

# LIM2010

Line Isolation Monitor (LIM)



# Line Isolation Monitor

## LIM2010



LIM2010

### Features

- No interference with electrical equipment
- Special phase-locking circuitry for ultimate stability and repeatability
- 2 programmable voltage-free SPDT contacts for external alarms
- Provision for remote indicators
- Easy to clean rugged front foil
- Digital and analog bar graph displays
- Automatic self-calibration and self-check
- Audible alarm volume adjustable via menu
- Transformer load monitoring (optional)
- Transformer overtemperature monitoring (optional)
- RS-485 connections for compatibility with Bender's remote communication system
- Provision to control multiple line isolation monitors via one intelligent remote
- Additional communication devices available:
  - Web browser based
  - E-mail and SMS
- Interfaces with BENDER ground fault location system

### Description

The LIM2010 Line Isolation Monitor (LIM) measures the Total Hazard Current (THC) in an isolated (ungrounded) AC system. The Total Hazard Current is calculated by measuring the system's leakage impedance to ground. Alarm indication is displayed on a seven-segment display, LED bar graph, and digital display.

The LIM2010 operates on systems from 100 to 240 V, 50 or 60 Hz. No auxiliary supply voltage is required.

Two separate ground connections are provided for ground connection monitoring. A break in either of these connections will activate the connection alarm.

The LIM2010 features many different alarms, including:

- Total Hazard Current (THC)
- Transformer overload
- Transformer overtemperature
- Overvoltage and undervoltage
- Ground connection
- Insulation resistance and impedance
- Ground fault location (when used with BENDER EDS location system)

The LIM2010 is ideal for retrofit applications regardless of the make or type of the existing product. No metal needs to be cut and simple instructions will generally facilitate a change-over in less than one hour.

### Operational information

Generally, the impedance between each isolated conductor and ground is different, resulting in a different current flowing through a person making physical contact between any one of the isolated conductors and ground. The LIM calculates and displays the true maximum value of the Total Hazard Current (THC). The BENDER LIM performs this function using a patented measurement technique.

The THC is shown on the seven-segment display and the LED bar graph. In the normal condition, the green "SAFE" LED is illuminated, the display shows a low leakage value (green) and the bar graph is in the non-alarm, or normal, green zone. THC levels will increase as additional loads are connected to the system, and/or when a line-to-ground fault has suddenly occurred or is slowly developing. A visual and audible alarm is generated when the THC exceeds the LIM setting of either 2 mA or 5 mA (red). Two programmable relay output contacts are available, which can be wired into a circuit to trigger an external alarm.

The red "HAZARD" LED remains illuminated for the duration of the alarm condition. The audible alarm may be silenced by pushing the "MUTE" button at the discretion of personnel. When the "MUTE" button is activated, the built-in amber LED in the "MUTE" button is illuminated to indicate a muted condition. After the fault is removed, the LIM will automatically reset to the normal condition.

Line isolation monitor indicators					
THC	THC display	Text display	Safe LED	Hazard LED	Buzzer
< 5 (2) mA	value (green)	SAFE	ON	OFF	OFF
≥ 5 (2) mA	value (red)	HAZARD	OFF	flashing	ON
> 9.9 mA	EF (red)	HAZARD	OFF	flashing	ON

The audible alarm volume level is adjustable via the configuration menu.

Activate the test button to check the LIM operation. This test does not add to the hazard current of a system in use, nor does the test include the effect of the line-to-ground stray impedance of the system.

The LIM has provisions to connect one or more remote indicators, with or without a digital meter. The remote indicators duplicate the audible and visible alarm signals of the LIM.

**Additional features**

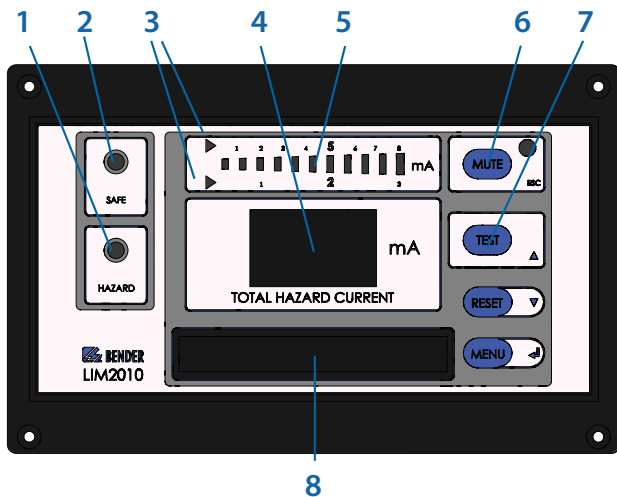
Bender's communication bus enables the LIM2010 to connect to several intelligent devices to provide a complete isolated power solution, including:

