

## BROADBAND POWER LINE MODEM

### Summary

The Wabtec Digital Mining Broadband Power Line Modem systems provide reliable and high-bandwidth communication links through harsh and rapidly changing environments. In these environments, alternative communications systems such as copper, fibre and wireless based Ethernet are either too fragile or too difficult and expensive to maintain and manage. Powerline communication technology however, injects data signals onto the 1kV mining power cables used to run equipment. Because the power cable must be maintained for the equipment to operate, the communications cable will always be available.

The Wabtec Digital Mining Broadband Power Line Modem system applies proven broadband powerline communication technologies to the mining industry, predominantly providing the "last mile" link to the mobile equipment at the mine face. These links are highly reliable, and regularly achieve PHY speeds of 20 – 80 Mbps.

### Technology

Power Line Modem technology allows the transfer of data over cables which are also used for power transmission. This removes the need for dedicated cabling for communications links, without sacrificing the benefits cables provide over wireless technologies. These two factors allow for simple deployment of a communications network in environments where wireless solutions are infeasible.

PLM devices inject signals onto the power cables and use decoupling circuits to extract the signal and isolate the modem from the high voltage power present on the cable. Traditional PLM technologies have operated at lower frequencies, and allow lower bandwidth communications links. Recent advances in DSP and embedded processing technologies, however, have seen the introduction of Broadband PLM systems. Broadband PLM technology operates at a much higher frequency than traditional PLM systems, and uses techniques such as Orthogonal Frequency Division Multiplexing (OFDM) to achieve substantially higher bandwidths over the same cables.

While PLM modems are generally only capable of providing point-to-point serial links using proprietary protocols, the additional bandwidth and processing power available to BPLM systems allows them to extend and maintain existing Ethernet networks. This progression to these standard and common protocols offer significantly improved flexibility and functionality to the end user by removing any reliance on the proprietary and closed protocols, and allowing many simultaneous connections over the same data link.

### Application of Technology

The Wabtec Digital Mining Broadband Power Line Modem allows the application of power line communication technology to a wide range of environments, but predominantly the underground mining industry. In this industry, traditional communications links can be notoriously unreliable.

Wireless network signals are significantly attenuated by the strata, and so are limited to line of sight links.

The bord-and-pillar style of mining commonly used in coal mines requires many line of sight links to provide coverage of even a small portion of the mine, and the limited number of channels available for use in wireless networks further compounds the problem.

Alternative solutions such as wireless systems with a leaky feeder antenna rely on installation of fixed infrastructure and cables, require constant expansion to match the development of the mine, and are easily damaged by heavy machinery. Cable-based solutions such as Ethernet over fibre are suitable for installation in developed areas of the mine, but are too fragile for connecting to mobile machinery at the mine face.

The Wabtec Digital Mining BPLM system, however, is suitable for connecting to the mobile equipment at the face, and provides connectivity between this equipment and the fixed fibre network. Because the power cable must be maintained for the equipment to operate, there is no danger of the communications link being lost for any length of time due to cable damage. Furthermore, because the communications link is directly to the machine itself, instead of the area in which it is working, the communication link is inherently flexible: wherever the machine is, there is coverage available.



- High bandwidth, long distance communication over power lines
- Ethernet, WiFi and Fibre Optic Interfaces
- Flexible and powerful capabilities
- Rugged enclosure for harsh environments

The Wabtec Digital Mine Broadband Power Line Modem (BPLM) extends your current network into previously unreachable areas. Using proven technology, the BPLM transfers high speed data over your existing power cabling.

## FEATURES

- Suitable for simple point-to-point links or complex networks
- Repeaters can be used to extend links over many kilometers
- Built-in network controller is capable of flexible and complex routing
- WiFi interface is capable of MIMO connections, improving its range, reliability and throughput in underground environments
- Rugged enclosure allows deployment in harsh industrial environments

## IDEAL FOR

- Monitoring mobile electrical machinery
- Extending communications to remote or temporary equipment
- Harsh environments unsuitable for fragile data cables
- Confined or inaccessible areas where adding additional cabling is unfeasible
- Multipath underground wireless communication

## Specifications

### Physical Dimensions

- 140 x 280 x 100 mm (w,l,h)

### Power Supply

- 24V<sub>DC</sub> (± 10%) at 1.5A

### BPL Link Range

- Up to 500m<sup>†</sup>

### Weight

- 3kg

### Temperature

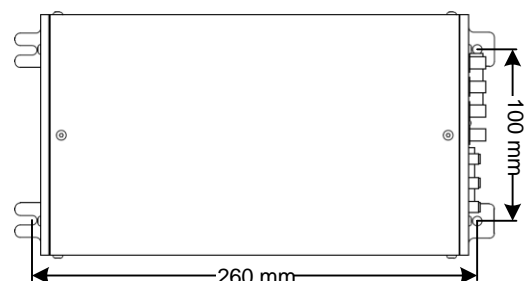
- 0 - 50°C

### Humidity

- 5 - 95%

<sup>†</sup> Maximum BPL link length dependent on cable type, environmental conditions and other factors.

Part Number: INTX100379-P



# 2.4 / 5 GHz RF BARRIER



- [Ex ia] I/IIC rated RF Barrier
- Approved for use in Zone 0, 1 and 2
- Suitable for Gas groups I, IIA, IIB and IIC
- Allows the connection of WiFi clients and APs to antennas located in the hazardous zone

The RF Barrier allows the connection of WiFi clients and access points located in the safe area to antennas located in the hazardous zone. Its small size makes it ideal for use in space-constrained environments.

## FEATURES

- [Ex ia] I/IIC certified
- Requires no power supply or external components
- Available in 2.4GHz and 5GHz models

## IDEAL FOR

- WiFi Networks in Underground Coal Mines,
- Oil Rigs and Refineries
- Hazardous Area Communications

## Specifications

### 2.4GHz Model

- At 50/60 Hz
- Um = 250Vrms
  - Uo = 354 Vp
  - Io = 1.35 nAp
  - Po = < 1uW
  - Co = Not limited
  - Lo = 49.5 mH

### At 2.5 GHz

- Um = 90 Vp
- Uo = 90 Vp
- Io = 14.3 mAp
- Po = 0.65 mW
- Co = Not limited
- Lo = 49.5 mH

### 5GHz Model

- At 50/60 Hz
- Um = 250 Vrms
  - Uo = 354 Vp
  - Io = 2.15 nAp
  - Po = < 1 uW
  - Co = Not limited
  - Lo = 49.5 mH

### At 5 GHz

- Um = 45 Vp
- Uo = 45 Vp
- Io = 26.8 mAp
- Po = 0.61 mW
- Co = Not limited
- Lo = 49.5mH

### Temperature Range

- -20°C to +90°C

### Humidity Range

- 10 to 90% non-condensing

### Ex Rating

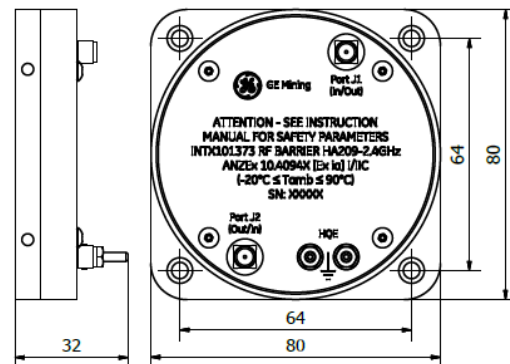
- [Ex ia] I/IIC

### Certificate/Test Report

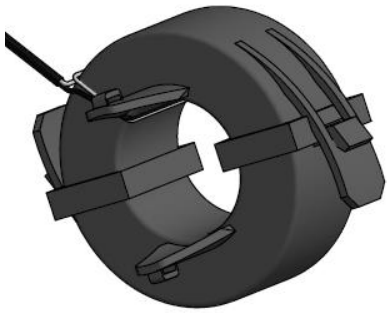
- ANZEx 10.4094X

Part Numbers:

- 2.4GHz - INTX101373
- 5GHz - INTX100428



## ➤ BPL INDUCTIVE COUPLER, LARGE

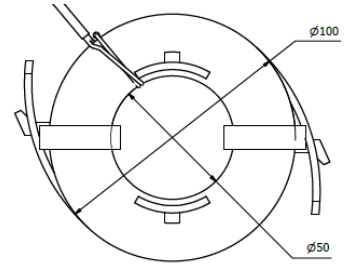


The inductive couplers are used to isolate the BPLM from the high voltages on the power lines, while still coupling the BPL signal onto the cable.

