ISSUE: July 2015

Two PSE Controllers Deliver 80 W For Class 5 PoE Power Injector

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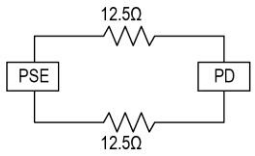
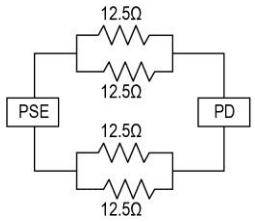
Many power over Ethernet (PoE) applications require 25.5 W or greater and Class 5 operation over a single port. This article explains how to use two power-sourcing-equipment (PSE) controllers with integrated power switches to obtain between 25.5 W and 80 W for a single-port PoE power application. This approach offers a cost-saving alternative to designs employing PSE controller ICs in combination with discrete power MOSFETs. It also provides higher power over a single port rather than resorting to a quad-port design.

We begin by discussing the wiring configuration that will be required to transmit up to 80 W using Cat 5e cabling and the associated transformer/connector needs. Basics of the PSE, which will use either the MAX5971A or MAX5971B controller, and powered device (PD) configurations will then be given before describing in further detail the configuration of two MAX5971A PSE evaluation kits for full-power, single-port Class 5 operation. Test results for this PoE single-port power injector will be provided in a separate spreadsheet.

Delivery System

For Class 5 operation, it is critical to minimize the system resistance in the Ethernet cabling so the application's PSE can deliver all available power to the PD. Cat 3 Ethernet copper cabling has approximately 20 Ω resistance per 100 m (about 330 feet) of cable, while Cat 5e cabling has approximately 12.5 Ω resistance per 100 m. These resistances are for a single Ethernet wire, but the Ethernet cable has eight wires, grouped into four pairs. For Class 5 operation, the cabling pairs are grouped into a 2 x 2 pair configuration. Table 1 details the single Ethernet wire, pair, and 2 x 2 pair configurations.

Table 1. A 2 x 2 pair Ethernet cabling configuration.

SINGLE ETHERNET WIRE	
2-PAIR ETHERNET WIRES	
2-PAIR ETHERNET CABLE	

The 2-pair Ethernet wire (i.e., the 2 x 2 pair) configuration consists of two parallel wires for a combined equivalent resistance of 6.25 Ω (12.5 Ω || 12.5 Ω) and another parallel set of wires for a combined resistance of 6.25 Ω. Therefore, the total loop resistance is 12.5 Ω (6.25 Ω + 6.25 Ω) for the PSE supply and return lines to the PD.

With a typical 2 x 2 pair PSE endpoint configuration, Ethernet wires 1 and 2 are connected in parallel as one line and Ethernet wires 3 and 6 form one parallel line as the other side of the pair. For a second PSE supply

operating in a midspan configuration, Ethernet wires 4 and 5 and wires 7 and 8 are connected in parallel and form both sides of the second pair.

The parallel pair connections are typically implemented using a center-tapped Ethernet magnetic transformer, such as a Bel 0826-1x1T-GH-F gigabit MagJack connector. The gigabit MagJack connector has a maximum rating of 720 mA at 57 V dc and 1.2 A at 57 V dc for up to 200 ms.

PSE Configuration

The PSE controllers used in this design idea deliver up to 40 W, thus two are required for 2 x 2 pair, Class 5, full-power 80-W operation. (The controller ICs can be either two MAX5971As or two MAX5971Bs.) One PSE controller must be configured for endpoint and the other controller for midspan operation. Each controller's overcurrent threshold and current limit must be configured for the desired Class 5 power-level operation. Table 2 explains how to configure the controllers; more information can be found in the device data sheets.

Table 2. MAX5971A Class 5 overcurrent threshold and current-limit settings

I_{LIM1} configuration	I_{LIM2} configuration	Overcurrent Threshold (mA)	Current limit (mA)
Unconnected	Unconnected	Class 5 disabled	Class 5 disabled
V_{EE}	Unconnected	748	850
Unconnected	V_{EE}	792	900
V_{EE}	V_{EE}	836	950

PD Reception

For 2 x 2 operation on the PD side, another Bel 0826-1x1T-GH-F gigabit MagJack is used to receive power and connect the respective pairs in parallel. Additionally a multisource high-power PD controller must be used since the design requires two independent PD controllers. The two PDs pass detection and classification separately, and provide power when both are ready. One PD controller accepts the endpoint PSE power, and the second controller receives the midspan PSE power.

Lab Verification

Two MAX5971A PSE evaluation (EV) kits were configured for full-power, Class 5 operation. One kit was configured for endpoint and the other for midspan operation.

For the endpoint PSE EV kit, an RJ45 Ethernet jack was used as the main power and data output. The jumper JU4 and resistors R5 - R8 were configured for endpoint, following instructions in the data sheet.

For the midspan PSE EV kit, resistors R5 - R8 were removed and jumper JU4 configured for midspan. A 16-gauge wire connected the midspan PSE kit's RTN pad to the endpoint PSE kit VC4 RJ45 Ethernet jack connection using the resistor R8 PCB pad. Another 16-gauge wire connected the midspan PSE kit GND pad to the endpoint PSE VC3 RJ45 Ethernet jack connection using the resistor R7 PCB pad on this kit. The figure shows the EV kit modifications.

