Instruction Bulletin - 01.4IB.48070B

Circuit Breaker Monitor (CBM)
Contact Information

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Signal Words

As stated in ANSI Z535.4-2007, 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 an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING**

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

**CAUTION**

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION, used without the safety alert symbol, is used to address practices not related to personal injury.

**NOTICE**

NOTICE is used to address practices not related to personal 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 energize, deenergize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
2. trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established 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
Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

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):

- 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. Wiring instructions
5. Procedure for obtaining data from CBM
6. Illustrations, photographs, and description of the modules

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**

*Be sure to follow the appropriate safety precaution while handling any of the equipment. Failure to do so may result in serious injury or death.*

To the extent required, the products described herein meet the applicable ANSI, IEEE, IEC, and NEMA Standards; however, no such assurance is given with respect to local codes and ordinances which may vary greatly.

C. **Instruction Bulletins Available Electronically**

For more information visit powellind.com. To contact the Powell Service Division call 1.800.480.7273, or email info@powellservice.com.

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

120.5 Process or 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.

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 uncrating the controllers.

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 medium voltage equipment described in this instruction bulletin is operated by a high-energy, high-speed mechanism that is interlocked to provide specific operating sequences. It is mandatory that the following rules be observed to ensure the safety of personnel associated with usage, installation, operation, and maintenance of these controllers.

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 Circuit Breaker Monitor (CBM).

C. General

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the circuit breaker monitor shall be allowed to work on this equipment. It is mandatory that this instruction bulletin, any 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 equipment's reliability and safety.

3. Service conditions 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. **DO NOT WORK ON ENERGIZED EQUIPMENT.** If work must be performed on a circuit breaker, remove it from service and remove it from the metal-clad switchgear.

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

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

4. 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 controller is handled, operated, or maintained.

**Notice**

*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°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 retained in a battery backed-up memory. The data communications from the CBM is via a built in IR transceiver.

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).
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)**

![External Indication Module (EIM)](image)

**Figure 4  Circuit Breaker Monitoring System Overview**

![Circuit Breaker Monitoring System Overview](image)
B. **Hall Effect Sensor**

The Hall Effect Sensor module is mounted within the wire bundle directly behind the circuit breaker's secondary disconnect. 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 *(Figure 5).*

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*
### Table A Main Input Connections

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ve Supply to Charge Motor</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>2</td>
<td>-ve Return from Charge Motor</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+ve Supply to Close Coil</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-ve Return from Close Coil</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>+ve Supply to Trip Coil</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-ve Return from Trip Coil</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Digital Input A for LCS Contact</td>
<td>Digital Sense Input</td>
</tr>
<tr>
<td>8</td>
<td>Digital Input B for LCS Contact</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Digital Input A for 52A Contact</td>
<td>Digital Sense Input</td>
</tr>
<tr>
<td>10</td>
<td>Digital Input B for 52A Contact</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Chassis Ground</td>
<td>Local Chassis Ground</td>
</tr>
<tr>
<td>12</td>
<td>+ve Supply to CBM</td>
<td>Supply Voltage</td>
</tr>
<tr>
<td>13</td>
<td>-ve Return from CBM</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 7  Circuit Breaker Monitor (CBM) Input Connections

- **a.** Temperature Sensor
- **b.** Main Inputs
- **c.** Hall Effect Sensor Connection
- **d.** BriteSpot® Inputs
### Table B  Hall Effect Input Connections

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+5V Power for HE</td>
</tr>
<tr>
<td>2</td>
<td>Ground for HE</td>
</tr>
<tr>
<td>3</td>
<td>Digital HE Signal</td>
</tr>
<tr>
<td>4</td>
<td>Shield for HE</td>
</tr>
</tbody>
</table>

### Table C  CBM LED Indicators

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Flashing - Operating as Expected</td>
</tr>
<tr>
<td>Red</td>
<td>Interacting with Flash, DO NOT POWER OFF</td>
</tr>
</tbody>
</table>

### Figure 8  IR Transceiver Window and LED Indicator Location

- **a. IR Transceiver Window**
- **b. LED Indicator**

### Table D  Hall Effect Module LED Indicators

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Operating as Expected</td>
</tr>
<tr>
<td>Red</td>
<td>Initializing or Calibration Mode</td>
</tr>
</tbody>
</table>
D. 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 for 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.

