POWELL

Powered by Safety®

Instruction Bulletin - 01.4IB.48070C

Circuit Breaker Monitor (CBM)

Contact Information

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Signal Words

As stated in ANSI Z535.4-2023, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are **"Danger"**, **"Warning"**, **"Caution"** and **"Notice"**. These words are defined as:

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

1. trained and authorized to test, energize, deenergize, lock out, tag, clear, and ground circuits and equipment in accordance with established general site-specific safety practices.
2. trained in the proper selection, care and use of personal protective equipment (PPE) including but not limited to insulating gloves, hard hat, safety glasses or face shields, arc flash clothing, etc., in accordance with established site-specific safety practices.
3. trained in rendering first aid if necessary.

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Ch 1 General Information

⚠ WARNING

The equipment described in this document may contain high voltages and currents which can cause death or serious injury.

The equipment is designed for use, installation, and maintenance by knowledgeable users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Powell immediately at 1.800.480.7273.

⚠ WARNING

This equipment is designed for use, installation, and maintenance by qualified persons who have demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

NOTICE

The information in this instruction bulletin is not intended to explain all details or variations of the Powell equipment, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems, which are not presented sufficiently for the user's purposes, contact Powell at 1.800.480.7273.

NOTICE

Powell reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

A. Scope

The information in this instruction bulletin describes the following Circuit Breaker Monitor (CBM) and components:

- AP.CBM.01IRIMK3 - Circuit Breaker Monitoring Kit (Includes IRIM & EIM)
- CBM - Circuit Breaker Monitor
- AP.CBM.01IRIM - IRIM
- AP.CBM.01EIM - EIM
- CBM-HE-SENSOR - Hall Effect Sensor

B. Purpose

The information in this instruction bulletin is intended to provide details required to properly install and operate the Circuit Breaker Monitor described in *Ch 1 General Information , A. Scope.*

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions on the operation of the Circuit Breaker Monitor
3. Instructions for installation
4. Illustrations, photographs, and description of the equipment described in *Ch 1 General Information, A. Scope.*

The illustrations contained in this document may not represent the exact construction details of the monitor. The illustrations in this document are provided as general information to aid in showing component locations only.

All illustrations and photos are shown using deenergized equipment.

⚠ WARNING

Follow the appropriate safety precautions while handling any of the equipment. Failure to do so could result in death or serious injury.

C. Standards

Table A Standards				
EMC Immunity				
Phenomena		*Standard*	*Range*	*Notes*
Electrostatic Discharge	Enclosures	IEC 61000-4-2	±6 kV Contact ±8 kV Air	Level 3
Radiated RF Immunity	Enclosures	IEC 61000-4-3	80 - 1000MHz, 1.4 - 2.7GHz 10 V/m(80%AM, 1kHz), Class A	Level 3
Electrical Fast Transients	Power, Com, IO	IEC 61000-4-4	±4kV	Level 4
Surge	Power, Com, IO	IEC-61000-4-5	±1 to 2kV	Level 3/2
Conducted RF Immunity	Power, Com, IO	IEC 61000-4-6	10Vrms DC power 150kHz-80MHz 1kHz 80% AM	Level 3
Voltage Dips & Interruptions	Power	IEC 61000-4-29	100% for 100ms, 60% and 30% for 100ms	-
Power Frequency Magnetic Field	Enclosures	IEC 61000-4-8	50,60Hz, 100A/m cont., 1000A/m 3s	Level 5
EMC Emission				
RF Conducted Emissions		FCC CFR 47, Part 15 Subpart B, ICES-003 Issue 5	0.15 - 30.0MHz	Class A
RF Radiated Emissions			30 - 1000MHz	
Environmental				
Ambient Temperature	Operating Temperature	IEC 60068-2-1 IEC 60068-2-2	-40°F to 158°F (-40°C to +70°C)	-
Mechanical	Vibration response Endurance by sweep Endurance @ fixed freq.	IEC 60068-2-6	10 to 2000Hz, 200m/s2 10 to 2000Hz, 200m/s2, 10 sweeps(2.5h) 67Hz, 93.5Hz, 103.3Hz, 10 min dwell ea.	-
Dielectric Strength and Impulse Tests				
Dielectric (Hi-Pot)		IEEE C37.90-2005	1.5 kVAC, contact I/O, power, chasiss GND	-

D. Instruction Bulletin Available Electronically

NOTICE

Changes to the instruction bulletin may be implemented at any time and without notice. Go to powellind.com to ensure use of the current instruction bulletin for Powell equipment.

To contact the Powell Service call 1.800.480.7273, or 713.944.6900, or email *serviceinfo@powellind.com.*

For specific questions or comments pertaining to this instruction bulletin, email *documents@powellind.com* with the Instruction Bulletin number in the subject line.

E. Associated Instruction Bulletins

All associated instruction bulletins are available online at *powellind.com*.

- 01.4IB.48040E BriteSpot® BSG3
- 01.4UM.48072 BreakerView™ Software User Manual

Ch 2 Safety

A. Safe Work Condition

The information in Section A is quoted from *NFPA 70E 2018 - Article 120, 120.5 Establishing an Electrically Safe Work Condition.*

NFPA is periodically updated. Refer to the latest version of any additional updates.

120.5 Process for Establishing and Verifying an Electrically Safe Work Condition.
Establishing and verifying an electrically safe condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2. After properly interrupting the load current, open the disconnecting device(s) for each source.

3. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

4. Release stored electrical energy.

5. Release or block stored mechanical energy.

6. Apply lockout/tagout devices in accordance with a documented and established procedure.

7. Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

N *Exception No. 1: An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage of the conductors or circuit parts at the work location, provided it meets the all following requirements: (1) It is permanently mounted and installed in accordance with the manufacturer's instructions and tests the conductors and circuit parts at the point of work; (2) It is listed and labeled for the purpose of verifying the absence of voltage; (3) It tests each phase conductor or circuit part both phase-to-phase and phase-to-ground; (4) The test device is verified as operating satisfactorily on any known voltage source before and after verifying the absence of voltage.*

N *Exception No. 2: On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.*

Informational Note No. 1: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements,* for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical system 1000 volts and below.

N Informational Note No. 2: For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, *Live Working - Voltage Detectors - Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.,* or IEC 61243-2, *Live Working - Voltage Detectors - Part 2: Resistive type to be used for voltages of 1kV to 36kV a.c., or* IEC 61243-3, *Live Working - Voltage Detectors - Part 3: Two-pole voltage type.*

8. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

    a. *Placement.* Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
    b. *Capacity.* Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

N Informational Note: ATSM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment,* is an example of a standard that contains information on capacity of temporary protective grounding equipment.

    c. *Impedance.* Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

B. Safety Guidelines

Study this instruction bulletin and all other associated documentation before installing or using the Circuit Breaker Monitor.

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures.

Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to the Circuit Breaker Monitor.

C. General

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of a circuit breaker shall be allowed to work on this equipment. It is mandatory that the appropriate instruction bulletins, supplements, and service advisories be studied, understood, and followed.
2. Maintenance programs must be consistent with both customer experience and manufacturer's recommendations, including service advisories and instruction bulletin(s). A well planned and executed routine maintenance program is essential for circuit breaker's reliability and safety.
3. Service conditions and circuit breaker applications shall also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

D. Specific

1. **OBSERVE ALL SAFETY PRECAUTIONS FOR ANY ASSOCIATED, ADJACENT OR ANCILLARY EQUIPMENT.**

2. **DO NOT WORK ON ENERGIZED EQUIPMENT. I**f work must be performed on a circuit breaker, remove it from service and remove it from the switchgear.

3. **DO NOT WORK ON EQUIPMENT WITH THE CONTROL CIRCUIT ENERGIZED.**

4. **ALL ELECTRICAL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE EQUIPMENT.**

5. Interlocks are provided to ensure the proper operating sequences of the equipment and for the safety of the user. If for any reason an interlock does not function as described, do not make any adjustments, modification, or deform the parts. **DO NOT FORCE THE PARTS INTO POSITION. CONTACT POWELL FOR INSTRUCTIONS.**

E. Safety Labels

The equipment described in this document has **DANGER**, **WARNING, CAUTION,** and instruction labels attached to various locations. All equipment **DANGER**, **WARNING, CAUTION,** and instruction labels shall be observed when the circuit breaker is handled, operated, or maintained.

NOTICE

Danger, Warning and Caution labels are located in various places. Do not remove or deface any of these warning/caution labels.

Ch 3 Equipment Description

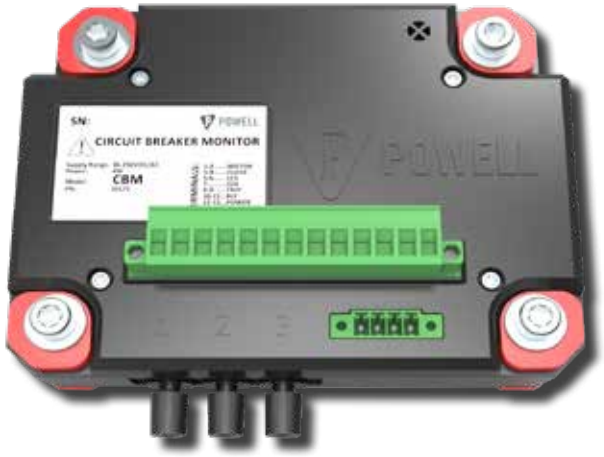
A. Overview

The Circuit Breaker Monitoring System *Figure 4* is comprised of three main modules:

1) *Circuit Breaker Monitor (CBM)*

The CBM *(Figure 1)* is an industrial multi-channel Data Acquisition Module. It provides four (4) analog and two (2) digital input channels, pre-configured and dedicated to the connected devices. The module is ruggedized and designed to withstand shock, vibration (IEC 60068-2-6), temperature extremes -40°F to 158°F(-40°C to +70°C) and relative humidity (5 to 95%). The module is designed to be embedded within the control housing of a circuit breaker, adjacent to the devices it monitors. The module is dedicated to monitoring the standard electromechanical devices which provide the major functions of charging, closing and tripping of a spring operated circuit breaker mechanism as well as the contacts which indicate circuit breaker state and spring charge state. The circuit board, battery and housing are designed to last for approximately 25 years when operated within the specified vibration, shock, temperature and relative humidity. With the onboard memory and embedded processing, signal data is analyzed for circuit breaker performance profile and compared to required performance values for basic alarm function. The performance values and raw analog curves for up to 1000 operations are permanently retained in FLASH memory. The data communications from the CBM is via a built in IR transceiver.

Figure 1 Circuit Breaker Monitor (CBM)



2) *Infrared Interface Module (IRIM)*

The IRIM *(Figure 2)* is an infrared to RS-485 Modbus transceiver mounted inside the circuit breaker compartment. It is placed such that the Circuit Breaker Monitor infrared transceiver can communicate its data to the IRIM. The IRIM permits multipoint two (2) wire RS-485 Modbus connection to additional IRIM units. Modbus and power connections for this unit are via an 8-pin Phoenix connector. Additionally, the IRIM has an RJ-45 (8P8C) connector for cable connections to the External Indication Module (EIM).

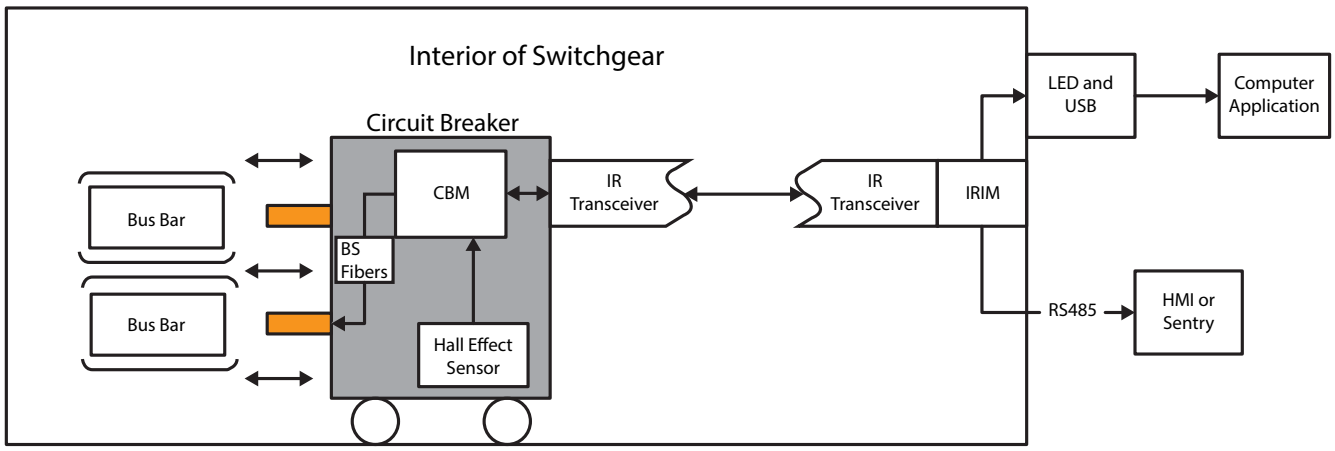
Figure 2 Infrared Interface Module (IRIM)

3) *External Indication Module (EIM)*

The EIM *(Figure 3)* is connected to the IRIM via RJ-45 connection and has an isolated USB connection for use by a laptop along with three LEDs behind a white lens for displaying circuit breaker condition. LED colors are GREEN (slow pulse - satisfactory condition), AMBER (slow pulse - warning), and RED (slow pulse - alarm). A laptop can be connected to the EIM via USB mini-B port connection.

