

**Installation, Operation and Maintenance Technical Manual**

# **ELF Standard and /F Series**

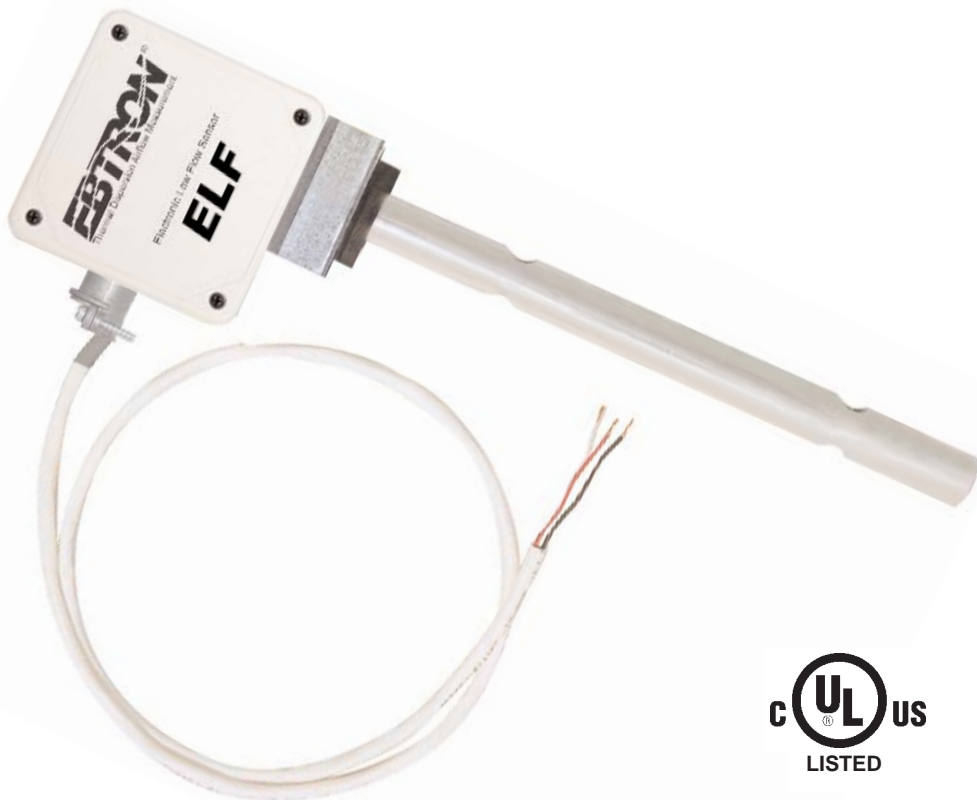
## **Electronic Low Flow Airflow Measurement Station**

### **Standard and /F Series**

For the following models:

ELF-XXXX: STANDARD 0-10/2-10VDC ANALOG OUTPUT  
ELF-XXXX/F00: STANDARD 0-10/2-10VDC ANALOG OUTPUT  
ELF-XXXX/F01: 0-5/1-5VDC ANALOG OUTPUT  
ELF-XXXX/F02: STAEFA EQUIVALENT OUTPUT  
ELF-XXXX/F03: 0-10/2-10VDC ANALOG OUTPUT, NO FLOW INTEGRATION  
ELF-XXXX/F04: 0-5/1-5VDC ANALOG OUTPUT, NO FLOW INTEGRATION

Document Name: TM\_ELF-F\_R1E



TM\_ELF-F\_R1E



**LIST OF EFFECTIVE AND CHANGED PAGES**

Insert latest changed pages (in bold text); remove and dispose of superseded pages.  
Total number of pages in this manual is **12**.

