Contents

1. Introduction ................................................................................. 4
2. Performance Specifications............................................................ 5
3. Installation .................................................................................... 5
4. Operation..................................................................................... 8
5. User Menu ................................................................................. 11
6. Periodic Maintenance and Testing............................................... 14
7. Factory Support .......................................................................... 14
8. Error Codes and Troubleshooting ............................................... 14
9. Manual Revision History .............................................................. 19
Hazard of Electric Shock, Explosion, or Arc Fault

- **Danger!** Hazardous voltages are present inside the Line Isolation Monitor as well as at the power connector and wiring harness! Disconnect power supplying this equipment before installation or servicing.

- Improper installation or operation can lead to serious injury or death. Refer to appropriate local electrical safety standard(s) for additional safety guidelines.

- Only qualified personnel should operate, maintain, and service this equipment. PG LifeLink assumes no responsibility for any consequences arising from the use of this document.

Equipment Damage Hazard

- **Caution!** Proper operation of this equipment is dependent on correct installation and setup.

- Do not modify this equipment or use in a manner for which it is not intended.

- Use only with PG LifeLink recommended accessories.

- Failure to adhere to the instructions contained in this document can result in personal injury, equipment malfunction, or serious damage to connected equipment.
1. Introduction

Isolated Power Systems (IPS) protect patients and attending personnel from certain electric shock hazards caused by common ground faults, without disconnecting power to critical electro-medical equipment. These specialized power safety systems are intended for use in patient care areas of health care facilities, and are designed to impede the circulation of hazardous fault currents resulting from damaged electrical insulation, or the presence of conductive materials such as fluids near energized conductors. IPSs are especially suited to protecting critical loads because, unlike GFCI or RCD protection devices, the presence of a single line-to-ground fault will not “trip” a circuit, thus preventing loss of power to critical equipment.

The PG LifeLink Mark V Line Isolation Monitor (LIM) is designed to continuously monitor the operation of an Isolated Power System, and alert personnel in the event that a line-to-ground fault is detected, or that the safety system has otherwise been compromised. The Mark V employs a unique monitoring technique to simultaneously analyze the line-to-ground impedance of both output legs of an IPS. It divides the line voltage by the lower of the two ground impedance measurements to calculate and display the system’s Total Hazard Current (THC).

THC is the predicted maximum current that could flow from any energized conductor of an IPS through any unintended path to ground (first-fault) in the event of a worst-case direct short to ground (second-fault) on the opposite leg. If the system’s THC exceeds a predetermined level, a “Hazard” alarm is activated, indicating that a first-fault condition has occurred and corrective action is required to identify and remove the source of the fault. Note that IPS are designed to maintain very high ground impedance on both energized conductors, thereby restricting the flow of actual fault current to very low levels even under a first-fault condition. Therefore, critical power is maintained and medical procedures can be safely completed without endangering patients or staff.

A complete discussion of the details of isolated power systems, their operation, and their installation requirements is beyond the scope of this document. Additional information can be found under the Technical Resources section of our website http://www.pglifelink.com. Technical assistance is also available by calling +1 800-287-4123 or via email at techsupport@pglifelink.com.

For design, installation, and testing requirements specific to your region, consult your national and local Codes.


Canada – CSA C22.1—Canadian Electrical Code, Part 1; and CSA Z32 - Electrical safety and essential electrical systems in health care facilities

2. Performance specifications:

- Operating voltage: 120 or 208/240 VAC (field selectable)
- Nominal power consumption: 10 VA
- Operating frequency: 50/60 Hz
- Accuracy: ±5% of full scale (@5mA THC)
- THC Alarm Level: 4.8 mA or 1.9mA (field selectable)
- Monitor Hazard Current: 25 μA max. @ 120V
  50 μA max. @ 208/240V

3. Installation

Check the LIM on arrival for shipping damage. Do not apply power if damage is evident. If unit will not be immediately installed, store it in a clean, dry location, protected from construction debris or other contamination.

The Mark V LIM is intended be installed only in conjunction with an Isolated Power System, according to all applicable codes and standards. Do not connect to grounded (non-isolated) power systems.

Unit weight is approximately 2.3 lbs. (1 kg). Four mounting holes are located on the corners of the front bezel. Affix unit using four each #4 - 40 x 1/2" machine screws (supplied with IPS panel). For other installations, including upgrade of older generation Line Isolation Monitors, custom retrofit mounting brackets and

Figure 1 - Mounting Dimensions
hardware are provided. Inform factory sales representative or application engineer of existing installation details when ordering.

