



ARA FTS Flow Calibrator

Operation Manual

August 1, 2016



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1 Introduction

The ARA FTS Flow Calibrator is a versatile volumetric air flow calibrator designed to efficiently calibrate and audit ambient air sampling equipment. The FTS is a portable, self-contained venturi-based calibrator that accurately measures air flow, barometric pressure, and ambient temperature. Volumetric flow rate is reported at “Ambient” and “Standard” conditions of temperature and pressure. The standard flow range is 5-25 LPM and the flow can be pulled or pushed through the Venturi Flow Device (VFD) with equal accuracy. Other flow ranges are available by simply plugging in the appropriate Venturi Flow Device (VFD). NIST traceable flow accuracy is better than +/- 1%.

2 Getting Started

2.1 Navigation

Navigate through the menus by rotating the selector knob to highlight a desired selection. Press the knob to select. The menu system is intuitive, especially to those with air sampling experience. To exit any menu, rotate the selector knob to highlight and select the menu option at the top of the LCD screen. **MODE: HOME** takes you back to the Home Screen.

2.2 Charge Battery

- Plug the wall mount charger into an appropriate AC outlet.
- Plug charger output connector into the charging jack on the side of the FTS case. It will take about 4-hours to charge a depleted battery. See Figure 1.
- Turn on FTS Calibrator using **ON/OFF** rocker switch on front panel. The FTS will boot into the Home Screen and Battery voltage is shown on the bottom line.
 - A fully charged battery will be greater than 10.5 volts (60 hours of use)
 - 10.0 volts indicates about 50% of battery capacity (30 hours of use)
 - 9.5 volts indicates about 10% (<6 hours of use)
- In addition, there is a battery indicator icon in the top right corner of the LCD screen to graphically show the level of charge left. The battery indicator icon starts blinking when there is less than 10% battery capacity left.



Figure 1. Battery charging jack.

2.3 Set Date and Time

- Select **SETUP** from the Home Screen
- Scroll down, highlight **SYSTEM SETUP** and select
- Scroll down, highlight **DATE/TIME** and select
- Scroll down until Day is highlighted and select
- Rotate the selector knob until the correct date is highlighted and select
- Repeat for Month, Year, Hour, Minute, and Second
- Select **DATE/TIME: EXIT**
- Select **YES** to save Date/Time
- Select **SYSTEM: EXIT**
- Select **MODE: SETUP** and scroll to **MODE: HOME** to return to Home Screen

2.4 Plug in Remote Temperature Probe

Plug temperature probe into jack on front panel. For performing audits, the probe has an alligator clip near the end to attach to radiation shield louvers on ambient air samplers. See Figure 2.

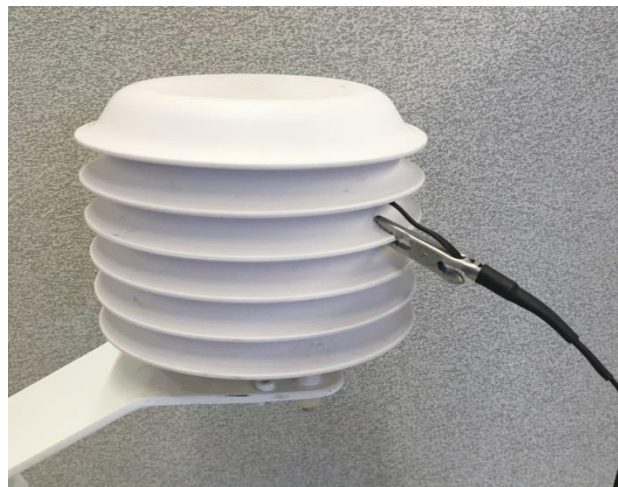


Figure 2. Temperature probe placement during audits.