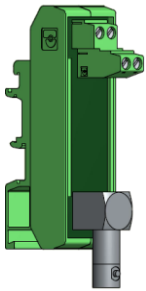
The coupler is rated to 400A and suitable for cables with diameter of up to 42mm. The coupler halves can be separated for simple clip-on installation.

A pair of couplers are used with each kit to inject the BPL signal onto 2 of the power line phases.

Part Number: INTX101247



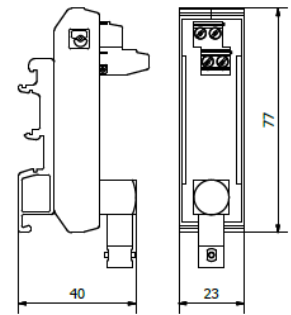
## ➤ BPL COUPLER SCREW TERMINAL BLOCK



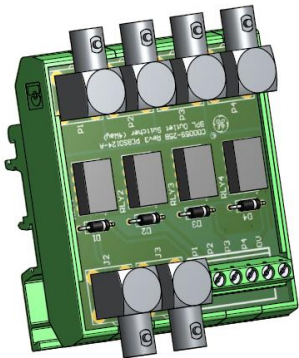
The terminal block allows the convenient connection of a pair of inductive couplers to a single coax cable. The coax cable can then be connected to the BPLM unit or via a Switcher for multi-outlet monitoring.

The terminal block is DIN rail mountable, and provides labels to ensure the coupler polarity is maintained.

Part Number: INTX100407



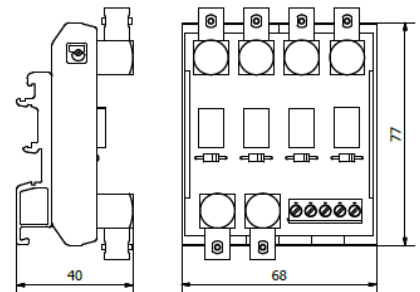
## ➤ BPL, SIGNAL SWITCHER, 4 WAY



The BPL signal switcher allows a single BPLM to be permanently connected to a number of cables, and allows users to select which cable or cables the BPL signal is coupled onto. This can be used in a distribution board, for example, where there are many outlets, and equipment can be connected to any of them. Signal switchers can be daisy chained.

The signal switcher is DIN rail mountable, and can be controlled from simple selector switch right through to full PLC control

Part Number: INTX101499

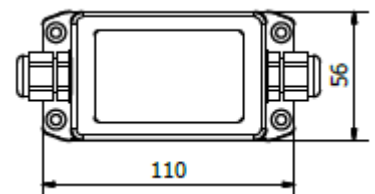


## ➤ BPL 1KV SHUNT



The shunt is used with the inductive couplers to enhance the quality and strength of the BPL signal. It is installed directly across two phases of the power line, and provides a return path for the BPL signal

Part Number: INTX100400



## Shunt Electrical Specifications

To ensure safety and reliability on the 1000V mains the shunt has been designed and tested to the following:

- Meets clearance and creepage requirements for Insulation Co-ordination (IEC 60664) Over-Voltage Category III (for 1000V<sub>AC</sub>). Impulse withstand voltage meets the requirements for 8kV over-voltage impulses (1.2/50 $\mu$ s waveform).
- Insulation resistance tested at 10kV DC.
- Short-term (<5s) over-voltage AC withstand tested to 2200V<sub>AC</sub> as per the requirements of IEC 60664.
- Long-term (>5s) over-voltage AC withstand tested to 1250V<sub>AC</sub> as per the requirements of IEC 60664.
- Redundant in-series shunt capacitors voltage rated to a total of 12.6kV. The components are tested and certified to 25.2kV<sub>DC</sub> for 5s by the manufacturer.
- Redundant in-series biasing resistors voltage rated to a total of 3.2kV. The components are tested and certified to 50x 1nF discharges at 14kV by the manufacturer as per IEC 60065.

The electrical parameters of the shunt coupler are as follows:

- Rated to 1000V<sub>AC</sub> with over-voltage category III
- Minimum DC resistance: 19M $\Omega$
- Maximum DC leakage current: 85 $\mu$ A @ 1600V<sub>DC</sub>
- Maximum DC leakage power: 135mW @ 1600V<sub>DC</sub>
- Minimum AC impedance: 347k $\Omega$  @ 50Hz
- Maximum AC leakage current: 3.2mA<sub>rms</sub> @ 1100V<sub>AC</sub>/50Hz
- Maximum AC leakage reactive power: 3.5VA @ 1100V<sub>AC</sub> 50Hz
- Maximum HF impedance: 20 $\Omega$  @ 2.0MHz

Discharge Considerations:

- Capacitance: 4.9 nF
- Stored Energy: 7.53mJ @ 1600V<sub>DC</sub>
- Maximum Discharge Time: 0.43s @ 1600V<sub>DC</sub>

## Coupler Electrical Specifications

To ensure safety and reliability around the 1000V mains the coupler has been designed and tested to the following:

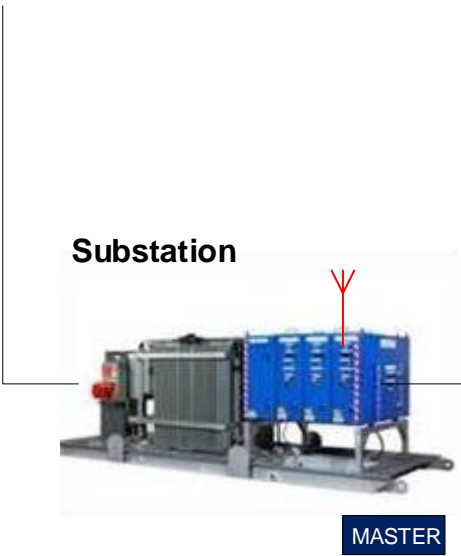
- Insulation resistance tested at 10kV DC

The electrical parameters of the coupler are as follows:

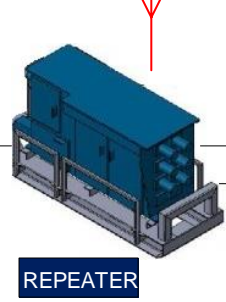
- Minimum DC resistance: 500G $\Omega$
- Maximum DC leakage current: 3.2nA @ 1600V<sub>DC</sub>
- Maximum DC leakage power: 5.1 $\mu$ W @ 1600V<sub>DC</sub>

Typical communications equipment when mine site fibre is connected to substation

Fibre comms to surface connection



DCB (Option 1)



