
INSTALLATION AND OPERATION INSTRUCTIONS

Original Issue Date: **8/12**

Model: **14RESA, 20RESA, and 20RESB**

Market: **Residential/Light Commercial**

Subject: **PowerSync™ Automatic Paralleling Module (APM) Kit
GM85144-KP1-QS and Circuit Breaker Kits GM86368-KP1-QS and
GM86369-KP1-QS**

Introduction

This document describes the installation and operation of the PowerSync™ Automatic Paralleling Module (APM) and optional circuit breakers for single-phase residential generator sets. The APM allows the use of two Model 14RESA or two 20RESA/20RESB generator sets in a single-phase paralleling system to supply power to one building or site.

The APM provides a common connection point for paralleling generators and permits individual control of the generator connections, allowing for synchronization, redundancy, and generator management.



Figure 1 PowerSync™ Automatic Paralleling Module

The following combinations of single-phase generator sets can be paralleled:

- Two single-phase Model 14RESA generator sets with the same 110/220, 115/230, 120/240, 220, 230, or 240 volt configuration
- Two single-phase Model 20RESAs, two 20RESBs, or one 20RESA and one 20RESB with the same 110/220, 115/230, 120/240, 220, 230, or 240 volt configuration

Automatic paralleling requires:

- Two single-phase generator sets as shown above.
- RDC2 paralleling firmware RDC2_###_#.bin version 105.4 or higher on each generator set. Download the paralleling firmware from TechTools.
- One Model RXT automatic transfer switch (ATS)
- One Automatic Paralleling Module (APM) kit
- A personal computer (laptop) with Kohler® SiteTech™ software version 3.5 or higher is required for system setup.
- A Load Control Module (LCM), Load Shed kit, or other load management system is **required** if one generator set cannot support the maximum total load.

The LCM or load shed kit is necessary in order to shed non-critical loads in the event that one generator set shuts down and the other generator set cannot support all of the loads. The RXT with the combined interface/load management board also satisfies this requirement.

The APM and associated equipment must be installed by a Kohler® trained and authorized distributor or dealer.

Circuit Breaker Kits

If the APM is not installed within sight of the generator sets, local codes may require the installation of circuit breakers near the APM. Circuit breaker kits are available for installation inside the APM enclosure.

Figure 2 shows the circuit breaker kit numbers for the 14RESA, 20RESA, and 20RESB generator sets. Verify that you have the correct kit for your generator set model.

Model	Circuit Breaker Kit	APM Kit
14RESA	GM86368-KP1-QS	GM85144-KP1-QS
20RESA 20RESB	GM86369-KP1-QS	

Figure 2 Kit Numbers

Other Accessories

Other compatible accessories include:

- Programmable Interface Module (PIM)
- OnCue® Plus Generator Management System

If OnCue will be used, a unique OnCue activation code is required for each generator set. Two activation codes are provided with the APM kit.

Definitions

Some terms used in these instructions are defined in Figure 3.

Term	Definition
Automatic paralleling module (APM)	The box that contains the contactors and optional circuit breakers. See Figure 1.
Single-phase paralleling system	System that includes the APM, two generator sets, current transformers (CTs), transfer switch, load control module (LCM) or load shed kit, optional PIM, and optional OnCue® Plus. See Figure 7.
Generator management	Determination of the number of generator sets needed to supply the load and logic for stopping one of the generator sets.
Load management	Shedding and adding loads using the load control module (LCM) or load shed kit.
Generator 1	The generator set connected to the left-side contactor in the APM.
Generator 2	The generator set connected to the right-side contactor in the APM.
Primary generator	The generator set whose RDC2 controller is controlling the RBUS network.
Secondary generator	The generator set whose RDC2 controller is monitoring but not controlling the RBUS network.
First-order generator	The generator set that is not stopped by generator management.
Second-order generator	The generator set that is turned off by generator management when it is not needed.
Runtime order selection	The generator with the fewest number of hours of operation is selected as the first order generator set. Runtime order selection may cause generators 1 and 2 to alternate order. See Section 5.3.2.
Manual order selection	The generator set that has last been taken off-line (see Auto-Off) is always the second order generator set. Runtime hours are ignored. See Section 5.3.2.
Auto-Off	Pressing the AUTO and OFF buttons simultaneously on one generator set's RDC2 controller removes that generator set from the bus. The other generator set will start if it is offline. See Section 5.3.2.
Auto-Run	Pressing the AUTO and RUN buttons simultaneously on either generator set places generator management in runtime hour selection mode. See Section 5.3.2.
Auto-Discovery	A required procedure after paralleling system installation, auto-discovery confirms that the system components are connected correctly and communicating as required. See Section 4.4.

Figure 3 Definitions

Related Literature

A single-phase paralleling system is made up of the APM module covered by this instruction sheet plus two generator sets and a Model RXT transfer switch. A load control module (LCM), load shed kit, or combined interface/load management board on the RXT is required if one generator set cannot support the maximum total load. An optional PIM and OnCue® Plus monitoring system may also be used with the power system. Refer to the documentation provided with the other system components for installation instructions. Related literature is listed in Figure 4.

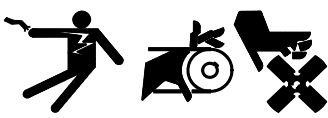
Document Description	Part Number
SiteTech™ Software Operation Manual	TP-6701
OnCue® Plus Operation Manual	TP-6928
Installation Manual, 14/20RESA/RESAL	TP-6803
Operation Manual, 14/20RESA/RESAL	TP-6804
Installation Manual, 20RESB	TP-6925
Operation Manual, 20RESB	TP-6926
Operation/Installation Manual, Model RXT Transfer Switch	TP-6807
Installation Instructions, Load Control Module (LCM)	TT-1574
Installation Instructions, Programmable Interface Module (PIM)	TT-1584
Installation Instructions, Load Shed Kit	TT-1609

Figure 4 Related Literature

Safety Precautions

Observe the following safety precautions while installing the kit.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or equipment connected to the set, disable the generator set as follows: (1) Press the generator set off/reset button to shut down the generator set. (2) Disconnect the power to the battery charger, if equipped. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent the starting of the generator set by the remote start/stop switch.

⚠ DANGER



Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocutation is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

Making line or auxiliary connections. Hazardous voltage can cause severe injury or death. To prevent electrical shock deenergize the normal power source before making any line or auxiliary connections.

Electrical backfeed to the utility. Hazardous backfeed voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent the connection of standby and other sources of power. Electrical backfeed into a utility electrical system can cause severe injury or death to utility personnel working on power lines.

1 Installation Procedure

Read the entire installation procedure and compare the kit parts with the parts list at the end of this publication before beginning installation. Perform the steps in the order shown.

For the generator sets, transfer switch, LCM or load shed kit, and other accessories, refer to the installation instructions provided with each component during this procedure.

Refer to the block diagram in Figure 7 and the APM dimension drawings in Section 8 as needed during installation.

1.1 Install the generator sets and current transformers (CTs).

1. Install the generator sets according to the instructions and diagrams in the generator set Installation Manual. Do not connect the wiring to the transfer switch at this time.
2. Identify the generator sets as generator 1 and generator 2. Use the decals provided to label Generator 1 and Generator 2.

Note: Be careful to keep track of generator 1 and generator 2 during the installation and connection procedures.

3. Install one current transformer (CT) (GM86609) inside each generator set enclosure. Install the CT below the customer-connection terminal block in the air intake area of the generator set.
 - a. Load lead L1 from the generator should enter the CT on the side with the dot. See Figure 5.
 - b. Load lead L2 must pass through the CT in the opposite direction from L1 as shown in Figure 5.

Note: Do not operate the paralleling system without the CTs in place. The CTs are used to measure power on each generator to allow the load to be shared.

4. Connect the CT harness to connector P3 on the RDC2 controller inside the generator set. See Figure 6.

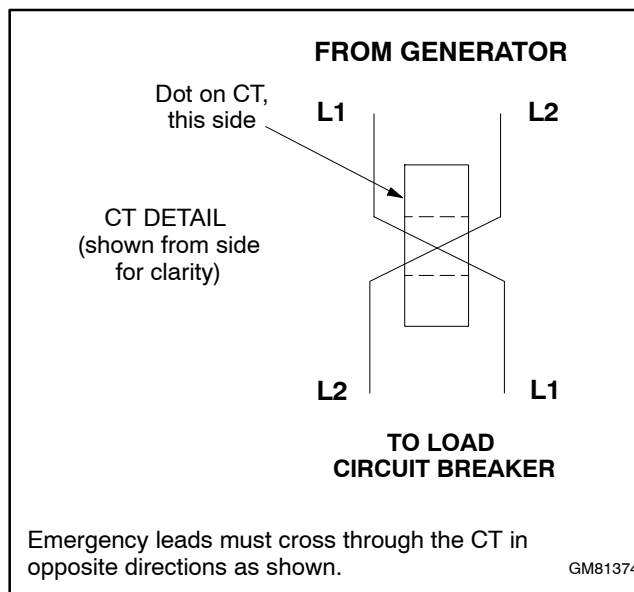


Figure 5 Load Lead Routing through Current Transformer (CT)

