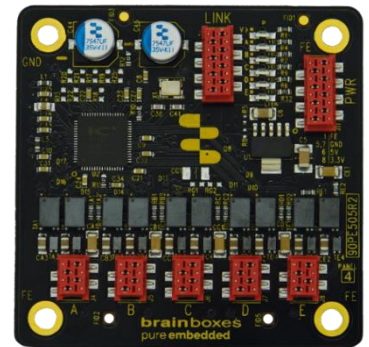


## PE-505 / PE-508 Pure Embedded 10/100 5/8 Port Industrial Ethernet Switch

### 1 Overview

The perfect fit for any stable, future-proof system, even where space is limited

- Stability of design guaranteed compatibility until at least 2034 (min. 10 years)
- Compact form – smaller than a standard business card (55 x 55 x 10 mm)
- Seamless integration with design software - logical placements and fixed distances
- 3D CAD files and PCB footprints
- Board-to-board and board-to-cable connection
- LEDs are visible from all angles, with optional routing through optical fibre or copper for remote indication



#### 1.1 Functionality and Features

- 5/8 port 10/100Mbps switch (10BASE-T/100BASE-TX)
- 3.3 or 5 VDC Input
- Reverse Polarity Protected
- Transient Voltage Protected
- 1500 V magnetic isolation between ports
- IEEE802.3az Energy Efficient Ethernet
- Auto MDI/MDIX – Non-blocking layer 2 operation
- Low power consumption 2.5 W Max
- Power and link indicators for all ports visible from all angles
- TE MicroMatch compatible connectors (Compatible with board-to-board and wire-to-board connections)
- Extremely compact 55 x 55 mm board size
- Full 2D and 3D CAD files available

### Pure Embedded Tool Kit

Table 1 – General Information

|                                     |                       | PE-505                                         | PE-508                                     |
|-------------------------------------|-----------------------|------------------------------------------------|--------------------------------------------|
| Power                               | Input Voltage         | 3.3 or 5 VDC                                   |                                            |
|                                     | Power Consumption     | 2.5 W Max: 758 mA @ +3.3 VDC / 500 mA @ +5 VDC |                                            |
| Ethernet                            | Ethernet Ports        | 5                                              | 8                                          |
|                                     | Ethernet Speed        | 10/100 Fast Ethernet                           |                                            |
| Environmental                       | Operating Temperature | -40 °C to +85 °C / -40 °F to +185 °F           |                                            |
|                                     | Storage Temperature   | -40 °C to +85 °C / -40 °F to +185 °F           |                                            |
|                                     | Humidity Rating       | 5 to 95% (Non-Condensing)                      |                                            |
| Physical                            | Form Factor           | Embedded                                       |                                            |
|                                     | Product Weight        | 0.018 kg / 0.039 lbs                           | 0.019 kg / 0.041 lbs                       |
|                                     | Product Dimensions    | 55 x 55 x 7.1 mm<br>2.16 x 2.16 x 0.27 in      | 55 x 55 x 12.4 mm<br>2.16 x 2.16 x 0.48 in |
|                                     | Packaged Weight       | 0.027 kg / 0.059 lbs                           | 0.028 kg / 0.061 lbs                       |
|                                     | Packaged Dimensions   | 100 x 90 x 30 mm / 3.3 x 3.5 x 1.2 in          |                                            |
| Product Compliance                  | GTIN                  | 837324004960                                   | 837324005431                               |
|                                     | HTS                   | 8517.62.00.00                                  |                                            |
|                                     | ECCN                  | 5A991.b                                        |                                            |
| Industry, EMC & Immunity Compliance | General               | CE, UKCA, RoHS, REACH, WEE                     |                                            |
|                                     | Ethernet              | IEEE 802.3, 802.3u, 802.3x                     |                                            |
|                                     | Safety                | IEC/EN/BS 62368-1                              |                                            |
|                                     | EMC                   | EN/BS 55032                                    |                                            |

|                           |                                |                                                                |
|---------------------------|--------------------------------|----------------------------------------------------------------|
|                           |                                | EN/BS 55035                                                    |
|                           | <b>Flammability</b>            | UL-94 V0                                                       |
|                           | <b>RoHS</b>                    | 2015/863/EU<br>IEC/EN/BS 63000                                 |
|                           | <b>REACH</b>                   | (EC)1907/2006                                                  |
|                           | <b>Robustness</b>              | EN 60068-2-31                                                  |
| <b>Company Compliance</b> | <b>General</b>                 | ISO9001, ISO14001, AEO (C-TPAT)                                |
|                           | <b>CAGE</b>                    | 8QCY6                                                          |
|                           | <b>NCAGE</b>                   | U0Q96                                                          |
|                           | <b>GSA</b>                     | 47QTCA23D009X                                                  |
|                           | <b>Sustainability</b>          | Ecovadis Silver Medal                                          |
|                           | <b>Country of Origin (COO)</b> | Made in GB, United Kingdom of Great Britain & Northern Ireland |

## 1.2 Connectors

The Board features 4-way female TE MicroMatch style connectors for Ethernet and 8-way female TE MicroMatch style connectors for link and power.

