six exciter rotor leads from diode terminals CR1 through CR6 and isloate them from ground.

Connect the megger between one of the leads and ground and conduct the test. Refer to Table 4-1 for megger voltage selection and required resistance values.

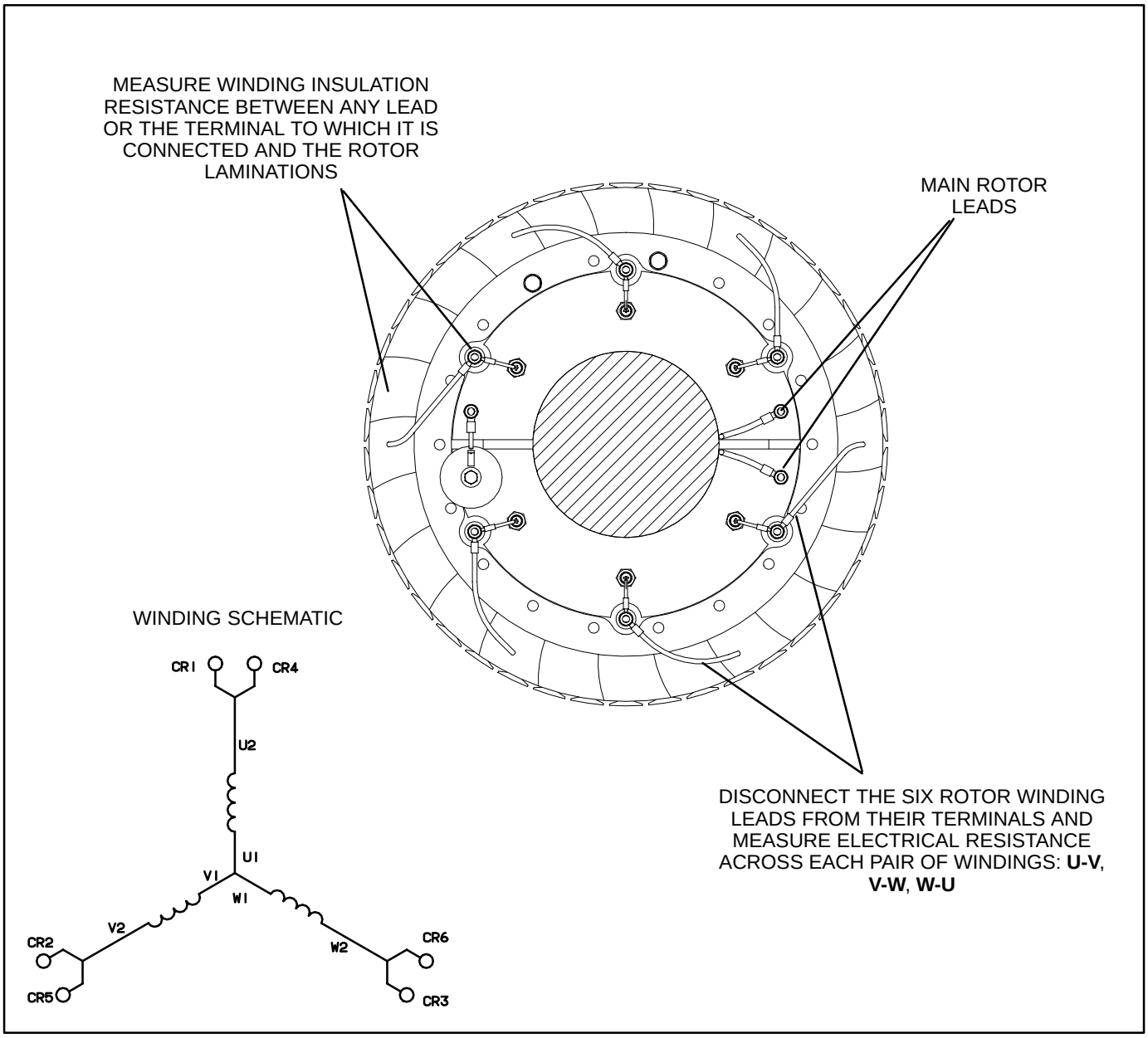

FIGURE 4-4. TESTING THE EXCITER ROTOR

MAIN ROTOR (GENERATOR FIELD)

Testing Winding Resistance: Disconnect the two leads of the main rotor from the terminals on the rotating rectifier assembly. See Figure 4-5. Measure electrical resistance between the two leads with a Wheatstone bridge or digital ohmmeter. Replace the rotor if the resistance is not as specified in Tables 4-2/4-3. Connect the rotor leads and torque the terminals to 24 in-lbs (2.6 N•m) when reassembling.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Insulation Resistance and PI Test: Disconnect the main rotor and voltage suppressor leads from terminals **F1+** and **F2–** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2–**).

Connect the megger between one of the rotor leads and ground and conduct the test. Refer to Table 4-1 for megger voltage selection and required resistance values.

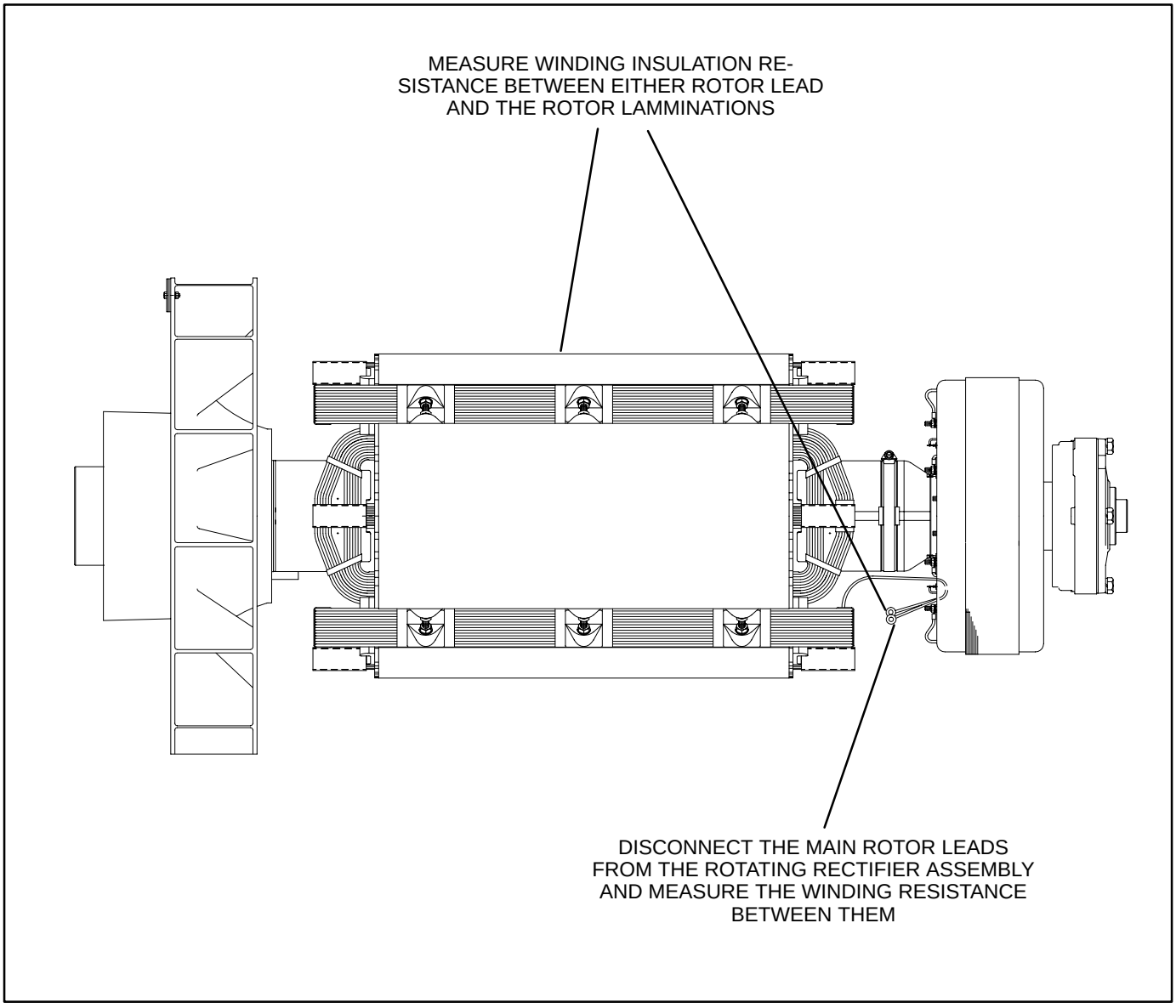

FIGURE 4-5. TESTING THE MAIN ROTOR

MAIN STATOR

Testing Main Stator Winding Resistance: Disconnect all stator leads from the terminals to which they are connected. Using a Wheatstone bridge having at least 0.001 ohm precision, measure electrical resistance across each pair of stator leads: **U1-U2, V1-V2, W1-W2, U5-U6, V5-V6** and **W5-W6**. Replace the stator if the resistance of any winding is not as specified in Tables 4-2/4-3.

Before performing the following insulation resistance test, refer to the *Insulation Resistance and Polarization Index Test* procedure at the beginning of this section.

Insulation Resistance and PI Test: Remove and separate all leads of the generator from the generator load terminal block. Number of neutral leads (three or six) to remove will vary between low and medium voltage generators.

Connect the megger between one phase of the stator and ground while grounding the other two phases and conduct the test. Refer to Table 4-1 for megger voltage selection and required resistance values.

Repeat this step in turn for the other two phases.

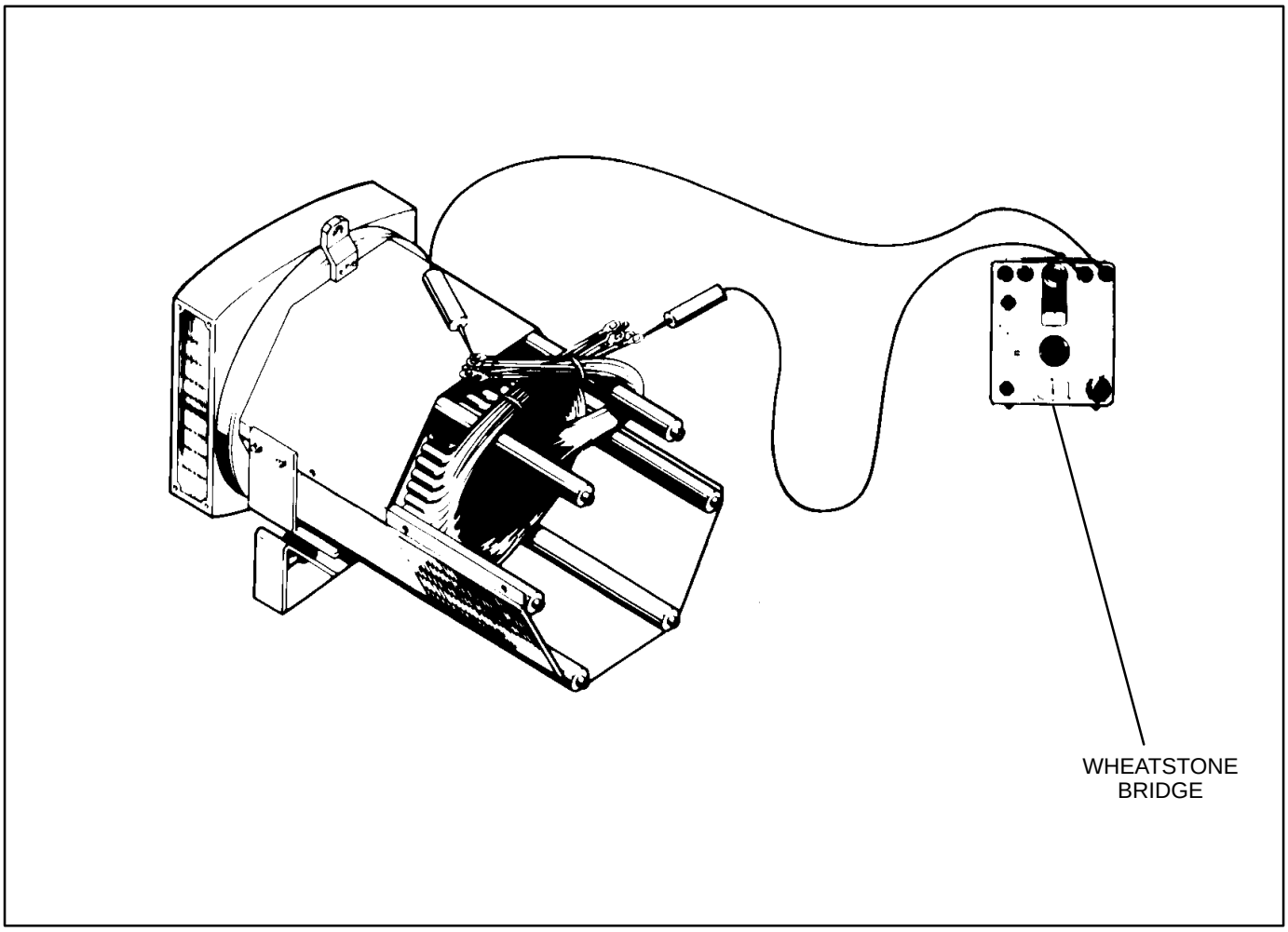

FIGURE 4-6. TESTING THE GENERATOR STATOR

TABLE 4-2. WINDING RESISTANCE VALUES (FRAME 7)*

FRAME SIZE	MAIN STATOR		MAIN ROTOR	EXCITER STATOR	EXCITER ROTOR
	WINDING 12	WINDING 07			
7G	0.0044	0.006	1.64	17	0.096
7H	0.0036	0.0044	1.75	17	0.096