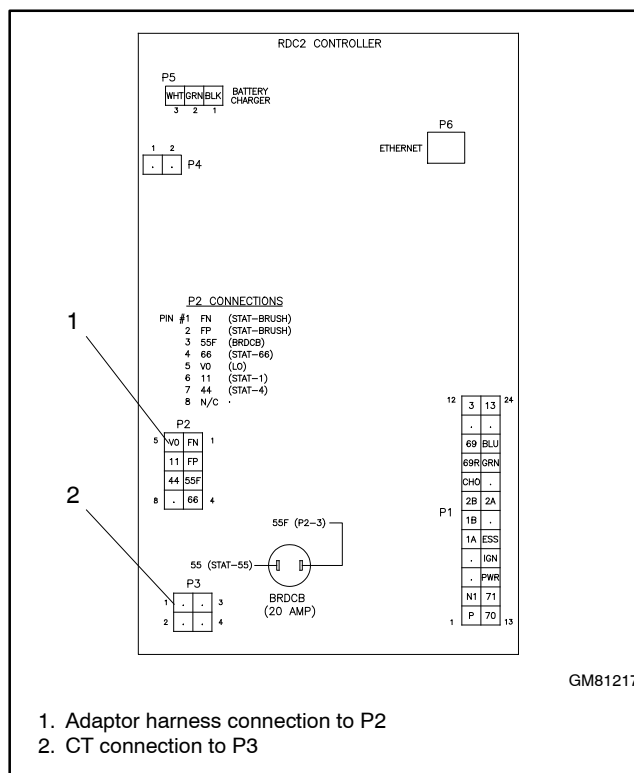


Figure 6 Current Transformer and Adaptor Harness Connections to RDC2

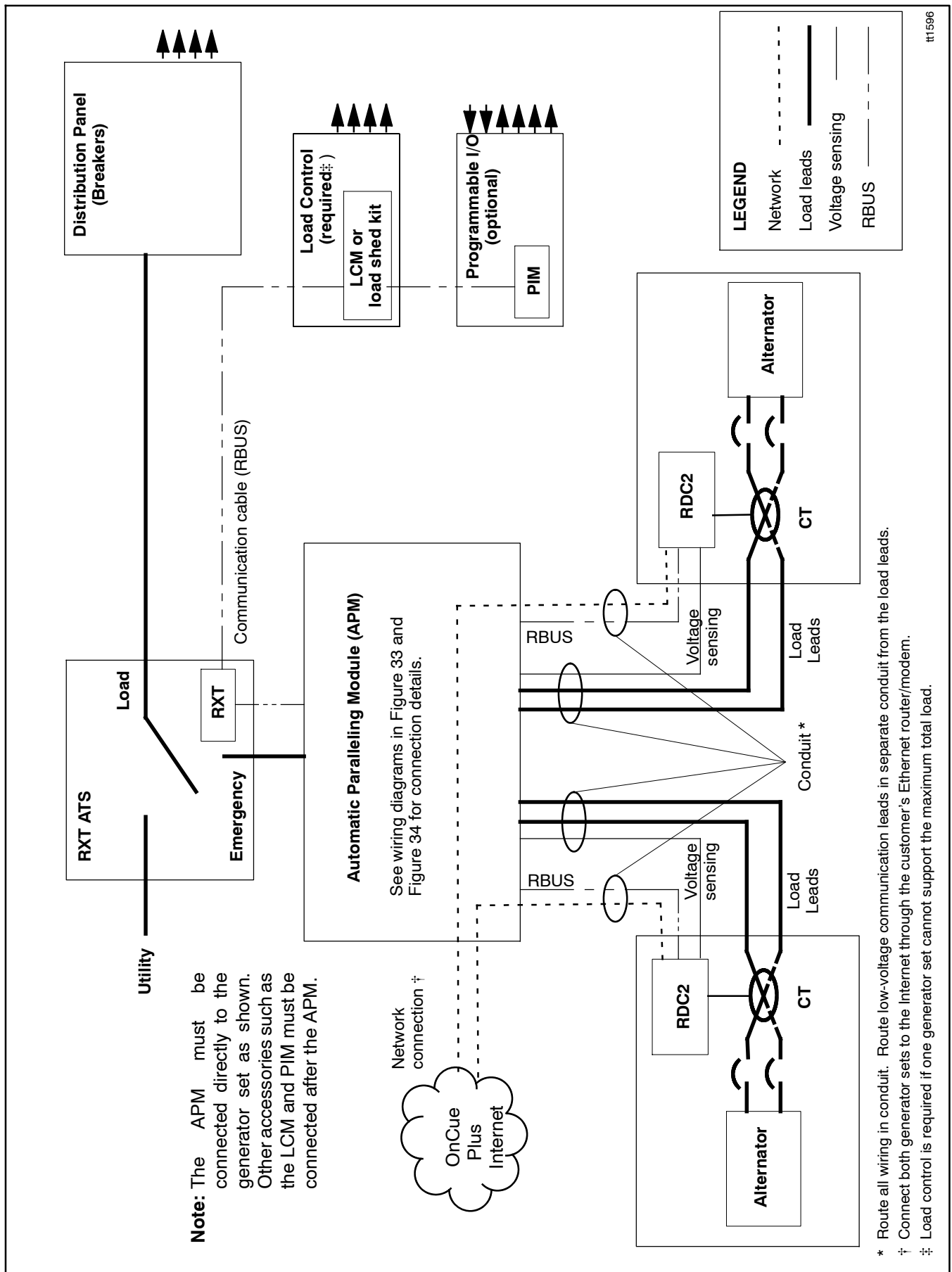


Figure 7 Block Diagram for Paralleling System Components and Connections

5. Install the adaptor harnesses for voltage sensing connection:
 - a. Disconnect the generator set harness at P2 on the back of the RDC2 controller. See Figure 6.
 - b. Connect the adaptor harness to P2 on the RDC2 controller. See Figure 6 and Figure 8.
 - c. Connect the other end of the adaptor harness to the generator set harness.
 - d. Repeat for the second generator set.
6. The adaptor harness connected in step 5 contains a voltage sensing lead (V9). Connect one 14-20 AWG lead to this lead and route it with the AC output leads from the generator to the APM location. Repeat for the second generator set.

Note: Do not operate the generators in parallel without the adaptor harness in place. The adaptor harness contains protective devices that prevent controller damage when connecting to a large inductive load (such as another generator).

Note: Electrical connections to the APM will be made later.

1.2 Install the automatic paralleling module (APM).

7. To remove the enclosure's front panel, support the panel while removing the screws. Pull the bottom of the panel out and down until the top clears the enclosure. Remove the inner panel to access the APM components.
8. See the dimension drawings in Section 8 for recommended cable entrance areas. Cover the components inside the enclosure. Then punch or drill cable entry openings in the APM enclosure.
9. Use a vacuum cleaner to remove debris from the enclosure.

Note: Do not use compressed air to clean the inside of the enclosure. Cleaning with compressed air can cause debris to lodge inside the components and damage the equipment.

10. Mount the enclosure to a wall or other rigid vertical supporting structure using the mounting holes provided in the enclosure. See Figure 32 for mounting hole spacing. Use shims to plumb the enclosure.

Note: The enclosure mounting holes are equipped with gaskets to seal out moisture. Use washers with the mounting screws to prevent damage to the gaskets.

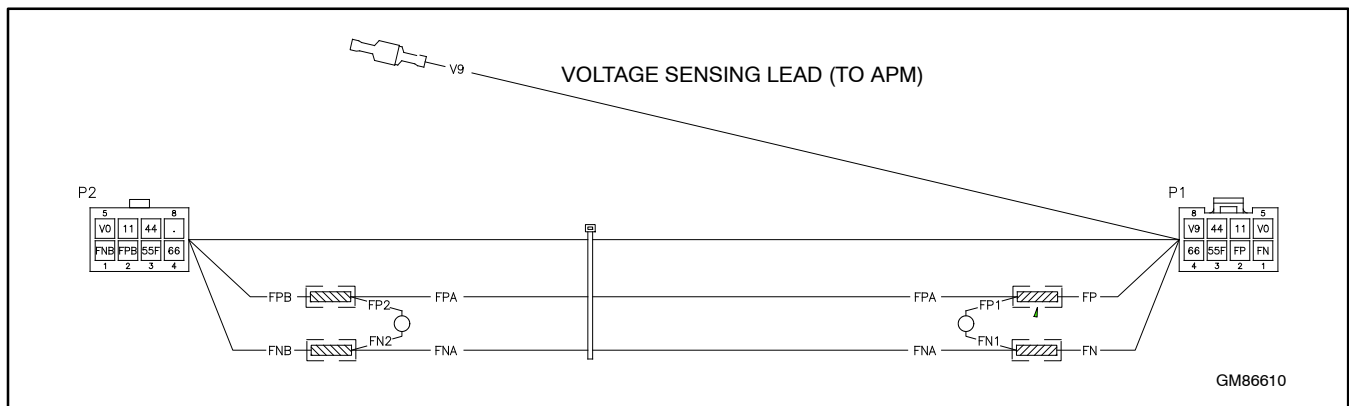


Figure 8 Adaptor/Protection Harness GM86610 (provided)

1.3 Install the circuit breaker kit, if required.

Note: The circuit breaker kit may be required if the APM is not installed within sight of the generator sets. Ensure that the installation complies with the NEC and local codes.

If the circuit breaker kits are not used, proceed to Section 1.4.

11. install circuit breaker mounting bracket GM85151 onto the back wall of the APM enclosure:

- Remove the 4 existing screws X-67-133 and 8 existing washers X-25-36 from the back wall of the enclosure. See Figure 9. Save the screws; the washers can be discarded.
- Align the bracket mounting holes with the holes in the enclosure.
- Secure the mounting bracket with the 4 screws that were removed above.

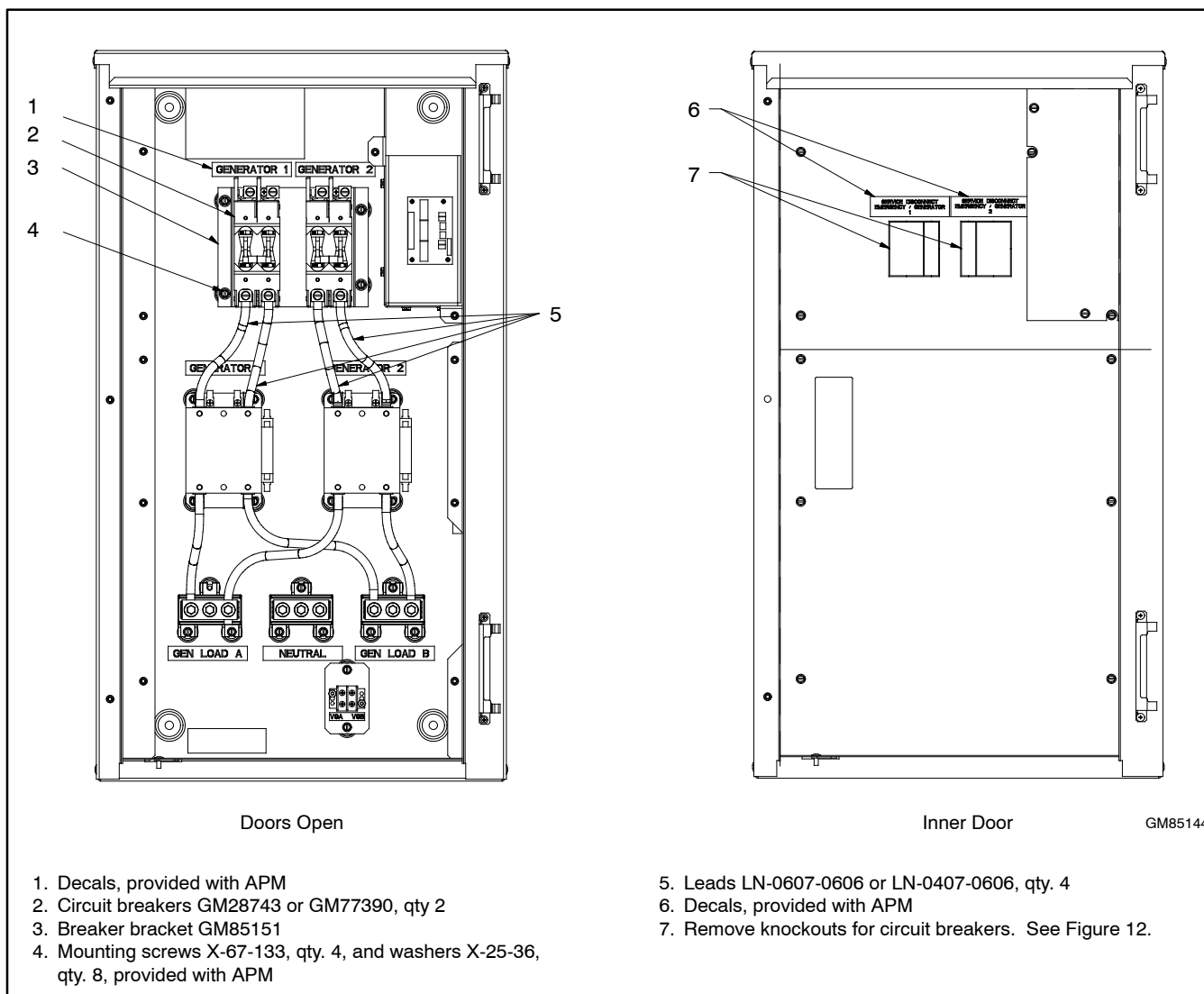


Figure 9 Circuit Breaker Kit Installation Inside the APM Enclosure

12. Mount two circuit breakers onto the bracket.

For the 14RESA, 70 amp circuit breakers:

- a. Use 4 X-67-132 thread-forming screws and 4 X-400-145 spacers for each circuit breaker. Install the spacers between the circuit breaker mounting tabs and the bracket. See Figure 10.
- b. Connect the circuit breakers to the APM contactors using 4 leads LN-0607-0606 provided with the circuit breaker kit. See Figure 9 and the wiring diagram in Section 8 for circuit breaker connections.

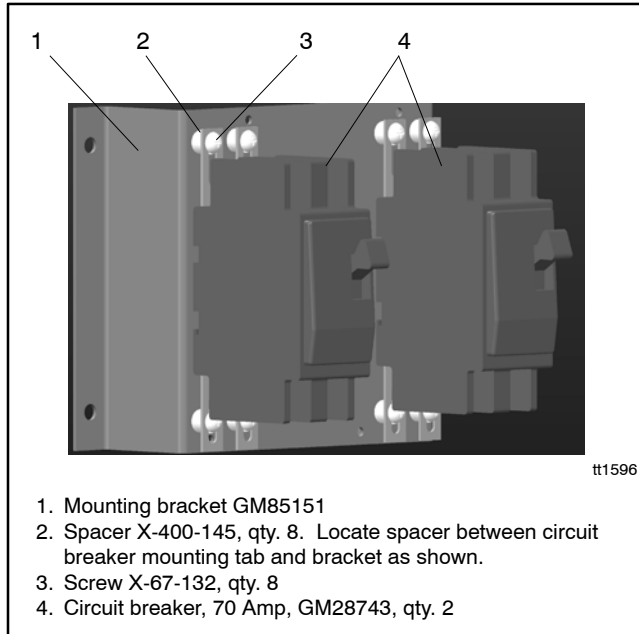


Figure 10 70 Amp Circuit Breaker Mounting, 14RESA

For the 20RESA or 20RESB, 100 amp circuit breakers:

- c. Use 2 X-67-132 thread-forming screws to attach each circuit breaker to the mounting bracket. See Figure 11.
- d. Connect the circuit breakers to the APM contactors using 4 leads LN-0407-0606 provided with the circuit breaker kit. See Figure 9 and the wiring diagram in Section 8 for circuit breaker connections.