Table 2 – Male Header Compatibility

| Number of Ways | Type          | Manufacturer | Part Number          |
|----------------|---------------|--------------|----------------------|
| <b>4-way</b>   | SMD           | Würth        | 690357280476         |
|                |               | TE           | 338728-4             |
|                | THT           | Würth        | 690357100472         |
|                |               | TE           | 215464-4             |
|                | Board to Wire | Würth        | 690157000472         |
|                |               | TE           | 215083-4<br>338095-4 |
| <b>8-way</b>   | SMD           | Würth        | 690357280876         |
|                |               | TE           | 338728-8             |
|                | THT           | Würth        | 690357100872         |
|                |               | TE           | 215464-8             |
|                | Board to Wire | Würth        | 690157000872         |
|                |               | TE           | 215083-8<br>338095-8 |

Table 3 – Connector Wiring Guide

| Connector/PIN                      | 1                | 2                | 3               | 4                | 5      | 6                  | 7   | 8                    |
|------------------------------------|------------------|------------------|-----------------|------------------|--------|--------------------|-----|----------------------|
| <b>Port A-E (H)<br/>(RJ45 Pin)</b> | RXD –<br>(Pin 6) | RXD+<br>(Pin 3)  | TXD-<br>(Pin 2) | TXD +<br>(Pin 1) | N/A    | N/A                | N/A | N/A                  |
|                                    | Orange           | Orange/<br>White | Green           | Green/<br>White  |        |                    |     |                      |
| <b>LINK</b>                        | Port A           | Port B           | Port C          | Port D           | Port E | LED Power          | GND | Self-Test            |
| <b>PWR</b>                         | FE               | -                | -               | -                | GND    | +VIN <sub>5V</sub> | GND | +VIN <sub>3.3V</sub> |



## 2 Ordering

Table 4 – Ordering Information

| Product Code           | Description                                                    |
|------------------------|----------------------------------------------------------------|
| <a href="#">PE-405</a> | Pure Embedded Industrial 10/100 Ethernet Evaluation Kit        |
| <a href="#">PE-505</a> | Pure Embedded Industrial 10/100 5 Port Ethernet Switch         |
| <a href="#">PE-508</a> | Pure Embedded Industrial 10/100 8 Port Ethernet Switch         |
| <a href="#">PE-415</a> | Pure Embedded Industrial Gigabit Ethernet Evaluation Kit       |
| <a href="#">PE-515</a> | Pure Embedded Industrial Gigabit 5 Port Ethernet Switch        |
| <a href="#">PE-205</a> | Pure Embedded DC-DC Industrial Power Supply Module, 3.3 V, 4 W |
| <a href="#">CC-500</a> | IDCMM Cable Pack (10/100)                                      |
| <a href="#">CC-510</a> | IDCMM Cable Pack (10/100/1000)                                 |

## 3 Changelog

Table 5 - Changelog

| Date    | Revision | Author | Notes                                                 |
|---------|----------|--------|-------------------------------------------------------|
| 03/2023 | 0.1      | BH     | Initial Draft                                         |
| 07/2023 | 1.0      | HR/LW  | First Publication                                     |
| 08/2023 | 1.1      | HR     | Resources link added                                  |
| 07/2025 | 1.2      | JM/BH  | Added PE-508, Improved Specification Clarity          |
| 11/2025 | 1.3      | JM     | Added CC-500/510, Updated Product Specification Table |

Please check: <https://www.brainboxes.com/product/pure-embedded/pe-505> for the most recent datasheet revision

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## 7 Accessories



IDCMM Cable Pack (10/100) – Pack of 5



IDCMM Cable Pack (10/100/1000) – Pack of 5

## 8 PE-405 Embedded Eval Kit

The PE-405 allows for further testing and debugging within a prototype system before any commitment to custom fixtures or designs is made.

A reference design of the evaluation kit is available to download from Brainboxes website and include in your system.

- Quick, easy access to all PE-505 functionality
- Simplifies integration into test systems

The mating board breaks out all ports and functionality to RJ45 or usable headers.