- Intelligent remote control stations monitoring multiple systems
- Fault location equipment, reducing time and cost finding faults
- Communication equipment to connect to industry standard communication networks, including Ethernet and Modbus

**Standards**

The BENDER LIM2010 Series LIM complies with UL 1022 and CSA-C22.2 No. 204-M1984. The intent is to include the LIM as part of an isolated power system that conforms with the applicable requirements of ANSI/NFPA 99, ANSI/NFPA 70, and CAN/CSA-C22.2 No. 29-M1989.

**Front display and operating elements**



- 1 - "HAZARD" LED (red) – Illuminates when THC > Alarm level
- 2 - "SAFE" LED (green) – Lit unless LIM is in alarm mode
- 3 - THC Set Point LED Markers (amber) – 5 mA or 2 mA
- 4 - Digital Display – Displays THC in mA
- 5 - Analog LED Bar Graph – Displays THC in mA
- 6 - "MUTE" Button w/built-in LED (amber) – Silences alarm buzzer
- 7 - "TEST" Button – Checks functions of the LIM
- 8 - Digital text display for status and menu options

**Ordering information - LIM2010**

Line isolation monitor			
Description	Approval	Part No.	Ordering No.
100 - 240 V / 1-phase LIM	c  US	LIM2010	B 9207 5021

**Ordering information - Accessories**

Refer to devices' respective datasheets for more information. Devices marked with an asterisk (\*) have multiple ordering numbers based on model.

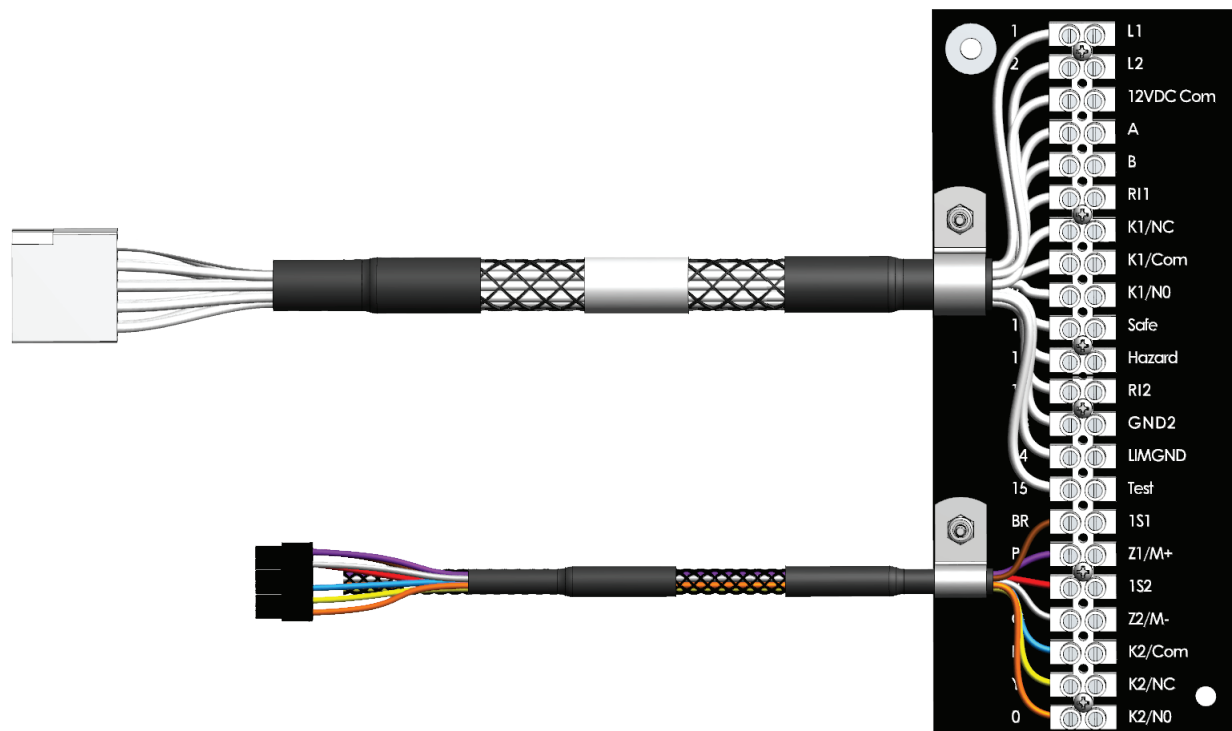
Connector plate			
Description	Approval	Part No.	Ordering No.
LIM + remote connections	c  US	CP-LIM2010	B 5111 00001