Each LIM is supplied with a wiring harness complete with 15-pin header connector (J-2). Ensure that power is disconnected prior to installation or any contact with wiring harness or connectors. Header is polarized to prevent reverse connection. Use caution when connecting or disconnecting header. Carefully align with pins located on underside of LIM. Remove by securely holding header and pulling straight down to avoid bending pins. Do not pull on wires as they may be dislodged from header and adversely affect LIM operation.

Refer to wiring diagram below (Figure 2) for proper connection. Wiring connection details are dependent on the various options installed, including RS-485 to Ethernet converter for LIM-CONNECT™, transformer load monitoring transducer, transformer temperature alarm, and external remotes.

Figure 2 - Wiring Diagram
Caution: Do not apply voltage greater than 150VAC to device unless switch SW1 on the PS (lower) board is placed in the 230V position! Application of voltage in excess of device setting may severely damage this device and/or endanger the user.

NOTE: Improper connection can damage the LIM and/or create danger for the user. Always verify correct connections before applying power!

The PG LifeLink Mark V Line Isolation Monitor has two selectable voltage range settings: 115V and 230V. Verify that the proper voltage range is selected BEFORE connecting or applying power to device. Failure to select the proper voltage range will severely damage the LIM, invalidate product warranties, and may endanger the user.

Units supplied as part of an IPS panel are preconfigured according to the panel’s output voltage. Do not move a LIM from one panel to another without verifying that the nominal output voltages of the two panels are the same. LIM’s supplied independently are configured according to customer’s requested voltage range. If no voltage is specified, units are typically configured for 120VAC application. Voltage range selection is accomplished via switch SW1, located on main supply board PCB inside the unit.

To access Voltage Selection Switch SW1:

1. De-energize panel and completely disconnect wiring harness connector J-2 from LIM.
2. Remove four (4ea.) black Phillips head screws securing front escutcheon plate to LIM housing. Carefully remove escutcheon.
3. Remove eight (8ea.) Phillips head screws securing upper and lower PCB assemblies to LIM housing. Carefully remove PCB assemblies.
4. Located Switch SW1 on bottom of main supply board. Set switch according to Table 1.
5. Carefully reinstall PCB assemblies into LIM housing and secure with original hardware.
6. Reinstall front escutcheon plate.

<table>
<thead>
<tr>
<th>Nominal Line Voltage (IPS)</th>
<th>Switch SW1 Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>110-120 VAC</td>
<td>115V</td>
</tr>
<tr>
<td>208-240 VAC</td>
<td>230V</td>
</tr>
</tbody>
</table>

Table 1 - Voltage Selection Settings

The Mark V LIM wiring harness is factory terminated in new IPS panels on a standard 11-pole control terminal block (TB-Remote) for field connection of accessories, including optional sensors, remote annunciators, or communication devices. Refer to Figure 2 for proper connection. Dashed lines indicate control wiring supplied by installer.

Certain units, including those supplied as part of a replacement or upgrade kit, may include a factory modified wiring harness, which is designed for the specific application. However, the power and ground connections are consistent for all
configurations. Connect terminals 14 & 15 to the panelboard bus bars for L1 & L2 respectively, using the correct color wire (orange and brown). Connect terminals 12 & 13 to the panel reference ground bus using green wires. These wires must be separate individual conductors, each terminated on its own separate terminal of the reference ground bus, to preserve the LIM's ground loss detection function.

From the control terminal block (TB-Remote), connect the low-voltage terminals to external devices as indicated in Figure 2. If possible use the same color wires that are on the “factory side” of the terminal block for remote annunciators, making logical substitutions where necessary. Avoid the use of orange, brown, or green wires for remotes or other low-voltage connections for easy identification and future maintenance except when matching factory wiring.

The Mark V is compatible ONLY with PG LifeLink remote annunciator models DRA-1 and DRA-VS. Damage may result if non-compatible remotes are connected. Other models, including those from other manufacturers, may be adapted to work with the Mark V in some cases, if sufficient application information is available. Consult PG LifeLink applications engineering for assistance with specific models, including replacement units or upgrades.

