Instruction Bulletin - 01.4IB.48070
Circuit Breaker Monitor™ (CBM)
Contact Information

Powell Electrical Systems, Inc.
powellind.com
info@powellind.com

Service Division
PO Box 12818
Houston, Texas 77217-2818

Tel: 713.944.6900
Fax: 713.948.4569
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

*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.
## Contents

### Ch 1 General Information

A. **Scope** ......................................................................................................................... 1

B. **Purpose** ....................................................................................................................... 2

C. **Instruction Bulletins Available Electronically** ............................................................... 2

### Ch 2 Safety

A. **Safe Work Condition** .................................................................................................... 3

B. **Safety Guidelines** ......................................................................................................... 3

C. General ............................................................................................................................. 4

D. **Specific** ....................................................................................................................... 4

E. **Safety Labels** ................................................................................................................ 4

### Ch 3 Equipment Description

A. **Overview** .................................................................................................................. 6

1) **Circuit Breaker Monitor™ (CBM)** .................................................................................. 6

2) **Infrared Interface Module (IRIM)** ................................................................................ 6

3) **External Indication Module (EIM)** ................................................................................ 6

B. **Hall Effect Sensor** ....................................................................................................... 9

C. **Inputs and Indicators** .................................................................................................. 10

D. **Circuit Breaker Monitor™ (CBM) Operation** ................................................................. 11

E. **IRIM Operation** .......................................................................................................... 11

1) **IR COM Parameters** .................................................................................................... 11

2) **IRIM Operation Outline** .............................................................................................. 12

3) **Communication Parameters** ...................................................................................... 12

4) **IRIM Wiring** ................................................................................................................ 12

F. **External Indication Module (EIM) Operation** ............................................................... 13

### Ch 4 Installation

A. **Receiving** .................................................................................................................. 14

B. **Handling** .................................................................................................................... 14

C. **Storage** ...................................................................................................................... 14

D. **Mounting** .................................................................................................................. 14

E. **BriteSpot™ Sliding Contact Temperature** .................................................................... 15

F. **Circuit Breaker Monitor™ Wiring** ................................................................................ 16

G. **Mounting and Placement of IRIM and EIM** ................................................................. 18

### Ch 5 Usage

A. **Software Overview** .................................................................................................... 19
Contents

Ch 6  Troubleshooting .................................................................................................................................21
   A. TROUBLESHOOTING THE CIRCUIT BREAKER MONITOR™ ................................................................. 21
      1) CBM Alarm Events .........................................................................................................................22
      2) CBM System Failure Indications .................................................................................................23

Ch 7  Specifications .......................................................................................................................................24
   A. CBM HARDWARE SPECIFICATIONS ............................................................................................ 24
   B. ENVIRONMENTAL SERVICE CONDITIONS ................................................................................... 26

Appendix A - ModBus Memory Map for CBM System .................................................................................27
### Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Circuit Breaker Monitoring System Overview .................................................. 7</td>
</tr>
<tr>
<td>Figure 2</td>
<td>CBM System Block Diagram ................................................................. 7</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Circuit Breaker Monitor™ (CBM) Input Connections ........................................... 8</td>
</tr>
<tr>
<td>Figure 4</td>
<td>IR Transceiver Window and LED Indicator Location ........................................... 8</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Hall Effect Sensor Module Wires ............................................................... 9</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Hall Effect Sensor Module Installed .......................................................... 9</td>
</tr>
<tr>
<td>Figure 7</td>
<td>IRIM (Infrared Interface Module) .................................................................. 11</td>
</tr>
<tr>
<td>Figure 8</td>
<td>IRIM Input Connections .............................................................................. 13</td>
</tr>
<tr>
<td>Figure 9</td>
<td>External Indication Module ................................................................. 13</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Typical Mounting Location ....................................................................... 14</td>
</tr>
<tr>
<td>Figure 11</td>
<td>CBM Bolt Hole Pattern ........................................................................... 15</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Fiber Routing .......................................................................................... 16</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Typical Circuit Breaker Monitor Wiring Diagram ....................................... 17</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Mounting Locations of IRIM and CBM ........................................................ 18</td>
</tr>
<tr>
<td>Figure 15</td>
<td>IRIM Mounted on Inside of Door ............................................................. 18</td>
</tr>
<tr>
<td>Figure 16</td>
<td>EIM Mounting Hole Pattern ..................................................................... 18</td>
</tr>
<tr>
<td>Figure 17</td>
<td>IRIM Mounting Hole Pattern .................................................................... 18</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Laptop Connected to EIM ........................................................................ 19</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Circuit Breaker Monitor™ Configuration Tool ........................................ 19</td>
</tr>
<tr>
<td>Figure 20</td>
<td>IRIM Configuration Software Screen ....................................................... 20</td>
</tr>
<tr>
<td>Figure 21</td>
<td>BreakerView™ Overview Screen .............................................................. 20</td>
</tr>
<tr>
<td>Figure 22</td>
<td>CBM LED Indicator .................................................................................. 21</td>
</tr>
<tr>
<td>Figure 23</td>
<td>IRIM LED Indicator .................................................................................. 21</td>
</tr>
<tr>
<td>Figure 24</td>
<td>EIM LED Indicator .................................................................................. 21</td>
</tr>
</tbody>
</table>
Tables

