# POE Isolation Barrier

This application note have been written to explain the requirement of the isolation barrier with Power over Ethernet (PoE) and the considerations that have to be made when selecting components and the Printed Circuit Board (PCB) layout.

## Requirements

The IEEE standard 802.3af (2003) contains section “33.4 - Additional Electrical Requirements” and within this is sub-section “33.4.1 - Isolation” (shown below).

**Abbreviations**

| | |
|---|---|
| PSE | Power Sourcing Equipment |
| PD | Powered Device |
| PI | Power Interface |
| SELV | Safety Extra Low Voltage |

**33.4.1 – Isolation**

The PSE shall provide electrical isolation between the PI device circuits, including frame ground (if any), and all PI leads.

The PD shall provide electrical isolation between all external conductors, including frame ground (if any), and all PI leads.

This electrical isolation shall be in accordance with the isolation requirements between SELV circuits and telecommunication network connections in subclause 6.2 of IEC 60950-1:2001.

This electrical isolation shall withstand at least one of the following electrical strength tests:

a) 1500 Vrms steady-state at 50-60 Hz for 60 seconds, applied as specified in subclause 6.2 of IEC60950-1:2001.

b) An impulse test consisting of a 1500 V, 10/700 µs waveform, applied 10 times, with a 60 second interval between pulses, applied as specified in subclause 6.2 of IEC 60950-1:2001.

There shall be no insulation breakdown, as defined in subclause 6.2.2.3 of IEC 60950-1:2001.

Conductive link segments that have different isolation and grounding requirements shall have those requirements provided by the port-to-port isolation of network interface devices (NID).

Silver Telecom offer a wide range of modules suitable for PD application, these can broadly be split into two section “Isolated PD modules” and “Non-Isolated PD modules”.

## Isolated PD Modules

All Silver Telecom Isolated PD modules conform to option “b”, detailed in sub-section 33.4.1. But the PD module is just one component that interfaces to the PI and crosses the barrier, the magnetics is another.

Figure 1 is a simplified block diagram showing the position of the isolation barrier and the components that cross it (examples of discrete 10/100-BASE-T magnetic modules are detailed in the Non-Isolated PD Module section).

The connections on the left side of the dotted line connect to the PI and the connection on the right side of the dotted line could directly (or indirectly) connect to an external conductor.

