

ST100 Series Technical Note: Flow Meter Verification

Methods for In-Situ Calibration Verification of FCI ST100 Series Thermal Mass Flow Meters



To comply with internal procedures and ensure process integrity and quality, and/or comply with regulations and government mandates, flow meter users are often required to periodically validate and verify the meter's calibration and operational integrity. Traditionally, the only way to meet this requirement was to pull the meter out of service and return it to a factory calibration center or a third-party calibration laboratory to have it checked. Clearly the expense and time to shut down the process, plus the labor to physically disconnect the meter and remove it, plug or by-pass the pipe, and to box and ship the meter, are very high. And after all this, to have the laboratory advise the meter's calibration was still valid and no adjustments were needed, is exasperating. Further, many regulations and best practices recommend checking the flow meter in its actual operating environment rather than the pristine conditions of a laboratory. Until now this ability to field-verify a flow meter's calibration on site has been elusive and, while still installed in the process piping, virtually impossible.

In response to these challenges, a few manufacturers of thermal flow meters now offer some type of self-checking capability. These range from a crude single point "zero" check, to fully extracting the

sensor and transmitter out of the process and bench testing with DMM while a wet towel is wrapped around the sensor head. Another manufacturer answers the challenge by recommending a second meter be purchased and installed as a check-meter. All of these techniques provide operational insights, but have limitations, user complexity, purchase expense and costs/time to conduct the test. These verification techniques are categorized as a "dry" verification, which simply means there is not actual fluid flow being measured. There is only one "wet" verification system, and that is an FCI exclusive as discussed here.

FCI's ST100 Series thermal mass flow meters respond to this in-situ calibration verification challenge by offering an embedded, no cost dry method and a true wet method. The best-in-class three point dry test is a standard feature in all ST100 Series models. FCI's exclusive and patented VeriCal™ system is optionally available. VeriCal is the only thermal flow meter "wet" in-situ calibration verification system available.

The following pages provide a description and details of these two FCI methods of in-situ verification of calibration with FCI ST100 Series air/gas flow meters.

ST100 Series In-Situ “Dry” Calibration Validation Self-Test

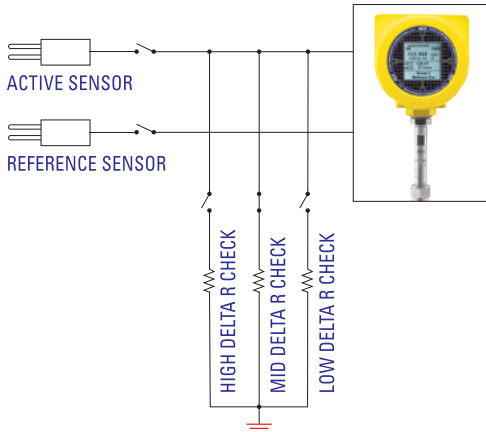
- Simple to initiate, one minute test
- Three point check across span
- No need to retract or remove meter from the process
- Pre-set to run automatically
- View and record results

A calibration self-test feature is standard with all ST100 Series flow meters. To save user time and expense, the self-test is performed in-situ – there is never a need for the ST100 to be removed or retracted from process piping or to suspend the processes operation.

This self-test feature initiates an electronic, three point calibration drift self-test. In the test mode, the ST100 automatically and sequentially substitutes three precision resistors into the measuring circuit and compares the resulting measurements against the same measurements at factory calibration* (Figure 1). These three points represent low-range, mid-range and high-range points to provide a thorough check across the span of the flow range.

* If the flow meter is a two-point model, e.g. ST102A, ST112A, STP102A or STP112A, there are total of six precision resistors and the self-test will be performed for both sensor circuits.

Figure 1. ST100 Series calibration self-test system



Unique to the FCI ST100 Series is that the self-test may be initiated in three ways by the user:

- 1) On demand from the ST100 flow meter’s keypad – through-the-glass activation, no need to remove the lid (Figure 2).
- 2) On demand from a computer connected to the flow meter’s USB port (Figure 3).
- 3) Automatically on pre-set day(s) and time(s), programmable.

The results of the self-tests provide the operator with an easy to understand PASS/FAIL message for each of the three test points, plus the digital reading of the actual base line values shown in comparison to the actual resulting test values. The results are displayed on the ST100’s digital display (Figure 2) and/or the computer connected to the USB port (Figure 3). If the test was initiated automatically, the results are recorded to the ST100’s on-board data logger with day and time stamp in a .csv format for easy user retrieval and creating hard copy reports as desired.

