MAGNET RUNDOWN UNIT

PRIMARY RUNDOWN UNIT KIT

GE PART NUMBER 5180313,

PRIMARY RUNDOWN UNIT

GE PART NUMBER 5196918-2

AND

REMOTE MAGNET RUNDOWN UNIT

GE PART NUMBER 5180187

OPERATING AND SERVICE MANUAL

(5265188TPH Revision 8)

GE PART NUMBER 5265188

20 April 2015

GE Healthcare
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Florence, SC 29501

This symbol is marked on the Magnet Rundown Unit (MRU) to indicate that this Operating and Service Manual is to be referenced for information regarding the part of the MRU marked with the symbol. For this marking on the MRU, there is a corresponding portion of this Operating and Service Manual, also marked with this symbol, which provides the pertinent information.

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1 GENERAL DESCRIPTION

The Magnet Rundown Unit (MRU) is designed to power the main coil heaters of the GE superconducting magnets, causing the magnetic field to rapidly decay. Power is removed from the heater after a preset time period. Internal battery backup is provided together with test functions to ensure MRU availability.

When its RUNDOWN pushbutton is depressed, the MRU provides a timed (30 seconds minimum, 50 seconds nominal) ⎓ 20 V source to both of the heaters in a GE Superconducting Magnet System. In addition, test circuits are provided to verify battery charger operation, battery charge condition and magnet heater element resistance limits.

Optionally, the MRU can be used with a Remote MRU (GE part number 5180187) to allow remote actuation of the MRU.

This MRU (GE part number: 5196918-2) is backward-compatible with the previous MRU versions (GE part number 5196918 and 46-294231G1). Using an adapter plate (GE part number 5180324), this MRU can be mounted to the wall using the bolt hole pattern for the 46-294231G1.

WARNING: *NO MODIFICATION OF THIS EQUIPMENT (EITHER MRU OR REMOTE MRU) IS ALLOWED.*

2 PHYSICAL CHARACTERISTICS

Height of MRU and Remote MRU: 8.10 inches (206 mm)
Width of MRU and Remote MRU: 11.28 inches (287 mm)
Depth of MRU and Remote MRU: 6.85 inches (174 mm)
Mounting hole pattern for MRU and Remote MRU: 8 9/32 inch x 4 23/32 inch (210 mm x 120 mm) – see Figure 4
Maximum cable run distance from MRU to Remote MRU: 100 feet – see Figure 8
MRU weight (with batteries): 6 lbs. (2.7 kg)
Remote MRU weight: 2.1 lbs. (1.0 kg)

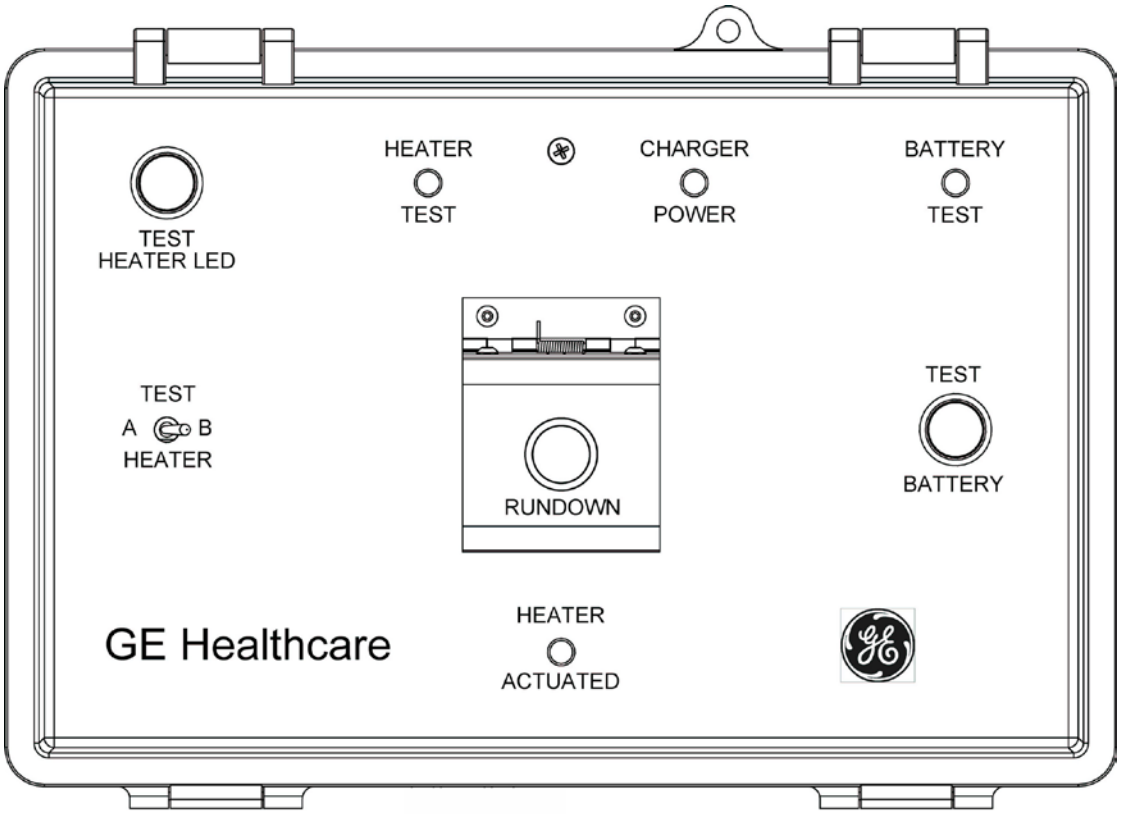


Figure 1 – MRU Front View

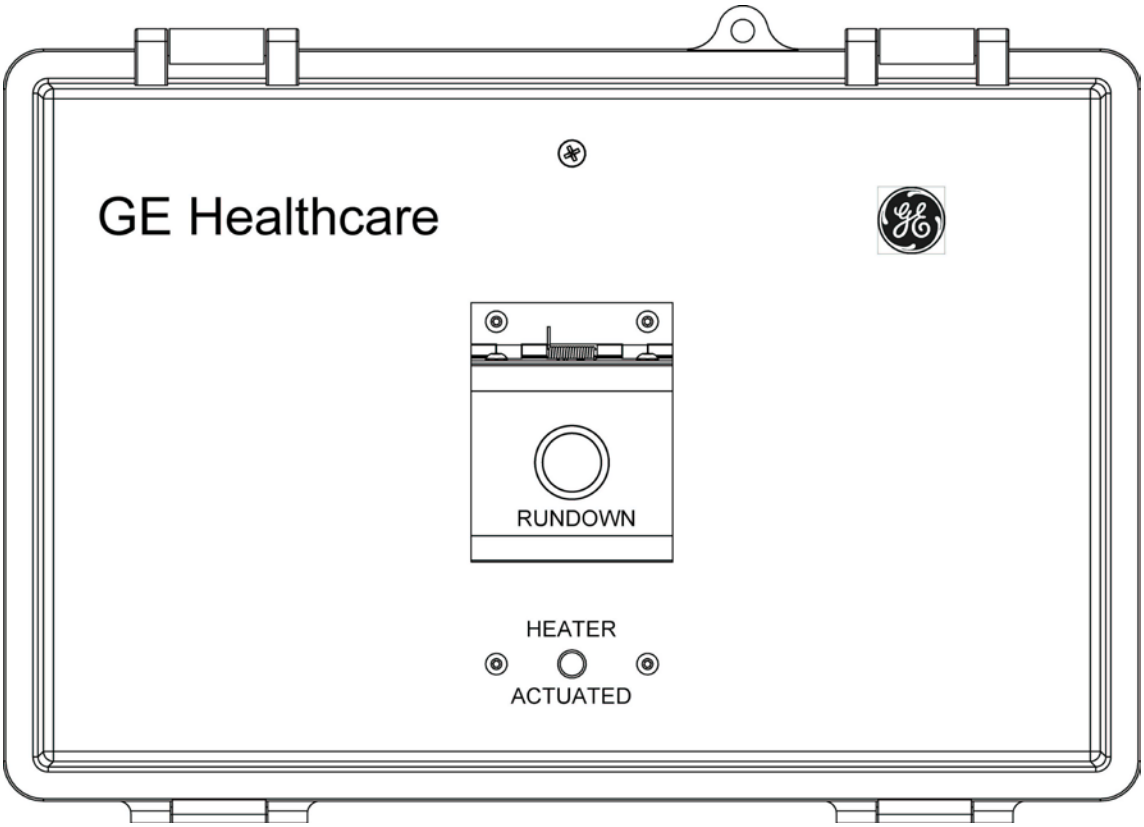


Figure 2 – Remote MRU Front View

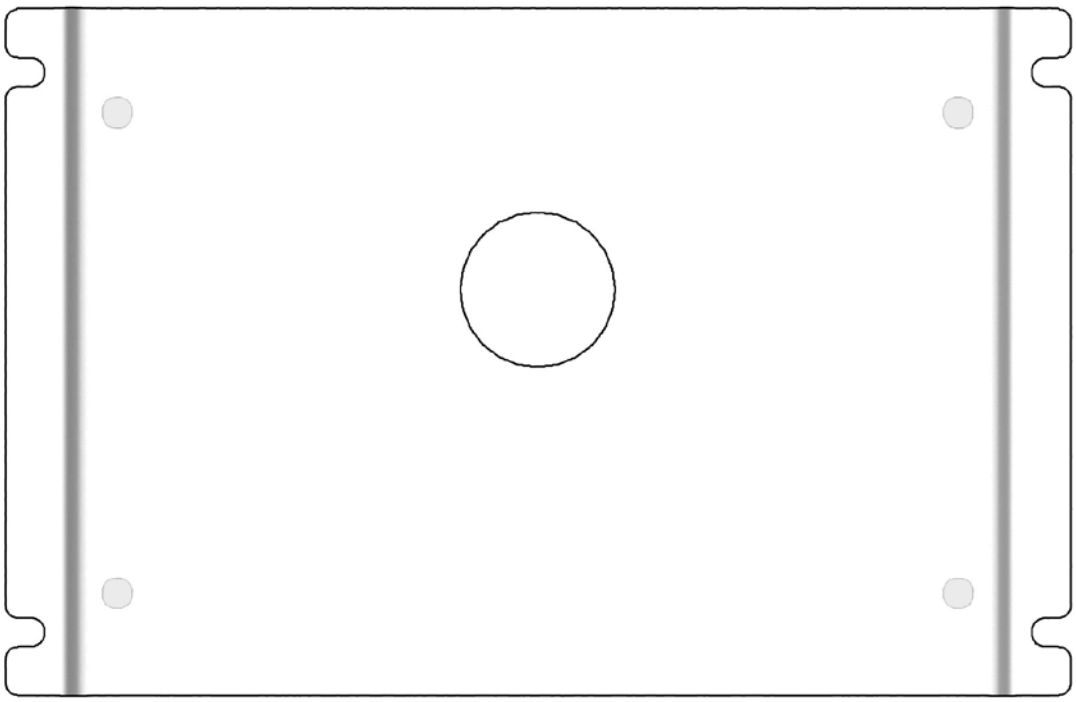


Figure 3 – Adapter Plate – Optional for Upgrade Sites Only
(for backward compatibility with the old MRU mounting hole pattern)