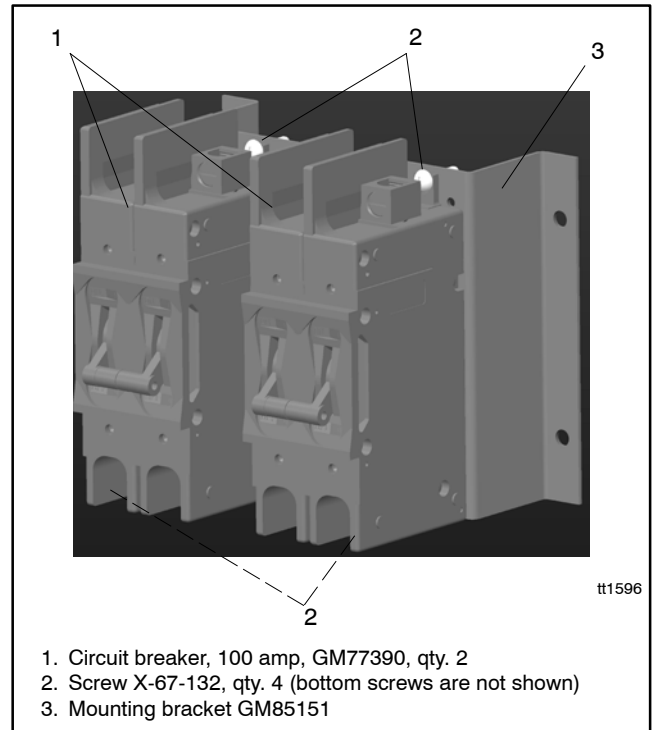


Figure 11 100 Amp Circuit Breaker Mounting, 20RESA and 20RESB

13. See Figure 9 and Figure 12. Carefully remove the knockouts for the circuit breakers in the inner cover of the enclosure:
 - a. Remove the larger portion on the left side of each knockout for the 70 amp breakers (14RESA) OR
 - b. Remove both portions of the knockout for the 100 amp breakers (20RESA/20RESB).

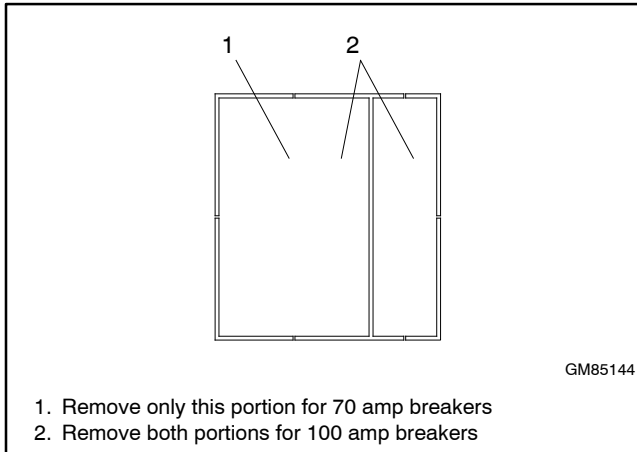


Figure 12 Circuit Breaker Knockouts

14. The decals shown in Figure 13 are provided in the literature bag with the APM. Attach the GENERATOR 1 and GENERATOR 2 decals above the circuit breakers as shown in Figure 9.
15. Attach the Service Disconnect decals to the outside of the inner cover near the openings for the circuit breakers. Be sure to correctly label the breakers for Generator 1 and Generator 2. See Figure 13 and Figure 9.
16. Close the circuit breakers between the APM and the generator sets.

The inner door for the APM enclosure will be installed later.

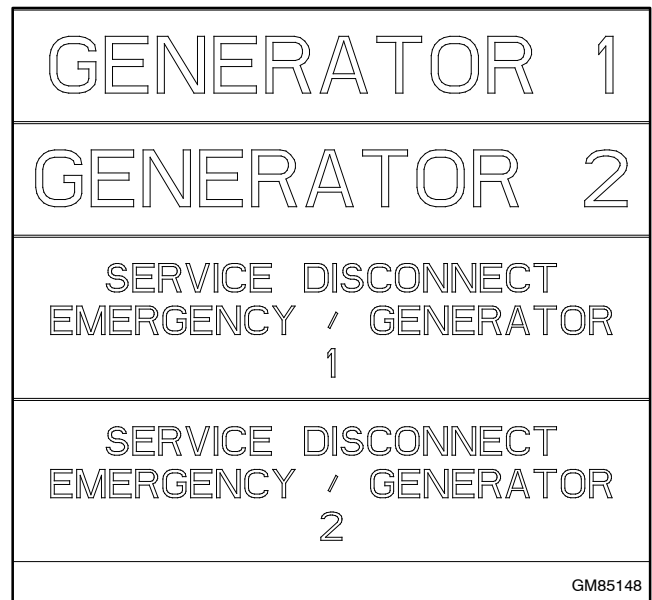


Figure 13 Decals provided with APM

1.4 Install the Model RXT transfer switch.

Note: Only one transfer switch can be used.

17. Install the ATS according to the installation instructions and dimension drawings in the transfer switch Installation Manual.
18. Do not connect the emergency source wiring or the RBUS connections until instructed later in this procedure.

1.5 Install the LCM or load shed kit and optional PIM, if used.

Note: One PIM and one LCM or load shed kit can be used. Multiple PIMs, LCMs, or load shed kits cannot be connected.

19. Follow the installation instructions provided with PIM and LCM or load shed kit(s).

Note: Connect sufficient non-critical loads to the LCM or load shed kit so that one generator set can support the remaining load, if necessary.

Note: Do not install the CT provided with the LCM or load shed kit. That CT is not needed, as the generator controllers each have built-in metering with the locally mounted CT that was installed in Section 1.1.

2 Connections

After the physical installation of the paralleling system components, make the electrical connections described in this section.

1. Press the OFF buttons on both generator set controllers.
2. Turn off the AC power that supplies the battery charger on both generator sets.
3. Disconnect the generator set engine starting battery(ies), negative (-) lead first.

Note: Route the communication cables in separate conduit from the power cables and voltage sensing leads.

Note: Refer to the block diagram in Figure 7 and the wiring diagrams in Section 8 when making the following connections. Be careful to connect Generator 1 and Generator 2 as instructed.

2.1 Voltage Sensing

4. Connect the voltage sensing leads from both adaptor harnesses installed in the generator compartment in step 5 to terminal block TB1 in the APM. See Figure 9 and Figure 14.
 - a. Connect voltage sensing lead V9 (RDC2 P2-8) from Generator 1 to TB1-1, labeled V9A, in the APM enclosure.
 - b. Connect voltage sensing lead V9 (RDC2 P2-8) from Generator 2 to TB1-2, labeled V9B, in the APM enclosure.

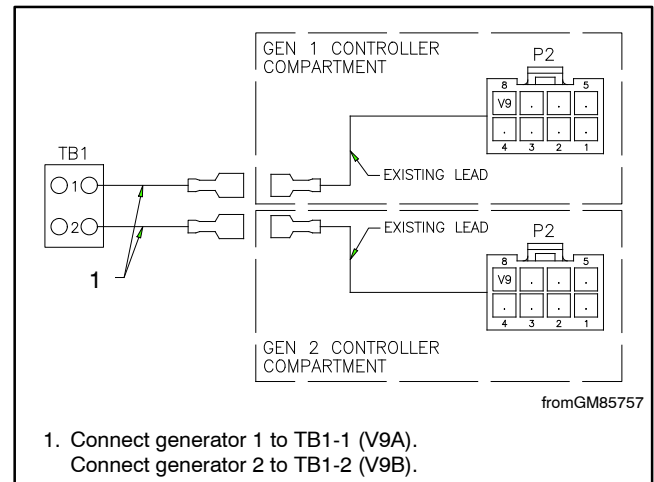


Figure 14 Voltage Sensing Connections

2.2 RBUS Communication Connections

Note: The RBUS communication wiring to the APM must be connected directly to the generator sets as shown in Figure 7. Other accessories such as the PIM, LCM, or load shed kit must be connected after the APM.

Measure the cable length from the furthest generator set to the last RBUS device in the system and compare to Figure 15. The maximum cable length depends on the number of optional modules connected. A module can be an APM, a Model RXT transfer switch, a programmable interface module (PIM), a load control module (LCM), or a load shed kit. See Figure 15 for the maximum cable lengths for 1, 2, 3, or 4 modules per cable run.

For RBUS communication connections A and B to the APM, Model RXT transfer switch, load control module (LCM), and/or optional PIM, use 20 AWG shielded, twisted-pair communication cable. Belden #9402 (two-pair) or Belden #8762 (single-pair) or equivalent cable is recommended.

For outdoor installations, including those with buried cables and/or conduit, use outdoor-rated Belden #1075A or equivalent 20 AWG shielded, twisted-pair communication cable.

For the PWR and COM connections from TB1 to the RXT, PIM, and/or LCM, use the second pair in the

two-pair communication cable for short runs, or use 12-14 AWG cable for longer runs as shown in Figure 15.

Note: All communication cables must be routed through conduit. Route the communication cables in separate conduit from the power cables.

5. Connect RBUS communication cables (A, B, PWR, and COM terminals). See Figure 16.
 - a. Connect the RBUS connections from the RDC2 controller on generator 1 to terminal block P21, labelled GEN 1, on the APM diode board.
 - b. Connect the RBUS connections from the RDC2 controller on generator 2 to terminal block P20, labelled GEN 2, on the APM diode board.
 - c. Connect P10 on the the APM PIB circuit board, which is mounted on the door, to the RXT interface board. See Figure 16.
 - d. If an optional PIM and/or LCM are used, connect the communication cables from the RXT to the accessory modules as described in the instructions provided with each module.
 - e. Connect the communication cable shields as shown in Figure 16, leaving one end disconnected.

Cable (TB1-PWR and COM)	Maximum length per run, meters (ft.)			
	Number of Modules (RXT, APM, PIM, and LCM or load shed kit) per Run			
	1 Module	2 Modules	3 Modules	4 Modules
Belden #9402 or equivalent 20AWG for indoor installations	46 (150)	15 (50)	5 (17)	Do not use 20AWG for PWR and COM
Belden #1075A or equivalent 20AWG for outdoor installations or buried cables	46 (150)	15 (50)	5 (17)	Do not use 20AWG for PWR and COM
14 AWG *	137 (450)	137 (450)	107 (350)	107 (350)
12 AWG *	137 (450)	137 (450)	137 (450)	137 (450)
* Use 12 or 14 AWG cable for PWR and COM connections only. For RBUS connections A and B, use shielded, twisted pair communication cable specified above.				

Figure 15 Maximum Communication Cable Lengths for Connection of RBUS Modules to the APM

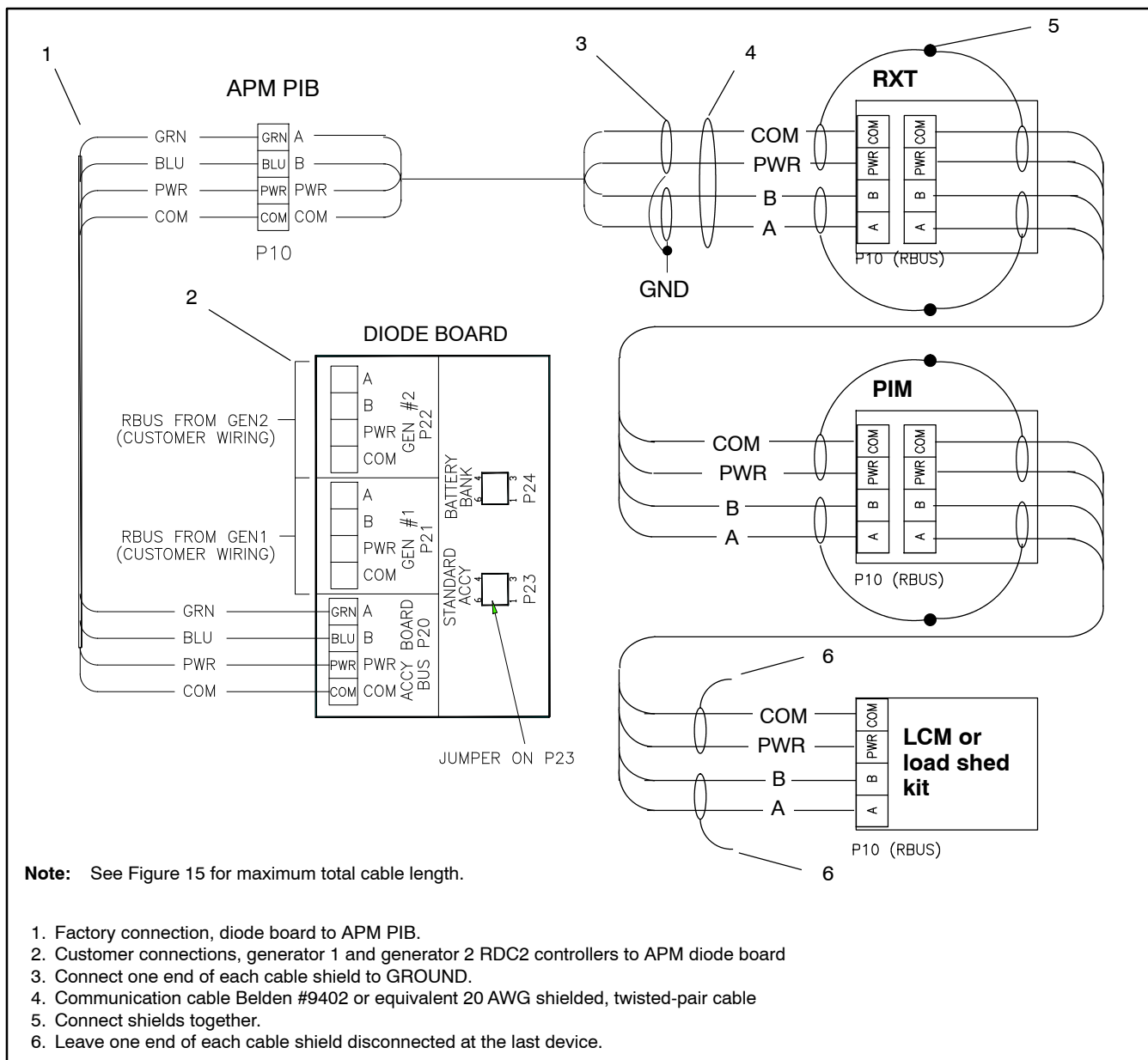


Figure 16 Communication (RBUS) Connection Details

2.3 AC Voltage Output Connections

6. Connect generator set AC output leads to the APM contactors or to the circuit breakers installed in Section 1.3, if used. Be sure to connect generator 1 to contactor 1 and generator 2 to contactor 2 in the APM. See Figure 17 or the wiring diagram, Figure 33.