Figure 3. PC using FCI included software; all three check points “PASSED”

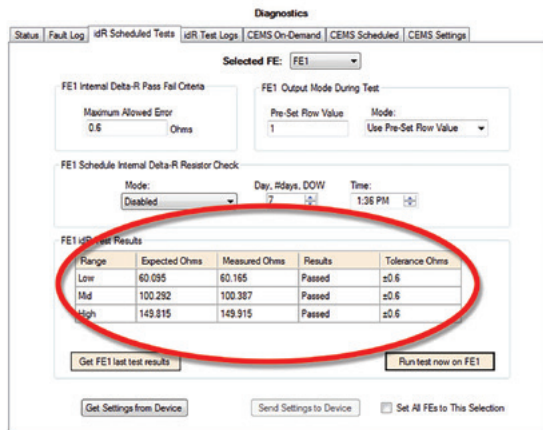


Figure 2: Front panel; all three check points show “P” (pass) and entire self-check “PASSED”



VeriCal™ In-Situ “Wet” Calibration Verification

Models ST110, ST112, STP110 and STP112

- Only “wet” check system available
- Validate performance on-site in minutes
- Save costs, no need to remove flow meter from process
- Comply with company procedures and local regulations for periodic calibration verification

Models ST110, ST112, STP110 and STP112 include FCI’s exclusive and patented VeriCal system. VeriCal provides the ability to perform field validation and verification of the flow meter’s measuring performance and calibration on demand without disconnecting the flow meter from the pipe or process.

In gas flow processes with procedures or regulations requiring periodic calibration verification, an FCI flow meter configured with VeriCal provides the most convenient and lowest cost solution. Performing a verification with VeriCal also provides a secondary benefit of cleaning the flow element to further ensure performance and reduces the need for routine maintenance.

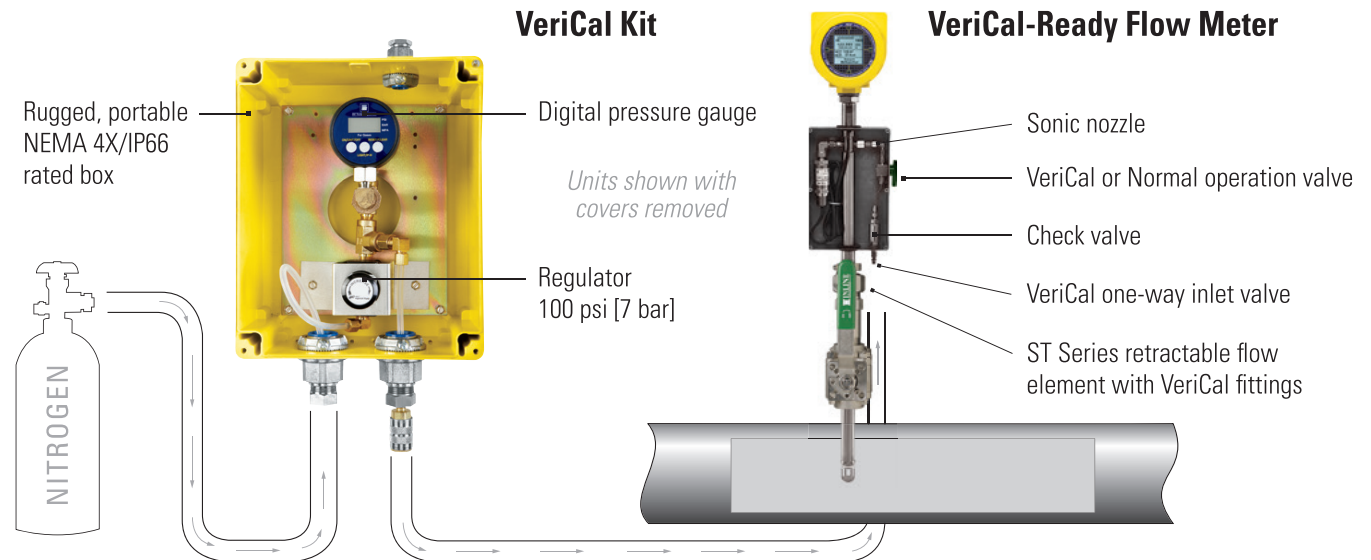
The VeriCal option is comprised of three components (*Figure 4*):