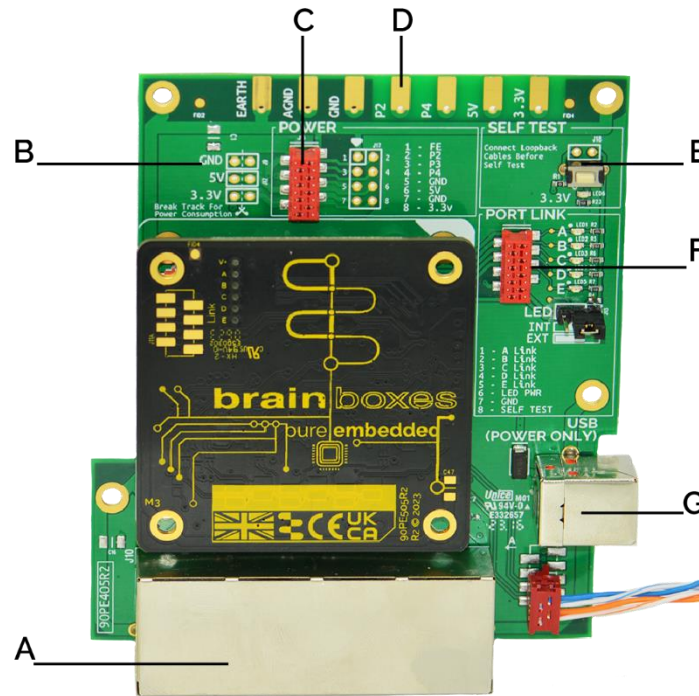


Figure 1 – PE-405 Evaluation Kit

Table 6 – PE-405 Features

| Features |                                                                                           |
|----------|-------------------------------------------------------------------------------------------|
| A        | 4 x RJ45 and 1 x MicroMatch Compatible 4-Pin Header                                       |
| B        | Power Consumption Monitoring                                                              |
| C        | Power Header                                                                              |
| D        | Crocodile Clip Power Points                                                               |
| E        | Self-Test Button                                                                          |
| F        | Link Header - 2 jumper selectable options:<br>Onboard LEDS/External LEDS (through header) |
| G        | USB Power                                                                                 |

Provides convenient access to all features of the PE-505 for evaluation and testing.

Notes on Power consumption monitoring:

- 3 tracks for monitoring power on 3.3 V, 5 V and GND power rails (Not compatible with USB supply)
- The indicated tracks can be cut to allow monitoring of power consumption

## 9 Design Guide

### 9.1 Connectors and pinouts

#### 9.1.1 Ethernet Header (4 Pin)

| RJ45 Pin | 100Base-T | 1000Base-T |
|----------|-----------|------------|
| 1        | TX+       | B+         |
| 2        | TX-       | B-         |
| 3        | RX+       | A+         |
| 4        | n/c       | C+         |
| 5        | n/c       | C-         |
| 6        | RX-       | A-         |
| 7        | n/c       | D+         |
| 8        | n/c       | D-         |

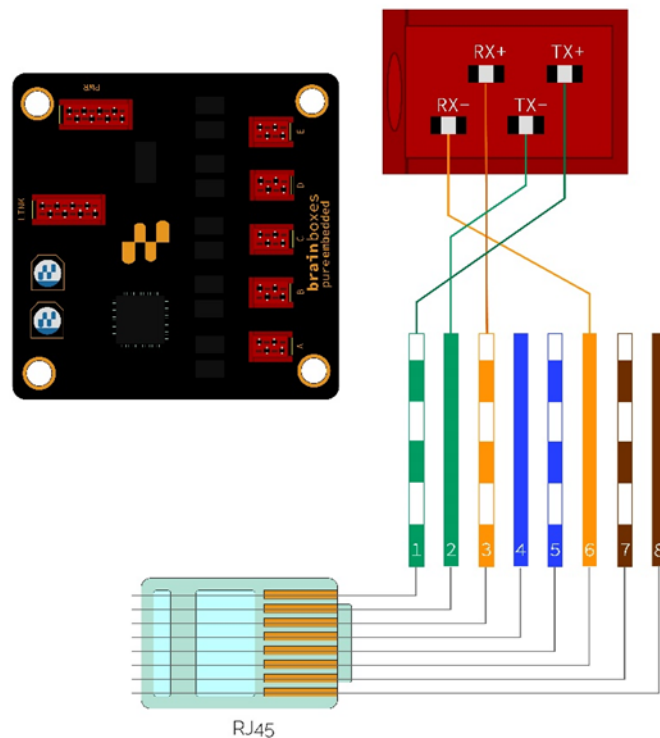


Figure 2 – Ethernet Header Pinout

As the PE-505 and PE-508 supports Auto MDI/MDIX, the wiring of the RX and TX pins are reversible. Section 1.2 above details the recommended pin configuration for the ethernet ports. Coloured Cat5 cable can be wired as shown.

For Longer distances (>1.5 m), using shielded cable is optimal. Shielding can be attached to the Functional Earth mounting points on the bottom corners of the board.

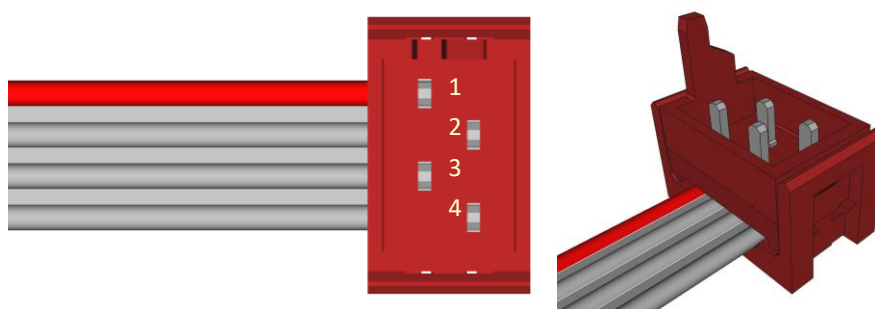


Figure 3 – 4 Pin Connector for 10/100 Ethernet (Red Wire Indicates Pin 1)