Note: If the optional circuit breakers are used, connect to the circuit breakers rather than the APM contactors.

- a. Connect L1 from generator 1 to 1L1 at the APM contactor 1. Connect L2 from generator 1 to 3L2 on APM contactor 1.
- b. Connect L1 from generator 2 to 1L1 at the APM contactor 2. Connect L2 from generator 2 to 3L2 on APM contactor 2.

Note: L1 and L2 polarity is important. Reversing these leads is a common cause of auto-discovery failure.

7. Connect the GEN LOAD A, GEN LOAD B, and NEUTRAL lugs in the APM to the emergency source lugs on the RXT transfer switch. See Figure 33, wiring diagram.

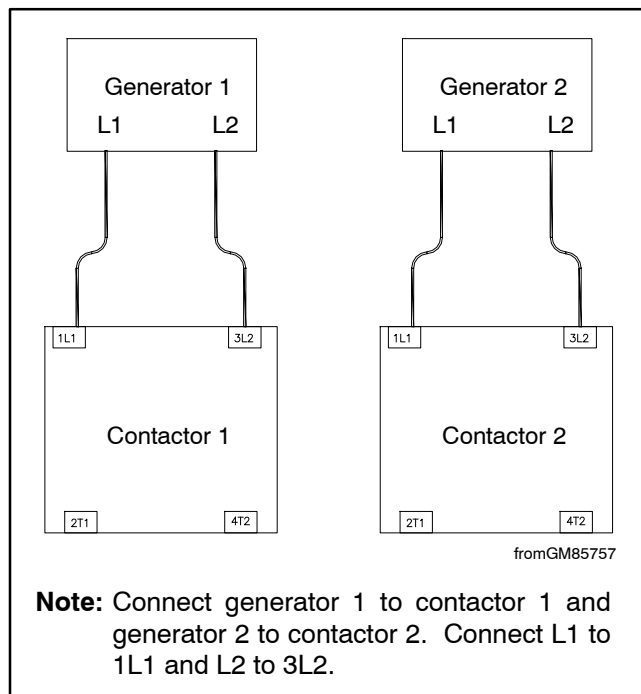


Figure 17 Generator Output Connections to APM Contactors (optional circuit breakers not shown)

2.4 Ethernet Connection for OnCue Plus

8. If OnCue® Plus will be used, connect both RDC2 controllers to the Internet by connecting to the Ethernet modem or router on the site. See the generator set Installation Manual for the location of the Ethernet cable on the generator set.

3 Prepare the equipment for operation.

3.1 Secure the APM enclosure and reconnect power to the generator sets.

1. The APM's NEMA 3R enclosure has a locking tab at the bottom of the enclosure. While the enclosure is open, turn the locking tab out so that the door can be locked with a padlock.
2. Install the inner door on the APM enclosure.
3. Install the APM enclosure door and use a customer-supplied padlock to lock the enclosure.
4. Reconnect the generator set engine starting batteries, negative (-) lead last.
5. Reconnect utility power to the generator sets.

3.2 Load firmware onto each generator set controller.

Note: A personal computer (laptop) with Kohler SiteTech™ software is required to complete the system installation and setup. SiteTech™ software is available to Kohler-authorized distributors and dealers.

Use a personal computer (laptop) and Kohler SiteTech™ software to load RDC2 paralleling firmware version 105.4 or higher. Download the paralleling firmware from TechTools and save it on the laptop. See TP-6701, SiteTech Software Operation Manual for instructions, if necessary. Load the paralleling firmware onto both generator sets' RDC2 controllers.

Note: Standard RDC2 controller firmware cannot be used on paralleled generator sets. The paralleling firmware is required.

Choose one generator set to be the primary device. The primary device will control the other RBUS devices (RXT transfer switch, PIM, and LCM, if equipped). The other generator set will be the secondary device.

1. Save the paralleling firmware file to your computer. The file name is RDC2_###_#.bin where ###_# is the code version number 105.4 or higher.
2. Use a USB cable to connect the laptop PC to the RDC2 controller on the primary generator set. Open the SiteTech program on the PC.
3. Load the paralleling firmware onto the RDC2 controller on the generator set. See TP-6701, SiteTech Software Operation Manual for instructions, if necessary.
4. Repeat steps 2 and 3 for the secondary generator set.
5. Check the firmware version number on each controller to verify that version number 105.4 or higher is loaded on each controller. See the generator set operation manual for instructions to check the firmware version number, if necessary.
6. If OnCue Plus will be used, refer to the instructions in the OnCue Plus Operation manual to set the password on each RDC2 controller.

3.3 Set the time, date, and exercise schedule on the primary generator set.

1. The RDC2 display on each generator set will prompt you to set the primary generator set. When the RDC2 controller powers up after the firmware update, the question "RBUS Primary?" will appear on the RDC2 controller display.
 - a. Use the up or down arrows to select TRUE for one generator set that you choose to be the primary generator set for controlling the exercise schedule, the PIM, and other RBUS devices.
 - b. Select RBUS Primary? FALSE on the other generator set.
2. Follow the instructions in the generator set installation manual to set the time, date, and exercise on the primary generator set only. The primary generator set communicates the exercise time to the secondary generator set, so that both generator sets exercise at the same time.
3. Proceed to Section 4, Setup and Commissioning.

4 Setup and Commissioning

The next procedures are **required** for setup and commissioning of the paralleling system.

Note: A personal computer (laptop) with Kohler SiteTech™ software version 3.5 or higher is required to complete the system setup. SiteTech™ software is available to Kohler-authorized distributors and dealers.

4.1 Verify communication connections.

Check the Network Information and Remote Devices menus on the RDC2 controller, or use Kohler SiteTech to check the RBUS Devices group parameters.

1. Verify that the primary controller recognizes the secondary controller as a “Kohler Power Generation Device.”
2. Check that the serial number of the Kohler Power Generation Device seen in the primary controller matches the serial number of the secondary controller. The secondary controller will not see the primary controller as an RBUS device.

Note: The controller serial number can be found in the RDC2 controller’s Genset Information menu.

4.2 Set up the LCM or load shed kit.

1. Check that the primary controller sees the LCM or load shed kit as an RBUS device. Check the Network Information and Remote Devices menus on the RDC2 controller, or use Kohler SiteTech to check the RBUS Devices group parameters.
2. Use SiteTech software connected to the primary controller to set the following parameters on the LCM.
 - a. Set the Genset Maximum Percent Capacity on the LCM or load shed kit to a higher value than the Automatic Stop Minimum Percent setting on the APM. See Figure 21 for the APM settings.
 - b. Set the Generator Overload Percent setting on the LCM or load shed kit at least 20% higher than the Automatic Stop Minimum Percent Load setting on the APM..

See instruction sheets TT-1574 for the LCM or TT-1609 for the load shed kit, if necessary.

4.3 Set up the PIM, if equipped.

If the system does not include a programmable interface module (PIM), proceed to Section 4.4.

1. If an optional Programmable Interface Module (PIM) is connected to the system, check that the primary controller sees the PIM as an RBUS device. Check the Network Information and Remote Devices menus on the RDC2 controller, or use Kohler SiteTech to check the RBUS Devices group parameters.
2. Use SiteTech software connected to the **primary** controller to set up the PIM inputs and outputs. See TT-1584, provided with the PIM, for the default input and output settings. See TP-6701, SiteTech Software Operation manual, for instructions to change the settings, if necessary.
3. Set the PIM settings on the secondary controller to match the primary controller’s PIM settings.

Although the secondary controller only reads the system status and does not control the RBUS devices, the PIM configuration on the secondary controller should be set up to match the primary so that the primary status can be switched between the controllers.

4.4 Perform the auto-discovery procedure.

Note: This procedure is **REQUIRED**.

1. Close the circuit breakers on both generator sets and in the APM (if equipped with the optional circuit breaker kit).
2. Press OFF on generator set 2. Press RUN to start generator set 1.
3. After generator 1 starts, the controller cycles through the relays in the APM. This process is necessary for the APM to recognize the output that drives the contactor, which connects the generator set to the paralleling bus.

Note: The contactor status will indicate that the contactor is closed during the process, but the status may display the wrong generator until auto-discovery is complete.

4. Verify that the connection LED on the APM lights to indicate that the generator set is connected. If the correct output is detected, it will turn on, turn off, turn on again and remain on. After successfully closing the contactor that connects a generator to the bus, the controller will remember which contactor is associated with that generator.
5. Press OFF to stop the generator set 1. Press RUN to start generator set 2. Repeat steps 3 and 4 for the other generator in the system to verify the relay cycling.

Troubleshooting Auto-Discovery

If the connection LED on the APM fails to illuminate or the relays do not cycle, check the following:

- Check the wiring between the generator and the APM. Pay special attention to the L1 and L2 connection.
- Check the connection of the sensing wire to V9 on the generator wiring harness. See Figure 14.
- Verify that generator 1 is connected to contactor 1 and generator 2 is connected to contactor 2 in the APM.

If the relays continue to cycle, even after the generator source on the ATS has indicated availability, check the wiring to both generator sets, especially the wiring from V9A and V9B on the APM transformers to the V9 terminals on the generator controllers. This connection is necessary for the auto-discovery of the output contacts.

If the correct output is detected, it will turn on, turn off, turn on again, and remain on. If the output continues to cycle on and off, verify that L1 and L2 are connected correctly from the generator to the APM. Verify that L1 and L2 are consistent throughout the APM. Make sure that the wiring in the APM has not been modified – the bus sensing needs to be accurate.

In SiteTech™, observe the Generator Voltage L2-L3 parameter. This voltage should match generator voltage L1-L2 when the contactor is closed, and read 0 (zero) volts when the contactor is open. If the Voltage L2-L3 parameter reads more than 200 volts when both contactors are open, reverse the L1 and L2 connections between that generator and the APM.

4.5 Verify synchronization and calibration.

1. Start generator 1 by pressing RUN on the RDC2 controller.
2. When the generator reaches rated voltage and frequency, verify that the corresponding contactor in the APM closes.
3. Verify that the Generator Rotation Actual parameter (under Generator Metering in SiteTech) reads a number between -300 and 300 (-30° and 30° phase angle across the closed contactor). If the Generator Phase Rotation is outside this range, the RDC2 controller on Generator 1 is not sensing the bus direction accurately.
4. Calibrate the voltage metering on Generator 1.
5. Calibrate the bus metering (listed as Generator Voltage L2-L3). Always calibrate the bus voltage with the generator running and the paralleling contactor closed.
 - a. The bus metering should match the calibrated generator metering.

Note: It is normal for the bus voltage to vary more than the generator voltage. Try to match the average bus voltage reading with the generator voltage.

 - b. Increase the Genset Calibration Factor Voltage L2-L3 to increase the measured bus voltage.
 - c. Decrease the Genset Calibration Factor Voltage L2-L3 to decrease the measured bus voltage.
6. Stop generator 1 and repeat the steps above for generator 2.
7. After completing synchronization checking, stop both generators and place them both in Auto (note: the generators will start if there is not utility present on the ATS).

4.6 Verify current metering.

1. Check that both generator sets are in AUTO mode.
2. Open the utility source breaker to the ATS to simulate loss of utility power. A loaded exercise can also be used. *

* A loaded exercise can be set at the generator controller.

3. Verify that the generators start, synchronize and close both contactors. This will enable the controllers to verify the metering. The engines may appear slightly unstable during the verification process.
4. Once the verification process is complete, the ATS will transfer. At this point, the metering has been verified.

Note: The metering verification only needs to be performed once. Subsequent losses of utility will result in more timely transferring of the ATS.
5. Close the utility source circuit breaker or wait for the loaded exercise to end. Verify that the ATS transfers to utility and both generator sets shut down.
6. Verify that both generator sets are in the AUTO mode after commissioning is complete.