Remote indicators			
Description	Approval	Part No.	Ordering No.
Mute	c  US	MK2000-G1	B 5213 00002
Mute + Test	c  US	MK2000P-G1	B 5213 00188
Mute + Overload	c  US	MK2000C-G1	B 5213 00020
Mute + Test + Overload	c  US	MK2000CP-G1	B 5213 00021
Digital remote indicator	c  US	MK2000CBM	B 5213 00022
Digital remote station	c  US	MK2430	*
Digital remote station	c  US	MK800	*

Load monitoring current transformers			
Description	Approval	Part No.	Ordering No.
Up to 100 A load current	c  US	STW3	B 9802 1000
Up to 200 A load current	c  US	STW4	B 9802 1001
Up to 100 A load current (split core)	c  US	SWL-100A	B 9802 1002

### LIM2010 connector plate

Actual cable length for connector cables is 20" (50.8 cm). Both plugs are connected to LIM2010.

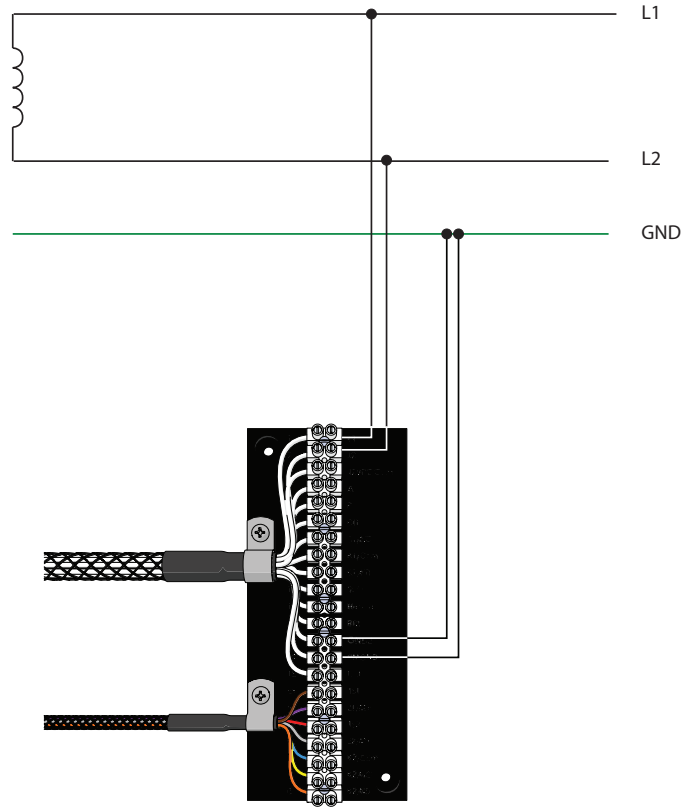


Connector plate terminals	
Type	Description
L1, L2	Connected to secondary of isolation transformer
12 VDC Com.	Common connection for remote indicators
A, B	RS-485 communication interface
RI1	Test button source for remote indicators
K1/NC	Alarm relay K1, N/C
K1/Common	Alarm relay K1, common
K1/NO	Alarm relay K1, N/O
SAFE	"SAFE" light connection for remote indicators

Connector plate terminals	
Type	Description
HAZARD	"HAZARD" light connection for remote indicators
RI2	Local and system muting from LIM and remote indicators
GND2, LIM GND	Separate ground connections
TEST	Connection for remote test
Z1/M+, Z2/M-	Connection for overtemperature sensor or analog meter
K2/Common	Alarm relay K2, common
K2/NC	Alarm relay K2, N/C
K2/NO	Alarm relay K2, N/O