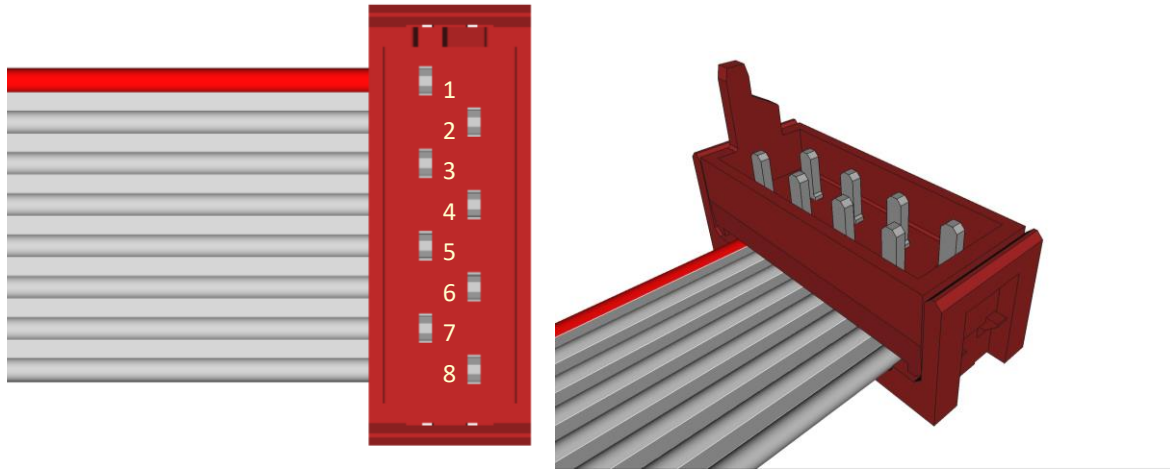


Figure 4 – 8 Pin Power and LED Connector (Red Wire Indicates Pin 1)

### 9.1.2 Link LED Header (8 Pin)

Each of the ports have a Link Indicator LED and the first five have a Link Indicator Output. The output current must be limited through a resistor. The resistor must be selected to limit the maximum draw to 20 mA @ 3.3 V. The LEDs must be powered from the LED Power Pin. The LEDs function in an active LOW configuration and should be connected as shown below in Figure 5.

The power draw of any supplementary LEDs is in addition to the specified power on the datasheet. Should it be impractical to implement an electronic-based Link LED forwarding, there are holes of  $\varnothing 1$  mm under the indication LEDs for ports A-E, suitable for housing optical fibres or light pipes of a length less than 50 cm.

*Please note: Not all LEDs are suitable for use with optical or copper cabling, please check specification prior to fitting.*

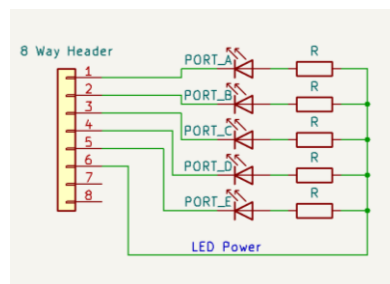


Figure 5 – External LED Wiring

### 9.1.3 Mounting Holes

The 4 x M3 mounting holes are connected to Functional Earth (FE) or Ground (GND) and labelled accordingly (See Section 10.1,