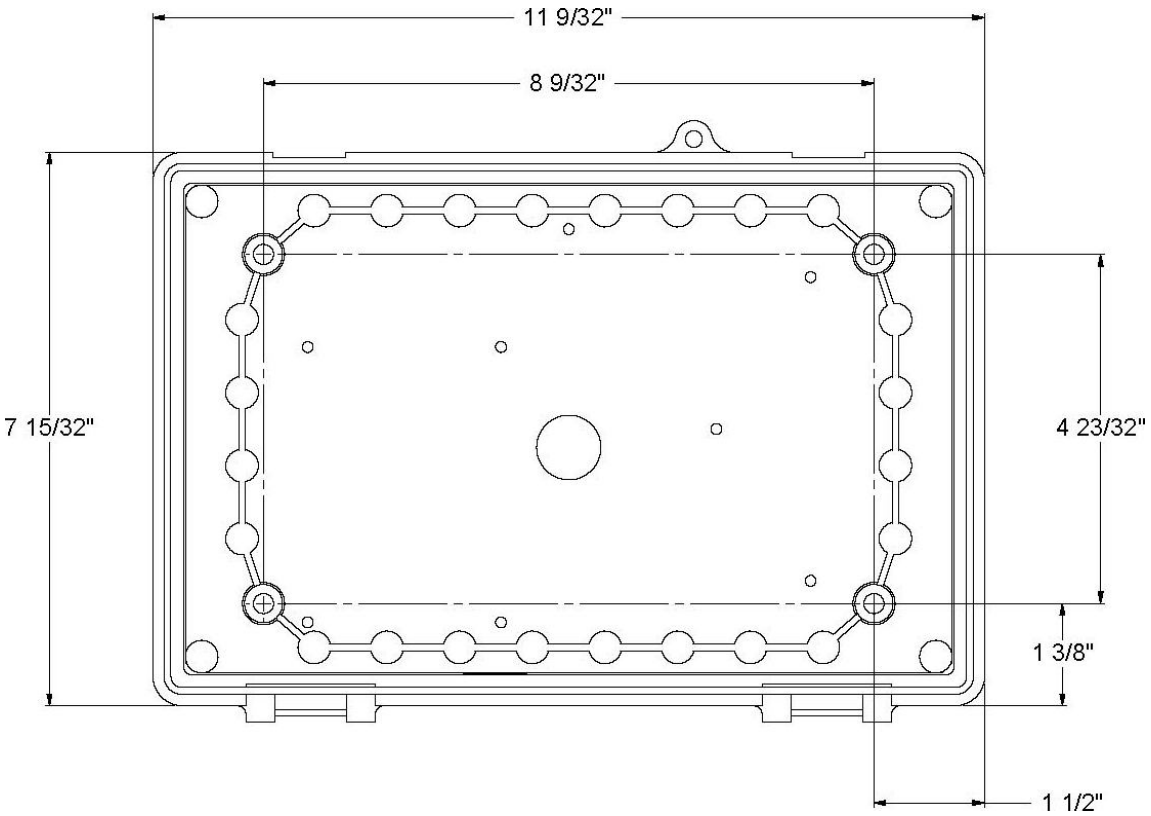


Figure 4 – MRU and Remote MRU mounting hole pattern
(Front View with Lid Not Shown)

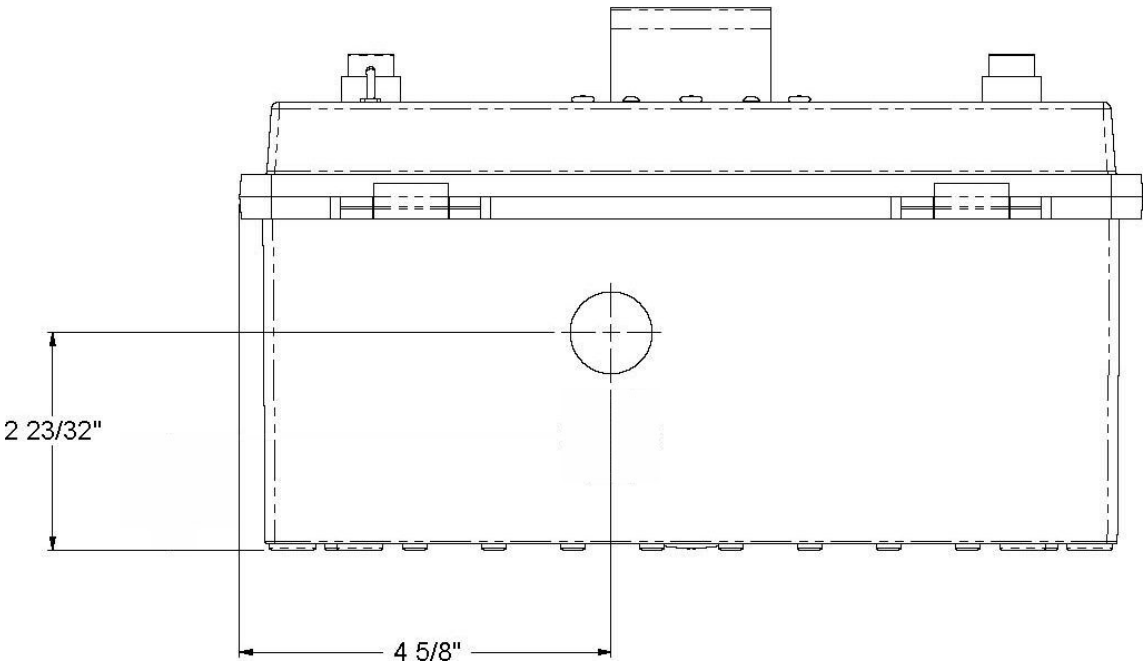


Figure 5 – MRU Bottom Cable Penetration Locations (Bottom View)

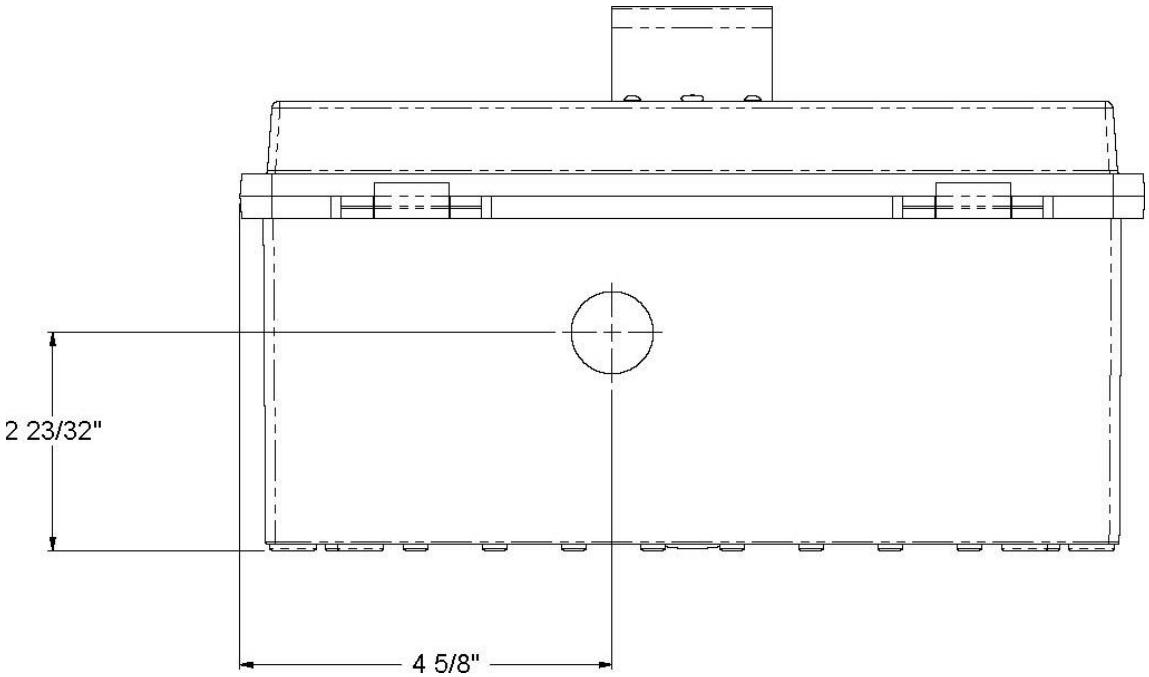


Figure 6 – Remote MRU Bottom Cable Penetration Location (Bottom View)

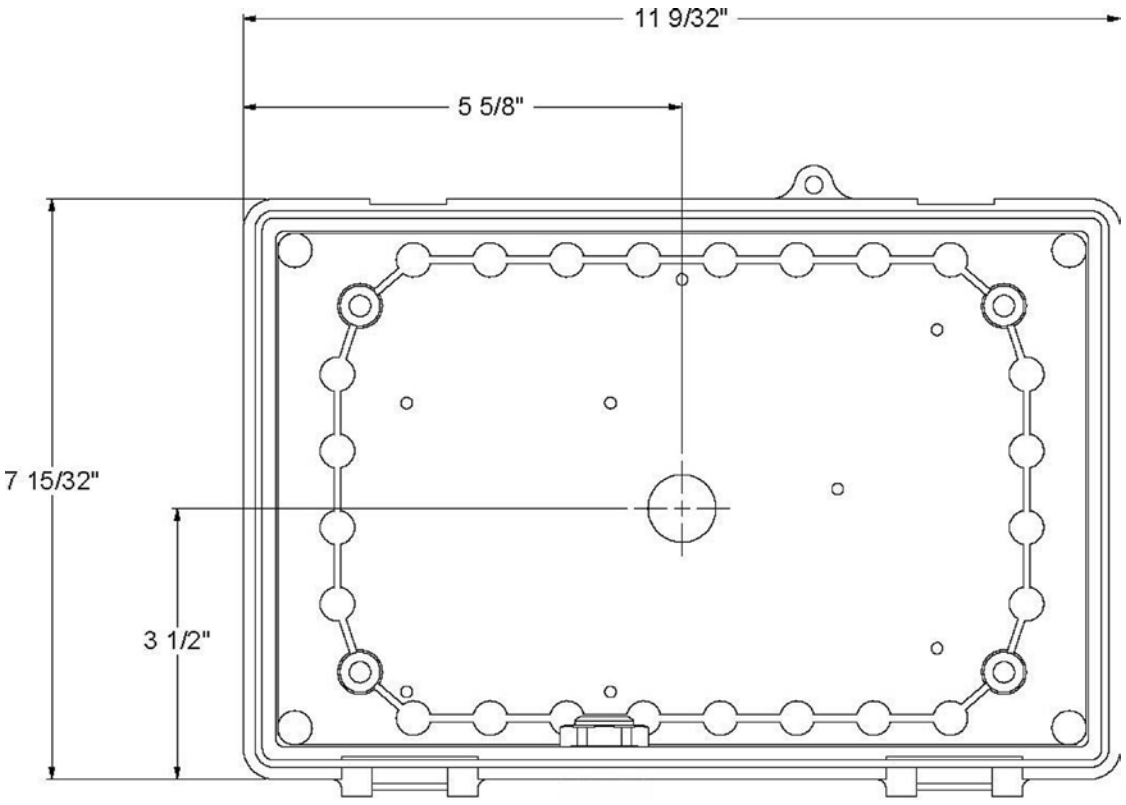


Figure 7 – MRU and Remote MRU Rear Cable Penetration Location
(Front View with Lid Not Shown)