Page No	Revision *	Description of Change	Date
<b>1, 2</b>	<b>R1E</b>	<b>Updated cover/title page to revision R1E</b>	<b>.06/29/2012</b>
<b>6</b>	<b>R1E</b>	<b>Corrected mechanical detail (changed 6" minimum to 4")</b>	<b>.06/29/2012</b>
5	R1D	Clarified placement diagram	.12/13/2011
3 to 12	R1C	Updated all Elf Standard references to include ELF/F00 model	.09/07/2011
3, 4	R1B	Changed temperature sensor type to bead-in-glass	.05/06/2011
6	R1B	Added missing caution note regarding accuracy up to 16-inch maximum duct	.05/06/2011
1	R1A	Changed document name from TM-ELF to TM_ELF-F.	
2 through 12	R1A	Incorporated all changes from TM_ELF_R2C and released as TM_ELF-F_R1A	.03/18/2011

\* R1C indicates an original page without change

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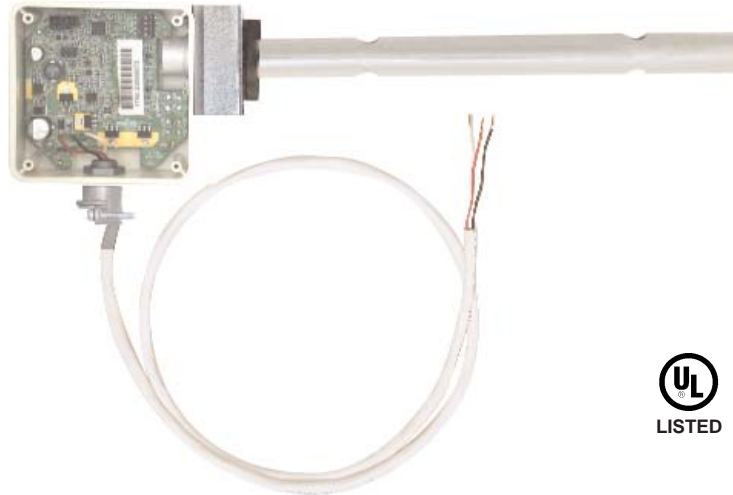


Figure 1. EBTRON ELF/F Electronic Low Flow Measurement Station

## OVERVIEW

The **EBTRON** ELF/F Series electronic low flow thermal dispersion analog output airflow measurement station features unique sensors designed for precise measurement and control of airflow or equivalent velocity pressure in small duct (16 inch max) and VAV box applications. Simple and flexible analog output options permits interface to virtually all modern building automation systems (BAS).

**EBTRON's** proprietary flow loss compensation techniques eliminate inaccuracies typically associated with small duct and low airflow measurement. Traditional measurement techniques produce readings that are greater than actual flow due to the inherently large ratio of duct wall surface to duct free area. The ELF/F uses a single factory calibrated probe equipped with one or two sensor nodes, depending on application.

ELF airflow sensors use high quality "bead-in-glass" thermistors to determine the airflow rate and temperature at each sensing location. The sensor relates the thermal transfer rate of a heated element to airflow rate. As the velocity across the sensor increases, the thermal transfer rate increases. Accuracy is ensured through individual sensor characterization over a range of 0 to 3,000 FPM (0 to 15.24 m/s) in wind tunnels calibrated to volumetric airflow standards. Accuracy is percent of reading (not percent of full scale) throughout the entire calibrated range. Convenient field selectors permit selection of airflow or equivalent velocity pressure measurement, and four output scaling ranges. A flow integration filter is standard to optimize system response, but can be omitted for custom applications (refer to Ordering Guide in this document for option codes). Analog outputs of 0-10/2-10VDC\* are provided on the standard /F00 and /F03 versions, and 0-5/1-5VDC\* on the /F01 and /F04 versions. A Staefa equivalent output is available on the /F02 version. Equivalent volumetric flow can be determined by simply applying an appropriate conversion formula. Each ELF airflow measurement station includes a factory calibrated sensor probe and an integral dedicated transmitter and mounting bracket.

<sup>1</sup> Minimum analog output of 0-10 or 0-5VDC models is 30 mV.

## ADVANCED TECHNOLOGY

- **EBTRON** Advanced Thermal Dispersion (TD) airflow measurement technology ensures accurate, repeatable measurement from zero flow (still air).
- Superior performance compared to conventional differential pressure- based pitot technology in challenging small duct and VAV box applications.
- Sensors are factory calibrated from 0-3,000 FPM to volumetric airflow standards.
- True volumetric airflow rate using independent sensors.
- Highest quality/stability hermetically sealed "bead-in-glass" thermistors.
- Advanced industrial grade components and robust microprocessor based design ensures accuracy, stability and long term reliability.
- Convenient field-selectable analog output signal options for airflow, equivalent velocity pressure and full scale ranges.
- Integrated mounting bracket simplifies field installation.