Figure 3 External Indication Module (EIM)

Figure 4 Circuit Breaker Monitoring System Overview



B. Hall Effect Sensor

The Hall Effect Sensor module is mounted within the wire bundle directly behind the circuit breaker's secondary disconnect *(Figure 6)*. In order to provide a consistent polarity signal the positive (+) polarity leads for the charging motor, close coil and trip coil are placed within the sensor.

The lead from the sensor is to be laced to the existing wire bundle. The lead will traverse the breaker frame from right to left with the wire bundle that passes from near the secondary disconnect where the sensor is attached to the upper left side of the frame where the Circuit Breaker Monitor is mounted.

Figure 5 Hall Effect Sensor Module Wires

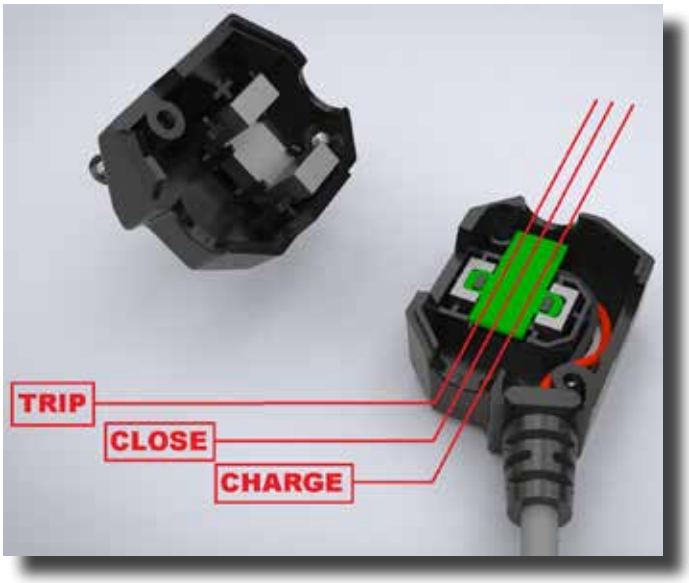
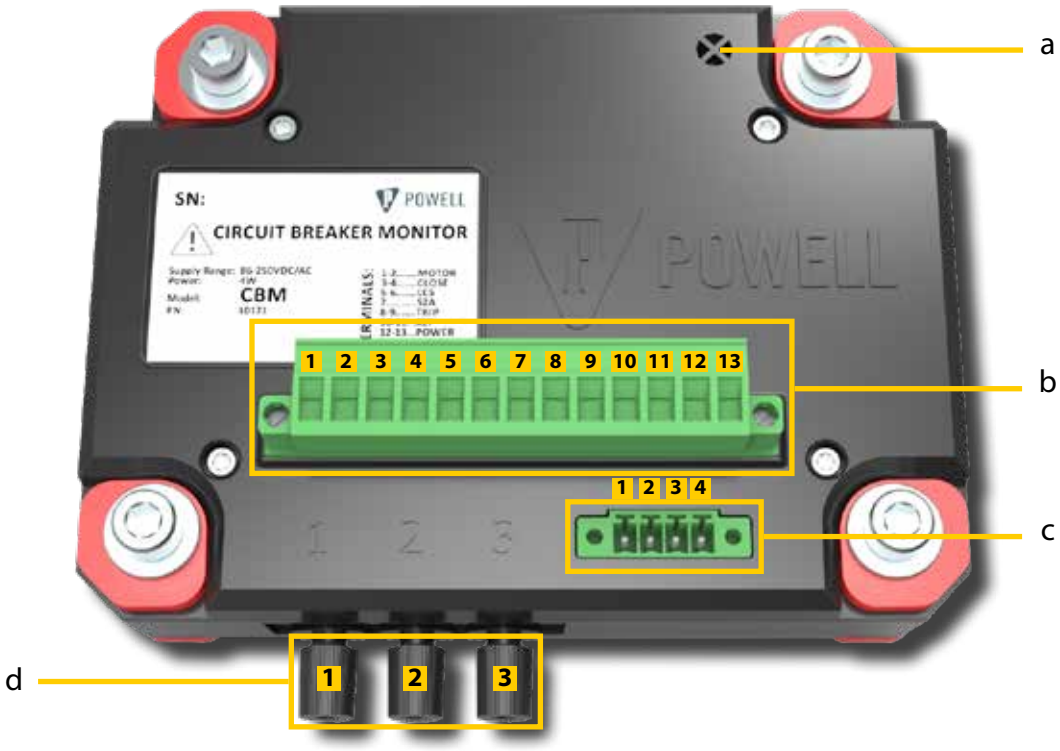


Figure 6 Hall Effect Sensor Module Installed

C. Inputs and Indicators

Table B Main Input Connections		
Pin Number	**Description**	**Function**
1	+ve Supply to Charge Motor	Analog Voltage Input
2	-ve Return from Charge Motor	
3	+ve Supply to Close Coil	Analog Voltage Input
4	-ve Return from Close Coil	
5	+ve Supply to Trip Coil	Analog Voltage Input
6	-ve Return from Trip Coil	
7	Digital Input A for LCS Contact	Digital Sense Input
8	Digital Input B for LCS Contact	
9	Digital Input A for 52A Contact	Digital Sense Input
10	Digital Input B for 52A Contact	
11	Chassis Ground	Local Chassis Ground
12	+ve Supply to CBM	Supply Voltage
13	-ve Return from CBM	

Figure 7 Circuit Breaker Monitor (CBM) Input Connections



a. Temperature Sensor
b. Main Inputs
c. Hall Effect Sensor Connection
d. BriteSpot® Inputs

Table C Hall Effect Input Connections	
Pin Number	**Description**
1	+5V Power for HE
2	Ground for HE
3	Digital HE Signal
4	Shield for HE

Table D CBM LED Indicators	
Color	**Description**
Green	Flashing - Operating as Expected
Red	Interacting with Flash memory, DO NOT POWER OFF

Figure 8 IR Transceiver Window and LED Indicator Location

a. IR Transceiver Window
b. LED Indicator

Table E Hall Effect Module LED Indicators	
Color	**Description**
Green	Operating as Expected
Red	Initializing or Calibration Mode

D. External Indication Module (EIM) Indications

- Slow pulse "green" means the breaker is "healthy" and fully operational.
- Slow pulse "amber" means a low priority warning has occurred indicating that a parameter is just outside of normal operation.
- Slow pulsing "red" means a high priority alarm has occurred that may directly affect circuit breaker operation.
- Fast "amber" strobing indicates the IR channel is not detected. This fast "amber" strobing may occur when opening a breaker door, if something is in the way of the IR path, or if power is not applied to the CBM.

Ch 4 Installation

A. Receiving

When the Circuit Breaker Monitor is received, check for any sign of damage. If damage is found or suspected, file all claims immediately with the transportation company and notify the nearest Powell representative.

Estimated size and weight for shipping a Circuit Breaker Monitor assembly:

- Size: 5.25" long x 4.5" height x 1.375" width
- Weight: 0.4 lbs

B. Handling

NOTICE

Do not handle the device by the inputs as damage may occur.

NOTICE

Do not drop the device as damage may occur.

C. Storage

Shipping and storage of electrical equipment requires specific measures to prevent the deterioration of the apparatus over a long unused period. The equipment is designed for use in a variety of environments. When the equipment is in transit and storage, these design considerations are not functional. In general, the following measures must be considered. The warranty of the equipment is not valid if proper handling and storage practices are not implemented. If equipment shipment is prolonged, such as ocean transit, these storage measures also apply to shipment.

Equipment designed for indoor installation must be stored indoors in a climate controlled environment to prevent condensation of moisture. Exposure to rain and the elements, even for a short period, can permanently damage the equipment. Humidity controlling desiccant materials should be utilized during shipment or storage. The temperature should be kept above 33°F/1°C and below 140°F/60°C. The relative humidity should be kept below 60% or a dew point of 59°F/15°C. If prolonged storage is anticipated, humidity controlling desiccant materials should be utilized. Desiccant packets should be installed in all compartments and packing containers.

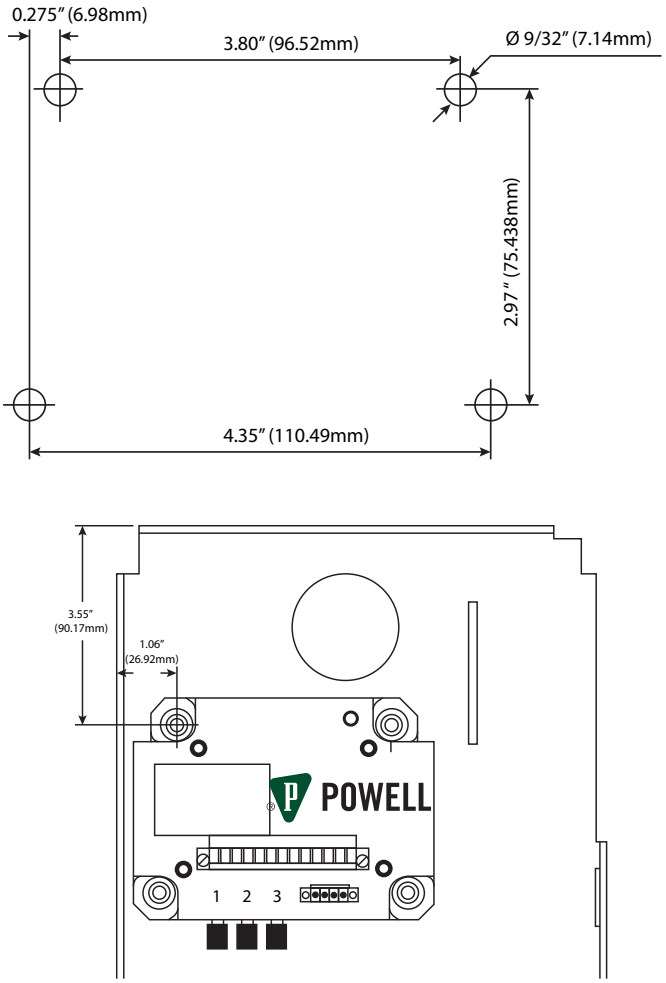
D. PowlVac® Installation

1) Mounting

The mounting location for the Circuit Breaker Monitor is typically in the top left corner of the circuit breaker, against the front *Figure 9*. The bolt hole pattern *Figure 10* for mounting the Circuit Breaker Monitor should be prepared prior to mounting.

Figure 9 Typical Mounting Location

Figure 10 CBM Bolt Hole Pattern



2) BriteSpot® Sliding Contact Temperature

The BriteSpot fiber probe will be mounted to the lower primary disconnect, adjacent to the sliding contact of each phase in the circuit breaker *(Figure 11)*. Each fiber probe will also be connected to the BriteSpot input of the Circuit Breaker Monitor. Perform the following to install the fibers:

1. Route the fiber towards the Circuit Breaker Monitor as shown in *Figure 11*.

2. To connect the fiber probe to the Circuit Breaker Monitor, unscrew the knob of the BriteSpot input, place the fiber into the hole of the knob and retighten the knob.

