

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

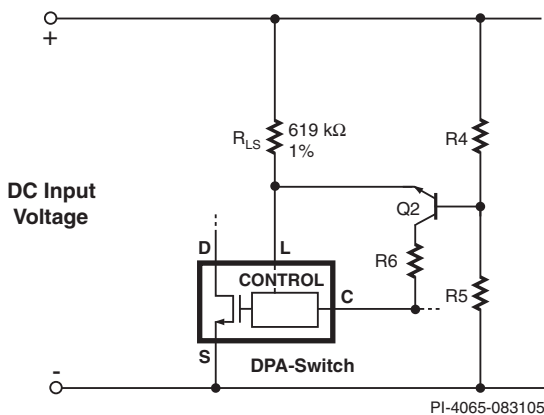


Figure 1. DPA-Switch With Lower OVSD ($R1 = 10\text{ M}\Omega$, $R2 = 560\text{ k}\Omega$, $R3 = 82\text{ k}\Omega$).

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 ($V_{IN(th)} = 60\text{ VDC}$). 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.

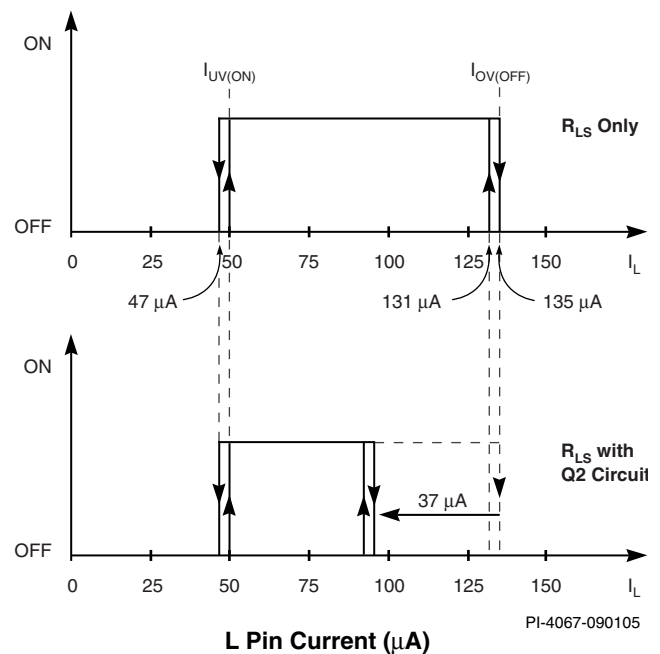


Figure 2. L-Pin Current Without/With Wide UVSD Circuit.

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:

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

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

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

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

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

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.

Power Integrations
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1 408-414-9200
Customer Service
Phone: +1-408-414-9665
Fax: +1-408-414-9765
Email: usasales@powerint.com

On the Web
www.powerint.com

Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS. The products and applications illustrated herein (transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at www.powerint.com. Power Integrations grants its customers a license under certain patent rights as set forth at <http://www.powerint.com/ip.htm>.

The PI logo, TOPSwitch, TinySwitch, LinkSwitch, DPA-Switch, PeakSwitch, EcoSmart, Clampless, E-Shield, Filterfuse, StackFET, PI Expert and PI FACTS are trademarks of Power Integrations, Inc. Other trademarks are property of their respective companies.
©2005, Power Integrations, Inc.