Each Mark V supports up to four (4ea.) model DRA-1 or two (2ea.) model DRA-VS remotes connected in parallel. The total length of control wire between the LIM and all remotes is limited to 300 ft. for DRA-1 and 150 ft. for DRA-VS remotes (refer to figure 2 for wire gauge). Greater distances can be accommodated in some cases by increasing the wire gauge or adding an auxiliary DC power supply. Consult the factory for engineering assistance and pricing in such situations.

The Mark V LIM includes a set of dry relay alarm contacts for external alarm indication in addition to standard remote modules. This provides a simple and flexible solution for interfacing with legacy annunciator systems, or connection to local BMS or other facility supervisory network. The relay contacts are rated for 200VDC or 240VAC, 2A max, 60 VA max. The normally open (N.O.) contact is closed whenever unit exhibits an alarm.

Other optional sensors and communication devices supplied with IPS are factory wired.

4. Operation

System Startup - After system has been properly installed and all wiring connections have been verified, energize the Primary Main Circuit Breaker in the Isolated Power System panel. The LIM will undergo the following initialization process each time unit is energized:

1. Three seconds after power is applied unit will perform a “lamp test”, illuminating all LED indicators and segments, as well as signaling audible alarm. The LCD screen displays current firmware version and serial number of the unit. If any problem is noted with LEDs or displays, or if the audible alarm signal is not present, contact technical support.

2. After “lamp test” is complete, the unit will enter self-calibration mode for approximately 30 seconds. “CA” is displayed on the LED screen, and the LCD display indicates “Status: Calibration”.

3. Upon completion of self-calibration, unit should enter normal operation mode.
4. If this is the first time LIM has been energized, or if unit has been turned off for more than two weeks, a reminder to set the system time will appear. Refer to User Menu section of this manual.

Normal Operation - Under normal operating conditions the LIM will exhibit the following:

1. The green “SAFE” indicator is illuminated, indicating unit is energized and condition is normal.
2. The red “HAZARD” and amber “SILENCED” indicators are extinguished. (Exception: if “Alarm Volume” has been set to “Mute” in the configuration menu, the amber “SILENCED” indicator will be continuously illuminated)
3. The 2-digit mA display, along with the 16-segment bar graph will indicate the calculated Total Hazard Current for the Isolated Power System, including any connected equipment.
4. The LCD display screen indicates “Status: System OK” along with the current time, measured line-voltage, and (if activated) % of system full load.

THC Measurement - The primary function of the Mark V Line Isolation Monitor is to continuously monitor the line-to-ground impedance of both line conductors of a single phase, ungrounded, Isolated Power System. A “fault” condition exists when a piece of connected equipment causes this impedance to drop significantly, causing a proportional rise in the calculated Total Hazard Current (THC). When the THC exceeds the selected alarm threshold value of 5 mA or 2 mA, audible and visual alarms are triggered on the front of the LIM as well as on any connected remote annunciators.

Loss of Ground - The Mark V LIM monitors its connection to the system reference ground, and triggers an alarm when connection is lost. There are two redundant connections from the LIM to ground, both of which must be maintained in order to permit normal operation. If one connection is lost the LIM will provide a ground loss alarm.

Alarms - Under alarm conditions the LIM will exhibit the following:

1. The green “SAFE” indicator is extinguished.
2. The red “HAZARD” indicator is illuminated along with an oscillating audible alarm.
3. For alarms corresponding to high Total Hazard Current, the 2-digit mA display will flash the calculated THC value and the LCD display will indicate “Status: Hi Haz Curr”.
4. For loss of reference ground connection alarm, the 2-digit mA display will flash “Gn” and the LCD display will indicate “Status: Ground Loss”.
5. For alarms corresponding to other features, including transformer overload and overheating, the 2-digit display will operate normally, and the LCD display will indicate the associated alarm status message.
6. For alarms corresponding to system errors, refer to System Errors in the Error Codes and Troubleshooting section of this manual.

What to do in the event of an alarm - If the LIM goes into alarm during a procedure, calmly press the “SILENCE” button to temporarily mute the audible alert, and then identify the type of alarm from the list above.

For high THC alarms, determine if alarm correlates to a particular piece of equipment. If alarm occurs within a few seconds of energizing or operating a specific device, that
device is likely the source of the fault. If it can be safely disconnected without affecting the patient or procedure, then disconnect and tag it for analysis by biomedical or other maintenance personnel, and continue the procedure. LIM will clear alarm and return to normal operation once fault is disconnected.