Troubleshooting Current Metering

If a generator shuts down and the RDC2 controller displays “No Current Shutdown,” verify that the AC output wires are crossing through the CT in opposite directions as shown in Figure 5 and that the CT is connected to the generator controller at P3. Correct and retry the current metering test from step 1 in Section 4.6.

The message “ErraticSig Shutdown Current Metering” indicates that the current reading is very unstable. Otherwise, the controller has successfully determined the direction of the CT connection on the generator when the ATS transfers.

4.7 Final adjustments.

At this point, the paralleling system is capable of providing power to the loads connected to ATS. Further adjustment of gains and windows to optimize performance can be completed at this time, if desired.

See Section 5.3.2, Order Selection Method, for instructions to set the generator set order of operation manually or to select the runtime hours method, which balances the generator set operation times according to the number of hours on each generator set. The runtime hours method is the default selection.

5 Operation

5.1 Synchronization and Paralleling

The RDC2 controllers on Generator 1 and Generator 2 control the synchronizing and paralleling of the generators. Each controller is responsible for making the required adjustments to synchronize to the other generator and to share real and reactive load once the generators are both online. The synchronizing and paralleling process starts after the generator reaches rated voltage and frequency and consists of 3 steps:

1. First-on determination
2. Synchronizing
3. Paralleling

These steps are described in the following sections.

5.1.1 First-On Determination

The generators exchange information across the RBUS network. When one of them is running at rated voltage and frequency, it alerts the other, then closes the paralleling contactor in the APM, which connects it to the bus.

Note: Either generator can be the first to close to the bus, depending on which one starts and reaches rated voltage and frequency first.

5.1.2 Synchronizing

Once one of the generators is connected to the paralleling bus in the APM (it is now called the running generator), the other generator (called the incoming generator) will see voltage on the bus and synchronize to it. If the incoming generator does not see voltage on the bus, the controller will issue a BusDeadLive warning.

Synchronizing involves adjusting the speed of the engine for the incoming generator until the dips and swells in the voltage waveform (which is roughly sinusoidal) align with the dips and swells in the voltage waveform of the running generator (which is trying to maintain a constant speed). When the waveforms align, the generators are considered synchronized. Figure 18 illustrates typical voltage waveforms when they are not synchronized.

Synchronizing also verifies that the bus voltage is not appreciably different than the generator voltage. If the voltage is significantly different, the controller will adjust the generator voltage to match. This is why the bus voltage must be calibrated as described in Section 4.5.

When the generators are synchronized, the paralleling contactor for the incoming generator will also close.

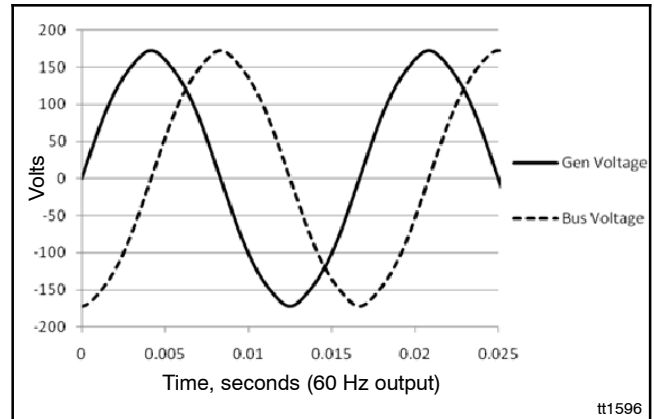


Figure 18 Voltage Wave Forms, Not Synchronized

5.1.3 Paralleling

After both contactors are closed, the generator controllers will act to ensure that the voltage regulators are targeting the same voltage (which should be nearly identical if the controllers are calibrated accurately) and that their throttles are effectively in the same position.

Voltage regulator target voltage differences are measured by the controller as reactive power. A positive reactive power (generated VARs) from a generator means that the voltage regulator on that generator is adjusted higher than the voltage regulator on the other generator. A negative reactive power (absorbed VARs) from a generator means that the voltage regulator on that generator is adjusted lower than the voltage regulator on the other generator. The controllers will adjust the target voltage on each generator up and down in an effort to make the reactive power match. The sum of the reactive power of generator 1 and generator 2 is the reactive power demanded by the load. This will typically be very low, unless a large motor is starting.

Throttle position variations are measured by the controller as real power. Opening the throttle on one of the generators will result in that generator producing more power. The controllers adjust the target speed of the engine (an input to the governor, also contained in the controller) to match the real power of the generators. The sum of the real power on generator 1 and generator 2 is the real power provided to the load. This is the load used for generator management calculations and for the load control module.

If any voltage dip is observed (typically by dimming lights) when a generator closes the paralleling contactor after synchronizing, it may be necessary to determine if the fuel systems of the generators are allowing them to maintain a stable speed. (The speed must be changing at the moment that the contactor closes).

If the throttle of one of the generators is closed or the generator fuel supply is exhausted, the generator will start to absorb power. This means that the alternator is acting as a motor and is spinning the generator. When this occurs the other generator will have to supply power to the load and supply power to the generator that is “motoring”. The controller will sense this condition and open the paralleling contactor for the generator that is absorbing power after 20 seconds.

5.2 Primary and Secondary Controllers

The generator set controllers are designated as primary and secondary.

The RBUS primary controller is responsible for initiating all communication over RBUS.

- The primary controller operates all of the RBUS modules (RXT transfer switch, PIM, and LCM).
- The primary controller reads status from all RBUS modules.
- If the primary controller loses power, RBUS communication for the paralleling system is lost.

The RBUS secondary controller responds to requests from the primary controller.

- The secondary controller monitors activity on the RBUS but is not able to control any RBUS devices.
- The secondary controller receives generator management information from the primary controller.
- The secondary controller can only change the state of the contactor for the secondary generator if the primary controller sends a request to close.

Note: The primary and secondary controller designations will change if AUTO-OFF is pressed on the primary controller. See Section 5.3.2.

5.3 Generator Management

The paralleling system performs generator management as described below.

- If one generator does not start, the other generator remains online and supplies as many loads as it can support. The LCM or load shed kit sheds the loads that exceed the capacity of the generator set.
- After both generators are connected to the load, one generator will disconnect from the bus and shut down if not needed for 5 minutes. If a load control module or load shed kit is connected, the generator will stop 5 minutes after all of the loads are added. The minimum time before a generator will stop is 5 minutes without a load management device and 11 minutes with a load management device.
- The generator management logic alternates generator set operation when possible to equalize the generator set run times.
- Operating order is changed during operation if the generator set run time hours differ by more than 24 hours.
- Generator management logic is solved in the primary controller. Generator management configuration is verified in the secondary controller when it connects. A message will warn the user of a difference in configuration.
- The primary controller can overwrite the configuration in each of the attached devices. Changing a generator management parameter setting at the primary controller will change the setting on both generator set controllers.

5.3.1 Generator Management Operation

If a single generator is overloaded, the load control module (if equipped) will shed load until the other generator has come online.

Generator Management requires the following to be true before it will consider stopping a generator:

- An ATS start signal is present, a loaded exercise is active, or an unloaded full-speed exercise is active.
- Both generators are online.
- All load control priorities have been added (generator management does not wait for all loads to be added if no Load Control Module exists on the RBUS network).
- The system has been stable (no changes in the above conditions) for 5 minutes.

Generator Management will start the second generator and run it for at least 5 minutes if it senses any of the following:

- The running generator fails (disconnects from the paralleling bus).
- A load is shed.

Generator Management stops generators based on the Automatic Stop Minimum Percent Load (Automatic Stop) parameter and the load on the system. The Automatic Stop setting is adjustable using SiteTech. The time before a generator is started or stopped depends on the difference between the maximum or minimum load setting and the load on the system.

- Lower loads result in quicker stopping and slower starting of a generator.
- Higher loads result in slower stopping and quicker starting of a generator.

The effect of the load on the start and stop times is illustrated in Figure 19 and Figure 20.

The generators will soft-unload when stopped by generator management. This means that the controller slowly closes the throttle and decreases the target voltage of one of the generators until it has minimal current flowing through the paralleling contactor. Then the controller will open the contactor, resulting in a smooth load acceptance by the other generator (no sudden changes in load).

Generator Management Settings

The parameters used for generator management are shown in Figure 21.

- The Automatic Stop Minimum Percent Load Delay is the time, in seconds, that the generator will take to stop if the load is 10% below the Automatic Stop Minimum Percent Load.
- The Start Delay is the time, in seconds, that the generator will take to start if the load is 10% above the Automatic Start level.

Notes about Load Shed Settings

Compare the APM settings to the settings on the LCM or load shed kit.

- Set the Generator Overload Percent setting on the LCM or load shed kit at least 20% higher than the APM Automatic Stop Minimum Percent Load setting.
- Set the generator Maximum Percent Capacity on the LCM or load shed kit higher than the APM Automatic Stop Minimum Percent Load setting.

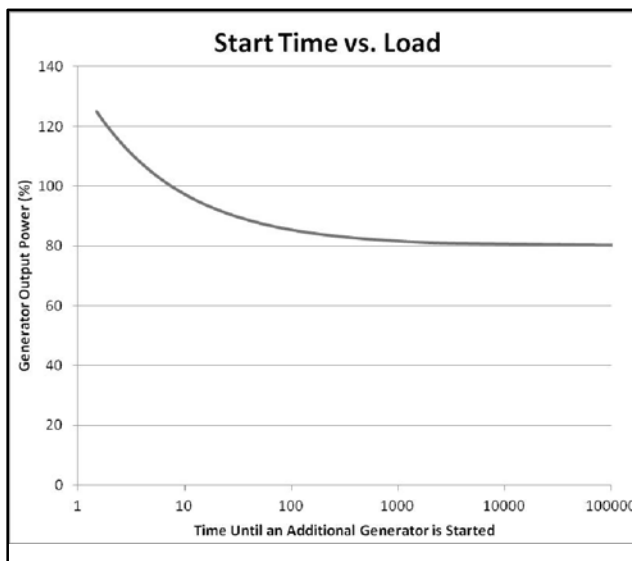


Figure 19 Start Time vs. Load

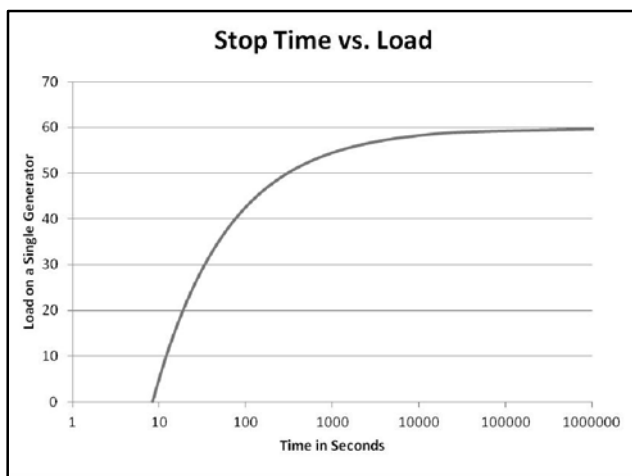


Figure 20 Stop Time vs. Load

Generator Management Parameter	Default	Maximum Setting
Automatic Stop Minimum Percent Load (Automatic Stop) *	20%	65%
Automatic Stop Minimum Load Delay (Stop Time Delay)	180 seconds (3 min.)	3600 seconds (1 hr.)
Automatic Start	Automatic Stop + 20%	
Start Delay	Stop Time Delay/10	
* See Notes About Load Shed Settings.		

Figure 21 APM Generator Management Settings

5.3.2 Order of Operation

There are two methods for selection of the generator set order of operation: runtime hours selection mode and manual selection mode.

Runtime Hours Selection Mode

Pressing the Auto and Run buttons simultaneously will place the generators in Runtime Hours selection mode. In Runtime Hours mode:

- The generator that has the fewest hours when the start signal is received continues to run.
- If the runtime on the running generator becomes at least 12 hours greater than the runtime on the stopped generator, they will switch roles.
- The running generator will automatically cycle every 24 hours (by nature of the above).

Manual Selection Mode

Pressing the Auto and Off buttons simultaneously will place the generators in Manual Selection mode. In Manual Selection mode:

- One generator always stops first. Press Auto-Off on the generator that should always stop first. The other generator set controller becomes the primary controller.
- If the load is too large for one generator, the other will run as well.
- If one generator fails, the other will start.
- See Auto-Off Functionality, below, for more information.

Auto-Off Functionality

Pressing the Auto and Off buttons simultaneously will cause the generator to attempt to unload and disconnect from the bus. The generators go into manual selection mode.

- If the load is too high, the generator will wait until the load decreases to stop the generator.
- If the generator goes into unloading state, the controller display indicates "Genset State Unloading".
- After the generator has unloaded, the contactor for that generator opens and the generator will either go into cooldown or stop immediately, depending on the engine temperature.
- After the contactor for this generator is open (during the stopping state) the other controller becomes the primary controller. The primary controller does not change until the acting primary disconnects from the paralleling bus.
- The ATS status lights blink off momentarily to indicate that the primary controller has transferred (no interruption in power will occur).

