

Design Idea DI-102

DPA-Switch® Lowered Overtoltage for Power over Ethernet (PoE)



Application	Device	Power Output	Input Voltage	Output Voltage	Topology
PoE/VoIP	DPA423G	-	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 Overtoltage

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. Overtoltage 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.

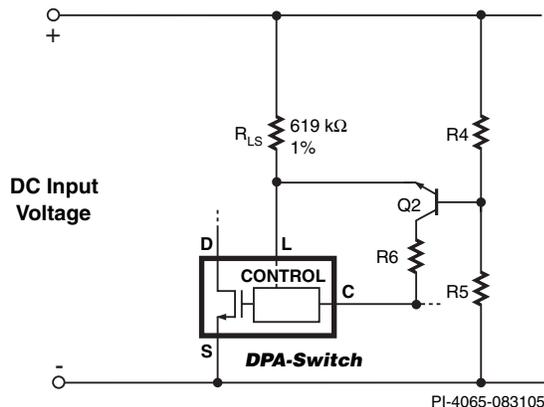


Figure 1. *DPA-Switch* with Lower OVSD ($R_1 = 10\text{ M}\Omega$, $R_2 = 560\text{ k}\Omega$, $R_3 = 82\text{ k}\Omega$).

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 under-voltage turn-on level, at the defined threshold voltage ($V_{IN(th)} = 60\text{ VDC}$). 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.

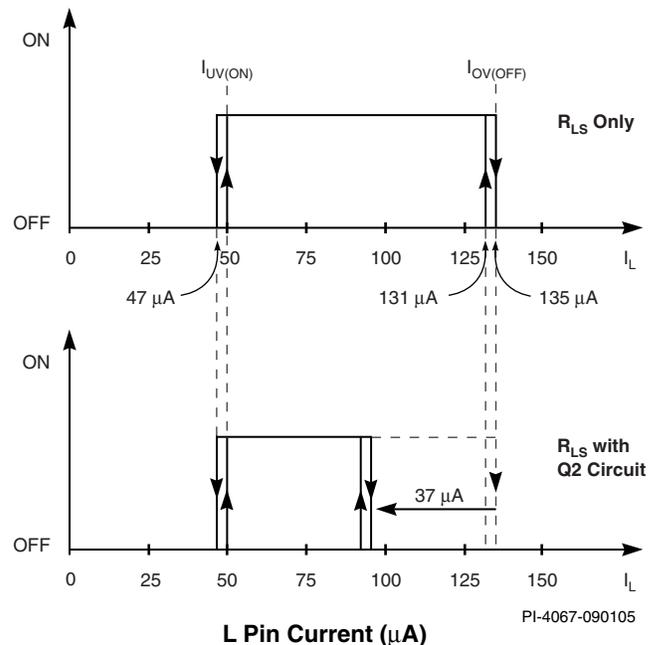


Figure 2. L-Pin Current without/with Wide OVSD Circuit.

Design Formulae

Component values are calculated as follows:

IEEE 802.3af overvoltage requirements 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:

$I_{OV_OFF} = 135$ μ A 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
 $\beta = 100$ 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:

$$R_4 \geq \frac{(V_{OV_OFF} - V_L - V_{Q1(BE)}) \cdot \beta}{I_{OV_OFF} \cdot K}$$

$$R_5 \geq \frac{(V_L + V_{Q1(BE)}) \cdot R_4}{V_{OV_OFF} - V_L - V_{Q1(BE)}}$$

$$R_6 = \frac{(V_L - V_C) \cdot R_{LS}}{V_{OV_OFF} - I_{OV_OFF} \cdot R_{LS} - V_L}$$

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

$$V_{OV_OFF} = \left(I_{OV_OFF} - \frac{V_C - V_L}{R_6} \right) \cdot R_{LS} + V_L$$

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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