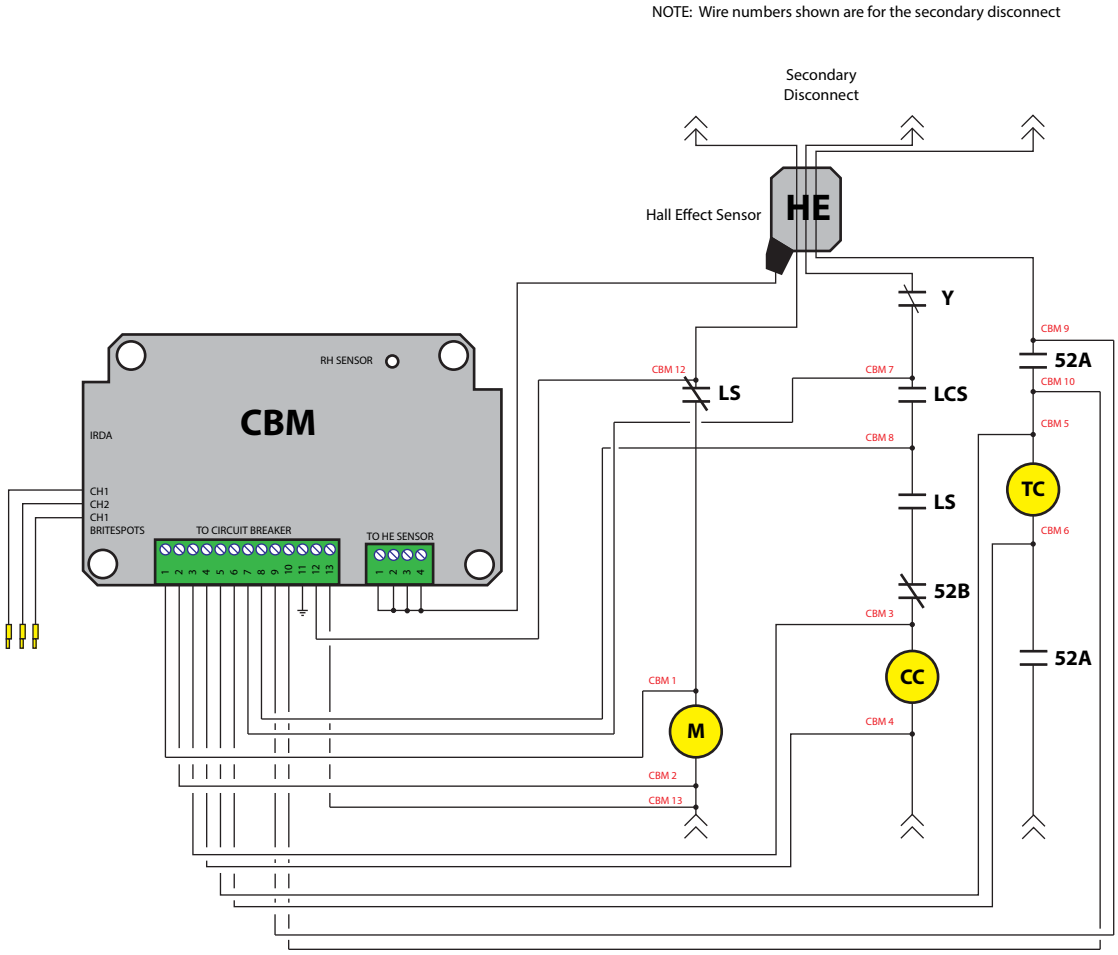
For additional BriteSpot support, refer to the latest version of the 01.4IB.48040 BriteSpot® BSG3 instruction bulletin.

Figure 11 Fiber Routing

3) Circuit Breaker Monitor Wiring

Figure 12 shows a typical wiring diagram for Circuit Breaker Monitor connection to a circuit breaker. Upon wiring the Circuit Breaker Monitor into the circuit breaker, the hall effect sensor shall be plugged in with the motor, trip coil, and close coil wires running through the sensor. The device requires control power from the circuit breaker it is installed into in order to operate. User interface software, BreakerView, provides dashboards and performance data displays for ease of performance trending, diagnostics and history of a circuit breaker. For networked CBMs, BreakerView provides status of each networked CBM. If so desired, BreakerView can be launched within a SCADA system. Alternatively, an individual CBM can be connected to by use of a laptop with BreakerView application connected via USB cable to the EIM.

Figure 12 Typical Circuit Breaker Monitor Wiring Diagram

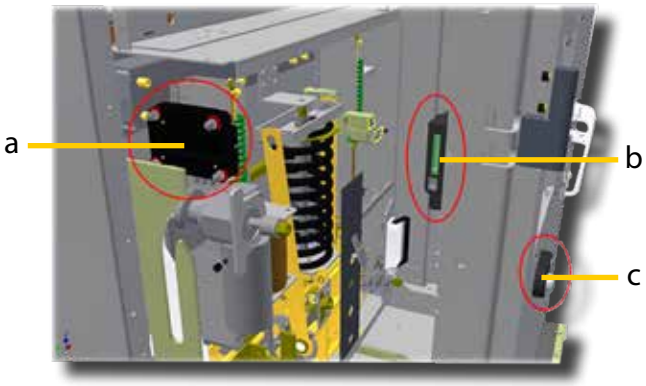


Note: *The contacts are shown with the breaker primary contact in open state and trip and close control circuits deenergized.*

4) Mounting and Placement of IRIM and EIM

The placement of the IRIM on the inside of any door requires that the infrared window of the IRIM be within a 20 degree angle of the associated Circuit Breaker Monitor infrared window line of sight. The shortest distance from the CBM to the IRIM (when the breaker is in the racked out position) will determine the most restrictive placement of the IRIM.

Figure 13 Mounting Locations of IRIM and CBM



a. Circuit Breaker Monitor (CBM)
b. Infrared Interface Module (IRIM)
c. External Interface Module (EIM)

Figure 14 IRIM Mounted on Inside of Door

a. Infrared Interface Module (IRIM)

Figure 15 EIM Mounting Hole Pattern

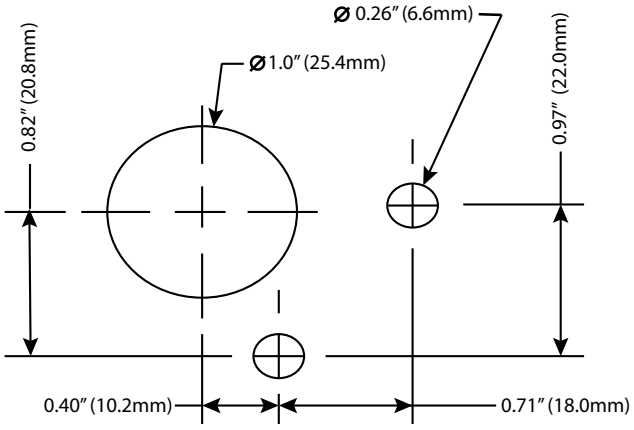
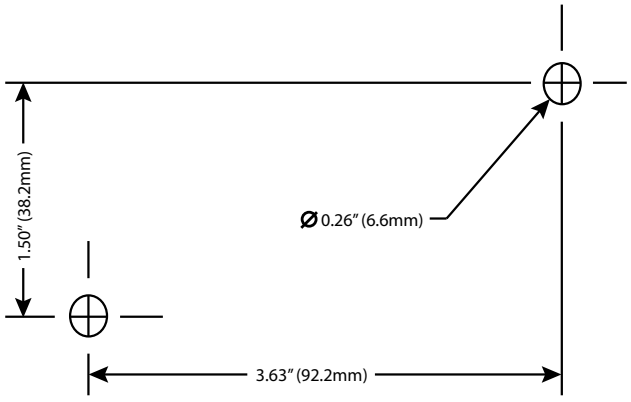


Figure 16 IRIM Mounting Hole Pattern

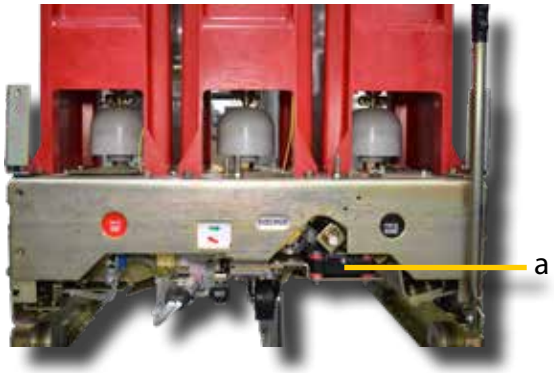


E. Power/Vac® Installation

Figure 17 CBM IR Window

a. CBM IR Window placement at front of circuit breaker front cover

Figure 18 CBM Placement at Front of Circuit Breaker



a. CBM Placement at front of Circuit Breaker with cover removed

1) IRIM and EIM

The infrared Interface Module (IRIM) communicates to the CBM via infrared. The data collected by the CBM is communicated to users by either a Modbus network wired to the IRIM, or a laptop connected to the EIM via USB mini.

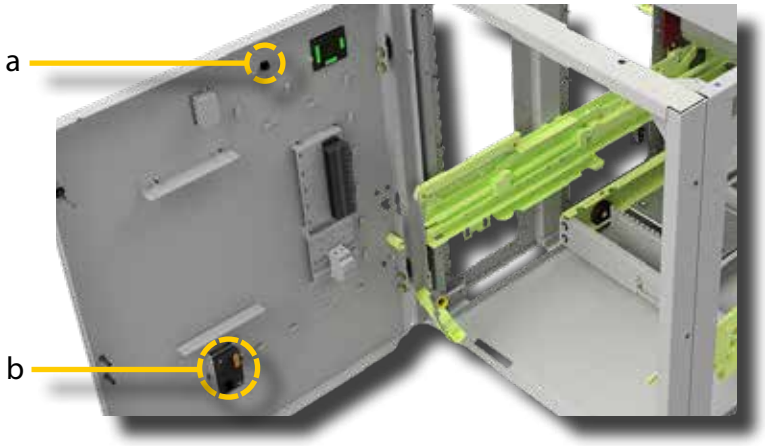
The infrared window of the IRIM has an admittance angle of 20 degrees as measured from the center line of the CBMs infrared window. This places restrictions on the placement of the IRIM to be inside the circuit breaker cubicle, in the lower right-hand corner as seen when facing the cubicle. See *Figure 19.*

2) Mounting IRIM and EIM

For an internal production facility, it is typical to order the IRIM and EIM modules from the part numbers shown in *Table W*, as they were designed to be easily mounted onto the circuit breaker compartment door. The EIM module will normally be mounted to the exterior in the upper half of the switchgear door. The EIM may be mounted elsewhere where necessary, as positioning is not critical.

The IRIM must maintain optical alignment with the IR window of the CBM. Deviation from the shown mounting position will result in poor communications between the CBM inside the Breaker and the IRIM. Do not change the position of the IRIM.

Figure 19 Relative Positions of EIM and IRIM Modules

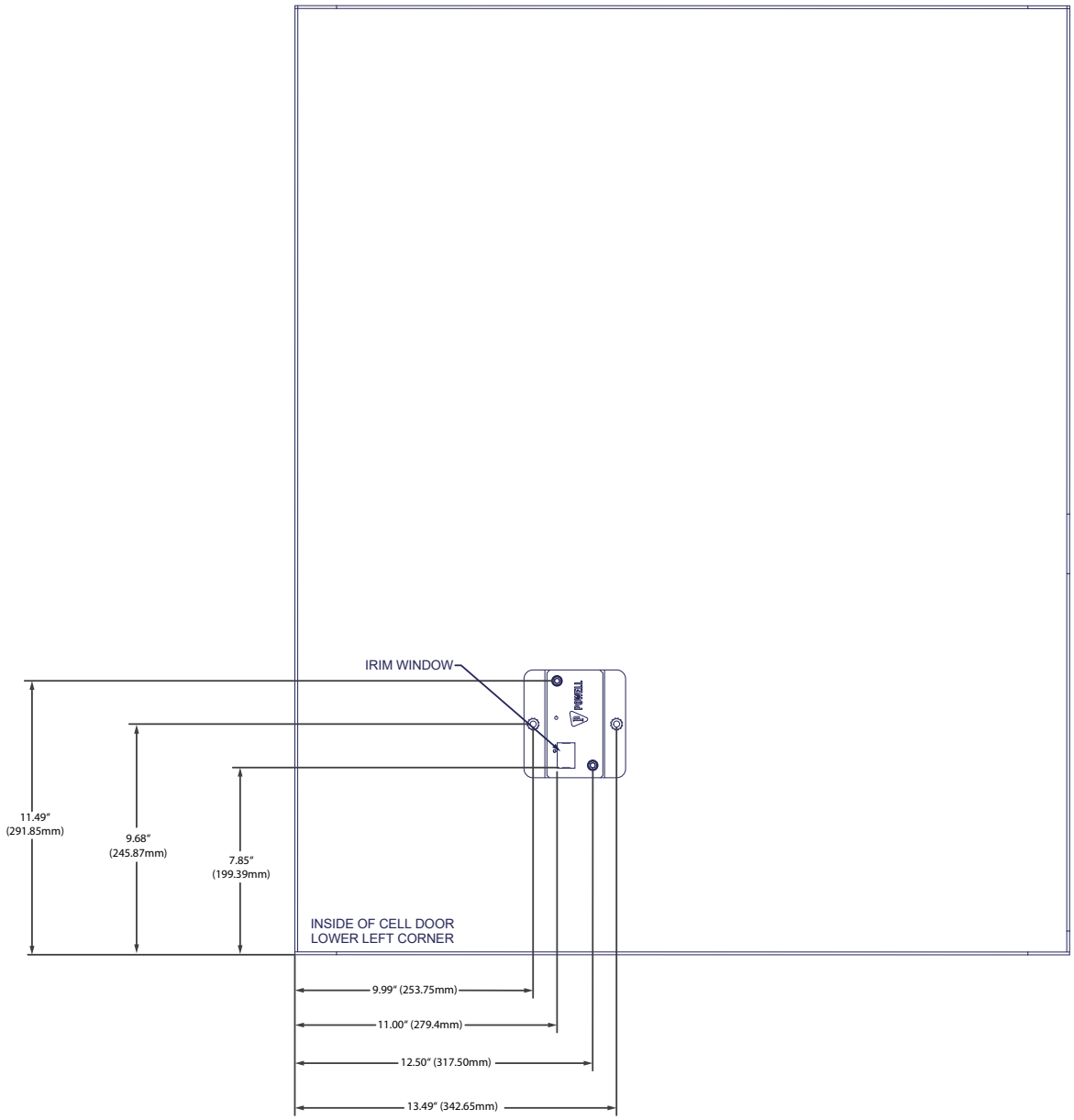


a. EIM is mounted to precut holes in Switchgear Door
b. IRIM is mounted to weld studs in the Switchgear Door

