

Powered Device Controllers Comparison: TPS2375/TPS2377 vs TPS2370/TPS2371

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ABSTRACT

Two generations of powered device (PD) controllers are available from Texas Instruments for Power-over-Ethernet PD solutions. They are the TPS2370/TPS2371 and the TPS2375/TPS2377. While they are largely pin-compatible, some differences between these two families of PD controllers make the TPS2375 and TPS2377 the preferred devices. This report explains the major differences between the two families.

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1 Introduction

Texas Instruments offers two families of powered device controllers (PDC): the TPS2370/71 and the TPS2375/76/77 for IEEE 802.3af powered device (PD) applications. Both families contain all of the features needed to develop an IEEE 802.3af-compliant powered device. The TPS2370/71 is the first generation PDC featuring 68-V ratings and a DC/DC enable output. The TPS2375/76/77 family is the second generation PDC that is rated 100 V and has a true open-drain, power-good function.

2 Comparisons

This section explains the key differences in features and parameters for comparison of these two generations of PDCs.

2.1 Maximum Voltage Ratings

A higher $V_{DD\text{-to-}V_{SS}}$ (or $V_{DD\text{-to-}V_{EE}}$) voltage rating is desirable due to transients, and the IEEE standard defined continuous input voltage can be as high as 57 V.

Both the TPS2370 and the TPS2371 have 68-V maximum voltage ratings and are adequate for Power-over-Ethernet (PoE) applications. A good PCB layout and a high-quality input transient voltage suppressor are required to minimize voltage spikes that may be seen on the device during transients.

The second generation PDCs, TPS2375/76/77, were released to market with a 100-V voltage rating, in order to reduce the design cost and increase application reliability. Compared to the TPS2370/71 family, the TPS2375/76/77 family is far more robust. In the latter family, sufficient margin exists to put in a low-cost transient suppressing Zener diode, even if a peak working voltage of 80 V is assumed.

Because of the higher voltage rating and improved ESD structure, a PD module with the TPS2375/76/77 can meet 15-kV system level ESD requirements.

2.2 Operation Temperature Range

An important consideration in designing powered devices is ambient temperature extremes. PD equipments exposed to the outdoors can experience extreme hot and cold temperatures over time. The TPS2370 and the TPS2371 can only operate over the commercial temperature range (0 to 70 °C). The TPS2375 family works over the full industrial temperature range (-40 °C to +85 °C). The second generation PDCs are thus suitable for a broader range of applications.

2.3 Current Limit and Inrush Termination

The current limit function is approximately the same for the two families; both set the current limit at 450 mA typically during normal operations.

The inrush current limit has been changed for easier design and better performance. The inrush current limits of both families are adjustable with an external resistor from the ILIM pin to VSS (or VEE). The relationship between the resistor value and the inrush current limit is different. For TPS2370/71, the inrush current limit is set by:

$$I_{LIM} = 0.45 - \frac{25000}{R_{ILIM}} \quad (1)$$

And for TPS2375/76/77, that changes to:

$$I_{LIM} = \frac{25000}{R_{ILIM}} \quad (2)$$

Inrush current termination is improved in the newer family. For the TPS2370/71, the inrush current limit is switched to the normal current limit (450 mA) as soon as the output voltage across the load is within 1.5 V of its final value. This causes a short-period current surge as the load capacitor is rapidly charged for the last 1.5 V. In order to eliminate this surge, the TPS2375/76/77 integrates a new inrush current control circuit that waits for charge current to drop before switching inrush current limit to normal current limit. Figure 1 shows the difference of inrush current termination for the two families of PDCs.