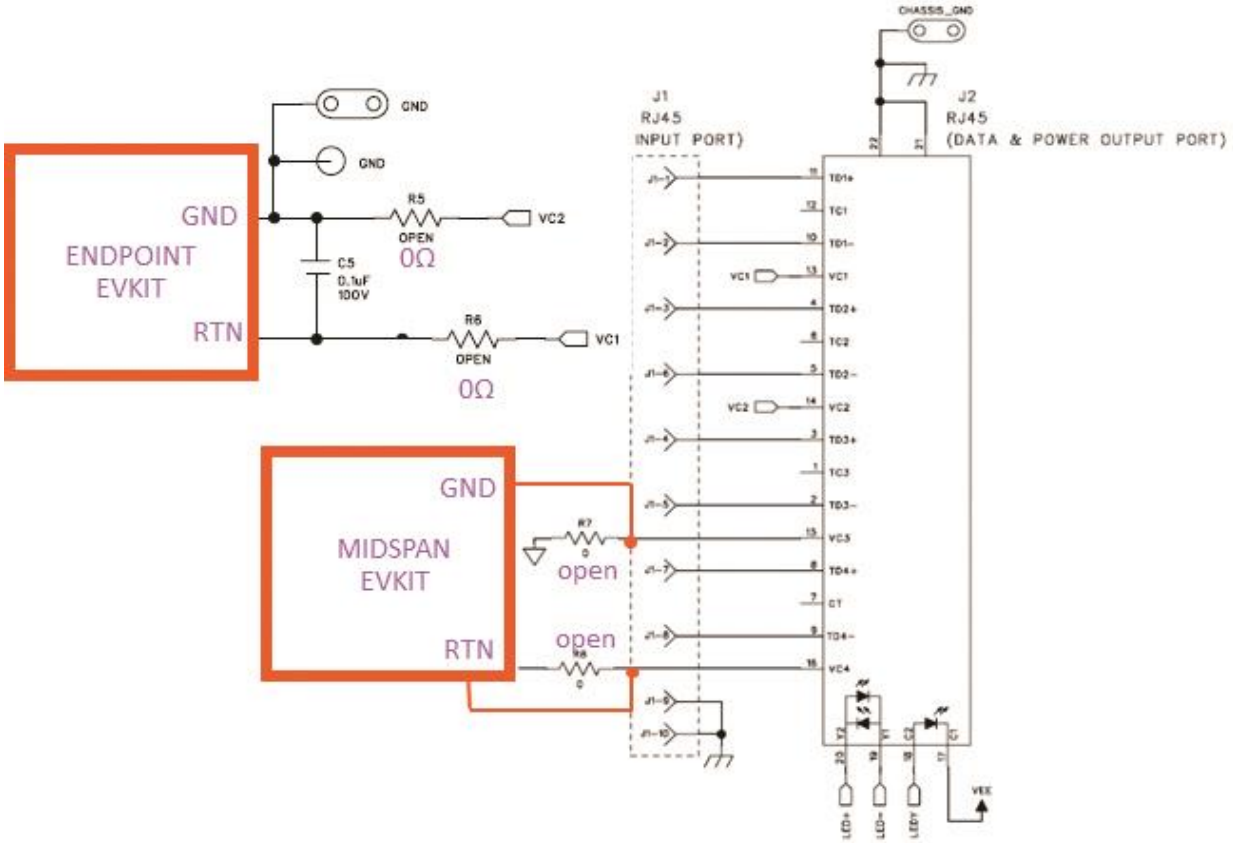


Figure. MAX5971A EV kit modifications for a 2 x 2 Ethernet pair.

A 7-ft (2.1-m) Cat 6 Ethernet cable connected the endpoint PSE Ethernet RJ45 output port to a multisource high-power PD controller. The PD controller's raw 57-V to 48-V output was connected to an HP6060B electronic load. Test data was taken at PD loading of 0 A, 0.35 A, 0.7 A, 1.05 A, and 1.40 A, for PSE input voltages of 57-V, 54-V, and 48-V input rails. Refer to the Excel spreadsheet for the test data.

Using the Cat 6 Ethernet cable and an input voltage of 57 V, the dual PSE controller configuration successfully supplied up to 78.6 W of power to the PSE output's RJ45 Ethernet output jack connected to the multisource high-power PD controller feeding the electronic load. The total PSE input power for this configuration was 80.4 W.

Additional tests were performed using 330 ft (100 m) of Cat 5e Ethernet cable and that test data is also provided. The dual PSE configuration successfully supplied up to 83.7 W of power to the PSE RJ45 Ethernet output jack when the input voltage was 57 V. The total PSE input power for this configuration was 85.8 W.

Conclusion

For PoE applications requiring Class 5 operation up to 80 W through a single port, two PSE controllers with an integrated MOSFET are an excellent cost-effective solution. The PSE controllers used in this design, the MAX5971A or MAX5971B with integrated MOSFET and a sense resistor, delivered up to 80 W to a single port using endpoint and midspan modes in a 2 x 2 configuration. The receiving PD must also be a multisource high-power PD controller for the dual PSE configuration.

About The Authors

Brian Rosario joined Maxim Integrated as an applications engineer in 2013. He has a BSEE from Santa Clara University in California.

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For further reading on designing power over Ethernet equipment, see the How2Power Design Guide, select the Advanced Search option, go to Search by Design Guide Category and select "Networking" in the Application category.