

Providing Intelligent Protection

Galvanically Isolated 8-Channel High-Side Switches and Digital Input ICs

The ISOFACE™ product family intelligently solves a challenge common to most industrial automation systems, e.g. Programmable Logic Controllers (PLCs), Drives, Industrial PCs, Robotic Systems, Distributed Control Systems, Building Control Systems, General Control Equipment and Sensor Input Modules.

*By Hubert Baierl, Business Manager, Industrial,
Infineon Technologies AG, Neubiberg, Germany*

The common challenge is the need for robust galvanic isolation between the 3.3V or 5V side, which is also called the “control-side” of the system, that’s where micro-controller or control-ASIC resides and the 24V factory-floor environment, also called the “process-side”.

Two main reasons are calling for that galvanic isolation:

Differential electric currents generated on both sides, the control-side and the process-side, can lead to substantial shifts of the ground potential. Particularly the low voltage control-side must be protected from such ground shifts. This protection can only be attained through electrically decoupling the control-side from the process-side. The means to attain that is by galvanic isolation. Such decoupling is possible since in the industrial control system only information is transported from the one side to the other side of the system, i.e. across the galvanic isolation barrier.

Inverters, for example used to control the speed of a motor, are a frequent source for energy-rich disturbances on the process-side giving cause for surges and rapid transients as well as high-frequency noise. Without galvanic isolation, such disturbances would directly affect the micro-controller or control-ASIC. On the process-side, in terms of its electrical characteristics, the galvanic isolation represents a circuit element which is of very high impedance. The resultant net effect is that the galvanic isolation protects the control-side from the energy loaded disturbances created by the inverter on the process-side.

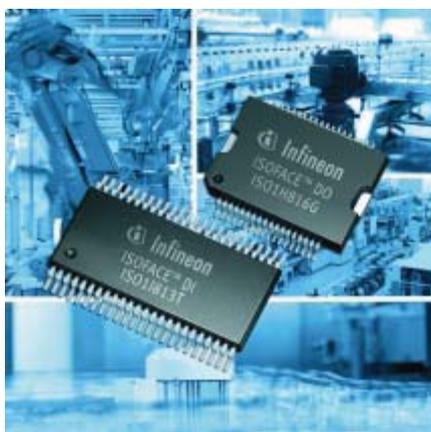


Figure 1: The ISOFACE™ product family intelligently solves a challenge common to most industrial automation systems - the need for robust galvanic isolation between the “control-side” and the “process-side” of a system

Galvanic isolation intelligently integrated

Common to both ISOFACE™ product families, the 8-channel high-side switches and the 8-channel digital input ICs, is the integrated galvanic isolation rated with 500V_{AC} (EN60664-1, UL508). This galvanic isolation is attained through inductive coupling and based on proven silicon technology which is in use in a range of industrial products from Infineon. The electro-magnetic robustness of the ISOFACE™ products has been certified in multiple tests, e.g. ISO11452-7 and IEC61131-2. This way robust galvanic isolation is attained between the process-side of an industrial control system and its control-side.

Unlike solutions based on opto-couplers, the silicon-based isolation technology from Infineon is not subject to degradation of the cur-

rent transfer ratio (“CTR”) due to high-temperatures or aging. [Note: In an opto-coupler based solution CTR is the ratio of the current through the LED versus the current on the output transistor.] ISOFACE™ products can durably be operated in the temperature range from -25°C up to +135°C. In comparison, affordable opto-couplers are typically rated to operate at temperatures of up to +105°C. To off-set the detrimental implications to CTR from operating an opto-coupler at elevated temperatures as well as to preemptively cancel out aging effects, frequently designers decide to increase the biasing current of the LED. [Note: As a side-effect, the more the biasing current is being increased the more the aging effects of opto-couplers are getting accelerated.] The galvanic isolation performance of ISOFACE™ products is not subject to this type of aging effects and its tolerance range over temperature is orders of magnitudes lower. Therefore, ISOFACE™ product performance over temperature as well as over product life-time is significantly more linear.

Protecting Outputs, Robust Galvanically Isolated 8-Channel Output Switches

The ISO1H81xG product family of 8-channel high-side switches can drive any kind of resistive, inductive or capacitive loads. The maximum nominal load current per channel is up to 1.2 A. Combining two output channels in parallel allows to switch 2 A loads. It is even possible to combine four output channels in parallel, this leads to a maximum permissible load current of 4 A. The integrated inductive clamping diodes can repeatedly absorb 1 Joule per output channel. This allows to switch inductive loads without a need for additional clamping diodes to absorb the commutation power.