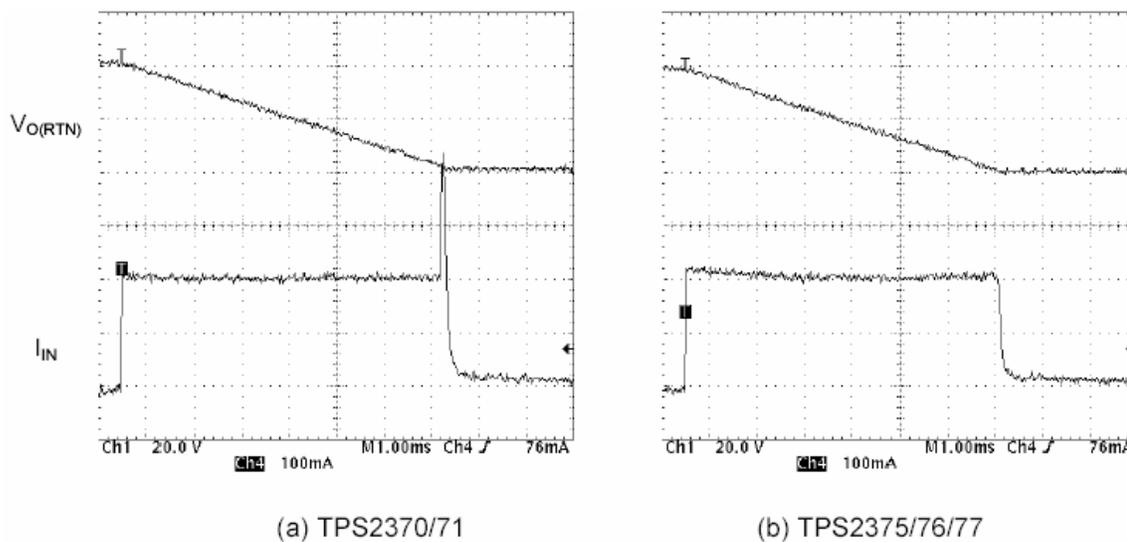


Figure 1. Inrush Current Limit and Termination Comparison of PDCs

2.4 PG vs EN_DC Output

The TPS2370/71 offers a soft-start DC/DC enable output EN_DC that is pulled down to VEE by an 80- μ A current source. The limited drive capability makes interface to some connectors more complex. The TPS2375/76/77 has a true open-drain, power-good (PG) output which can easily sink 2 mA.

2.5 Other Changes

The TPS2375/76/77 family has additional improvements. These include improved regulation over the classification voltage range, new undervoltage-lockout (UVLO) thresholds, and the post-inrush PG delay function. The changes related to classification and UVLO allow greater flexibility in input diode selection and greater compatibility with legacy power-sourcing equipment (PSE) in the PoE market. The TPS2371 has a post-inrush UVLO delay (adjustable with an external capacitor) to enable legacy IEEE 802.3af compatibility. The TPS2377 improved inrush allows operation with legacy PSE without the delay.

2.6 Summary

Table 1 summarized the comparisons between the two generations of PDCs. For more detailed parameters, see the relevant data sheets of these devices.

Table 1. Comparison of the TPS2370/71 and TPS2375/76/77 PDCs

Features/Parameters	TPS2375/76/77	TPS2370/71
Switch, $R_{DS(ON)}$	1 Ω	0.60 Ω
V_{DS_MAX} (Abs Max)	100 V	68 V
Operating Temperature Range	-40°C – 85°C	0°C – 70°C
Inrush Current, I_{LIM}	25k / R_{LIM}	0.45 – (25k / R_{LIM})
PG vs EN_DC	Open drain to RTN, 2 mA	Current sink to VEE, 80 μ A
Classification (nom)	13 V – 21 V, improved regulation	12.5 V – 22.5 V
802.3af UVLO (nom)	30.6 V / 39.4 V	31.4 V / 40.2 V
Legacy UVLO (nom)	30.5 V / 35.0 V	30.5 V / 35.0 V
Post-Inrush UVLO Delay	No	70 – no, 71 – yes
Inrush Termination	Enhanced	N/A

3 Replacing TPS2370/71 with TPS2375/77

A typical application diagram with a TPS2370 or a TPS2371 PDC is shown in Figure 2, where the capacitor C_D is only for applications with TPS2371. Assuming the initial inrush current limit is set to 250 mA, then the resistance for R_{LIM} must be 125 k Ω . The pullup resistance R_{PULL_UP} is for demonstration only, but has to be at least 0.5 M Ω in this example.