TABLE 4-3. WINDING RESISTANCE VALUES (FRAME 8)*

FRAME SIZE	VOLTS L-L	HZ	MAIN STATOR	MAIN ROTOR	EXCITER STATOR	EXCITER ROTOR
LV814C	380-415	50	0.000483	1.33	15	0.096
	440-480	60	0.000483			
	600	60	0.000700			
LV814D	380-415	50	0.000368	1.426	15	0.096
	440-480	60	0.000368			
	600	60	0.000500			
MV814C	3.3K	50	0.0544	1.164	15	0.084
	4.16K	60	0.0544			
	2.4K	60	0.0200			
MV814D	3.3K	50	0.0429	1.229	15	0.084
	4.16K	60	0.0429			
	2.4K	60	0.0140			
HV814C	6.6K	50	0.340	1.21	15	0.084
	11K	50	0.945			
	7.2K	60	0.340			
	13.8K	60	0.945			
HV814D	6.6K	50	0.280	1.28	15	0.084
	11K	50	0.780			
	7.2K	60	0.280			
	13.8K	60	0.780			
HV814E	6.6K	50	0.220	1.38	15	0.084
	11K	50	0.615			
	7.2K	60	0.220			
	13.8K	60	0.615			

***** Resistance figures are approximates, at 68° F (20° C) ± 10%.

TESTING THE PMG

⚠ DANGER ***HIGH VOLTAGE. Touching uninsulated high voltage parts inside the control and power output boxes will result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching high voltage parts.***

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry and wear elbow length insulating gloves intended for hazardous voltages.

1. Disconnect connector **10** from the regulator output module.
2. Start the engine at the set and let the speed stabilize.
3. Measure voltage across lead pairs **10-1** & **10-4, 10-4** & **10-5**, and **10-5** & **10-1**. Voltage should be at least 150 VAC for 50 Hz sets and at least 180 VAC for 60 Hz sets, and should be approximately the same for each set of leads. If the voltages are low or uneven, check all the leads and connections between the voltage regulator output stage module and the PMG and repair as necessary before disassembling the PMG.
4. Stop the set and measure electrical resistance across lead pairs **10-1** & **10-4, 10-4** & **10-5**, and **10-5** & **10-1** with a Wheatstone bridge or digital ohmmeter. Refer to *Generator Reassembly* in this section for frame size.

TABLE 4-3 PMG STATOR RESISTANCE

FRAME SIZE	PMG STATOR RESISTANCE
7	2.6
8	1.1

FRAME 7 BEARING INSPECTION/REMOVAL

The end bearing is enclosed in a pre-packed machined cartridge. A grease fitting is provided to allow re-greasing of the bearing with a grease gun (see *Operator's* manual for grease quantities, maintenance intervals, and procedure).

Bearing Inspection: If a situation occurs which allows an opportunity to visually inspect the end bearing with it installed, check the color of the grease. The color of the grease is the only indication that can be used to determine if the bearing is defective.

New grease is a whitish-beige color but some mild discoloration will occur with use. If the grease shows signs of gross discoloration, the bearing should be replaced.

Bearing Removal: The bearing is press fitted onto the shaft and can be removed with standard workshop tools (i.e., two or three legged manual or hydraulic bearing pullers). The bearing should only be removed for replacement (bearing is destroyed during removal and must be replaced).

The end bearing is enclosed in a pre-packed cartridge housing and must only be dismantled as necessary for relubrication, replacement, or when a major overhaul is carried out on the generator set.

Removal of the bearing can only be accomplished after removal of the endbracket, as follows:

1. Remove the endbracket (complete steps 1 through 21 of the *Main Stator and Rotor Removal (Frame 7)* procedure.
2. Remove the four screws holding bearing cap.
3. Remove cap.
4. Remove circlip.
5. Remove bearing cartridge housing complete with bearing.

Bearing Replacement: The instruction sheet provided with the bearing kit is required to complete the following procedure.

Frame 7 generator component parts cannot be ordered from Onan. Refer to the Newage nameplate and supply all available information. Contact your nearest Newage distributor for assistance in ordering component parts.

1. Lift slightly on end of rotor shaft and install wooden shims to hold rotor on center with stator.
2. Install bearing onto rotor shaft. Refer to bearing kit instruction sheet.
3. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.
4. Install endbracket to the stator frame using the proper screws and lock washers, but do not tighten securely as yet.
5. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.
6. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.
7. Securely tighten the endbracket fasteners.
8. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.
9. Install the PMG assembly. Refer to *Permanent Magnet (PMG) Installation (Frame 7)* procedure.

FRAME 7 GENERATOR DISASSEMBLY

The following procedures provide information for removal and reassembly of the generator PMG exciter, the control housing and stator/rotor assemblies. Be sure to read through this section first, before performing procedures listed, to determine the steps most appropriate for the service attention required.

⚠ DANGER ***Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/ qualified to work with distribution voltages.***

Permanent Magnet (PMG) Removal (Frame 7)

1. Disconnect the negative (-) battery cable to prevent accidental starting of the generator set while servicing.

   ⚠WARNING ***Arcing at battery terminals, arcing in light switch or other equipment, flame, pilot lights and sparks can ignite battery gas causing severe personal injury.***

   Ventilate battery area before working on or near battery—Wear safety glasses—Do not smoke—Switch trouble light ON or OFF away from battery—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

   ⚠ CAUTION ***Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.***

   ⚠WARNING ***Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (–) cable from the battery terminal.***

2. Remove the control housing lower and middle front panels (see Figure 4-7).

3. Remove the two front frame separators.

4. Remove the three M5X12mm capscrews and lockwashers from the PMG cover, and remove cover.

5. Disconnect the PMG wiring harness connector.

6. Remove the four bolts and clamps retaining the exciter stator housing to the endbracket.

7. Tap the stator housing out of its spigot, and carefully remove from generator endbracket.

   The highly magnetic rotor will attract the stator core; care must be taken to avoid any contact which may damage the windings.

8. Remove the hex head through-bolt from the rotor shaft and firmly pull the complete rotor assembly from its location. Keep the rotor clean by avoiding contact with metal dust or particles.

   Place in a plastic bag as soon as is practicable.

   ⚠ CAUTION ***The rotor assembly must not be dismantled, or the magnetic properties will be destroyed.***

Permanent Magnet (PMG) Installation (Frame 7)

1. Install the complete rotor assembly to the end of the main rotor shaft using the hex head through-bolt. Keep the rotor clean by avoiding contact with metal dust or particles.

2. Carefully locate the stator housing to position on the generator endbracket. (The leads must be located at the top and facing out, Figure 4-2.) Fasten in place using the 4 bolts and clamps, and tighten securely.

   The highly magnetic rotor will attract the stator core, care must be taken to avoid any contact which may damage the windings.

3. Connect the PMG wiring harness connector.

4. Install the PMG assembly cover using the three M5x12mm capscrews and lockwashers, and tighten securely.

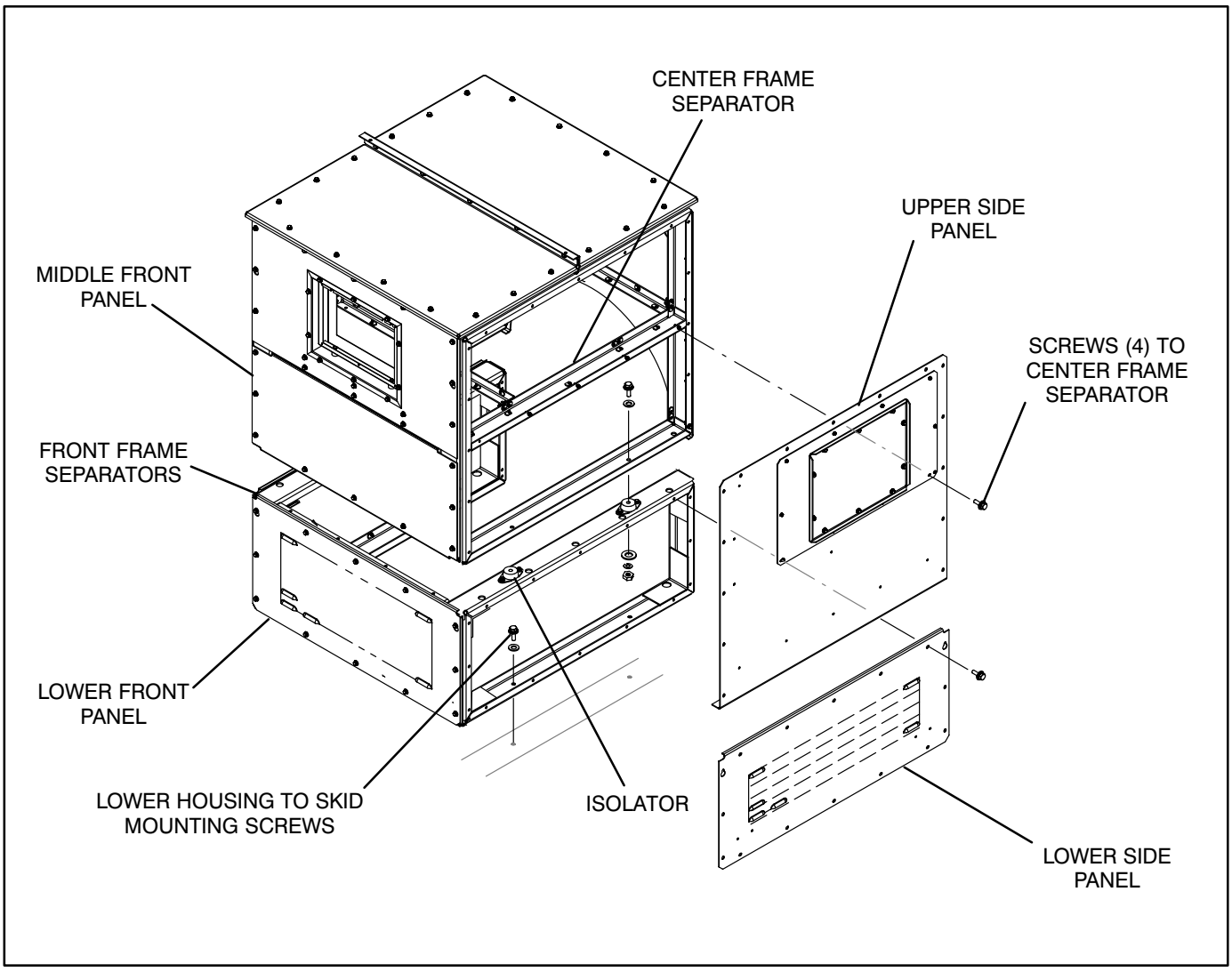

FIGURE 4-7. REMOVING FRAME 7 CONTROL HOUSING

Main Stator and Rotor Removal (Frame 7)

1. Remove the PMG, refer to *Permanent Magnet Exciter Removal,* earlier this section.

2. Remove the upper and lower side panels of the control housing. To remove the upper side panels, note that there are four screws (M6) that secure the panel to a center frame separator.