E. 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 9 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 9  CBM System Block Diagram

- Sentry or HMI
  - Modbus RS485
  - IRIM to RS485 Modbus Converter
    - Isolated USB and Indicator
      - Optical Wireless
        - USB
          - Computer w/ USB

- CBM on Breaker
  - Core Module
    - Ambient Temperature and Humidity
    - Isolation
      - 13 Position Connector
        - 4 Position Connector
          - TM4C129x MCU
            - Flash Memory
              - G2.1 Temperature Sensors (3ch)
                - Communications Module
                  - Infrared Transceiver
                    - Flare Effect Sensors (3ch)
                      - Optional Module

- Hall Effect Sensor
  - Split Core Hall Effect Sensor
    - Charging Motor
      - Close Coil
        - Trip Coil

- LCS
  - Trip Voltage
  - Close Voltage
  - Spring Charging Motor Voltage
  - Supply Voltage

- LCS
  - LCS
  - Trip Voltage
  - Close Voltage
  - Spring Charging Motor Voltage
  - Supply Voltage
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 10  IRIM Input Connections*

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**Table E  IRIM Wiring**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND ISO</td>
<td>Isolated RS-485 Interface</td>
</tr>
<tr>
<td>2</td>
<td>A (-)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>B (+)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>COM</td>
<td>Normally Open Output Relay</td>
</tr>
<tr>
<td>5</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Chassis Ground</td>
<td>IRIM Input Power, 60-240VDC/AC</td>
</tr>
<tr>
<td>7</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

---

**F. 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 11, 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 11, 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 11  Breaker Status Indicator**

- **a.** Mini-USB Port
- **b.** Embedded LEDs

**External Indication Module LED Indications**

- Slow pulse "green" means the breaker is "healthy" and fully operational.
- Slow pulse "amber" means a low priority warning has occurred that is just outside of normal operation.
- Slow pulsing "red" means a high priority alarm and 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 or if something is in the way of the IR path.
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

**CAUTION**

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

**CAUTION**

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. Mounting

The mounting location for the Circuit Breaker Monitor is typically in the top left corner of the circuit breaker, against the front (Figure 12). The bolt hole pattern (Figure 13) for mounting the Circuit Breaker Monitor should be prepared prior to mounting.

**Figure 12  Typical Mounting Location**
E. **BriteSpot® Sliding Contact Temperature**

The BriteSpot fiber probe will be mounted to the lower primary adjacent to sliding contact of each phase in the circuit breaker. 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 14.
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 BriteSpot instruction bulletin.
**F. CIRCUIT BREAKER MONITOR WIRING**

*Figure 14 Fiber Routing*

*Figure 15* 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. The battery only provides power to maintain memory. 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.
**G. 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 16  Mounting Locations of IRIM and CBM**

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

**Figure 17  IRIM Mounted on Inside of Door**

- a. Infrared Interface Module (IRIM)

**Figure 18  EIM Mounting Hole Pattern**

**Figure 19  IRIM Mounting Hole Pattern**
Ch 5 Usage

A. 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 20), refer to BreakerView software manual for more details.

Figure 20 BreakerView Overview Screen

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 (Figure 21). Configuration of the IRIM, by a separate application, permits the 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. The IRIM Production Assistant will be launched from a laptop directly connected via a USB cable to the associated EIM to the connected IRIM.

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.

Configuration of the CBM will be performed by factory personnel or Powell Service Division personnel.
**Figure 21  IRIM Production Assistant Screen**

![IRIM Production Assistant Screen](image)

1. **Connect to IRIM and Verify Info**
   - Read IRM Info
   - Current IRIM Section / Modbus: Scanning
   - Current IRIM Section Name: Scanning
   - Current IRIM IR Port: Scanning

2. **Enter IRIM Configuration**
   - Section Number (Modbus Slave ID)
   - Location Specifier: N/A, A, B
   - IRIM Site Location
   - Breaker Site Location
   - Active IR Port: Front, Side
   - Baud Rate: 9600

3. **Submit and Verify Configuration**
   - Click Write to IRIM and verify the configuration settings above.
Ch 6 Troubleshooting

A. Troubleshooting the Circuit Breaker Monitor

Table F CBM LED Indications

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Flashing - normal operation, no alarm</td>
</tr>
<tr>
<td>Red</td>
<td>Flashing - CBM writing to flash memory after operation, or alarm mode</td>
</tr>
</tbody>
</table>

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 22 CBM LED Indicator

Table G Hall Effect Module LED Indications

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Normal Operation</td>
</tr>
<tr>
<td>Red</td>
<td>Initializing or Calibration Mode</td>
</tr>
</tbody>
</table>

Figure 23 Hall Effect Module LED Indicator

Table H IRIM LED Indications

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Flashing - occurs approximately once every 4 seconds or strobes red/green when communicating with CBM</td>
</tr>
<tr>
<td>Red</td>
<td>Flash - occurs once every 15 seconds if loss of communications with CBM</td>
</tr>
</tbody>
</table>

Figure 24 IRIM LED Indicator
### Table I  EIM LED Indications

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Flashing - occurs when the EIM is connected to a laptop and is communicating with the CBM</td>
</tr>
</tbody>
</table>

**Figure 25  EIM 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).

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 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 CBM.

