**Worried About Heat in Your I/O Module? No Need to Sweat**

The IEC 61131-2 standard for PLCs specifies three different types of digital input receivers: Types 1, 2 and 3. The standard states that ideal implementations for Type 3 should draw as close to 2mA as possible in the logic-high state and have voltage transition thresholds between 5V and 11V.

A typical discrete implementation of a Type 3 receiver is illustrated in Figure 2. Isolation is provided using an optocoupler. The received input signal threshold is set using voltage-divider R1 and R2 and then interpreted as a logic-high or logic-low using a voltage comparator with hysteresis (to provide noise immunity).

This circuit configuration is inefficient since it only uses resistors to limit current consumption (which is obviously voltage dependent). For a 32V input, this configuration can consume over 10mA.

In compact multi-channel modules, power consumption (and its associated heat dissipation) is a critical concern. Therefore, a more sophisticated form of current limitation must be implemented. A custom-designed current-limiting circuit can be built but would require more than 10 discrete components: a TVS, resistors, a transistor, a voltage reference, and a comparator. Current consumption for this solution would typically be 5mA—over twice the ideal 2mA for a Type 3 input—and the board area consumed by such a design is relatively large. Another disadvantage of this approach is that while current-limiting is more accurate than using a simple resistor-divider, the range of digital input voltages across which it functions can be quite limited.
The small 6-lead SOT23 package, measuring 2.8mm × 2.9mm, reduces the required board area by up to 40% compared to the discrete-component implementation. Depending on the desired application, this part can be configured either to source or sink current. It has a fast 250ns response time which supports high-speed DI devices, and 1kV surge protection (using an external TVS) ensures robustness even in the most challenging industrial conditions.

The thermal image in Figure 5 shows the effective heat reduction when using this IC, when compared to a discrete DI implementation. Both solutions are on the same board, and the temperature differential recorded was > 15°C for a single 24V input signal in a typical lab environment. The potential for heat reduction in the confined space of a multi-channel module is obvious.

Figure 5. Thermal Image of Discrete DI vs. MAX22191

Conclusion

We reviewed the limitations of a typical discrete component implementation of a digital input for PLCs and then compared its performance to an almost completely integrated approach. We presented a parasitically powered digital input IC that provides a smaller, lower power solution with much less heat generation. It is suitable for process automation, industrial automation, motor controls, individually isolated inputs and applications with current sinking/sourcing inputs.
Glossary Terms

**PLC**: Programmable logic controller. A ruggedized, microprocessor-based system which provides factory or plant automation by monitoring sensors and controlling actuators in real time.

**TVS**: Transient voltage suppressor. Semiconductor device designed to protect a circuit from voltage and current transients. Typically implemented as a large silicon diode operating in avalanche mode to absorb large currents quickly.

**IEC 61131-2**: International electrotechnical commission standard for PLCS

**LDO**: Low-dropout linear regulator. A linear voltage regulator that will operate even when the input voltage barely exceeds the desired output voltage.

Learn more:

MAX22191 Parasitically Powered Digital Input

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