3. Remove the generator air discharge covers (see Figure 4-1).

   ⚠ CAUTION ***Do not use fan blade to bar over engine. That can damage blades and cause property damage and personal injury.***

4. Crank or bar the engine/generator to position the rotor such that a full pole face is at the bottom of the main stator core. Proper positioning can be viewed through the generator access openings. Refer to engine service manual for proper cranking or barring procedure.

5. Disconnect all load wires from the reconnection terminal block assembly. If equipped with the circuit breaker option, disconnect load wires from circuit breaker. Check that all leads are labeled to ease reassembly.

6. Disconnect the remote control wiring and conduit from the control housing. For reconnections later, make sure each wire is clearly marked to indicate the correct terminal.

7. Disconnect the three ground cables inside the control housing that attach to the following assemblies: front panel control box, electronics box and the control housing. Disconnect the cables from the generator saddle.

8. Disconnect the engine harness connectors (INLINE A, B, and C) and the DC power connector for the engine block heaters (INLINE F) and place harness on top of control housing.

9. Disconnect and remove PT/CT harness assembly (connectors 08 and 09) from inside electronics box.

10. Use a hoist or similar lifting device to support the control housing assembly (see Figure 4-8).

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

11. Remove the center screw of the four mounting isolators to separate the upper housing from the lower housing assembly. The upper and lower housing assemblies must be removed as two separate items to prevent damaging the mounting isolators.

12. Using the hoist, remove the upper control housing assembly from the generator.

13. Remove the fasteners that secure the lower housing assembly to the skid (four screws per side) and using the hoist, remove lower housing from generator.

14. Remove as necessary, air intake components to engine that may interfere with disassembly and reassembly of generator.

    To remove the stator and rotor at the same time, refer to *Generator Assembly Removal*, later this section. To remove the stator and rotor individually, continue with step 15.

15. Remove the four bolts retaining the bearing cartridge housing in the endbracket (outer four bolts).

16. Remove the eight bolts holding the endbracket to the generator housing.

17. Insert two bolts (M10) in the two holes provided for “jacking” purposes, on the endbracket center line. Screw bolts in until endbracket spigot is clear of locating recess.

18. Carefully tap the whole assembly off the bearing cartridge housing, ensuring the endbracket is supported to prevent the exciter stator from damaging the windings on the exciter rotor.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

19. Assemble lifting eyes to generator (see Figure 4-8). Rear of generator requires a bracket (not supplied) with three holes, to attach lifting eye to rear of generator. Secure this bracket to the top of the generator housing using two of the bolts removed in Step 16.

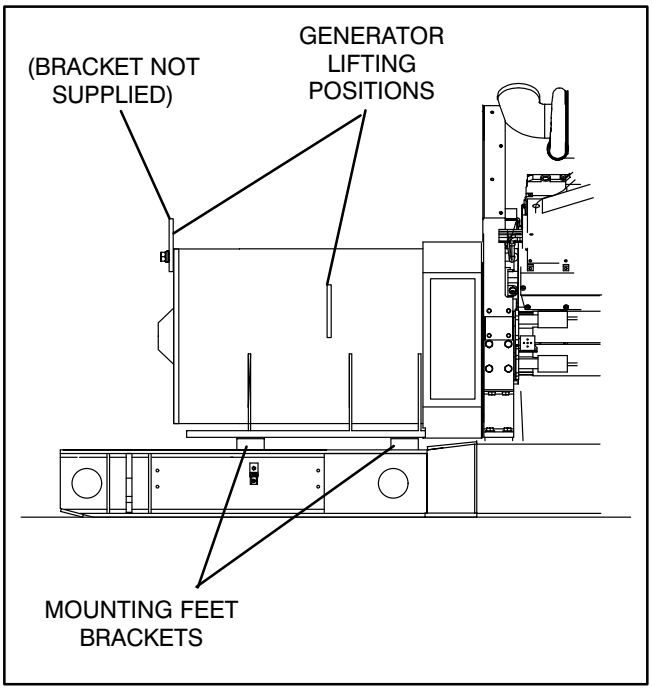

FIGURE 4-8. FRAME 7 LIFTING POSITIONS

20. The exciter stator is now accessible for inspection and removal from endbracket/engine adaptor.

21. The end bearing can now be removed if required. Refer to Bearing Removal (Frame 7).

22. Remove the fasteners from the four generator mounting feet brackets.

23. Using an adequate lifting device, lift the generator (at lifting eyes, and main stator housing) until the mounting feet brackets are clear of the frame member (see Figure 4-8).

24. Disconnect the grounding strap from the flywheel housing.

25. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly. See Figure 4-9.

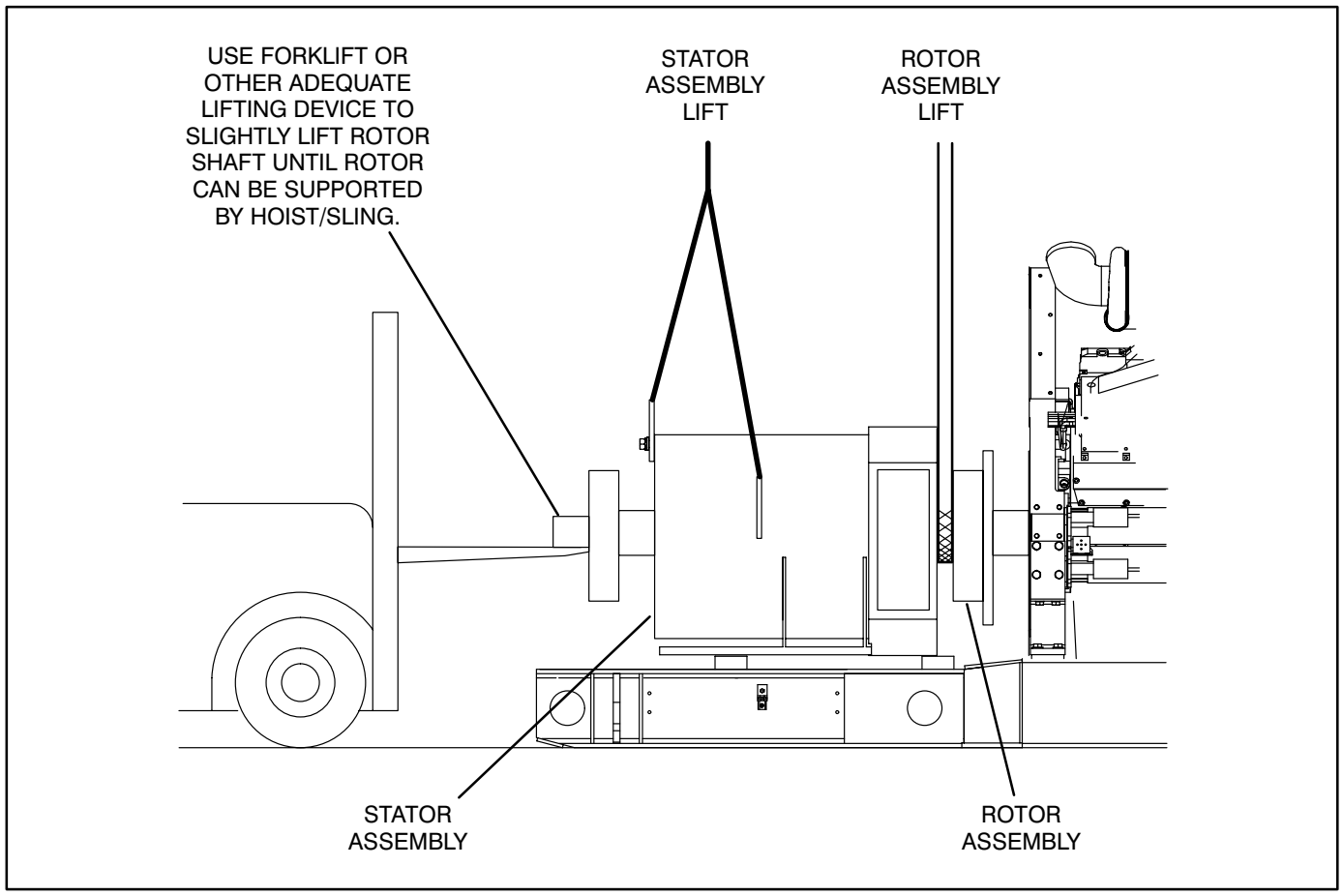

FIGURE 4-9. REMOVING STATOR ASSEMBLY (FRAME 7)

26. Verify that the stator is adequately supported and then carefully remove the capscrews from the stator attachment ring.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

⚠CAUTION ***Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/strapped to maintain level control of stator assembly while lifting and moving.***

27. Being careful not to drag the windings on the rotor, move the stator assembly sufficiently away from engine to sling and support the rotor assembly. Do not allow rotor assembly to hang on engine flywheel.

⚠CAUTION ***Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.***

28. Reposition or add hoist and sling support for the main rotor, and remove the forklift. See Figure 4-10, Rotor Lift detail.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

29. Remove the stator assembly, being careful not to drag the windings on the rotor. Place stator assembly away from the chassis in the horizontal position.

30. Using the hoist and sling to support the rotor, carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

31. Remove the rotor assembly and place it on wood blocks in the horizontal position. To avoid possible distortion, do not allow the drive discs and fan to rest on anything.

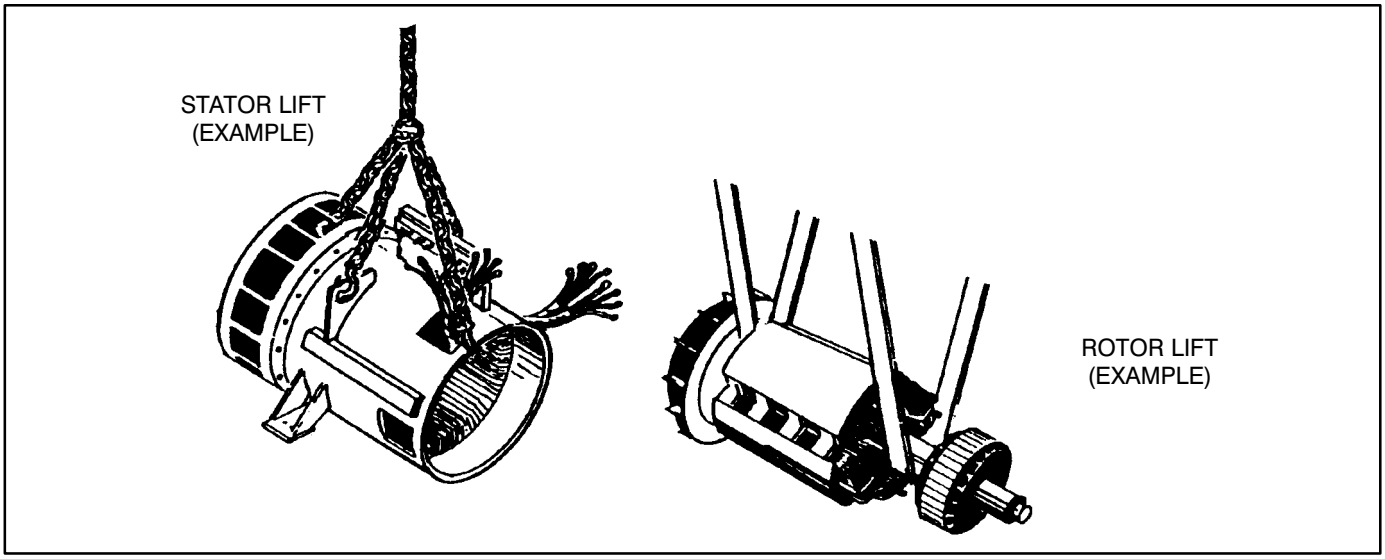

FIGURE 4-10. STATOR/ROTOR LIFT EXAMPLE

Generator Assembly Removal (Frame 7)

32. Remove the fasteners from the four generator mounting feet brackets.

33. Using an adequate lifting device, lift the generator (refer to Step 19).

34. Disconnect the grounding strap from the flywheel housing.

35. Carefully remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

36. Verify that the generator assembly is adequately supported. Carefully remove the capscrews securing the engine adaptor endbracket to the engine flywheel housing.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

    ⚠ CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/strapped to maintain level control of assembly while lifting and moving.***

37. Remove the generator assembly away from engine. Place generator assembly on floor with a piece of wood beneath the stator housing (toward PMG end) to allow for endbracket removal, if desired.