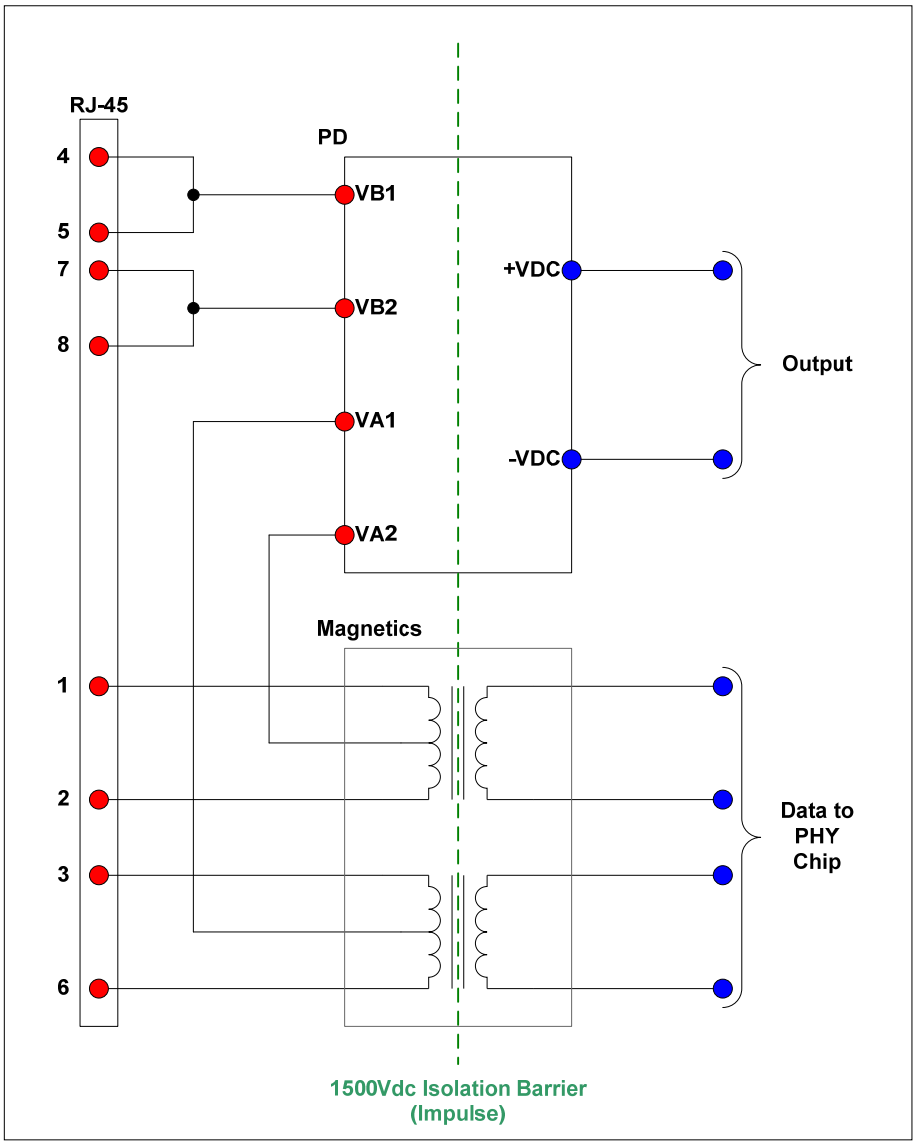


Figure 1: Isolation Barrier

To optimise space a number for manufacturers produce RJ45 connectors that have integrated magnetics. An example of such an integrated connector is the "MJX11UXXXX8-VB110" from Elec and Eltek Magnetic Product Limited. So now the integrated RJ45 connector crosses the isolation barrier.

Figure 2 shows the electrical connections and Figure 3 shows the mechanical connections of the "MJX11UXXXX8-VB110" connector.