2.5 Standard Conditions

The ARA FTS uses US-EPA standard conditions of 25°C and 760 mm-Hg as defaults. If other “standard conditions” are desired, they can be input by the following:

- Select **MODE: SETUP** and scroll to **SYSTEM SETUP**
- Select **STANDARD TEMP PRESS** to make changes to the temperature and pressure

3 Operation Overview

There are three FTS operational modes – **HOME**, **FLOW**, and **SETUP**. To switch between modes, select **MODE**: at the top of the LCD screen and rotate knob to select the desired mode.

3.1 Mode: Home

Once the FTS is powered **ON**, the Home Screen appears. It is the administrative mode of the FTS. The parameters displayed in **HOME** are:

TM: Current Date and Time

AMB TEMP: 3-foot remote probe temperature, °C

BAROM: Current barometric pressure, mm-Hg

GAS TEMP: Temperature of sensor in the Venturi Flow Device (flowing gas temp), °C

BATT VOLT: Rechargeable battery pack voltage

Note: In the upper right of the LCD screen, there is a battery charge icon indicating the level of charge left.



3.2 Mode: Flow

The **FLOW** mode is the operational mode where flow measurements are displayed.

Turn the knob and select **ZERO** to initialize the measurement sensors. Normally the operator will want to use the **ZERO** function when entering **FLOW** mode to initialize the sensors. In addition, use the **ZERO** function any time there is any indicated flow rate at a no-flow condition.

The parameters displayed in **FLOW** mode are:

AMB FLOW: Gas Flow Rate at local Ambient Conditions, LPM

STD FLOW: Gas Flow Rate at Standard Conditions, LPM

Note: The FTS uses US-EPA prescribed "standard conditions" of 25 Deg. C, and 760 mm-Hg. If other conditions are desired, they can be changed in the SYSTEM SETUP menu.

GAS TEMP: Temperature of sensor in the Venturi Flow Device (VFD), °C

BAROM: Current barometric pressure, mm-Hg

AMB TEMP: 3-foot remote probe temperature, °C

VFD SER: Serial Number of Venturi Flow Device (VFD) plugged into FTS

3.3 Mode: Setup

The **SETUP** mode has various options relating to the FTS data and system setup.

CLEAR ALL DATA: For future use. Please check ARA Instruments website – www.arainstruments.com - for firmware updates.

EXPORT SETUP: For future use. Please check ARA Instruments website – www.arainstruments.com - for firmware updates.

SYSTEM INFO: Displays FTS Serial Number, Calibration Dates, and the Firmware Version (Date)

UPDATE FIRMWARE: Allows operator to upload the latest firmware via USB Flash Drive. The latest firmware files are available at ARA Instruments website – www.arainstruments.com.

SYSTEM SETUP: Allows the user to set and calibrate various FTS parameters:

DATE/TIME: User can set current date and time

AMBIENT TEMPERATURE: This mode allows the user to turn **ON** or **OFF** the ambient temperature sensor if desired. If turned **OFF**, the sampler defaults to a user-defined standard temperature of 25° C. The user can also enter an offset for calibration purposes.

GAS TEMPERATURE: The user can enter an offset for flowing gas temperature calibration.

BAROMETRIC PRESSURE: The user can enter an offset for barometric pressure sensor calibration.

STANDART TEMP PRESS: The user can enter desired values for “standard conditions” of temperature and pressure.

LCD BRIGHTNESS: User can set LCD Backlight brightness. *Note: It is suggested to use the minimum level acceptable, because the backlight uses significant battery power.*

BLUETOOTH ENABLE: For future use. Please check ARA Instruments website – www.arainstruments.com - for firmware updates.

FLOW CALIBRATION: Displays FTS parameters required for performing FTS calibration. Allows user to enter a linear relationship slope and intercept correction to a traceable flow standard after calibration is performed.

INLET AND DROP: Displays raw outputs from static pressure and VFD differential pressure sensors.

RESTORE DEFAULTS: Will set sampler back to factory defaults. **Note: be cautious in using this option since it will erase all user entered calibration data.**

REBOOT: Manually restart the FTS. This function is the same as cycling the ON/OFF rocker switch.

