PROCESS INSTRUMENTATION

External or Internal Flowmeter Verification – **An independent review**

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To increase the reliability of field devices, some manu¬facturers equip instruments with internal verification functions based on integrated hardware components. Procedures for the internal testing of devices are not new to the market, but rather a standard feature – at least for MID (European Measuring Instrument Directive) devices. This article looks at the advantages and disadvantages of advanced integrated verification functions for electromagnetic (MAG) flow meters with advanced integrated verification functions compared to external verification.

Verification mechanisms have long been built into MAGs by measuring instrument manufacturers, either as software packages or using hardware components. Recently, however, greater emphasis has been placed on the hardware approach, which is marketed as the quantum leap in instrumentation. Marketing depicts it as a real benefit for the end customer, offering reduced testing costs and increased device reliability. This creates the impression that field devices with built-in verification are better designed to extend calibration cycles and cut operational costs. This view needs to be questioned, as alternative technologies with a high error detection rate have already been on the market for a long time.

Taking a closer look at available verification technologies will provide a better understanding of the advantages and disadvantages. In addition, it is worthwhile to analyze the above statements with consideration for applicable standards and regulations (e. g. MID or ISO).

Verification technologies

Over the years, measuring instrument manufacturers have developed and constantly refined a variety of verification technologies. Initially, the primary target was not to sell these verification tools to the end customer, but rather to equip in-house service teams with test tools and to sell long-term service agreements. The testing technology was based on an inspection of the device or device components in comparison with external, traceable references. A few years ago, a new verification approach based on components built into the device became available. This internal verification method aims to eliminate the need for external inspection in order to save operating costs, though the customer pays for it with a higher product price.

External verification

In the case of external verification, an additional, external test device is electrically connected to the field device to be tested. Alternatively, the measuring device can be removed and mounted on a test bench. The test device or bench includes references directly traceable to international standards, which ensures that the references are accurate and correct over decades regardless of the components integrated in the unit under test.

The external verification is an additional, independent inspection parallel to the self-monitoring functions established by each MID-certified flow meter. The test process generally creates a report that can be saved on the test device or bench and transferred to a PC.

Internal verification

Using components integrated into the measuring device, internal verification is a more recent proposal from a number of measuring instrument manufacturers. It builds on traditional asset management tool functionalities. Functional checks are used to permanently carry out self-monitoring of the diagnostic parameters compared against defined limit values. The EU directive 2014/32/EU MID requires that flow meters include such a self-monitoring function, generally referred to as “checking facility to detect significant faults“ (EN ISO 4064-1, “MI 001” chapter 3 and appendix B, OIML 3.18). Functional checks are standard for all MAGs certified according to the standards mentioned above.

Another standard feature is that the error states detected during the check are made visible from the outside as process and device diagnostic messages. However, the internal verification test process may include additional checks extending far beyond the common tests defined for MAGs. The validity of these tests must be evaluated in detail, though.

In addition to the continuous self-monitoring procedure, internal verification supports a “check-on-demand“ function that includes a test procedure based on further internal reference processes. At this point, another report is usually generated that certifies whether the device has passed the test. If it did not pass, error information is provided.

These functions are embedded in the device and include both software and hardware components. The classical self-monitoring function of a field device is generally free of charge for the customer, whereas the “check-on-de¬mand“ functionalities are optional and available for an additional charge.

A report summarizing the test results is automatically generated and saved on the device. It is also possible to transfer reports to a PC or a mobile device.

Technical aspects of internal verification

Internal verification technology requires the reference comparison to be integrated into the hardware and software of a device. For example, using additional, built-in reference components, test signals are fed into the connection between the sensor and microprocessor during device production and the measured signals are stored in the device before it is delivered. Repeating the test on-site now allows comparison of the factory-saved test signal with the newly received test signal. This method is called a fingerprint comparison. From the manufacturer’s point of view, the regularly repeated comparison of the actual state vs. the delivery state covers and compensates for the potential aging of references. If the electronics need to be replaced at any point over the lifetime of the device, the new electronics will be equipped with new fingerprint pictures.

Product Characteristic	External Verification	Internal Verification
Application	Mainly MID	MID and other devices
Coverage of the installed base	20 years	Max. 4 years
Test procedure	External reference	Internal reference
Interruption during test	Yes	No
Sensor test	Yes	Yes
Transmitter test	Yes	Yes
I/O Test	Analog only	Analog only
Cable intergrity	Yes	Unknown
Connection	Cable	WLAN, cable, bus
Approved for hazardous areas	No	Yes
Report	External memory, PDF	Internal Memory, PDF
Availability	Purchase/rental	Purchase

Table 1: Comparison of features of the external and internal verification

In practical terms, the fingerprint method works best if the frame conditions of the replicate tests are always exactly the same, meaning that the process conditions would need to be identical for all comparisons. Realistically, however, this is rarely the case.