Table A  Main Input Connections ..................................................................................... 10
Table B  Hall Effect Input Connections ......................................................................... 10
Table C  CBM™ LED Indicators ...................................................................................... 10
Table D  Hall Effect Module LED Indicators .................................................................. 10
Table E  IRIM Wiring ....................................................................................................... 12
Table F  CBM LED Indications ....................................................................................... 21
Table G  Hall Effect Module LED Indications ................................................................ 21
Table H  IRIM LED Indications ....................................................................................... 21
Table I  EIM LED Indications ......................................................................................... 21
Table J  Power Supply Details ....................................................................................... 24
Table K  Power/Signal Connector .................................................................................. 24
Table L  Hall Effect Connector ...................................................................................... 24
Table M  Analog Voltage Input ...................................................................................... 24
Table N  Digital Voltage Input ....................................................................................... 25
Table O  Internal Environment Monitoring .................................................................... 25
Table P  Hall Effect Sensor ........................................................................................... 25
Table Q  Optical Wireless Communication .................................................................... 25
Table R  Fiber Optic Temperature Measurement ........................................................... 26
Table S  LED .................................................................................................................... 26
Table T  CBM Dimensions & Mounting .......................................................................... 26
Table U  Environmental Conditions ............................................................................. 26
MODBUS Memory Map for CBM System .................................................................... 27
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 CBM, IRIM & EIM)
- AP.CBM.01M - Circuit Breaker Monitor
- AP.CBM.01IRIM - IRIM
- AP.CBM.01EIM - EIM
- AP.CBM.01CS1 - 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](http://powellind.com). To contact the Powell Service Division call 1.800.480.7273 or 713.944.6900, 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 2012 - Article 120, 120.1 Establishing an Electrically Safe Work Condition.

120.1 Process of Achieving an Electrically Safe Work Condition

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

5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are deenergized. Test each phase conductor or circuit part both phase-to-phase, and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.

Informational Note: See ANSI/ISA-61010-1 (82.02.01)/UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000V and below.

6. 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 deenergized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

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.*
This page is intentionally left blank.
Ch 3  Equipment Description

A. Overview

The Circuit Breaker Monitoring System (Figures 1 & 2) is comprised of three main modules:

1) Circuit Breaker Monitor™ (CBM)

The CBM (Figure 3) 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 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 7) 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 9) 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 1  Circuit Breaker Monitoring System Overview**

![Circuit Breaker Monitoring System Overview Diagram]

**Figure 2  CBM System Block Diagram**

![CBM System Block Diagram]

- **Interior of Switchgear**
  - Circuit Breaker
  - CBM
  - IR Transceiver
  - IRIM
  - LED and USB
  - Computer Application
  - Bus Bar
  - Bus Bar
  - EB Fiber
  - Hall Effect Sensor

- **Figure 2**
  - CBM on Breaker
  - Core Module
    - Ambient Temperature and Humidity
    - Isolation
  - 13 Position Connector
  - 4 Position Connector
  - TMAC129x MCU
    - Flash Memory
  - Infrared Transceiver
  - Communications Module
  - G2.1 Temperature Sensors (3ch)
  - Optional Module
  - S2A
  - LCS
  - Trip Voltage
  - Close Voltage
  - Spring Charging Motor Voltage
  - Supply Voltage
  - Hall Effect Sensor
    - Charging Motor
    - Close Coil
    - Trip Coil
  - Split Core Hall Effect Sensor
  - Optical Wireless
  - Isolated USB and Indicator
  - Modbus RS485
  - IRIM to RS485 Modbus Converter
  - USB
  - Computer w/ USB
Figure 3  
**Circuit Breaker Monitor™ (CBM) Input Connections**

