

TPS272C45 Enables Smart Power Management of Remote I/Os



The development and subsequent expansion of IO-Link (IEC 61131-9) open standards protocol has fueled the rapid adoption of rugged yet intelligent remote I/O modules in industrial systems. High side switches in remote I/O modules are used to power field devices such as sensors and actuators. As the module sizes shrink to ever smaller form factors, power dissipation and thermal management become key challenges for the module design. This is especially true with the fully-enclosed IP67 ingress protection rated remote I/O modules.

In this note, we will introduce TI's industrial smart high side switch (TPS272C45) with features specifically designed to overcome this thermal challenge. In addition, in order to distribute power and drive output loads optimally, the TPS272C45 also provides protection and diagnostic capabilities. The robust protection and the enhanced diagnostics can be taken advantage of to prevent extended downtimes for factories.

High-Side Switches in Remote I/O

The IO-link specification defines one (Class A) or two (Class B) power supplies per port. With the addition of Class B port specification, the total load current supplied from each port has increased (up to 3.5 A from pin #2 of Class B port). The key requirements for these output ports are:

- Ability to provide large inrush currents into the sensor device loads with large input capacitances (driving large capacitive loads)
- Withstand short circuit faults without impacting the 24-V supply to the other ports

Typically, high side switches are used to turn on these port outputs. A connection diagram showing the TPS272C45 switching the two power supply outputs is shown in the figures below. Also shown is a possible use of the switch in TPS272C45 as a high current digital output at the C/Q pins (standard I/O option).

I/O Link – Port Class A

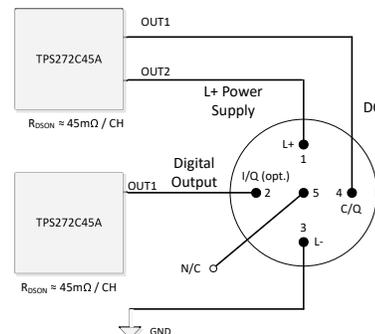


Figure 1. IO-Link Class A Port Supply and Digital Outputs

I/O Link - Port Class B

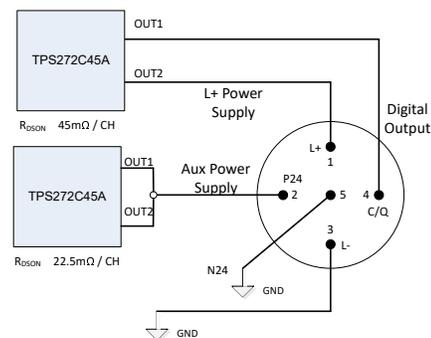


Figure 2. IO-Link Class B Port Supply and Digital Outputs

TPS272C45: Features

The smart high side switch family of devices is designed with unique features intended for remote I/O modules. The TPS272C45 is a dual channel, 45 mΩ, high side switch with adjustable current limit protection and a variety of diagnostic and protection features such as integrated current sense, drain-source voltage clamp protection, and open load detection. In addition to the aforementioned features, the TPS272C45 also supports paralleling of two

channels to enable current loads up to 4 A. The device reduces power dissipation with the low (45 mΩ) on-resistance ($R_{ds(on)}$) and the low (40-mW maximum per channel) quiescent power dissipation. The product is available in a 5 mm x 4 mm leadless QFN package.

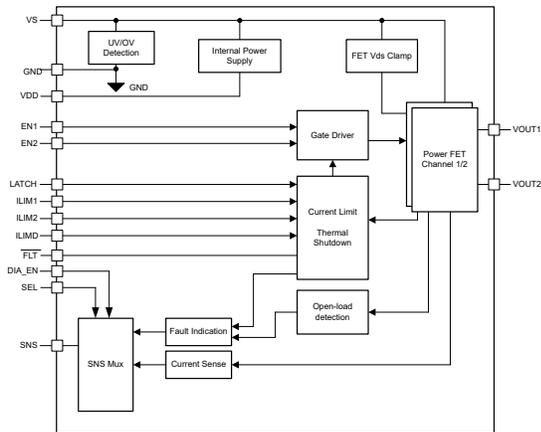


Figure 3. TPS272C45 Functional Block Diagram

Adjustable Current Limit

The TPS272C45 integrates a dual stage adjustable current limit and the threshold is configurable with an external resistor. For the most efficient and reliable output protection, the current limit can be set as close to the DC current level as possible. The resistors on ILIM1/2 pins set the per channel current limit thresholds and ILIMD pin resistor sets a delay time. During the delay time, the current limit is two times higher to support large inrush requirements.

The adjustable current limit functionality enables the system to be designed with power supply input capability closely matching the maximum load current. The lower current limit enables robust protection against short-circuit events.

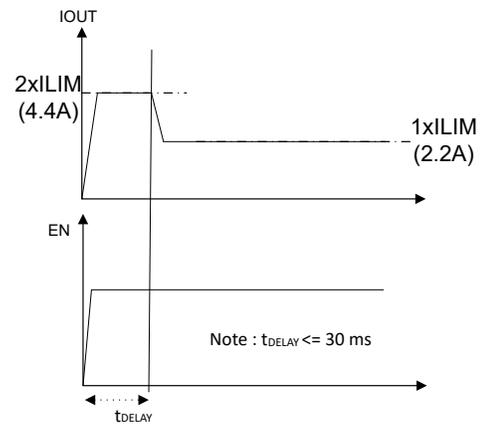


Figure 4. Current Limiting Behavior with Inrush Current Handling

The programmable delay adjustable inrush current limit enables two different system advantages when driving loads:

- Enables higher load current for a short period of time to drive loads such as incandescent bulb
- Enables fast charging of capacitive load using the initial higher inrush current limit and then using a lower current limit to protect the module under overload or short circuit conditions

Accurate Current Sense

TPS272C45 incorporates a high accuracy ($\pm 4\%$ @1-A load) current sense output. The load current sense feature can be used to detect sensor performance variations with time and thus degradation in sensor performance. In addition to detecting sensor performance, the current sense can also be used to detect the notch current and hold current of a valve or a solenoid (see [TIDA-01250](#)) driven by the switch. This is specifically useful in detecting on/off state of an actuator.

Conclusion

There is a need for smarter and smaller modules in industrial automation systems. The high side switches play a critical role in the power path that can enable significant size reduction from improved thermal management and better load diagnostics. The TPS272C45 family of high side switches with features such as low ON resistance, adjustable current limiting, accurate current sense, and tiny package are geared towards enabling the next generation remote I/O modules.

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