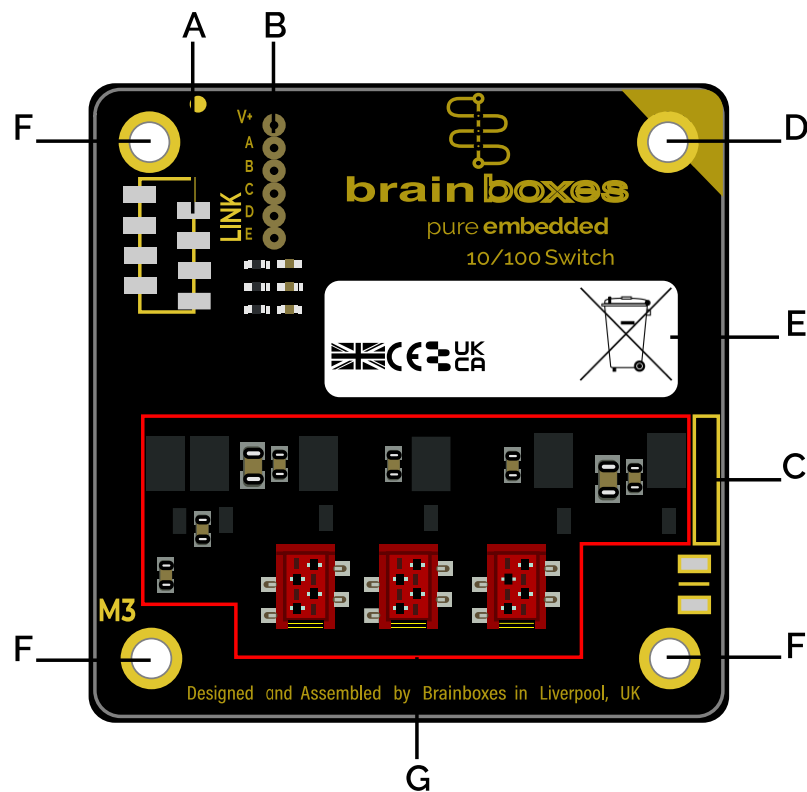
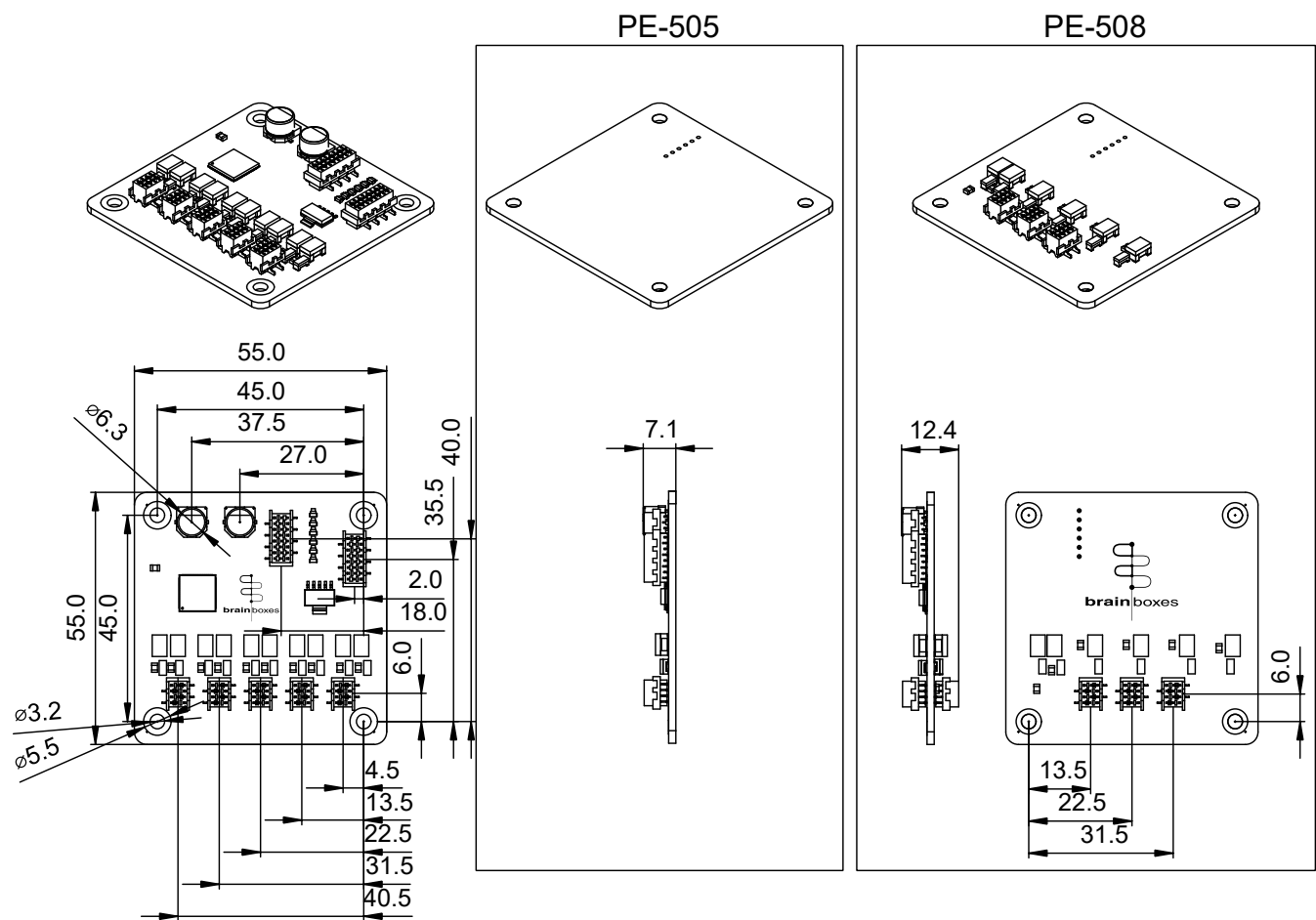


Figure 9). If the device does not share a common ground with the rest of the system, it is recommended to use a nonconductive standoff or isolated mounting point.