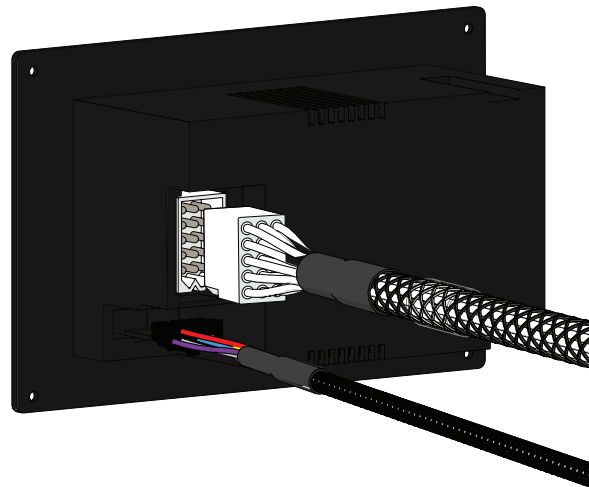
**Wiring diagram: Basic connections to connector plate**

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**Connecting LIM2010 to connector plate**

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## Technical data: LIM2010

### Insulation coordination acc. to UL 1022 and IEC 60664-1

Rated insulation voltage	AC 250 V
Rated impulse voltage / pollution degree	2.5 kV / III
Voltage test acc. to UL 1022 and IEC 61010-1	2.0 kV

### Supply Voltage

Supply voltage $U_s$	= $U_n$
Power consumption	< 22 VA

### Isolated Power System Monitored

Nominal voltage $U_n$	AC 100 - 240 V
Operating range of $U_n$	85% - 110%
Frequency range $f_n$	50 / 60 Hz
Operating range of $f_n$	± 5%

### Insulation and THC monitoring

Response value: THC	2 mA / 5 mA (5 mA)*
Response Tolerance	1.8 - 2 mA / 4.5 - 5 mA
Hysteresis	20%
Response value Z	10 - 200 k $\Omega$ (off)*
Response tolerance	± 15%
Hysteresis	25%
Response value R	20 - 200 k $\Omega$ (off)*
Response tolerance	± 15%
Hysteresis	25%
Response time $t_{an}$	< 4 s

### Measuring circuit

Measuring voltage $U_m$	± 48 V
Measuring current $I_m$ (at $Z_f = 0 \Omega$ )	< 32 $\mu$ A
Internal resistance	≥ 1.5 M $\Omega$
Monitor hazard current MHC, 120 V / 240 V	60 $\mu$ A / 95 $\mu$ A
When EDS mode is active:	
Monitor Hazard Current MHC	< 950 $\mu$ A
Test cycle / idle time	2 s / 4 s

### Voltage monitoring

Response value, undervoltage / undervoltage (<U / >U)	80 - 300 V (off)*
Response tolerance	± 5%
Hysteresis	5%

### Load current monitoring ("C" option)

Response value	10 - 200 A (off)*
Response tolerance	± 5%
Hysteresis	5%

### Temperature monitoring

Response value (fixed)	4 k $\Omega$
Release value	1.6 k $\Omega$
PTC resistor acc. to DIN 44081	max. 6 connected in series

### Adjustable time delays (does not apply to THC alarm)

Response delay $t_{on}$	0 - 99 s (0 s)*
Delay on release $t_{off}$	0 - 99 s (0 s)*

### Displays, memory

14-segment display	8 digits, multi-functional
Displayable value, THC	0.0 - 9.9 mA
Operating uncertainty, THC	+ 7%, ± 0.1 mA
Measured value, load current (as % of response value)	10 - 199 %
Operating uncertainty, load current (as % of response value)	± 5%, ± 0.2 A
Measured value, load current (in A)	0.5 - 250 A
Operating uncertainty, load current (in A)	± 5%, ± 0.2 A
Measured value, system voltage	10 - 300 V
Operating uncertainty, system voltage	± 5%, ± 2 V

Measured value, insulation impedance Z	0 - 1 M $\Omega$
Operating uncertainty, insulation impedance	± 5%, ± 1 k $\Omega$
Measured value, insulation resistance R	2 k $\Omega$ - 1 M $\Omega$
Operating uncertainty, Z ~ R	± 20%, ± 1 k $\Omega$
Measured value, leakage capacitance C	0 - 500 nF
Operating uncertainty, Z ~ $X_C$	± 20%, ± 5 nF
Condition for separate readings of R and C	Z ≥ 2 k $\Omega$
7-segment display	2 digits, digital THC indication
Bar graph indicator	analog THC indication
History memory	300 data records
Data logger	300 data records