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 CBM.
## Ch 7 Specifications

### A. CBM Hardware Specifications

#### Table J Power Supply Details

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

#### Table K Power/Signal Connector

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pins</td>
<td>13</td>
</tr>
<tr>
<td>Pitch</td>
<td>5.08mm (0.2 in.)</td>
</tr>
<tr>
<td>Additional Info</td>
<td>Flanged including threaded plug retention</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>300VAC Nominal Voltage</td>
</tr>
</tbody>
</table>

#### Table L Hall Effect Connector

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pins</td>
<td>4</td>
</tr>
<tr>
<td>Pitch</td>
<td>3.81mm (0.15 in.)</td>
</tr>
<tr>
<td>Additional Info</td>
<td>Flanged including threaded plug retention</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>125VAC Nominal Voltage</td>
</tr>
</tbody>
</table>

#### Table M Analog Voltage Inputs

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Range</td>
<td>+/-33 to +/-407VDC</td>
</tr>
<tr>
<td>Resolution</td>
<td>1V or better</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Greater of 1V or +/-2% injection with +/- LS digit</td>
</tr>
<tr>
<td>Leakage Current (between separate inputs)</td>
<td>Less than 250uA</td>
</tr>
<tr>
<td>Applications</td>
<td>Monitoring: Close coil voltage</td>
</tr>
<tr>
<td></td>
<td>Trip coil voltage</td>
</tr>
<tr>
<td></td>
<td>Spring charge motor voltage</td>
</tr>
<tr>
<td></td>
<td>Auxiliary supply voltage</td>
</tr>
</tbody>
</table>
### Table N  Digital Voltage Input

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Operating Voltages Range</td>
<td>+/-407VDC</td>
</tr>
<tr>
<td>Operating Characteristics</td>
<td>Wet/dry. Self-excited contact monitoring input</td>
</tr>
<tr>
<td>Isolation</td>
<td>2.5VAC for 1 minute</td>
</tr>
<tr>
<td>Leakage Current (when monitored contacts are open)</td>
<td>Less than 250uA</td>
</tr>
<tr>
<td>Response Time</td>
<td>Less than 0.5ms</td>
</tr>
<tr>
<td>Applications</td>
<td>Monitoring: &quot;52A&quot; contact &quot;LCS&quot; contact</td>
</tr>
</tbody>
</table>

### Table O  Internal Environment Monitoring

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM Internal Temperature</td>
<td>-40°C to 85°C +/-2°C</td>
</tr>
</tbody>
</table>

### Table P  Hall Effect Sensor

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Measurement Range</td>
<td>Min +/-0.25A</td>
</tr>
<tr>
<td></td>
<td>Max +/-20.0A</td>
</tr>
<tr>
<td>Measurement Resolution</td>
<td>0.05A</td>
</tr>
<tr>
<td>Measurement Accuracy</td>
<td>+/-5% of FSD</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-40°C to 70°C</td>
</tr>
</tbody>
</table>

### Table Q  Optical Wireless Communication

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>850nm (Infrared)</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>0.5Mbps</td>
</tr>
<tr>
<td>Range</td>
<td>24 inches with direct line of sight</td>
</tr>
<tr>
<td>Viewing Angle</td>
<td>30 degrees</td>
</tr>
</tbody>
</table>

### Table R  Fiber Optic Temperature Measurement

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>3 point temperature measurement using BriteSpot® G2.1 module</td>
</tr>
<tr>
<td>Application</td>
<td>Monitors the operational temperatures of the sliding contacts</td>
</tr>
</tbody>
</table>

### Table S  LED

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>LED - Red, Green, &amp; Yellow as both solid and flashing (0.5Hz) colors</td>
</tr>
<tr>
<td>Application</td>
<td>Used to indicate state of circuit breaker and CBM unit</td>
</tr>
</tbody>
</table>