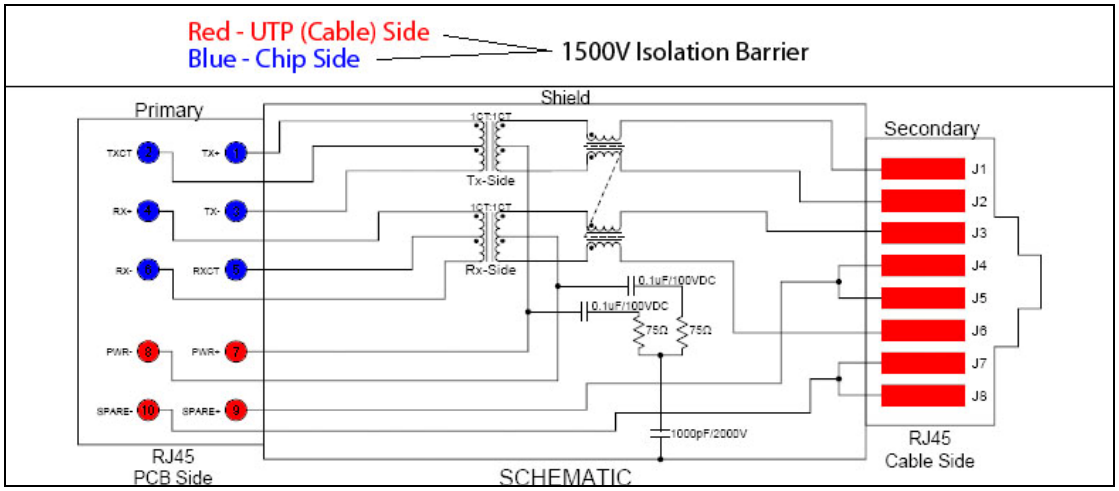


Figure 2: MJX11UXXXX8-VB110 electrical connection

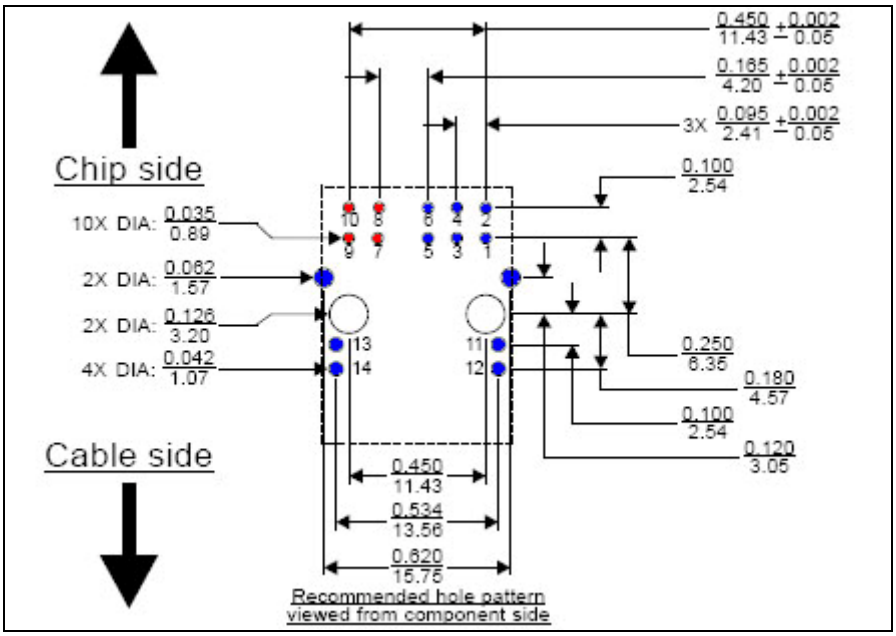


Figure 3: MJX11UXXXX8-VB110 mechanical connection

In Figures 2 and 3 the red pins are connected to the PI (or cable side) of the barrier and the blue pins are connected to components that may be connected to an external conductor.

Figure 4 shows a simple layout using the MJX11UXXXX8-VB110 integrated RJ45 connector with an Ag9000-S module. The tracks shown in red are on the PI side of the barrier and the tracks in blue are on the external conductor side of the barrier, the hatched area shows the isolation barrier.

As a guide, the clearance between conductors on either side of the barrier should be at least 3mm, anything less than this could introduce a flash point.