### Inputs / Outputs

Analog current output M+ / M-	0 - 400 $\mu$ A
Operating uncertainty	± 10%
Output RI1, 12 VDC common	12 V / 200 mA
RI2, SAFE, HAZARD, TEST	Maximum four (4) MK2000(C)(P)
Cable length	≤ 32 ft

### Serial Interface

Interface A-B / Protocol	RS-485 / BMS bus
Baud rate	9600 baud
Cable length	≤ 3900 ft
Recommended cabling	Shielded, twisted pair, one end grounded
Termination resistor	120 $\Omega$ (also activated via DIP switch) (off)*
Assignable BMS bus addresses	1 - 90 (1)*

### Relays

Number of switching elements	2 SPDT contacts
Operating principle	normally energized or de-energized operation (N/E)*
Electrical service life, number of cycles	10,000
Contact data acc. to IEC 60947-5-1	

#### Relay 1:

Utilization category	AC-13	AC-14	DC-12	DC-12	DC-12
Rated operational voltage	230 V	230 V	24 V	110 V	220 V
Rated operational current	5 A	3 A	1 A	0.2 A	0.1 A
Minimum contact load	1 mA at AC / DC 10 V				

#### Relay 2:

Utilization category	DC-12	DC-12	DC-12
Rated operational voltage	24 V	110 V	220 V
Rated operational current	1.2 A	0.4 A	0.25 A
Minimum contact load	1 mA at AC / DC 10 V		
Rated Contact Voltage	AC 125 V / DC 30 V		

### Environment / EMC

EMC	IEC 61326
Operating Temperature Range	+ 14 - + 122 °F - 10 - + 50 °C
Storage Temperature	- 13 - + 158 °F - 25 - + 70 °C

### Connection

Connection type	Molex plug 15-pin, type 03-09-2159 and 12-pin, type 43045-1215
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### General data

Operating mode	continuous operation
Mounting position	display-oriented
Degree of protection, internal components (EN 60529)	IP30 (NEMA 1)
Enclosure material	polycarbonate
Flammability class	UL94 V-0
Screw fixing	Qty. 4, #4-40 oval head, black oxide finished
Screw torque	(2.6 - 3.5 lb-in) 0.3 - 0.4 N-m
Weight	≤ 1.2 lb

### Technical data: Connector plate

#### LIM2010 Connector Plate – CP-LIM2010

Cable Length	20"
Terminal Strip	22 terminals
Connector	15 pin Molex
Conductor Size	AWG 22 - 12
Tightening torque	8 in-lb
Mounting Orientation	any
Weight	Approx. 7 oz.

#### Technical data: MK2000-G1 / MK2000-G2 / MK2000P-G1 / MK2000C-G1 / MK2000CP-G1 / MK2000CBM

Operating voltage	12V DC or 12V AC
Max. current	50 mA
(MK2000CBM)	100 mA)
Operation class	continuous operation
Ambient temperature when operating	+32° F to +122° F 0° C to +50°
when stored	-13° F to +158° F -25° C to +70° C
Connection	screw terminal block
Conductor size	AWG 30 - 12
Tightening torque	5 - 7 lb In.
Mounting	by screws
Weight	
MK2000-G1 / MK2000P-G1 / MK2000C-G1 / MK2000CP-G1	0.25 lb
MK2000-G2 / MK2000CBM	0.32 lb

### Technical data: STW3, STW4, STW-100A

#### Insulation coordination according to IEC 60664-1:

Rated voltage $U_m$	AC 720 V / AC 720 V / AC 600 V
Rated impulse voltage $U_{isol}$	4 kV / 4 kV / 2.2 kV