Generator Reassembly (Frame 7)

Generator reassembly is the reverse of disassembly procedure.

To assemble the stator and rotor at the same time, continue with step 1. To assemble the stator and rotor individually, skip to step 15.

1. Using an adequate lifting device, locate the generator assembly into position near the engine flywheel housing. Align the holes of the rotor drive discs with the holes of the engine flywheel. Install the capscrews and flat washers that secure the drive discs to the engine flywheel, hand tighten.

   ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

   ⚠ CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the generator by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the generator is adequately hooked/strapped to maintain level control of assembly while lifting and moving.***

2. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Tighten fasteners to 85-100 ft-lbs. (116-136 N•m).

3. Secure the rotor assembly to the flywheel. Tighten fasteners to 150-180 ft-lbs. (204-245 N•m).

4. Connect the grounding strap to the flywheel housing using a capscrew and EIT locking washer; and tighten securely.

5. Install the mounting feet bracket fasteners; and tighten securely.

   If endbracket has been removed, continue with step 6, otherwise skip to step 14.

6. Lift slightly on end of rotor shaft and install wooden shims to hold rotor on center with stator.

7. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket

8. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.

9. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.

10. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.

11. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.

12. Securely tighten the endbracket fasteners.

13. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.

14. Install the PMG assembly, if removed. Refer to Permanent Magnet Exciter Installation.

    Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to the following steps.

    To assemble the control housing, skip to step 32.

    To assemble the stator and rotor individually begin here.

15. If removed, replace exciter rotor and rotating rectifier assembly to main rotor shaft. Reconnect main rotor wire leads to positive and negative terminals of rectifier assembly.

16. If removed, install the drive disk spacer, drive disc and pressure plate on the rotor shaft. Install the cap screws and flat washers and tighten to 607 ft-lbs. (822 N•m).

17. Using a hoist and sling to support the rotor, align the holes in the drive disc with the corresponding holes in the flywheel.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

18. Secure the rotor assembly drive disc to the flywheel using appropriate capscrews and flat washers. Tighten fasteners to 150-180 ft-lbs. (204-245 N•m). Do not allow rotor assembly to hang on engine flywheel.

    ⚠CAUTION ***Drive disc damage can be caused by allowing the rotor assembly to hang on flywheel. Use adequate hoist and sling to support the rotor assembly.***

19. Reassemble engine adaptor endbracket to stator frame if removed. Using an adequate lifting device, carefully move the stator into position over the rotor assembly, being careful not to drag the windings on the rotor.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

    ⚠CAUTION ***Improper stator assembly rigging and handling can result in damage to stator and rotor assemblies. Lifting eyes may not be at center-of-gravity position of stator assembly. Therefore, lifting and moving the stator assembly alone, by hoisting at lifting eyes only, presents the hazard of load imbalance; allowing one end to drop and other end to rise. Make sure the stator is adequately hooked/strapped to maintain level control of stator assembly while lifting and moving.***

20. Using a forklift, position a lifting bar of the forklift (inside and inline with the generator) under the rotor shaft. Lift the rotor shaft slightly so that rotor is not resting on inside of stator assembly.

21. Remove the hoist/sling support of the rotor assembly. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Tighten fasteners to 95-105 ft-lbs. (129-142 N•m).

    Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to step 22.

22. Reassemble the covers over the generator air discharge openings and fasten securely.

23. Connect the grounding strap to the flywheel housing using a capscrew and EIT locking washer; and tighten securely.

24. Install the mounting feet bracket fasteners; and tighten securely.

25. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.

26. Assemble exciter stator, if removed, to inside of endbracket. Tighten fasteners to 4.5 ft-lbs. (6 N•m) torque.

27. Install endbracket to the stator frame using the proper capscrews and lock washers, but do not tighten securely as yet.

28. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.

29. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.

30. Securely tighten the endbracket fasteners.

31. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.

32. Remove generator lifting eyes. Reassemble control housing mounting brackets to sides of generator and fasten securely.

33. Use an adequate lifting device to lift the control housing in position for mounting to the stator frame. Replace the capscrews and lock washers and tighten to 20 ft-lbs. (27 N•m) torque.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

34. Reassemble any engine air intake components removed during generator disassembly.

35. Connect all control wires and generator leads using the proper generator set AC and DC wiring diagram/schematic.

36. Refer to Permanent Magnet Installation.

37. If equipped with the circuit breaker option, reconnect load wires to circuit breaker. Reconnect all lead wires to the terminal block assembly.

38. Verify that all connections are proper and secure and then install the air inlet panel and access covers to control housing.

39. Connect the negative (-) battery cable and test the generator set for operation.

FRAME 8 BEARING INSPECTION/REMOVAL

The end bearing is enclosed in a pre-packed machined cartridge. A grease fitting is provided to allow re-greasing of the bearing with a grease gun (see *Operator's* manual for grease quantities, maintenance intervals, and procedure).

Bearing Inspection: If a situation occurs which allows an opportunity to visually inspect the end bearing with it installed, check the color of the grease. The color of the grease is the only indication that can be used to determine if the bearing is defective.

New grease is a whitish-beige color but some mild discoloration will occur with use. If the grease shows signs of gross discoloration, the bearing should be replaced.

Bearing Removal: The bearing is press fitted onto the shaft and can be removed with standard workshop tools (i.e., two or three legged manual or hydraulic bearing pullers). The bearing should only be removed for replacement (bearing is destroyed during removal and must be replaced).

1. Remove the PMG (see *Permanent Magnet Removal* procedure).

2. Disconnect PMG stator leads P2, P3, and P4.

3. Remove external bearing lubricating pipe. Note component locations before removal to aid in re-assembly.

4. Remove the four bolts retaining the outer bearing cap and remove the outer bearing cap and PMG stator as an assembly, taking care not to damage the PMG stator windings.

5. Remove wave washer and circlip on the outer side of the bearing inner race.

6. Crank or bar the engine/generator to position the rotor such that a full pole face is at the bottom of the main stator core. Refer to engine service manual for proper cranking or barring procedure.

7. Remove the four bolts retaining the bearing cartridge housing in the endbracket (outer four bolts).

8. Remove the eight bolts holding the endbracket to the generator housing.

9. To support the end bracket and rotor during end bracket to frame removal, attach a suitable sling with a pair of hooks located into two of the end bracket inspection holes. The lifting capacity will vary according to the generators core length, but could be as much as 4,000 pounds.

10. Insert two bolts (M10) in the two holes provided for "jacking" purposes, on the endbracket center line. Screw bolts in until endbracket spigot is clear of locating recess.

11. Carefully tap the whole assembly off the bearing cartridge housing, ensuring the endbracket is supported to prevent the exciter rotor from dropping onto the exciter field bore.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

12. Remove bearing cartridge housing complete with bearing.

13. The cartridge housing contains an O-ring which should be examined and replaced if worn.

Bearing Replacement: The instruction sheet provided with the bearing kit is required to complete the following procedure.

Frame 8 generator component parts cannot be ordered from Onan. Refer to the Newage nameplate and supply all available information. Contact your nearest Newage distributor for assistance in ordering component parts.

1. Lift slightly on end of rotor shaft and install wooden shims to hold rotor on center with stator.

2. Install bearing onto rotor shaft. Refer to bearing kit instruction sheet.

3. Install two threaded studs into end bearing cartridge to aid subsequent procedures. Position the end bearing cartridge assembly close to proper position for hole alignment with endbracket.

4. Install endbracket to the stator frame using the proper screws and lock washers, but do not tighten securely as yet.

5. Insert and start the threads of the bearing cartridge fasteners, and remove threaded alignment studs, through the endbracket into the cartridge housing.

6. Lift slightly on endbracket and remove wooden shims holding rotor on center with stator.

7. Securely tighten the endbracket fasteners.

8. Tighten the bearing cartridge fasteners to 4.5 ft-lbs. (6 N•m) torque.

9. Install the PMG assembly. Refer to *Permanent Magnet (PMG) Frame 8*.

FRAME 8 GENERATOR DISASSEMBLY

The following procedures provide information for removal and reassembly of the generator PMG exciter and generator assembly from the engine and removal of end bearing. Be sure to read through this section first, before performing procedures listed, to determine the steps most appropriate for the service attention required.

⚠ DANGER ***Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator. Service personnel must be well-trained/ qualified to work with distribution voltages.***

Generator Assembly Removal (Frame 8)

1. Remove the generator air discharge covers (see Figure 4-7).

   ⚠ CAUTION ***Do not use fan blade to bar over engine. That can damage blades and cause property damage and personal injury***

2. Crank or bar the engine/generator to position the rotor such that a full pole face is at the bottom of the main stator core. Proper positioning can be viewed through the generator access openings. Refer to engine service manual for proper cranking or barring procedure.

   ⚠ CAUTION ***Use shims between all poles to maintain air gap between rotor and stator during generator removal or permanent damage to exciter and PMG assembly will occur.***

3. Place shims (non-compressible material such as plastic) between all four poles. Minimum air gap must be maintained in all radial directions from the center of the bore to prevent damage to the exciter and PMG assembly. Minimum air gap is 0.2 inch (5 mm). Normal air gap is approximately 0.3 inch (7.5 mm).

4. Disconnect all load wires from the reconnection terminal block assembly. If equipped with the circuit breaker option, disconnect load wires from circuit breaker. Check that all leads are labeled to ease reassembly.

5. Disconnect remote control wiring between generator and control box. For reconnections later, make sure each wire/plug is clearly marked to indicate the correct terminal.

6. Remove as necessary, air intake components to engine that may interfere with removal of the generator assembly.

7. Attach cables of lifting device to generator lifting points shown in Figure 4-11. (Two lifting points per end-plate).

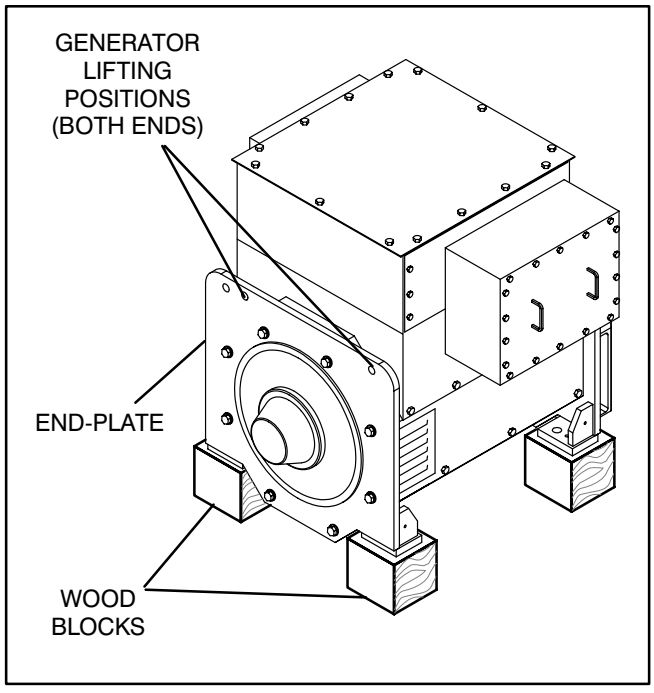

FIGURE 4-11. FRAME 8 LIFTING POSITIONS

8. Remove the fasteners from the four generator mounting feet brackets.

9. Disconnect the grounding strap from the flywheel housing.

10. Remove the capscrews and flat washers that secure the drive discs to the engine flywheel.

11. Remove the capscrews securing the engine adaptor endbracket to the engine flywheel housing.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

    ⚠CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Make sure the generator is adequately hooked/ strapped to maintain level control of assembly while lifting and moving.***

12. Remove the generator assembly away from engine. Place generator assembly on the floor using wood blocks under the four mounting feet brackets so that the stator does not rest on the floor and also to prevent the generator from rolling.

Generator Reassembly (Frame 8)

Generator reassembly is the reverse of disassembly procedure.

1. Using an adequate lifting device, locate the generator assembly into position near the engine flywheel housing. Align the holes of the rotor drive discs with the holes of the engine flywheel. Install the capscrews and flat washers that secure the drive discs to the engine flywheel, hand tighten.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

    ⚠CAUTION ***Improper generator assembly rigging and handling can result in damage to stator and rotor assemblies. Make sure the generator is adequately hooked/ strapped to maintain level control of assembly while lifting and moving.***

2. Align the holes of the engine adaptor endbracket with the holes in the flywheel housing and install the capscrews and lock washers. Tighten fasteners to 85-100 ft-lbs. (116-136 N•m).