## 9.2 2D Drawing

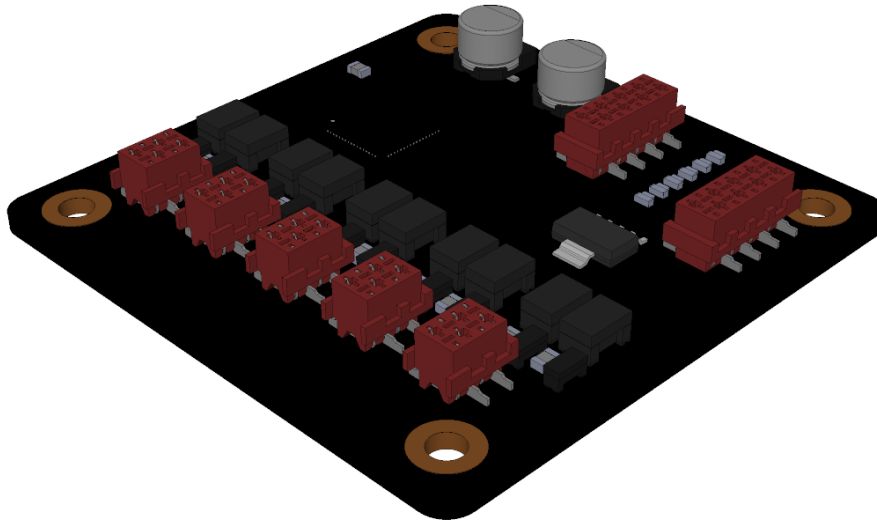


*Figure 6 – Mechanical Drawing, PE-505/PE-508*

### 9.3 3D Step File

The full 3D model can be downloaded from the Brainboxes website:

- [PE-505](#)
- [PE-508](#)



*Figure 7 – 3D Step File*

### 9.4 Recommended Footprint

The mating LED Header and Port Header are not essential and can be excluded if not required. For applications where the module is frequently inserted and removed, we recommend using through-hole mating connectors. Avoid placing components within the 55 x 55 mm square occupied by the PE-505 or PE-508.

- The PE-505 should be given 12 mm of clearance from the mating surface
- The PE-508 should be given 20 mm of clearance from the mating surface

Recommended footprint can be downloaded from the Brainboxes website or constructed from the following:

- An array of 4-way headers with coordinates of: (4.5,6),(13.5,6),(22.5,6),(31.5,6),(40.5,6)
- 2 x 8-way headers with the centre locations: (2,35.5),(18,40)
- 4 x M3 mounting holes at: (0,0), (45,0), (0,45) and (45,45)(GND)

Either Through-Hole or SMT headers can be used as per the part numbers detailed in Section 1.2.

## 9.5 Routing

When designing custom boards for Brainboxes PE devices, it is important to take into consideration routing the device to connectors across a board.

### Routing Recommendations:

- Maintain uniform spacing between differential pairs to minimize signal degradation.
- Keep pairs at as close length as possible.
- Place a GND plane between different pairs
- Ensure pairs do not cross plane boundaries
- For more information we recommend reading:
  - Microchip AN2054 (Ethernet Differential Pairs)
  - Texas Instruments SNLA387 (Ethernet PHY PCB Design Layout Checklist)

