

## Active Bridge Rectifiers Reduce Heat Dissipation within PoE Security Cameras – Design Note 519

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### Introduction

Power over Ethernet (PoE) has been embraced by the video surveillance industry as a solution to an age-old problem: complicated cabling. For instance, a basic, traditional fixed-view security camera requires two cables: one for power (10W to 15W from a 24V AC or 12V DC), and a separate, coax cable for the video signal. With PoE, a single Ethernet cable carries both video data and power. Everything is simplified. Right?

Not quite. To meet compatibility with existing systems, camera manufacturers must produce PoE-enabled cameras that are also compatible with legacy power sources—they must accept PoE 37V to 57V DC from an RJ-45 jack or 24V AC, +12V DC, or -12V DC from an auxiliary power connector.

### The Old Way Loses Power

Figure 1 shows the power architecture used by many PoE camera manufacturers to solve this problem. A full-bridge diode rectifier after the auxiliary (old-school) input produces positive DC power from either 24V AC, +12V DC or -12V DC. The resulting DC power and the

PoE inputs are diode-ORed with the winning supply fed to a wide input voltage isolated switching power supply, which in turn powers the camera electronics.

This power architecture presents a few challenges. When the camera is powered from the auxiliary input, three diodes (circled in Figure 1) fall into the power path. In addition to the inefficiency of this design and possible heat problems from the power dissipated by the diodes, the three diodes lead to a significant voltage drop at the input to the switching power supply. With a 10W to 15W camera, these challenges are easily surmountable, but the latest security cameras have doubled this power consumption. Features like pan/tilt/zoom (PTZ) and camera lens heaters for outdoor operation have made this power architecture unsuitable for this new wave of cameras.

To illustrate the architecture's deficiencies, consider a 26W camera. For a 12V DC auxiliary input (assumed to

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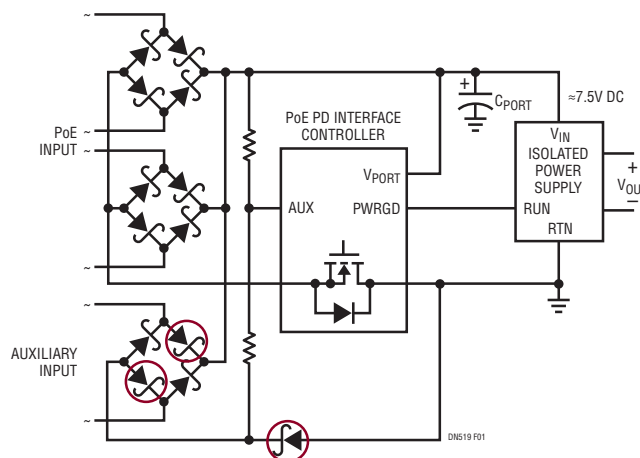


Figure 1. Auxiliary Input and PoE Power Architecture

actually be 9V DC due to use of unregulated wall warts/ AC adapters) and three 0.5V drop Schottky diodes, the input voltage of the switching power supply is 7.5V ( $9V - 3 \cdot 0.5V$ ). The input current for this camera is approximately 3.5A ( $26W/7.5V$ ). The resultant power dissipation of the three Schottky diodes in the power path is 5.2W ( $3.5A \cdot 3 \cdot 0.5V$ ). This power dissipation leads to higher temperature within the camera, which is difficult, time consuming and expensive to mitigate.

### Improve Performance with Ideal Diodes

Figure 2 shows a way to counter this shortcoming. Here, the two diodes of the full-bridge rectifier are replaced by ideal diodes, circled (black) in Figure 2. Ideal diodes are simply MOSFETs controlled to behave like regular diodes. The advantage of an ideal diode is that one can use MOSFETs with low channel resistance ( $R_{DS(ON)}$ ), thus reducing the forward voltage drop ( $I_{DS} \cdot R_{DS(ON)}$ ) to much less than a Schottky diode drop. The LT<sup>®</sup>4320 ideal diode bridge controller enables the control of four MOSFETs in a full-bridge configuration. The third diode drop due to the diode-OR in Figure 1 is eliminated by the LT4275 LTPoE++<sup>™</sup>/PoE+/PoE PD controller. Its topology allows the use of a few small-signal diodes, circled together (red) in Figure 2, for auxiliary input sensing. These diodes are not in the power path as in the traditional architecture, so they do not contribute any additional voltage drop or heat issues.

### Results

The power architecture shown in Figure 2 significantly reduces overall power losses when compared to that of Figure 1. To quantify, the LT4320 combined with low channel resistance MOSFETs results in a 20mV drop across each ideal diode bridge MOSFET. This produces an input at the isolated supply of 8.96V ( $9V - 2 \cdot 20mV$ ). The higher input voltage drops the required input current to only 2.9A ( $26W/8.96V$ ) versus the original 3.5A.

The resulting power dissipation of the improved architecture is now a scant 116mW ( $2.9A \cdot 2 \cdot 20mV$ ), versus 5.2W for the original architecture—a 45x reduction! Additionally, the lower input current further reduces power dissipation in the isolated power supply's power components (i.e., input filter inductor, power transformer and switching MOSFETs) due to the reduction of their  $I^2R$  power losses. A simple calculation puts this reduction at 31% ( $100\% - 2.9A^2/3.5A^2$ ).

### Conclusion

Adding the LT4320 and LT4275 to the auxiliary and PoE inputs of a PoE-enabled security camera recovers more than 5W ( $5.2W - 116mW$ ) of power dissipation over traditional full-bridge/diode-OR designs. This reduction of power eases the thermal design time and complexity of PoE security cameras.

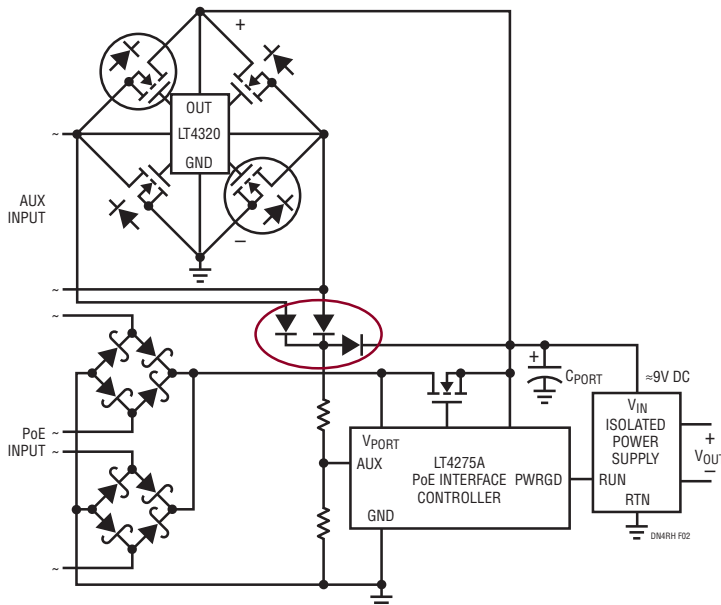


Figure 2. Improved Power Architecture with No Diode Drops in Power Path

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dn519f LT/AP 1013 111K • PRINTED IN THE USA



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