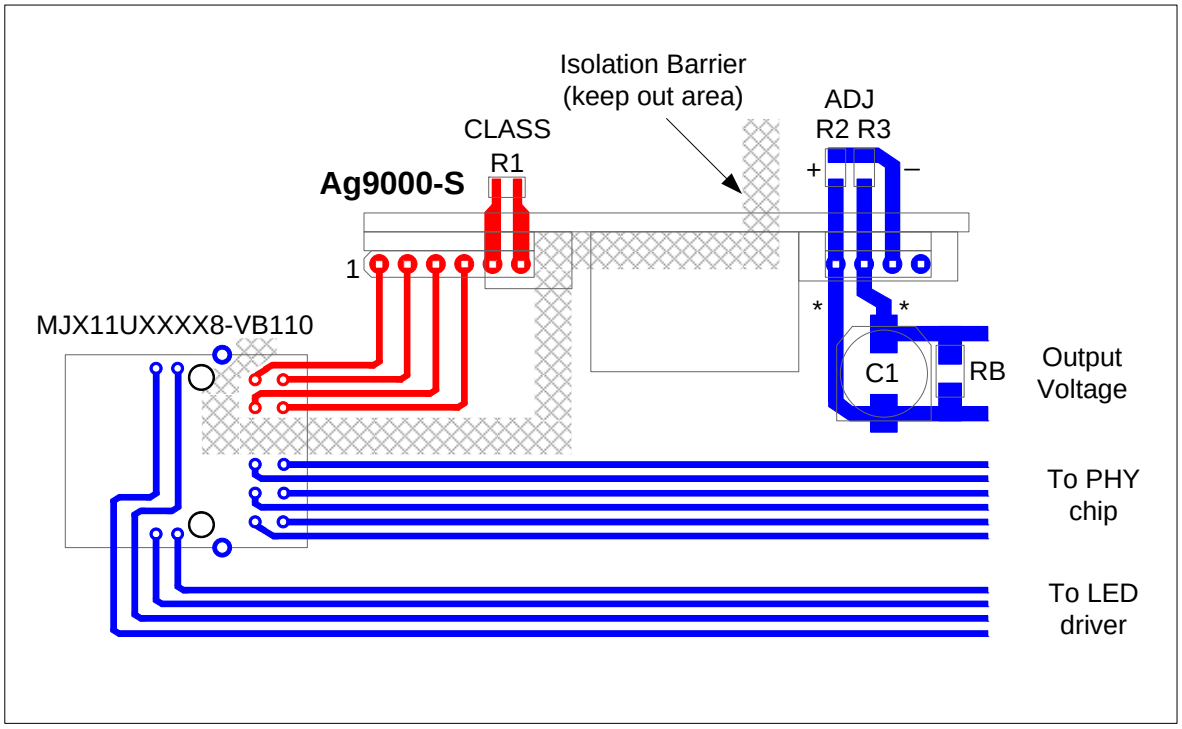


Figure 4: Example layout

There are a number of areas that need extra care in the layout: -

The Ag9000 datasheet shows the position of the isolation barrier at the pin side of the module (see Figure 5). Basically components and tracks on the left side of the isolation barrier line will be connected to the PI and those to the right will be connected to the external conductor. Because of the high component density on the module there are tracks and components very close to this bottom edge. Therefore it is important that tracks from one side of the barrier are not routed under the module on the top conductor layer, as they could compromise the barrier on the module.

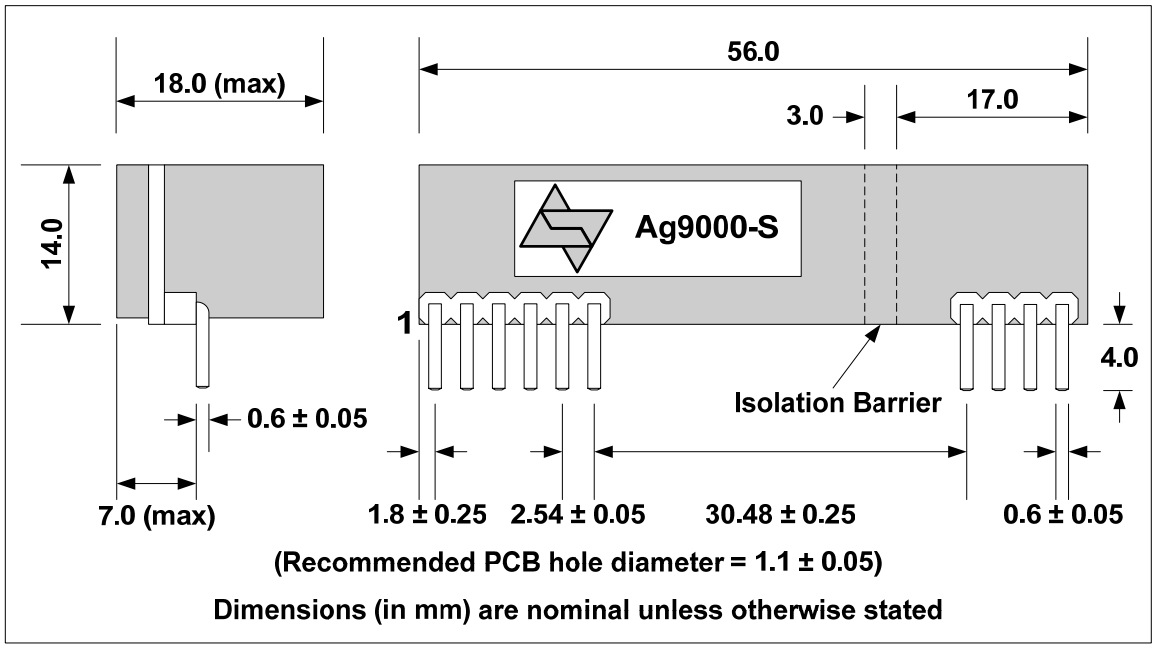


Figure 5: Package drawing from Ag9000 datasheet (v2.10)