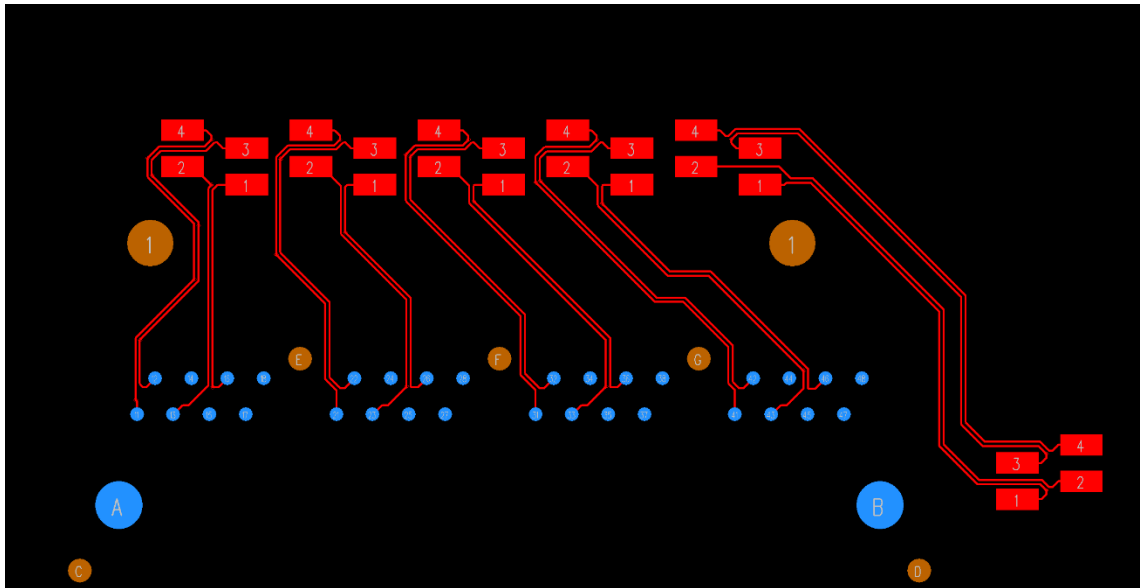


Figure 8 – PE-405 Evaluation Board Routing

10 Troubleshooting

10.1 Device Markings

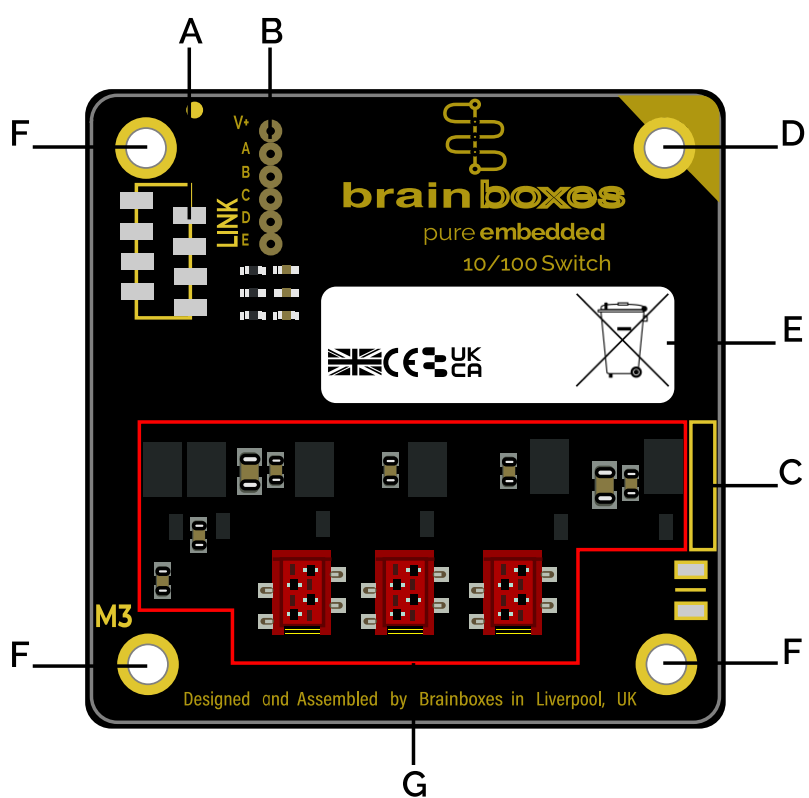


Figure 9 – Device Markings Outline

**Please Note: Markings on the rear of this device are subject to change. This will not affect the functionality of the device.**

Table 7 – Device Markings

| Markings |                                                            |
|----------|------------------------------------------------------------|
| A        | Debug Header (See 0 below)                                 |
| B        | LED Status Indicators                                      |
| C        | 90PE505R2 <- PCB Revision                                  |
| D        | GND Mounting Hole                                          |
| E        | Product Variant, Serial Number and Date of Manufacture     |
| F        | FE Mounting Holes                                          |
| G        | <b>PE-508 Only</b> – 3 x MicroMatch RJ45 Ports & Magnetics |

## 10.2 Power Supply Verification

There are several pads on the reverse of the board, these can be used to diagnose issues with power delivery. The voltage on pads  $V_{in}$  and  $V_{3.3}$  must be within the tolerances defined in Table 9. If the measured values exceed those listed, correct operation is no longer guaranteed.

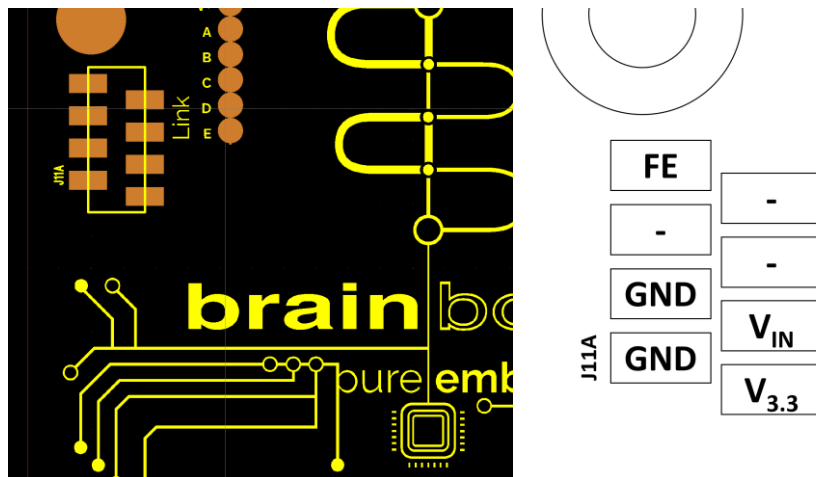


Figure 10 – Power Header Debugging

## 10.3 Self-Test Procedure

Check Section 10.1 above to determine device revision. If your revision is not included here, check the Brainboxes website for the updated datasheet. **Note: The PE-508 utilises the PE-505 PCB.**

