Application Brief

How to optimize PoE systems using discrete current sensing

Power over Ethernet (PoE) describes several standards that pass power along with data on twisted-pair Ethernet cabling. PoE allows a single cable to provide both data connection and power to devices such as wireless access points (WAPs), Internet Protocol (IP) cameras, and voice-over-Internet Protocol (VoIP) phones.

Power sourcing equipment (PSE) such as network switches or video recorders are used to power powered devices (PDs). However, many PDs have an auxiliary power connector for an optional external power supply, which often acts as backup power.

PoE offers several classes from one to eight, allowing input powers between 4W and 71W. Powered devices must be designed so that they do not exceed the PoE class specification chosen. If a powered device exceeds its PoE class limit, the PSE turns off the PD.

There are several methods to avoid PSE shutdown. One solution would be to characterize the load by measuring the maximum power consumption of every subsystem in the PD, and designing for a PoE class that is within that characterized peak power to guarantee that the powered device never exceeds the PoE class limit. However, this method is not ideal because it requires more characterization and the selection of an arbitrarily high PoE class.

Suppose designers chose not to characterize their systems for the highest possible power consumption and want to dynamically control system power consumption to stay within a lower PoE class limit, in this case, their circuit design would require current sensors.

Current sensors can monitor DC/DC converter current and report to an MCU or PMIC that controls the various subsystems within a PD, throttling power, and cycling functionality to avoid exceeding the PoE class limit.

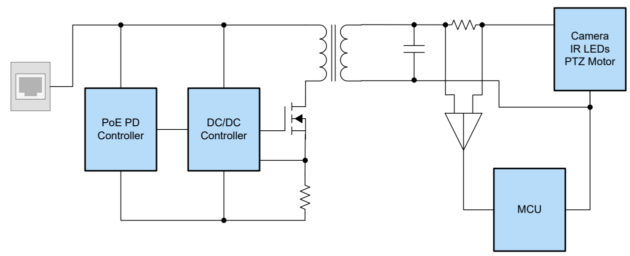

Figure 1. Current sensor in a PoE-powered device (IP camera)

Flyback converters are a common choice for DC/DC conversion in low-power applications like PDs due to their low cost and BOM count. These DC/DC converters reduce the voltage from 48 V to 12 V. Current sensors can be placed in several locations around the flyback transformer before the load. Measuring current on the primary and high-voltage side of the flyback offers the greatest accuracy as the power seen here includes losses in the DC/DC. However, designers must select a higher common-mode input range capable device like the INA238 to accommodate the 44-V to 57-V rail.

Low-side current sensing on the primary side offers diminished accuracy as this option does not include power losses in the transformer. Still, these current sensing devices (like the INA180) do not require high common-mode voltage capability. Current sensing on the secondary side of the transformer also allows designers to choose lower common-mode input voltage devices, but the sensor will not include power losses in the flyback converter. This leads to diminished current sensing accuracy because designers must estimate or characterize power losses in their DC/DC converter to know the power consumption of the entire PD.

The next selection is the technology of the current sensor. Digital power monitors like the INA219 can measure bus voltage and current, multiplying these to output a power calculation over I2C. Having power information means designers can more accurately and easily know how close the powered device is to the PoE class limit.

The second option is to use an analog-output current sense amplifier like the INA180 which will not give bus voltage information, so if the rail voltage fluctuates, designers will not be able to know the total power consumption of the PD with as great accuracy.

Ultimately, this power or current information communicates to a microcontroller or SoC. This microcontroller or SoC is responsible for making decisions about turning off or throttling power and current to downstream electronic subsystems when current reaches too close to the class limit. So in an IP camera, for example, the MCU or SoC could turn off the pan-tilt-zoom (PTZ) motor, heater, or IR LEDs when power consumption gets too close to the class limit.

Current sensors can be used for other uses in powered devices. Specifically for IP cameras, subsystem current can be monitored. Often IP cameras are used outside in cold weather conditions and heaters must be implemented. Power is a leading indicator for temperature for resistive heating, therefore digital power monitors or current sense amplifiers can be used to actively control heating elements. Current sensing can also be used for safety and diagnostics in PTZ servo/stepper motors.

Additionally, IP cameras often have auxiliary power inputs in the form of 24 V_{ac} and 12V_{DC}coaxial inputs. Current sense amplifiers can be used with a FET in a simple e-fuse configuration on these input rails to monitor if current exceeds a threshold, triggering the FET and turning the device off to protect downstream electronics.

Related Documentation:

1. Texas Instruments, *Getting Started with Digital Power Monitors* application note
2. Texas Instruments, *Integrating the Current Sensing Signal Path* application brief

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