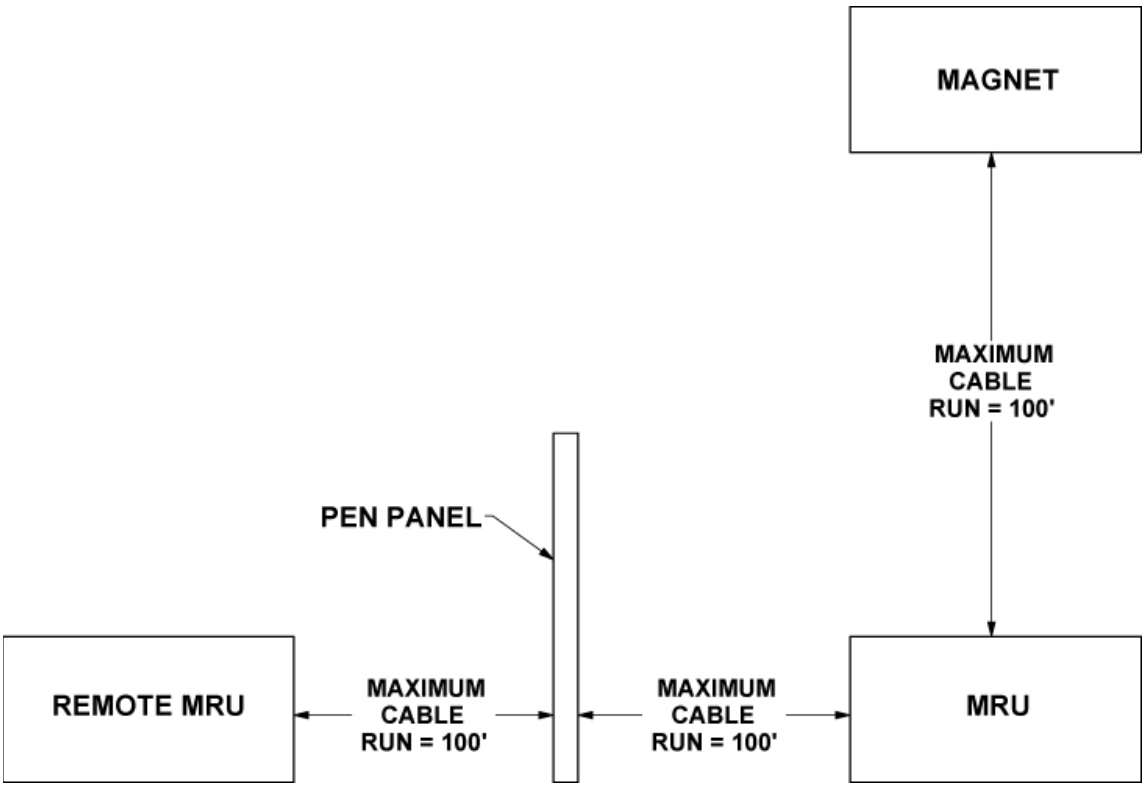


Figure 8 – Maximum Cable Run Distances

3 SPECIFICATIONS

NOTE: *Unless specifically stated, each of these specifications applies to both MRU and Remote MRU.*

Class I Equipment (type of protection against electric shock)

IPXO / Ordinary (degree of protection against ingress of water)

Input AC supply mains requirement (for MRU) is ∿ 100-120 V or ∿ 200-240 V ±10%, single phase, 50-60 Hz, 85 VA maximum. MRU's are shipped configured for ∿ 100-120 V input.

If operation of MRU from ∿ 200-240 V is required, fuse F1 (on bottom PC board) and fuse F1 SPARE (on main PC board) must *BOTH* be changed to T 200mA 5x20mm fuses (see replacement parts list), and voltage selector switch S3 must be set to the 230V setting.

Note: Input of up to 55 VA may be required during initial battery recharging. If the

magnet rundown switch is actuated during the initial battery recharging time, the AC supply mains input could be as high as 85 VA while the magnetic field is being collapsed.

Remote MRU requires no power for operation. All signals between it and the MRU are carried by the cables provided with the Remote MRU.

Output is ⎓ 20 V at 1.8 A into 2 parallel 22 ohm (nominal) loads. The duration of output is 30 seconds (minimum).

The charging duty cycle is continuous.

Temperature rating: Operating — 50 to 90 F (10 to 32 C)
Storage — -22 to +140 F (-30 to +60 C)

Humidity rating: Operating — 0 to 95% (non-condensing)
Storage — 0 to 95% (non-condensing)

Altitude rating: Operating — -500 to 15,000 feet above sea level
Storage — -500 to 15,000 feet above sea level

Magnetic field immunity: Operating — 200 gauss
Storage — 200 gauss

Storage shelf life: MRU — recharge batteries after every 6 months of storage
Remote MRU — indefinite

Set points are calibrated at a nominal 72 F (22 C).

4 OPERATION

WARNING: THIS PROCEDURE IS FOR EMERGENCY USE ONLY. LOSS OF COOLING FLUIDS AND POSSIBLE MAGNET DAMAGE WILL RESULT.

In normal operation, the MRU green LED labeled CHARGER POWER will be lit.

To initiate a magnet rundown, open the clear protective cover and firmly press the red rundown button momentarily. If the remote MRU is installed, the red rundown button can be pressed on either the MRU or the remote MRU. The red button will remain depressed for approximately 30 seconds as the magnetic field is collapsed.

The red LED indicator labeled HEATER ACTUATED will light and stay illuminated indefinitely whenever the RUNDOWN button is operated; if the Remote MRU is installed, the HEATER ACTUATED LEDs on both the MRU and the Remote MRU will

light. Reset of the HEATER ACTUATED indicator should be performed only by a Qualified Service representative.

5 WEEKLY TESTING

WARNING: POTENTIAL MAGNET QUENCH

Do not press the Rundown/Quench button throughout this process

Do not reconnect MRU cable if it is found disconnected. GEHC strongly recommends that you stop using the system, and immediately call your qualified service representative

Confirm that the MRU is connected to the magnet and operating properly by performing the following test on the MRU.

5.01 Verify the green CHARGER POWER LED is lit.

5.02 Depress and hold the TEST BATTERY switch for 15 seconds. The green BATTERY TEST LED should light and remain lit while the TEST BATTERY switch is depressed.

5.03 Place the TEST HEATER toggle switch in the A position. The green HEATER TEST LED should light and remain lit until toggle released.

Note: Wait at least 5 seconds before switching between position A and B

Not doing so may cause the red Heater Actuate LED to light

5.04 Place the TEST HEATER toggle switch in the B position. Green HEATER TEST LED should light and remain lit until toggle released.

If the MRU test does not perform as described in each of the 4 steps above, with the specified LED lighting in each step, GEHC strongly recommends that you stop using the system, and immediately call your qualified service representative.

NOTE: THE REMAINDER OF THIS MANUAL IS INTENDED FOR USE BY A QUALIFIED SERVICE REPRESENTATIVE OR GE AUTHORIZED AGENT FOR INSTALLATION, SERVICE AND MAINTENANCE OF THE MRU.

6 INSTALLATION LOCATION

WARNING: *CARE SHOULD BE USED IN SELECTING THE MOUNTING LOCATION TO AVOID AN ACCIDENTAL ACTIVATION OF THE GUARDED MRU SWITCH BY CLEANING STAFF, ETC.*

The Magnet Rundown Unit (MRU) is designed for permanent wall mounting, and is intended for use is in controlled environment. Mounting hardware should be capable of supporting a 32 lb. (14.5 kg) load. Mounting holes are provided in the rear surface. Holes are provided in the rear and bottom surface for standard electrical conduit (hard wire) installation.

The MRU and Remote MRU (if installed) should be mounted outside of any area with a magnetic field greater than 200 gauss.

7 PRE-INSTALLATION

WARNING: *TO AVOID THE RISK OF ELECTRIC SHOCK, THIS EQUIPMENT MUST ONLY BE CONNECTED TO AN AC SUPPLY MAINS WITH PROTECTIVE EARTH.*

WARNING: *NO MODIFICATION OF THIS EQUIPMENT (EITHER MRU OR REMOTE MRU) IS ALLOWED.*

WARNING: *FOLLOW ALL LOCAL SAFETY CODES FOR LOCK OUT-TAG OUT.*

Installation must be performed only by a Qualified Service representative.

7.01 The MRU batteries should already be installed. The charge on the batteries should be verified at ⎓ 20 V (minimum, with proper AC supply mains power applied) before any adjustments are made.

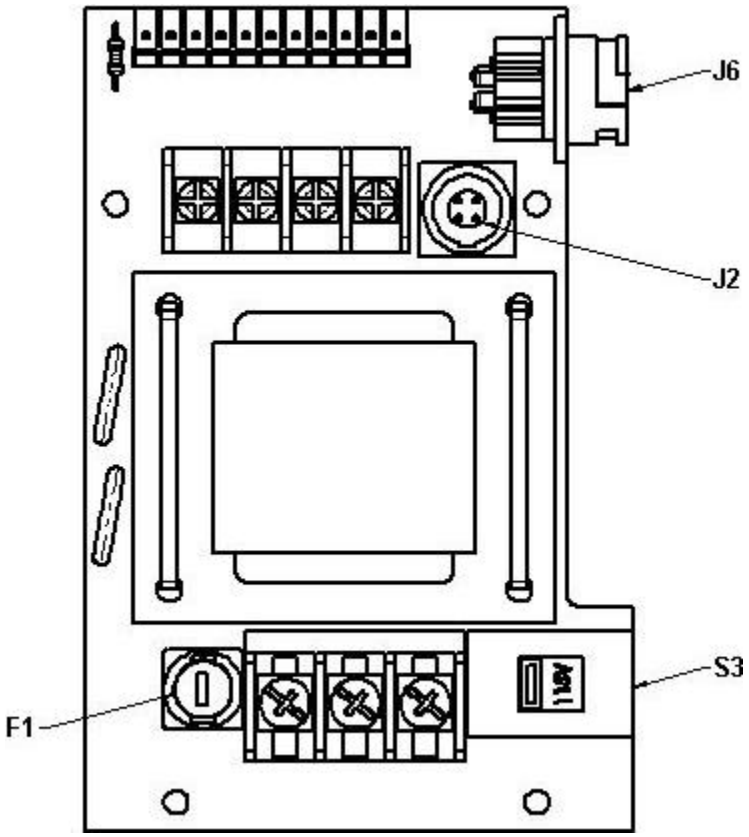


Figure 9 – Bottom PC Board

7.02 Verify that AC supply mains power of ∿ 100-120 V or 200-240 V ±10%, single phase, 50-60 Hz, 85 VA (maximum) is available. MRU'S ARE SHIPPED CONFIGURED FOR ∿ 100-120V INPUT.

If operation from ∿ 200-240 V is required, fuse F1 (on bottom PC board) and fuse F1 SPARE (on main PC board) must *BOTH* be changed to T 200mA 5x20mm fuses (see replacement parts list), and voltage selector switch S3 must be set to the 230V setting. Refer to Figure 9.

7.03 **MRU'S MUST BE PERMANENTLY INSTALLED** (hard wired to AC supply mains power). Plastic electrical conduit must be used for the wiring between the MRU and the AC supply mains (recommend 1/2" PVC schedule 40). Wire the AC supply mains to the outer two terminals of TB1 (line to the terminal marked "L" and neutral to the terminal marked "N"), and protective earth to the center terminal of TB1. A No. 2 Phillips screwdriver is required to open the front cover.

All installations shall be connected to a dedicated AC supply mains circuit, with a disconnect device that is in compliance with local regulatory standards. *DISCONNECT DEVICE SHALL BREAK BOTH AC SUPPLY MAINS CONNECTIONS.*

7.04 Inspect mounting surface and obtain the type of mounting fasteners required for the surface involved. Use fasteners capable of supporting a 32 lb. (14.5kg) load. The case (of both the MRU and the Remote MRU) is drilled for 1/4" or 6 mm bolts arranged in a rectangular pattern. Horizontal spacing is 8 9/32 inches (210 mm) and vertical spacing is 4 23/32 inches (120 mm). A No. 2 Phillips screwdriver is required to open the front cover. Use flat washers under the heads of the fasteners used to mount the MRU and Remote MRU to the wall.

This MRU (GE part number: 5196918-2) is backward-compatible with the previous MRU versions (GE part number 5196918 and 46-294231G1). Using adapter plate (GE part number 5180324), this MRU can be mounted to the wall using the bolt hole pattern for the previous MRU versions. The adapter plate can also be used to mount the Remote MRU (GE part number 5180187) if needed.

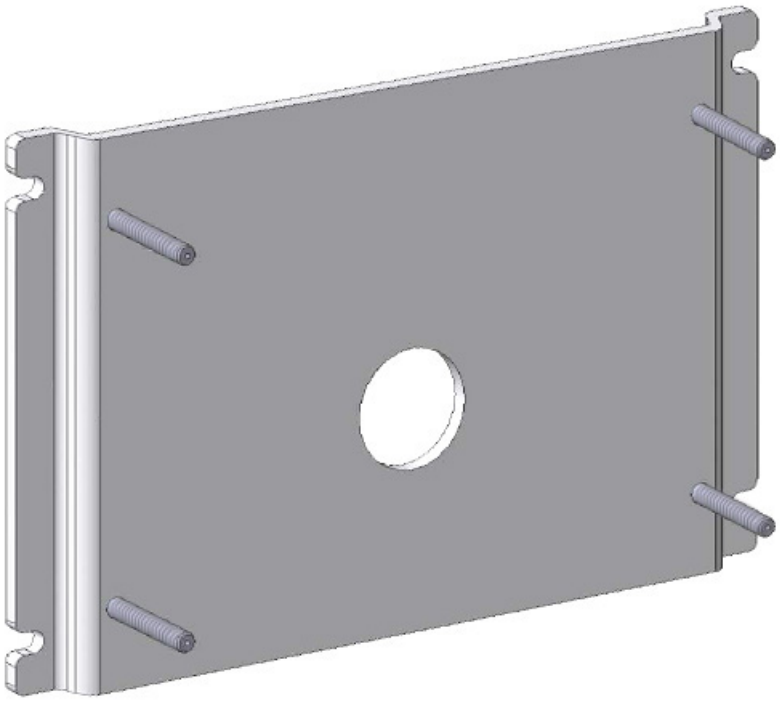


Figure 10 – Adapter Plate 5180324

7.05 Verify that magnetic field intensity is less than 200 gauss at the mounting location of both the MRU and Remote MRU (if installed).