#### Measuring circuit

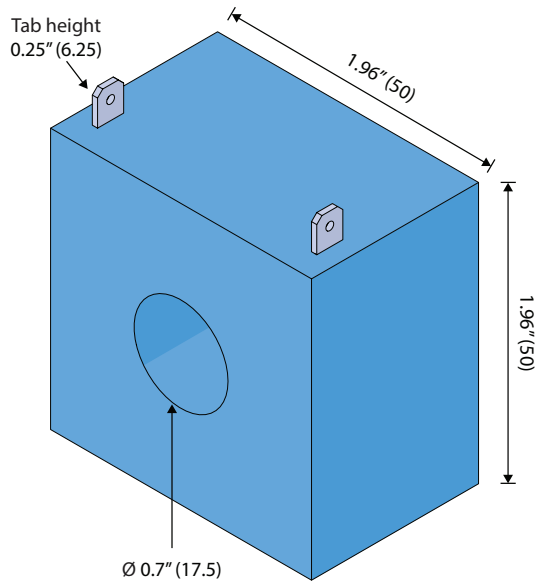
Max. rated primary current	100 A / 200 A / 100 A
Min. rated primary current	1 A / 2 A / 0.1 A
Nominal frequency	50 - 400 Hz

#### General data

Ambient temperature, during operation	+32° F to +122° F 0° C to +50° C
Operating mode	continuous operation
Position	any position
Connection	Faston plug 6.3 x 0.8 mm / screw terminals
Type of connection to the measuring current transformer	
Single wires $\geq$ AWG 18	up to 3 ft
Single wires, twisted $\geq$ AWG 18	up to 30 ft
Screened cable $\geq$ AWG 20 (single-ended connection to ground) e.g. J-Y(St)Y 2 x 0.8	up to 130 ft
Mounting	Screw Mounting M3 / zip ties
Flammability class	UL94V-0

### Dimensions: STW3 / STW4

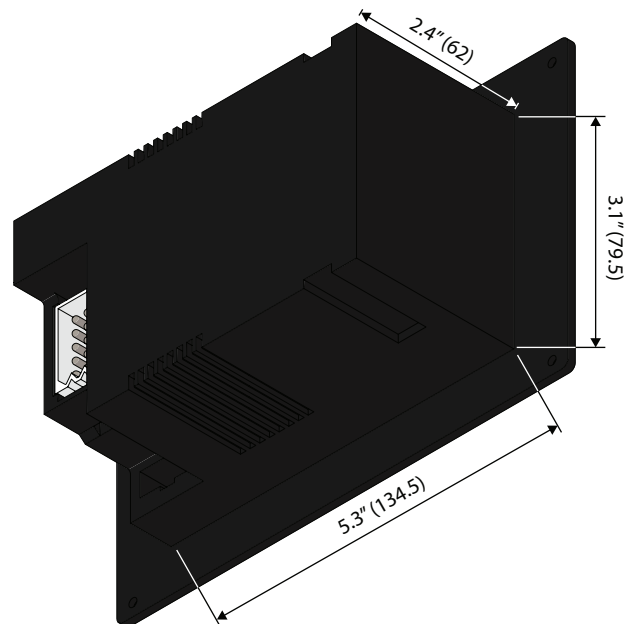
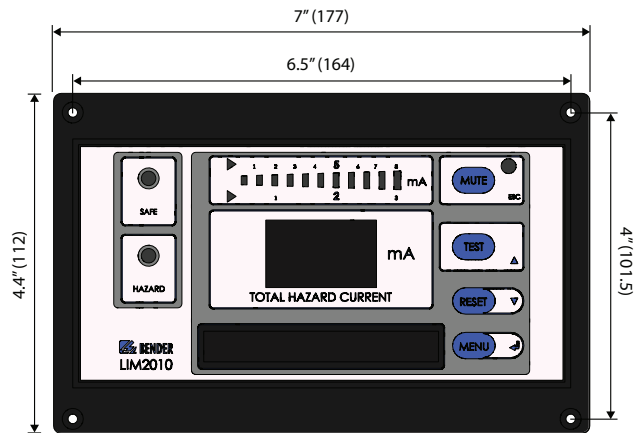
Dimensions in inches (mm).



### Dimensions: LIM2010

Dimensions in inches (mm).