- a. Temperature and Humidity Sensor
- b. Main Inputs
- c. Hall Effect Inputs
- d. BriteSpot® Inputs

Figure 4  
**IR Transceiver Window and LED Indicator Location**

- a. IR Transceiver Window
- b. LED Indicator
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*
C. Inputs and Indicators

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>+V Charge Motor Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>2</td>
<td>-V Charge Motor Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>3</td>
<td>+V Close Coil Analog Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>4</td>
<td>-V Close Coil Analog Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>5</td>
<td>+V Trip Coil Analog Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>6</td>
<td>-V Trip Coil Analog Input</td>
<td>Analog Voltage Input</td>
</tr>
<tr>
<td>7</td>
<td>Isolated DI A for LCS</td>
<td>Digital Voltage Input</td>
</tr>
<tr>
<td>8</td>
<td>Isolated DI B for LCS</td>
<td>Digital Voltage Input</td>
</tr>
<tr>
<td>9</td>
<td>Isolated DI A for 52A</td>
<td>Digital Voltage Input</td>
</tr>
<tr>
<td>10</td>
<td>Isolated DI B for 52A</td>
<td>Digital Voltage Input</td>
</tr>
<tr>
<td>11</td>
<td>Chassis Ground</td>
<td>Local Chassis Ground</td>
</tr>
<tr>
<td>12</td>
<td>+V Supply/Signal</td>
<td>Supply Voltage</td>
</tr>
<tr>
<td>13</td>
<td>-V Supply/Signal</td>
<td></td>
</tr>
</tbody>
</table>

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>

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>

Powered by Safety®

Equipment Description
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. Coil resistance (assuming coil saturation is reached).
4. Coil inductance (via algorithms in BreakerView™).
5. Spring charge time.
6. Close coil armature time (via algorithms in BreakerView).
7. Trip coil armature time (via algorithms in BreakerView).
8. Supply voltage values and fluctuations.
9. Phase temperatures on lower primaries near sliding contact.
10. Ambient temperatures.
11. Relative humidity with the circuit breaker truck near the CBM.

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, temperatures, and relative humidity and performs calculations then compares these results to determine circuit breaker health.

E. **IRIM Operation**

The IRIM (Infrared Interface Module) is used to convert the CBM's proprietary infrared communications to ModBus RTU (RS-485), USB communications, and translate the data stream to determine the EIM LED for circuit breaker health indication.

![Image of IRIM (Infrared Interface Module)]

1) **IR COM Parameters**

The IR COM channel is used to communicate wirelessly (optical) between the IRIM and CBM. The channel uses proprietary IR hardware and SIR encoding. The baud rate is 576000bps and range is around 18 inches down to one inch. The IRIM can switch between different IR directions and powers. After 20 status timeouts the IRIM assumes no communication and switches between the side IR channel and the front IR channel as well as switches between power levels (this increases the dynamic range).
2) **IRIM Operation Outline**

*Figure 2* shows how data goes through the IRIM. The Mode selection is controlled by timing parameters within the IRIM. Only one channel will control the IR COM at any given time to prevent conflict and corrupted messages. The USB connection will be the active channel control when it is connected and functioning.

3) **Communication Parameters**

a. **Modbus Parameters** - The Modbus RTU channel is a half-duplex RS-485 channel. The Data-(B) line is connected to Pin 2 and Data+(A) line is connected to Pin 3. The RS-485 driver is isolated and can support a maximum of 256 devices on the line. The default baud rate is 115200 bps and can be set to 9600, 19200, 38400, or 115200.

b. **USB Parameters** - The USB plugs into the External Indication Module (EIM) which contains a USB to serial controller. The controller is isolated from the IRIM power. The IRIM acts as a buffered straight through converter. The baud rate to communicate through the virtual COM port created by the controller is 576000 bps.

4) **IRIM Wiring**

Module has RJ-45 connector to connect to external IRIM module as well as 8 position Phoenix contact connector for power, relay, and RS-485 connection.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND ISO</td>
<td>RS-485 Isolated Interface</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>Relay</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>COM</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Chassis Ground</td>
<td>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 mounted on either the circuit breaker cubicle door or the instrument compartment door provides basic indications of the CBM status via embedded LEDs located under the white dome (Figure 9, a). This is a visual indication of circuit breaker health.