If device cannot be disconnected without affecting the patient or procedure, or if source of alarm cannot be identified, then complete the case as normal. Follow facility procedures to notify biomedical and/or facilities engineering department(s) to investigate and resolve the root cause. Note that the audible alert will reactivate if the alarm condition is not removed before the silence feature times out.

**Hazard Current Range** - The alarm threshold value and Total Hazard Current scale are selectable for either 2mA or 5mA. Selecting the proper range is accomplished by a setting in the User Menu. In most areas, the mandated THC alarm threshold is 5mA. In some areas including Canada, a lower 2mA threshold is required. The default setting is 5mA. See *User Menu* section for instructions.

**Self-Testing** - The Mark V LIM includes an automatic self-testing/self-calibrating function. This function is activated automatically based on the “Auto-Cal” interval setting in the system configuration menu. This function lasts approximately 25 seconds, during which the 2-digit display will indicate “CA”. During these operations the LIM temporarily disconnects itself from the reference ground of the isolated power system to avoid inducing unnecessary fault current into the system and applies an internal precision reference network to simulate the selected full scale THC alarm level. The unit also compensates for variations in line voltage or other parameter shifts that may affect hazard current calculation.

In addition to the automatic self-test interval, the Mark V automatically enters the self-calibration process whenever it is powered on.

**Manual Testing** - The internal test feature can also be activated manually at any time by pressing and holding the “TEST” button of the front of the LIM. The LIM measures the calibration reference network while showing its response on the displays, and when the indication reaches the predefined set point, the audible and visual alarms will be triggered.

For ease in precisely testing the LIM’s alarm threshold, press and hold the Silence and UP buttons, and briefly press and release the Select button. A reading with 3-digit precision will appear on the screen. Press Select to exit this mode at any time, or allow it to exit automatically after about 3 minutes.

**Optional Transformer Load Current monitoring** - An optional current transducer is available for measuring the transformer primary current. The Mark V has configuration settings to match to the properties of the panel. The current is displayed on the main operating screen in % of full-load current.

**Optional Transformer Core Temperature monitoring** - An optional temperature alarm transducer is available, to warn of excessive heat buildup in the transformer. When enabled in its configuration menu, the Mark V will provide an alarm when the preset temperature threshold is exceeded. Note: The isolation transformer over-temperature monitor is a factory option that must be selected when IPS is ordered. Field installation is not available.

**System Logs** - A set of system logs is accessible from the LCD user interface. Log memory is permanent and non-volatile, storing up to 75 entries each for Events and Alarms. Once the capacity is reached, new entries replace old ones in a First-In-
First-Out discipline. See User Menu section for instructions on viewing recorded Events and Alarms.

Additional Features

The LIM contains an internal real-time clock to provide accurate date and time stamps for event logs. It has a battery backup that lasts about 2-3 weeks, after which the date & time information will need to be re-entered. The display will indicate “Time Setting Invalid” if the clock has lost its time due to a drained battery.

The Mark V LIM automatically senses the power line frequency (50 or 60 Hz) and the voltage range (80 -140 or 180 - 265VAC) at startup.

In addition to traditional remote annunciator modules, the Mark V supports connection to a PC running PG Lifelink’s LIM-CONNECT™ software (sold separately). This specialized monitoring and control system facilitates consolidated live status monitoring and remote operation of all user interface commands from the convenience of a Facility Engineering office. Consult setup guide and installation manual supplied with LIM-CONNECT™ software for more information.

5. User Menu

The Mark V has a menu-driven user interface to provide access to configuration settings and event memory. Editable settings include hazard current range, alarm volume, time and date, self-calibration interval, and auxiliary alarm limits. Event memory is accessed through the menu and contains two log queues, one of which records the time, date, and description of the most recent 75 alarms, and the other the most recent 75 non-alarm system events including power-up, self-calibration, and clock synchronization by LIM-CONNECT™ software.

Refer to Figure 3 for description and sequence of user interface commands.

To access the Mark V Main Menu, press the Menu key. The user menu will appear. It will display the choices “View”, “Cfgr”, and “Exit”, with “View” as the default.

