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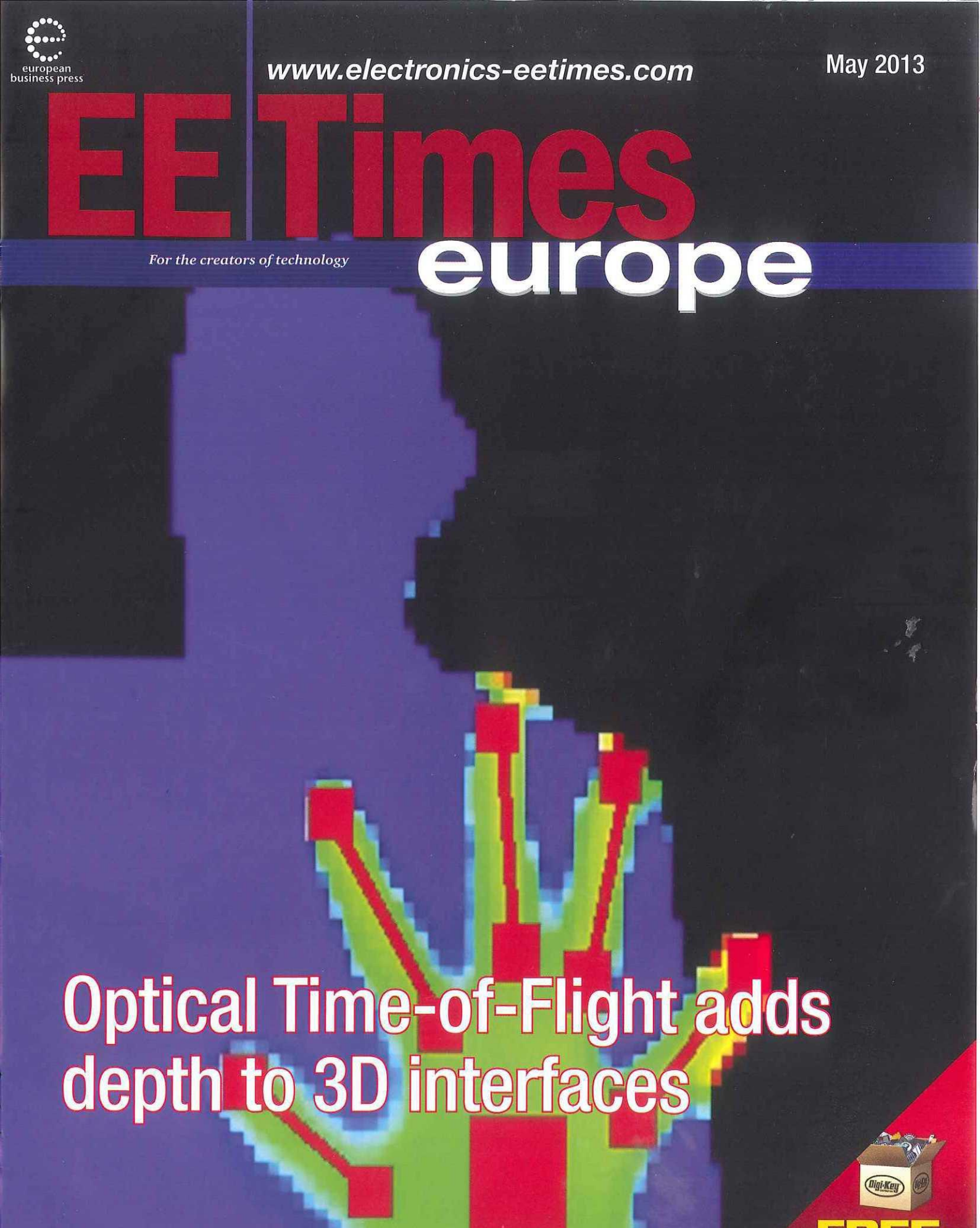

Optical Time-of-Flight adds depth to 3D interfaces

Technology roadmap:
TSMC looks at 10nm chips

Special focus:
Power Components

Intelligent diagnostics maximize factory-floor up-times

By Hubert Baierl

MORE THAN OFTEN it is common that when technical equipment fails, finding the root cause of the failure consumes significantly more time than actually fixing the problem. In highly sophisticated factory automation environments where capital intensive equipment is in operation or where time-coupled chemical processes are at work, line-downs can have substantial implications on the commercial viability of the enterprise. Therefore, the days of machinery providing no diagnostic feedback are becoming obsolete. Solutions that can provide intelligent diagnostic feedback as the system is beginning to fail ("preventive maintenance") or when a hard failure has occurred ("repair") are key to reducing expensive unscheduled downtimes.