- **VeriCal ready flow element** – This specially-constructed flow element includes a flow port at the sensors, internal tubing, sonic nozzle, a valve to select “normal” or “VeriCal” operation, and a welded and sealed inlet check valve to prevent hazardous

process gases from escaping. After the flow meter system has been precision calibrated for normal operation gas(es) with NIST and ISO 17025 traceable equipment in FCI’s calibration laboratory (*Figure 5*), the lab also performs an additional nitrogen calibration and obtains five (5) baseline measurement points across its flow range to which all field checks using the VeriCal system are compared (*Figure 6*). With each ST110, ST112, STP110 or STP112, FCI provides a printed document showing the five baseline VeriCal flow readings for field technicians’ use. The VeriCal calibration curve is stored as one of the ST100’s calibration groups which is easily selectable via the meter’s keypad or serial port.

- **VeriCal kit** provides the fixtures and fittings to meter and control a precise flow of nitrogen across the ST flow element. The VeriCal kit provides a specially designed 100 psig [6,9 bar(g)] pressure regulator and LCD digital pressure gauge packaged in a NEMA 4 (IP66) rated enclosure, and a 25 foot [7,6 m] air hose with quick disconnect fittings to connect the kit to the VeriCal ready flow element. The kit is fully portable or can be permanently mounted. The VeriCal kit, part number 020849-03, is ordered separately. A single VeriCal kit can be used with and support any number of VeriCal-ready flow elements.
- **Nitrogen or pressurized air source** (user supplied) regulated 125 psig to 150 psig [8,6 bar(g) to 10,3 bar(g)], either from an installed plant line or a portable supply tank. A typical test requires approximately 40 ft³ [1,1 m³] of nitrogen.

Figure 4. FCI’s exclusive, patented VeriCal system




Nitrogen or compressed air, hose user supplied

How It Works

With the VeriCal kit attached to the ST flow meter and the nitrogen or air source, a positive-pressure nitrogen or air injection is introduced. With the ST flow element fully retracted from the actual flow stream and the ST set in the VeriCal Calibration group mode, the user adjusts the pressure at the VeriCal kit to inject small, controlled doses of nitrogen* or air* at specific pressures (prescribed on the FCI VeriCal calibration document). At each pressure point, a maximum volume of nitrogen is passed through the sonic nozzle, resulting in highly accurate and repeatable flow rates, which are compared to the respective baseline readings in the VeriCal calibration document provided by FCI. This procedure is performed at initial installation, then as often as desired.

* For applications in which nitrogen or air cannot be put into the process, FCI can supply the system with a bleed port to vent calibration check gas into the atmosphere.

Figure 5. Flow meter calibration



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Model ST110
Flowmeter

CALIBRATION CERTIFICATE

Customer Order Number: _____
Serial Number: _____
Purchase Order Number: _____
Customer Flow Range: 100 to 24000 NCMH
Customer Line Size: 600 mm i.d. DNG00s4.00
Customer Temperature Range: 100 to 140 deg C
Customer Pressure Range: 1 Bar(abs) Normal
Customer Installation: Horizontal / Side / Left to Right
Customer Standard Conditions: 0 deg C and 1.01325 Bar(abs)
Customer Actual Media: Air
FCI Calibration Media: Air

End User Name: _____
Part Number: ST110-W0Y01302B4B1EBLV003
FCI Calibration Procedure: 19EN000058 Rev. NC
Local Tag #1: _____
Local Tag #2: _____
Local Tag #3: _____
Remote Tag #1: _____
Remote Tag #2: _____
Remote Tag #3: _____

Output Information

Output #1: 4-20 mA = 0 to 24000 NCMH
Calibration Equation: NCMH = 1500.00 x mA - 6000
(Slope = 150 NCMH @ 4067 mA)

Output #2: 4-20 mA = -20 to 80 Deg C
Temperature Equation: Deg C = 6.25 x mA - 45.00
(Based on manufacturer's recommended temperature vs. resistance equation)

Output #3: 4-20 mA = -20 to 80 Deg C
Temperature Equation: Deg C = 6.25 x mA - 45.00
(Based on manufacturer's recommended temperature vs. resistance equation)

Calibration Notes

- Calibration performed using equipment traceable to N.I.S.T. (US National Institute of Standards and Technology) and ISO/IEC 17025, International Standards for Test Lab Quality systems.
- Flat Profile Calibration. Extended Range Calibration.