The menu will disappear and the display will revert to the System Status screen in about 2 minutes if there is no further button activity, or if “Exit” is pressed, without making any further changes. The user can return to the Main Menu at any time by pressing “Menu”.

To View data without making any changes, press “Select” while the cursor is on “View”. The available choices will be “Alrm”, “Evnt”, and “Info”. Use the “Up” & “Down” keys to move the cursor to the desired option, and “Select” to select it.

“View” allows the user to browse through the Event and Alarm logs and to check to be controlled separately from the LIM. In the “Alrm” and “Evnt” selections, scroll through stored log entries with the “Up” and “Down” keys.

“Info” displays the welcome screen including the firmware version number and the unit serial number.

The Configuration Menu allows the user to change system settings. To change settings, use the “Up” key to change the cursor to “Cfgr”, and press the “Select” key 5 times within 10 seconds. This requirement for multiple key presses reduces the possibility of accidental operation.
### Attribute | Value | Description
--- | --- | ---
Alarm Volume | High | Beeper volume high
Silence Timeout | 30 | Minutes before resumption of audible alarm
Calib Frequency | Hour | Multiple times daily
Calib Interval | 6 | Every 6 hours
Calib Time | 6 | 6 AM (will only take effect if Freq is set to Day)
CT Range | 0 | Load Monitoring disabled
Pri Brkr Amps | 80 | 80% of CT Range setting
Load Alarm Limit | 80 | Alarm at 80% of primary breaker amps rating
Temp Monitor | Off | Transformer temperature monitoring disabled
Hazard Current Range | 5mA | Full-scale hazard current

Table 2 - Default Settings

![User Interface Menu Tree](image)

Figure 3 - User Interface Menu Tree (factory defaults shown in **bold**).

---

© 2014 PG LifeLink, Inc. - All rights reserved
The “Cfgr” menu allows the user to step through all system setup options. Use the “Up” key to step from one option to the next, or “Down” to the previous option.

Hour, Minute, Month, Day, Year - sets real-time clock time and date, in 24-hour format (note: all time settings will be overridden by time sync commands from LIM-CONNECT™ at local midnight if installed and running.) Setting the minute value resets the seconds to :00.

Alarm Volume - sets either “High” or “Low” volume, or “Mute”, for the LIM itself. Does not affect remotes.

Silence Timeout - provides control of the duration of manual silence during alarms. The alarm will sound again after this time has elapsed, to reduce the possibility of users forgetting that an alarm has occurred.

Calibration Frequency - sets the schedule format for automatic self-calibration. Options are “Hour” (multiple times per day at a selectable interval) or “Day” (once per day at a selectable time).

Cal Interval / Time - selects desired frequency and timing of self-test/calibration function. If the Calib Frequency field is changed from Day to Hour or vice-versa, the Hour or Interval setting is reset to the factory default. Available values for “hourly” interval are 1 through 12. Available values for “day” time are 0 to 23 (per 24 hour clock). Factory default setting is once every six (6) hours at midnight, 6:00, 12:00, & 18:00. Note that since a new log entry is created for every calibration event, setting the unit for more frequent calibrations will fill the limited onboard memory more quickly, thus limiting the reviewable time span of stored events in the log.

Calibration frequency by Day (once daily) – at the top of the selected hour, or Calibration frequency by Hour – at the following times:
1 = 24 per day: every hour
2 = 12 per day: every 2 hours, at even-numbered hours
3 = 8 per day: every 3 hours starting at 0:00
4 = 6 per day: every 4 hours starting at 0:00
5 = 5 per day: 0:00, 5:00, 10:00, 15:00, 20:00
6 = 4 per day: every 6 hours starting at 0:00 (default value)
7 = 4 per day: 0:00, 7:00, 14:00, 21:00
8 = 3 per day: every 8 hours starting at 0:00
9 = 3 per day: 0:00, 9:00, 18:00
10 = 3 per day: 0:00, 10:00, 20:00
11 = 3 per day: 0:00, 11:00, 22:00
12 = 2 per day: 0:00, 12:00

CT Range - selects the full-scale current range of the optional load metering current transformer installed in the IPS panel, if so equipped. For panels without this optional equipment, or to disable it if present, set to 0. Options are 0 (inactive), 10, 20, 50, 100, 150, and 200A. This setting must match the range of the CT itself, which in turn is selected by the factory to match the expected range of transformer primary current. If Inactive, the “Pri Brkr Amps” and “Load Alarm Limit” menu options will not be displayed.

