

Simple PSE Solution Delivers High Power-Over-Ethernet to 16–18-W PD Over Two Pairs

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ABSTRACT

This application report discusses a solution to the additional power required in those PoE applications that exceed the power requirements defined in the current IEEE802.3af standard. Specifically, the document offers a two-pairs solution for 16-W to 18-W powered devices.

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1 Introduction

The Power-over-Ethernet (PoE) technology provides electrical power via standard Cat-5 Ethernet cables, thereby eliminating the need for wall adapters or other external power sources for equipment connected in an Ethernet network. The two major components in a PoE system are the power sourcing equipment (PSE), that provides the power, and the powered device (PD), that receives and uses this power (see [Figure 1](#)).

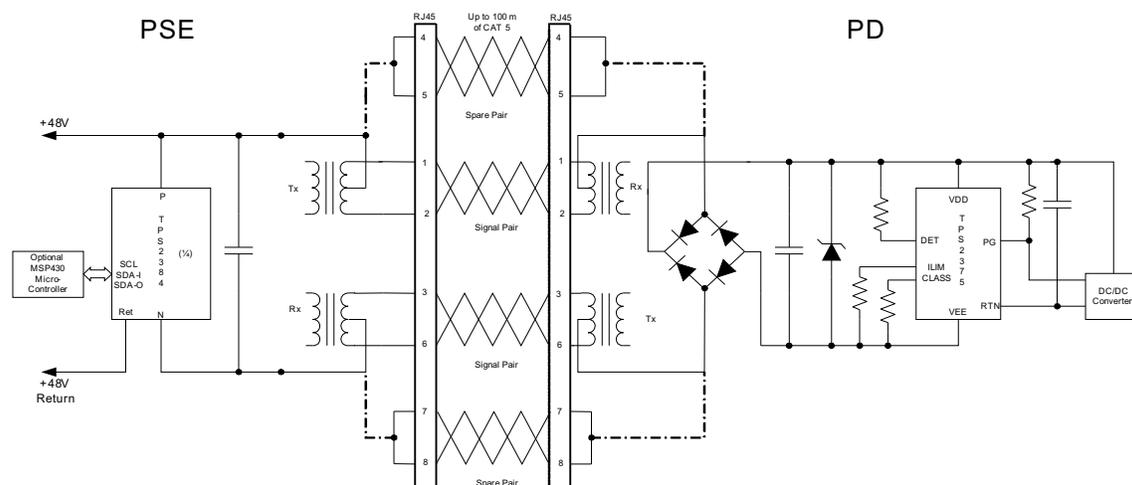


Figure 1. Typical PoE Application Diagram

Recently, practical applications using PoE have been developed. Many of these new applications require more power than the power limit defined in the current 802.3af standard (approximately 13 W at the PD end). For example, a sophisticated security system with motor-controlled cameras would benefit from high-power PoE.

2 Recommended Characteristics

Any high-power solution must meet the following basic criteria:

- Must not overheat the Ethernet cables
- Must not result in an imbalance of current within a pair of wires, thereby avoiding saturating Ethernet transformers
- Must be useable with the existing cabling system, based on Cat-5 cable type
- No overheating in the PSE nor in the PD
- Operating voltage within the 802.3af standard voltage range

Also, such a solution should provide (if possible) the following features:

- Power provided over two pairs only
- Compatibility with 802.3af standard PDs: discovery, classification, current consumption, inrush current, current limit, etc.
- Power management capability
- Use of magnetic components compatible with 802.3af standard
- No additional heating in PSE, PD, or in between
- No loss of efficiency in complete system; even better if efficiency increases

3 Simple High-Power PSE Solution

The IEEE802.3af standard stipulates a PSE output voltage from 44 V to 57 V, with an I_{CUT} (represents a level beyond which power consumption is regarded as an overload) of 350 mA minimum and an I_{LIM} (represents the highest consumption level possible) of 400 mA minimum. Using 100 m of cable with a worst-case feed resistance of 20 Ω (from IEEE802.3af), this results in a limit of 12.95 W at the PD's input, when operating at the minimum allowed voltage.