Continuous Miner



Feeder breaker



**Legend**



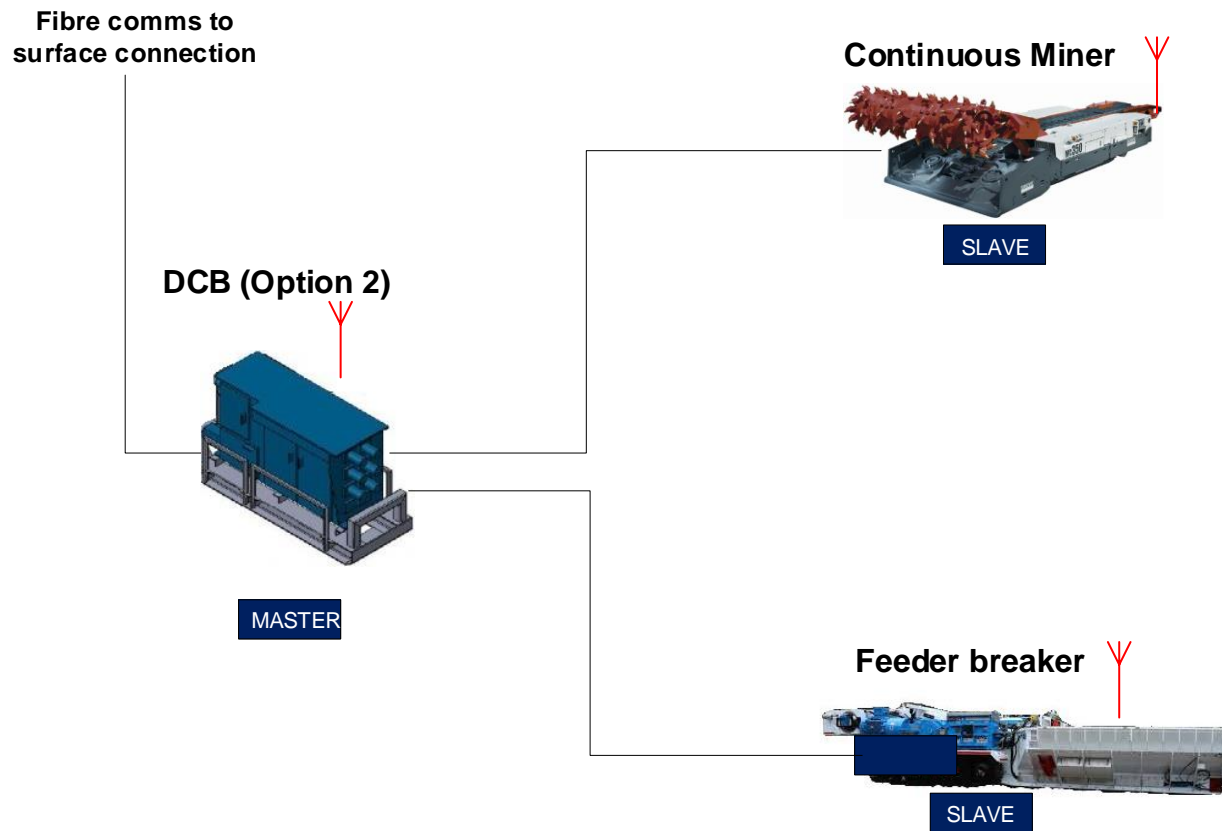
-  BPL equipment
-  Optional WiFi

Diagram  
Broadband communications layout option 1



Typical communications equipment when mine site fibre is connected to DCB.



**Legend**



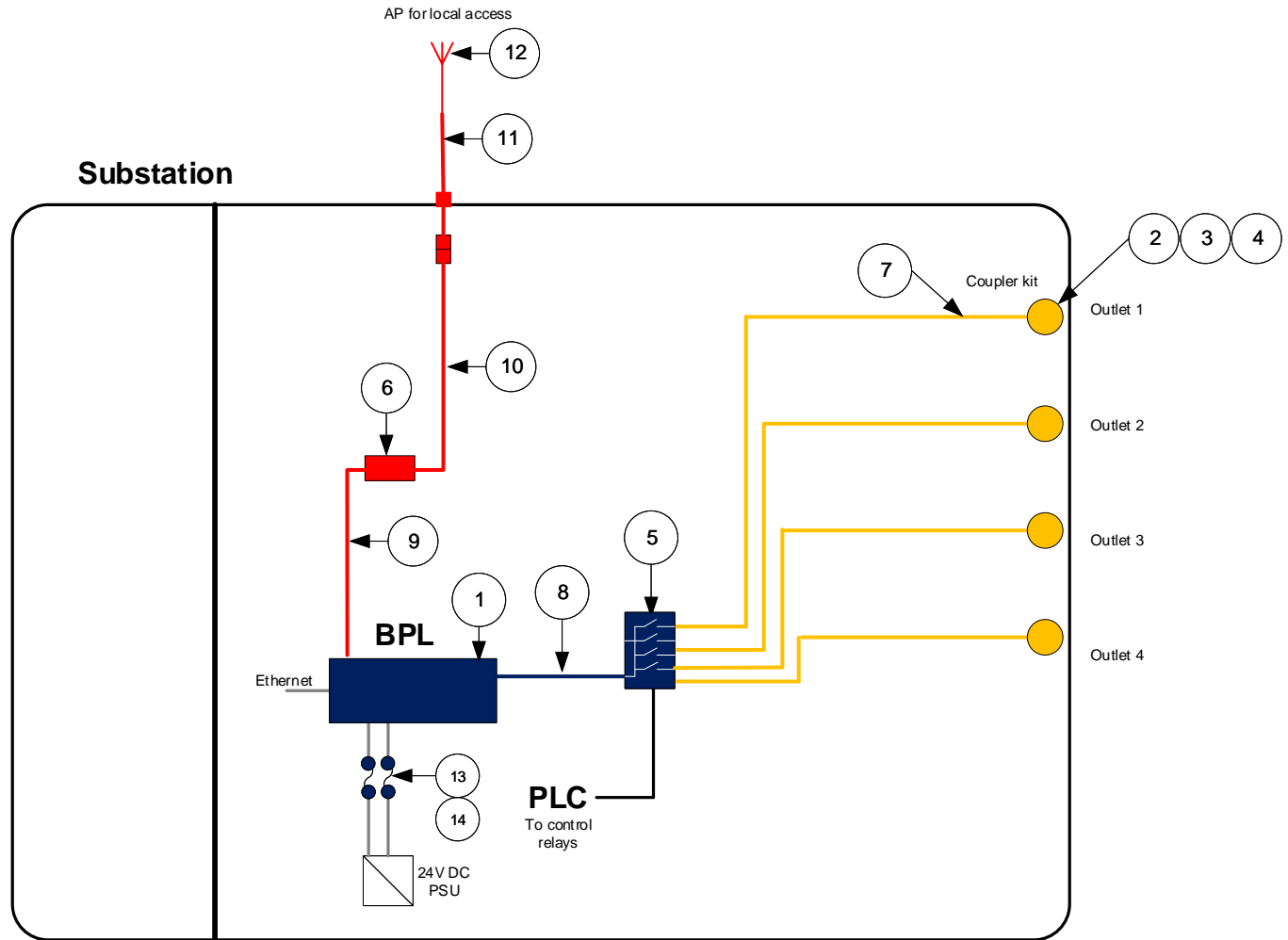
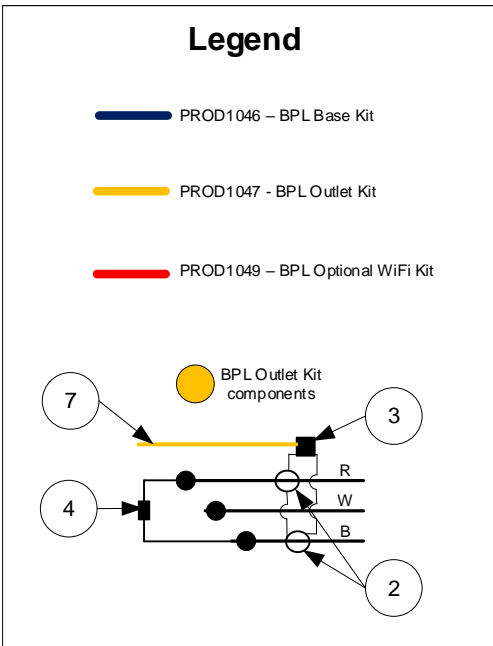
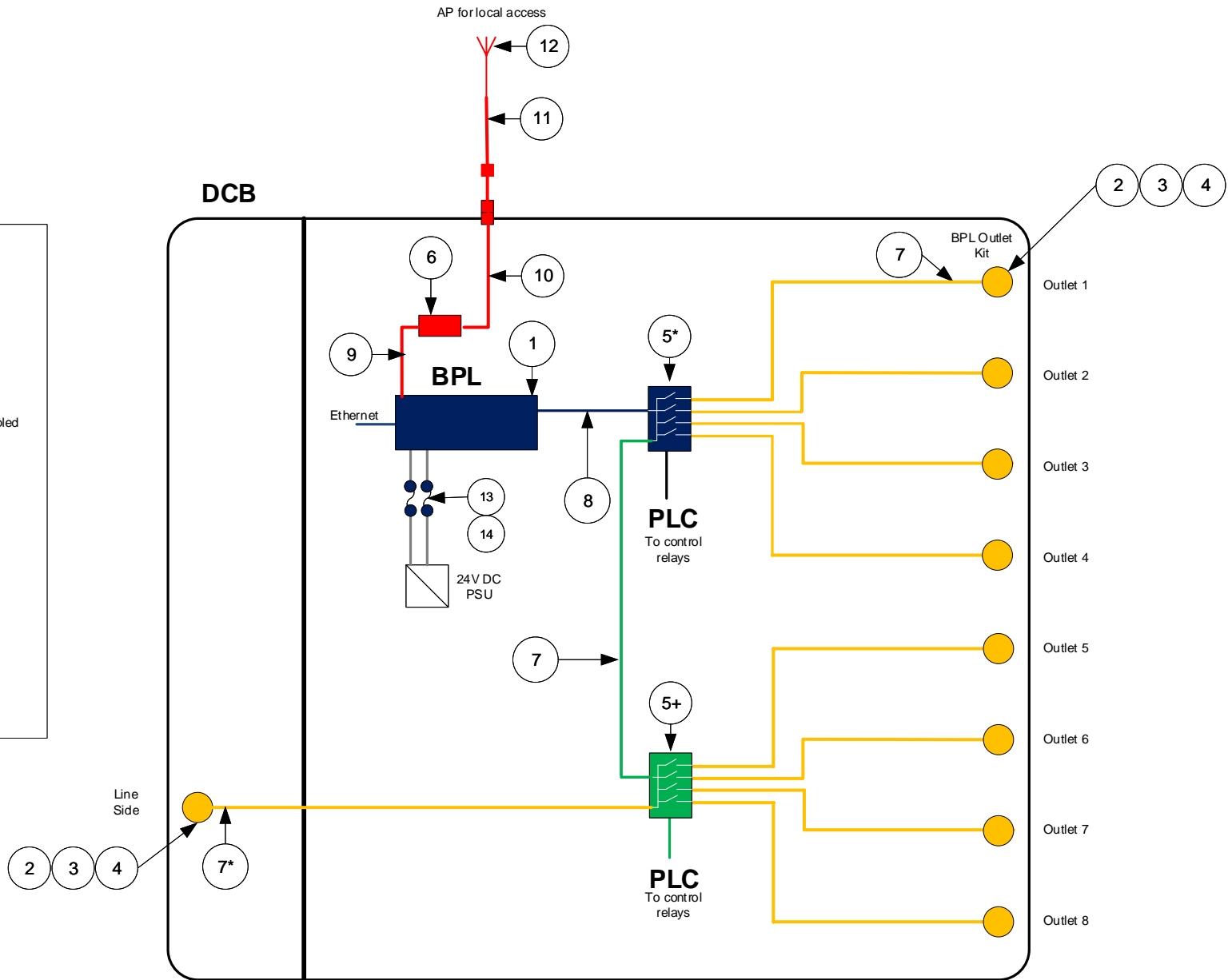
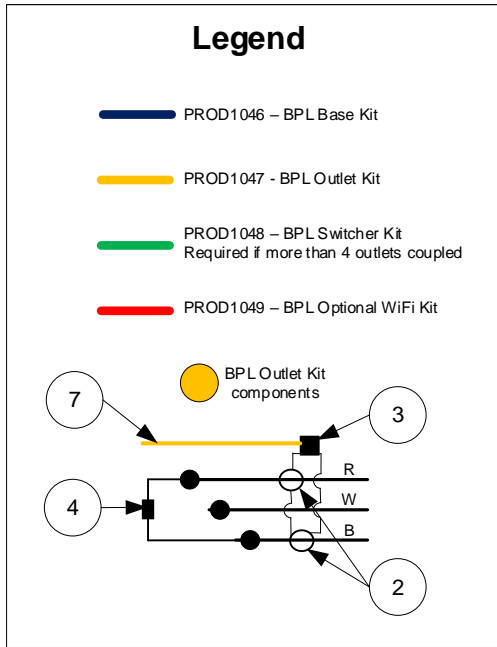
-  BPL equipment
-  Optional WiFi

