

Application Note:

Connect Power over Ethernet to the WiPort/WiPort NR

Overview

Power over Ethernet (PoE) technology allows all types of network devices to receive power as well as data over existing LAN cabling. This technology has been standardized internationally by the IEEE committee and is called IEEE802.3af. Using the standard IEEE 802.3af specification, it is possible to power the WiPort/WiPort NR with the same cable that provides the data signals. This will allow data and power to be supplied via one CAT5 Ethernet cable.

This application note provides Hardware Engineers design information to assist them in using Power over Ethernet in a Lantronix WiPort/WiPort NR application.

Connecting Power over Ethernet to a WiPort/WiPort NR

The WiPort/WiPort NR features both a wireless 802.11B and a wired Ethernet port. The wired Ethernet port is a fully integrated 100BASE-TX/10BASE-T Physical Layer. For obvious reasons, a POE solution is only possible using the wired Ethernet port. To complete a POE solution, it will require the addition of magnetics, an RJ45 connector, an interface controller and a DC/DC converter to complete the interface.

Overview of POE

A standard CAT5 Ethernet cable has four twisted pairs, but only two of these are used for 10BASE-T and 100BASE-T. The specification allows two options for using these cables 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 spec 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 pair on pins 3 and 6 and the pair on pins 1 and 2 can be of either polarity. This is shown in Figure 2.

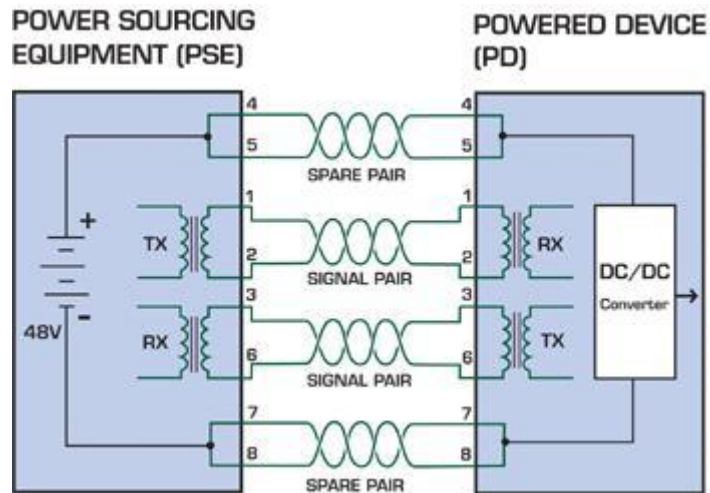


Figure 1 – Power Through the Cable on the Spare Pairs

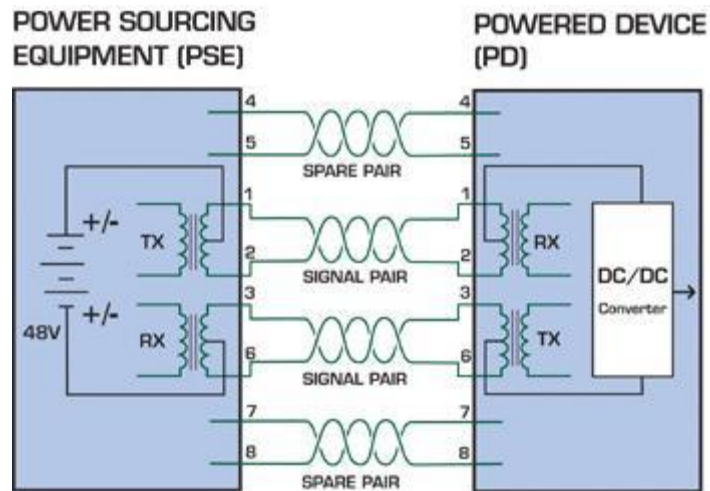


Figure 2 - Power Supplied over the Data Pins

Details of the Power Supply

The Power Sourcing Equipment (PSE) can apply power to either set of wires. The Powered Device (PD) must be able to accept power from the spare or the signal pair. The IEEE802.3af specification allows either set of wires to be used. However, only one of them can be used in a PD at a time.

The sourced voltage is nominally 48V. There is about 13W of power is available at the Powered Device. To power the WiPort/WiPort NR, an isolated DC-DC converter is required to transform the 48V to 3.3V. 1500V of isolation is recommended for safety reasons.

A major requirement of the specification is to prevent damage to existing Ethernet equipment. A "discovery process", run from the Power Sourcing Equipment (PSE), examines the Ethernet cables, looking for devices that comply with the specification. It does this by applying a small current-limited voltage to the cable to check for the presence of a 25k ohm resistor in the remote device. Only if the resistor is present is the full 48V is applied, but this is still current-limited to prevent damage to cables and equipment in 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.