## SPECIFICATIONS

### General

Power Requirement: 24 VAC (22.8 to 26.4 VAC)  
 Power Consumption: 5 VA max.  
 Accuracy: ±3% of reading typical, 0 to 3,000 FPM<sup>1</sup>  
 Repeatability: ±0.25%  
 Ranges Available<sup>1</sup>:  
 0 to 500 FPM [0 to 2.54m/s]  
 0 to 1,000 FPM [0 to 5.08m/s]  
 0 to 2,000 FPM [0 to 10.16m/s]  
 0 to 3,000 FPM [15.24m/s]  
 0 to 0.05 inches water column (WC) (12.45 Pascal)  
 0 to 0.15 inches WC (37.36 Pascal).  
 0 to 0.25 inches WC (62.27 Pascal)  
 0 to 0.5 inches WC (124.5 Pascal)  
 Operating Temperature Range (transmitter):  
 -20°F to 120°F [-28.9°C to 48.9°C]  
 Operating Temperature Range (sensor probe):  
 30°F to 160°F [-1.1°C to 71.1°C]  
 Operating Humidity Range:  
 0 to 99% (non-condensing)  
 Agency Listing:  
 UL873 Airflow & Temperature Indicating Devices

### Probe Sizes

Standard Sizes:  
 4 to 10 inches (101.6 to 254 mm), in 1 inch (25.4 mm) increments; and >10 to 16 inches (>254 to 406.4 mm), in 2 inch (50.8 mm) increments.

Specification Notes: <sup>1</sup> Accuracy for duct sizes up to 16 inches (406.4 mm). Consult factory for other sizes.  
<sup>2</sup> Output on Standard /F00 and /F03 is 0-10/2-10VDC; on /F01 and /F04 versions, 0-5/1-5VDC.  
<sup>3</sup> The minimum analog output in 0-10 or 0-5 VDC modes is typically 30 mV.  
<sup>4</sup> Resolution is 0.015% FS for 0-10/2-10VDC output and 0.03% FS for 0-5VDC/1-5VDC output.

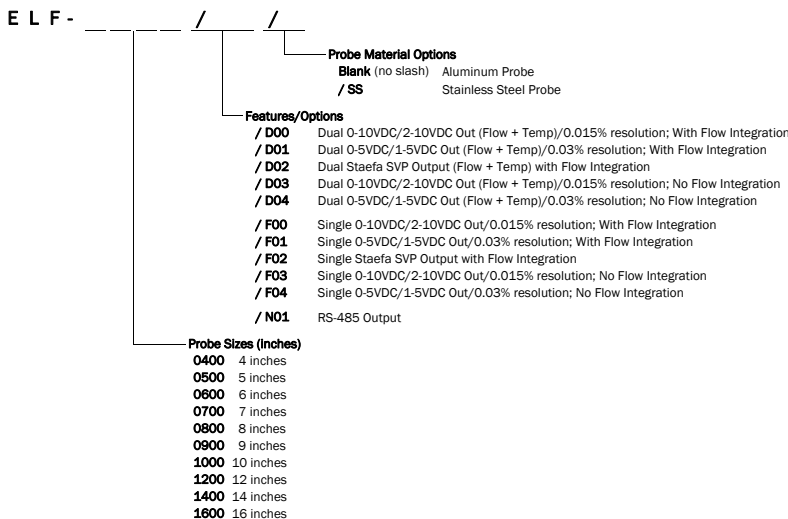
### Sensor Probes

Sensor housing: Glass-filled polypropylene (Kynar<sup>®</sup> with 316 SS option)  
 Sensor potting material: Marine grade, waterproof epoxy  
 Internal wiring: Kynar<sup>®</sup> coated copper  
 Mounting Style: Insertion Mount, with integral mounting bracket  
 Probe Construction:  
 0.75 inch (19.05 mm) diameter tubing;  
 Type 6063 aluminum alloy standard  
 Type 316 stainless steel optional  
 Probe Sizes: 4 to 16 in.  
 Sensing Points per probe:  
 2 per probe from 5 to 16 inches;  
 1 per probe on 4 inch probes  
 Probe Configuration (maximum):  
 1 Probe x 2 Independent Sensors  
 Sensor Assembly (each point):  
 Bead-in-glass thermistor devices bonded in housing with waterproof marine grade epoxy  
 Instrument cable: UL<sup>®</sup> Plenum Rated, PVC jacket;  
 3 feet (0.91 m) standard