Figure 20 Exterior of Switchgear Door Showing EIM Unit

a. EIM Unit on exterior of Switchgear Door

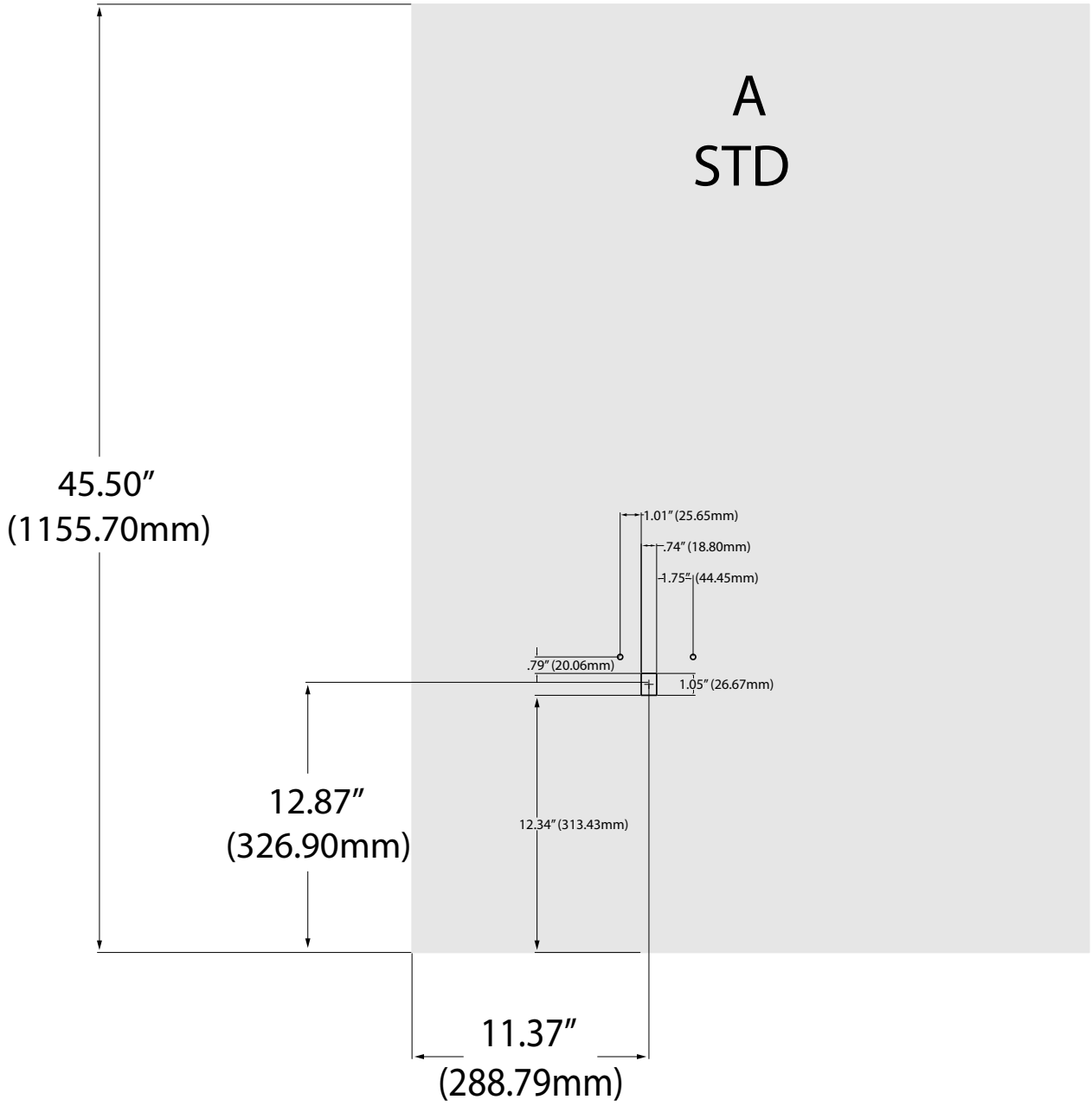
Figure 21 Placement of the IRIM for Power/Vac® Inside Switchgear Breaker Compartment Door



Note: *1. Dimensions are specific to roll-in doors*
2. Drawing indicates:
a) Relative measurements for bracket placement door
b) Relative IRIM bolt locations on bracket

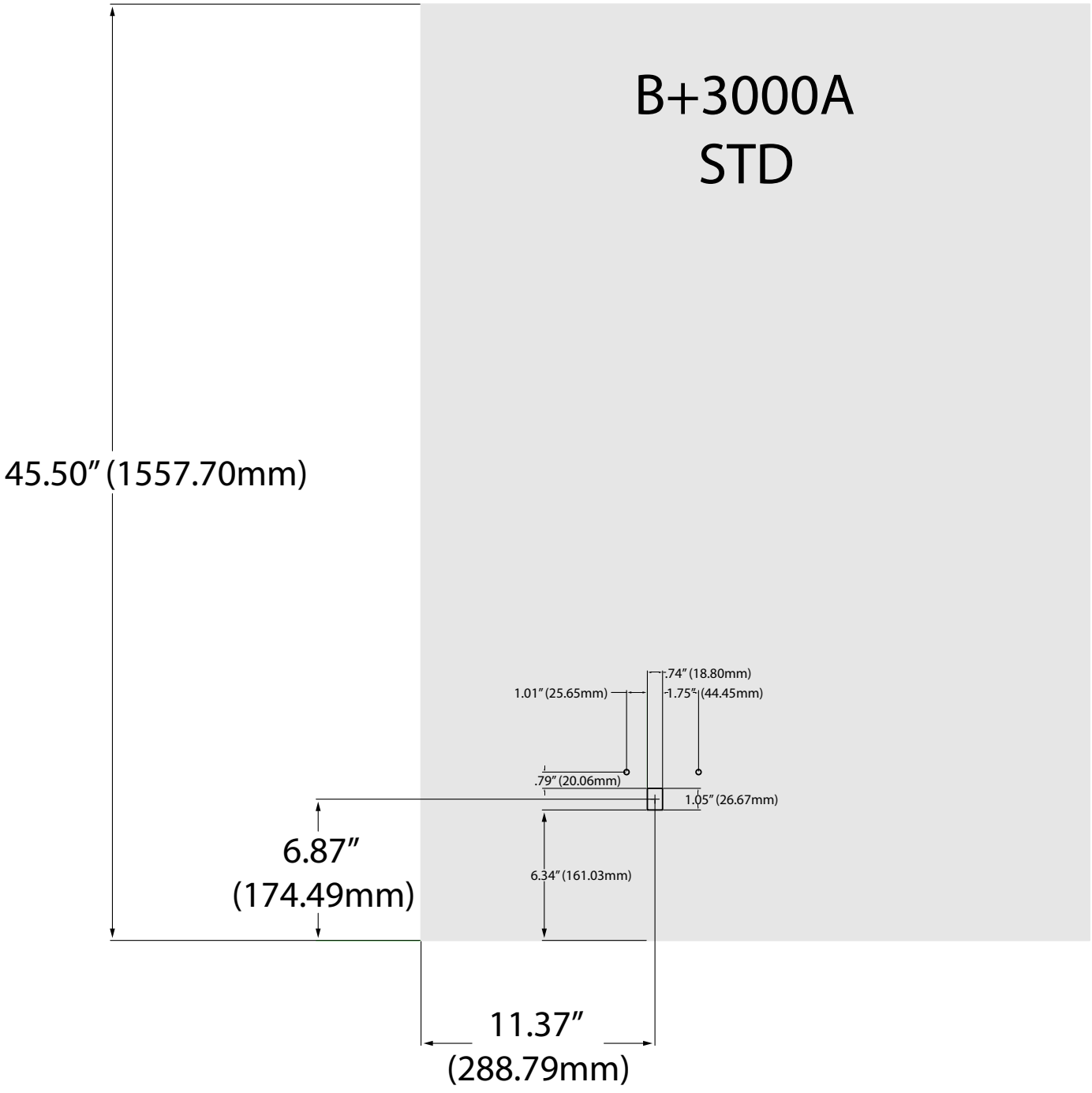
The following figures describe recommended placement of weld studs for each door type, and the center of the IRIM IR window. **If absolutely necessary**, the IRIM and weld studs can be rotated about the center of the window to accommodate hole geometry on the door.

Figure 22 Placement of the IRIM for Power/Vac® A STD Compartment Inside Switchgear Breaker Compartment Door



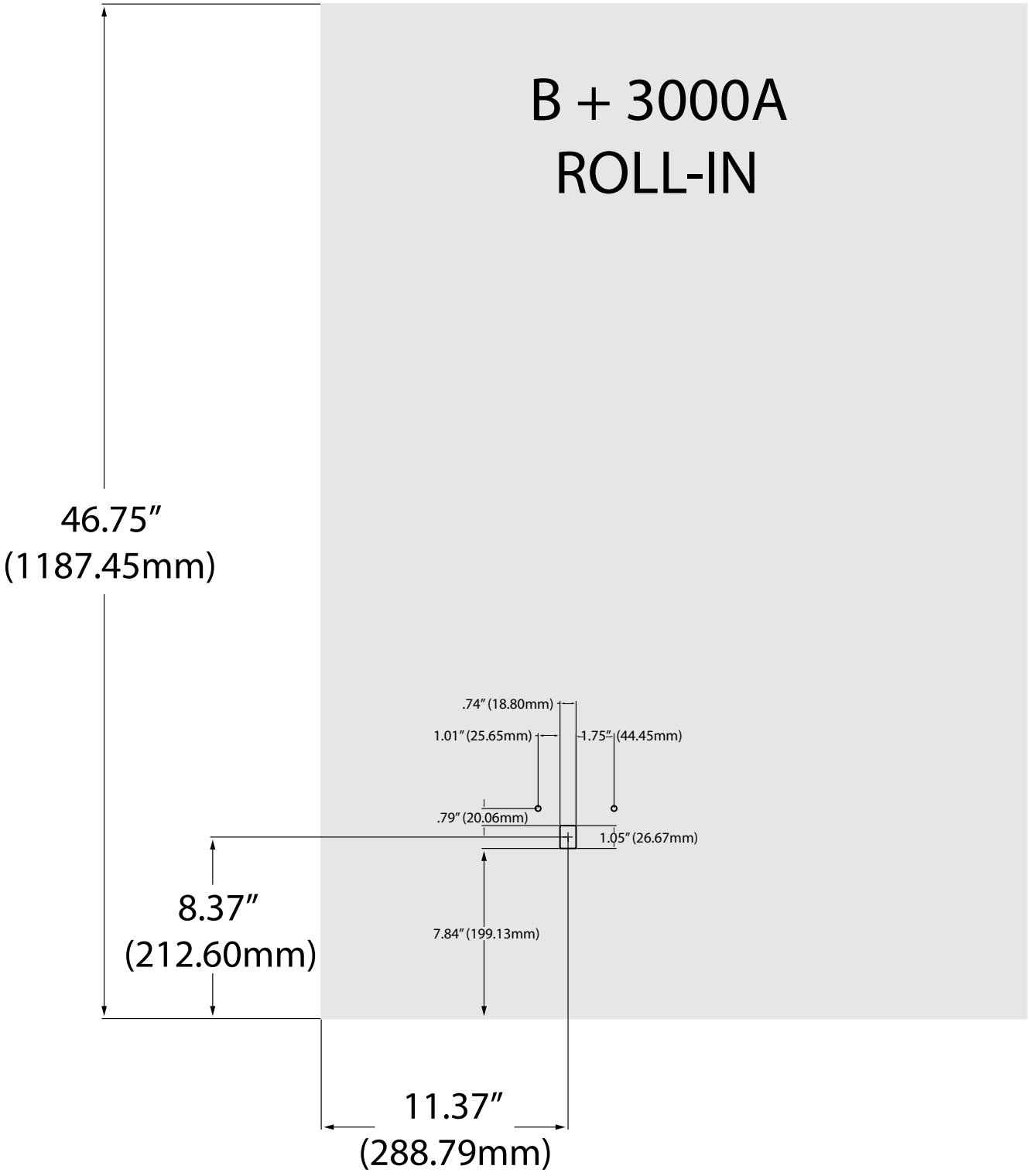
Note: *Dimension are measured in inches*

Figure 23 Placement of the IRIM for Power/Vac® B and 3000A STD Compartment Inside Switchgear Breaker Compartment Door