_ specifications_
### 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 U  Environmental Conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Lifetime (for 0 to 50°C operation)</td>
<td>Approximately 25 years</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to 70°C</td>
</tr>
<tr>
<td>Operating Temperature (transport log system)</td>
<td>-40°C to 85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-40°C to 85°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>5% to 95%</td>
</tr>
<tr>
<td>Shock/Vibration</td>
<td>As per IEC 60255-21-1/1/2/3 (class 2) Simulation of 10,000 breaker operation cycles</td>
</tr>
<tr>
<td>Pollution Degree</td>
<td>3 (IEC 60664)</td>
</tr>
<tr>
<td>Overvoltage Category</td>
<td>II</td>
</tr>
<tr>
<td>Altitude</td>
<td>2000m</td>
</tr>
<tr>
<td>Atmosphere Pressure</td>
<td>80-115kPa</td>
</tr>
</tbody>
</table>
Appendix A ModBus Memory Map for CBM System

ModBus registers are available for use within SCADA system to provide:

1. CBM Serial Number
2. Breaker Serial Number
3. Supply Voltage
4. BriteSpot Ch1 Status
5. BriteSpot Ch2 Status
6. BriteSpot Ch3 Status
7. Phase A Temperature
8. Phase B Temperature
9. Phase C Temperature
10. Circuit Breaker Status
11. Processed Coil Operation Count
12. Last Trip Total Time
13. Last Close Total Time
14. Last Charge Motor Total Time
15. Operation Analog Counter Offset
<table>
<thead>
<tr>
<th>Register Name</th>
<th>Read/Write</th>
<th>Register Type</th>
<th>Description</th>
<th>Default</th>
<th>Range Format</th>
<th>UOM</th>
<th>Register Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM SN</td>
<td>R</td>
<td>Input</td>
<td>CBM Serial Number</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30011~12</td>
</tr>
<tr>
<td>Breaker SN</td>
<td>R</td>
<td>Input</td>
<td>Breaker Serial Number (Byte Packed ASCII)</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30017~32</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>R</td>
<td>Input</td>
<td>Supply Input Voltage</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Voltage (v)</td>
<td>30057</td>
</tr>
<tr>
<td>BriteSpot Status Ch3</td>
<td>R</td>
<td>Input</td>
<td>OK = 0, No Fiber Present, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30061</td>
</tr>
<tr>
<td>BriteSpot Status Ch2</td>
<td>R</td>
<td>Input</td>
<td>OK = 0, No Fiber Present, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30062</td>
</tr>
<tr>
<td>BriteSpot Status Ch1</td>
<td>R</td>
<td>Input</td>
<td>OK = 0, No Fiber Present, PWM Saturated = 2, Temperature Out of Range = 4, Channel Not Stable = 8</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30063</td>
</tr>
<tr>
<td>Phase Temp C (Ch3)</td>
<td>R</td>
<td>Input</td>
<td>Phase A Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Degree Celsius (°C)</td>
<td>30064</td>
</tr>
<tr>
<td>Phase Temp B (Ch2)</td>
<td>R</td>
<td>Input</td>
<td>Phase B Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Degree Celsius (°C)</td>
<td>30065</td>
</tr>
<tr>
<td>Phase Temp A (Ch1)</td>
<td>R</td>
<td>Input</td>
<td>Phase C Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Degree Celsius (°C)</td>
<td>30066</td>
</tr>
<tr>
<td>Breaker Status</td>
<td>R</td>
<td>Input</td>
<td>OK = 1, Warning = 2, Alarm = 4</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30071</td>
</tr>
<tr>
<td>Processed Coil Operation</td>
<td>R</td>
<td>Input</td>
<td>Total Processed Coil Operations Count</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30079</td>
</tr>
<tr>
<td>Last Trip Time</td>
<td>R</td>
<td>Input</td>
<td>Last Total Measured Trip</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Millisecond (ms)</td>
<td>30083</td>
</tr>
<tr>
<td>Last Close Time</td>
<td>R</td>
<td>Input</td>
<td>Last Total Close Time</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Millisecond (ms)</td>
<td>30095</td>
</tr>
<tr>
<td>Last Charge Motor Time</td>
<td>R</td>
<td>Input</td>
<td>Last Total Measured Charge Motor Time</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>Millisecond (ms)</td>
<td>30107</td>
</tr>
<tr>
<td>Analog Counter Offset</td>
<td>R</td>
<td>Input</td>
<td>Operation Offset Counter set during FITR Operation</td>
<td>0</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30117</td>
</tr>
</tbody>
</table>
01.4IB.48070B
Circuit Breaker Monitor (CBM)

July 2020