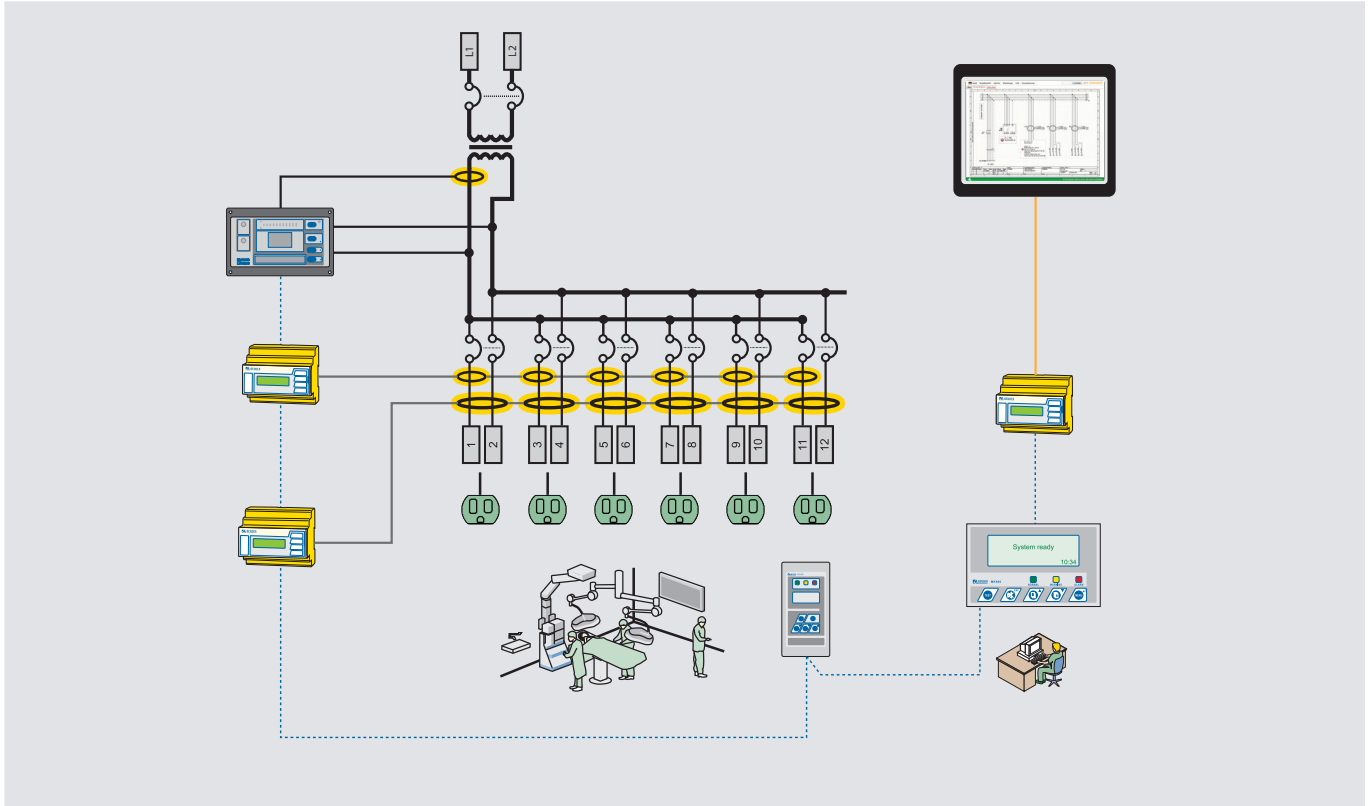
The front plate provides four holes with a diameter of 1/8" (3.2 mm) for screw mounting. Use the provided #4-40 oval head, black oxide finished screws. Use minimum 2.6 lb-in (0.3 N-m), maximum 3.5 lb-in (0.4 N-m) torque. A 15-pin female connector and a 12-pin female Molex connector are built into the back of the LIM2010.





# The complete isolated power solution

## Monitor, locate, and communicate system ground faults



### Advanced, fast remote communication to hospital staff

- Notification of faults to nurse station
- Multiple isolated power panels may be monitored at a single remote station indicator (MK800 / 2430) with customizable messages
- Connecting Bender system to COM465IP allows for viewing status of isolated power system via simple web browser based GUI
- COM465IP also connects to Modbus/TCP networks to integrate into existing communication networks

### Ground fault location while the system remains online

- Fast, automated location of ground faults while the system remains online
- Reduced maintenance costs and downtime
- Indication of faulty circuit shown on LCD display at panel (EDS461), at remote indicating station (MK2430 / MK800), and at remote station through web browser-based GUI or Modbus/TCP (COM465IP)
- Available built into panel, modular design also allows for simple retrofitting and upgrading
- Current transformers for fault location built into panel as option, simple landing terminals provided for branch wiring

### Ordering Information: Fault Location Equipment

Fault location equipment can be ordered integrated into an isolated power panel, or separately for retrofitting purposes.