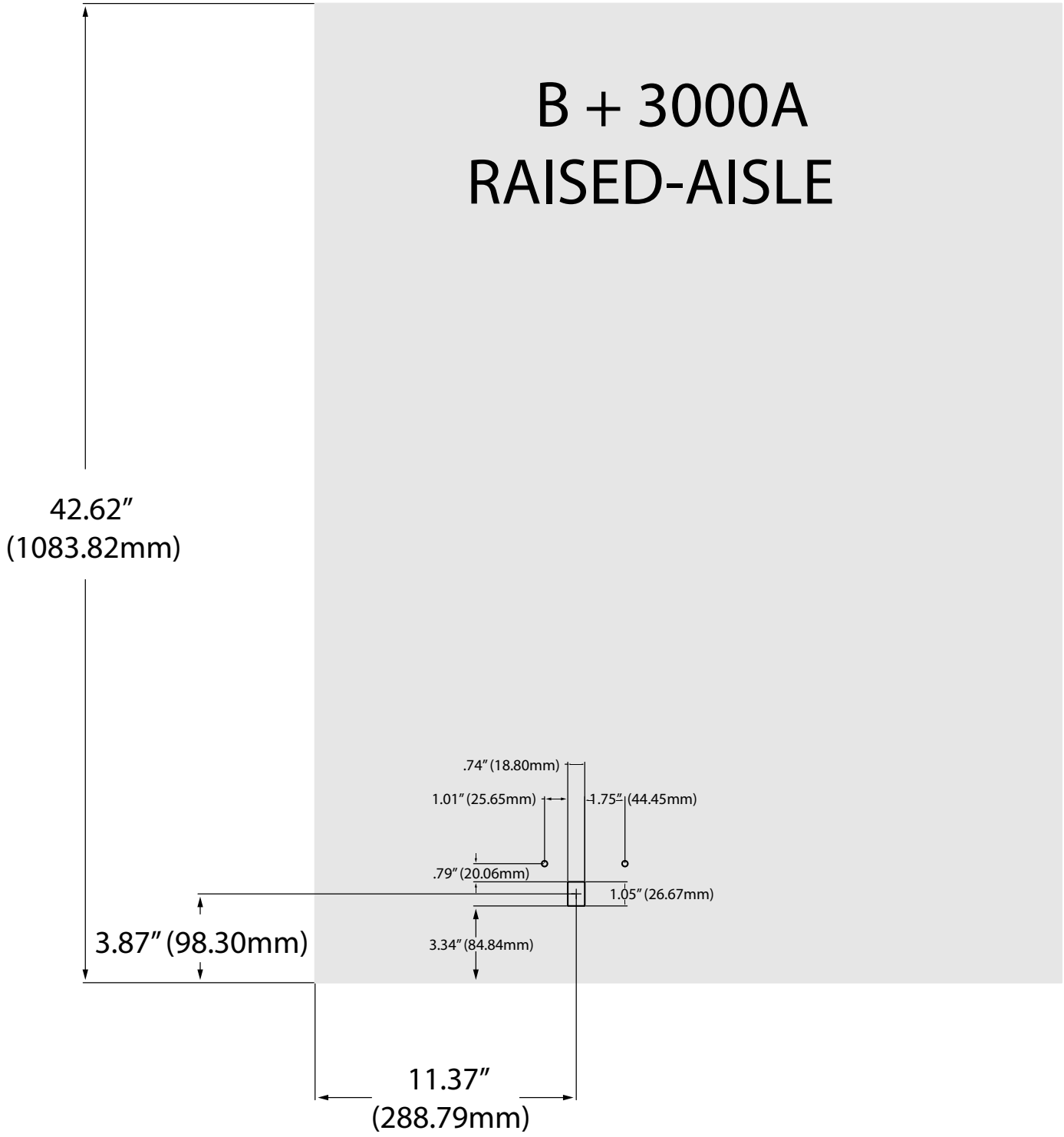
Note: *Dimensions are measured in inches*

Figure 24 Placement of the IRIM for Power/Vac® B and 3000A Roll-In Compartment Inside Switchgear Breaker Compartment Door



Note: *Dimensions are measured in inches*

Figure 25 Placement of the IRIM for Power/Vac® B and 3000A Raised-Aisle Compartment Inside Switchgear Breaker Compartment Door



