There has been a misconception with Power over Ethernet (PoE) regarding the amount of power that is actually available to supply the end device. This has not been helped by some Powered Device specifications claiming to offer 15 Watts.

This application note is a guide to help calculate the actual available power and to show where the losses are.

There are two IEEE standards that relate to PoE. The first standard is IEEE802.3af which was approved on June 12, 2003, by the Institute of Electrical and Electronic Engineers (IEEE). The second standard is IEEE802.3at which still awaiting ratification by the IEEE Task Force (as of 1st December 2007).

PoE can basically be split into two sections: -

1. Power Sourcing Equipment (PSE)
2. Powered Device (PD)

The PSE is used to inject power onto the Cat 5 ethernet cable and the PD is used to extract power and drop the voltage down to a useable level (3.3V, 5V or 12V are the most common voltages).

Figure 1 shows a basic PoE overview block diagram with four points (A to D) marked: -

Point A – The power available from the PSE
Point B – The power available at the input of the polarity protection circuit *
Point C – The power available to the PD *
Point D – The power available to the Load (the circuit to be powered)

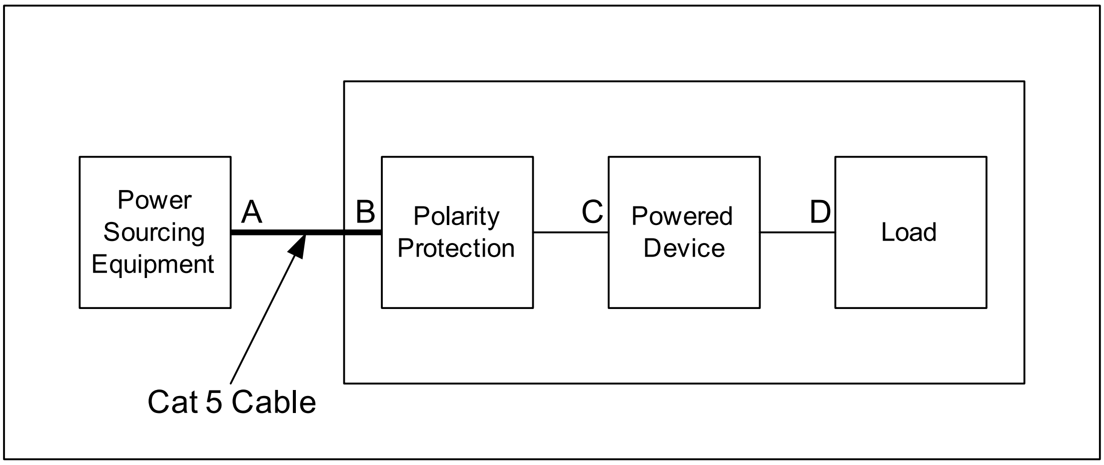

Figure 1: Power Plane

* Note: Sometimes the polarity protection is built into the PD, but for this example it will be shown as a separate block.

The IEEE802.3af specification states that the minimum PSE output voltage is 44V and the maximum output current (in normal mode) is 350mA. So from the simple calculation P = V * I, the minimum output power at Point A as 15.4W.

Straight forward enough so far, so let's move on to Point B. The PD must work with an input voltage as low as 36V (at Point B). This is to take into account for the worst case losses in the cables, connectors etc. (the cable can be up to 100m in length). The IEEE802.3af specification uses a 20Ω resistance to simulate this worst case condition. If this is now added into the equation (at maximum current 350mA) the voltage drop from Point A to B will be 7V (V = I * R). Subtracting this from Point A, the voltage at Point B could now be as low as 37V (44V - 7V). Allowing for this voltage drop the available power at Point B is 12.95W (37V * 350mA).

The next block is in the polarity protection circuit, this is mandatory in the IEEE802.3af specification for extracting the power from the Data pair or the Spare pair. Some products have built-in polarity protect, but if required this can be simply achieved by using two bridge rectifiers (one connected to the Spare pair and the other to the centre tap of the magnetics connected to the Data pair). If we take a worse case drop across each diode as 1V, then the bridge would drop 2V. So the minimum voltage at point C could be further reduced to 35V (37V – 2V). This now takes our minimum power at point C down to 12.25W (35V * 350mA).

The final loss that needs to be taken into account is the efficiency of the PD. If for example an efficiency figure of 85% is used, the available power at Point D can now calculated 12.25W * 0.85 = 10.41W.

So from the initial PSE output power of 15.4W (Point A), the actual available power at the Load (Point D) can be as low as 10.41W. It is important to emphasise that this value is calculated from worst case condition.

The same principle for calculating the available power applies to IEEE802.3at applications, although the minimum power available from the PSE (Point A) will be higher.