DI-102 Design Idea
DPA-Switch®

Lowered Overvoltage for Power over Ethernet (PoE)

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
PoE/VoIP	DPA423GN	–	36 – 57 VDC	–	–

Design Highlights
- Optimized overvoltage for PoE Powered Devices (PD's)
- Turn-off threshold 65 VDC and turn-on threshold 63 VDC
- Compliance to IEEE 802.3af standards over complete voltage window ensures compatibility with power sending equipment

Wide Hysteresis Overvoltage
The default under-voltage and overvoltage shutdown thresholds of the DPA-Switch are programmed with a single resistor (R_{LS}) connected from the positive input voltage to the L-pin. The default overvoltage and under-voltage thresholds have a fixed ratio (approximately 2.7:1).

The operating voltage range for PoE systems is 36 VDC to 57 VDC, a much smaller ratio. Overvoltage Shutdown (OVSD) on the PD allows protection against possible system faults, giving the design an increased level of robustness. This can be achieved by adding a simple discrete circuit.

Operation
This circuit allows the overvoltage shutdown threshold to be set to approximately 63 VDC. The DPA-Switch detects the input voltage via the current in L-pin resistor R_{LS}. Above the OV-off threshold (135 µA), the DPA-Switch is disabled and below the OV-on threshold (131 µA), the DPA-Switch becomes operational again. At start-up, transistor Q2 is pulled low (off) via resistor R5, so as not to interfere with the under-voltage detection threshold. Transistor Q2 is pulled high (on) via resistor R4 and will turn on once the input voltage comfortably exceeds the undervoltage turn-on level, at the defined threshold voltage ($V_{IN(th)}$ = 60 VDC). When turned-on, transistor Q2 connects the Control pin (C) voltage (V_C) to the L-pin via R6, thus adding a fixed current (approximately 37 µA) to the L-pin. This additional current lowers the OV on and off voltage thresholds.

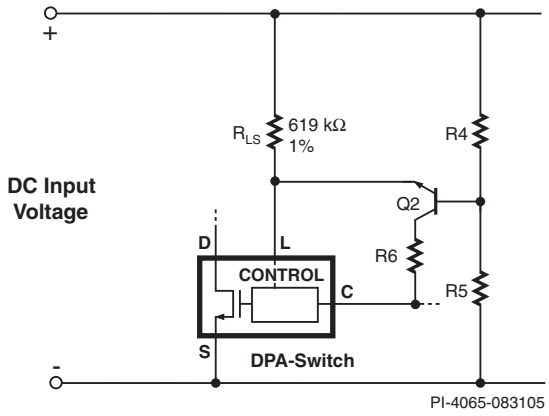

Figure 1. DPA-Switch With Lower OVSD (R1 = 10 MΩ, R2 = 560 kΩ, R3 = 82 kΩ.

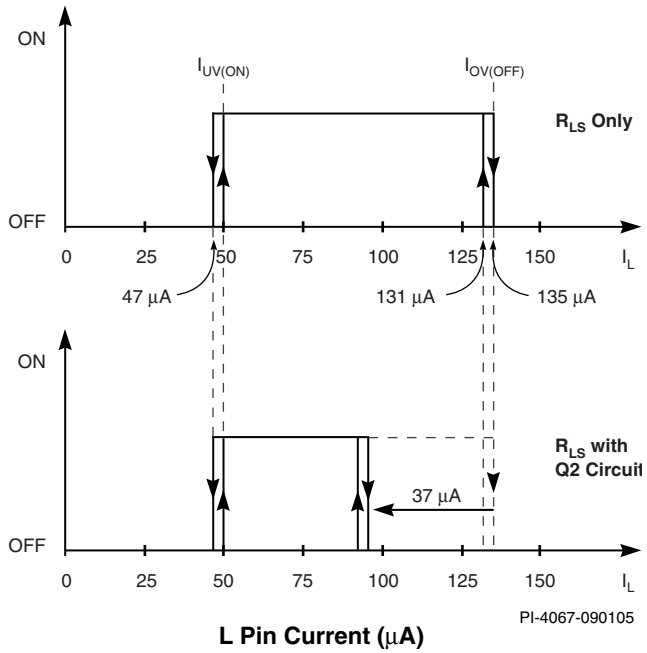

Figure 2. L-Pin Current Without/With Wide UVSD Circuit.

Design Formulae
Component values are calculated as follows:

IEEE 802.3af overvoltage requiements are:

V_{OV_OFF} = 63 VDC	Input voltage turn-off
$V_{IN(th)}$ = 60 VDC	OVSD becomes active

From the DPA-Switch data sheet we have the following:

I_{OV_OFF} = 135 µA	This is the L-pin current at which the device turns off
V_L = 2.5 VDC	L-pin voltage at $I_L = I_{OV\_OFF}$
V_C = 5.8 VDC	Control-pin voltage

Assumptions:

$V_{Q1(BE)}$ = 0.7 VDC	Transistor base-emitter voltage
β = 100	Transistor minimum current gain
K = 10	This is the ratio of transistor bias versus collector current (larger K gives stronger bias)

Resistor values R4, R5 and R6 are calculated as:

$$R_4 \geq \frac{(V_{OV\_OFF} - V_L - V_{Q1(BE)}) \times \beta}{I_{ON\_OFF} \times K}$$

$$R_5 \geq \frac{(V_L + V_{Q1(BE)}) \times R_4}{V_{ON\_OFF} - V_L - V_{Q1(BE)}}$$

$$R_6 = \frac{(V_L - V_C) \times R_{LS}}{V_{ON\_OFF} - I_{OV\_OFF} \times R_{LS} - V_L}$$

$$V_{IN(th)} = \frac{(V_L + V_{Q1(BE)}) \times (R_4 + R_5)}{R_5}$$

$$V_{ON\_OFF} = \left(I_{ON\_OFF} - \frac{V_C - V_L}{R_6}\right) \times R_{LS} + V_L$$

Key Design Points
- 1% accuracy resistors should be used to maintain the highest accuracy for the OV on and off thresholds.
- To avoid interfering with the under-voltage thresholds, the voltage $V_{IN(th)}$, must be programmed above under-voltage levels.
- The D_{MAX} limit of the DPA-Switch linearly decreases with increasing input voltage (increasing L-pin current), when using only resistor R_{LS} for under/overvoltage detection. However when the overvoltage threshold is modified with additional circuitry, this will effectively change the D_{MAX} limit proportionally at voltages above the threshold voltage ($V_{IN(th)}$). The power supply designer should therefore make sure that the power supply can still deliver the required power with the reduced maximum duty cycle at high line.

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