Fault location modules			
Description	Approval	Part No.	Ordering No.
Fault location for 12 branches		EDS461-D-2	B 9108 0006

Current transformers for fault location module			
Description	Approval	Part No.	Ordering No.
0.78" (20 mm) opening		W20-8000	B 9808 0009
1.37" (35 mm) opening		W35-8000	B 9808 0017
2.36" (60 mm) opening		W60-8000	B 9808 0027

### Ordering Information: Communication Gateways

Communication gateways			
Description	Approval	Part No.	Ordering No.
Ethernet and Modbus/TCP		COM465IP	B 9506 1065

# Isolated power equipment and accessories



Standard isolated power panel

## Isolated power panels

- Listed to UL 1047 (standard for isolated power systems equipment)
- Meets requirements for NFPA 99 / CSA Z32 for isolated power systems
- Single-phase, low-leakage isolation transformer, with primary and secondary voltages configured at factory and rated to system requirements
- Primary circuit breaker
- Up to 16 branch circuit breakers (maximum allowed by UL)
- LIM2010 line isolation monitor
- Reference ground bus
- Available with built-in receptacles and ground jacks
- Available with circuit lockout control
- Optional onboard, integrated ground fault location system
- Optional transformer load and temperature monitoring



MK2000P-G1 remote indicator

## MK2000 series remote indicators

- Visual and audible indication of line isolation monitor (LIM) status
- Green SAFE LED and red HAZARD LED
- Audible alarm with mute button and amber LED
- LED display for long life
- Uses low voltage 12 V wiring
- Mounts to standard electrical gang box
- Easy-to-clean Lexan front foil
- Available with remote test button
- Available with transformer overload LED
- Available in digital version, duplicating THC digital display of the LIM2010



MK2430 (left) / MK800 (right)

## Advanced remote monitoring stations (MK2430 / MK800)

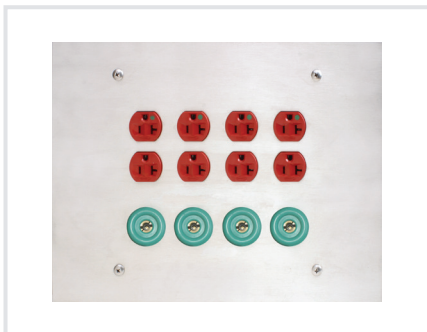
- Centralized remote station for Bender equipment
- Full-featured remote indicating station for operating status, warnings, and customized alarm messages
- Compatible with both LIM2010 line isolation monitor and EDS fault location systems
- Connects to Bender equipment via RS-485
- Internal and external RS-485 network connections: Internal bus connects up to 150 Bender devices; up to 99 internal buses can connect to the external bus
- Large, backlit LCD display
- Up to 1000 customizable alarm messages
- Memory with real-time clock to store up to 1000 timestamped alarm messages
- Configurable with PC software
- Flush and surface mounted models



ZT1590 (left) and MK1550 (right)

**ZT1590 series digital clocks / timers**

- Dual display for 12/24 hour clock and elapsed timer
- Elapsed time in minutes/seconds, automatically carried over to hours/minutes
- All devices features and setup carried out either via onboard pushbuttons or connected MK1550 clock remote
- Pluggable connectors for simple installation
- Utilizes external Class 2 power supply
- Integrated power outage backup for at least 24 hours, no batteries required



GPM series ground/power module

**GPM series ground and power modules**

- Hospital grade outlet devices for power supply and grounding of portable equipment
- Configurable to contain combination of hospital grade power receptacles, hospital grade ground jacks, and/or aluminum or copper ground buses
- Available with ground bus only to serve as a collection point for room grounding conductors
- Customizable quantity of hospital grade power receptacles and/or ground jacks
- Available on standard size wall plate or built into stainless steel front trim with backbox



XRM series x-ray receptacle module

**XRM series x-ray / laser receptacle modules**

- Hospital grade outlet for supply of power to x-ray and laser equipment
- Includes NEMA rated plug matched to configuration of equipment
- Option for built-in MK2000 series remote indicator for line isolation monitor
- Door contact with limit switch
- Designed for use with Bender isolated power panels with PLC control
- Built on custom front trim with backbox
- Flush- or surface-mounted backbox
- Integrated LIM remote indicator
- In-use indicating light



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