3. Secure the rotor assembly to the flywheel. Tighten fasteners to 150-180 ft-lbs. (204-245 N•m).

    Perform the 'Aligning Generator with Engine' procedures, later in this section, then return to the following steps.

    ⚠WARNING ***To prevent personal injury, use adequate lifting devices to support heavy components. Keep hands and feet clear while lifting.***

4. Reassemble any engine air intake components removed during generator disassembly.

5. Connect all control wires and generator leads.

6. If equipped with the circuit breaker option, reconnect load wires to circuit breaker. Reconnect all lead wires to the terminal block assembly.

7. Perform the *Aligning Generator with Engine* procedure, later in this section.

8. Connect the negative (-) battery cable and test the generator set for operation.

Permanent Magnet (PMG) Removal (Frame 8)

1. Disconnect the negative (-) battery cable to prevent accidental starting of the generator set while servicing.

   ⚠WARNING ***Arcing at battery terminals, arcing in light switch or other equipment, flame, pilot lights and sparks can ignite battery gas causing severe personal injury.***

   Ventilate battery area before working on or near battery—Wear safety glasses—Do not smoke—Switch trouble light ON or OFF away from battery—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

   ⚠CAUTION ***Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.***

   ⚠WARNING ***Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (–) cable from the battery terminal.***

2. Remove the four screws and lockwashers from the PMG cover, and remove cover.

3. Disconnect the PMG wiring harness connector.

4. Remove the four bolts and clamps retaining the exciter stator housing to the endbracket.

5. Tap the stator housing out of its spigot, and carefully remove from generator endbracket.

   The highly magnetic rotor will attract the stator core; care must be taken to avoid any contact which may damage the windings.

6. Remove the hex head through-bolt from the rotor shaft and firmly pull the complete rotor assembly from its location. Keep the rotor clean by avoiding contact with metal dust or particles.

   Place in a plastic bag as soon as is practicable.

   ⚠CAUTION ***The rotor assembly must not be dismantled, or the magnetic properties will be destroyed.***

Permanent Magnet (PMG) Installation (Frame 8)

1. Install the complete rotor assembly to the end of the main rotor shaft using the hex head through-bolt. Keep the rotor clean by avoiding contact with metal dust or particles.

2. Carefully locate the stator housing to position on the generator endbracket. Fasten in place using the 4 bolts and clamps, and tighten securely.

   The highly magnetic rotor will attract the stator core, care must be taken to avoid any contact which may damage the windings.

3. Connect the PMG wiring harness connector.

4. Install the PMG assembly cover using the four screws and lockwashers, and tighten securely.

ALIGNING GENERATOR WITH ENGINE

Proper alignment of the generator and engine assemblies is necessary to avoid premature wear and improper operation of the genset. Review the following alignment conditions and procedures for aligning the generator assembly to engine flywheel housing.

Angular Misalignment: Is the result of the generator bearing center axis not aligning with axis of the engine crankshaft. This condition creates an angle between the generator shaft axis and the crankshaft axis. The cause of this type of misalignment is usually shimming error.

Axial Misalignment: Is the result of the generator shaft axis not aligning with engine crankshaft axis. The tolerances in the bolted flywheel and drive disc connection may add up to displace the generator axially relative to the crankshaft axis.

Misalignment Symptoms: If the assembly is allowed to run under these conditions, the discs must flex in alternate directions twice for each engine revolution. It is important to minimize the amount of disc flexing since, if it is excessive, the drive disc will crack. Although perfect bearing alignment is desirable, it is more important to keep disc deflection to the minimum possible. This procedure assumes that the pilot bore of the drive discs are in the exact center and the flywheel counterbore (pilot) has no practical runout. Under these conditions, perfect Angular alignment will be attained when no deflection of the disks is measured.

Excessive Axial misalignment will cause more generator vibration than Angular misalignment.

Axial misalignment should be checked only when an objectionable vibration is present.

Either type of misalignment may be present in a generator set assembly, with angular misalignment being the most common problem. Angular alignment may also be effected by set installation conditions and/or mishandling during shipping of the genset.

Angular Alignment Procedure

⚠WARNING ***Accidental starting of the generator set during this procedure presents the hazard of severe personal injury or death. Make sure to disconnect the negative (–) battery cable(s) before beginning.***

Fasten a dial indicator to either the generator shaft or the cooling fan with the sensing point resting on the capscrew head or the flat surface of the drive disc at the bolt circle diameter, see Figure 4-12. Bar the engine over in a clockwise rotation as viewed from engine flywheel. Do not allow it to roll back on compression at the end of the travel of each reading. It is unnecessary to zero the indicator since the total indicator reading (T.I.R.) of the deflection measurement to the bolt heads is what is required. T.I.R. will be the sum of the maximum positive and negative dial indicator readings as the engine completes one revolution.

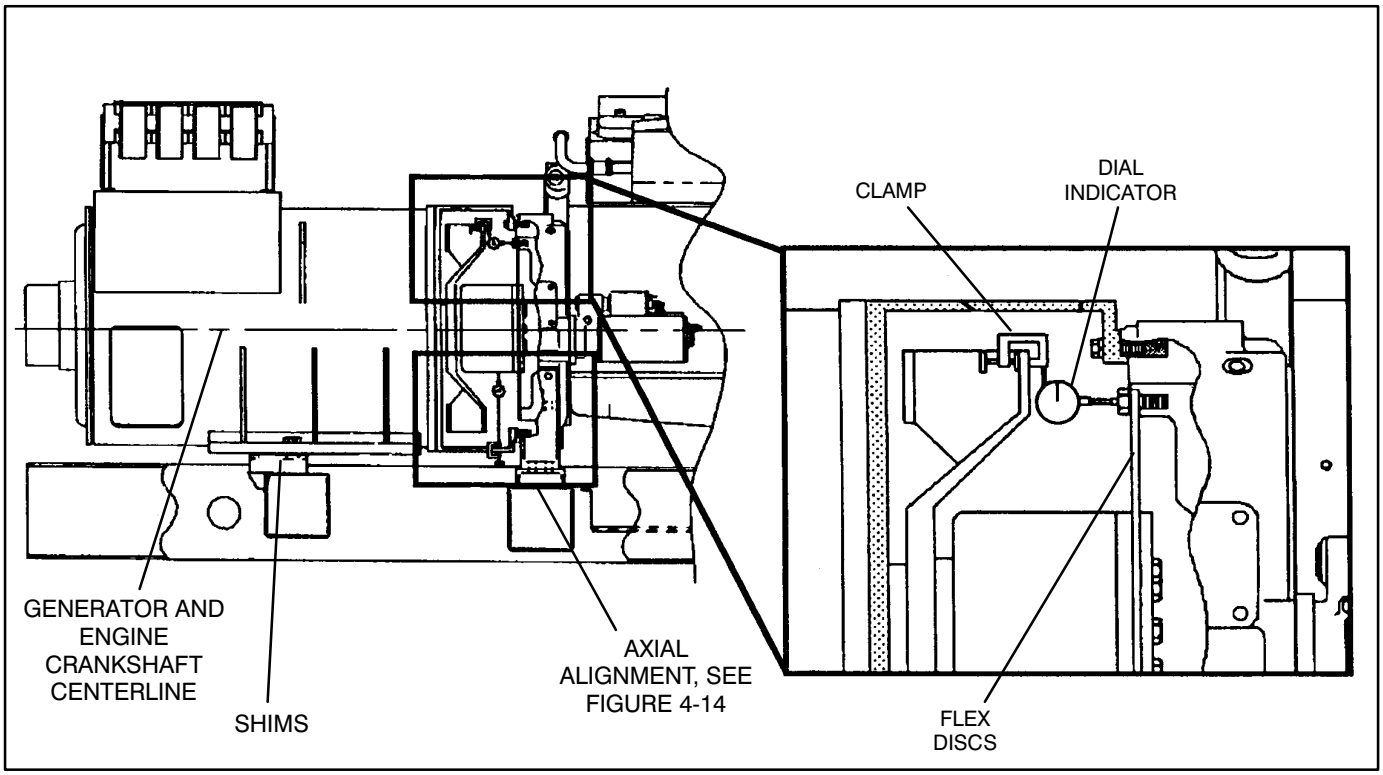

FIGURE 4-12. ANGULAR ALIGNMENT MEASUREMENT

Sample Generator Runout Readings

When taking the deflection readings described, make a diagram similar to the example shown in Figure 4-13, where a total indicator reading of .025". (The highest positive value of +.010 and the largest negative value of -.015".) The indicator is closer to the top and further away at the bottom. This example indicates that the generator bearing is high. Since the side readings are equal, the generator is centered side to side. To lower the generator, remove equal shims from under the four generator mounting feet. To approximate the amount of shims to remove or add:

1. Measure the distance between the center of the generator shaft to the point the indicator is measuring at. (For example; a SAE 18 Disc coupling distance is 10.7").
2. Measure the distance from the generator side of the flex discs to the center of the generator mounting bolt, refer to Figure 4-12. (For example; a HC6 Frame's distance is 28.4".)
3. Compare the distance measured in steps 1 and 2. (28.4" vs 10.7" or a 2.65 to 1 ratio.) Multiply this ratio times one half the T.I.R. (In our example, .025" divided by 2 is .0125". This, times 2.65 equals .033". Therefore, remove .033" of shims from under the four mounting feet of the generator.)

In general, the T.I.R. should not be more than .001" for each inch of radius (center of shaft to indicator axis). If we use our example of 10.7", then the maximum T.I.R. would be .011". This would only require a correction of .014" from the T.I.R. of .025". (A reading of +.002 at the top and -.009 at the bottom would fall within the satisfactory range.)

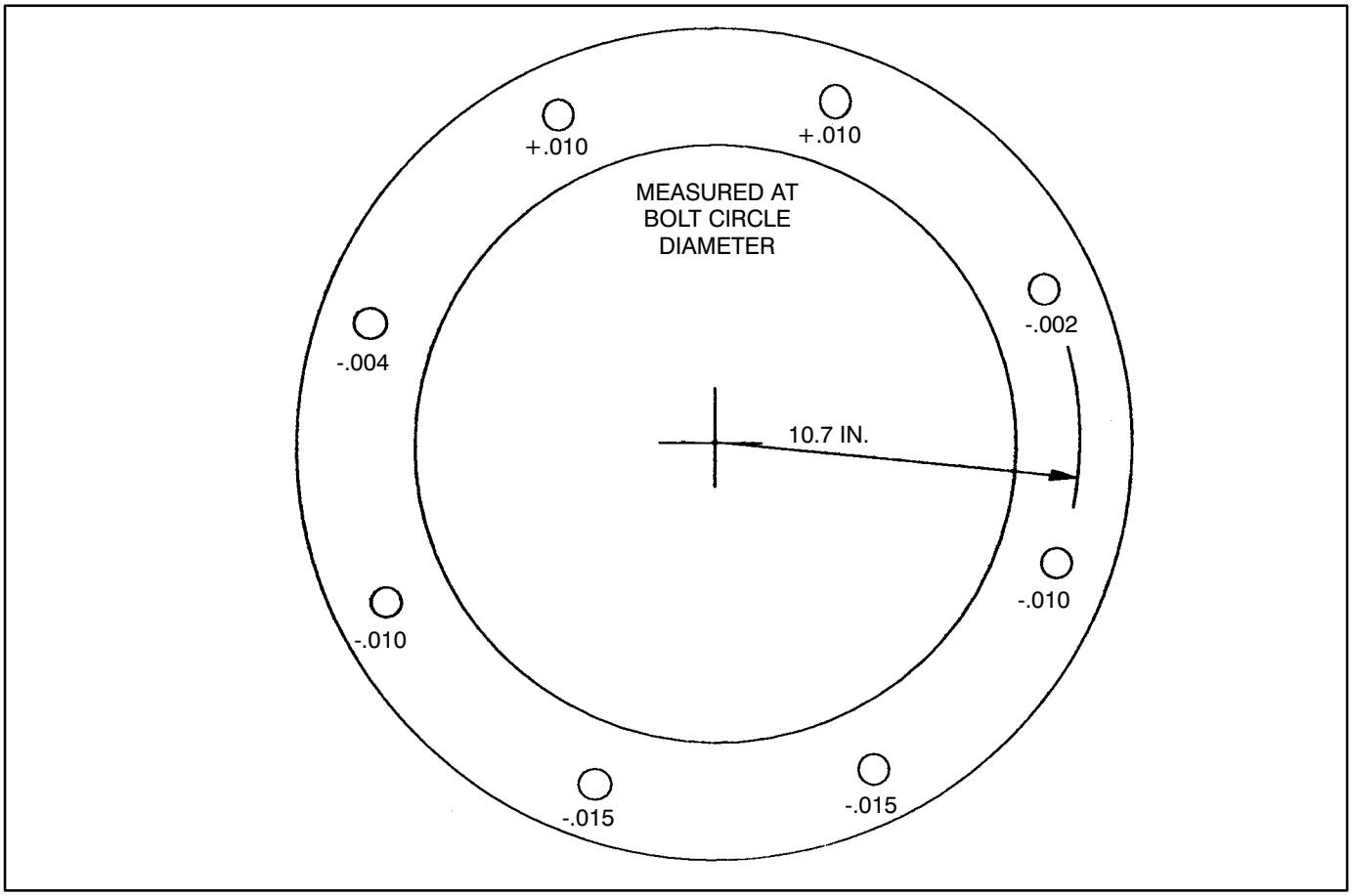

FIGURE 4-13. ANGULAR ALIGNMENT MEASUREMENT READINGS (Example)

Axial Alignment Procedure

Axial misalignment needs to be checked only when an objectionable vibration is present.