Power management with built-in diagnostics

The ISO2H823V is a power management integrated circuit with built-in intelligent diagnostic functions designed for use in a wide range of industrial control applications, including Programmable Logic Controllers (PLCs), Distributed Control Systems, Robotics and many more. This 8-channel high-side driver IC features integrated 2.5kVrms galvanic isolation, which exceeds the IEC 61131-2 requirements for reinforced isolation. Concurrently, the device sets a new standard for system-level diagnostics.

Each of the 8 channels is equipped with five-fold diagnostic monitoring capabilities: Open Load Active (OLA), Open Load Inactive (OLI), Short-to-Vbb, Over Current and Over Temperature. Additionally five types of diagnostic feedback on the IC-level are provided. This is all integrated into a small 12x12 mm VQFN package. In the industrial control system, thanks to the integrated galvanic isolation, the ISO2H823V is positioned between the 3.3V micro-controller domain ("control side") and the 24V factory floor domain ("process side").

The most frequent failure mechanisms on the application level include overload of the driver outputs or actually having no load ("open load") connected to the driver outputs. Another severe deficiency is lack of or insufficient supply of the 24V Vbb on the on the factory side of the system. The ISO2H823V can detect either of these problems and many more. This capability is highly valuable for OEMs to prompt preventive maintenance and in case of malfunctions to drastically reduce the time required for repair.

The benefit for the system designer rests in the fact that many powerful diagnostic capabilities are available in the single IC. This eliminates the need to develop complex and potentially cumbersome circuit layouts based on multiple discrete components, to be able to perform diagnostic monitoring. In consequence, system design efforts, risks and time are reduced substantially, PCB area can be kept small, and the reliability of the solution is not compromised.

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Fig. 1: Line-downs can have substantial implications and early diagnostic feedback can limit potential losses.

Five types of diagnostics for each individual channel:
Overload [OCL]

Wear-out of machinery may lead to an output overload. In its extreme form there is actually a short circuit to GND caused either by erroneous wiring, short-circuit during operation or a natural disaster which leaves the equipment flooded, i.e. it literally is under water. The ISO2H823V can detect such cases. When the switch of a channel is "on", that channel's output current is monitored. If the output current exceeds the threshold to activate the current limitation, typically set at 1A, then Over Current Limitation ("OCL") is flagged to the micro-controller – see figure 2. Unlike other products, the ISO2H823V provides not only overload feedback, but it also informs the system controller which channel is subjected to the overload. This information can be instrumental to identify the root cause, which is critical to getting the system back on line within the shortest time possible.

Open load [OLA]

Mechanical strain, e.g. vibration or excessive bend stress of a cable, as well as corrosion can lead to the wiring between the IC switching output and the load to become high-ohmic or even disconnected ("wire-break"). The ISO2H823V can detect such circumstances. The IC performs output current monitoring, but not only for the purpose of limiting the maximum output current. The same capability is used to detect "no load" situations. An Open Load Active ("OLA") feedback is provided if an output is turned on and the output current of an individual channel is less than 0.5mA to 3mA - see figure 3. The system hardware design has the freedom to set the triggering threshold level within this range.

No other driver product designed for the industrial control

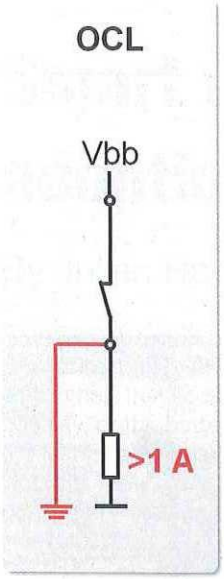

Fig. 2: Over-load and short-to-GND diagnostics per channel: the output current is monitored and if the current limitation of 1A (typically) is activated, then diagnostic feedback OCL is triggered.

market provides integrated "open load" detection that is specific to any of the individual channels. Like with the overload detection, this greatly helps OEMs to reduce the time to identify the root cause of such a failure.

Other channel-specific feedbacks

Even before the switch is turned on, an open load ("wire-break") can be detected. This is possible because in addition to monitoring the output current, the voltage at the output of the IC is also being monitored. In case of the output being in "off" state a small trickle current of 25µA is flown through the load. For loads with an ohmic resistance of less than 12 kOhm, if the output is disconnected from the load, the output will float at a voltage higher than 2V which in turn triggers the OLI diagnostic feedback (Open Load Current). The switch output could erroneously be connected to Vbb. Root causes may include wiring error, short-circuit during operation or a natural disaster which leaves the equipment flooded. This condition can also be detected by the ISO2H823V. Excessive heavy duty operation of outputs may be an indication for gradual degradation of the machinery on the factory floor. For this reason each of the output channels is equipped with an individual temperature sensor. When the output driver temperature reaches 150°C the respective output channel is automatically turned off to avoid material damage to the IC.