Pri Brkr Amps - use the “Up” and “Down” keys to enter the trip rating (A) of the Primary Main Circuit Breaker which is being monitored. The actual full-load primary current of the transformer may also be used as the reference for the
alarm limit if desired. Factory default is 80% of the selected CT Range.

**Load Alarm Limit** - use the “Up” and “Down” keys to enter the alarm limit value of load current. This setting is shown as a percentage of the Primary Breaker current value. PG LifeLink recommends a setting of 75 — 85% of rated transformer primary current to provide warning as the limit is approached, with a minimum of nuisance alarms. Factory default is 80%.

**Xfmr Temp Mon** - enables or disables the transformer winding temperature alarm, in panels equipped with this option. For panels without this optional equipment, or to disable it if present, set to Off.

**Hazard Current Range** - selects 5mA or 2mA full-scale sensitivity

**Language** - selects the language of the display text

6. Periodic Maintenance and Testing

Other than verifying accuracy of system date and time, no regular maintenance is required.

PG LifeLink recommends annual testing of the Mark V Line Isolation Monitor and associated IPS panel by a qualified technician. In addition to the basic internal “Self-Test” function, this testing should include verification of LIM alarm point using simulated external faults and calibrated digital multi-meter. Many jurisdictions require mandatory testing of LIMs on annual or monthly basis. NFPA 99 requires that newly installed LIMs be tested prior to being placed into service, after any repair or modification of the IPS, and on a recurring twelve (12) month cycle. Refer to your local Code for minimum testing requirements, or contact PG LifeLink for more information on comprehensive IPS Testing Services available in your area.

7. Factory Support

The Mark V LIM is covered by a standard two (2) year manufacturer’s warranty from date of purchase. If the unit is determined to be non-conforming, contact PG LifeLink immediately at +1 800-287-4123, or via email at techsupport@pglifelink.com. A technical support associate will assist in troubleshooting the issue, and if necessary, arrange for return of the item via our standard RMA process. PG LifeLink will analyze the equipment to verify non-conformance and determine the root cause. At its option, PG LifeLink will either repair or replace returned equipment during this period, provided that no abuse or damage to the product has occurred, and unit has been properly installed and operated in accordance with this manual. PG LifeLink reserves the right to modify this policy.

The Mark V LIM does not contain any user-serviceable parts. Tampering by personnel without prior written authorization from the factory voids the warranty, and may also void applicable agency certifications.

8. Error Codes and Troubleshooting

Portions of the following troubleshooting procedures may expose the technician to electrical hazards. **Troubleshooting should be performed only by qualified**
personnel in accordance with all established safety procedures. Death or personal injury, or equipment damage, can result from improper service procedures. Turn off and lock-out all power to the isolated power panel including the LIM before contacting any electrical connections.

LIM displays "CA" (Calibrate) during operation

- This is a normal occurrence at intervals during operation, occurring in accordance with the unit's schedule settings. The unit should return to normal within about 30 seconds. If unit does not return to normal mode, or continuously cycles through “CA” sequence, contact Technical Support.

LIM indicates very high hazard current at time of installation

- The LIM is connected to a grounded (non-isolated) power source. Verify that the power source is isolated.

- There may be too much external equipment connected to the isolated power system, or faulty wiring, or a fault in the connected equipment. [Note: only perform this procedure once patient(s) and attending clinical personnel have left the area] To locate the fault(s), turn off all the branch circuit breakers in the isolated power panel, and verify that the LIM indication then decreases to a safe level. Turn the breakers back on one at a time, allowing the LIM indication to stabilize for each one. Any circuit which causes the LIM indication to increase significantly when turned on has a problem. Unplug all connected equipment, if any, from that circuit. If the fault remains, inspect all wiring and devices powered from that branch for chafed or pinched wires, terminals touching exposed metal surfaces, foreign matter, or any other unintentional conductive path from power to ground. When all permanent equipment and wiring has been verified, reattach powered equipment one device at a time to locate the fault(s).

