

Cascading of input serializers boosts channel density for digital inputs

By Frank Dehmelt, *Systems Engineer Analog Products*

Introduction

Programmable logic controllers (PLCs) play an integral role in industrial automation. They allow inputs from digital as well as analog sensors and provide outputs to drive actuators. The digital inputs represent a significant share of those I/Os, accepting inputs from end switches, proximity switches, fuel sensors, light barriers, over-temperature sensors and many others.

The traditional approach

There are several types of digital inputs; the IEC-61131-2-standard defines those most commonly used.

Traditionally, digital inputs used discrete components and required a parallel processor interface. Current limitation was achieved by a series of high-power resistors. Resistor-capacitor (RC) filters reduced bouncing of mechanical switches, while a per-channel optocoupler connected to the parallel processor interface. This design, however, requires bulky components, many isolation channels, and a large footprint host controller to allow for the parallel inputs. It also creates significant power dissipation.

With a typical resistor chain providing about 2.2 k Ω , the current at the nominal 24 V rises to 11 mA and results in power consumptions of 260 mW or 400 mW at 30 V. Considering that this dissipation may occur simultaneously for all input channels — along with the bulky components and the processor interface — it severely limits channel density.

A new approach

TI's SN65HVS88x product family addresses these limitations and more. The digital input serializer (as the name implies) serializes the inputs into a single SPI data stream and reduces the number of isolators by 50%.

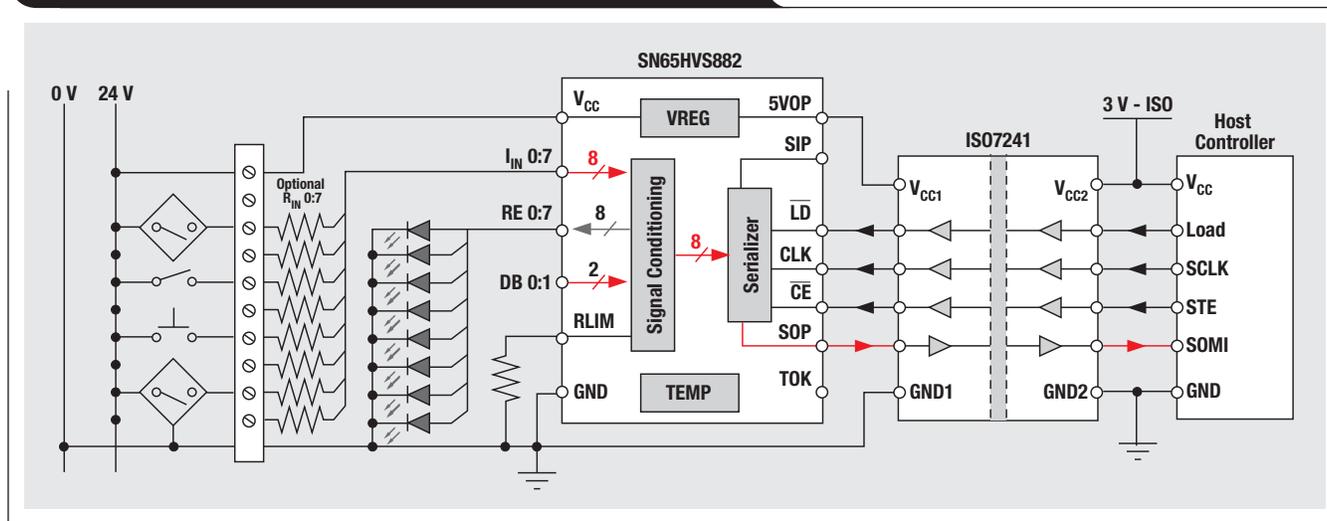
The resistors and LEDs shown in Figure 1 are required by the IEC-61131-2-standard; they can be omitted for inputs that do not require conformance with this standard. Regardless, the integrated current limit allows use of a lower power resistor.

The input current is fed to an output pin, which allows to drive an external LED to indicate the current state of the input. Without the LED, this pin simply connects to ground.

The HVS88x family allows for the cascading of several devices, all sharing the same SPI interface. For a 32-channel input, it still provides a four-channel isolation, saving 87% of ISO channels.