4 FTS Flow Calibrator Operation

4.1 Measure Flow Rate – FRM Style Air Sampler Example

- Select **MODE: HOME** and rotate the selector knob to select **MODE: FLOW**
- With no flow running through the VFD, select **ZERO** to zero the sensors
- After using the **ZERO** function, AMB FLOW, and STD FLOW should be 0.00 LPM. If not, select **ZERO** again to re-initialize the sensors.
- Connect the FRM adapter to the sampler inlet. The other end of the hose should be connected to the VFD outlet (right side).
- Turn on the Sampler to be audited or calibrated. Wait a few minutes for the FTS Gas Temperature to stabilize. At this point the Ambient and Standard Flows should be accurate.
- When flow measurements have been completed, turn **OFF** sampler being tested. The displayed Standard and Ambient Flows should return to 0.00 LPM. If not, select **ZERO** to re-initialize the sensors, and repeat the measurements.



*See **Appendix A** for a detailed example on using an FTS Flow Calibrator to calibrate an ARA N-FRM Sampler.



Note: The FTS will switch to power save mode if it is turned on and does not receive input from the selector knob for a few minutes. To wake up the FTS press and hold the selector knob for 3-seconds.

4.2 Measuring Flow Rates of Other Devices

The FTS Flow Calibrator is capable of measuring flows from most air sampling devices. The user will need to provide fittings and tubing to connect the device being tested to the VFD. Flow can be pulled or pushed through the VFD with equal accuracy as long as the flow is in the direction of the arrow on top of the VFD.

The flow measuring steps are the same as outlined in Section 4.1.

4.3 Calibration

US-EPA recommends annual recertification of flow transfer standards. If a suitable Traceable Flow Standard is available, a multi-point calibration of the FTS can be performed. The FTS relationship to the Traceable Standard is determined by linear regression, and a corresponding **Slope** and **Intercept** can be input to correct the FTS. The **Slope** and **Intercept** can be adjusted in **MODE: SETUP**. Rotate the selector knob and select **SYSTEM SETUP**, then **FLOW CALIBRATION**. If desired, the FTS Flow Calibrator can also be returned to ARA Instruments for re-calibration.

5 Warranty Policy

At ARA Instruments we pride ourselves on high quality workmanship and materials. All equipment manufactured by ARA Instruments is under warranty for one year, from the date of shipment, for parts and labor. Equipment not manufactured by ARA Instruments is covered by the warranty of its manufacturer, which includes Lithium-Ion Batteries and Chargers.

At our discretion, ARA Instruments will either repair or replace defective equipment at no charge during the warranty period for equipment proven defective at our facility. Acknowledgement and approval must be received from ARA Instruments prior to shipping equipment (prepaid) to our facility.

If the purchaser, its employees, or other users do not handle, operate, and install the equipment according to our instruction, the purchaser will assume all liability for its consequences and the warranty will be void. ARA Instruments is not liable for loss, damage, or injury to property or persons for the installation, operation, use, misuse, nonuse, repair, or replacement of equipment.

Upon use of this equipment, the purchaser agrees to all terms issued in this warranty. No other express warranty is given by ARA Instruments.