Note: *Dimensions are measured in inches*

Figure 26 IRIM Bolt Hole Pattern Showing Infrared Window Position

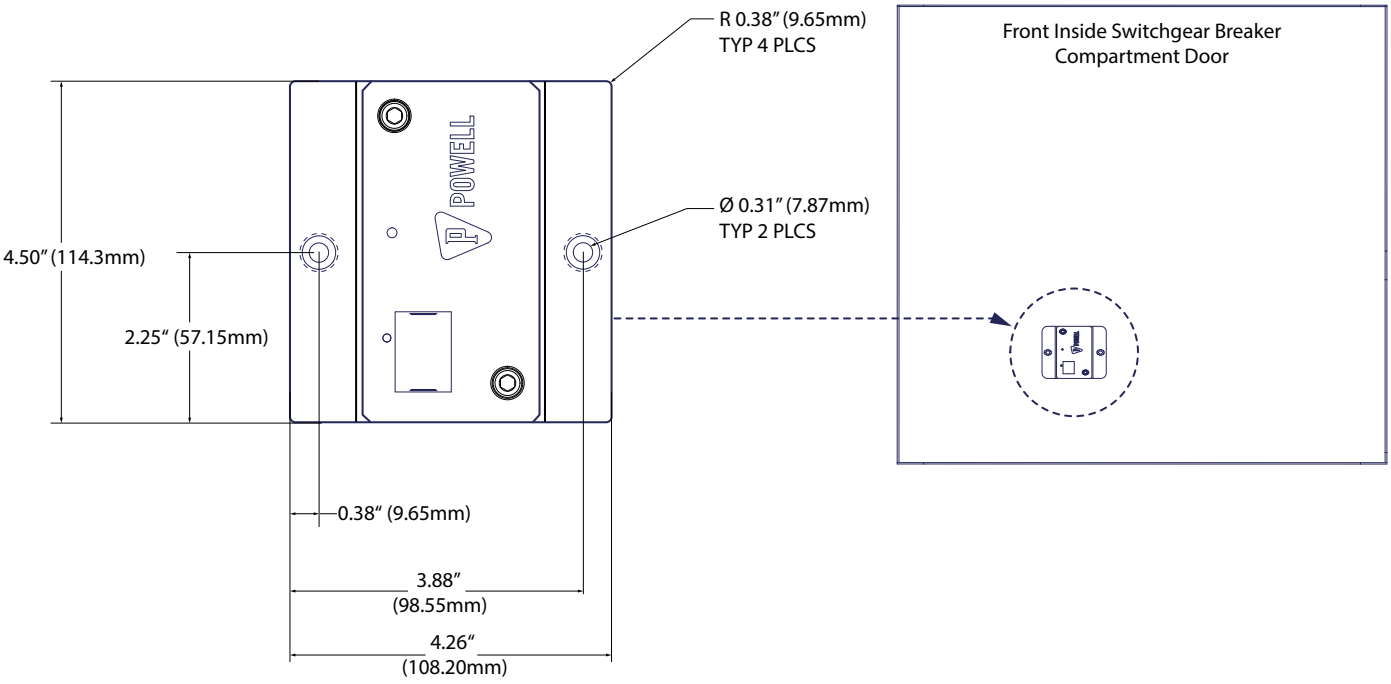


Figure 27 IRIM Bracket Bolt Pattern Dimensioned Top View

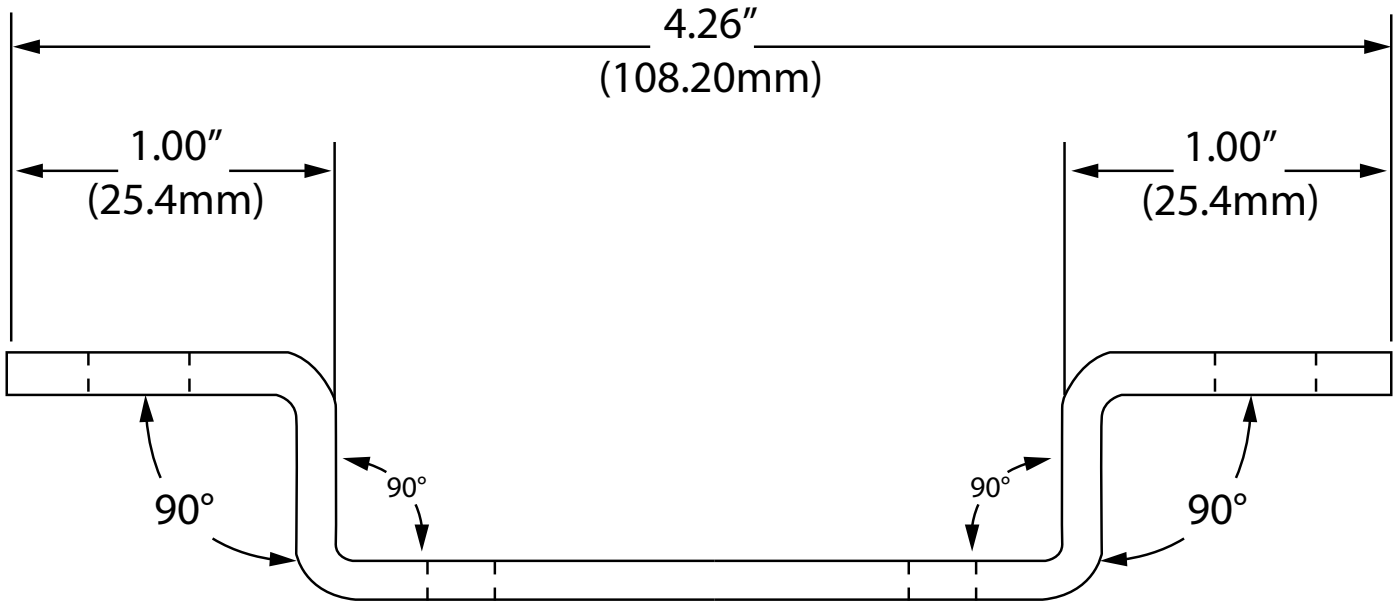


Figure 28 IRIM Bracket Bolt Pattern Dimensioned Front View

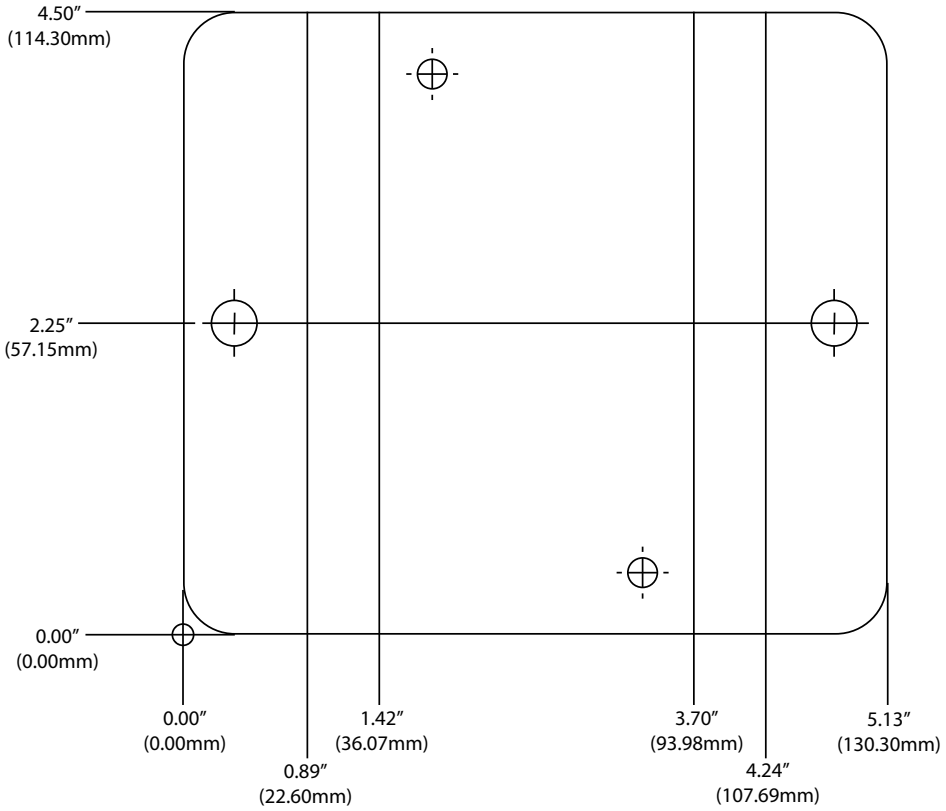


Figure 29 IRIM on Bracket Side View

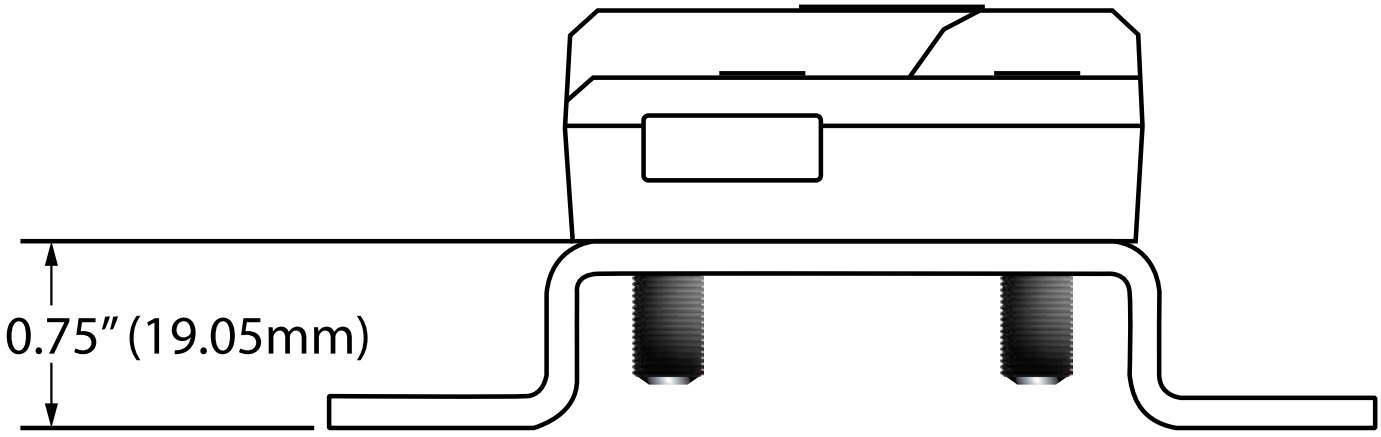
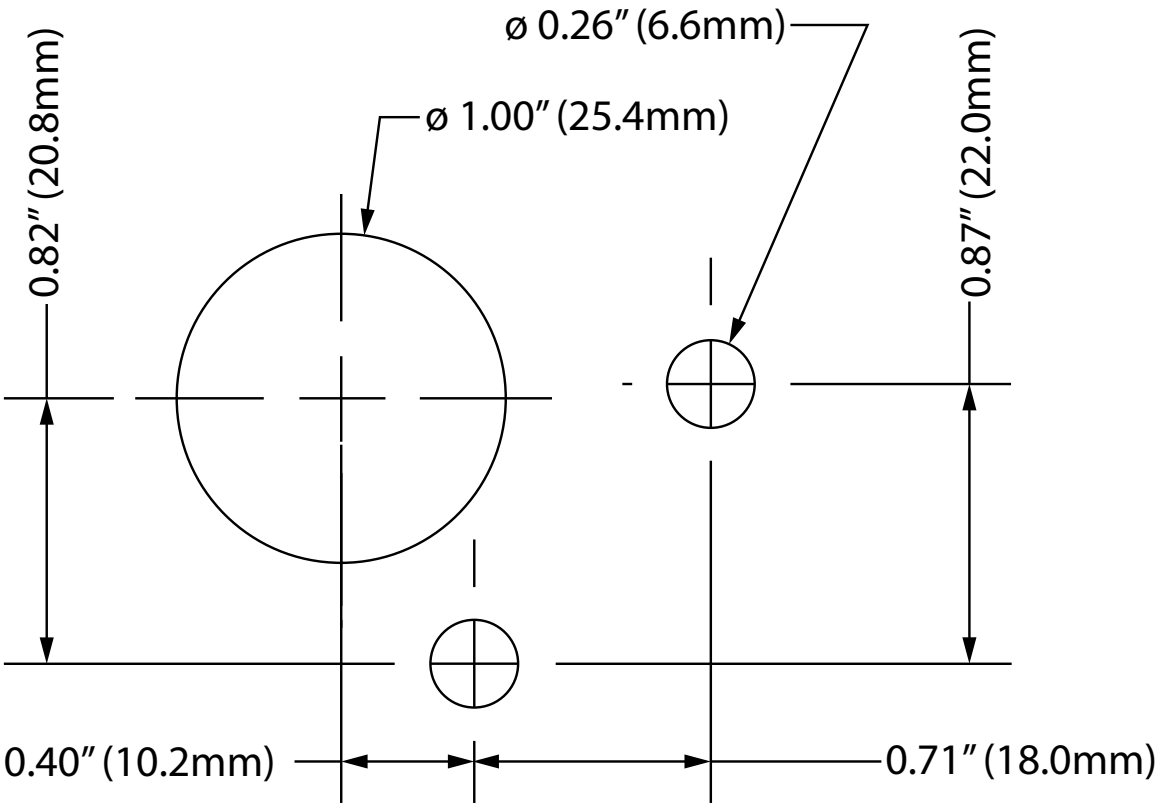


Figure 30 IRIM Bracket

Figure 31 Hole Pattern for EIM Mounting



3) *Hardware and Torque Requirements for the EIM and IRIM*

The IRIM and EIM each use two (2) Socket Head (black-oxide) ¾" long thread, ¼" - 20 hardware (Part number W1106) for mounting.

Figure 32 Socket Head (Black-Oxide)

IRIM Bracket (07070P00710009) *(Figure 30)* used to mount IRIM on compartment door is attached to pre-manufactured weld studs in our example.

Alternatively, the bracket mounting holes will accommodate two PEM Studs, 1¼" long ¼" - 20 hardware in the location identified. Align the IRIM carefully as shown in *Figure 21* to ensure optical alignment between CBM and IRIM IR windows.

All hardware uses either, nut with lock washer, nut with star washer, or nyloc nut. Torque the hardware to ¼ turn past hand tight or 45 - 55 inch-lbs.

4) *Labeling of EIM*

The EIM label explains the meaning of the light behavior. The label in *Figure 33* should be attached to the outside of the switchgear adjacent to the EIM.

Figure 33 EIM Light Behavior

5) BriteSpot® Placement

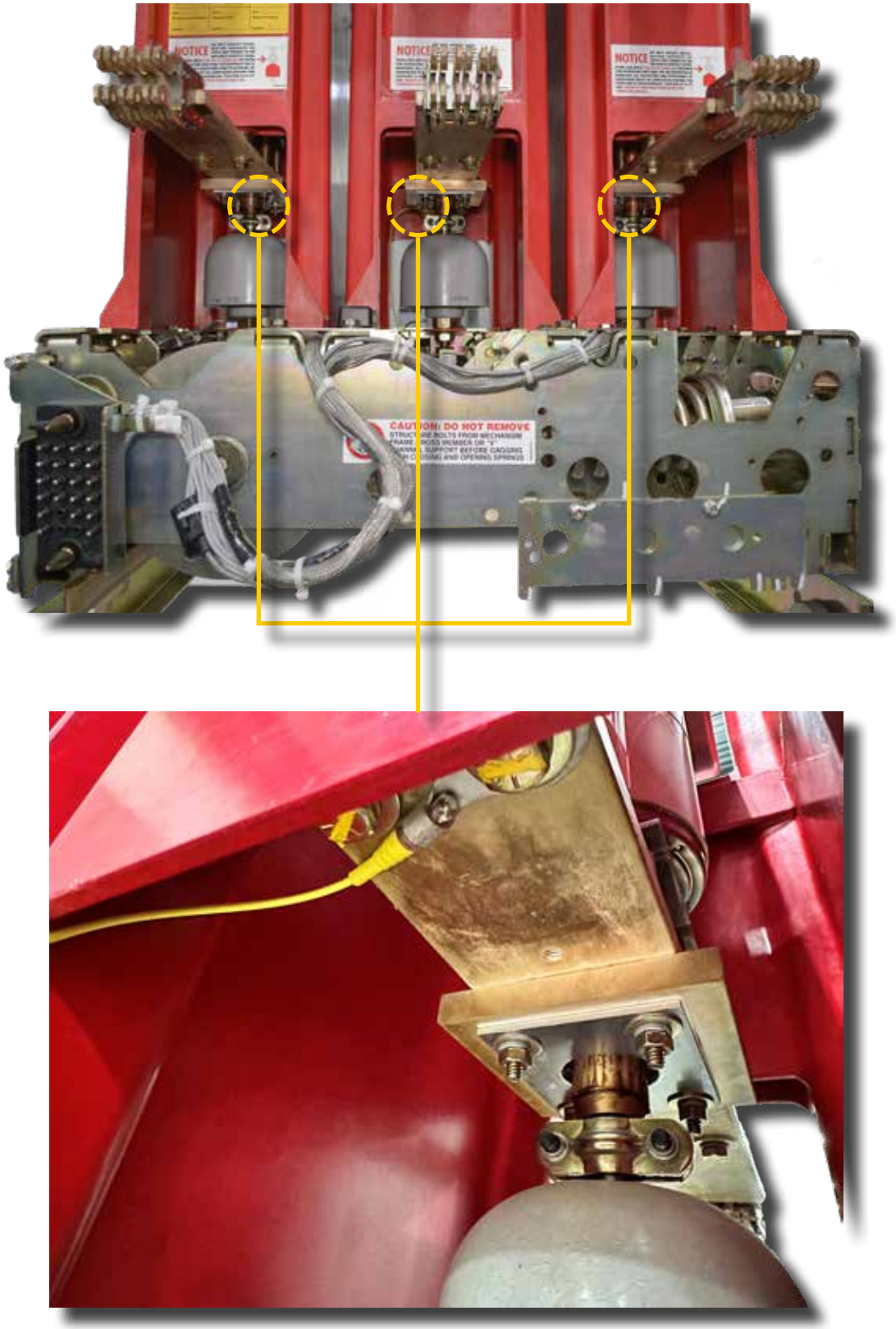
The BriteSpot fiber probe will be mounted to the lower primary as close to the current transfer point (sliding contact or multilam) as possible on each phase of the circuit breaker. Each fiber probe will be connected to the BriteSpot input of the Circuit Breaker Monitor.

Perform the following to install the fibers:

a. Locate BriteSpot probes on the lower circuit breaker primary *(Figure 34)*.
b. Route the fiber towards the Circuit Breaker Monitor *(Figure 36)*.
c. To connect the fiber probe to the Circuit Breaker Monitor, unscrew the knob of the BriteSpot input, place the fiber into the hole of the knob and retighten the knob. Fiber termination to CBM is shown in *Figure 36*.

For additional BriteSpot support, refer to the latest version of Instruction Bulletin 01.4IB.48040 BriteSpot® BSG3.

Figure 34 BriteSpot® Thermal Mounting Probe on Power/Vac® 5kV Below Lower Primary



It is important to ensure that the BriteSpot® fibers are routed in a manner that avoids contact with any moving parts of the phase assembly (bell crank, pushrod). Then, route the fiber along the left side of the circuit breaker frame up to the CBM device. Refer to latest version Instruction Bulletin of 01.4IB.48040 BriteSpot® BSG3 for information on securing and routing the fiber.

Figure 35 Fiber Routing Through Base of Circuit Breaker

Figure 36 Fibers Terminate in CBM Unit

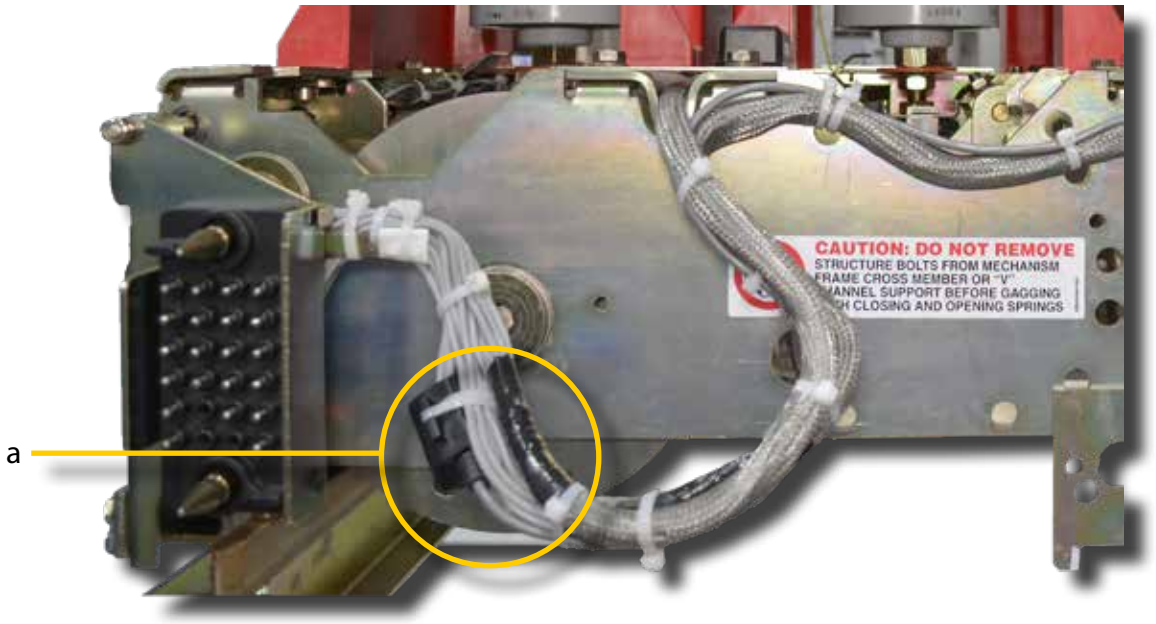
a. Circuit Breaker Monitor (CBM) Unit

6) Hall Effect Sensor (HES) Placement within Breaker

The HES is used by the CBM to monitor the current flowing in the Close & Trip coils and the spring charge motor. It is a simple split core device placed over the wires feeding these circuits as they exit the secondary disconnect plug at the rear of the circuit breaker.