### 10.3.1 90PE505R2, 90PE505R3

The PE-505 and PE-508 implement a self-test facility to ensure that each port is operating correctly. Each port should be looped back by connecting RX+ to TX+ and RX- to TX- for testing. We recommend using a PE-405 Eval Kit for this purpose:

1. Connect 2 ports directly together using a suitable cable or connect Pin 1 to Pin 3 and Pin 2 to Pin 4 for each of the ports (RX+ to TX+ and RX- to TX-)
2. Connect a push Button between Pin 6 and Pin 8 of the LINK status connector
3. Power the device on
4. Press the test button
5. Wait 5 seconds and press the test button again
6. Ports which pass the Loopback test should Light their link LED
7. Ensure any loopbacks are removed prior to reconnecting the switch to your network to avoid network issues

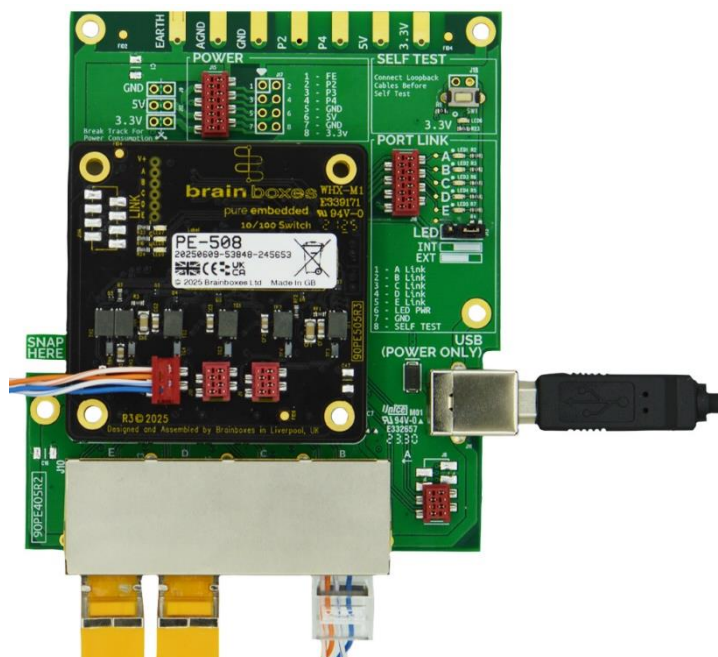


Figure 11 – Self-Test Procedure

## 11 Operating Conditions

### 11.1 Absolute Maximum Ratings

Stresses exceeding absolute maximum ratings may cause permanent damage. Functional performance and device reliability are not guaranteed under these conditions. All voltages are specified with respect to GND.

Table 8 – Absolute Maximum Ratings

| Parameter                     | Max       | Unit | Notes |
|-------------------------------|-----------|------|-------|
| Direct Supply Voltage         | 3.63      | V    |       |
| Supply Voltage                | 7.5       | V    |       |
| Ambient Operating Temperature | -40 to 85 | °C   |       |

### 11.2 Electrical Characteristics

Table 9 – Typical Electrical Characteristics

| Parameter                                         | Symbol               | Min  | Typical | Max  | Unit | Notes                               |
|---------------------------------------------------|----------------------|------|---------|------|------|-------------------------------------|
| Supply Voltage                                    |                      | 3.15 | 3.3     | 3.45 | V    |                                     |
| 3.3V Direct Supply Power Consumption <sup>1</sup> | P <sub>100MF</sub>   |      | 1.3     |      | W    | All port link 100Mbps Fully active  |
|                                                   | P <sub>10MF</sub>    |      | 1.2     |      |      | All port link 10Mbps Fully active   |
|                                                   | P <sub>IDLE</sub>    |      | 0.30    |      |      | All port unlink                     |
| Supply Voltage                                    |                      | 4.5  | 5       | 6.0  | V    |                                     |
| 5V Supply Power Consumption <sup>2</sup>          | P <sub>100MF</sub>   | 1.7  |         | 2.3  | W    | All port link 100 Mbps Fully active |
|                                                   | P <sub>10MF</sub>    | 1.6  |         | 2.2  |      | All port link 10 Mbps Fully active  |
|                                                   | P <sub>IDLE</sub>    | 0.35 |         | 0.50 |      | All port unlink                     |
| LED Output Low                                    | LED On               | 0    |         | 0.35 | V    |                                     |
| LED Output High                                   | LED Off              | 2.5  |         | 3.45 | V    |                                     |
| Startup time                                      | T <sub>startup</sub> |      |         | 100  | ms   |                                     |

## 12 Stability of Design Guarantee

Brainboxes guarantees that all our off-the-shelf embedded board products will remain available for a minimum of 10 years from the initial launch date. Our Change Control Policy, along with other regulatory documents, can be found here: <https://www.brainboxes.com/regulatory-declarations>

<sup>1</sup> Specified Power Consumption Excludes load attached to the LINK LED header

<sup>2</sup> Specified Power Consumption Excludes load attached to the LINK LED header