### Output to Host Controls

ELF/F Interface (Analog Output<sup>2</sup>):  
 Non-isolated 0<sup>3</sup>-10/2-10VDC (0<sup>3</sup>-5/1-5VDC) or Staefa equivalent airflow or equivalent velocity pressure.  
 Output Resolution<sup>4</sup>: 0.015% FS (Standard /F00 and /F03)  
 0.03% FS (/F01 and /F04 versions)

## ORDERING GUIDE



Examples:  
 For a 9 inch duct, single 0-10/2-10VDC Airflow Output and an aluminum probe, specify order code ELF-0900/F00.  
 For a 9 inch duct, single 0-5/1-5VDC Output and a stainless steel probe, specify order code ELF-0900/F01/SS.  
 For a 9 inch duct, Staefa SVP single output and an aluminum probe, specify order code ELF-0900/F02.  
 For a 9 inch duct, RS-485 Output and an aluminum probe, specify order code ELF-0900/N01.  
 For a 9 inch duct, dual 0-10/2-10VDC analog output with flow integration filter and an aluminum probe, specify order code ELF-0900/D00.

## ELF PLACEMENT

The following paragraphs detail the procedure for determining optimum placement of the ELF in typical installation applications.

### CAUTION



Installation of the ELF at the exact location indicated in the Minimum Placement Guidelines below is critical for proper performance of the airflow measurement station.

### Minimum Placement Guidelines

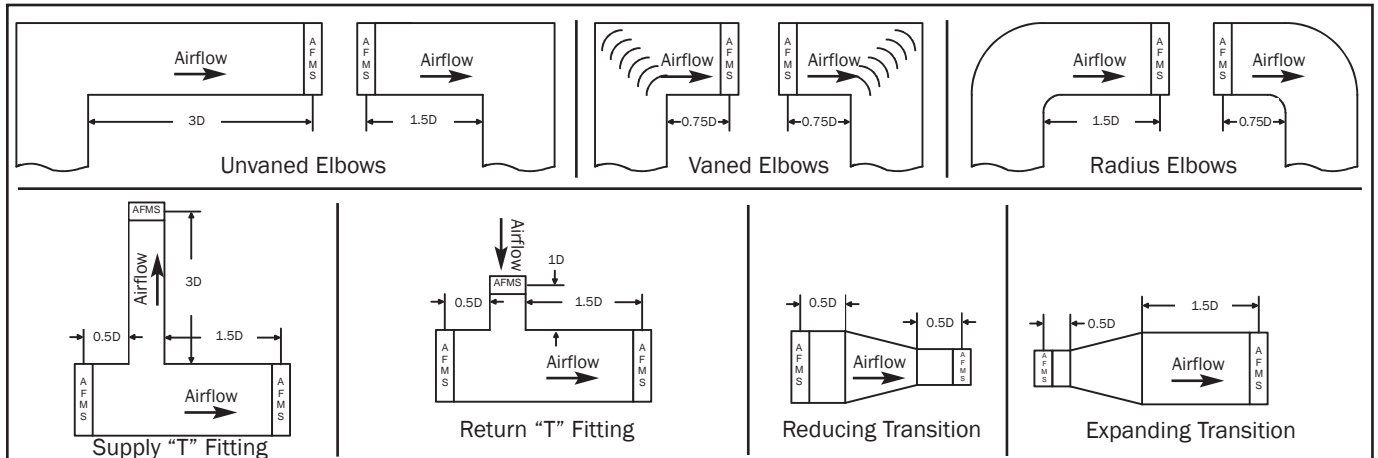
The ELF small duct airflow measurement station sensor probes are computer calibrated between 0 and 3,000 FPM (0.25 and 15.24 m/s) in individual wind tunnels to volumetric airflow standards. As a result, performance on smaller ducts is improved by compensating for flow losses near the duct wall. Small ducts have a large duct wall surface to free area ratio that typically results in higher than actual flow measurement when traditional multi-point traverse airflow measurement techniques are used.