8 MAGNET RUNDOWN UNIT INSTALLATION OR REMOVAL AND ADJUSTMENT

WARNING: *HAZARDOUS VOLTAGES ARE ACCESSIBLE AT COMPONENTS F1, TB1, S3, RV1, AND RV2 AND AT THE LOWER TERMINALS OF T1. TO AVOID ELECTRIC SHOCK, USE CAUTION WHEN THE MRU COVER IS OPEN TO ASSURE THAT CONTACT IS NOT MADE WITH ANY OF THESE COMPONENTS.*

A No. 2 Phillips screwdriver is required to open the front cover.

8.01 Mount the MRU to the wall surface.

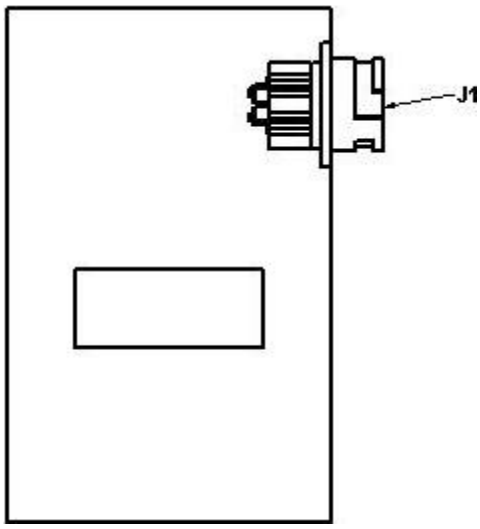


Figure 11 – Remote PC Board

8.02 If installing the optional Remote MRU, also mount it to the desired wall surface. Then, connect the Remote-MRU-to-pen-panel cable to J1 in the Remote MRU (refer to Figure 11, and to the appropriate D-sub connector at the pen panel. Also, connect the MRU-to-pen-panel cable to the corresponding D-sub at the pen panel, and to J6 in the MRU (refer to Figure 9).

8.03 Turn on AC supply mains power to the MRU.

WARNING: *ENSURE THE MAGNET HEATERS ARE NOT CONNECTED TO J2 TO PREVENT INADVERTENT MAGNET QUENCH.*

8.04 Confirm fuse F2 is not installed. Connect a digital voltmeter (DVM), positive to the test point labeled +20.7V, and negative to the test point labeled GND. The multimeter should read ⎓ 20.7 V. Adjust R3 if necessary to obtain ⎓ 20.7 V. Verify CHARGER POWER LED on the front panel is lit.

8.05 Remove the 20 ohm 5% power resistor from the plastic bag and connect it between terminals 1 and 2 of TB2.

WARNING: *THE 20 OHM POWER RESISTOR WILL BECOME HOT DURING THIS TEST.*

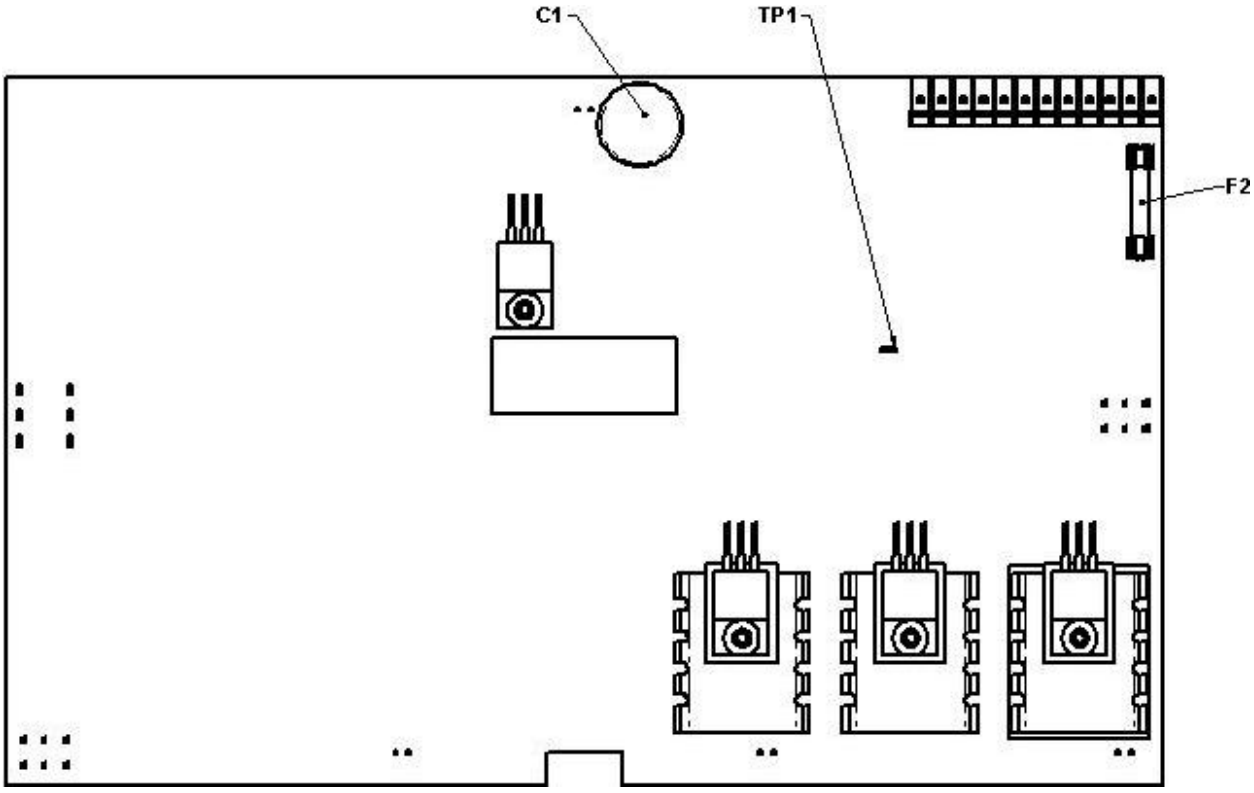


Figure 12 – Main PC Board

8.06 Install fuse F2 (from plastic bag) – refer to Figure 12. Again, measure the voltage at test point +20.7V with respect to test point GND; it should now be between ⎓ 15 V and ⎓ 20.7 V. If the MRU batteries have been stored for more than one year without charging, it may be necessary to wait for up to 8 hours for the voltage to reach ⎓ 20.7 V.

8.07 Depress and release the MRU RUNDOWN button. Measure the elapsed time until the RUNDOWN button pops back out; the time must be a minimum of 30 seconds. The red HEATER ACTUATED LED will light and remain lit until reset with switch S6. Press pushbutton switch S6 on the MRU main printed circuit board to reset the HEATER ACTUATED LED. The red LED will not be reset until after the timeout.

8.08 If the optional Remote MRU is installed, then depress and release the Remote MRU RUNDOWN button. Then, measure the elapsed time until the Remote MRU RUNDOWN button pops back out; the time must be a minimum of 30 seconds. The red HEATER ACTUATED LEDs at both the MRU and Remote MRU will light and remain

lit until reset with switch S6. Press pushbutton switch S6 on the MRU main printed circuit board to reset the HEATER ACTUATED LEDs. The red LEDs will not be reset until after the timeout.

8.09 Remove fuse F2. Move the power resistor from terminals 1 and 2 of TB2 to terminals 3 and 4 of TB2. Repeat steps from 8.06 to 8.08.

8.10 Remove the power resistor from TB2 and place it back in the plastic bag. Disconnect the DVM and close the front cover.

8.11 Verify the green CHARGER POWER LED is lit.

8.12 Depress and hold the TEST BATTERY switch for 15 seconds. The green BATTERY TEST LED should light and remain lit while the TEST BATTERY switch is depressed, indicating a battery-good condition. The battery-good set point is ⎓ 16.5 V.

WARNING: *BEFORE CONNECTING P2 TO J2, ASSURE THAT AC SUPPLY MAINS POWER HAS BEEN APPLIED TO THE MRU FOR AT LEAST 3 MINUTES AND THAT THE RUNDOWN BUTTON HAS NOT BEEN ACTUATED FOR AT LEAST 3 MINUTES. FAILURE TO HEED THIS WARNING MAY CAUSE A MAGNET QUENCH.*

8.13 Open the MRU cover and connect the main coil heater cable plug P2 to matching connector J2. Close and fasten the cover.

8.14 Place the TEST HEATER toggle switch in the A position. Green HEATER TEST LED should light.

8.15 Place the TEST HEATER toggle switch in the B position. Green HEATER TEST LED should light.

Note: If green HEATER TEST LED does not light, depress TEST HEATER LED switch. If the green TEST HEATER LED does not light, replace MRU.

8.16 Complete the maintenance log with date and signature.

8.17 MRU REMOVAL AND REPLACEMENT

WARNING: *HAZARDOUS VOLTAGES ARE ACCESSIBLE AT COMPONENTS F1, TB1, S3, RV1, AND RV2 AND AT THE LOWER TERMINALS OF T1. TO AVOID ELECTRIC SHOCK, USE CAUTION WHEN THE MRU COVER IS OPEN TO ASSURE THAT CONTACT IS NOT MADE WITH ANY OF THESE COMPONENTS.*

DANGER

DEATH OR SERIOUS INJURY!
THE NEED TO TAKE PROPER PRECAUTIONS WHEN SERVICING HIGHLY FERROUS COMPONENTS IN A MAGNETIC ENVIRONMENT IS CRITICAL. FAILURE TO DO SO MAY RESULT IN DEATH OR SERIOUS INJURY TO SERVICE ENGINEERS.

Table 1: Planning the Path

When servicing any magnetic equipment, it is critically important that the Service Engineer consciously plan the path to be taken when moving highly ferrous devices in the magnet environment. The path should be as far from the magnet as practical and avoid high flux-density fields.
Safety Requirement

1. Movement of ferrous material in the Magnet Room must follow the GE service procedure for that device. When exiting, move away from the magnet in the most direct manner possible. Except when moving ferrous material to/from its native location on or near the magnet, the static magnetic field in any portion of the service path shall not exceed 200 Gauss.
2. Two MR safety trained personnel must be present at all times when servicing highly ferrous devices in the areas of magnetic fields.

When planning a service path, it is critical that the path be clear and sufficiently wide. Ensure there are no trip hazards, obstacles, clutter, slippery surfaces, or any other items even partially restricting the path. If there are portable obstacles in a path, temporarily remove them from the area and replace them after the service action is completed. It is required to walk the paths prior to beginning service to ensure there is sufficient space through which to pass for yourself and the object being serviced.

Table 1-1: Highly Ferrous Material Pre-Work Checklist

Check When Action is Taken:	Action to Take:
	Make sure there are two or more qualified people are present to work with highly ferrous materials.
	Make sure the service path is outside the 200 Gauss field. Consider marking it with tape or other visible indicators that can easily be removed after the service event.
	Make sure the service path is wide enough to walk through with the device being serviced.
	Make sure the service path is free of clutter: • Remove all trip hazards. • Remove all obstacles. • Move portable equipment out of the way (including the phantom cart) • Look for and clean up slippery surfaces.
	Walk the path before beginning the service. Make sure there is sufficient space for you and the ferrous object you are servicing. The path should be as far from the magnet as possible.
	Make sure that this written checklist is completed to confirm that the above actions have been taken. The second MR trained person also must complete this checklist.

