Application Note:

XPort-AR Power over Ethernet

Overview

Power over Ethernet (PoE) technology allows network devices to receive power over existing LAN cabling. This internationally standardized technology is known officially as IEEE 802.3af. Using the IEEE 802.3af specification, it is possible to power your serial device (security system, access control pads, etc.) through the XPort-AR with the same cable that provides the data!

This application note provides Hardware Engineers design information to assist them in using Power over Ethernet in a Lantronix XPort-AR application.

Introduction to IEEE 802.3af

In a Power over Ethernet compliant network, there are three basic components, the Power Sourcing Equipment (PSE), the Powered Device (PD), and the cable. A standard CAT5 Ethernet cable has four twisted pairs, but only two of these are used for data. The IEEE 802.3af specification allows two options for using this cable for power:

- **The spare pairs are used**. Figure 1 shows the pair on pins 4 and 5 connected together and forming the positive supply, and the pair on pins 7 and 8 connected and forming the negative supply. (The specification allows either polarity to be used).

- **The data pairs are used**. Since Ethernet pairs are transformer coupled at each end, it is possible to apply DC power to the center tap of the isolation transformer without upsetting the data transfer. In this mode of operation the pairs on pins 1 and 2 and on pins 3 and 6 can be of either polarity. This is shown in Figure 2.
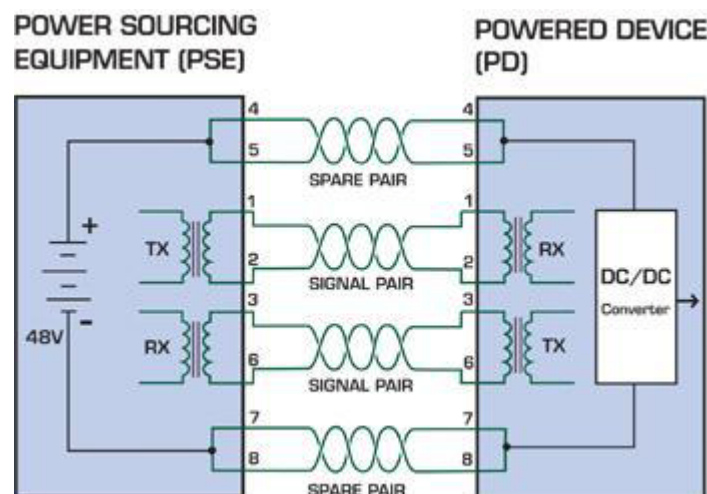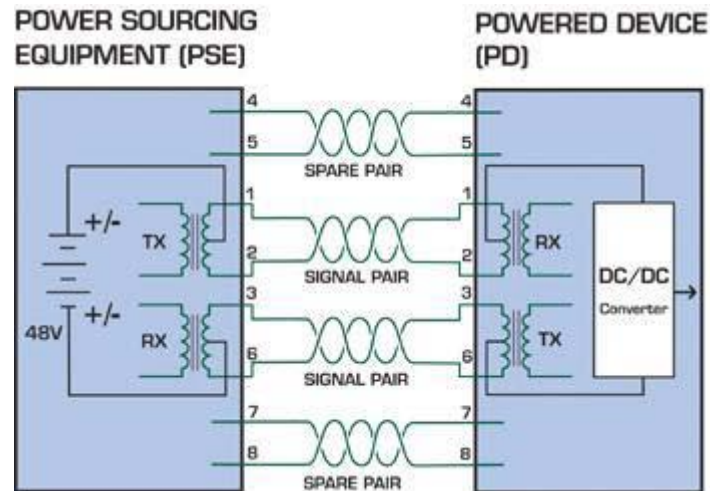

Figure 1 – Power Through the Cable on the Spare Pairs

Figure 2 - Power Supplied over the Data Pins

Details of the Power Supply

The IEEE 802.3af specification allows the Power Sourcing Equipment (PSE) to supply power on either set of wires. The Powered Device (PD) must be able to accept power from the spare pair or the signal pair. However, only one of them can be used in a PD at a time.

A requirement of the specification is to prevent damage to existing Ethernet equipment. To accommodate this requirement, the Power Sourcing Equipment (PSE), examines the cable pairs looking for devices that comply with the specification. This "discovery process" is performed by applying a small current-limited voltage to the cable to check for the presence of a 25K ohm resistor in the Powered Device (PD). If the resistor is present, then the full 48V is applied, but this is still current-limited to prevent damage to cables and equipment in case of fault conditions.

The Powered Device must continue to draw a minimum current. If it does not (for example, when the device is unplugged) then the PSE removes the power and the discovery process begins again.

The power available from PoE is sufficient to power many components in the edge device. The sourced voltage is nominally 48V at 350mA. There is about 13 watts of power available at the Powered Device after line loss. To power the XPort-AR, an isolated DC-DC converter is required to transform the 48V to 3.3V. 1500V of isolation is recommended for safety reasons.

Connecting Power over Ethernet to a XPort-AR

The XPort-AR is a fully integrated Device Server into the shell of an RJ-45 connector. The XPort-AR passes both of the PoE power pairs and shield common to the circuit board for regulation by the main circuit.

PoE Controller

To implement a PoE design requires an IEEE 802.3af compliant interface controller for handshaking with the power source to provide discovery, classification and power safety. For reference, we use the Linear Technology LTC4257 interface controller. The PoE controller acts as an interface between the PSE and the PD. The LTC4257 integrates all the Powered Device requirements of the IEEE 802.3af specification.

To discover a valid PD on the Ethernet line, the PSE applies a voltage in the range of 1.8V to 10V to sense the 25KΩ signature resistor. This identifies the device at the end of the cable as a PD. The power applied to the PD is allowed to use either of two polarities. The PD must be able to accept this. To accommodate this requirement, a diode bridge is used on the input from the spare pair.