- Incorrect wire type or installation techniques may have been used for wiring. Article 517-160 of the NEC states that wire with a dielectric constant less than 3.5 is preferred for use in isolated power systems, recommends that all conduit runs be made as short (direct) as practical, and specifically forbids the use of pulling compounds that increase the dielectric constant. This is because a significant portion of the total system leakage current is produced by the capacitance between energized components (including wires) and grounded components such as conduit and ground wires, and exists regardless of the condition of the insulation or how high its resistance may test at DC such as with a “megger”. Leakage current increases directly in proportion to capacitance. Dielectric constant is the measure of a material’s effect on this capacitance, with higher numbers indicating a higher capacitance multiplication effect if all else is equal. Wire type XHHW-2 is a commonly available trade type meeting these requirements. The NEC also specifies the colors of wire to be used in isolated power systems: orange for the wire connected to devices as neutral, brown for the one connected as “hot”.

- Certain kinds of equipment are known to exhibit high leakage current and can cause issues when powered from isolated systems. These items are typically commercial-grade (non-medical grade) and include some lighting fixtures especially those with ballasts, motorized equipment, and switching power supplies such as are typically used in computers. Sometimes these devices are permanently wired and cannot be unplugged to test, but must be
disconnected at a junction box. Contact PG LifeLink technical support if you suspect that a piece of equipment is contributing excessive leakage current on the system.

- If the LIM THC indication remains high with all breakers turned off, the isolated power panel or the LIM itself may be malfunctioning or damaged. If another known-good LIM of the same voltage rating is available, try substituting it into the panel; or if a known-good panel of the same voltage rating is available, try substituting the LIM into that panel. If the problem moves with the LIM, suspect the LIM; if it stays with the panel, the LIM is not the cause. Or, if a suitable insulation tester is available, the panel and wiring can be directly tested for faults.

- Poor-quality incoming power with excessive harmonics or transients can cause both high actual THC and erroneous LIM readings. Equipment with high-power rectifiers or switching elements connected to the same source as the isolated power panel, such as battery chargers and motor speed controls, is a common cause of this kind of problem. Connect the isolated power system to an alternate power source.

LIM indication always very low or near zero regardless of external conditions

- This can happen as a result of faulty installation, if both ground wires are disconnected from ground but are properly connected to each other. This condition totally isolates the LIM from ground since these wires are its only connection to earth ground. This prevents the LIM from “seeing” earth ground, and it therefore cannot measure the impedance between the isolated power circuit and ground. However, if the ground wires remain connected to each other, it will also be prevented from identifying a “ground loss” condition even if they are both disconnected from ground. It is not possible for the LIM to identify this condition on its own. Trace all ground wiring and verify proper connections. Verify ground system integrity by measuring the resistance from pins 12 & 13 of the LIM connector to a known good earth ground such as a water pipe, building steel, or electrical service ground. This resistance should be very low, much less than 1 ohm.

Remote annunciator malfunction

- Verify wiring between LIM and remotes. Look for things like disconnected or shorted wires, +5 VDC and Gnd exchanged, or the 2 data wires swapped.

- Check the voltage between the +5 VDC and Gnd terminals at the remote. It should be at least 4.5VDC. If the supply voltage reaching the annunciator is too low, the annunciator may become unreliable or even cease working altogether. To remedy this excessive voltage drop, run larger wires for the +5 VDC and ground connections. Up to 12 gauge stranded wire may be used, or larger wire can be used if pigtails of 18 to 12 gauge wire are used at the remote. When increasing wire size, only the +5VDC and Ground wires (Red and Black) are necessary to be made larger; the signal wires (blue, violet, and grey) carry very little current and their size does not normally affect operation. If the power supply voltage at the terminals is still below the acceptable limit even with larger wire, an auxiliary power supply located at the remote can be used. Contact PG LifeLink Technical Support or Sales for assistance.

- Check the remote’s mounting in its box. Verify that no exposed electrical parts of the remote, including the circuit board or the terminals, is touching the
enclosure. This can happen only when screws are tightened, so carefully check the alignment of the parts to the box.

- Shorts from remote parts or wiring to earth ground will affect LIM operation.

The problems below may indicate an internal failure of the LIM. If the LIM requires service, it must returned to the factory. Contact PG LifeLink Technical Support or Sales for a Returned Materials Authorization. No returns will be accepted without a RMA. Normal replacement procedure is to require a valid form of payment before shipment, then credit will be issued after the returned unit has been received at the factory and inspected.

LIM displays do not illuminate
- Verify that the correct line voltage is applied at pins 14 & 15 of the LIM connector. Disconnect all wiring from the remote annunciator terminal board. If the correct line voltage is present and all external equipment is disconnected from the LIM but it still does not function, the LIM must be returned for service.