Pressing Auto and Off simultaneously is also used to remove one generator set from operation for maintenance or service, as described in the next section.

5.4 Generator Set Maintenance

When it is necessary to perform maintenance or service on the generator sets, use the following procedure to remove one generator set from the system at a time.

1. On the generator set to be serviced, press the AUTO and OFF buttons on the RDC2 controller simultaneously for about 1 second.
2. Wait for the generator set to shut down. Turn off non-critical appliances to reduce the load, if necessary.
3. Press OFF to shut down the generator set, if necessary.
4. Disconnect utility power to the generator set.
5. Disconnect the generator set battery, negative (-) lead first.
6. Follow the instructions in the generator set manual to service the unit as needed.
7. Reconnect the generator set battery, negative (-) lead last.
8. Reconnect utility power to the generator set.
9. Press the AUTO and RUN buttons on the RDC2 controller simultaneously to return the system to runtime hours mode, if desired.

5.5 Faults

Fault messages displayed on the RDC2 controller are shown in Figure 22 and Figure 23.

To clear the warnings listed in Figure 22 press AUTO or OFF.

- Press AUTO to clear the fault without shutting down the generator set.
- Pressing OFF will clear the fault AND stop the generator set.

LossOfComAPM Fault

One possible cause of this fault is that the primary controller is powered down. If the primary controller is powered off without using the AUTO-OFF sequence described in Section 5.3.2, the paralleling system will not function. To allow the system to function, go to the secondary controller's Communications menu, RBUS network. Set RBUS primary to True on the secondary controller. When the former primary controller powers up again, set RBUS Primary? to False. .

Fault Text	Description	When Active	Warning Delay	Display Cleared On
Voltage L1-L2 High Warning	Over Voltage	Paralleled	10	Press AUTO or OFF *
Voltage L1-L2 Low Warning	Under Voltage	Paralleled	10	Press AUTO or OFF *
Frequency High Warning	Over Frequency	Paralleled	10	Press AUTO or OFF *
Frequency Low Warning	Under Frequency	Paralleled	10	Press AUTO or OFF *
Current A High Warning	Over Current	Paralleled	10	Press AUTO or OFF *
Reactive Power Low Warning	Loss of Field	Paralleled	10	Press AUTO or OFF *
Real Power High Warning	Over Power	Paralleled	10	Press AUTO or OFF *
Real Power Low Warning	Reverse Power	Paralleled	10	Press AUTO or OFF *
* Pressing OFF will stop the generator set.				

Figure 22 Warning Messages (protective relay disconnect)

Fault Text	Description	Possible Causes
CfgModelNum	The two generators which are intended to be paralleled have different model numbers.	Incorrect configuration of one of the generators. Different generator types. The paralleled generator sets must be the same kW model. (i.e. two 14RESAs, two 20RESAs, or one 20RESA and one 20RESB.)
LossOfComm2	The Primary controller has lost communication with the secondary controller. (A secondary controller was detected, then communication was lost.)	RBUS disconnected, secondary controller battery disconnected, updating firmware in secondary controller, or intermittent RBUS connections.
CfgSysVolt	The system voltage of the two generators intended to be paralleled is not the same. Because the system does not know which voltage is correct, the generators will not be allowed to start.	One of the two generators is incorrectly configured. Intermittent connections on RBUS network wiring.
LossOfComAPM	The Automatic Paralleling Module has stopped communicating on RBUS. (An APM was detected on the RBUS network but is no longer communicating.)	APM is unplugged. Primary controller is powered down. Check the battery connections. See previous page for more information. Intermittent connections on RBUS network wiring. Check RBUS communication connections.
SyncFailure	The generator has been attempting to synchronize for over 2 minutes without success.	Generator is hunting (fuel system). Advanced speed control settings need adjustment. Load is changing frequently to disturb the online generator.
MeteringOk	The Generator has verified that the metering is connected correctly and that the direction is consistent with expected power direction.	Status message indicates that the CT is connected to the generator correctly.
NoCurrent	The generator has applied load (using the other generator) and has observed no current on the power sensing inputs.	The CT is not connected to the controller. The output leads from the generator do not go through the CT in the correct direction. See Figure 5.
ErraticSig	The Power metering on this controller gives a signal that is not consistent with the system configuration. Reversing the power direction does not resolve the problem.	Bad wiring to the CT. Too much tension on wires from the CT to the controller.
ChkngMeter	This generator has paralleled to the other generator and is verifying that the metering is connected and establishing the connection direction.	Status message appears the first time the two generators are paralleled.
MeterUnknown	This generator does not know if the metering is connected or the orientation of the connection. This means that the generators can't share load accurately until this information is known.	System commissioning and startup not yet complete. See Section 4.
ConNotDeterm	APM connection auto-discovery is not complete. This means that the generator does not know which contactor is connected to it.	Generators not yet started in RUN with other generator in OFF. See Section 4.4, perform the auto-discovery procedure.
ConChecking	Performing APM connection auto-discovery.	This generator has started in RUN, the other generator is in OFF.
ConCheckFail	Failure to Auto-Discover APM connections.	Wires 9A and 9B crossed between the generators. Wires 9A or 9B not connected
ContactorOk	Successful auto-discovery of APM connections.	Auto-discovery was activated by placing other generator in OFF and this generator in RUN.

Fault Text	Description	Possible Causes
LossOfField	This generator has absorbed more than 25% reactive power (magnetic excitation current) for 20 seconds	Generator voltage on this generator is not calibrated correctly. Generator voltage on other generator is not calibrated correctly. Bus voltage on this generator is not calibrated correctly. Bus voltage on the other generator is not calibrated correctly.
BusDeadLive	The Bus is measured to be dead when one of the generators is supposed to be supplying voltage to the bus (closed contactor)	Bus metering V9A and V9B connections to V9 of paralleling protection harness are connected incorrectly.
BusLiveDead	The Bus is measured to be live when no generators are connected to it (both contactors open).	Bus metering V9A and V9B connections to V9 of paralleling protection harness connected incorrectly.

Figure 23 Other Events

5.6 Status Indicators

The APM is equipped with an LED panel that indicates the system status. See Figure 24 and Figure 25.

Note: A model RXT transfer switch is required for power connection status indication. See Figure 25.

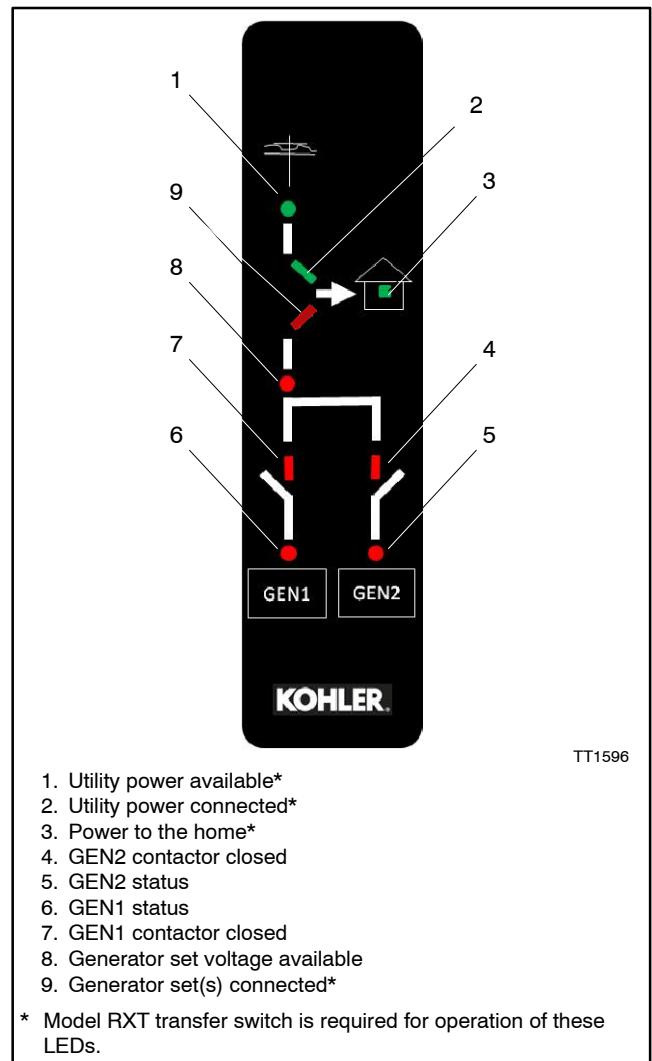


Figure 24 Status Indicators

LED Indicator	LED Color	LED State		
		OFF	Flashing	ON
Utility power available *	Green	Not available	—	Utility power available
Utility power connected *	Green	Not connected	—	Utility power connected
Power to home *	Green	No power to the home	—	Home has power
GEN1 status	Red	Not running	Genset fault	Generator is running
GEN1 contactor closed	Red	GEN1 contactor open	Synching	GEN1 contactor closed, providing power to the home
GEN2 status	Red	Not running	Genset fault	Generator is running
GEN2 contactor closed	Red	GEN2 contactor open	Synching	GEN2 contactor closed, providing power to the home
Generator set voltage available	Red	Generator set voltage not available	—	Generator set voltage available
Generator set(s) connected *	Red	Generator power not connected to the home	—	Generator power connected to the home

* Model RXT transfer switch is required for operation of these LEDs.

Figure 25 LED Operation/Status Indication

6 OnCue Plus Generator Management System

The APM kit includes two OnCue® activation codes to allow the connection of both generator sets to the OnCue Plus server. Follow the instructions in the OnCue Plus Operation manual to connect both generator sets to OnCue.

The OnCue Plus Status view will show two generator sets. See Figure 27. The secondary generator set can monitor the RBUS devices such as the optional PIM, but cannot control them.

The primary and secondary generator sets can be changed using the RBUS settings on the RDC2 controllers or using SiteTech™ software to change the Modbus Master parameter. SiteTech version 3.5 or higher is required. The AUTO-OFF procedure described in Section 5.3.2 can also change the primary and secondary designations.

The generator set states shown in Figure 26 are unique to a paralleling system. The generator set state is displayed in the power chain view as shown in Figure 27.

Generator Set State	Description
Synchronizing	The generator is actively trying to match frequency, voltage and phase with that of the paralleling bus.
Generator Management Off	This generator has been stopped by generator management because it is not presently needed to supply the load. The generator is available and will start if it is needed again.
Unloading	The generator is actively trying to transfer load from itself to the other generator.
ProtectiveRelayTrippedContactor	The contactor has been forced to open to protect one of the generators or the customer's load.

Figure 26 Generator Set States Related to Paralleling

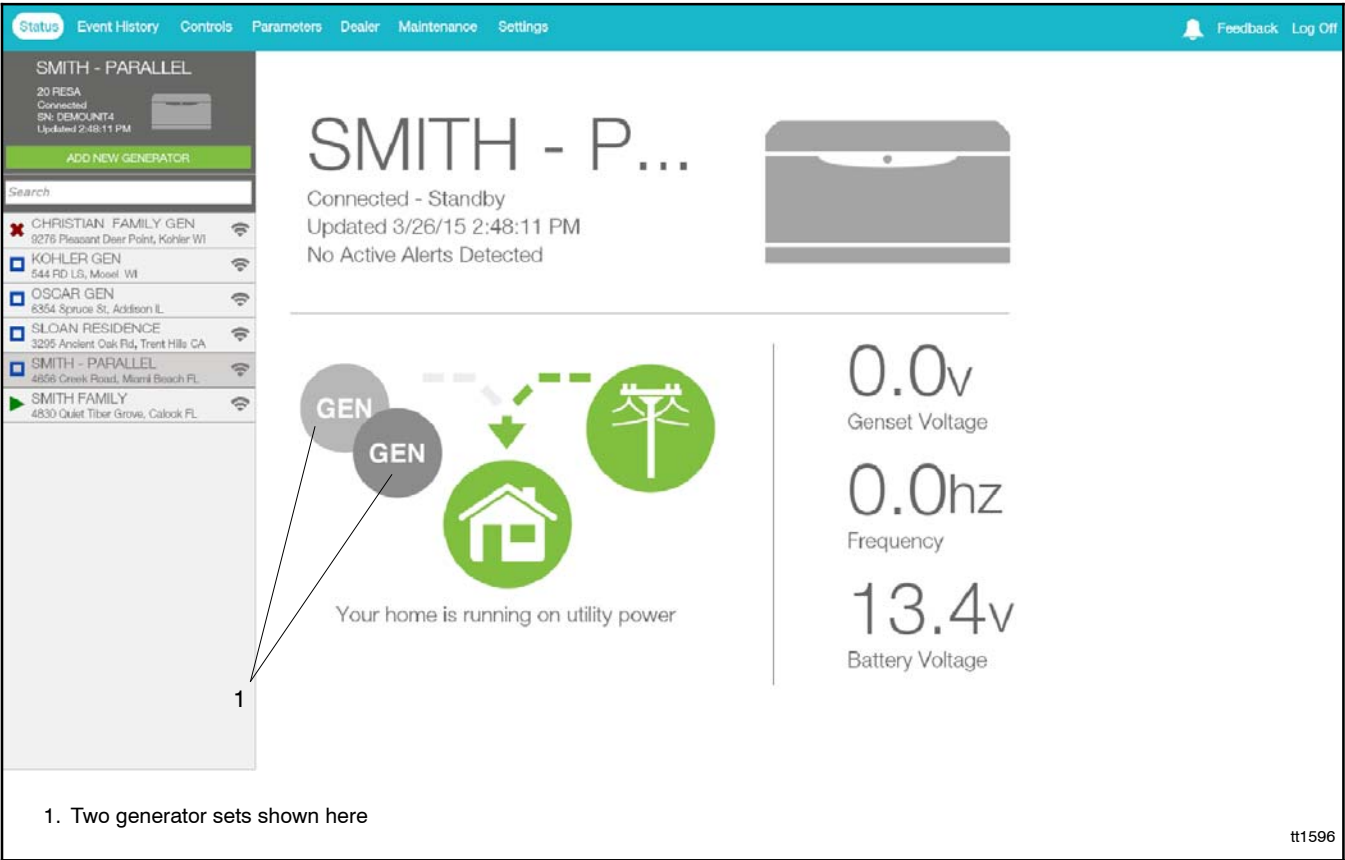


Figure 27 OnCue Plus Status View with Paralleled Generator Sets

7 Additional Troubleshooting

If the paralleling system does not operate as expected, check the items in the following tables. Section 4 also includes some troubleshooting tips for problems that may arise during the initial setup.