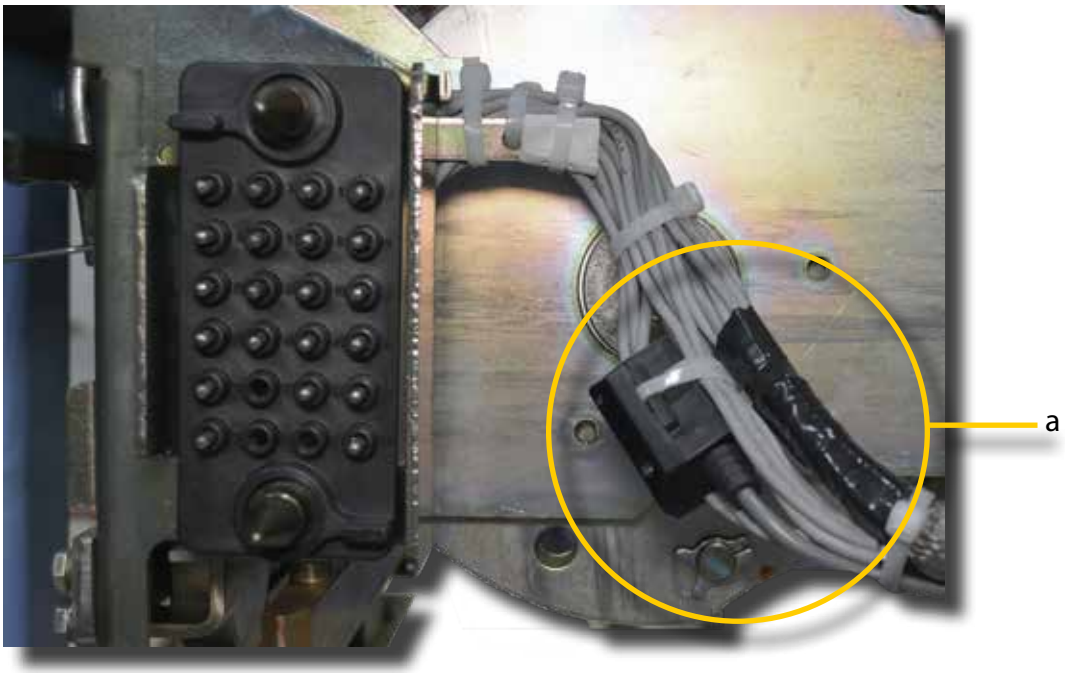
To prevent premature failure, it is important to handle this device with care and avoid striking it heavily. As part of the manufacturing process, the device will be fastened to the cable harness using nylon cable ties. The communication cable between the HES and the CBM modules runs along with the other breaker wiring and is also secured in place with nylon cable ties.

Figure 37 Hall Effect Sensor (HES)



a. Hall Effect Sensor adjacent to the secondary disconnect in rear of circuit breaker

Figure 38 Hall Effect Sensor Close Up View



a. Close Up of Hall Effect Sensor and Cable Routing

Ch 5 Operation

A. Circuit Breaker Monitor (CBM) Operation

The CBM, when powered and properly connected to the devices on a circuit breaker, will provide direct or indirect measurement of parameters for the following:

1. Primary contact touch time.
2. Primary contact part time.
3. Spring charge time.
4. Close coil armature time (via algorithms in BreakerView).
5. Trip coil armature time (via algorithms in BreakerView).
6. Supply voltage values and fluctuations.
7. Phase temperatures on lower primaries near sliding contact.
8. CBM internal ambient temperature.

The CBM will directly provide for basic alerts those parameters not requiring BreakerView algorithms. These alerts will be visually indicated by the EIM's LED color.

The CBM measures the parameters of voltages, currents (charging motor and coils), contact timing, and temperatures then performs calculations to determine the circuit breaker health.

The intent of the CBM timing measurements is to provide continuous trending of these key parameters and the method used to obtain them supports this adequately. The primary contact touch and part times are measured through the operation of the auxiliary contacts within the breaker electrical control scheme. While these are directly and mechanically linked to the primary contact operating mechanism, some variance is to be expected between a breaker contact timing measurement obtained through a primary contact driven timing device and the CBM. This variance is expected to be consistent over the life of the circuit breaker.

B. IRIM Operation

The IRIM (Infrared Interface Module) is the interface between the CBM's proprietary infrared communications link to ModBus RTU (RS-485) and USB communications interfaces. It also indicates the circuit breaker health through the EIM LED.

1) Infrared Communication Interface

Infrared (IR) communication is used to connect the IRIM and CBM. This is a "line-of-sight" interface that avoids the need for additional wiring in the circuit breaker control plug for communication purposes. It uses an adaptive IR protocol to ensure reliable, high speed communication over distances varying from 1 inch and approximately 18 inches. If the communication link between the IRIM and CBM is interrupted the EIM, connected to the IRIM, will indicate this.

2) IRIM Operation

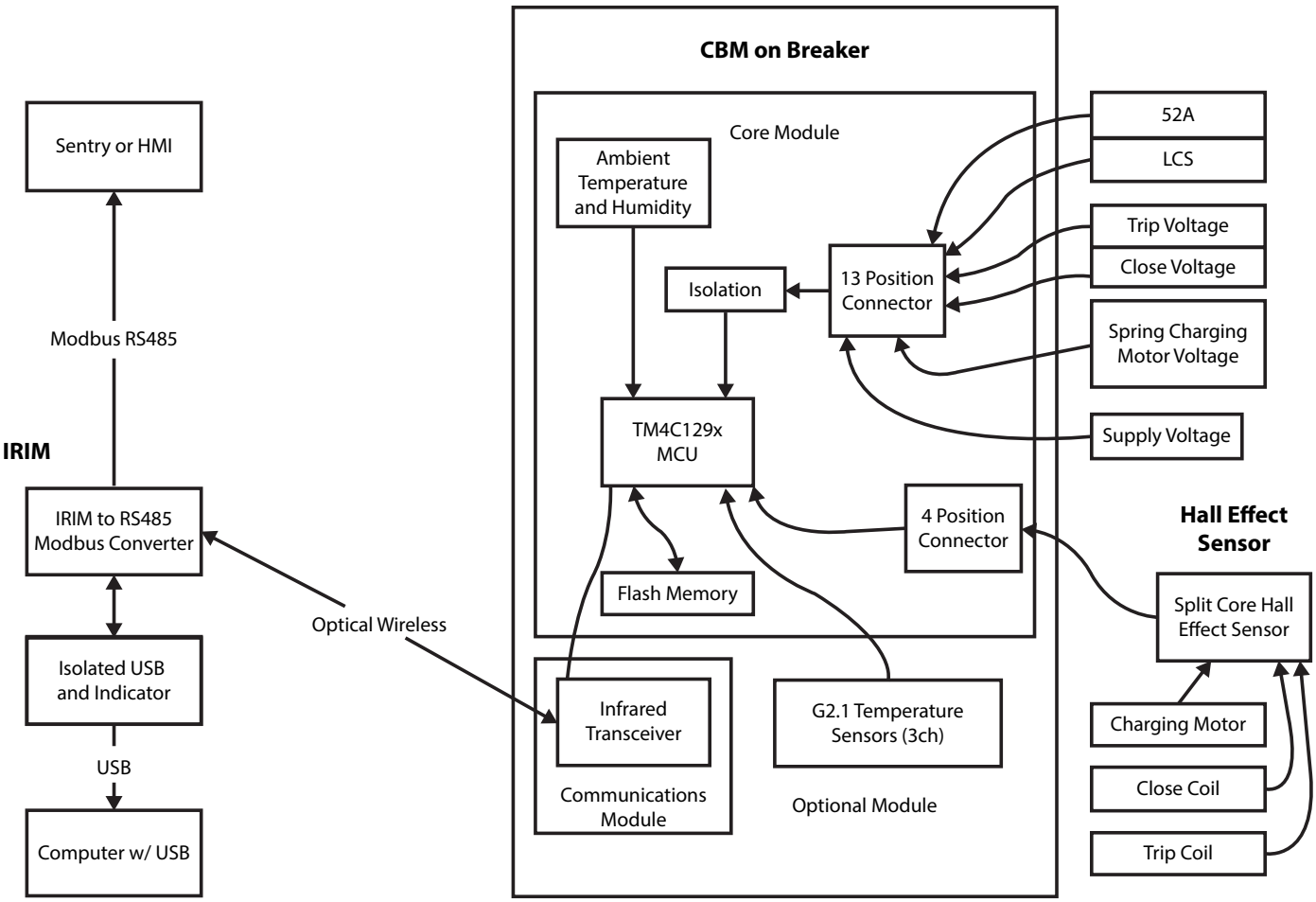
Figure 39 shows a block diagram of the circuit breaker, CBM, associated components and two communication interfaces. The IRIM and EIM combination provides an isolated RS-485 interface for Modbus RTU communication and a mini USB connector for direct USB communication to a local computer. The IR communication between the IRIM and CBM is shared between these two interfaces with the USB taking priority.

3) Communication Interfaces

a. **RS-485 Interface** - This interface supports the Modbus RTU protocol. The "GND ISO" (pin 3) should be connected to the RS-485 cable shield and not a local ground. Refer to RS-485 wiring details for more information. The default interface parameters are Modbus ID #1, 115200 baud, 8 data bits, no parity and 1 stop bit. The Modbus ID and baud rate can be adjusted using Powell's IRIM production assistant software. The IRIM supports the following baud rates: 9600, 19200, 38400, or 115200.

b. **USB Interface** - This is used to make a direct connection between the CBM and a local Microsoft® Windows based computer running Powell's software (eg. BreakerView). A USB driver may be required for this interface, this can be downloaded from *breakerview.powellind.com*. Once installed this driver is automatically configured.

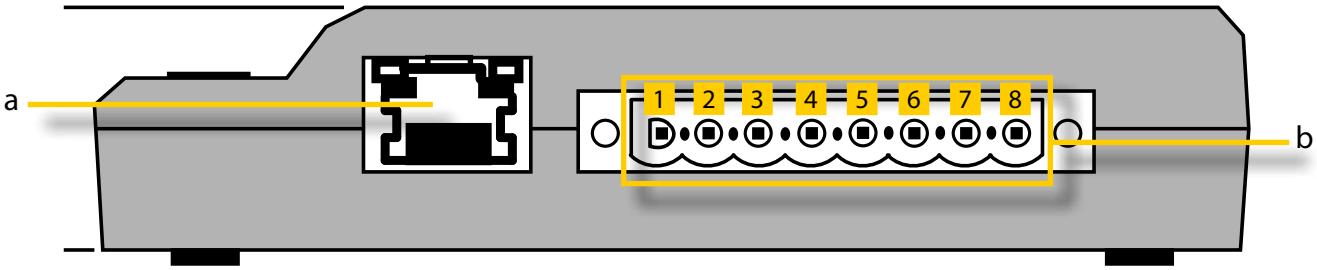
Figure 39 CBM System Block Diagram



4) IRIM Wiring

The IRIM features a 8 position Phoenix Contact Combicon connector for power, output relay, and RS-485 interfaces. It also features a RJ-45 connector used with a "straight-through" cable to connect to the EIM.

Figure 40 IRIM Input Connections



a. RJ-45 Connection to EIM
b. Main Inputs

Table F IRIM Wiring			
Pin	Description	Function	Wire Type
1	GND ISO	Isolated RS-485 Interface	Belden 3105A Drain Wire
2	A (-)		Belden 3105A White/Blue
3	B (+)		Belden 3105 Blue/White
4	COM	Alarm Relay - Dry Contact	16 - 22 AWG
5	Normally Open		
6	Chassis Ground	Protected Ground	
7	L - Line	IRIM Input Power, 60-240VDC/AC	
8	N - Neutral		

C. External Indication Module (EIM) Operation

The EIM provides a basic "traffic light" style indication of the circuit breaker and CBM health using the illuminated breaker status indicator *(Figure 41, b)*. The EIM is typically mounted on the switchgear door in a location where the user can easily observe it. The EIM also features a mini-USB port *(Figure 41, a)* for direct communication between the CBM and a computer with Powell's BreakerView software installed. The small communication LED provides indication of when communication between the computer and the CBM is occurring.