Figure 2: The ISO1H81xG product family of 8-channel high-side switches can drive any kind of resistive, inductive or capacitive loads

Safety and Diagnostics built in

The output current of each of the high-side switches is monitored on-chip and in case of a short-circuit at an output the maximum current is limited to a level continuously sustainable by the IC. In consequence, the output switches can withstand prolonged short-circuits and still be safely switched off. Additionally, over-temperature protection for each of the output channels is being built in. When the over-temperature threshold of 135°C ($t_{junction}$) is exceeded, the respective output channel is automatically turned off. After cooling down, the respective channel is automatically turned on again, provided the micro-controller or control-ASIC has not issued a turn-off command in the meanwhile.

Moreover, to ensure proper switching of the MOSFET output stages, the supply voltage on the process-side (V_{bb}) is monitored. In case V_{bb} decreases to a level of 10.5V or less, the outputs are automatically switched off.

"Loss of ground" on the process-side can be a challenge for solutions which are built using switches which do not have the galvanic isolation integrated. In such designs both sides of the switching IC share a common ground connection. When loss of ground occurs, the control signals of this switching IC lose their ground reference as well. This can lead to a situation where the switching IC can not be turned off. ISOFACE™ output switches have the galvanic isolation integrated. For this reason, if loss of ground happens on the process-side the control-side remains fully functional. Therefore, even under loss of ground ISOFACE™ output switches can reliably be turned off.

To complete the safety-concept an extra disable pin is provided. This "emergency off" feature allows the micro-controller or control-ASIC to concurrently turn-off all of the outputs. This is a particularly useful feature if multiple Digital Output ICs are connected to one micro-controller or to one control-ASIC.

In their combination, these features underscore the extreme ruggedness built into the ISOFACE™ output switches.

Whilst the safety features work autonomously, the user will not remain blind sighted. In cases of over-load or over-temperature or insufficient V_{bb} a diagnostic feedback is provided to the micro-controller or control-ASIC. This is a valuable contribution to improve the maintenance support at system level.

Protecting Inputs, Galvanically Isolated Digital Input ICs

The ISOFACE™ ISO1181xT product family offers a completely integrated system input interface solution. On the process-side the ICs has 8 galvanically isolated digital input channels which directly interface with digital sensors and switches. On the control-side the ICs can seamlessly be connected to the micro-controller or control-ASIC. Robust 500V_{AC} galvanic isolation between the two sides of the system is integrated.

Up to 8 digital inputs according to IEC61131-2 (Type 1/2/3) can be connected per IC. The IC's inputs serve as current sinks. A result of their precise current sink characteristics is that the power dissipation per channel is up to 2.5-times lower when compared with legacy solutions using a combination of opto-couplers and passive components. Input status LEDs can be deployed optionally. As a consequence of the lower power dissipation and high level of functional integration system designers can either create very compact input module designs, or alternatively, substantially increase the number of input channels within a given form-factor.

To improve the EMI robustness of the system solution, the 8 input channels are equipped with deglitching filters. In case of the ISO11811T, jumpers can be used to select one of the four possible settings common to all inputs. The ISO11813T offers perfection. It allows to program the filter setting individually for each of the channels, even reprogramming during operation is possible. Common to both products is the bypass mode which sets the deglitching filtering time to zero. The bypass mode offers backward compatibility for system solutions that

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employ a system-ASIC which already has an integrated deglitching filter.

The ISOFACE™ Digital Input ICs flexibly support sampling frequencies in the range from 50 kHz up to 500 kHz per input channel. This is multiple times higher than the approximately 25 kHz offered with affordable opto-couplers. Within the range supported by ISOFACE™ the system designer can adapt the sampling frequency to the actual system requirements. The high sampling speed is of particular relevance for high-precision or high-speed motor drive applications, like bottling machines, or for example for equipment used in the paper and printing industries.



Figure 3: The ISO181xT product family offers a completely integrated system input interface solution

A feature only available with the ISO1813T is the capability to synchronously capture the input signals from multiple input ICs. This is of significant practical value when an isochronous time-stamp of the status of a complex machine with numerous sensors needs to be gathered.

Comprehensive diagnostics

The diagnostic capabilities of the ISO1813T include the detection of a wire-break

between the IC’s input pins and the sensors or switches connected to it. Since system requirements can vary substantially, it is the system designer who can determine the sensitivity level of the wire-break detection. Interestingly, the wire-break detection can be masked on a channel-specific level. This is an important provision for applications where a hybrid set of inputs is attached to the same ISO1813T IC, i.e. sensors which support wire-break detection and those which do not. When wire-break is detected, the micro-controller or control-ASIC receives a respective feedback from the ISOFACE™ Digital Input IC. In a subsequent step it is possible to identify the individual channel where the wire-break occurred.