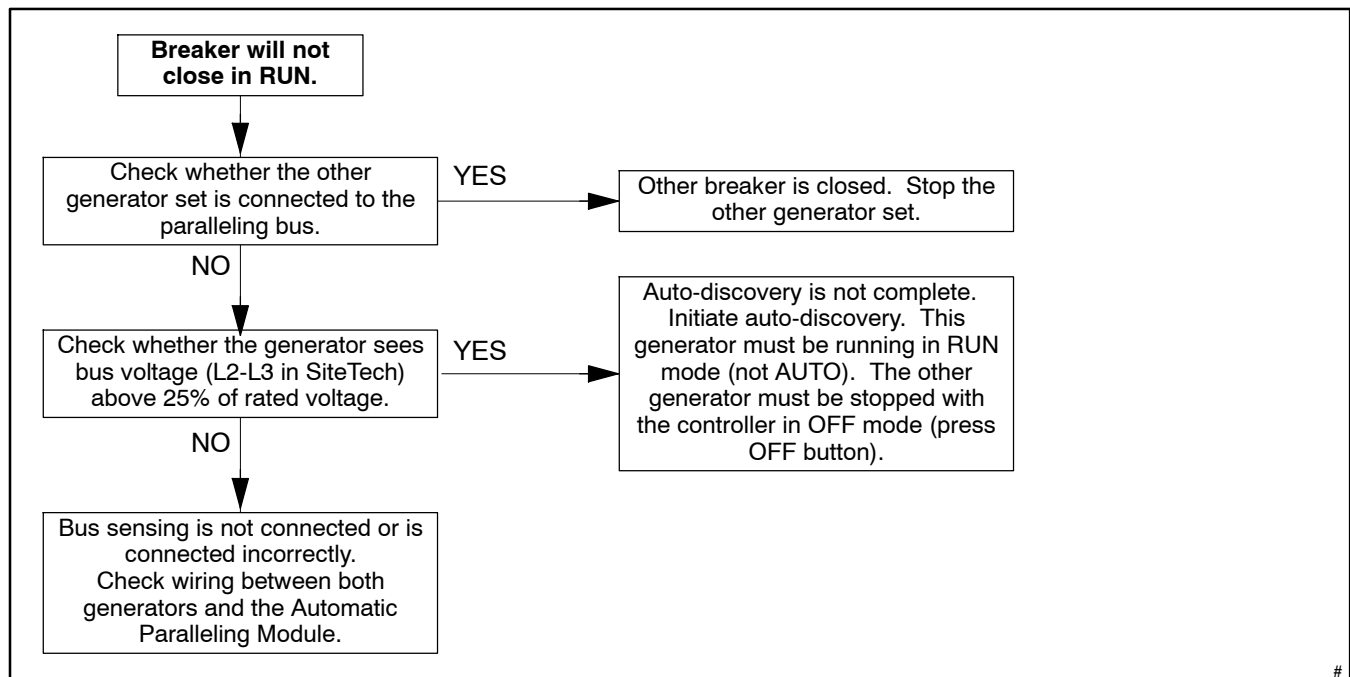


Figure 28 Troubleshooting: Breaker Will Not Close

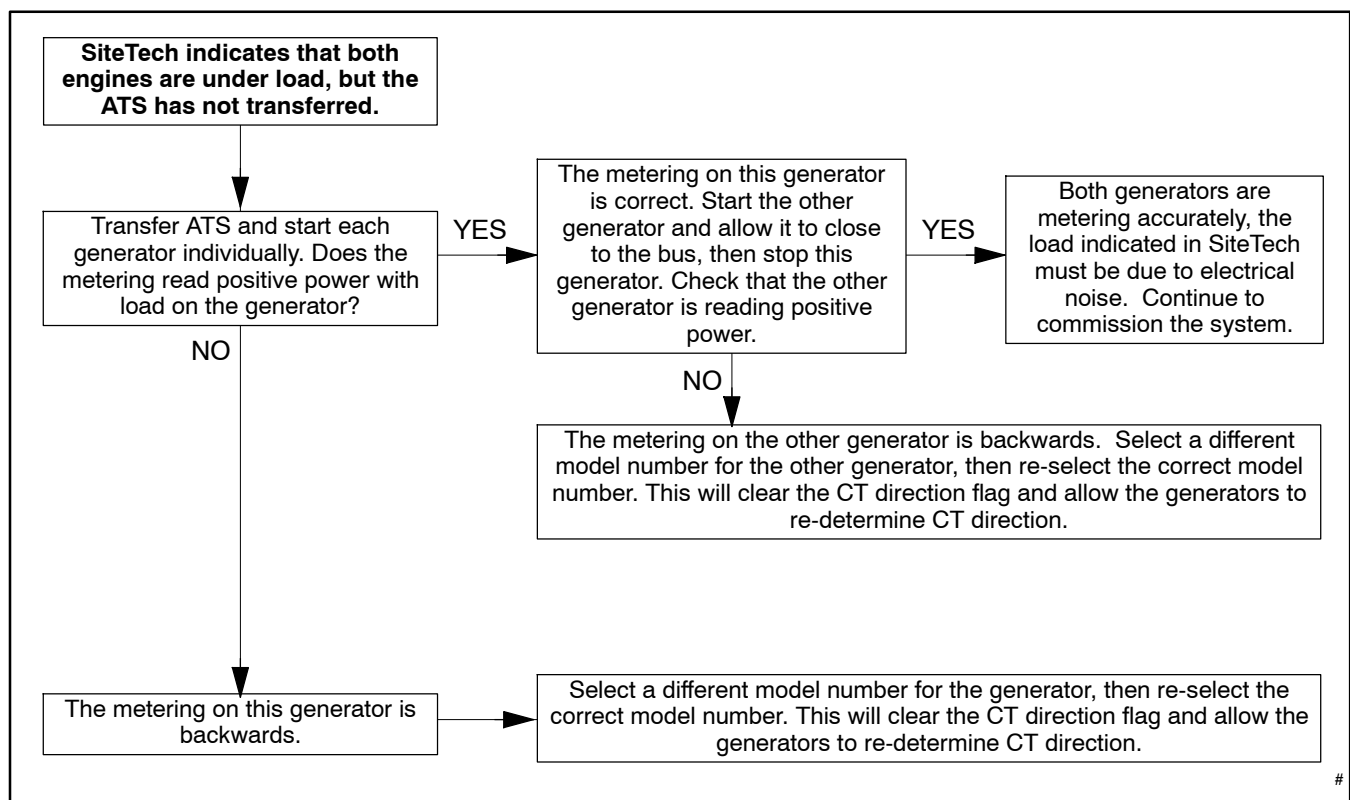


Figure 29 Troubleshooting: ATS Has Not Transferred

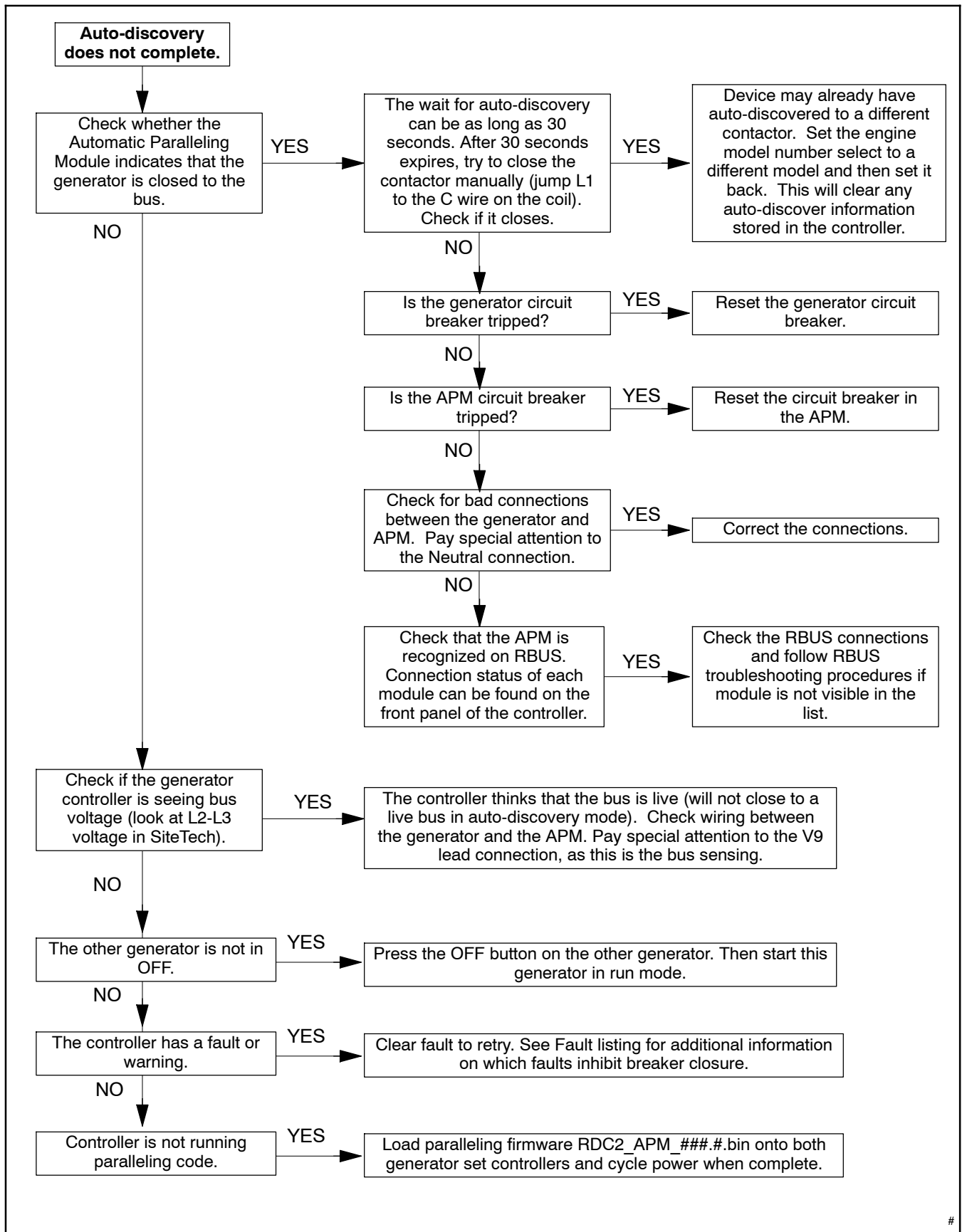


Figure 30 Troubleshooting: Auto-discovery

8 Diagrams and Drawings

The paralleling system dimension drawing, wiring diagram, and schematic diagram are shown on the following pages. Also refer to Figure 7, Block Diagram, on page 5.