Traditional traceability metrics require a comparison of built-in components against external references recalibrated in defined intervals, applying an international standard. As the internal verification process does not involve any comparison with a measurement standard, the entire verification process is based on component or element characteristics known exclusively by the device manufacturer. Every quality department should have a problem with this approach. Another issue is that not all device parts are examined via internal verification. Hence, in many cases only the analog outputs are read back and compared to the initial value, with pulse outputs remaining unchecked most of the time. From a technical point of view, this does not make sense for many users; it is precisely the pulse outputs that are used for legal-for-trade measurements and are therefore essential.

In general, internal verification of a properly equipped device can be initiated by pressing a key combination on the device, via bus connection or WLAN (point-to-point). Connection via WLAN may be problematic, though, as the receiving devices may exclude each other. Furthermore, a situation where several WLAN networks overlap often results in the strongest WLAN reception dominating the others. Hence, the connection to the unit under test may be lost from time to time. It is possible to initiate internal verification from the control room using an asset-management tool or the automation infrastructure. Communication then takes place via the fieldbus and the operator never actually sees the unit under test. That means the device is checked only virtually via remote verification, without any direct visual inspection being performed. Any serious error pattern caused by the terminals, the tightness of the enclosure, the process connections or the process itself will be detected only partially by a virtual inspection.

Conformity with standards and directives

Marketing efforts proclaim the added value of internal verification technology for the customer, underlining conformity with standards and directives or pointing out new features and technical aspects like traceability and long-term stability. All of these factors contribute to the conclusion that the internal verification technology allows for longer test and recalibration intervals.

DIN EN ISO 9001:2008 §7.6 is one of the main arguments used by field device suppliers to promote internal verification. ISO 9001 requires that measuring instruments are a) calibrated, or b) checked at regular intervals or before use, applying methods that can be traced back to international or national measurement standards.

Unfortunately, ISO 9001 does not provide a clear distinction between the terms “calibration” and “verification”. Based on this ambiguity, suppliers conclude that calibration and verification are equally admissible methods of performing traceable performance tests according to ISO 9001. The updated DIN EN ISO 9001:2015 is even more ambiguous in its wording. However, distinct definitions of these terms can be found in the International Vocabulary of Metrology (VI M), which also establishes that calibration and verification should not be confused and that not every verification actually constitutes a validation.

Internal vs. external verification

Internal verification runs as an automated process and checks the field device against a virtual reality. While this method is simple and cost-efficient, it is certainly not sufficient. Serious error conditions such as humidity inside the electronics room or corroded connections are not at all likely to be detected. The same is true for process-related error conditions. A comparison of the built-in parts against a regularly traced-back measurement standard is lacking. Moreover, internal verification significantly increases the complexity of an instrument with additionally installed hardware components, which certainly does not meet the requirement for a simple and robust standard field device.

A major advantage of external verification stems from the need to open the instrument, closely inspect it and connect it to the external test device. This results in a real visual inspection of the device and process connection. The additional complexity of the test process is placed in a separate device, enabling a simpler and more robust design of the field device itself. A further benefit is the traceability of the reference components that are regularly compared to an international measurement standard. This ensures a higher level of reliability than the previously mentioned fingerprint method.

Conclusion

Internal verification was introduced as a groundbreaking feature for the field device market, with a very manufacturer-friendly interpretation of international standards and directives. Functionalities a field device is already required to have in order to meet the European directive 2014/32/EU MID were cleverly repackaged and marketed as an innovation. Field device manufacturers have invested massively in the development of an internal reference system (e.g. additional quartz crystals and resistances, reference current supply, etc.). While this may improve internal error detection, it certainly does not equal the reliability offered by verification using an external device regularly recalibrated according to an international standard.

Internal verification is clearly aimed at applications in functional safety systems per EN ISO 61508, such as system-critical measurements or dosing processes. These applications require regular verification – generally once a year – to ensure the devices work within the defined operational limits and meet the requirements for safety-related use. Therefore, the main benefits of internal verification are to be found in the chemical, pharmaceutical, food and beverage, oil and gas, and power generation industries.

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