Integrated power controllers like the TPS2384 are factory-set to meet this requirement. The TPS2384 is capable of delivering 425 mA (I_{LIM}) nominally to the port for a short time. Also, if the port current exceeds 375 mA (I_{CUT}) for more than 62 ms ($T_{OVL D}$), the TPS2384 turns off the port.

The high-power solution proposed in this document, using the TPS2384, involves operating at a higher bus voltage. Currently, Cat-5 communications wiring is the recognized minimum for broadband services. Its specific standard designation is EIA/TIA-568; it is built with 24 AWG conductors which results in worst-case feed resistance of 12.5Ω . It is assumed in the following demonstration that such cable is used.

The minimum operating voltage (at the PSE input) must increase to 53 V, with 55 V nominal and 57 V maximum. In so doing and considering the losses in a Cat-5 cable and the PSE, the minimum power available at the PD's input increases from 13 W to 16 W (see Figure 2).

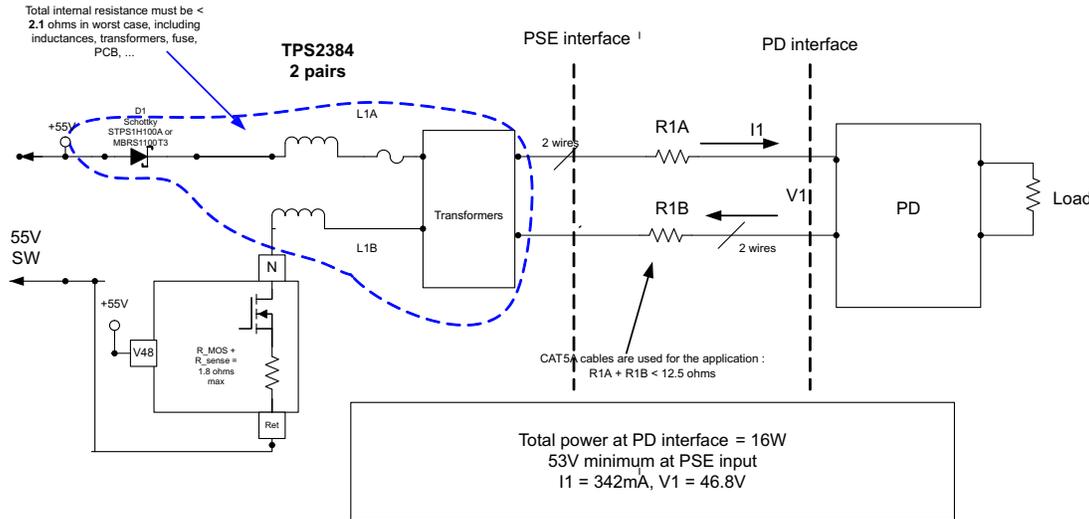


Figure 2. Diagram of a Simple, Two-Pairs Solution for 16-W PD Minimum Worst Case

The benefits of such a solution include:

- Better system efficiency: Normally, a PD uses a switching power supply, which at higher input voltages, consumes less current for a given output power. The effect is that the losses in the cable, the PSE, and the PD input stages decrease. System efficiency increases by 2.5% by increasing input voltage from 44 V to 53 V.
- Dissipation in the cables, PSE, and PD front-end does not increase even if the PD input power increases by 23%.
- Existing Cat-5 cable installations are still useable.
- The risk of imbalance on wires and saturation of magnetics is no greater than with standard PoE applications. However, good design rules must be followed to ensure that no such situation becomes a problem. In some cases, resistor-capacitor ballast networks may have to be installed.
- Compatible with 802.3af standard PDs
- Operating voltage of 53 V to 57 V is within the 802.3af standard voltage range of 44 V to 57 V.
- Power provided over two pairs only
- Power management achievable with the MSP430 microcontroller
- The magnetic components are the same as those used for a standard 802.3af PSE.