Figure 41 Breaker Status Indicator

a. Mini-USB Port
b. Embedded LEDs

Figure 42 BreakerView Overview Screen

D. Software Overview

Powell's BreakerView™ software provides a series of screens with dashboards and values that permit rapid determination of the overall health of a circuit breaker. This is an asset management tool in direct support of condition based maintenance as a more targeted data driven version of predictive maintenance. Any operational performance issues are identified and diagnostics with corrective actions provided. Recording of events is provided in the embedded database. Corrective maintenance as well as any routine maintenance records can be created and stored within the embedded database allowing a more complete record of performance of the circuit breaker and efforts required to ensure its reliability. Trending of the circuit breaker performance and time required to maintain it is readily available through use of this software *(Figure 42)*, refer to BreakerView User Manual for more details.

Configuration of the CBM will be performed by factory personnel or Powell Service Division personnel.

Figure 42 shows BreakerView screen with dashboards providing circuit breaker health and performance measures.

The software can be downloaded from *breakerview.powellind.com*.

For IRIMs that are to be used in a network, a configuration of those modules is required. Configuration of the IRIM, by a separate application or BreakerView, permits each IRIM in each switchgear section to have a specific Modbus address assigned. With this methodology, any circuit breaker with an embedded CBM will be identified with its switchgear location, thus circuit breakers can be installed within any cubicle for which they have the correct rating and will be locatable via BreakerView. Please refer to the latest version of 01.4UM.48072 BreakerView™ Software User Manual for details of how to use BreakerView to configure IRIMs.

Communications to a CBM via Modbus will be degraded while a laptop is connected to a given EIM through the USB. The system is designed to respond to the local USB connection as the primary data communications port.

Ch 6 Troubleshooting

A. Troubleshooting The Circuit Breaker Monitor

Table G CBM LED Indications	
Color	**Description**
Green	Flashing - normal operation, no alarm
Red	Flashing - CBM writing to flash memory after operation, or alarm mode

Note: *CBM writing to flash and thus RED flashing LED will occur for approximately 50 seconds, if it continues well after this time period, the CBM is in alarm.*

Figure 43 CBM LED Indicator

a. LED Indicator

Table H Hall Effect Module LED Indications	
Color	**Description**
Green	Normal Operation
Red	Initializing or Calibration Mode

Figure 44 Hall Effect Module LED Indicator

a. LED Indicator

Table I IRIM LED Indications	
Color	**Description**
Green	Flashing - occurs approximately once every 4 seconds or strobes red/green when communicating with CBM
Red	Flash - occurs once every 15 seconds if loss of communications with CBM

Figure 45 IRIM LED Indicator

a. LED Indicator

Table J EIM LED Indications	
Color	**Description**
Green	Flashing - occurs when the EIM is connected directly to a laptop through USB and is communicating with the CBM

Figure 46 EIM LED Indicator

a. LED Indicator

1) CBM Alarm Events

a. Flashing RED LED

i. Parameter in Alarm Range

Parameters Used for Breaker Performance:

- Total Close Time
- Total Charge Time
- Total Trip Time
- Close Coil Voltage
- Charge Motor Voltage
- Trip Coil Voltage
- Supply Voltage Sag/Swell
- Close Fail
- Charge Fail
- Trip Fail

Parameters Used for Environmental Conditions:

- Supply Voltage (Control Voltage to Breaker)
- Event Voltage Transient (Close, Charge, & Trip)
- Phase Temperature
- Ambient Temperature

ii. CBM loss of Hall Effect connection
iii. CBM BriteSpot Fiber loss
iv. CBM watchdog alarm

b. Troubleshooting CBM Alarms that are not Circuit Breaker Related

i. Connect to the CBM via IRIM/EIM and using BreakerView software determine if the BriteSpot® fibers are reading.
ii. In the BreakerView software inspect the coil and motor current signature for presence, if no current signature, inspect Hall Effect LED.
iii. If current signature is not present, Hall Effect may have failed/disconnected after the breaker operation. If practical, remove the breaker from the switchgear and inspect the Hall Effect with the breaker powered and cover removed.
iv. If the breaker can't be removed from service, inspect current signature at first operation.
v. If all BriteSpot fibers are connected and functioning correctly and Hall Effect is functioning correctly, the alarm is a CBM watchdog alarm. CBM will need to be replaced.

c. Clearing CBM Parameter Alarms

Circuit breaker performance parameter alarms can only be cleared by performing a satisfactory circuit breaker operation (the operation must be within the normal band). Any alarm will remain regardless of acknowledgment until a good operation is performed. Acknowledgement within BreakerView™ is required in order to remove alert flags there.

Environmental alarms can be cleared by:

i. Correcting the environmental condition (restore the value to within the normal band).
ii. Clicking on the "Acknowledge All" button and entering a name within the BreakerView™ Software (refer to BreakerView Software manual for additional details).

2) CBM System Failure Indications

a. Troubleshooting CBM Power Loss/Failure

i. No CBM LED indications.
ii. No communications from the CBM to the IRIM, BreakerView will not show the breaker as available.
iii. Check power to CBM circuit.
iv. If no power present, correct power connections.
v. If power is present, replace and reconfigure the CBM.

b. Troubleshooting CBM IRIM Power Loss/Failure

i. No IRIM LED indications.
ii. No EIM pulsing or flashing LEDs.
iii. No communications on network to IRIM.
iv. Check power to IRIM circuit.
v. Inspect wiring to IRIM.
vi. If no power present, correct connections.
vii. If power present at IRIM, replace and reconfigure the unit.

c. Troubleshooting CBM Voltage Indications Not Present

i. Inspect BreakerView "Operations" tab for display of voltage, verify that "Voltage" is selected.
ii. If the display is correct, inspect wiring to CBM from device to input channel.
iii. If wiring is correct, replace the CBM.

Ch 7 Specifications

A. CBM Hardware Specifications

Table K Power Supply Details	
Rated Supply Voltage	110-240VAC, 50/60Hz, 110-250VDC
Input Voltage Range	80VAC/DC to 288VAC/DC, holdup time >10ms@80VAC/DC
Power Consumption	<5W
Power Fail Detection	Auxiliary voltage less than 80VDC for 5ms
RTC Operation Lifetime	>25 years with nominal environmental conditions
Internal Battery Power	Tadiran battery TL-5186, 25 years continuous operation of RTCC

Table L Power/Signal Connector	
Pins	13
Pitch	0.2 inch (5.08mm)
Additional Info	Flanged including threaded plug retention
Rated Voltage	300VAC Nominal Voltage

Table M Hall Effect Connector	
Pins	4
Pitch	0.15 inch (3.81mm)
Additional Info	Flanged including threaded plug retention
Rated Voltage	125VAC Nominal Voltage

Table N Analog Voltage Inputs	
Operating Range	±33 to ±407VDC
Resolution	1V or better
Accuracy	Greater of 1V or ±2% injection with ± LS digit
Leakage Current (between separate inputs)	Less than 250uA
Applications	Monitoring: Close coil voltage Trip coil voltage Spring charge motor voltage Auxiliary supply voltage

Table O Digital Voltage Input	
Maximum Operating Voltages Range	±407VDC
Operating Characteristics	Wet/dry. Self-excited contact monitoring input
Isolation	2.5kV AC for 1 minute
Leakage Current (when monitored contacts are open)	Less than 250uA
Response Time	Less than 0.5ms
Applications	Monitoring: "52A" contact "LCS" contact

Table P Internal Environment Monitoring	
Measurement	CBM Internal Temperature
Temperature	-40°F to 185°F ±35.6°F (-40°C to 85°C ±2°C)

Table Q Hall Effect Sensor	
Supply Voltage	5VDC
Measurement Range	Min ±0.25A Max ± 20.0A
Measurement Resolution	0.05A
Measurement Accuracy	±5% of FSD
Operating Temperature Range	-40°F to 158°F (-40°C to 70°C)

Table R Optical Wireless Communication	
Wavelength	850nm (Infrared)
Baud Rate	0.5Mbps
Range	24 inches with direct line of sight
Viewing Angle	20 degrees

Table S Fiber Optic Temperature Measurement	
Monitoring	3 point temperature measurement using BriteSpot® G2.1 module
Application	Monitors the operational temperatures of the sliding contacts

Table T LED	
Type	LED - Red, Green, & Yellow as both solid and flashing (0.5Hz) colors
Application	Used to indicate state of circuit breaker and CBM unit

Table U CBM Dimensions & Mounting	
Dimensions	1.5 x 4 x 5.3 inch (38 x 100 x 135mm)
Mounting	4 x 1/4" -20 bolts
Enclosure Type	Injection molded ABS plastic
IR Window Size	9/16 x 13/16 inch (21 x 15mm)

B. Environmental Service Conditions

- Circuit Breaker Monitor is intended to be installed inside Powell circuit breakers
- Non-Hazard classification (non-explosive atmosphere)
- PCB conformal coating option is not available

Table V Environmental Conditions	
Design Lifetime (for 0 to 50°C operation)	Approximately 25 years
Operating Temperature	-40°F to 158°F (-40°C to 70°C)
Operating Temperature (transport log system)	-40°F to 185°F (-40°C to 85°C)
Storage Temperature	-40°F to 185°F (-40°C to 85°C)
Humidity	5% to 95%
Shock/Vibration	As per IEC 60255-21-1/1/2/3 (class 2) Simulation of 10,000 breaker operation cycles
Pollution Degree	3 (IEC 60664)
Overvoltage Category	II
Altitude	6,561.67 ft. (2000m)
Atmosphere Pressure	80-115kPa

Ch 8 Recommended Renewal Parts

Table W Circuit Breaker Monitor Modules		
Part Number	**Description**	**Order Entry**
AP.CBM01K2	Complete Power/Vac® installation kit with CBM1 module, wire harness, current sensor, 3 point BriteSpot® fiber kit. Includes; AP.CBM.01M; AP.CBM.01W2	Any Powell production facility or external Customer
07070P00710009	Power/Vac mount for IRIM device	Any Powell production facility or external Customer
AP.CBM.01W2	Complete Power/Vac installation kit with wire harness, current sensor, 3 point BriteSpot fiber kit and CBM mounting bracket. No module included. Includes; AP.CBM.01CS1; AP.CBM.01F1	Any Powell production facility or external Customer
AP.CBM.01EIM	External optional switchgear mounted Infrared communication module for wireless capability	Any Powell production facility or external Customer
AP.CBM.01IRIM	Internal optional switchgear mounted Infrared communication module for wireless capability.	Any Powell production facility or external Customer
AP.CBM.01IRIMK3	Internal optional switchgear mounted Infrared communication, External optional switchgear mounted Indication module with LED indicators and USB connection for communication	Any Powell production facility or external Customer

Appendix A Modbus Memory Map for CBM System

The following table lists the Modbus registers available from the CBM, via the IRIM. These registers are intended to be polled by a SCADA system for historian purposes. Polling frequency should not exceed 1 poll per second.

Note: *The current breaker operation count is obtained by dividing the "processed coil operation" register by 2, then add it to "analog counter offset" register.*

Table X MODBUS Memory Map for CBM System

Register Name	Read/ Write	Register Type	Description	Default	UOM	Register Address
CBM SN	R	Input	CBM Serial Number	N/A	N/A	30011~12
Breaker SN	R	Input	Breaker Serial Number (Byte Packed ASCII)	N/A	N/A	30017~32
Supply Voltage	R	Input	Supply Input Voltage	N/A	Voltage (V)	30057
BriteSpot Status Ch1	R	Input	OK = 0, No Fiber Present = 1, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8	N/A	N/A	30061
BriteSpot Status Ch2	R	Input	OK = 0, No Fiber Present = 1, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8	N/A	N/A	30062
BriteSpot Status Ch3	R	Input	OK = 0, No Fiber Present = 1, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8	N/A	N/A	30063
Phase Temp A	R	Input	Phase A Temperature	N/A	Degree Celsius (°C)	30064
Phase Temp B	R	Input	Phase B Temperature	N/A	Degree Celsius (°C)	30065
Phase Temp C	R	Input	Phase C Temperature	N/A	Degree Celsius (°C)	30066
Breaker Status	R	Input	OK = 1, Warning = 2, Alarm = 4	N/A	N/A	30071
Processed Coil Operations	R	Input	Total Processed Coil Operations Count	N/A	N/A	30079

Table X Modbus Memory Map for CBM System (Cont.)						
Register Name	**Read/ Write**	**Register Type**	**Description**	**Default**	**UOM**	**Register Address**
Last Trip Time	R	Input	Last Total Measured Trip Time (Conversion: measured value * 0.10 = value in ms)	N/A	Millisecond (ms) after conversion	30083
Last Close Time	R	Input	Last Total Close Time (Conversion: measured value * 0.10 = value in ms)	N/A	Millisecond (ms) after conversion	30095
Last Charge Motor Time	R	Input	Last Total Measured Charge Motor Time (Conversion: measured value * 15.3846 = value in ms	N/A	Millisecond (ms) after conversion	30107
Analog Counter Offset	R	Input	Operation Offset Counter set during FITR Operation	0	N/A	30117

POWELL

01.4IB.48070C
Circuit Breaker Monitor (CBM)

September 2025

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