It is important that the tracks routed to the RJ45 connector also maintain sufficient clearance to preserve the barrier. The tracks going to pins 1 to 4 of the Ag9000-S should NOT be routed on the top layer, as the RJ45 shield is an external conductor. In the example layout shown in Figure 4 the connector shield has been left unconnected, but this could be connected to ground if required. The tracks going from pins 5 and 6 of the Ag9000 to R1 (optional class programming resistor) can be on either side of the board.

When selecting an integrated RJ45 connector, be careful that the part has sufficient clearance between pins that are on opposite sides of the isolation barrier (this includes the shielding can). Many integrated RJ45 connectors have adjacent pins that are on opposite sides of the barrier on a standard 0.1" (2.54mm) pitch. Maintaining an adequate isolation barrier with these connectors would be problematic.

The Ag9000-S has been used as an example, but the same principles apply to all Silver Telecom Isolated PD modules.

## Non-Isolated PD Modules

Just because a PD module is non-isolated, this does not preclude its use in a product that needs to conform to the IEEE 802.3af standard. If the product is self contained and can be enclosed in a non-conductive case, the enclosure itself will act as the isolation barrier (see Figure 6).

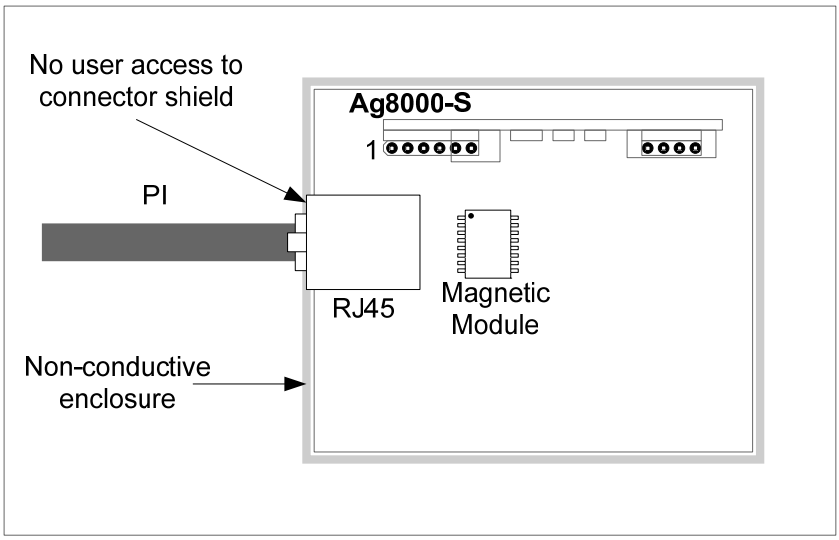


Figure 6: Non-conductive enclosure

In this case, the RJ45 connect must not have a conductive shield that would compromise the barrier. It would probably be easier to use a separate RJ45 connector and magnetics, as shown in Figure 6.

There are many manufacturers of 10/100-BASE-T magnetic modules suitable for PoE, here are just a few examples: -

| | | |
|---|---|---|
| Elec and Eltek Magnetic Products Limited | – | “824-M0145R” |
| Wurth Electronik | – | “749013010” |
| Pulse Engineering Inc. | – | “H2019” |

Note: all of the above modules are pin of pin compatible

It is difficult to prevent user access to output data connectors (for example). Isolation is much easier to achieve by this method if the product is “self contained” and has no output ports.

The Ag8000-S has been used as an example, but the same principles apply to all Silver Telecom Non-Isolated PD modules.