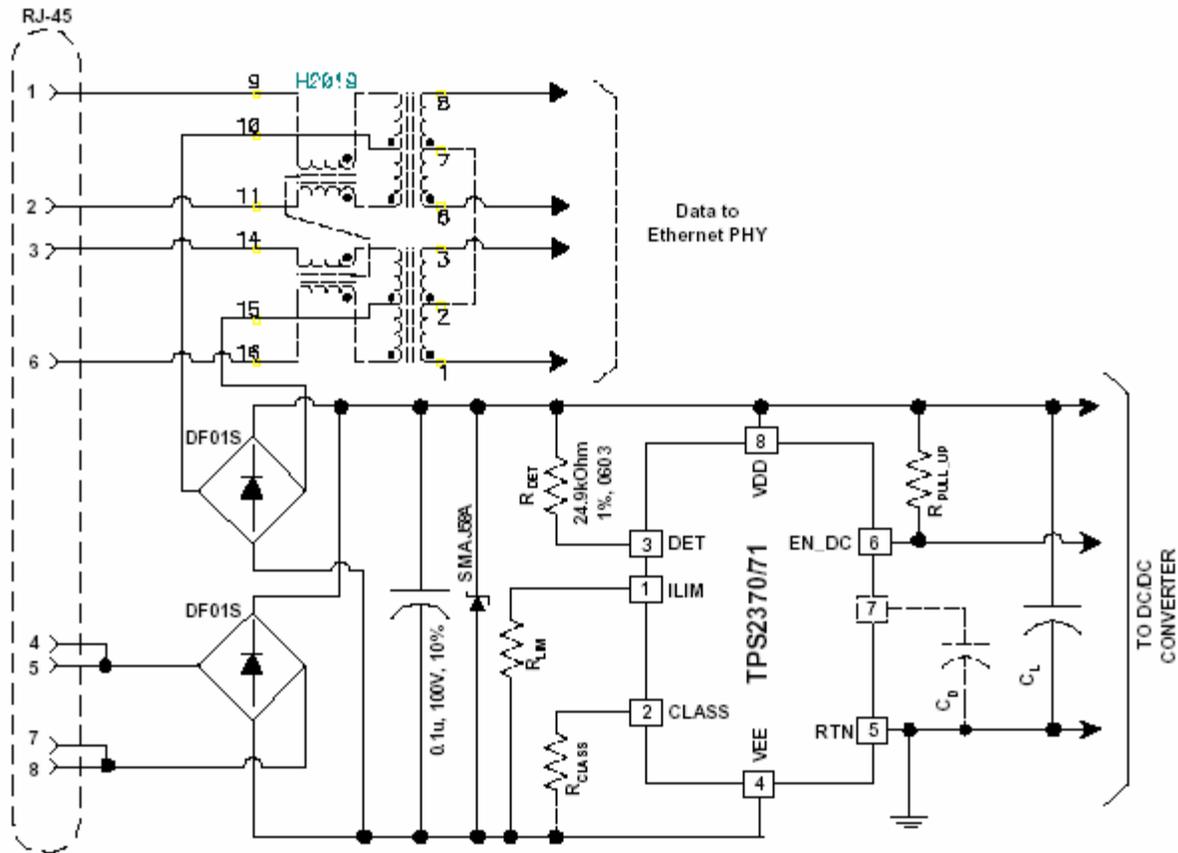


Figure 2. A Typical PD Front-End Application Diagram With TPS2370/71

In contrast, a typical application diagram with the TPS2375/77 is the same as that with a TPS2370 except that the values of R_{LIM} and R_{PULL_UP} may be different, as shown in Figure 3. To get 250-mA inrush current limit, R_{LIM} needs to be 100 k Ω . The pullup resistance can be as low as 20 k Ω .

Because of the pin compatibility between these devices, layout changes are not needed when replacing a TPS2370/71 with a TPS2375/77 in an existing design. Only the value of R_{LIM} needs to be changed, as it has a different relationship with the inrush current in these two families of PDCs. The pullup resistance only needs to be changed if a different drive capability is required.