The MRU is classified as a Highly Ferrous Object.

8.18 Turn off AC power to the MRU, conduct Lock Out and Tag Out to meet local site standards.

8.19 Open cover using a No. 2 Phillips screwdriver to remove the center screw on the cover. Be very careful when opening the cover, if careless unwanted quench can occur, always maintain control of cover and protect the quench button. Using a Volt (DVM) meter, ensure that AC power is off by checking between the outer two terminals of TB1 (line to the terminal marked "L" and neutral to the terminal marked "N"). Note reading should be 0.0 Volts.

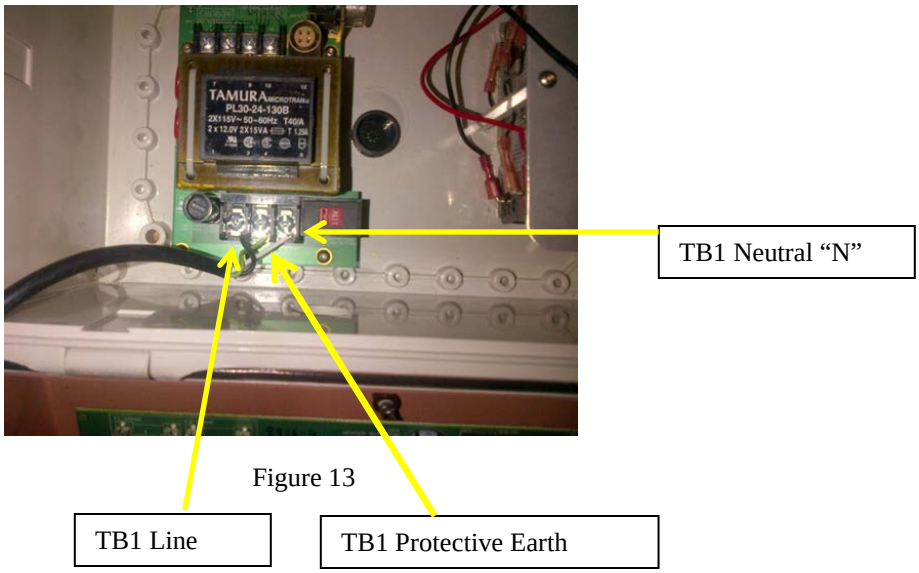


Figure 13

8.20 Disconnect the main Heater Coil Cable Plug P2 from Connector J2 Magnet. If a remote MRU has been installed you will need to remove the Connector Cable P6 from the J6 Remote Plug.

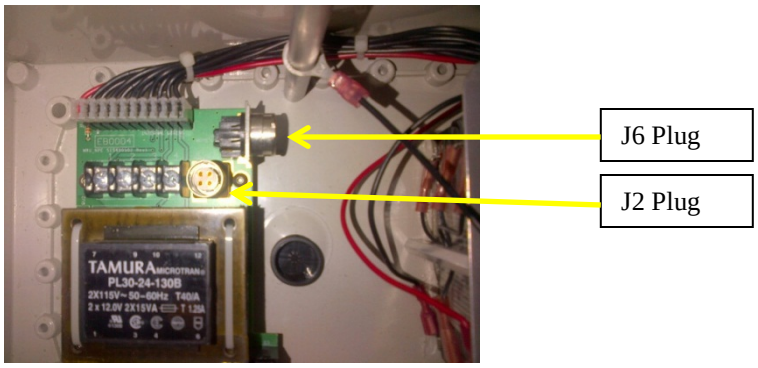


Figure 14

8.21 Using the No. 2 Phillips screwdriver disconnect the power cables from TB1.

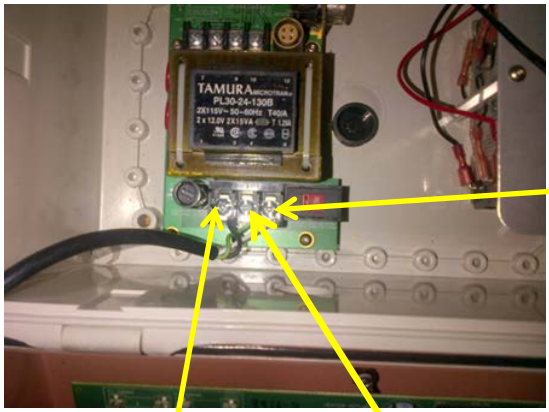


Figure 15

8.22 Remove the conduit attaching star nut and slide over the disconnected wires and cables. Save star nut.

8.23 Use a proper sized screwdriver to remove the mounting screws (note screw size may vary with each site installation). Save the mounting screws

8.24 Pull the disconnected MRU away from the wall ensuring that all the wires are free and clear of the MRU. Walk the MRU out of the scan room by taking a route that keeps the MRU outside of the 200 gauss line.

8.25 Walk the new MRU along the same path as the one used to remove the old MRU, remaining outside of the 200 gauss line.

8.26 Slide the connection wires and cables though the proper connection holes for the conduit.

8.27 Use the proper sized screwdriver to re-install the removed mounting screws.

8.28 Slide the star nut over the connecting wires and cables tighten on the conduit.

9 FUNCTIONAL TEST

<u>WARNING:</u> POTENTIAL MAGNET QUENCH

Do not press the Rundown/Quench button throughout this process

Do not reconnect MRU cable if it is found disconnected. GEHC strongly recommends that you stop using the system, and immediately call your qualified service representative

Please see section 5 for test process.

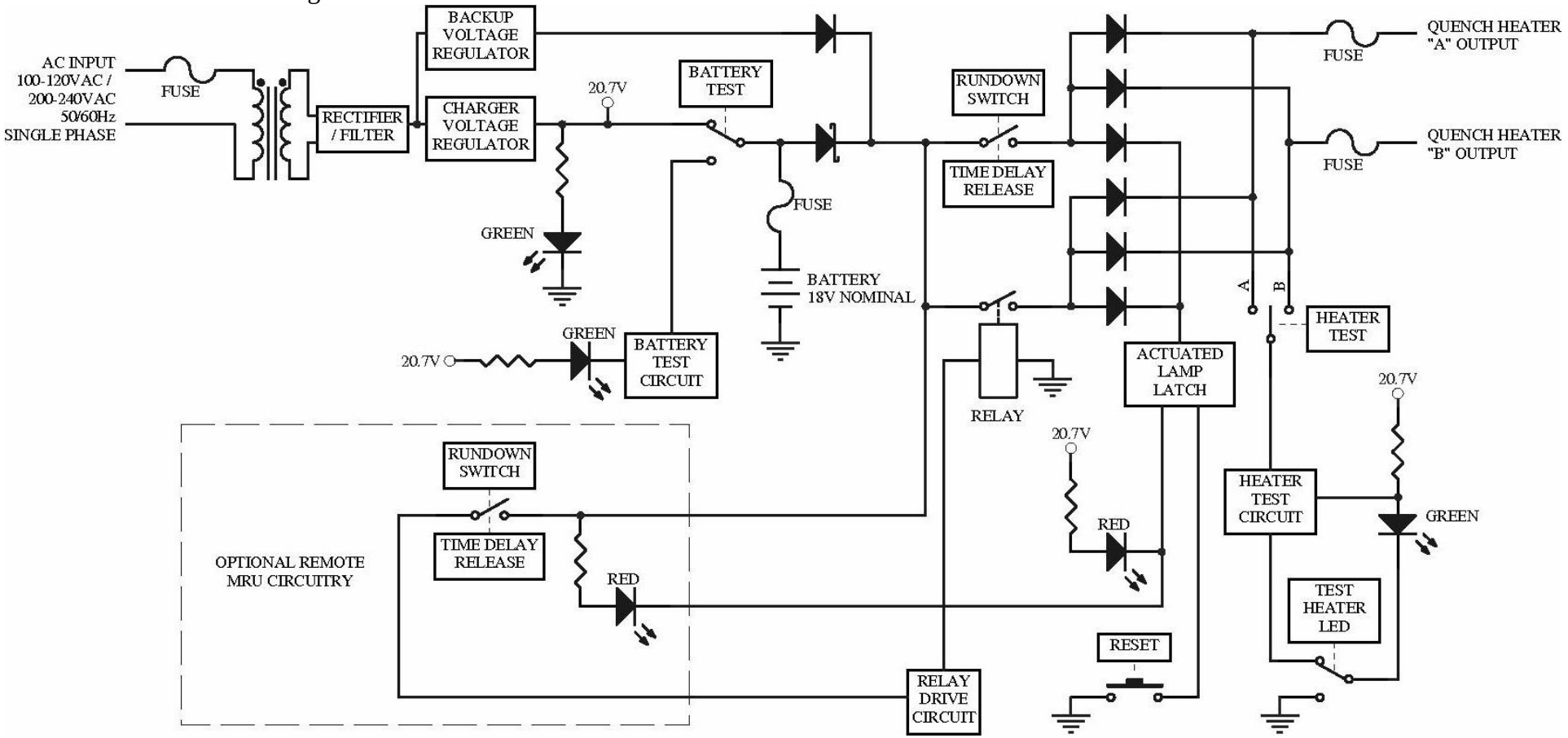
10 THEORY OF OPERATION WITH SCHEMATICS

10.01 General System Description

When its RUNDOWN pushbutton is depressed, the MRU provides a timed (30 seconds minimum, 50 seconds nominal) ⎓ 20 V source to both of the heaters in a GE Superconducting Magnet System. In addition, test circuits are provided to verify battery charger operation, battery charge condition and magnet heater element resistance limits.

If the optional Remote MRU is installed, then the timed ⎓ 20 V source can be provided to the magnet heaters by actuation of the Remote MRU RUNDOWN pushbutton *OR* the MRU RUNDOWN pushbutton.

10.02 Functional Block Diagram



10.03 Power supply and regulator

AC supply mains voltage is connected to TB1. This voltage is connected through fuse F1 and switch S3 to transformer T1. S3 configures the T1 input windings for either ∿ 100-120 V or ∿ 200-240 V input by connecting the input windings either in parallel (for ∿ 100-120 V operation) or in series (for ∿ 200-240 V operation). Varistors RV1 and RV2 provide protection against input voltage transients and surges. A full wave rectifier CR4 and capacitor C1 provide filtered DC voltage to U3, an LM350T linear regulator, and to U2, an LM317T linear regulator. U3, in conjunction with resistors R6 and R10, provides a ⎓ 20.95 V output; this output provides voltage to magnet heaters (through CR14) in the event of a battery failure. U2, in conjunction with R4, provides a current-limited input (700 mA nominal) to U1, an LM317T linear regulator. U1, in conjunction with R1, R2 and R3, provides a ⎓ 20.7 V output for charging the battery assembly. Diodes CR2 and CR1 provide transient and reverse polarity protection. R3 is adjusted to set the float charge on the battery assembly to ⎓ 20.7 V. DS1 provides a continuous indication of regulator output with isolation provided by diode CR3 to prevent lamp indication with AC supply mains input or regulator failure. Diodes CR13 and CR14 isolate the battery voltage from the ⎓ 20.95 V output from U3, allowing power to be supplied to the magnet heaters if either the ⎓ 20.95 V output has failed or the batteries have failed.

During the BATTERY TEST function, a 15 ohm test load is switched across the battery (resistors R7 and R9 in parallel) by switch S1, and the regulator is disabled by the second half of S1 to ensure that the battery is the only source of power.

10.04 Test Circuits

During the BATTERY TEST function, S1 also applies an input via R27 to a comparator circuit consisting of 1/4 of U4 and associated components. U5 provides a reference voltage which, in conjunction with voltage divider resistors R26, R27 and R28, establishes a ⎓ 16.5 V battery-good threshold. When R26 is properly adjusted, LED DS2 (BATTERY TEST) will light when the battery voltage is at ⎓ 16.5 V and above and not light when the battery voltage is below ⎓ 16.5 V. Resistors R29, R30 and capacitor C7 provide a low pass filter and transient protection to the comparator input.