Five types of diagnostics on IC-level

Of all of the IC-level diagnostics, Vbb-monitoring is probably the most important one. Vbb-monitoring checks the voltage level on the driver's output side. The possible reasons for this voltage failing and falling below the normal operation level could be that the power supply is not adequately designed for the loads, or the power supply is simply beginning to fail. It is also conceivable that the electrical connection between the power supply and the switching IC is gradually increasing its ohmic resistance, i.e. corrosion may be at work. In a large number of applications the nominal supply voltage (Vbb) on the factory side is 24V +/-20%. However, if that voltage drops to a level as low as 9V, the outputs are turned off while it is still possible to do so. This is not done without a pre-warning, as a matter of fact, there are two intermittent stages:

If the supply voltage drops below 16V then an Under-Voltage warning [UV] is issued. At that voltage the performance level of outputs of the IC is not yet compromised. The UV feedback provides a pre-warning. If the supply voltage drops further, i.e. to a level of 13V and below, then a Missing Voltage warning [MV] is sent. At this supply voltage level, the IC outputs are still working. However one may be well advised to perform a controlled system shut-down while it is still possible. Only if the supply voltage drops to 9V or less, all outputs are automatically turned off and a Wait-for-Power [W4P] feedback is triggered. In this case the supply voltage has dropped to a level too low for proper operation - see figure 4.

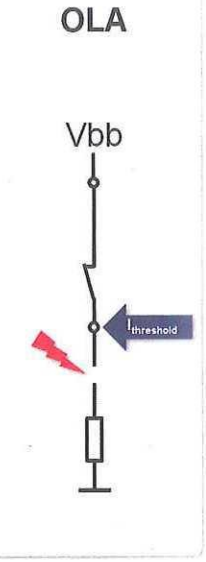

Fig. 3: Open load diagnostics per channel: the current across the switch is monitored and a threshold current can be selected from 0.5 to 3mA. If the current is below the threshold, then the diagnostic feedback OLA is triggered.

Four additional IC-level feedbacks

In addition to the temperature monitoring of each of the eight output channels, the IC has a ninth temperature sensor. This additional sensor provides on IC-level over temperature protection. The threshold is set to 125°C in order to remain below the glazing temperature of standard FR4 PCB materials. When this threshold is exceeded all outputs are automatically shut off ("OTP"). While the ISO2H823V delivers compelling benefits over previous generation solutions, it must also be able to retrofit with factory automation systems which are not yet at the end of their operational life. The detection of the presence of an incandescent lamp (used for signaling purposes on the factory floor) is a requirement for many such legacy systems. The LAMP feedback permits the system controller to distinguish between turning on a cold incandescent bulb and a short-circuit.

To attain uncompromised robustness against electro-magnetic interference the communication across the integrated galvanic isolation is save-guarded by multiple proprietary measures. In the unlikely event there were to be disturbance of that communication its occurrence would be flagged to the µC by way of setting the transmit error ("TE") flag. If this error were to occur repetitively then it would indicate a substantial problem present on PCB-level. To verify system status, but also for safety reasons, it can be of importance to be sure that all outputs are in fact off. The IC provides such explicit "ALLOFF" feedback if indeed all outputs are off.

Preventive diagnostics and full control

With this impressive list of ten different types of diagnostic feedbacks, the ISO2H823V clearly sets a new standard in diagnostics for industrial control applications. The channel-specific diagnostic as well as the types of channel-specific diagnostic feedbacks can be enabled and disabled on a channel per channel basis. This grants the user the maximum of flexibility and allows the selective use these features to meet application specific requirements.

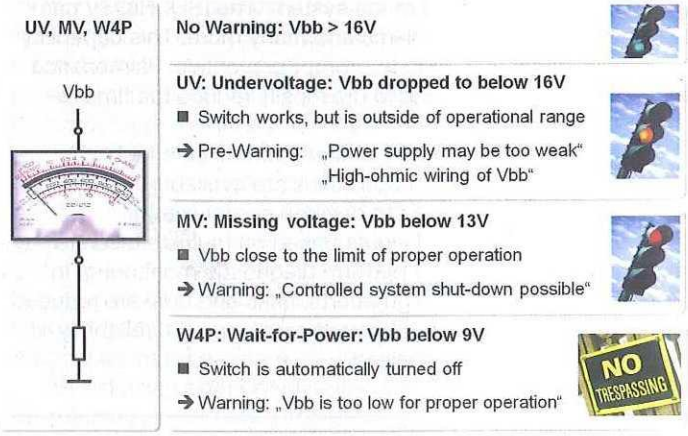

Fig. 4: Various responses triggered under Vbb monitoring.