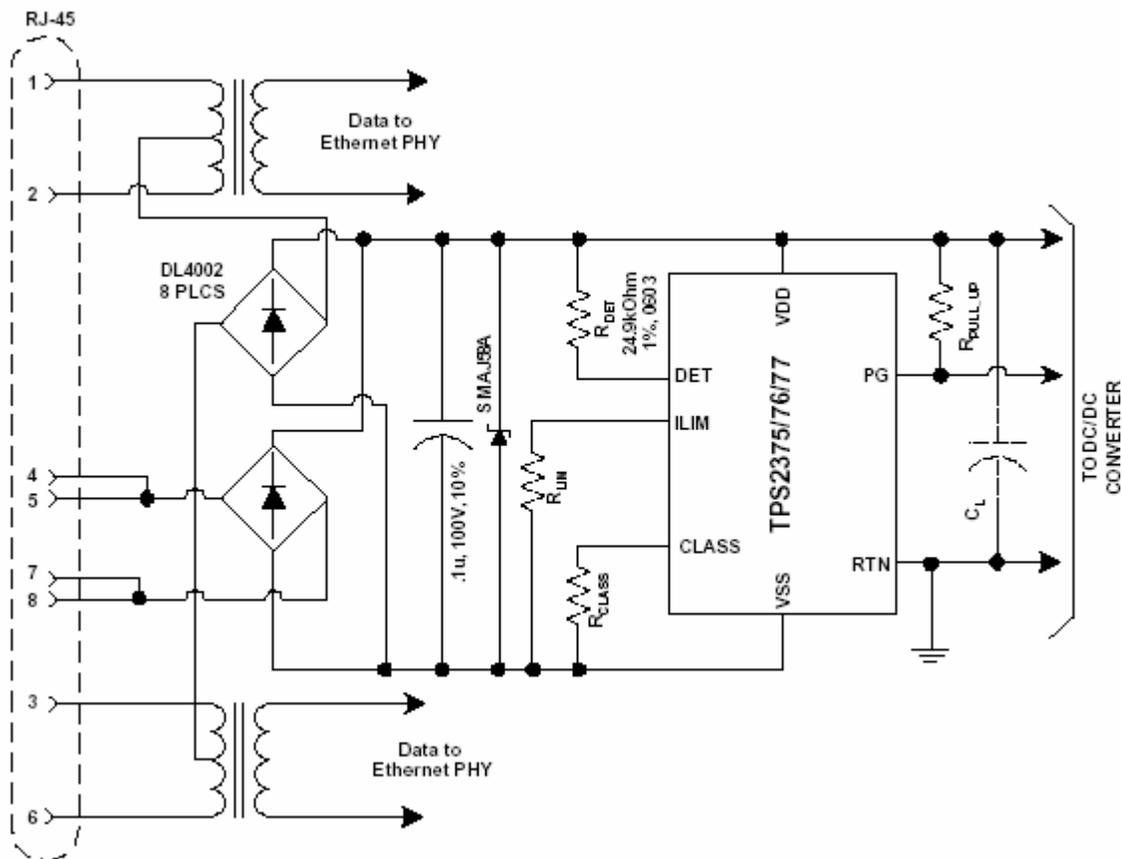


Figure 3. A Typical PD Front-End Application Diagram With TPS2375/77

4 Conclusions

The TPS2375/76/77 family is an enhanced and so preferred option for power device controllers. Customers can transition their TPS2370/71 designs to the 2375/76/77 family without any difficulty. For existing designs with TPS2370/71, no layout changes may be required for upgrading to a TPS2375/77 as the PDC.

5 References

1. *TPS2370, IEEE 802.3af Power Interface Switch for Power Over Ethernet (PoE) Powered Devices (SLUS537)*
2. *TPS2371, Legacy/IEEE802.3af Compatible Power Interface Switch for Power Over Ethernet (PoE) Powered Devices (SLUS566)*
3. *TPS2375, TPS2376, TPS2377, IEEE 802.3af PoE Powered Device Controllers (SLVS525)*

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