LIM displays "Gn" (Ground loss)
- One of the two ground wires, at pins 12 & 13 of the connector, is disconnected. Check all wiring carefully. If it appears intact, verify its integrity by measuring the resistance from pin 12 to pin 13 of the connector with it disconnected from the LIM after verifying that power to the equipment is turned off. It should be very low, well below 1 ohm.
- A wire to a remote annunciator is shorted to earth ground. Disconnect all wiring from the remote annunciator terminal board; if the problem clears, check the wiring at each remote first, looking for nicked insulation, bare wires, part of the remote touching its mounting box, etc.; If the problem is not cleared, check all wires for a short to ground using an ohmmeter.
- If the problem is not caused by faulty wiring, the LIM’s ground loss detection circuit has failed. One possible cause is damage from prior improper connection (not covered under warranty).

LIM displays "NO LIM COMMUNICATION"
- The LIM CPU Board contains the firmware for operation both as a LIM and as a DRA-VS remote. It makes the determination of which it is by the presence of power line sync signals from the Power Supply Board. This error indicates that the CPU is not receiving power line sync. It can be caused by an internal failure; a common external cause is shorted remote wiring. Check the wiring as described in the above section covering the LIM displaying "Gn" before returning the LIM for service.
- On a DRA-VS, this indicates a loss of data reception from the LIM. Check the RS-485 data wires, including verifying that they are not reversed.

LIM displays "Er" (Error) and/or one of the "System Error" Messages
- The LIM has detected an internal malfunction. Contact the factory for service.
- System Errors are very rare. If any of them occurs and cannot be cleared by power-cycling the unit, it must be returned to the factory for service. However, if one does occur, please make a note of the circumstances under...
which it occurred if possible, to aid in troubleshooting by phone or e-mail, or in case the malfunction cannot be reliably replicated at the factory.

- System Errors 23 & 24 can be caused by faulty remote annunciator wiring. Check the wiring by following the procedure in the above section covering the LIM displaying “ Gn”. They can also be caused by poor quality incoming AC power.

System Error Code Reference

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Problem in 1st level of user menu</td>
</tr>
<tr>
<td>21</td>
<td>Problem in 2nd level of user menu</td>
</tr>
<tr>
<td>22</td>
<td>Invalid switch command received from remote</td>
</tr>
<tr>
<td>23</td>
<td>Power line sync signal not within 50 — 60 Hz range</td>
</tr>
<tr>
<td>24</td>
<td>Line voltage outside normal range (approx. nominal -15% to +20%)</td>
</tr>
<tr>
<td>25</td>
<td>Unable to read internal Real Time Clock data</td>
</tr>
<tr>
<td>26</td>
<td>Analog channel command out of range</td>
</tr>
<tr>
<td>27</td>
<td>Factory cal procedure step is out of range</td>
</tr>
<tr>
<td>28</td>
<td>Stored hazard current range is invalid</td>
</tr>
<tr>
<td>29</td>
<td>Stored value for the auto-cal interval is bad</td>
</tr>
<tr>
<td>30</td>
<td>120V factory calibration value is out of range</td>
</tr>
<tr>
<td>31</td>
<td>240V factory calibration value is out of range</td>
</tr>
<tr>
<td>32</td>
<td>Cannot set Real Time Clock as commanded by LIM-CONNECT™</td>
</tr>
<tr>
<td>33</td>
<td>Calibration constant (unit sensitivity) outside acceptable range</td>
</tr>
<tr>
<td>34</td>
<td>Failure to write successfully to non-volatile event memory</td>
</tr>
</tbody>
</table>

Table 3 - Error Codes
### 9. Manual Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Dec. 08, 2009</td>
<td>Release — Firmware Rev 3.0b</td>
</tr>
<tr>
<td>1.1</td>
<td>Jan. 28, 2010</td>
<td>Revision — Firmware Rev 3.1</td>
</tr>
<tr>
<td>1.1a</td>
<td>July 13, 2012</td>
<td>Revision — Wiring Harness Details</td>
</tr>
<tr>
<td>2.0</td>
<td>May 29, 2014</td>
<td>Revision — Firmware Rev 4.0</td>
</tr>
</tbody>
</table>

### Notes:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________