And what about power dissipation with a 32-channel interface? We previously calculated a worst-case dissipation of 400 mW/channel totaling almost 13 W; this is too much for a PLC slice which is about the size of a deck of cards. The HVS88x family allows the designer to set current limitation anywhere between 200 μ A and 5.2 mA. For a type-1 or type-3 switch, choose a limit in the 3-mA range, limiting the per-channel dissipation to 90 mW at 30 V. This reduces power dissipation by more than 75% vs. a discrete approach.

Figure 1. 8-channel digital input using HVS882 and ISO7241



The designer can further reduce the number of external components by using the integrated debounce filter, set to filter pulses of less than 3 ms or 1 ms in duration. For the fastest acquisition of glitch-free switches, bypass the filter as well.

The parts operate from the 24-V nominal field supply and generate the internally used 5 V themselves. This supply is also available to drive external circuitry such as the field side of the isolation barrier on the SPI interface.

The HVS88x family allows high-density digital inputs by serialization, cascading, a significant reduction of power dissipation, and elimination of external components. Production material, samples, and evaluation boards are available.

Related device

ISO721 – High-speed digital isolator
www.ti.com/iso721

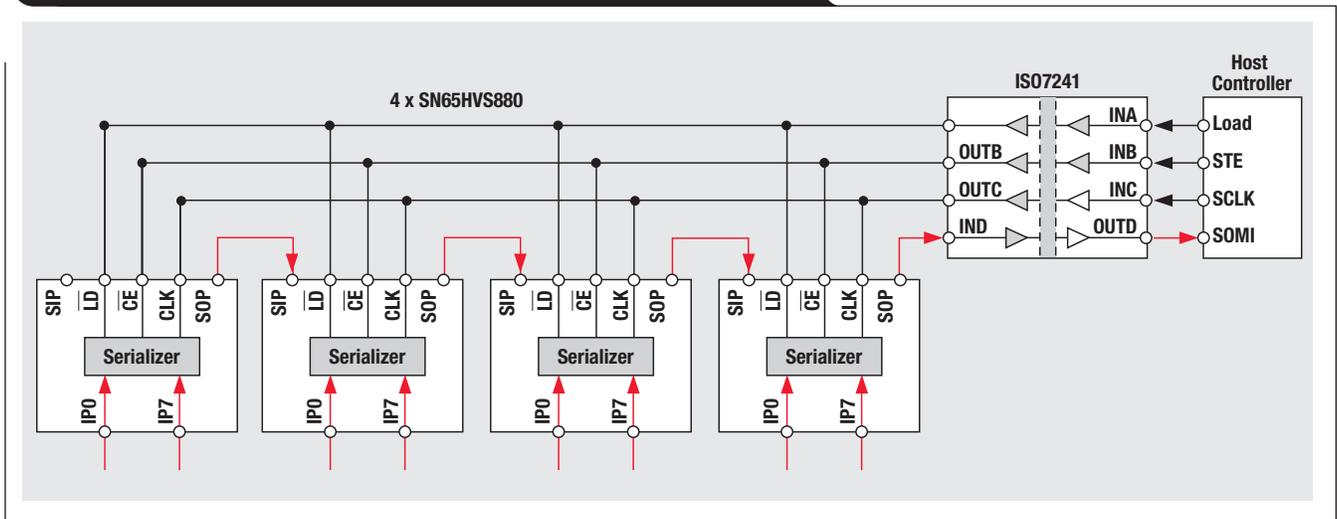
Related Web sites

interface.ti.com
www.ti.com/sn65hvs882

Table 1. The SN65HVS88x digital input serializer family digital isolator

PARAMETER	SN65HVS880	SN65HVS882
Serialization	Yes	Yes
Cascading	Yes	Yes
Current Limitation	Yes (0.2 to 5.2 mA)	Yes (0.2 to 5.2 mA)
Debounce Filter	Yes (0 ms, 1 ms, 3 ms)	Yes (0 ms, 1 ms, 3 ms)
V _{CC}	18 V to 30 V	10 V to 34 V
Undervoltage Indicator	Yes (~15 V)	No
5-V Output	Yes	Yes
Input Voltage Range	0 V to 30 V	0 V to 34 V
Temperature Range	-40°C to 85°C	-40°C to 125°C
Over-Temperature Protection	Yes	Yes

Figure 2. Simplified 32-channel digital input with cascading, using four HVS88x serializers and one ISO7241 digital isolator



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