System designers may decide to use this pre-warning information to change the system’s mode of operation or alternatively to safely and in a controlled manner shut down the system. If Vbb falls in the range between 13V and 9V the IC is still working, however, the input data collected on the process-side is invalid. This is called the warning range and a “Vbb missing voltage” feedback is provided.

Both, the ISO1811T and the ISO1813T are equipped with an error pin which indicates “Vbb missing voltage”, however the trigger levels differ. At the ISO1811T the error pin becomes active when Vbb is below the 13V threshold. At the ISO1813T the error pin

ISOFACE™	Features	OEM Benefits
Integrated galvanic isolation	No aging effect	Improved system reliability
	Wider temperature range (+135°C)	
Integrated system solutions	Less external components	Higher integration level for a given form-factor
	Lower power dissipation	
Digital Output ICs	Robust switches Diagnostics	Rugged System maintenance support
Digital Input ICs	Diagnostics Speed (up to 500 kHz) Deglitching filters	Versatile

Table 1: Features and benefits using the ISOFACE product family

Furthermore, the ISO1813T can monitor the supply voltage on the process-side (Vbb) and differentiate between three states. The IC provides an indication for Vbb being higher than 16V, this is the normal mode of operation. When Vbb drops below 16V, but remains above 13V level, a so called pre-warning information „Vbb under-voltage“ is issued to the micro-controller or system-ASIC. As long as Vbb remains above this 13V level the IC is still operating properly.

indicates „Vbb under-voltage“, i.e. Vbb is below the 16V threshold, in other words entering the pre-warning range is being flagged.

Both, wire-break monitoring and Vbb monitoring greatly improve the factory level maintenance support thus are providing a very valuable contribution to minimize costly machine down-times.

Flexible micro-controller and control-ASIC interfaces

Common to both product families, the digital output ICs and the digital input ICs, is that they are supporting both, serial and parallel interfaces to the micro-controller or the control-ASIC. The 8-bit parallel interfacing capability enables system designers to up-grade from opto-coupler solutions to ISOFACE™ without the need to change the control-ASIC. The 4-wire serial interface is the designer’s choice, if smallest possible PCB area is a design criteria. Naturally, the serial interface will also be used, when multiple digital output ICs or digital input ICs are concatenated in daisy chain mode.

The digital output products are available

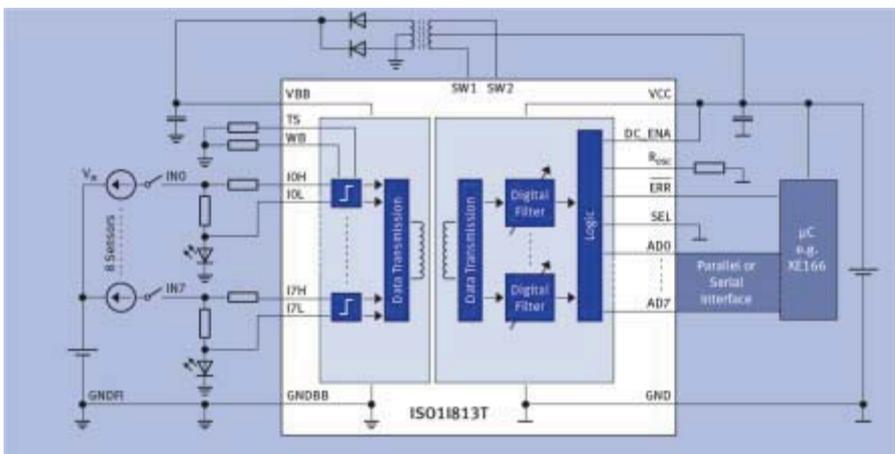


Figure 4: Typical application based on the ISO181xT galvanically isolated digital input IC

either with serial or parallel interface. The digital input products can flexibly be configured by the system designer to either operate in serial or in parallel mode. The ISO11813T offers an extra level of safety in serial mode, optionally supporting CRC-checking of the serial communication.

Conclusions

Only the Infineon ISOFACE™ products offer a complete system solution: Integrating a) an intelligent micro-controller/control-ASIC interface, b) robust galvanic isolation and c) robust high-side switches or versatile digital input functionality.

Since the galvanic isolation is based on silicon technology, ISOFACE™ products can durably operate at higher temperatures than opto-coupler solutions. Moreover, the ISOFACE™ products offer a substantial reduction of the quantity of components required to attain a complete system solution. Two key benefits result from that.

ISOFACE™ products are the enablers of the next generation of compact and cost-efficient industrial control solutions. The high level of functional integration leads to significantly improved system stability and reliability. Last but not least, the robustness as well as the diagnostic feedback built into ISOFACE™ products greatly improve system safety and provide strong support for system maintenance.

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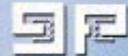
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