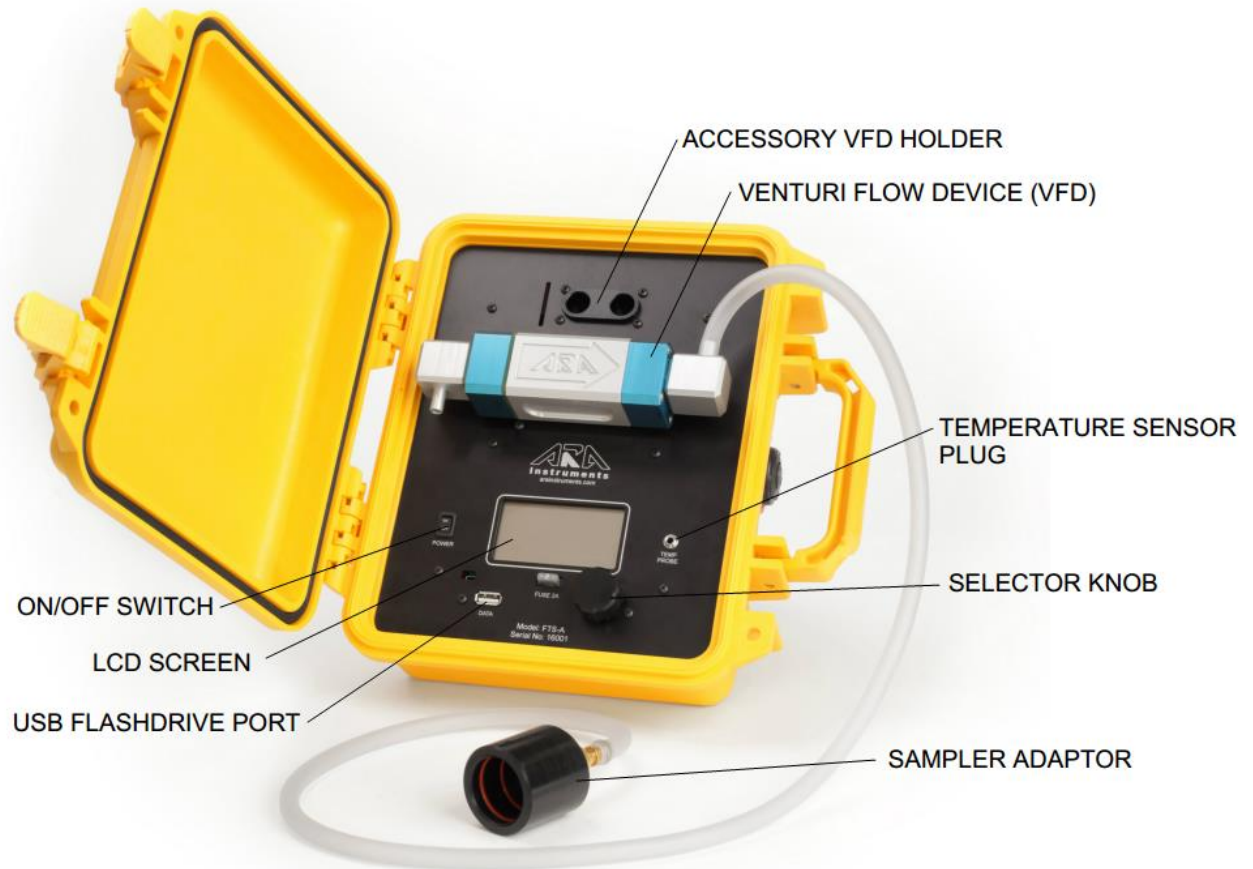
If equipment becomes damaged or defective, please consider the following:

- Call ARA Instruments about the problem
- Obtain approval from an ARA Instruments technician to return damaged equipment
- Package equipment very carefully with sturdy packaging
- Include a packing slip with all items clearly marked
- Include Name, Address, and Phone Number

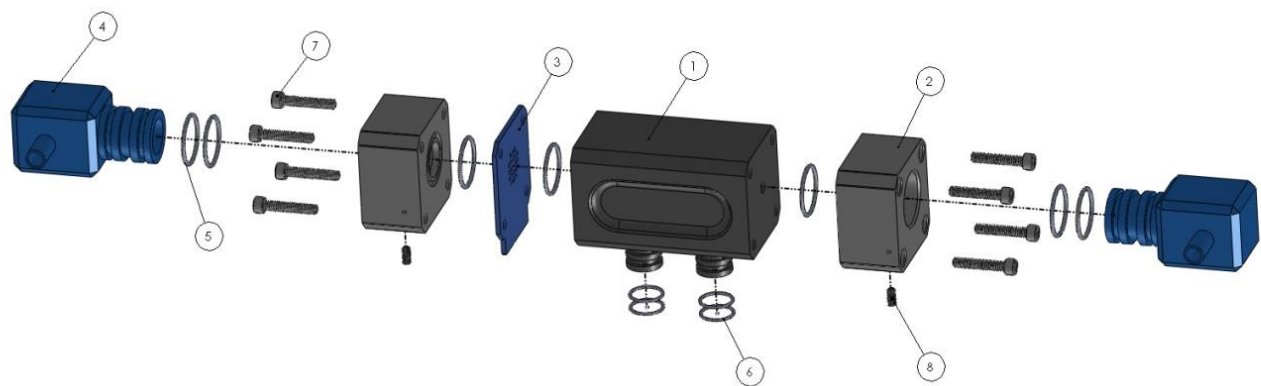
Ship To:

ARA Instruments
90 Hillview 1 – Bldg 2
Eugene, OR 97408, USA
541.844.1686
sales@arainstruments.com

6 Parts List



VFD Flow Block
PN 400-000



NO.	PART NUMBER	PART DESCRIPTION
	400-000	VFD Flow Block Assembly
1	400-210	VFD Body
2	400-300	VFD End Cap
3	760-700	VFD Circuit Board
4	400-400	VFD Hose Adaptor
5	908-016	O-Ring, S70, 016
6	908-012	O-Ring, S70, 012
7	903-212	6-32 x 1" Socket Cap Screw
8	907-102	4-40 x 3/16" Set Screw

Appendix A: Calibration Using an ARA FTS Flow Calibrator

Use the *Quality Control Form* located on the last page to record data easily in the field.

Calibrate Temperature

On the N-FRM Sampler Home Screen select **SETUP** and then select **SYSTEM SETUP**. Scroll down and select **AMBIENT TEMPERATURE** and then select **OFFSET**. Change the value to **0.000** and select **YES** to save changes.

Place the tip of the FTS Temperature Sensor into the louvers and attach the clip onto the N-FRM Sampler temperature radiation shield. Allow the sensors enough time to equilibrate before recording the Indicated Temperature (sampler) and Actual Temperature (FTS). Determine the difference between the Indicated Temperature and Actual Temperature to be used as the offset value.



$$\text{OFFSET} = (\text{FTS Temp}) - (\text{N-FRM Temp})$$

On the N-FRM Sampler Home Screen select **SETUP** and then select **SYSTEM SETUP**. Scroll down and select **AMBIENT TEMPERATURE** and then select **OFFSET**. Change the value to the desired offset, calculated above and select **YES** to save changes.

Calibrate Barometric Pressure

On the N-FRM Sampler Home Screen select **SETUP** and then select **SYSTEM SETUP**. Scroll down and select **BAROMETRIC PRESSURE** and then select **OFFSET**. Change the value to **0.000** and select **YES** to save changes.

Record the Indicated Barometric Pressure (N-FRM) and the Actual Barometric Pressure (FTS). Determine the difference between the Indicated Barometric Pressure and the Actual Barometric Pressure to be used as the offset value.

$$\text{OFFSET} = (\text{FTS Barometric Pressure}) - (\text{N-FRM Barometric Pressure})$$

On the N-FRM Sampler Home Screen select **SETUP** and then select **SYSTEM SETUP**. Scroll down and select **BAROMETRIC PRESSURE** and then select **OFFSET**. Change the value to the desired offset, calculated above and select **YES** to save changes.

Calibrate Flow Rate

To calibrate an N-FRM Sampler, a multi-point calibration must be performed in order to determine the calibration factors. These values can then be entered manually into the N-FRM Sampler.

FTS Calibrator:

- Select **MODE:HOME** and rotate the selector knob to select **MODE:FLOW**
- With no flow running through the VFD, select **ZERO** to zero the sensors
- After using the **ZERO** function, AMB FLOW, and STD FLOW should be 0.00 LPM. If not, select **ZERO** again to re-initialize the sensors.
- Connect the FRM adapter to the sampler inlet. The other end of the hose should be connected to the VFD outlet (right side).