Diagram  
Broadband communications layout option 2



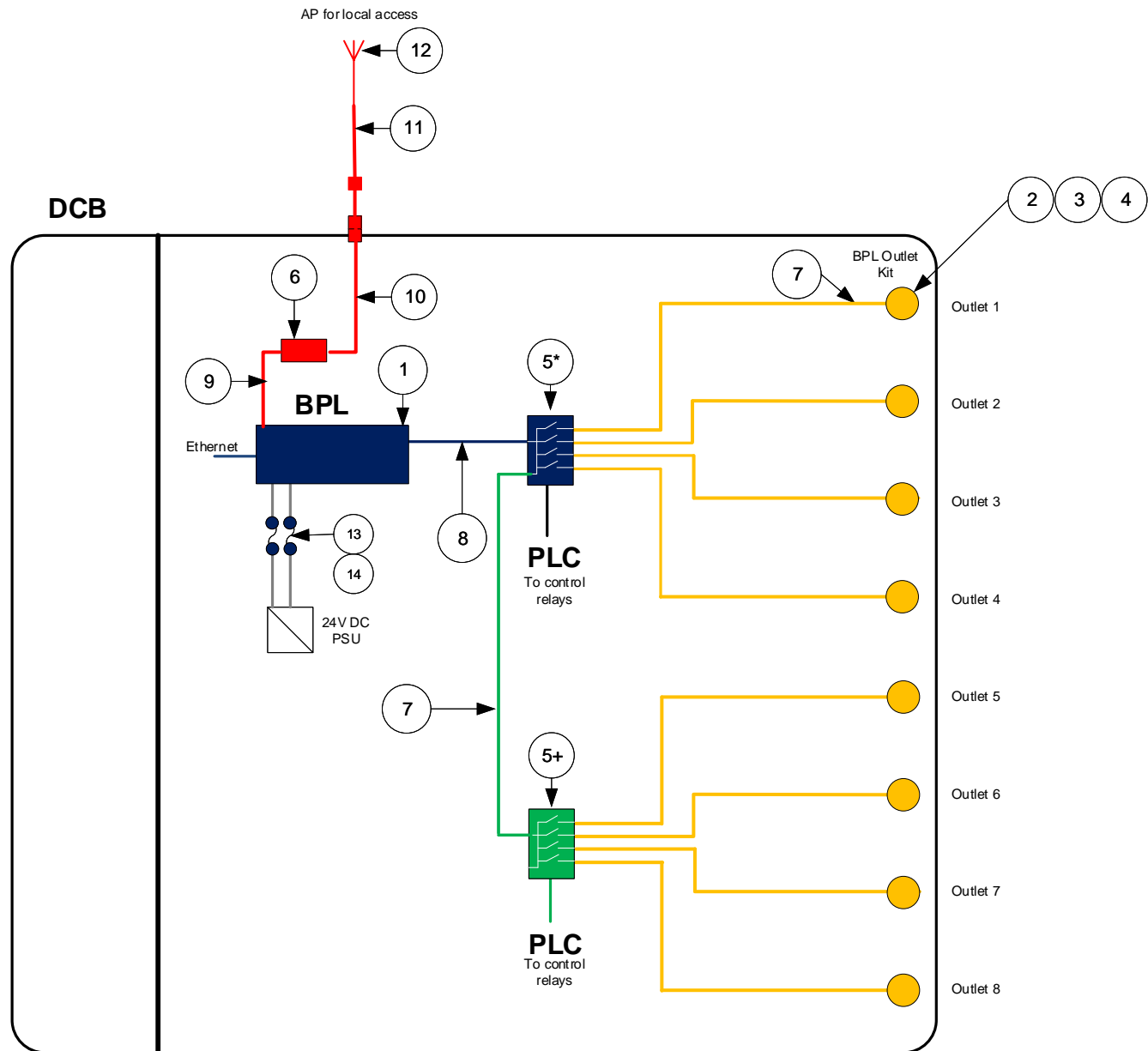
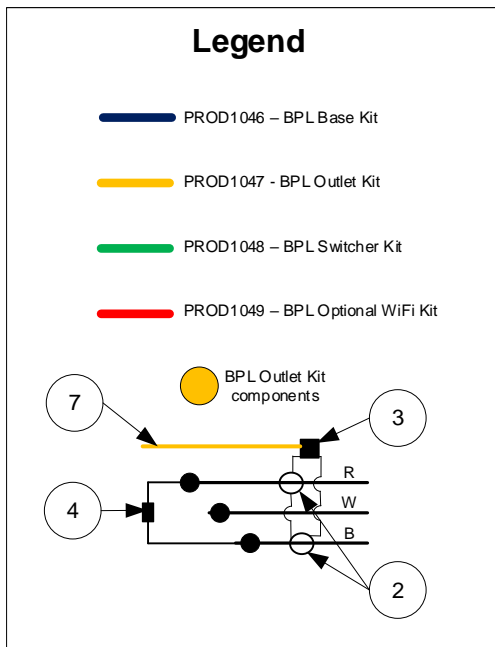
**Diagram**  
**SUBSTATION EQUIPMENT**