Once the PSE has detected a PD, it may optionally classify the PD. The classification level of a PD identifies how much power the PD requires from the Ethernet line. The PoE controller will also limit inrush and steady state current drawn from the Ethernet line. The 0.1uf cap on the input is used to eliminate oscillations at turn-on caused by line inductance. The Transzorb (SMAJ58A) protects against any transients that may couple into the Ethernet line. For more details on the PoE controller, see the Linear Technology LTC4257 data sheet.

Power Regulator

To complete the design, a high performance switching regulator is required to convert the 48VDC supplied by the powered Ethernet to the 3.3V required by XPort-AR. In this application note, we will use a Linear Technology LTC1725 DC/DC converter. The LTC1725 delivers 3.3V at 3.5A from a 37V to 57V input with 90% efficiency. Since the ground potential is often unknown, especially in industrial settings, isolation is recommended.

When selecting a DC/DC converter it is important to meet or exceed the XPort-AR's power requirements listed below. For more details on the power regulator, see the Linear Technology LTC1725 data sheet.

DC Characteristics

Symbol	Parameter	Min	Nominal	Max	Units
Vcc	Supply voltage (typical 3.3) (+/-5%)	3.14	3.3	3.46	V
V_{IL}	Low Level Input Voltage	0		0.8	V
V_{IH}	High Level Input Voltage	2.0		5.5	V
V_{OL}	Low Level Output Voltage			0.4	V
V_{OH}	High Level Output Voltage	2.4			V
IL	Input Leakage Current			1	µA
Icc	Supply Current (prelim)			450	mA

PoE to XPort-AR Block Diagram

Figure 3 shows a block diagram of the circuit to power an XPort-AR using PoE. As always, it recommended that you consult the chip manufacturers applications guide as well as the IEEE 802.3af specification before implementing a Power over Ethernet solution.
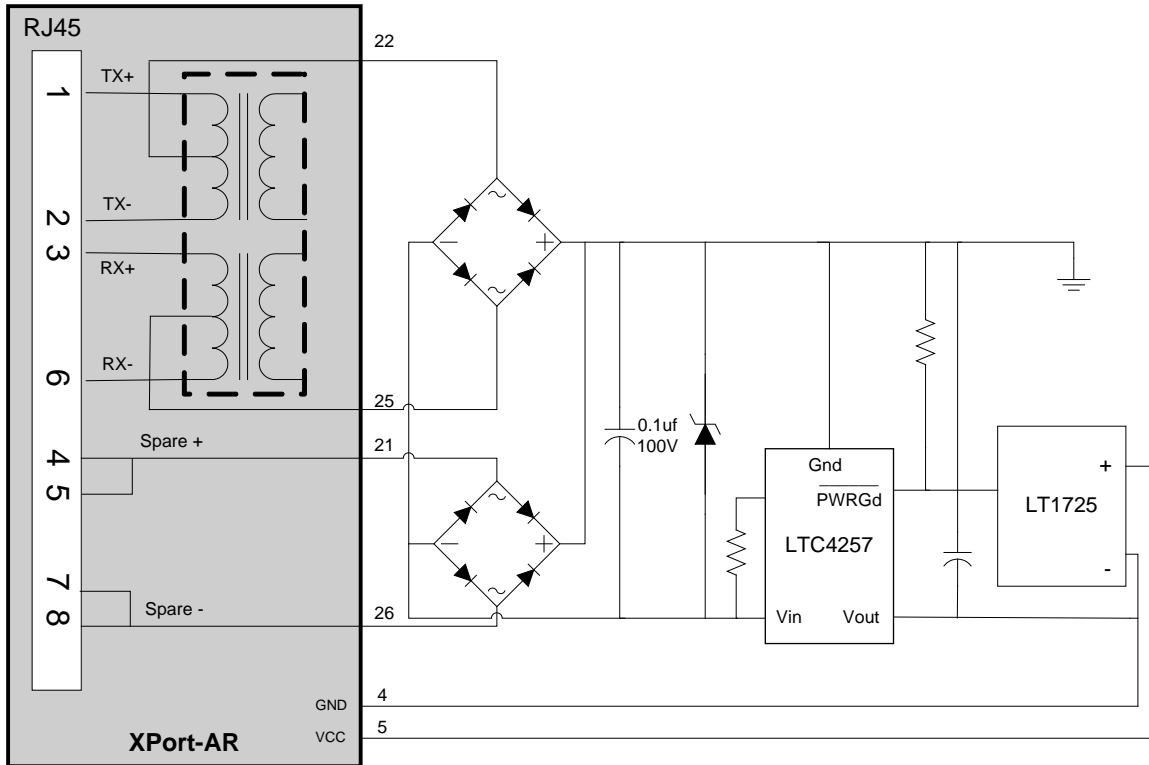
Figure 3 – XPort-AR PoE Block Diagram

References

1. IEEE 802.3af, Data Terminal Equipment (DTE) Power via Media Dependant I/F (MDI), IEEE computer Society, Draft D4.3, April 2003.

2. IEEE 802.3af Power Over Ethernet: A Radical New Technology, www.PowerOverEthernet.com.

3. LTC4257 Data Sheet, Linear Technology Corporation, www.linear-tech.com

4. LTC1725 Data Sheet, Linear Technology Corporation, www.linear-tech.com

5. Power over Ethernet, Linear Technology Chronicle, Vol. 12 No 8., www.linear-tech.com

6. Lantronix Application Note "How to Connect a Wired Ethernet Port to the WiPort", www.lantronix.com