N-FRM Sampler:

- From the Home Screen select **SETUP**
- Scroll down, select **SYSTEM SETUP**, and then select **FLOW RATE**
- Select **SLOPE**, turn knob to set slope to **1.000**, and select **YES** to save changes
- Select **INTERCEPT**, turn knob to set intercept to **0.000** and select **YES** to save changes
- Select **SET FLOW** and adjust to **14.5** and select **YES** to save changes
- Select **PUMP:OFF** to turn the pump **ON**
- Allow the pump to run for a few minutes until the FTS Gas Temperature stabilizes
- Record the **IND. FLOW** from the N-FRM Sampler and the **AMB. FLOW** from the FTS Flow Calibrator
- Repeat the above steps, adjusting the **SET FLOW** to 15.5, 16.5, 17.5, and 18.5.

Calculations:

For easy calculations, our *Calibration Worksheet* Excel file is available for download on the Support page on our website, www.arainstruments.com/support, or you can create your own.

Input the Indicated Flow Rate and Actual Flow Rate values into the spreadsheet. Determine the Slope and Intercept.

	A	B	C	D	E	F	G
	Set Flow Rate	Indicated Flow (Sampler)	Actual Flow (FTS)	Adjusted Flow	Difference	Percent Error	
1							
2	14.5	14.53	14.63	14.63385267	0.0038527	0.026334044	
3				=B2*\$B\$10+\$B\$11	=D2-C2	=E2/C2*100	
4	15.5	15.5	15.58	15.58610685	0.0061068	0.039196719	
5	16.5	16.51	16.58	16.57167273	-0.008327	-0.050224769	
6	17.5	17.48	17.52	17.51820631	-0.001794	-0.010237981	
7	18.5	18.48	18.49	18.49401411	0.0040141	0.021709638	
8							
9							
10	Slope	0.975807806	=SLOPE(C2:C6, B2:B6)				
11	Intercept	0.461085849	=INTERCEPT(C2:C6, B2:B6)				
12							

Figure 9. Determine Slope and Intercept in Excel.

Change the Slope and Intercept on the N-FRM Sampler:

- From the Home Screen select **SETUP**
- Scroll down, select **SYSTEM SETUP**, and then select **FLOW RATE**
- Select **SLOPE** and turn knob to desired value
- Select **YES** to save changes
- Select **INTERCEPT** and turn knob to desired value
- Select **YES** to save changes

QUALITY CONTROL FORM

SITE INFORMATION

Location: _____ Sampler: _____ Serial No: _____
 Tech: _____ Flow Rate Standard: _____ Serial No: _____
 Date: _____ Temperature Standard: _____ Serial No: _____
 Time: _____ Pressure Standard: _____ Serial No: _____

MAINTENANCE SCHEDULE

Weekly:	Service Water Trap
Monthly:	Clean PM10 Inlet, PM2.5 Cyclone, Filter Holder, and RTP Profiler Filter Inspect O-Rings Perform Leak Check Perform flow, temperature, pressure, and clock verification
Annually:	Replace PM10 Inlet, PM2.5 Cyclone, and Filter Holder O-Rings Rebuild Pump Perform flow, temperature, and pressure calibrations

AUDIT RESULTS

ACTION	INDICATED (Sampler)	ACTUAL (FTS)	% DIFFERENCE	CONTROL LIMITS
Flow Rate (LPM)				4%
Ambient Temp. (°C)				± 2°C
Barometric Pressure (mmHg)				±10 mmHg
Clock Time				±2 min/mo
Leak Check				0.00 LPM

Comments: _____

MULTI-POINT CALIBRATION

SET FLOW (LPM)	INDICATED FLOW (Sampler)	ACTUAL FLOW (FTS)
14.5		
15.5		
16.5		
17.5		
18.5		

	INITIAL	FINAL
SLOPE:		
INTERCEPT:		