Note: \* Item 7\* connects to 5\* if additional signal switcher 5+ is not fitted

**Diagram**  
**DCB EQUIPMENT Option with line side coupling**



Note: \* Item 7\* connects to 5\* if additional signal switcher 5+ is not fitted

**Diagram**  
**DCB EQUIPMENT Option without line side coupling**

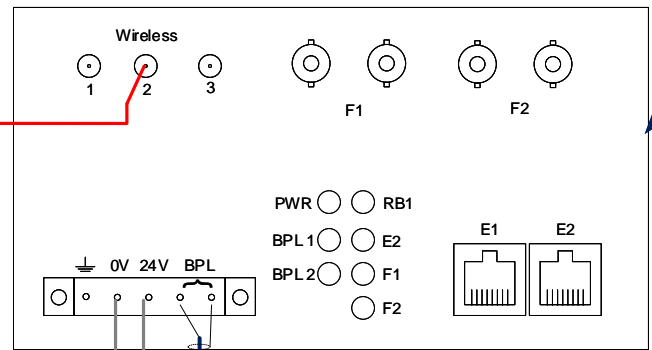
AP for local access  
12

11

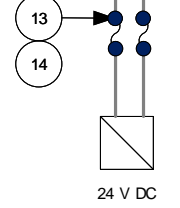
10

6

9



1



24 V DC

13

14

8

4

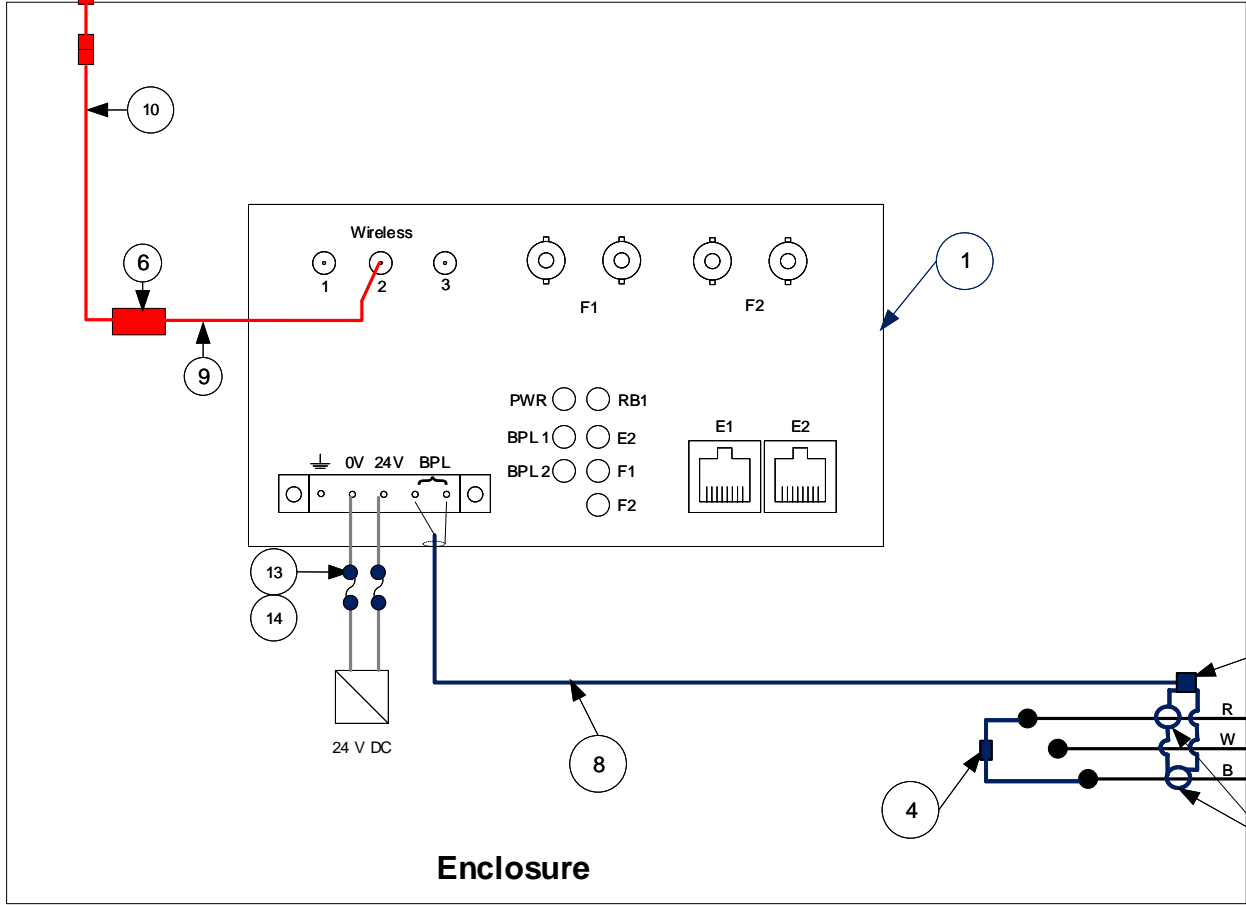
3

2

### Legend

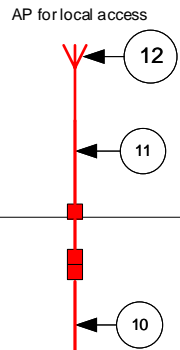
- PROD1113 – BPL CM Base Kit
- PROD1049 – BPL Optional WiFi Kit

Configuration can also be used in end of line equipment requiring Ethernet connection.