If excessive vibration remains after the angular alignment, check for concentric alignment of the generator shaft/engine crankshaft axes.

Fasten dial indicator holding device to skid base, engine block, or generator shell with a magnetic base or clamp and position so the sensor point of indicator rests on the generator shaft hub, see Figure 4-14. Bar the engine over in a clockwise rotation as viewed from engine flywheel, through a couple of rotations. Record indicator readings in eight equally spaced points around the shaft diameter. This will provide a T.I.R. for Axial shaft misalignment.

The maximum allowable T.I.R. runout is subjective, the optimal T.I.R. for runout would be .000", however, that may not be attainable. The recommendation of this procedure will be to reduce the measured T.I.R. runout by one half. Specific out-of-tolerance runout levels are difficult to establish due to the varying surface quality of the generator shaft's drive disc mountain hub.

The goal of the Axial realignment is to reduce the vibration level of the genset while it is operating. A small improvement in the T.I.R. runout may have dramatic effects in the mechanically measured or physically observed vibration levels.

To correct for an out of tolerance T.I.R. indication, remove the capscrews connecting drive discs and flywheel. Mark the drive discs and flywheel with respect to each other. Rotate either the engine or generator so that drive discs holes are repositioned 180 degrees from their original location. Put the drive discs capscrews back in and retorque. Recheck shaft alignment as before. If shaft T.I.R. runout remains unchanged then the discs should be rotated to either 30, 60, or 90 degrees from original location to correct the out of tolerance condition. If the T.I.R. does not improve after repositioning, a closer inspection of the flywheel pilot and drive disc runouts is required. This will help determine the cause of the Axial misalignment.

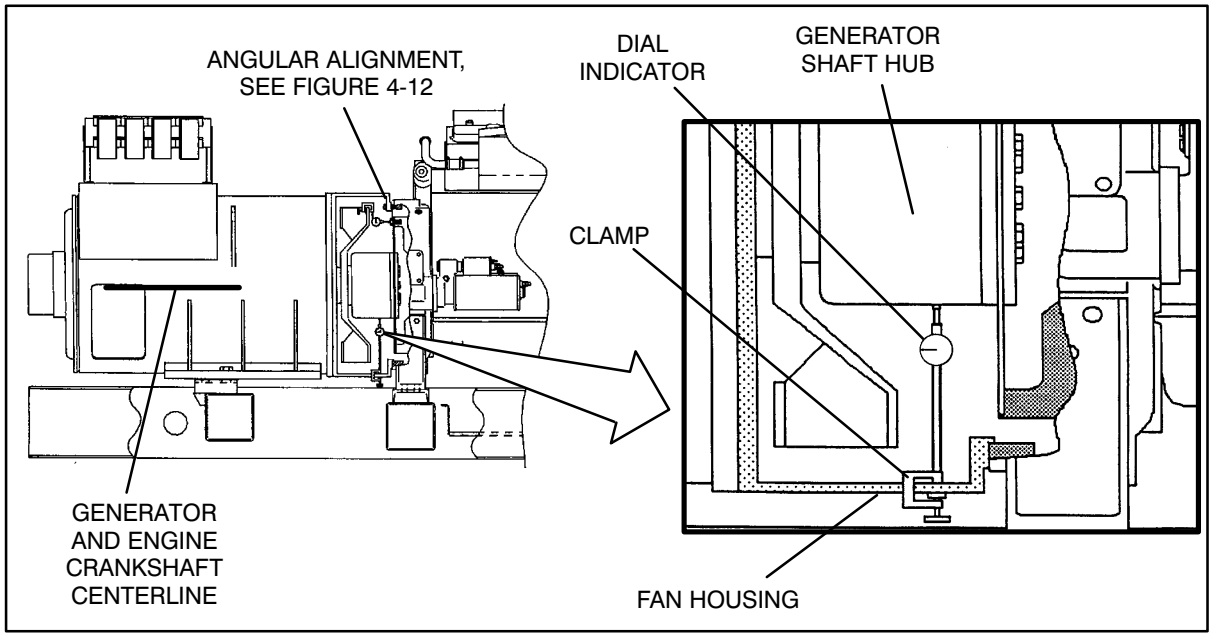

FIGURE 4-14. AXIAL ALIGNMENT MEASUREMENT

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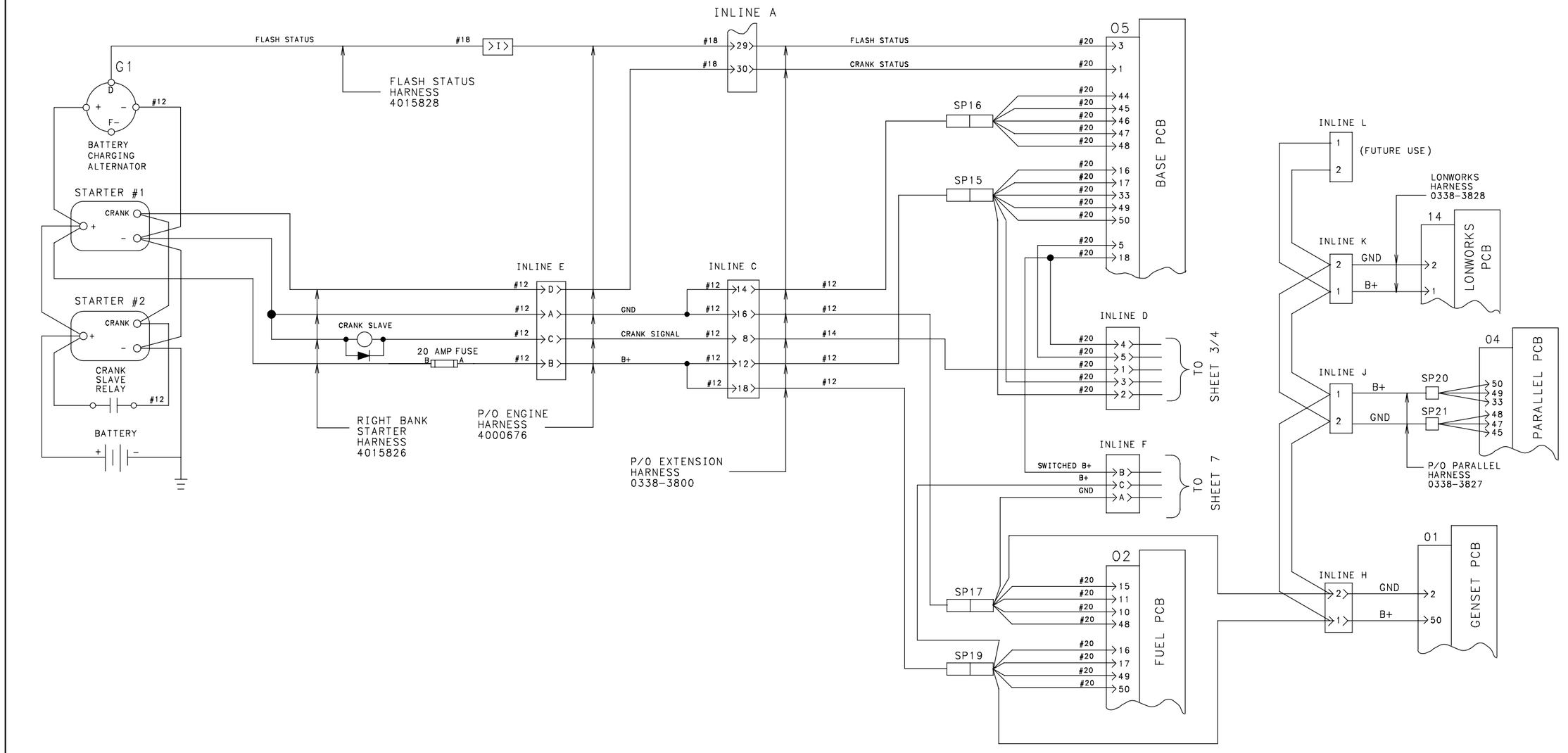
5. Wiring Diagrams

GENERAL

This section consists of the schematic and connection wiring diagrams referenced in the text. The following drawings are included.

- Page 5-2 through 5-9, Genset Wiring Diagram



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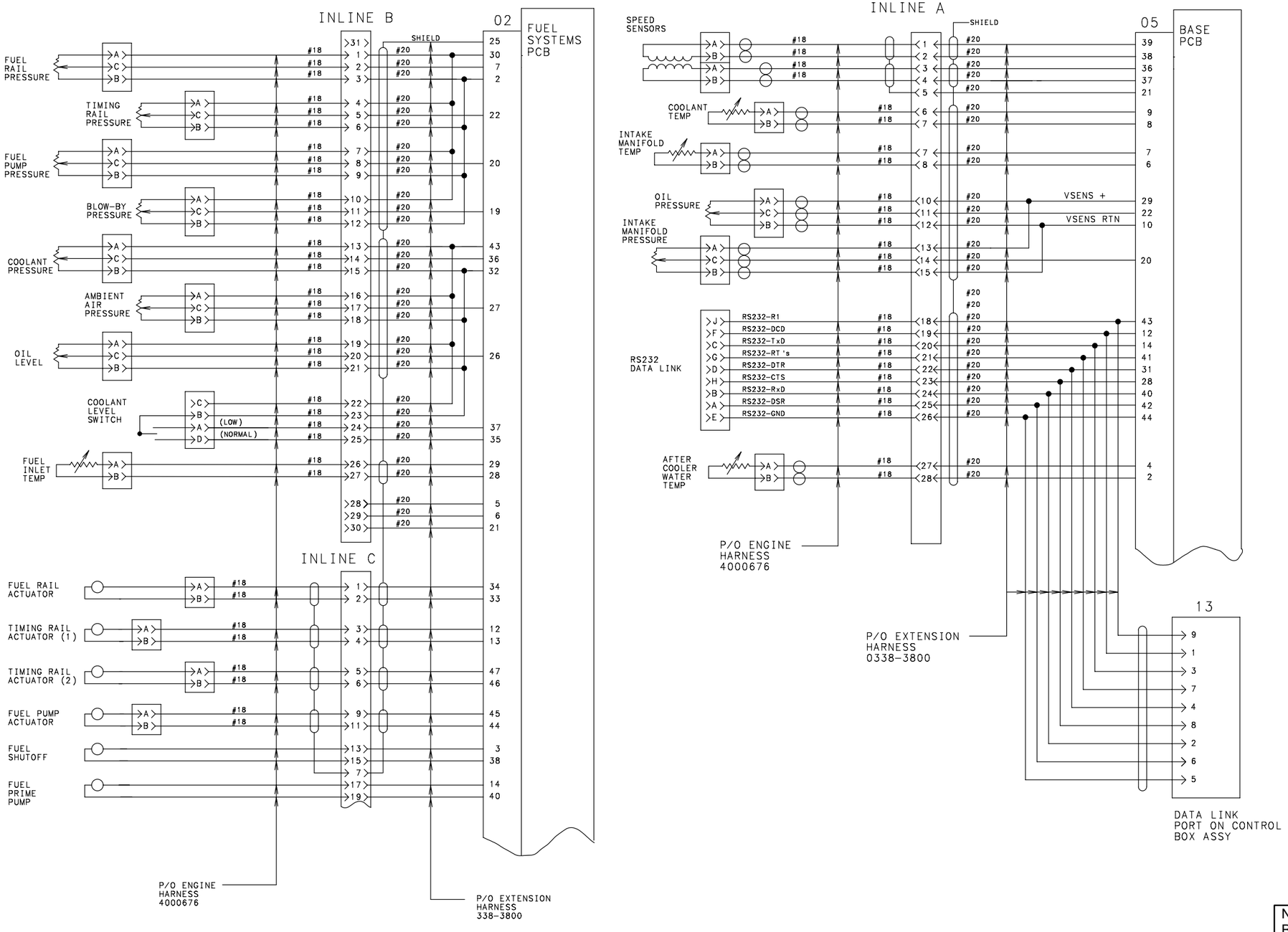