For this application, the WiPort/WiPort NR is the powered device and is referred to as the PD, although, the power available from PoE may be sufficient to the attached device.

PoE Controller

To implement a PoE design requires an 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 IEEE802.3af 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 WiPort/WiPort NR. 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. Because 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 WiPort/WiPort NR's power requirements listed below. For more details on the power regulator, See the Linear Technology LTC1725 data sheet.

DC Characteristics for Serial and Power Interface

Symbol	Parameter	Min	Nominal	Max	Units
V _{CC}	Supply voltage (typical 3.3) (+/-5%)	3.14	3.3	3.46	V
V _{IL}	Low Level Input Voltage	-0.3		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		+/-0.01	+/-1	µA

LAN Magnetics and Connector

There are two choices for the addition of LAN magnetics and an RJ45 connector. The first choice is to use an external magnetic isolation module and a regular RJ45 connector. If PC board space is critical, the second choice is to use an integrated RJ45 connector with built-in magnetics. For more information, please refer to the Lantronix Application Note "How to Connect a Wired Ethernet Port to the WiPort/WiPort NR".

PoE to WiPort/WiPort NR Block Diagram

Figure 3 shows a block diagram of the circuit to power a WiPort/WiPort NR using PoE. As always, it is recommended that you consult the chip manufacturers applications guide as well as the IEEE 802.3af specification before implementing a Power over Ethernet solution.

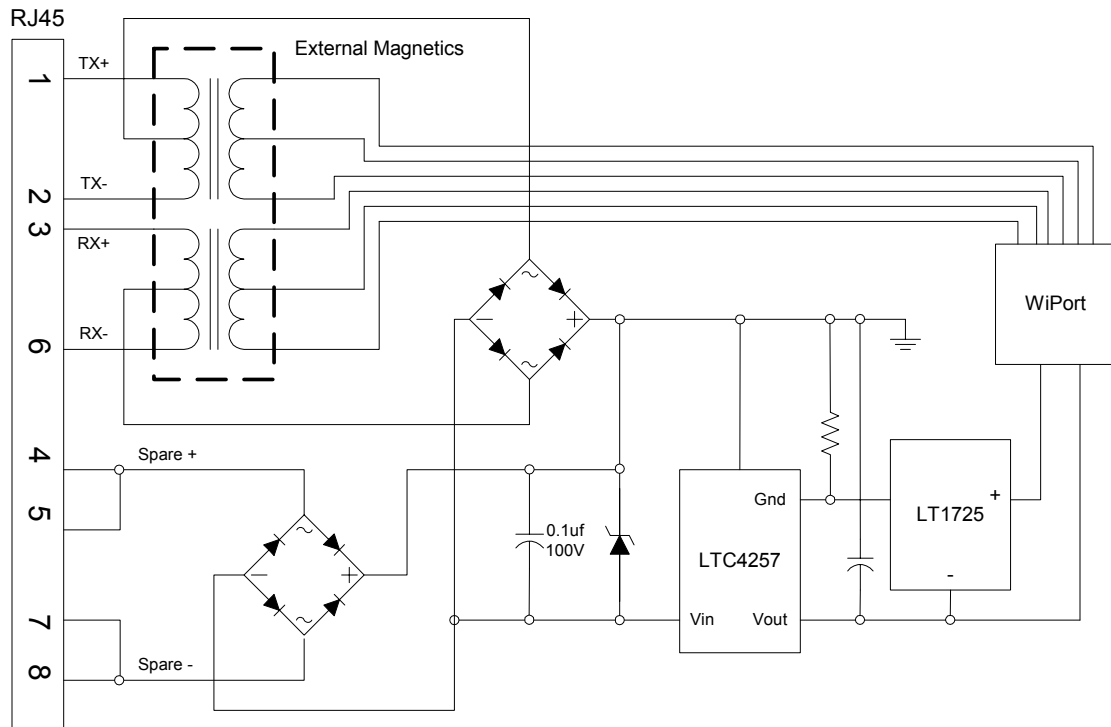


Figure 3 – WiPort/WiPort NR PoE Block Diagram

References

1. IEEE802.3af, Data Terminal Equipment (DTE) Power via Media Dependant I/F (MDI), IEEE computer Society, Draft D4.3, April 2003.
2. IEEE802.3af Power Over Ethernet: A Radical New Technology, www.PowerOverEthernet.com.
3. LTC4257 Data Sheet, Linear Technology Corporation, www.linear.com
4. LTC1725 Data Sheet, Linear Technology Corporation, www.linear.com
5. Power over Ethernet, Linear Technology Chronicle, Vol. 12 No 8., www.linear.com
6. Lantronix Application Note "How to Connect a Wired Ethernet Port to the WiPort/WiPort NR", www.lantronix.com