A USB mini port is located on the face of the EIM for usage with a laptop to communicate directly with the associated CBM.

**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.

---

**Figure 8  IRIM Input Connections**

![Diagram of IRIM Input Connections]

- a. RJ-45 to External IRIM
- b. Main Inputs

**Figure 9  External Indication Module**

![Diagram of External Indication Module]

- a. Embedded LEDs
**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 10). The bolt hole pattern (Figure 11) for mounting the Circuit Breaker Monitor should be prepared prior to mounting.

**Figure 10 Typical Mounting Location**
Figure 11 CBM Bolt Hole Pattern

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 12.
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 01.4IB.48040B BriteSpot instruction bulletin.
Figure 12  Fiber Routing

F. Circuit Breaker Monitor™ Wiring

Figure 13 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.
Figure 13  Typical Circuit Breaker Monitor Wiring Diagram

NOTE: Wire numbers shown are for the secondary disconnect
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 14  Mounting Locations of IRIM and CBM**

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

**Figure 15  IRIM Mounted on Inside of Door**

- a. Infrared Interface Module (IRIM)

**Figure 16  EIM Mounting Hole Pattern**

**Figure 17  IRIM Mounting Hole Pattern**
Ch 5  Usage

A. SOFTWARE OVERVIEW

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 data base. Corrective maintenance as well as any routine maintenance records can be created and stored within the embedded data base 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 18), refer to BreakerView software manual for more details.

Figure 18  Laptop Connected to EIM

The Circuit Breaker Monitor Configuration Tool (Figure 19) is a separate application that is used to configure a CBM. It captures the circuit breaker serial number, order code, trip cycles, and voltages used. All of this data is programmed into the CBM and used by its firmware to determine basic performance bands and for use by BreakerView.

For IRIMs that are to be used in a network, a configuration of those modules is required (Figure 20). 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 configuration software 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 significantly 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.

Figure 20  IRIM Configuration Software Screen

Figure 21 shows BreakerView™ screen with dashboards providing circuit breaker health and performance measures.

Refer to the BreakerView software manual for more details on installation and use of the software package. The software can be downloaded from powellind.com and a Cloud based version of the software is available for use and can be found at breakerview.powellind.com.
Ch 6  Troubleshooting

A. Troubleshooting the Circuit Breaker Monitor™

<table>
<thead>
<tr>
<th><strong>Table F  CBM LED Indications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
</tr>
<tr>
<td>Green</td>
</tr>
<tr>
<td>Red</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>
<thead>
<tr>
<th><strong>Table G  Hall Effect Module LED Indications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
</tr>
<tr>
<td>Green</td>
</tr>
<tr>
<td>Red</td>
</tr>
</tbody>
</table>

**Table H  IRIM LED Indications**

<table>
<thead>
<tr>
<th><strong>Color</strong></th>
<th><strong>Description</strong></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>

**Note:** Observing the status LED on the IRIM is not possible with the cubicle door closed and opening a door to observe this would be very impractical in most all instances.

**Figure 23  IRIM LED Indicator**

<table>
<thead>
<tr>
<th><strong>Table I  EIM LED Indications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
</tr>
<tr>
<td>Green</td>
</tr>
</tbody>
</table>

**Figure 24  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 Armature Time
         • Trip Armature Time
         • Close Mechanism Time
         • Trip Mechanism Time
         • Close Coil Voltage
         • Charge Motor Voltage
         • Trip Coil Voltage
         • Supply Voltage Sag/Swell
         • Close Coil Resistance (only when coil saturates)
         • Trip Coil Resistance (only when coil saturates)
         • 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
         • Relative Humidity
         
         ii. CBM loss of Hall Effect connection
         iii. CBM BriteSpot Fiber loss
         iv. CBM watchdog alarm

   b. Troubleshooting CBM Alarms
      
      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 present, Hall Effect may have failed/disconnected after the breaker operation. Inspect the Hall Effect with the breaker powered and cover removed, if practical.
      