Diagram or Drawing	Drawing Number		Page
APM Dimension Drawing	ADV-8518	Sheet 1	30
		Sheet 2	31
Wiring Diagram	GM85757	Sheet 1	32
		Sheet 2	33
Schematic Diagram	GM85758	Sheet 1	34
		Sheet 2	35





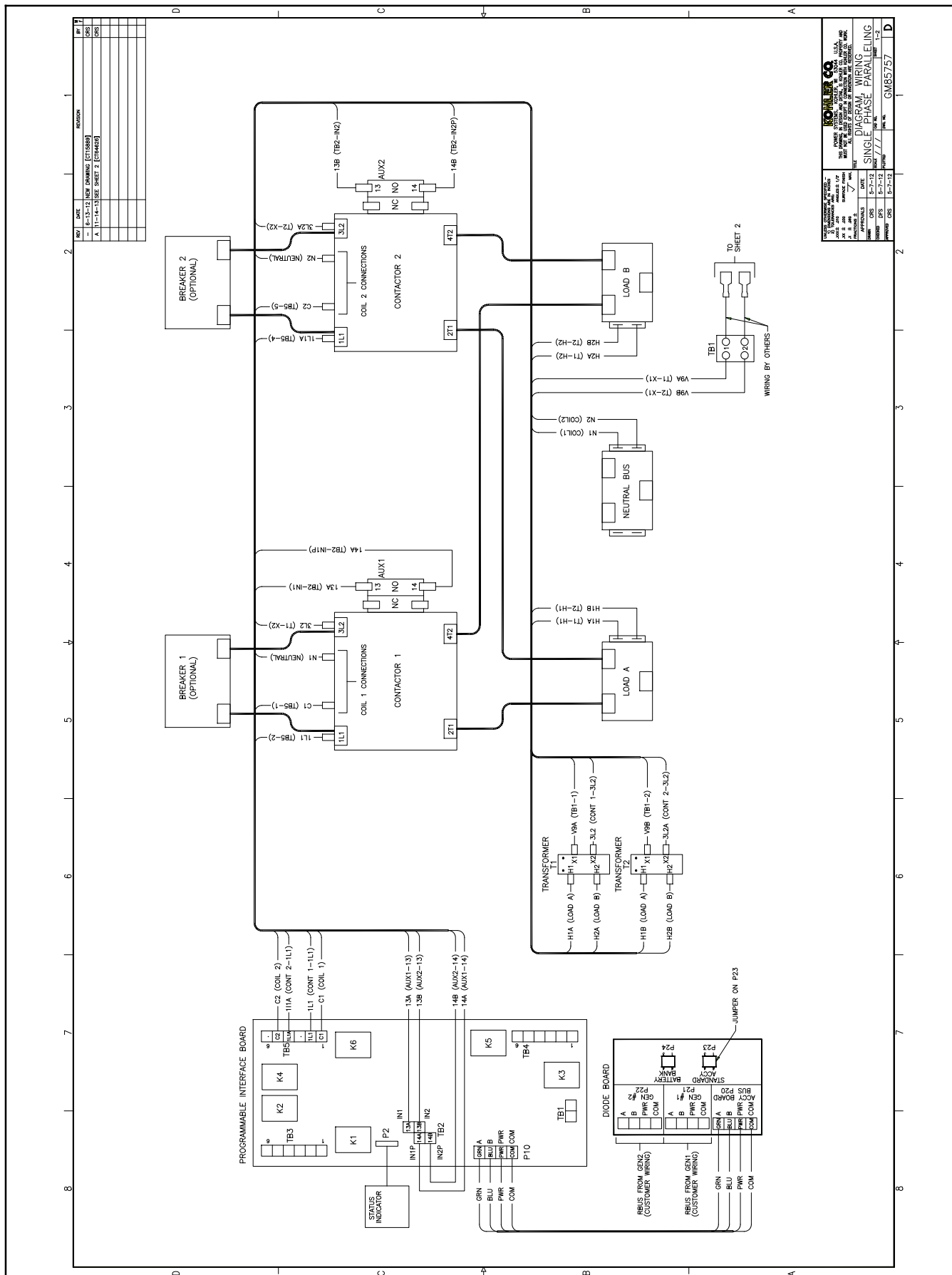
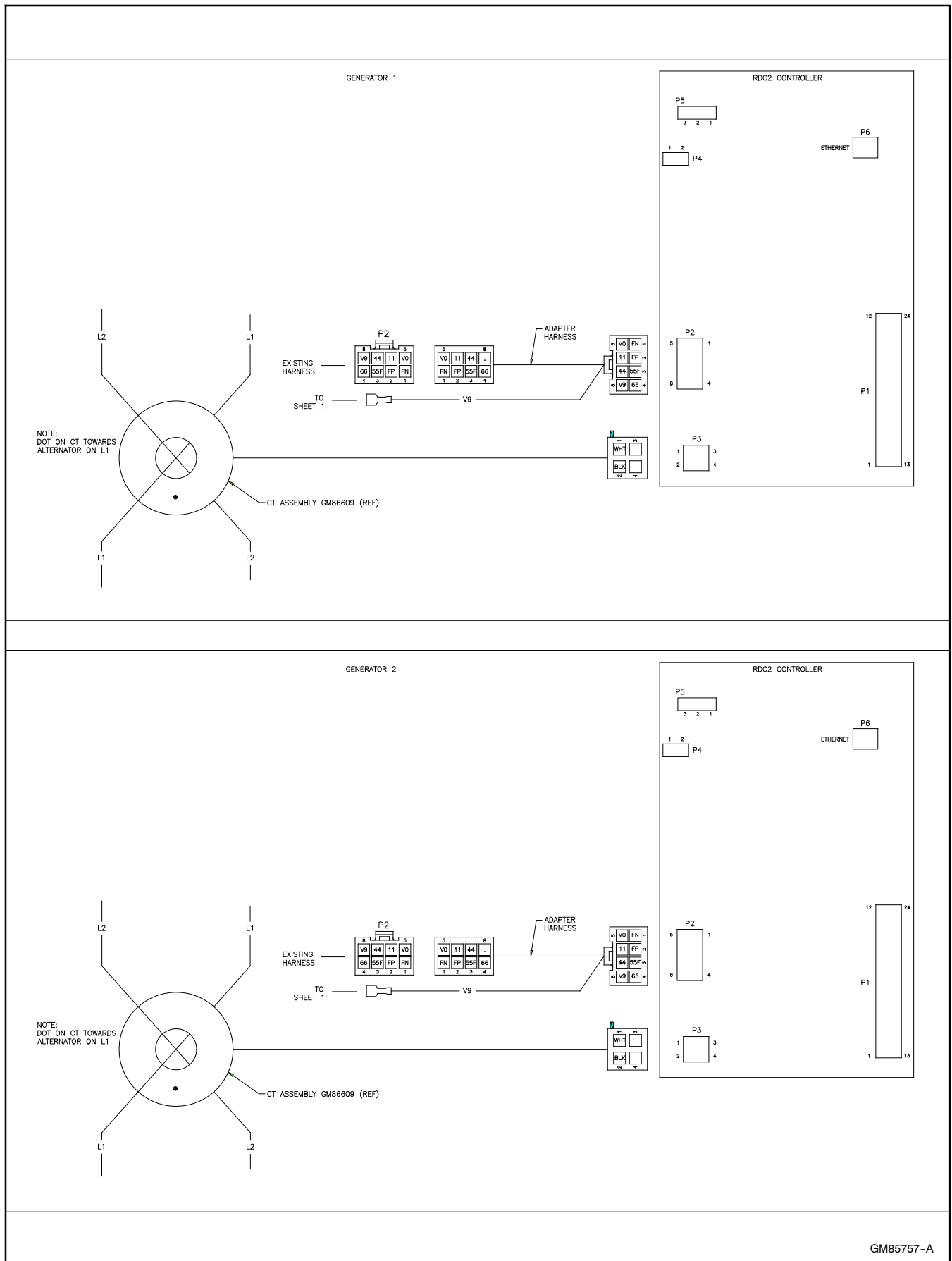


Figure 33 Wiring Diagram, GM85757 Sheet 1



GM85757-A

Figure 34 Wiring Diagram, GM85757 Sheet 2

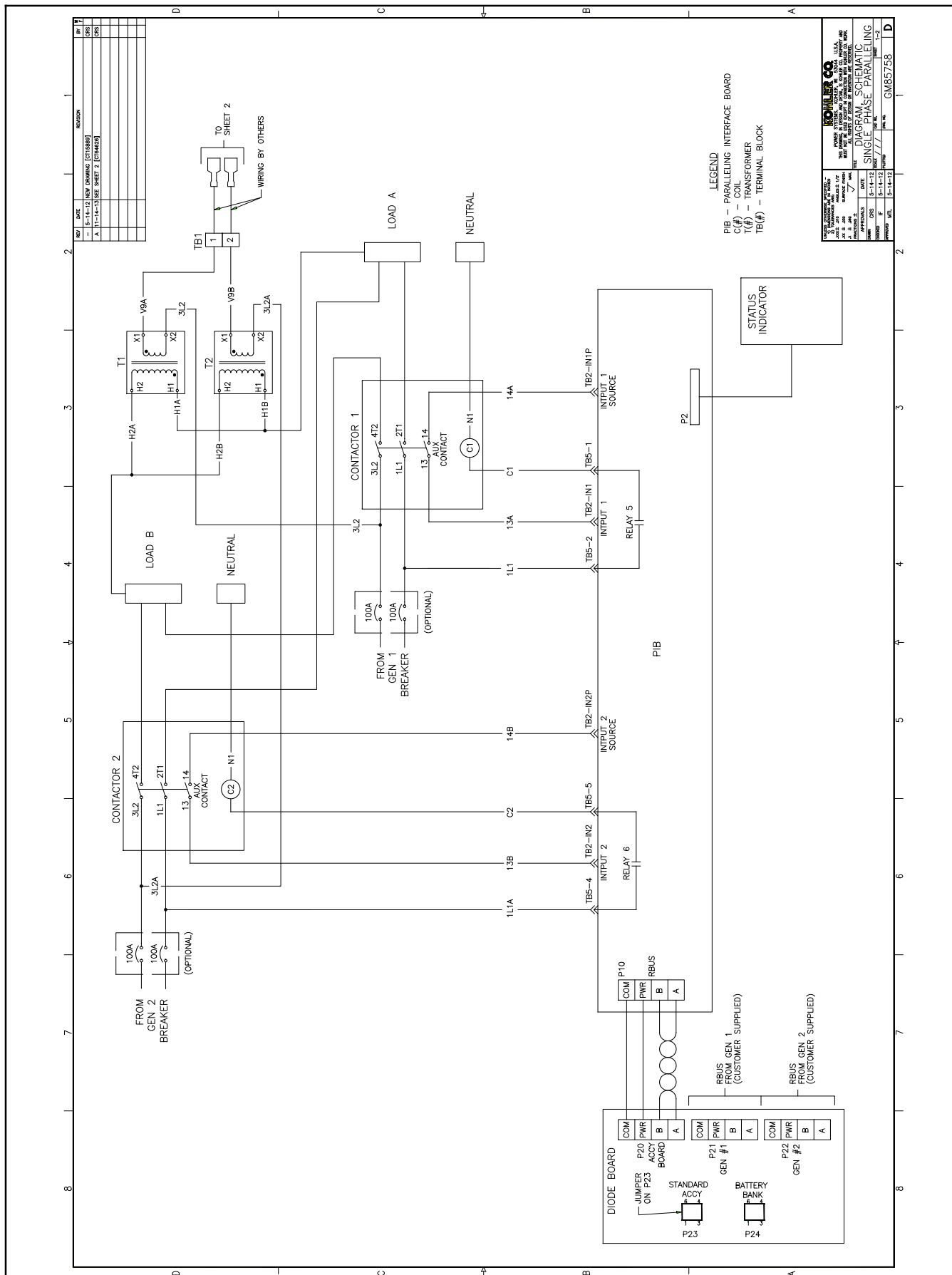


Figure 35 Schematic Diagram, GM85758, Sheet 1

9 Parts Lists

Automatic Paralleling Module (APM)

Kit: GM85144-KP1-QS		
Qty.	Description	Part Number
2	OnCue, RDC2/DC2/VSC	GM81385-1
1	Automatic Paralleling Module, 200A N3R	GM85144-1
2	Transformer, Current Assy	GM86609
2	Harness, Adapter	GM86610
1	Installation Instructions	TT-1596

Circuit Breaker Kit, 14RESA

Kit: GM86368-KP1-QS		
Qty.	Description	Part Number
2	Breaker, Circuit 70A	GM28743
1	Bracket, Circuit Breaker	GM85151
4	Lead	LN-0607-0606
1	Installation Instructions	TT-1596
8	Spacer, .209 ID x .375 OD x .234 in.	X-400-145
8	Screw, Tapping	X-67-132

Circuit Breaker Kit, 20RESA and 20RESB

Kit: GM86369-KP1-QS		
Qty.	Description	Part Number
2	Breaker, Circuit	GM77390
1	Bracket, Circuit Breaker	GM85151
4	Lead	LN-0407-0606
1	Installation Instructions	TT-1596
4	Screw, Tapping	X-67-132

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