Two other sections of U4 are used to sense upper and lower limit heater resistance during the HEATER TEST mode. Pressing S2 to either the A or B position allows approximately 3.7mA to flow from the battery through R5 and the heater element under test. The magnet heater element becomes part of a voltage divider network consisting of R5, the magnet heater element resistance, R16, R21 and R22. R17 and R8 constitute another voltage divider network; R8 is adjusted to set a 12 ohm lower limit for the magnet heater element resistance. R19, R23 and R20 constitute a third voltage divider network; R20 is adjusted to set a 32 ohm upper limit for the magnet heater element resistance. If the heater resistance is between 12 ohms and 32 ohms, the HEATER TEST LED will light. Since this is a critical test, a switch, S5, is provided to TEST HEATER LED. R12, R13, R14, R15, C4 and C5 provide low pass filtering and transient protection.

10.05 Time Delay and Output Circuits

Actuation of the covered push-button RUNDOWN circuit breaker energizes both magnet heater elements by resetting the thermally timed circuit breaker. The 100mA rated sensing element passes approximately 170 mA for a nominal 50 seconds, after which time the circuit breaker opens, interrupting current flow through the heaters. The current drawn through the circuit breaker heating element is set by resistor R34 and the circuit breaker internal sensing element resistance. While the circuit breaker is actuated (for 50 seconds nominally), it switches the ⎓ 20.7 V to the magnet heaters through diodes CR8 and CR9. Diodes CR8 and CR9 isolate the two magnet heaters, so that a failure in either heater will not prevent the other heater from being heated. The ⎓ 20.7 V switched by the circuit breaker also provides current to the gate of SCR SCR1 through CR11 and R34. Diodes CR6 and CR11 allow the SCR to be latched by either the MRU circuit breaker or the Remote MRU circuit breaker (via K1). When gate current is provided to SCR SCR1, it latches, causing the red LED marked HEATER ACTUATED to light and stay lit; it will also be latched if the HEATER TEST switch is activated and the heater circuits are open. Resistor R18 and capacitors C9 and C10 damp and filter the input to the SCR gate, to prevent the SCR from being latched by noise. Switch S6, resets the SCR by momentarily shunting current around it.

10.06 Remote Heater Actuation Circuits

If the optional Remote MRU is installed, then the magnet heater elements can be energized by actuating a covered push-button RUNDOWN circuit breaker at the Remote MRU. When the Remote MRU circuit breaker is actuated, the 100mA rated sensing element passes approximately 170 mA for a nominal 50 seconds, after which time the circuit breaker opens, interrupting current flow through the heaters. The current drawn through the circuit breaker heating element is set by resistor R3 and the circuit breaker internal sensing element resistance. While the Remote MRU circuit breaker is actuated (for 50 seconds nominally), it switches the ⎓ 20.7 V from the MRU to the input of U6 (in the MRU), an LM340T-12 linear regulator. U6 provides a regulated ⎓ 12 V to the coil of relay K1. The contacts in relay K1 close to switch the ⎓ 20.7 V to the magnet heaters through diodes CR5 and CR7. Diodes CR5 and CR7 isolate the two magnet heaters, so that a failure in either heater will not prevent the other heater from being heated. The ⎓ 20.7 V switched by the relay also provides current to the gate of SCR SCR1 through CR6 and R34, latching it as previously described. When the remote MRU circuit breaker contacts open, the ⎓ 20.7 V is removed from the input of U6. This removes the ⎓ 12 V from the relay K1 coil, causing its contacts to open, removing voltage from the magnet heater elements.

10.07 Bottom PC board

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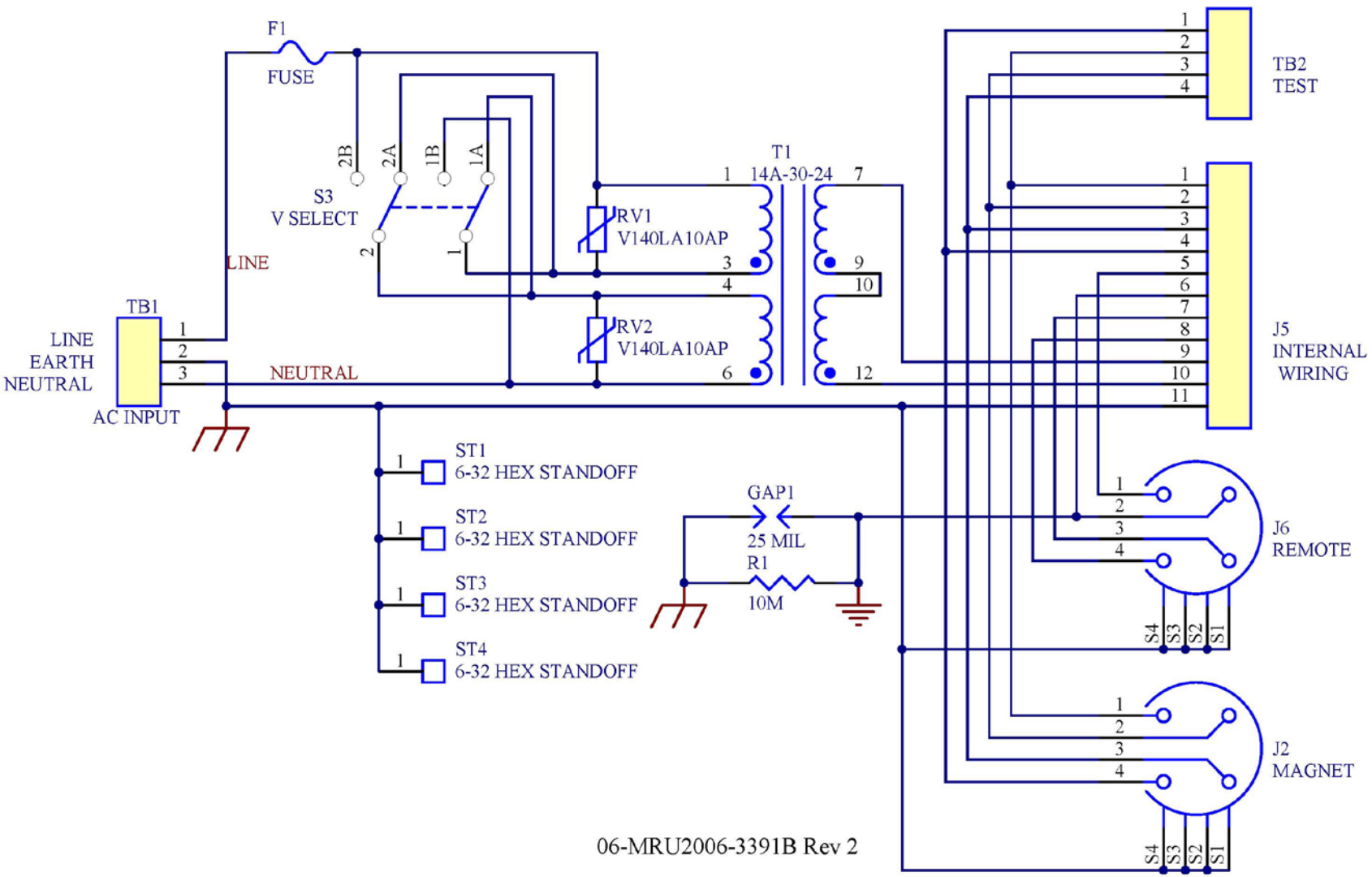
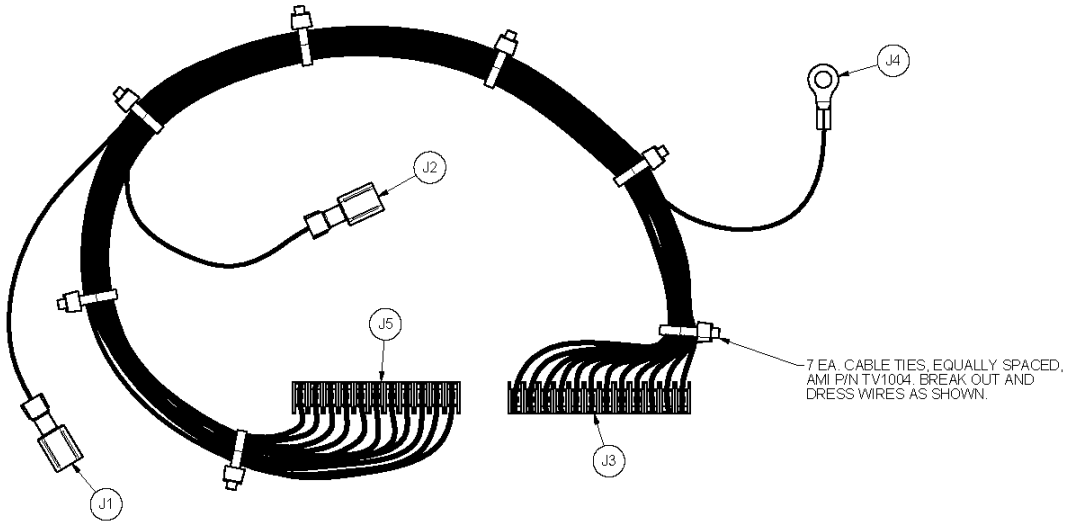
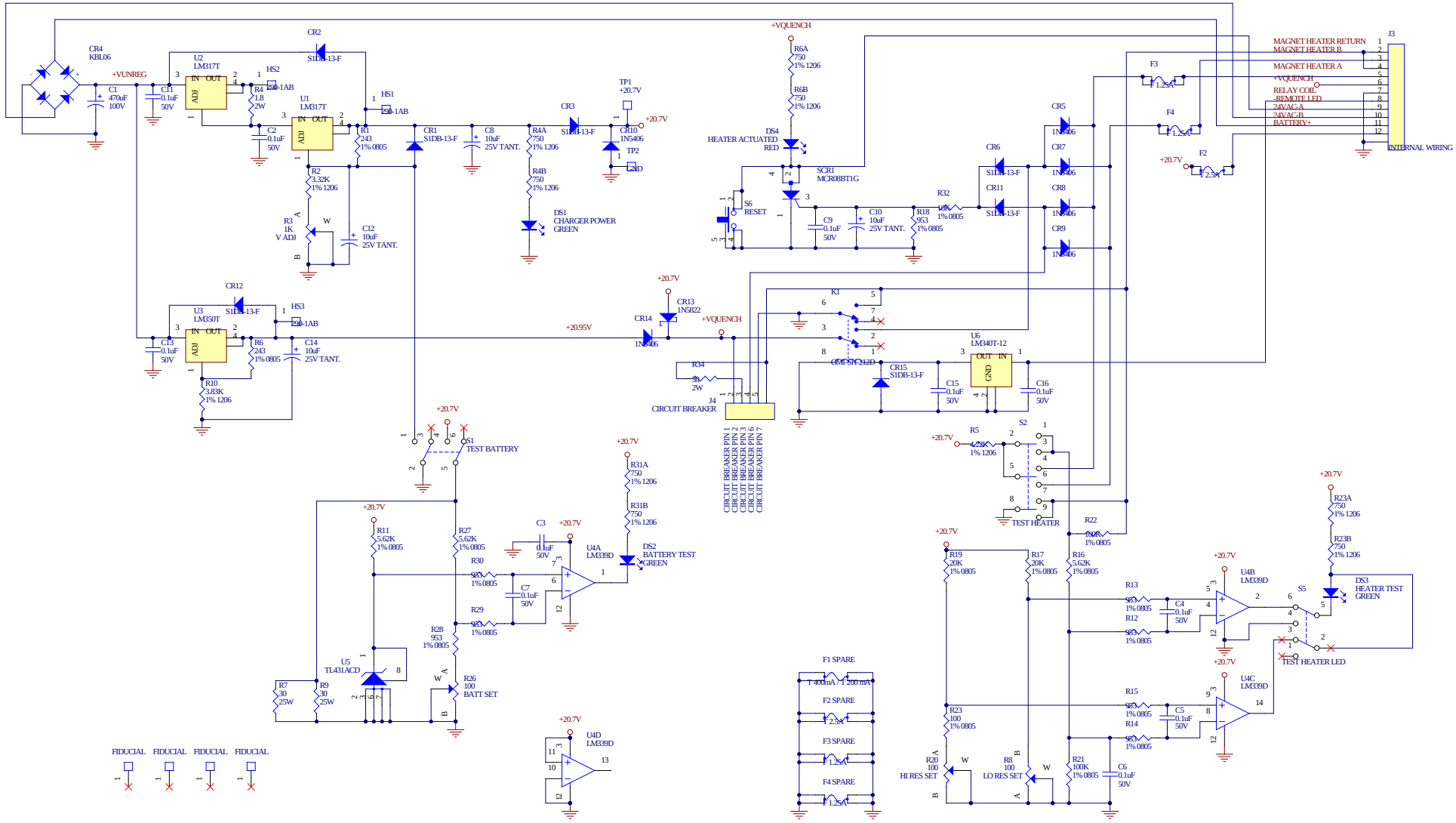
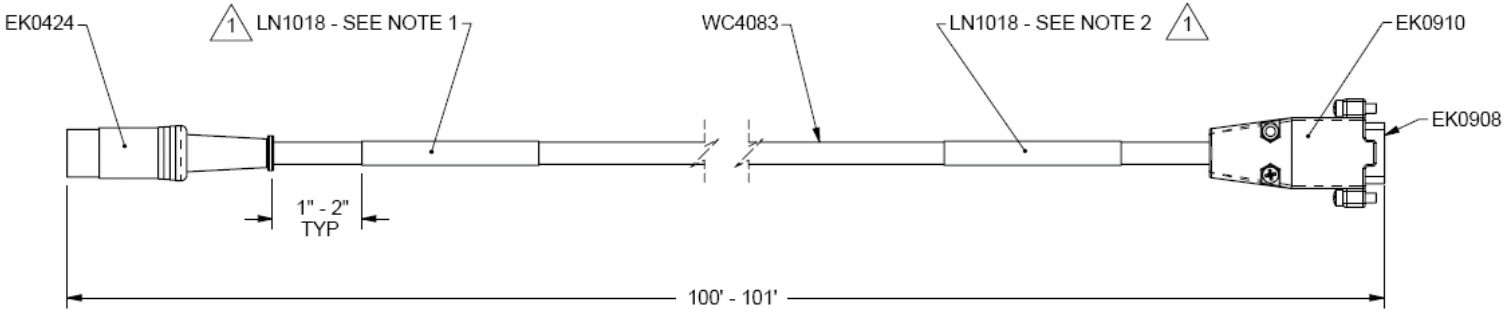