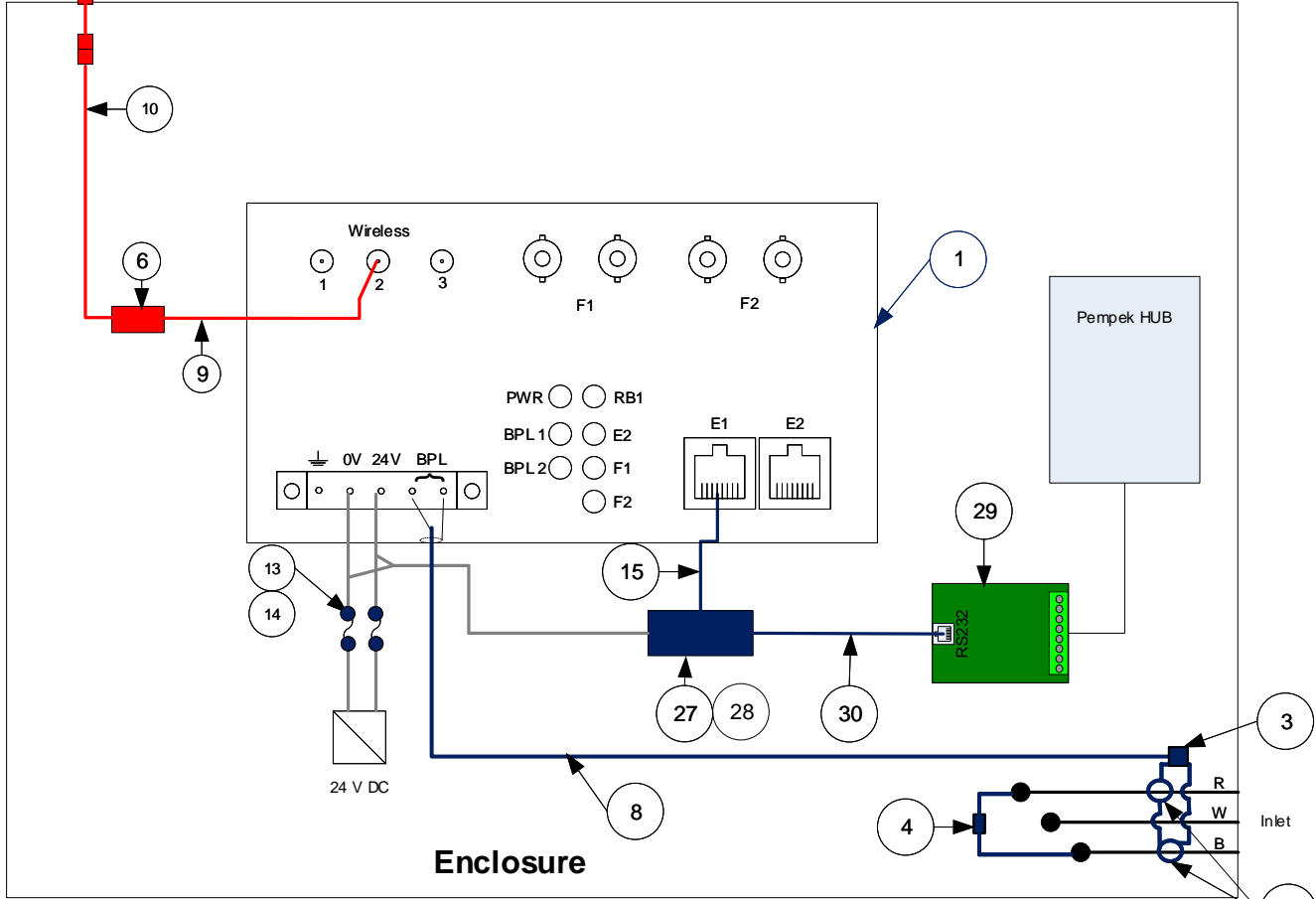
Enclosure

**Diagram  
CONTINUOUS MINER EQUIPMENT**

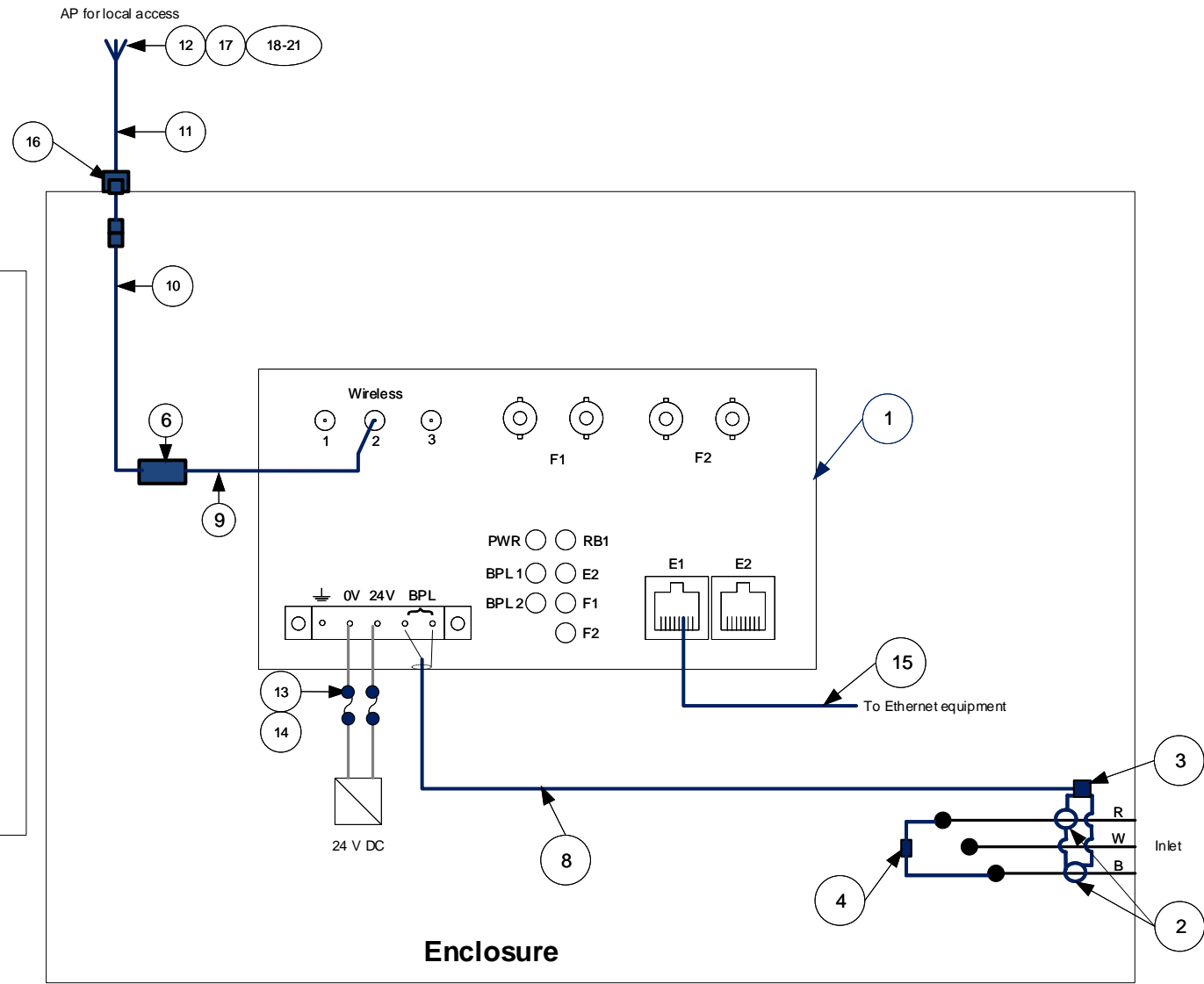


### Legend

- PROD1114 – BPL Sandvik CM Base Kit
- PROD1049 – BPL Optional WiFi Kit



**Diagram**  
**SANDVIK CONTINUOUS MINER EQUIPMENT**

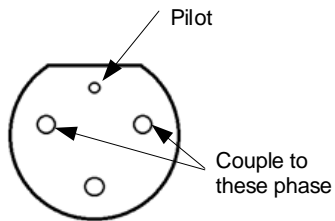
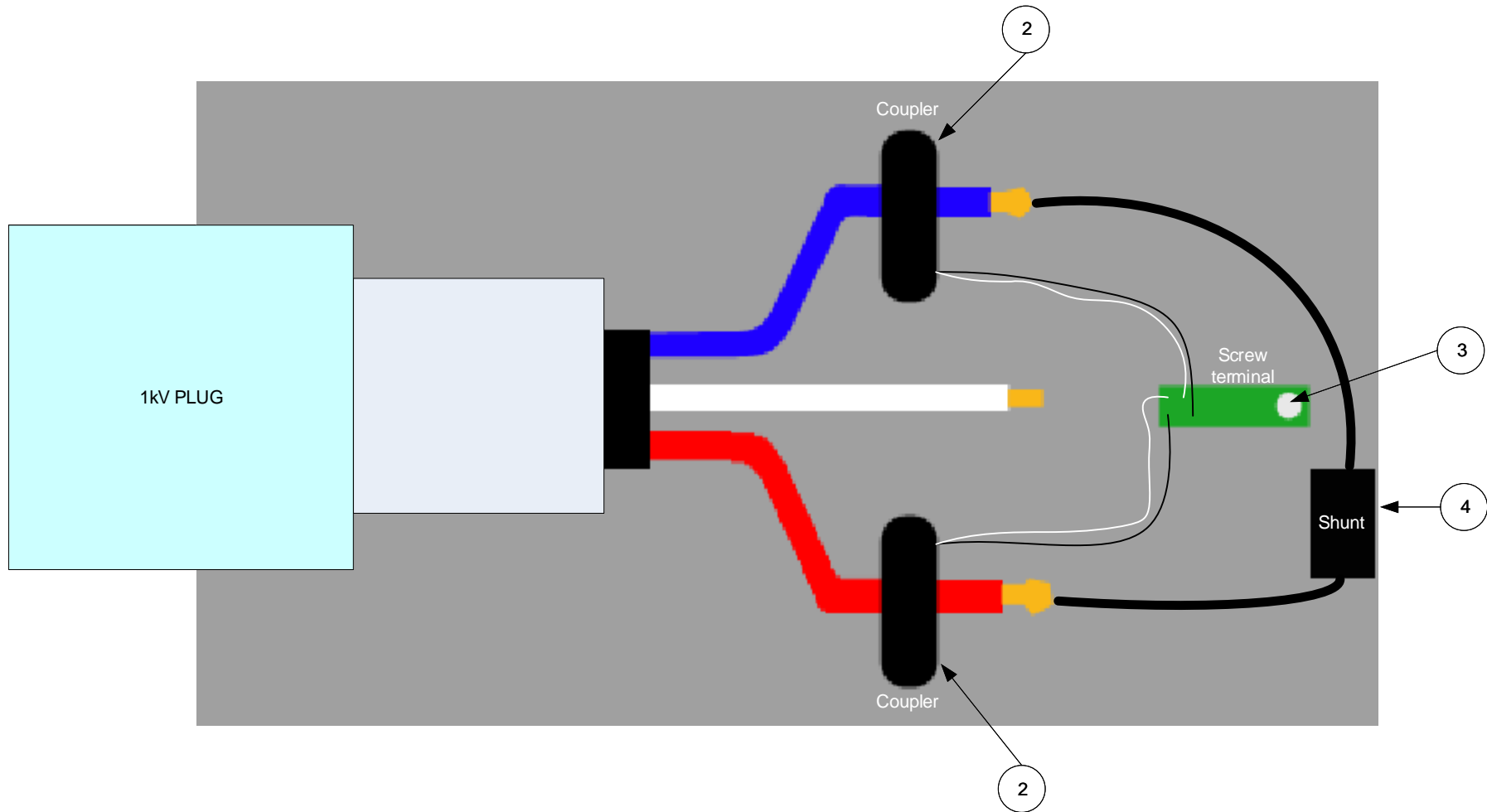


### Legend

— PROD1126 – BPL Feeder Breaker Kit

**Diagram  
FEEDER BREAKER EQUIPMENT**

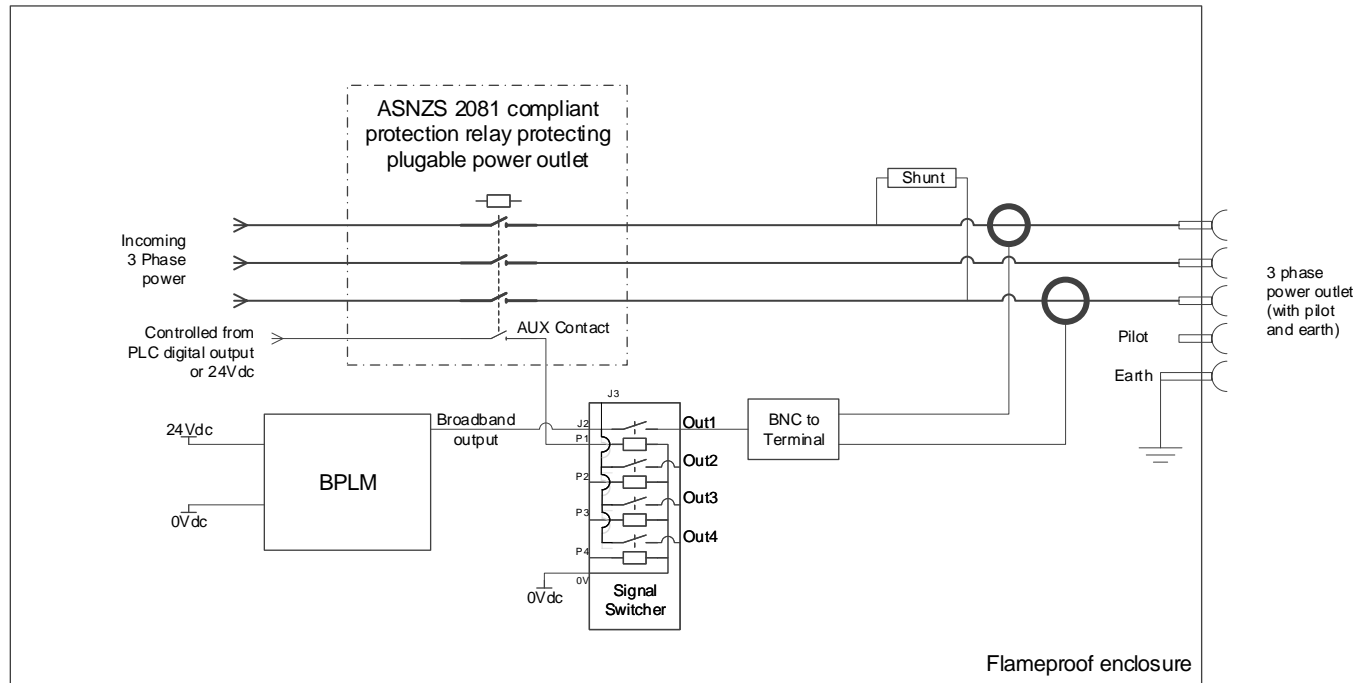
## Coupler Connections



**Notes:**

- 1: Couplers are to be fitted between the 1kV plug and shunt
- 2: When connecting couplers, cable feed **MUST** be on same side, as illustrated, both facing the same direction.

**Diagram**  
**BPL Coupler Connection**



**Notes:**

- 1: Each BPLM output signal switching control must be interlocked through an its respective auxiliary on the vacuum contactor, Earth Continuity relay, Pilot/Earth relay, or whatever other method of outlet de-energisation is achieved.