Final Flow Verification performed on E Stand

Desired NCMH Per Stand	Model ST110 Indicated NCMH	Actual % Reading Difference	Allowed % Reading Difference
23916	23894	-0.09	±1.25
17962	17766	-1.09	±1.42
11984	11902	-0.68	±1.75
6018	5997.1	-0.35	±2.74


N.I.S.T. Traceable Equipment: E Stand

Calibration Control Number	Calibration Date	Calibration Date	Equipment Description
EL-331	7-Sep-17	7-Sep-18	Frequency Counter
EL-799	5-May-17	5-May-18	HP Data Acquisition Unit
FM-002	1-May-17	1-May-18	10" Turbine Meter
FM-194	29-Aug-17	28-Feb-18	4" Turbine Meter
FM-205	29-Aug-17	28-Feb-18	3" Rotary Meter
PG-271	20-Sep-17	20-Sep-18	Pressure Transducer
TE-045	20-Sep-17	20-Sep-18	Temperature XTD (4")
TE-046	20-Sep-17	20-Sep-18	Temperature RTD (10")

Technician: _____
Calibration Date: _____

- Model ST110:** Single-point insertion flow meter configured with VeriCal
- Model ST112:** Dual-element flow meter; both elements configured with VeriCal
- Model STP110:** Single-point flow meter with pressure measurement configured with VeriCal
- Model STP112:** Dual-element flow meter with pressure measurement option; both elements configured with VeriCal
- P/N 020849-03:** VeriCal kit

Figure 6. VeriCal baseline certificate



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ST110 Verical Certificate

Customer: _____
Serial Number: _____
Customer Order: _____
Group: 5
Head: 1

Lab Conditions: 14.614 psia, 70.60 °F, 25.00 %RH

Calibration Verification Results:

Standard Pressure (PSIG)	Indicated Flow (SFPS)	Indicated Temp (°F)	Indicated dR (Ohms)	Indicated TCdR (Ohms)	Indicated Refr (Ohms)
0.001	0	77.423	212.345	213.405	1098.389
13.268	31.944	75.702	87.237	87.603	1094.68
26.945	80.897	73.837	71.953	72.19	1090.658
40.64	88.663	72.111	63.918	64.013	1086.937
54.327	113.502	70.609	58.959	59.018	1083.696

N.I.S.T. Traceable Equipment:

CCN	Cal Date	Due Date	Description
EL-892	1/19/2018	1/19/2019	HP Data Acquisition Unit
EL-939	4/17/2017	4/17/2018	Data Acquisition Unit
PG-410	10/3/2017	4/3/2018	Pressure Transducer

Calibration Verification Notes:

- Calibration Verification performed using equipment traceable to NIST (U.S. National Institute of Standards and Technology).
- Tested with shop-grade compressed air.
- End user should establish and record their own "As-Installed" baseline measurements upon flowmeter commissioning.

Calibration Technician: _____
Calibration performed on _____



Users of thermal mass air/gas flow meters (TMF) looking to perform field verification of their flow meter's calibration must be aware of manufacturer's limitations. The techniques deployed by TMF manufacturers to do field, in-situ calibration verification and drift checks vary significantly in their thoroughness, complexity, and costs. FCI's "dry" check is the industry's only three point check and only one that can be pre-programmed to run automatically. FCI's VeriCal is the only multipoint, full span "wet" verification system available.

To see videos of the VeriCal operation or for more information on the ST100 Series flow meters, visit FCI online:

www.FluidComponents.com > *Products* > *Mass Flow Meters*

www.FluidComponents.com > *News/Events* > *Demos & Videos*



FCI VeriCal In-Situ Calibration Sensor Installation And VeriCal Procedure Demonstration

<http://www.fluidcomponents.com/verical-demo>



VeriCal In-Situ Calibration Demonstration With ST100 Flow Meters

<http://www.fluidcomponents.com/verical-ST100>



ST100 Demo With Close-Ups Of All Models And Their Features

<http://www.fluidcomponents.com/assets/media/fci.swf>



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