TERMINATION A	WIRE	TERMINATION B
J5 (EK1100) PIN 1	20.2" (WC4049)	J3 (EK1200) PIN 1
J5 (EK1100) PIN 2	19.9" (WC4047)	J3 (EK1200) PIN 2
J5 (EK1100) PIN 3	19.6" (WC4047)	J3 (EK1200) PIN 3
J5 (EK1100) PIN 4	19.3" (WC4047)	J3 (EK1200) PIN 4
J5 (EK1100) PIN 5	19.0" (WC4047)	J3 (EK1200) PIN 5
J5 (EK1100) PIN 6	18.7" (WC4047)	J3 (EK1200) PIN 6
J5 (EK1100) PIN 7	18.4" (WC4047)	J3 (EK1200) PIN 7
J5 (EK1100) PIN 8	18.1" (WC4047)	J3 (EK1200) PIN 8
J5 (EK1100) PIN 9	17.8" (WC4047)	J3 (EK1200) PIN 9
J5 (EK1100) PIN 10	17.5" (WC4047)	J3 (EK1200) PIN 10
J5 (EK1100) PIN 11	22.0" (WC4047)	J4 (EK0000)
J1 (EK0073)	19.0" (WC4049)	J3 (EK1200) PIN 11
J2 (EK0073)	18.0" (WC4047)	J3 (EK1200) PIN 12



10.010 MRU-to-pen-panel Cable



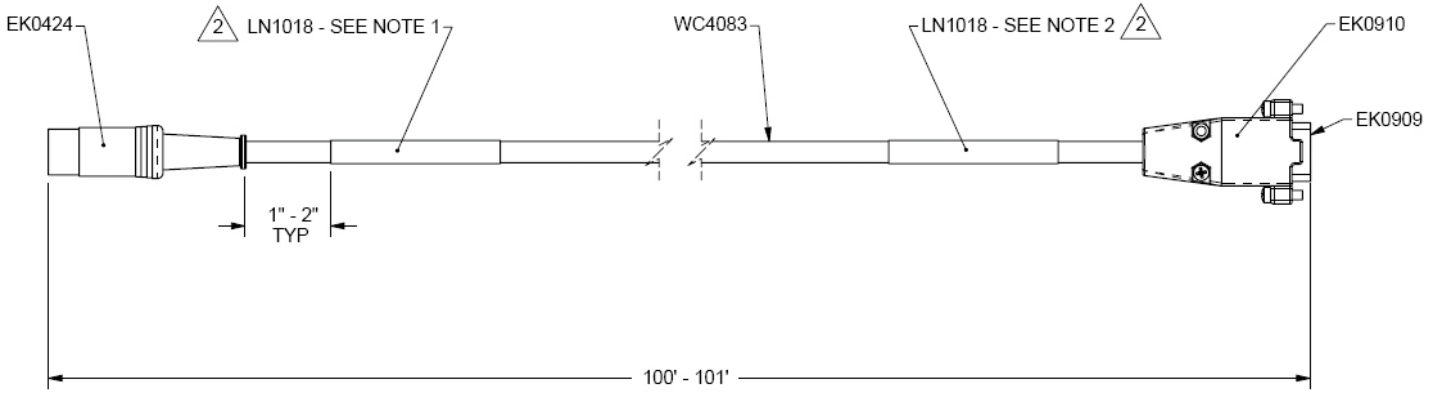
1 AMI P/N: MOD GE 5196920

TERMINATION A	WIRE	TERMINATION B
DIN (EK0424) PIN 1	BLACK	D-SUB (EK0908) PIN 1
DIN (EK0424) PIN 2	RED	D-SUB (EK0908) PIN 2
DIN (EK0424) PIN 3	GREEN	D-SUB (EK0908) PIN 3
DIN (EK0424) PIN 4	CLEAR	D-SUB (EK0908) PIN 4
DIN (EK0424) SHELL	SHIELD DRAIN	D-SUB (EK0908) PIN 5

1 NOTES:

1) MARK: RUN NO. 1265 REMOTE MRU END
5196920
G.E. CO.
2) MARK: RUN NO. 1265 PEN PANEL END
5196920
G.E. CO.

10.011 Remote-MRU-to-pen-panel Cable

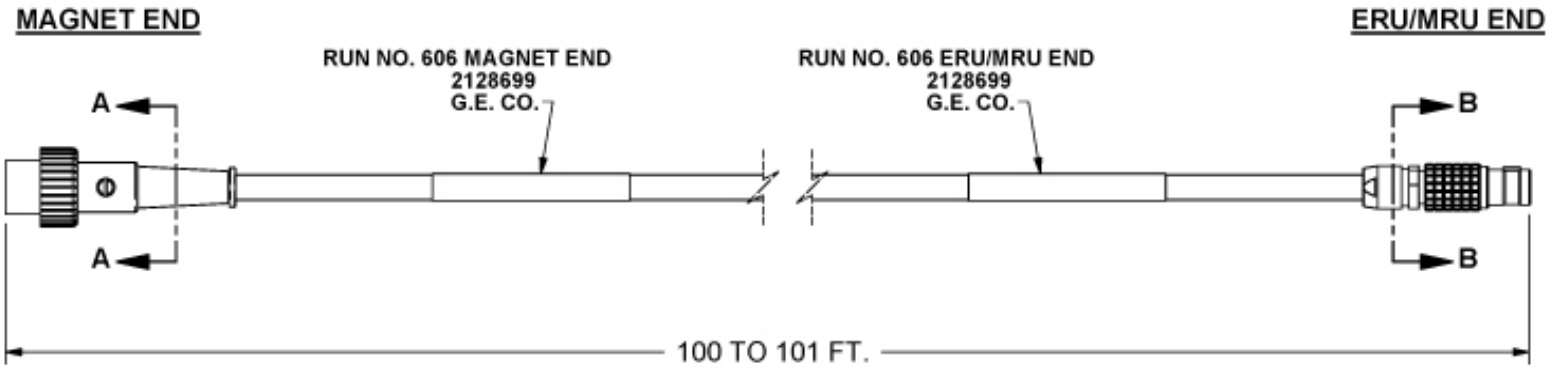


2 **AMI P/N: MOD GE 5196921**

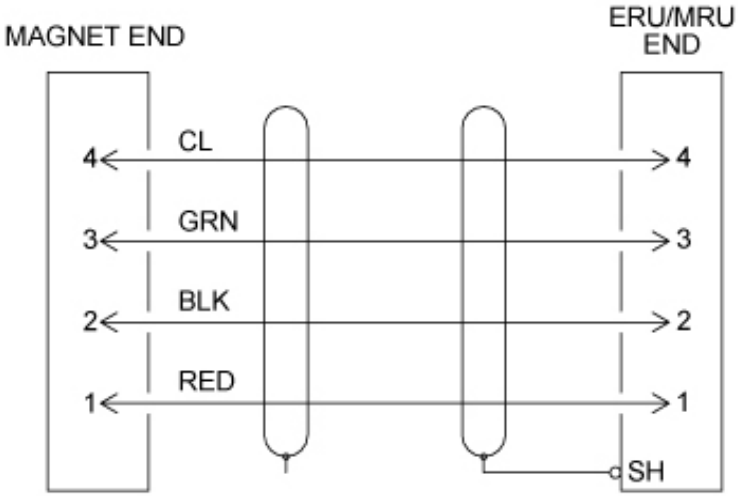
TERMINATION A	WIRE	TERMINATION B
DIN (EK0424) PIN 1	BLACK	D-SUB (EK0909) PIN 1
DIN (EK0424) PIN 2	RED	D-SUB (EK0909) PIN 2
DIN (EK0424) PIN 3	GREEN	D-SUB (EK0909) PIN 3
DIN (EK0424) PIN 4	CLEAR	D-SUB (EK0909) PIN 4
DIN (EK0424) SHELL	SHIELD DRAIN	D-SUB (EK0909) PIN 5

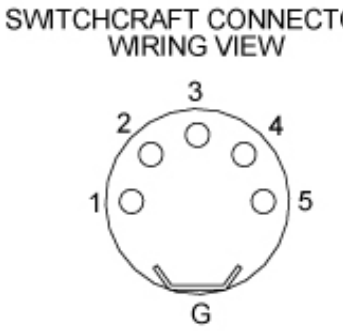
2 **NOTES:**

1) MARK: RUN NO. 1266 REMOTE MRU END
5196921
G.E. CO.
2) MARK: RUN NO. 1266 PEN PANEL END
5196921
G.E. CO.