**Diagram**  
**BPL Switcher Connection**



## BPL KIT ORDERING PARTS LIST

| PROD1046 BPL BASE KIT |             |              |  | Quantity required |
|-----------------------|-------------|--------------|--|-------------------|
| Item                  | Qty per Kit | PN           | Description                                    |                   |
| 1                     | 1           | INTX100379-P | BPL MODEM WITH 3 X WIFI AND 2 X ST FIBRE       |                   |
| 5                     | 1           | INTX101499   | BPL, SIGNAL SWITCHER, 4 WAY                    |                   |
| 8                     | 1           | INTX101485   | COAX, RG58, 4M, SINGLE BNC                     |                   |
| 13                    | 2           | INTX100715   | DIN RAIL 20MM FUSE HOLDER LEAVER ACTION        |                   |
| 14                    | 2           | INTX100722   | FUSE, COOPER BUSSMANN CERAMIC HBC, 6.3A 250VAC |                   |

| PROD1047 BPL OUTLET KIT |             |            |   | Quantity required |
|-------------------------|-------------|------------|---|-------------------|
| Item                    | Qty per Kit | PN         | Description                                   |                   |
| 2                       | 2           | INTX101247 | BPL INDUCTIVE COUPLER, LARGE                  |                   |
| 3                       | 1           | INTX100407 | BPL COUPLER SCREW TERMINAL BLOCK              |                   |
| 4                       | 1           | INTX100400 | BPL 1KV SHUNT                                 |                   |
| 7                       | 1           | INTX102479 | COAX, RG58, 4M, BNC TO BNC (FIELD TERMINATED) |                   |

| PROD1048 BPL SWITCHER KIT |             |            |   | Quantity required |
|---------------------------|-------------|------------|---|-------------------|
| Item                      | Qty per Kit | PN         | Description                                   |                   |
| 5                         | 1           | INTX101499 | BPL, SIGNAL SWITCHER, 4 WAY                   |                   |
| 7                         | 1           | INTX102479 | COAX, RG58, 4M, BNC TO BNC (FIELD TERMINATED) |                   |

| PROD1049 BPL OPTIONAL WIFI KIT |             |            |  | Quantity required |
|--------------------------------|-------------|------------|--|-------------------|
| Item                           | Qty per Kit | PN         | Description  |                   |
| 6                              | 1           | INTX101373 | WIFI BARRIER [EX IA] 2.4GHZ - HAE, BARRIER, HA209-24                 |                   |
| 9                              | 1           | INTX101359 | COAX, 2M, SMA-M-RP TO SMA-M-RA                                       |                   |
| 10                             | 1           | INTX101135 | COAX, RG58, 3M, N MALE TO SMA MALE (FIELD TERMINATED)                |                   |
| 11                             | 1           | INTX101268 | COAX, 5M, N-M-RA TO N-F, FRAS  |                   |
| 12                             | 1           | INTX103676 | ANTENNA, MINI OMNI, 2.4 GHZ, COMPLETE WITH ISOLATED MOUNTING BRACKET |                   |

| PROD1113 BPL CONTINUOUS MINER KIT |             |              |  | Quantity required |
|-----------------------------------|-------------|--------------|--|-------------------|
| Item                              | Qty per Kit | PN           | Description                                    |                   |
| 1                                 | 1           | INTX100379-P | BPL MODEM WITH 3 X WIFI AND 2 X ST FIBRE       |                   |
| 2                                 | 2           | INTX101247   | BPL INDUCTIVE COUPLER, LARGE                   |                   |
| 3                                 | 1           | INTX100407   | BPL COUPLER SCREW TERMINAL BLOCK               |                   |
| 4                                 | 1           | INTX100400   | BPL 1KV SHUNT                                  |                   |
| 8                                 | 1           | INTX101485   | COAX, RG58, 4M, SINGLE BNC                     |                   |
| 13                                | 2           | INTX100715   | DIN RAIL 20MM FUSE HOLDER LEAVER ACTION        |                   |
| 14                                | 2           | INTX100722   | FUSE, COOPER BUSSMANN CERAMIC HBC, 6.3A 250VAC |                   |

| PROD1114 BPL SANDVIK CONTINUOUS MINER KIT |             |              |  | Quantity required |
|---|-------------|--------------|--|-------------------|
| Item                                      | Qty per Kit | PN           | Description  |                   |
| 1   | 1           | INTX100379-P | BPL MODEM WITH 3 X WIFI AND 2 X ST FIBRE                             |                   |
| 2   | 2           | INTX101247   | BPL INDUCTIVE COUPLER, LARGE   |                   |
| 3   | 1           | INTX100407   | BPL COUPLER SCREW TERMINAL BLOCK                                     |                   |
| 4   | 1           | INTX100400   | BPL 1KV SHUNT  |                   |
| 8   | 1           | INTX101485   | COAX, RG58, 4M, SINGLE BNC   |                   |
| 13  | 2           | INTX100715   | DIN RAIL 20MM FUSE HOLDER LEAVER ACTION                              |                   |
| 14  | 2           | INTX100722   | FUSE, COOPER BUSSMANN CERAMIC HBC, 6.3A 250VAC                       |                   |
| 15  | 1           | INTX101555   | NETWORK CABLE, CUSTOM CAT5E, 2.5M, BLUE, TERMINATED ON SITE          |                   |
| 27  | 1           | INTX100008   | COMMUNICATIONS ADAPTOR, UDP TO RS232                                 |                   |
| 28  | 1           | INTX103564   | MOUNTING PLATE, DIN RAIL MOUNTING BRACKET FOR COMMUNICATIONS ADAPTOR |                   |
| 29  | 1           | INTX101065   | PLM, ITX PLM INTERFACE TERMINAL BLOCK RJ45 TO S/TERM                 |                   |
| 30  | 1           | INTX102920   | ITX INTERFACE CABLE DB9 FEMALE TO RJ45, 1M                           |                   |

Turn over for additional kits

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## BPL KIT ORDERING PARTS LIST

| PROD1126 | BPL FEEDER BREAKER KIT |              |  | Quantity required |
|----------|------------------------|--------------|--|-------------------|
| Item     | Qty per Kit            | PN           | Description  |                   |
| 1        | 1                      | INTX100379-P | BPL MODEM WITH 3 X WIFI AND 2 X ST FIBRE                             |                   |
| 2        | 2                      | INTX101247   | BPL INDUCTIVE COUPLER, LARGE   |                   |
| 3        | 1                      | INTX100407   | BPL COUPLER SCREW TERMINAL BLOCK                                     |                   |
| 4        | 1                      | INTX100400   | BPL 1KV SHUNT  |                   |
| 6        | 1                      | INTX101373   | WIFI BARRIER [EX IA] 2.4GHZ - HAE, BARRIER, HA209-24                 |                   |
| 8        | 1                      | INTX101485   | COAX, RG58, 4M, SINGLE BNC   |                   |
| 9        | 1                      | INTX101359   | COAX, 2M, SMA-M-RP TO SMA-M-RA                                       |                   |
| 10       | 1                      | INTX101135   | COAX, RG58, 3M, N MALE TO SMA MALE (FIELD TERMINATED)                |                   |
| 11       | 1                      | INTX101268   | COAX, 5M, N-M-RA TO N-F, FRAS  |                   |
| 12       | 1                      | INTX103676   | ANTENNA, MINI OMNI, 2.4 GHZ, COMPLETE WITH ISOLATED MOUNTING BRACKET |                   |
| 13       | 2                      | INTX100715   | DIN RAIL 20MM FUSE HOLDER LEAVER ACTION                              |                   |
| 14       | 2                      | INTX100722   | FUSE, COOPER BUSSMANN CERAMIC HBC, 6.3A 250VAC                       |                   |
| 15       | 1                      | INTX101555   | NETWORK CABLE, CUSTOM CAT5E, 2.5M, BLUE, TERMINATED ON SITE          |                   |
| 16       | 1                      | INTX100701   | HAE, REDUCER M32 TO M20  |                   |
| 17       | 1                      | STEE0600     | FEEDER BREAKER RF ANTENNA MOUNTING PLATE                             |                   |
| 18       | 4                      | FAST0413     | SCREW M6x20 CAP HD SOCKET S/S  |                   |
| 19       | 8                      | FAST0158     | WASHER M6 FLAT S/S   |                   |
| 20       | 4                      | FAST0347     | WASHER M6 LOCK SPLIT SPRING S/S                                      |                   |
| 21       | 4                      | FAST0295     | NUT M6 S/S   |                   |

Notes:

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NAME: \_\_\_\_\_

COMPANY: \_\_\_\_\_

DATE: \_\_\_\_/\_\_\_\_/\_\_\_\_