However, for this solution to work, the switching power supply providing the 55 V must regulate at a tighter tolerance ($\pm 3.5\%$) Because the operating voltage is high, the 55-V overvoltage protection (OVP) function must be disabled by the MSP430 software. The TPS2384 allows disabling both the OVP and the Port Under Voltage Protection on all four ports simultaneously. The 55-V power supply must incorporate OVP to ensure that any power supply failure does not propagate to the PSE, the loads, or the end-users (as in any standard PoE application).

For applications requiring more power, it is possible to increase the minimum PD power to as much as 18 W (see Figure 3) by using a special release of the MSP430 software.

The characteristics of such a system are:

- Power provided at the PD input increases by 38% versus a standard PoE system.
- Operating voltage range of 53 V to 57 V is within the 802.3af standard voltage range of 44 V to 57 V.

Conclusion

- System efficiency increases by 1% when increasing input voltage from 13 W/44 V to 18 W/53 V.
- Power provided over two pairs only
- Power management is available with the MSP430 microcontroller.
- The magnetics used are the same as those used in a standard 802.3af PSE.
- Existing Cat-5 cable installations still useable
- This level of power requires operation up to 400 mA. This is still within the capability of magnetic components, cables (Cat-5), and connectors used in PoE applications. It is also within the 802.3af standard.
- In PoE applications, good design rules must be followed in order to ensure current balancing between wires within each pair, especially important at this current level.
- The I_{CUT} function is disabled, but the I_{LIM} (400 mA to 450 mA) remains in operation.
- In overload, the output is limited to the I_{LIM} current level. The difference is that the port shutdown is triggered by a thermal detection mechanism rather than by a timer.
- This extra power requires that the PD input current limit is not below 400 mA.

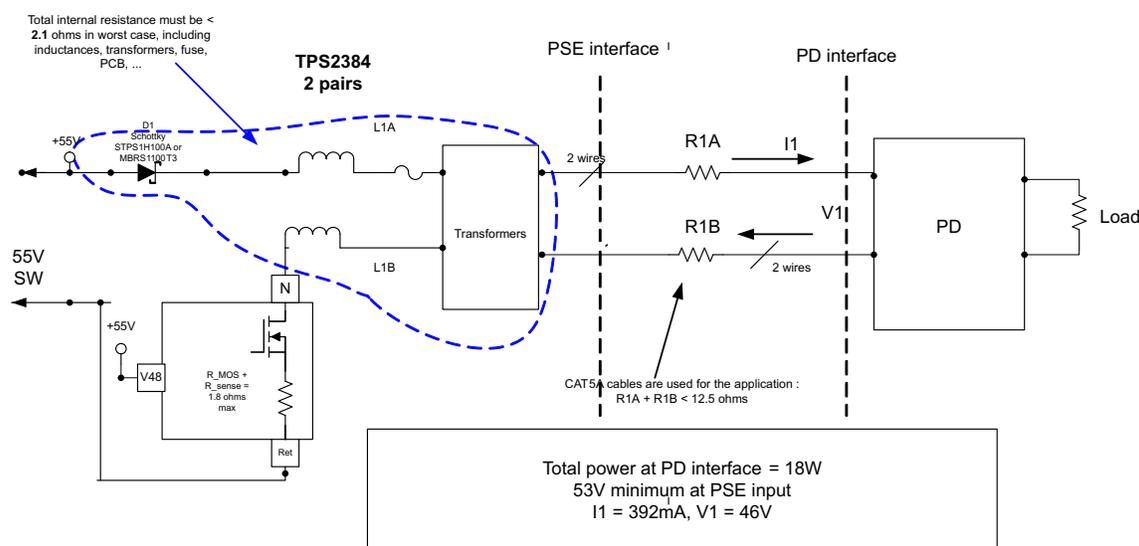


Figure 3. Diagram of Simple Two-Pairs Solution for 18-W PD Minimum Worst Case

4 Conclusion

For higher power, a simple solution based on the usage of a tighter tolerance power supply is possible by using the TPS2384. Available power (with Cat-5 cable) then can be increased from 23% to 38%.

5 References

1. TPS2384 User's Guide, [SLVU126](#)

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