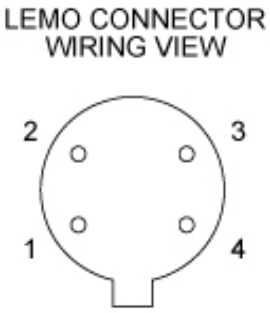


AMI P/N: EH2331
GE P/N: 2128699

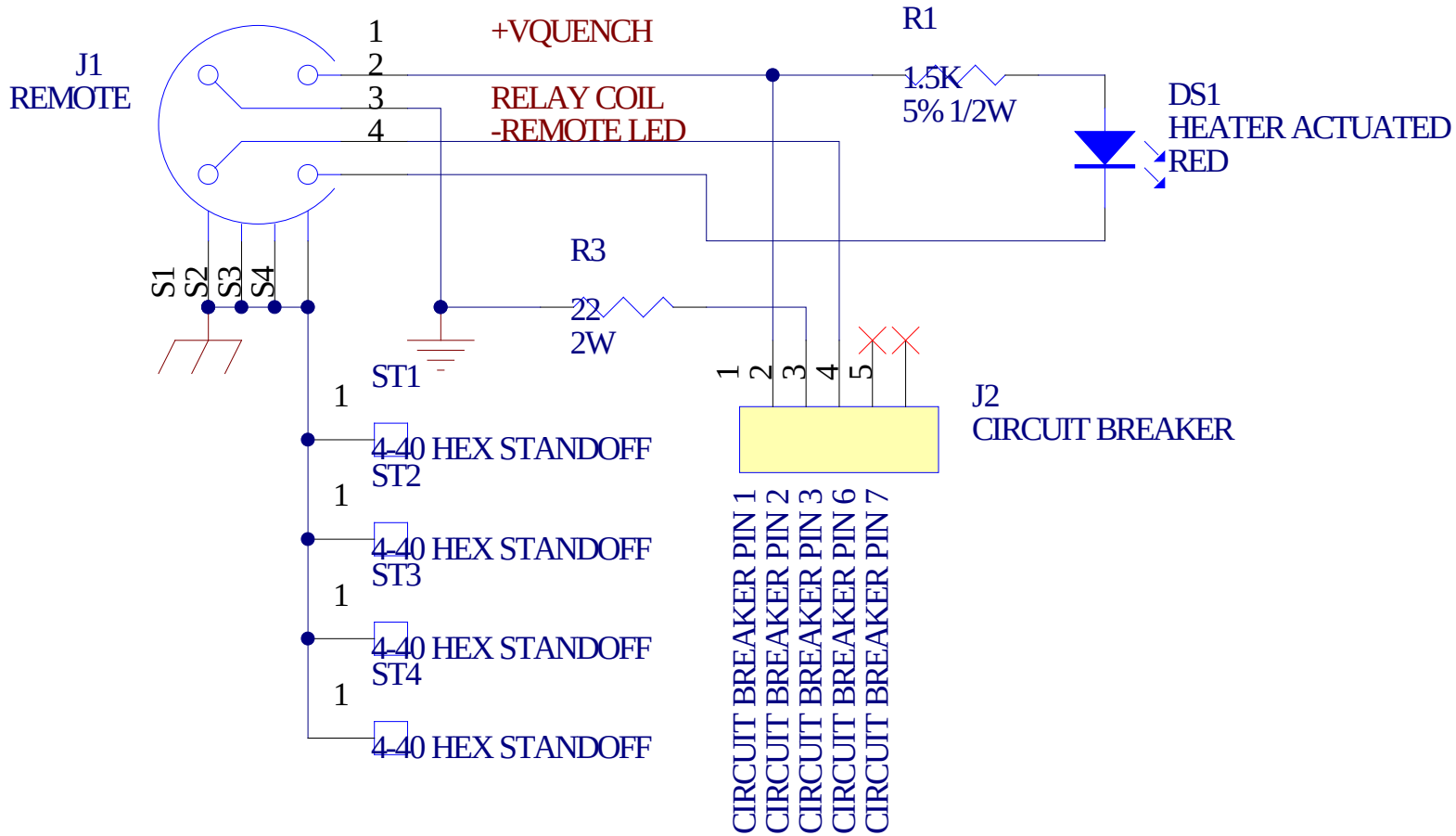




SECTION A-A



SECTION B-B



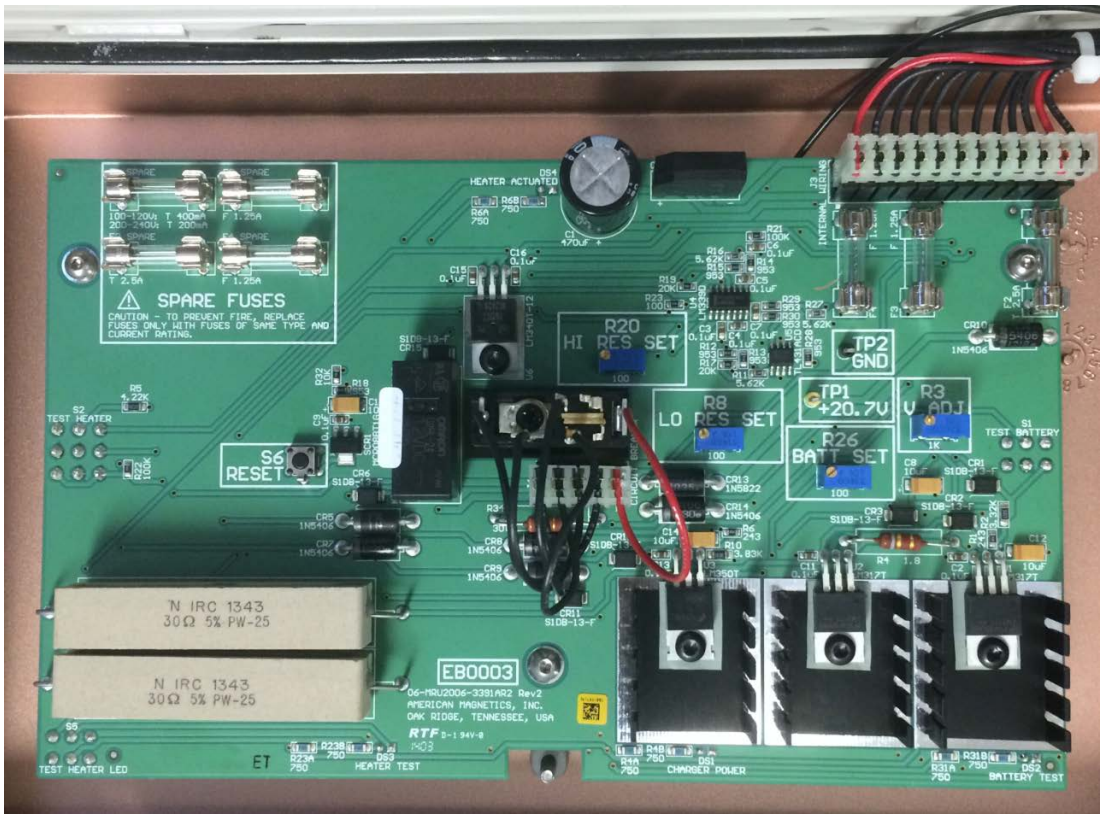


Figure 16: MRU Key Components 1

Figure 17: MRU Key Components 2

11 REPLACEMENT PARTS LIST

AMI Part Number	GE Part Number	Description
MOD GE 5196918-2	5196918-2	Magnet Rundown Unit (Primary)
MOD GE 2128699	2128699	Cable, Magnet to MRU (Run 606)
MOD GE 5199742	5199742	Parts Pack, power resistor-fuse-hole plug

Table 2 MRU Kit Assembly (GE Part #: 5180313)

AMI Part Number	GE Part Number	Description
MOD GE 5196919	5196919	Magnet Rundown Unit (Remote)
MOD GE 5196920	5196920	Cable, Primary MRU to Pen Panel (Run 1265)
MOD GE 5196921	5196921	Cable, Remote MRU to Pen Panel (Run 1266)
MOD GE 5128562	5128562	Label, MRU Danger

Table 3 Remote MRU Kit Assembly (GE Part #: 5180187)

AMI Part Number	GE Part Number	Description
MOD GE 5363631	5363631	Kit, Spare fuse for MRU
SA 0018	5199490	Battery pack assembly (3-battery set with series wiring)

Table 4 FRU Parts

12 PERIODIC MAINTENANCE

WARNING: *HAZARDOUS VOLTAGES ARE ACCESSIBLE AT COMPONENTS F1, TB1, S3, RV1, AND RV2 AND AT THE LOWER TERMINALS OF T1. TO AVOID ELECTRIC SHOCK, USE CAUTION WHEN THE MRU COVER IS OPEN TO ASSURE THAT CONTACT IS NOT MADE WITH ANY OF THESE COMPONENTS.*

WARNING: *POTENTIAL MAGNET QUENCH*

DO NOT attempt to measure resistance by connecting Ohmmeter across magnet heater connections.

12.01 Quarterly, qualified service representative

WARNING: POTENTIAL MAGNET QUENCH

Do not press the Rundown/Quench button throughout this process

Do not reconnect MRU cable if it is found disconnected. GEHC strongly recommends that you stop using the system, and immediately call your qualified service representative.

12.01.1 Perform test described in section 5.01 to 5.04.

12.01.2 If green BATTERY TEST LED does not light or goes dark during 15 second test then replace the batteries and check charger voltage level as described in section 12.02.5.

12.01.3 If green HEATER TEST LED does not light, depress TEST HEATER LED switch. If the green TEST HEATER LED does not light, replace MRU.

12.02 Yearly, qualified service representative

12.02.1 Perform tests in sections 12.01.1 through 12.01.3.

WARNING: *THE 20 OHM POWER RESISTOR WILL BECOME HOT DURING TESTS*

12.02.2 Remove magnet heater connector P2 from J2.

WARNING: *ENSURE THE MAGNET HEATERS ARE NOT CONNECTED TO J2 TO PREVENT INADVERTENT MAGNET QUENCH*

12.02.3 Open the front cover and visually inspect the entire unit for any evidence of overheating, discoloration, etc. Remove fuse F2. Remove batteries and hold down plate. Visually inspect battery terminals for any evidence of corrosion. If any corrosion is evident, replace batteries (see sections 12.03.1 through 12.03.3) and/or battery connecting terminals. If new batteries or terminals are needed, apply a thin layer of silicone grease or petroleum jelly to terminals after assembly.

12.02.4 Reinstall battery hold down plate and fuse F2. Locate 20 ohm 5% 20 watt power resistor in plastic bag; remove resistor from bag and connect to terminals 1 and 2 of TB2. Connect a digital voltmeter (DVM) across this resistor and press the RUNDOWN button. The DVM should read approximately ⎓ 20 V for approximately 50 seconds. The power resistor must remain energized for a minimum of 30 seconds. Allow a minimum of 3 minutes for RUNDOWN circuit breaker to cool before subsequent power resistor timing cycles. Move the power resistor from terminals 1 and 2 of TB2 to terminals 3 and 4 of TB2. Connect the DVM across this resistor and press the RUNDOWN button. The DVM should read approximately ⎓ 20 V for approximately 50 seconds. The power resistor must remain on for a minimum of 30 seconds. Remove the power resistor from TB2. If supplied with the Remote MRU, repeat test as stated, except depress the RUNDOWN button on remote MRU. Press pushbutton switch S6 on the MRU main printed circuit board to reset the HEATER ACTUATED LED.

12.02.5 Connect the DVM to test point +20.7V and test point GND. The meter should read ⎓ 20.7V +/- 0.1V. If not, remove fuse F2 and adjust R3 for ⎓ 20.7V. Then replace F2.

WARNING: *BEFORE CONNECTING P2 TO J2, ASSURE THAT AC SUPPLY MAINS POWER HAS BEEN APPLIED TO THE MRU FOR AT LEAST 3 MINUTES AND THAT THE RUNDOWN BUTTON HAS NOT BEEN ACTUATED FOR AT LEAST 3 MINUTES. THE HEATERVOLTAGE IS OFF BEFORE CONNECTING TO THE MAGNET. FAILURE TO HEED THIS WARNING MAY CAUSE A MAGNET QUENCH.*

12.02.6 Disconnect the DVM, plug P2 into J2, close the cover, and perform tests 12.01.1 through 12.01.3. Log the test date and time.

12.02.7 The battery pack must be replaced every three years. At the yearly maintenance determine how many years have elapsed since the MRU was manufactured, by subtracting the year of manufacture of the MRU (as shown on the MRU box) from the current year. eg. current year (2015) - year of manufacture (2012) = 3. If the number of years that have elapsed is a multiple of 3, ie. 3,6,9,12,15,18, etc then replace the battery pack.

12.03 **Battery Replacement — Applies if battery failure occurs, qualified service representative**

12.03.1 Replace all three 6V sealed lead-acid batteries (see replacement parts list). *OBSERVE BATTERY POLARITY.* Batteries contain lead, and must be disposed of properly.

12.03.2 If the batteries have been stored for one year or more, it may be necessary to wait for as long as 8 hours for battery voltage to reach ⎓ 20.0 V minimum. Initial charge current is approximately 700 mA which will decrease to approximately 3 mA when fully charged.

12.03.3 Perform the Yearly tests and check battery charger voltage as described in sections of 12.02.