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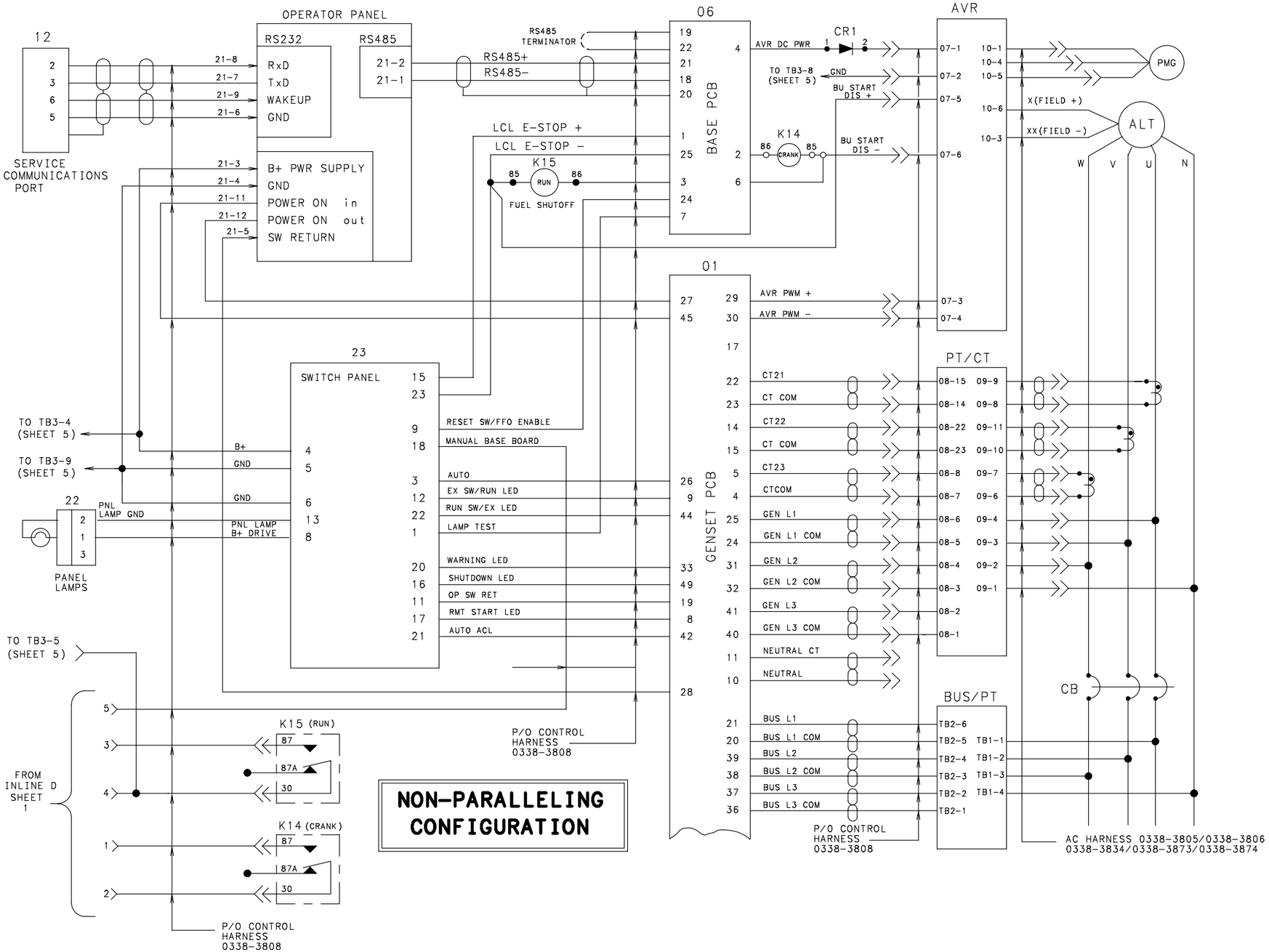
GENSET WIRING DIAGRAM (2 OF 8)



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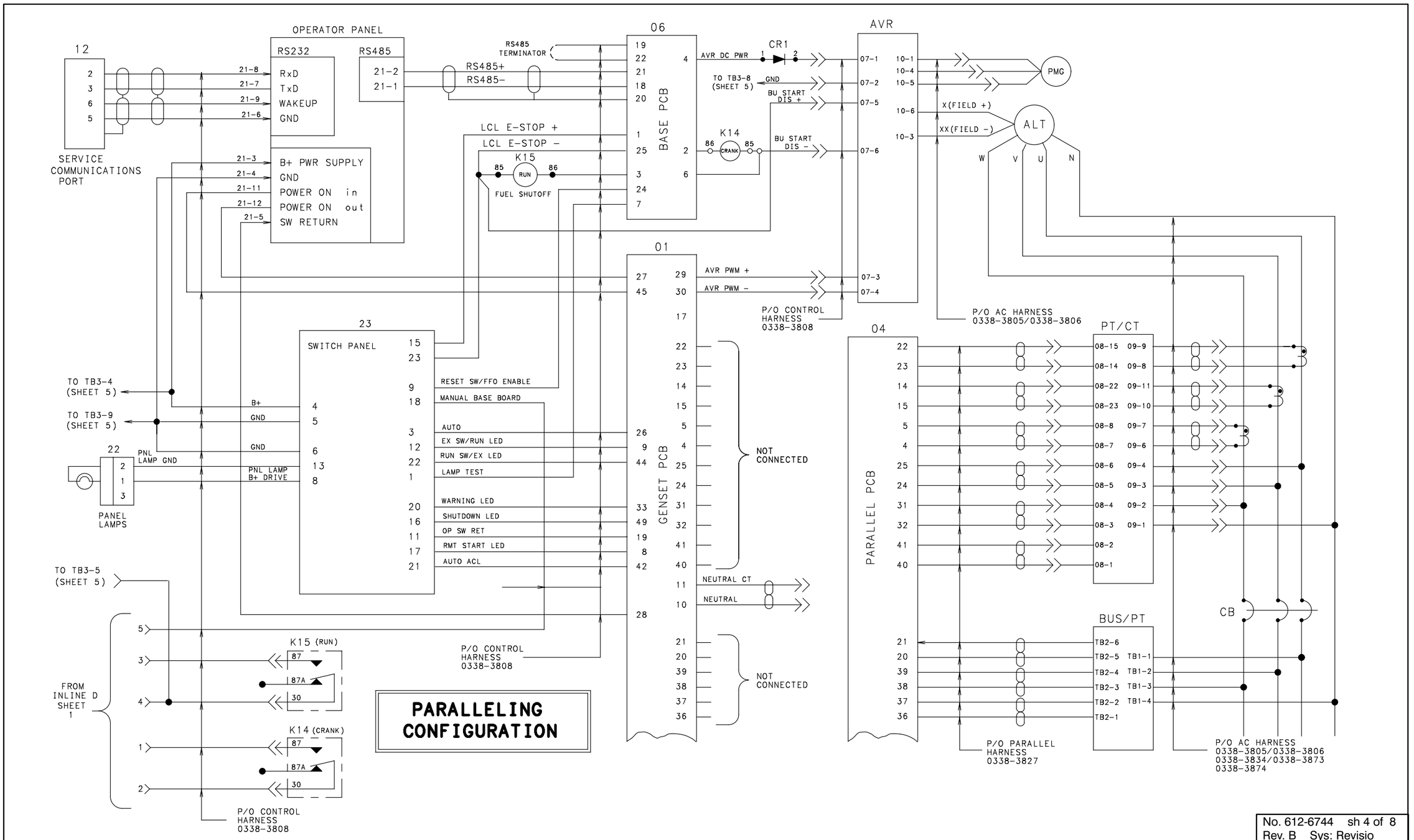
GENSET WIRING DIAGRAM (3 OF 8)



PARALLELING CONFIGURATION

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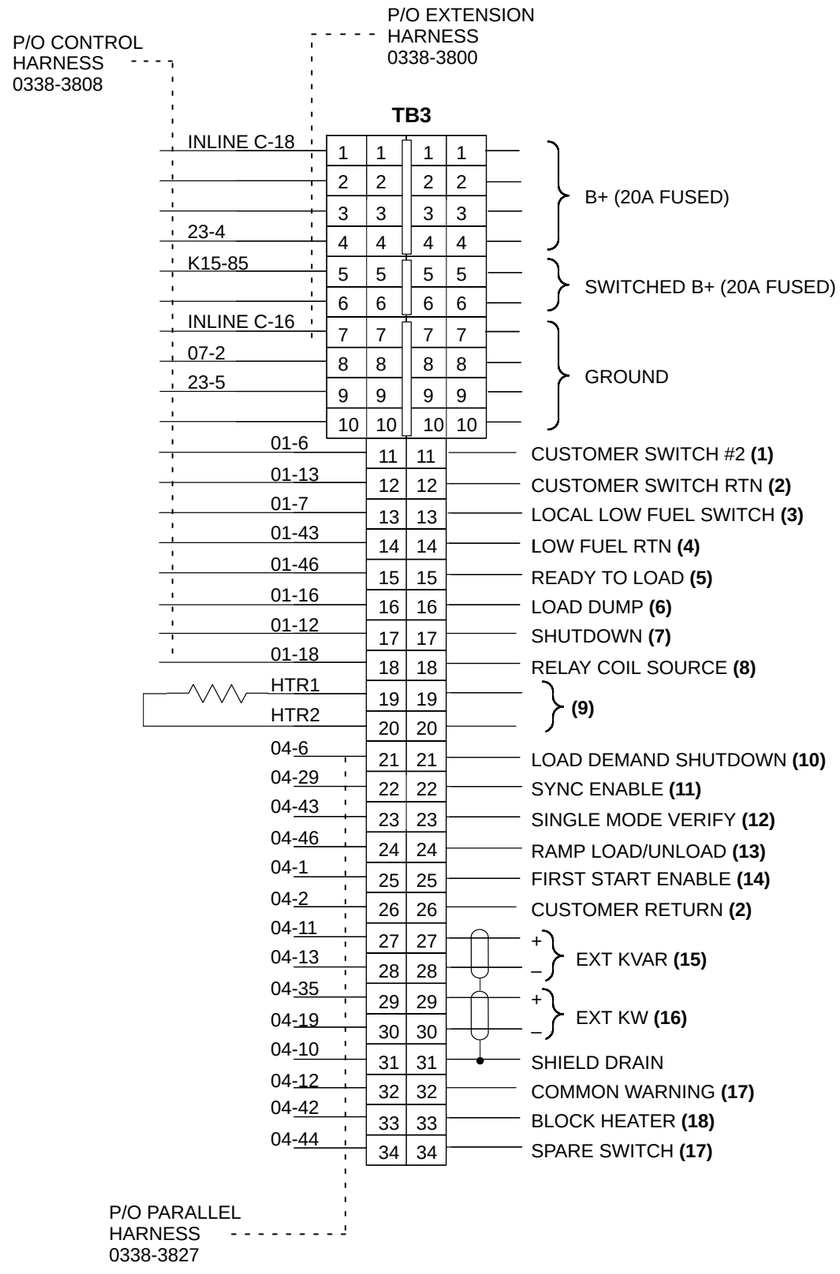
GENSET WIRING DIAGRAM (4 OF 8)



NOTES:

1. CONFIGURABLE CUSTOMER WARNING OR SHUTDOWN SWITCH WITH WAKE-UP CONTROL. APPLY TO CUSTOMER SWITCH RTN TO ACTIVATE.
2. RETURN CONNECTION FOR CUSTOMER SWITCHES.
3. LOCAL LOW FUEL WARNING. APPLY TO LOW FUEL RTN TO ACTIVATE. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
4. RETURN CONNECTION FOR LOCAL LOW FUEL SWITCH AND REMOTE LOW FUEL SWITCH.
5. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) OPERATES WHEN GENERATOR HAS REACHED 90% AC VOLTAGE AND FREQUENCY.
6. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) CONFIGURABLE OPERATION AT UNDER FREQUENCY, OVERLOAD, OR BOTH.
7. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) OPERATES ON GENERATOR SHUTDOWN.
8. RELAY COIL SOURCE HIGH SIDE DRIVER FOR READY TO LOAD, LOAD DUMP, SHUTDOWN, AND MODEM CONTROL RELAY DRIVERS.
9. 120 VAC OR 240 VAC AT 50W.
10. FOR MULTIPLE UNIT OPERATION. APPLY TO CUSTOMER RTN OR GROUND TO SHUTDOWN INDIVIDUAL CAPACITIES AS LOAD DICTATES. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
11. FOR SINGLE / UTILITY PARALLEL MODE. APPLY B+ (24 VDC) TO ENABLE SYNCHRONIZER.
12. FOR SINGLE / UTILITY PARALLEL MODE. APPLY TO CUSTOMER RTN OR GROUND WHEN PARALLEL WITH UTILITY. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
13. APPLY TO CUSTOMER RTN OR GROUND TO LOAD GENSET. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
14. FOR MULTIPLE UNIT OPERATION. APPLY B+ (24 VDC) TO ENABLE FIRST UNIT.
15. ANALOG 0–5 VDC INPUTS TO CONTROL GENERATOR REACTIVE POWER IN UTILITY PARALLELING MODE.
16. ANALOG O–5 VDC INPUTS TO CONTROL GENERATOR REAL POWER IN UTILITY PARALLELING MODE.
17. SELF PROTECTED RELAY DRIVER (200mA @ 24 VDC) OPERATES ON CUSTOMER DEFINED WARNING OR STATUS.
18. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) FOR OPERATING ENGINE BLOCK HEATER.

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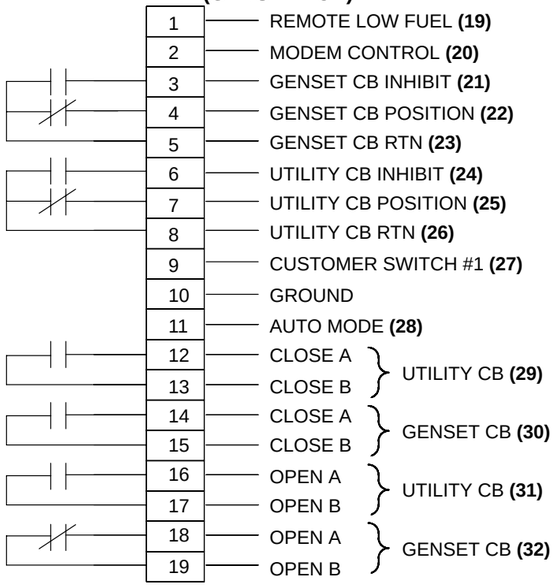
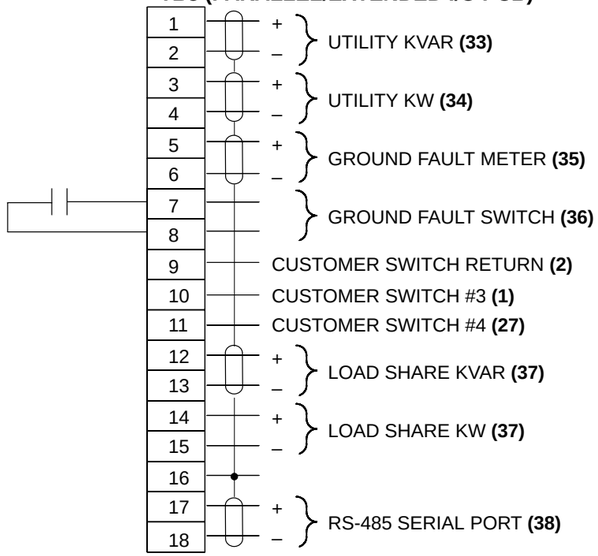
TB4 (GENSET PCB)



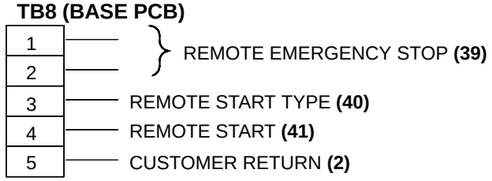
TB5 (PARALLEL/EXTENDED I/O PCB)



NOTES:

19. REMOTE LOW FUEL WARNING. APPLY TO GROUND OR LOW FUEL RTN TO ACTIVATE. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
20. SELF PROTECTED RELAY DRIVER (200mA @ 24 VDC) FOR APPLYING POWER TO MODEM.
21. APPLY TO GENSET CB RETURN TO INHIBIT GENSET CB FROM CLOSING. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
22. INPUT FROM GENSET CB “B” CONTACT TO INDICATE CB POSITION.
23. RETURN FOR GENSET CB INHIBIT AND POSITION.
24. APPLY TO UTILITY CB RETURN TO INHIBIT UTILITY CB FROM CLOSING. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
25. INPUT FROM UTILITY CB “B” CONTACT TO INDICATE CB POSITION.
26. RETURN FOR UTILITY CB INHIBIT AND POSITION.
27. CONFIGURABLE CUSTOMER WARNING OR SHUTDOWN SWITCH. CONFIGURABLE TO ACTIVATE WHEN EITHER THE CIRCUIT IS OPENED OR CLOSED TO CUSTOMER SWITCH RETURN.
28. INDICATES GENSET IS IN AUTO MODE. ACTIVE HIGH (24 VDC). FUSED AT 5A.
29. CLOSE RELAY CONTACT FOR UTILITY CB. FUSED AT 5A (N/O).
30. CLOSE RELAY CONTACT FOR GENSET CB. FUSED AT 5A (N/O).
31. OPEN RELAY CONTACT FOR UTILITY CB. FUSED AT 5A (N/O).
32. OPEN RELAY CONTACT FOR GENSET CB. FUSED AT 5A (N/C).
33. ANALOG MONITOR SIGNAL (0–5 VDC) FOR UTILITY REACTIVE POWER.
34. ANALOG MONITOR SIGNAL (0–5 VDC) FOR UTILITY REAL POWER.
35. ANALOG INPUT FOR GROUND FAULT CURRENT.
36. APPLY N/O RELAY CONTACT. ACTIVATES ON GROUND FAULT.
37. PARALLEL LOAD SHARE LINES (0–1mA).
38. RS–485 SERIAL PORT CONNECTION.
39. OPEN CONNECTION TO INITIATE EMERGENCY STOP. THESE TERMINALS MUST BE SHORTED TOGETHER IF REMOTE EMERGENCY STOP OPTION NOT USED.
40. DETERMINES REMOTE START TYPE: APPLY TO CUSTOMER RTN FOR NORMAL START SEQUENCE WITH WARM-UP. OPEN = EMERGENCY START SEQUENCE.
41. APPLY TO CUSTOMER RETURN OR GROUND TO INITIATE A REMOTE START. ACTIVE LOW WITH LESS THAN 50mA CURRENT.

TB8 (BASE PCB)



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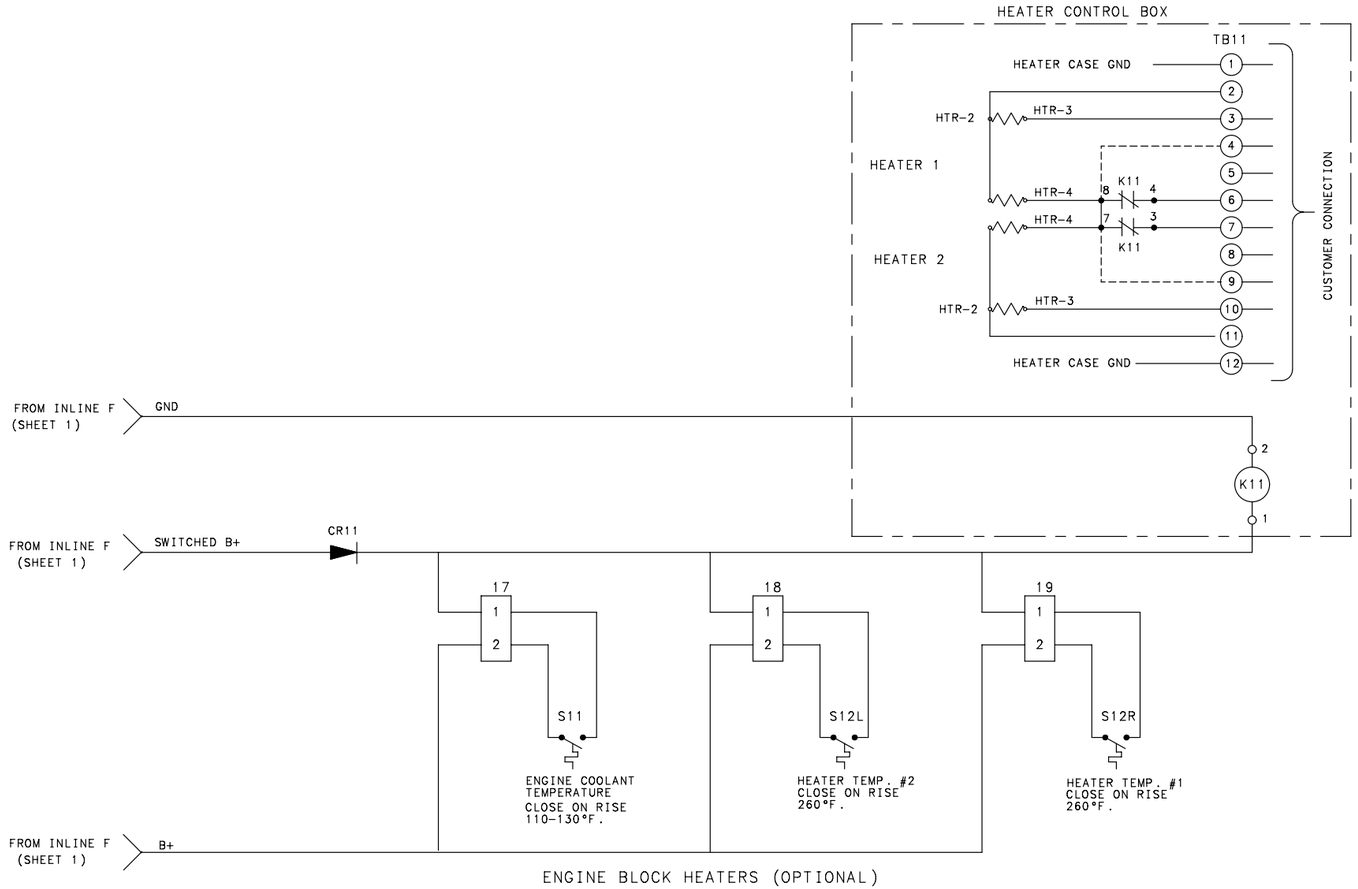
GENSET WIRING DIAGRAM (6 OF 8)



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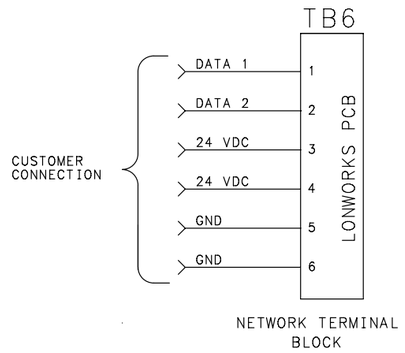
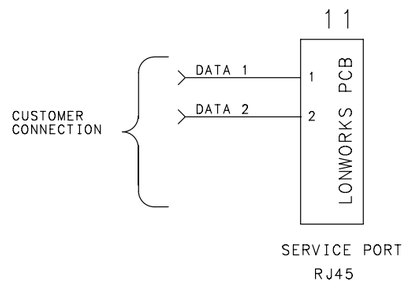
GENSET WIRING DIAGRAM (7 OF 8)





LONWORKS OPTION

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