

## USING THE Si3400 AND Si3401 IN HIGH POWER APPLICATIONS

### 1. Introduction

Emerging Power over Ethernet (PoE) applications, such as multi-band and 802.11n access points, often require more power than the 12.95 W specified by the IEEE 802.3af. This application note outlines how to use the Si3400 and Si3401 to support powered device (PD) applications over 15 W output, which corresponds to about 20 W of input power from the PSE.

The current standard for Power over Ethernet or PoE is IEEE Std™ 802.3-2005, clause 33. Although there is currently no ratified standard beyond this, a standard, commonly referred to as PoE+, is being actively developed in the p802.3at subcommittee. While this note attempts to be consistent with the general direction in discussion by the p802.3at committee, it should be emphasized that no standard currently exists to support power above the current specification's 12.95 W maximum of power available at the PD. The proposed solutions in this document are intended to serve as practical solutions for higher power PDs before p802.3at is ratified.

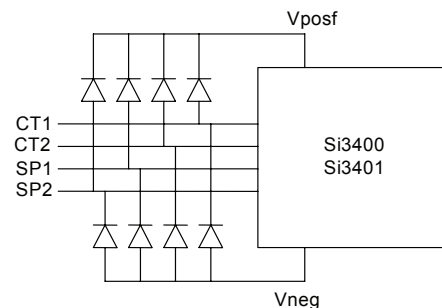
Based on current discussions in the p802.3at committee, it appears likely that the minimum PSE output voltage will be increased, and the maximum cable resistance will be decreased to support PoE Plus. It is also likely that there will be a provision for classifying at the current maximum supported power of 12.95 W input and then negotiating with the PSE for higher power via a simple data exchange with the Ethernet switch using, for example, the 802.3 (LLDP) layer.

### 2. Power and Thermal Considerations

The Si3400 and Si3401 were intentionally designed with "hot swap" switch current limits well above the 350 mA maximum current specification of 802.3af so as not to limit the PD from drawing more power from a PSE as long as the PSE is capable of providing the power. The typical value is 525 mA for the Si3400 and 550 mA for the Si3401. Also, the switcher FET is designed for current levels of up to 4 A with a very low on-resistance of 0.5 Ω (typical). What this means is that the Si3400 and Si3401 are capable of operating at higher power levels, subject to thermal constraints and proper thermal management on the PCB. While the exact voltage and cable resistance have not yet been determined for the PoE+ or 802.3at applications, it is estimated that

support of 15 W output power will require a minimum hot swap switch current limit of about 470 mA. The Si3401 supports a minimum hot swap current limit of 470 mA.

For a typical 5 V isolated application, the dissipation of the Si3400 and Si3401 is 1.2 W for the maximum power of 10 W output with 12.95 W input power. This results in a thermal rise of 54 °C (plus heating due to other components), which is close to the typical 160 °C thermal shutdown temperature specification of the Si3400 and Si3401 when the ambient temperature is 85 °C. While the Si3400 and Si3401 are designed to handle the 12.95 W power level, there is simply too much power dissipation in the Si3400 and Si3401 packages when used beyond this currently-specified limit. To work around this, it is possible to bypass the Si3400's and Si3401's two internal diode bridges using the circuit shown in Figure 1.



**Figure 1. Internal Diode Bridge Bypass**

It is recommended that the diode bridges internal to the Si3400 and Si3401 remain connected so as to allow the early power loss feature (PLOSS signal) to remain active. Low-cost diodes, such as 1N4002, can be used to bypass the diodes on the Si3400 and Si3401 because they have a slightly lower voltage drop. This will help spread the heat in higher power applications. For higher efficiency, Schottky diodes can be used. It is also possible to use just the upper four or lower four diodes for half the benefit at half the cost.

Using the full bypass, the power in the Si3400 and Si3401 is reduced to 0.5 W at 5 V/2 A output and 0.83 W at 5 V/3 A (15 W) output. Both of these power levels are well within the thermal capability of the Si3400 and Si3401 packages.

With the one-half bypass, the power in the Si3400 and Si3401 packages is at the 1.2 W maximum for a 5 V/ 2.6 A (13 W) load.

### 3. Other BOM Considerations

For 802.3af-compliant applications, the basic BOM recommendations for the Si3400 and Si3401 are documented in “AN296: Using the Si3400/01 POE PD Controller in Isolated and Non-Isolated Designs” and the Si3400 and Si3401 ISO EVB user’s guides.

When using the Si3400 or Si3401 at higher power levels, the following other BOM changes are required:

1. Pulse transformer:  
A Coilcraft FA2671 (10:3–3.3 V), FA2672 (10:4–5 V), or FA2732 (1:1–12 V) (transformer with an EP10 core and 40  $\mu$ H magnetizing inductance is currently recommended. For the higher-power application, an EP13 core with the same turns ratio and magnetizing inductance is used.
2. Input Ethernet transformer and jack:  
Several vendors are now offering Ethernet transformers for PoE+, but these are more commonly not integrated in the Ethernet RJ-45 jack.

### 4. Recommended Options for Higher Power Applications

Table 1 lists the recommended options for higher-power, isolated supply applications.

**Table 1. Recommended Options for Higher Power Applications**

PD Controller	Circuit Configuration	Output Power Efficiency	802.3af Compliant Power	Evaluation Systems
Si3400	On-chip diode bridges EP10 or EP13 transformer <sup>1</sup>	10 W 80%	Yes	Si3400ISO-EVB Si3400-EVB
Si3401	Diode bridge bypass EP13 transformer	14–15 W 82%	No <sup>2</sup>	Si3401ISO-EVB Si3401-EVB

**Notes:**

1. EP13 is recommended for short circuit protection.
2. Available output power will depend on minimum PSE voltage and maximum UTP cable resistance.

## 5. Conclusion

The Si3400 is designed for a maximum input power of 12.95 W, which is consistent with the IEEE 802.3af standard. Taking into account cost-effective dc-dc converter implementations and high-efficiency performance, this results in a maximum output power of 10 W.

For applications requiring more than 10 W output power, the Si3401 features an increased hot swap switch current limit of 470 mA (minimum). This allows the Si3401 to support 14 to 16 W applications with a small number of BOM modifications and by selecting an appropriate power supply topology.

Si3401-EVB and Si3401ISO-EVB application boards are available with these recommendations. Complete circuit and performance data are documented in the corresponding user's guides.

## DOCUMENT CHANGE LIST

### Revision 0.1 to Revision 0.2

- Si3400 and Si3401 minimum hot swap switch current limits included.

**NOTES:**

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