      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 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 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.
# Ch 7 Specifications

## A. CBM Hardware Specifications

<table>
<thead>
<tr>
<th>Table J Power Supply Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated Supply Voltage</strong></td>
</tr>
<tr>
<td><strong>Input Voltage Range</strong></td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
</tr>
<tr>
<td><strong>Power Fail Detection</strong></td>
</tr>
<tr>
<td><strong>RTC Operation Lifetime</strong></td>
</tr>
<tr>
<td><strong>Internal Battery Power</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table K Power/Signal Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pins</strong></td>
</tr>
<tr>
<td><strong>Pitch</strong></td>
</tr>
<tr>
<td><strong>Additional Info</strong></td>
</tr>
<tr>
<td><strong>Rated Voltage</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table L Hall Effect Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pins</strong></td>
</tr>
<tr>
<td><strong>Pitch</strong></td>
</tr>
<tr>
<td><strong>Additional Info</strong></td>
</tr>
<tr>
<td><strong>Rated Voltage</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table M Analog Voltage Input</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Range</strong></td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
</tr>
<tr>
<td><strong>Frequency Response</strong></td>
</tr>
<tr>
<td><strong>Measurement Step Response</strong></td>
</tr>
<tr>
<td><strong>Leakage Current (between separate inputs)</strong></td>
</tr>
<tr>
<td><strong>Applications</strong></td>
</tr>
</tbody>
</table>
### Table N  Digital Voltage Input

<table>
<thead>
<tr>
<th>Specifications</th>
<th></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 that can withstand full operating voltage from the remainder of the system the product is installed in.</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>Operational range &amp; accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>5-95%RH +/-4%</td>
</tr>
<tr>
<td>Temperature</td>
<td>-40°C to 85°C +/-2°C</td>
</tr>
</tbody>
</table>

### Table P  Hall Effect Sensor

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Measurement Signal Output</td>
<td>Amplitude: linear and levels to be appropriate to electronics &amp; supply rails. Topology: balanced line voltage output to minimize susceptibility to electrical interference.</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>Measurement Frequency Response</td>
<td>Flat between 0Hz and 1.5Hz Roll off as appropriate for ADC sample rate</td>
</tr>
<tr>
<td>Measurement Step Response</td>
<td>No input to +/-FSD with 150us rise time, output delay to be less than 0.5ms</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>Specifications</th>
<th></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>At lest 1 meter with direct line of sight</td>
</tr>
<tr>
<td>Viewing Angle</td>
<td>30 degrees</td>
</tr>
<tr>
<td>Encoding</td>
<td>SIR (serial with (\frac{3}{16}) pulse)</td>
</tr>
</tbody>
</table>

---

 Specifications

 Powered by Safety®
Table R  Fiber Optic Temperature Measurement

| Monitoring | 3 point temperature measurement using BriteSpot G2.1 module |
| Application | Monitors the operational temperatures of the sliding contacts |

Table S  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 T  CBM Dimensions & Mounting

| Dimensions | 38 x 100 x 135 [mm] (1.5 x 4 x 5.3 in.) |
| Mounting | 4 x 1/4” -20 bolts |
| Enclosure Type | Injection molded ABS plastic (stamped aluminum can protection) |
| IR Window Size | 21 x 15mm (9/16 x 13/16 in.) |

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

| Design Lifetime (for 0 to 50°C operation) | 25 years |
| Operating Temperature | -40°C to 70°C |
| Operating Temperature (transport log system) | -40°C to 85°C |
| Storage Temperature | -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 | 2000m |
| Atmosphere Pressure | 80-115kPa |
Appendix A ModBus Memory Map for CBM System

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

1. Circuit Breaker Status, OK = 1, warning = 2, and alarm = 3
2. Phase A Temperature
3. Phase B Temperature
4. Phase C Temperature

<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>Bkr Status</td>
<td>R</td>
<td>Holding</td>
<td>OK = 1, Warning = 2, Alarm = 3</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30071</td>
</tr>
<tr>
<td>Phase Temp A</td>
<td>R</td>
<td>Holding</td>
<td>Phase A Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30064</td>
</tr>
<tr>
<td>Phase Temp B</td>
<td>R</td>
<td>Holding</td>
<td>Phase B Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30065</td>
</tr>
<tr>
<td>Phase Temp C</td>
<td>R</td>
<td>Holding</td>
<td>Phase C Temperature</td>
<td>N/A</td>
<td>-32,768 to 32,767</td>
<td>N/A</td>
<td>30066</td>
</tr>
</tbody>
</table>
01.4IB.48070
Circuit Breaker Monitor™ (CBM)

September 2017