Placement of the ELF is critical for proper operation and accuracy of the airflow measurement station. Figure 2 shows minimum placement requirements for the ELF in typical applications. Placement is indicated in multiples of 'Simple Equivalent Duct Diameter - 'D', which is determined as follows:

$$'D' = \frac{(\text{duct width} + \text{duct height})}{2}$$

- Using the illustration in Figure 2 that most closely matches the installation, multiply the the calculated 'D' value above by the value indicated in the application illustration. This is the calculated ELF location.
- Mark duct location and install the ELF at the calculated location.

### MINIMUM PLACEMENT GUIDE



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Minimum placement is indicated in multiples of duct diameter 'D':





See separate diagrams for VAV box applications. Consult **EBTRON** for applications not indicated in the diagrams.

**Figure 2. ELF Minimum Placement Requirements Guide**

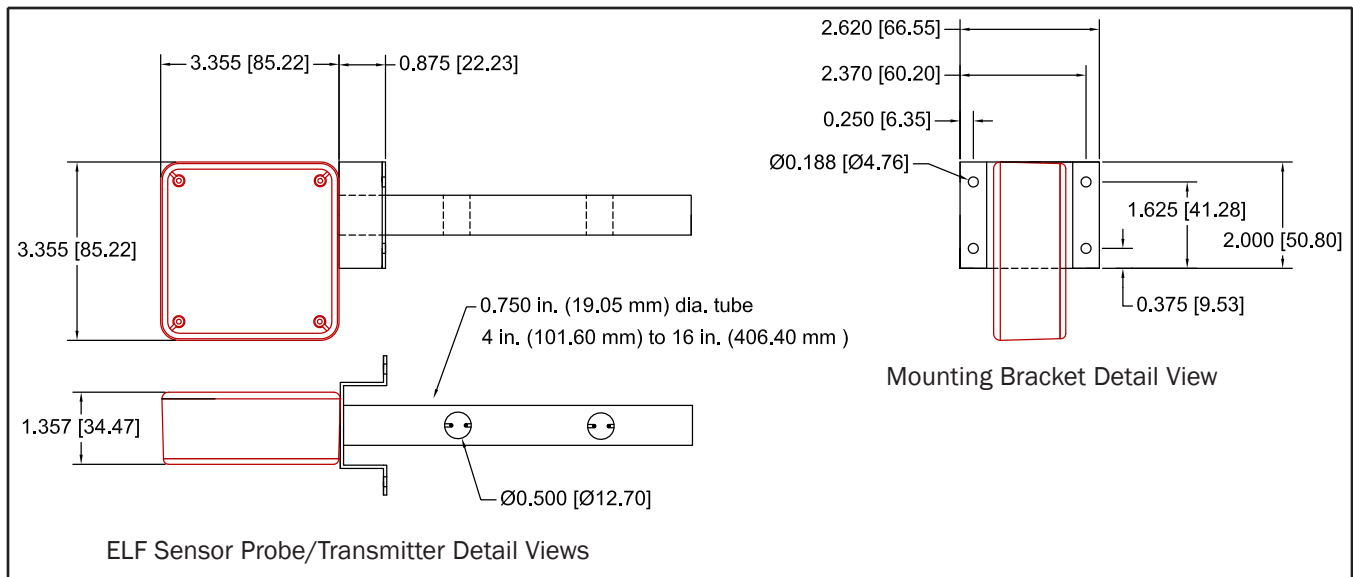
## ELF INSTALLATION

The ELF is designed for use in smaller ducts (up to 16 inches) and in VAV terminal box applications in an environment between -20°F to 120°F (-28.9°C to 48.9°C) where it will not be exposed to rain or snow. ELF airflow measurement station sensor probes are designed for insertion mounting through one side of the duct or VAV box. Mount the instrument in an accessible location to permit set up. Locate the instrument so that the attached instrument cable will reach the customer provided BAS control interface.

### CAUTION

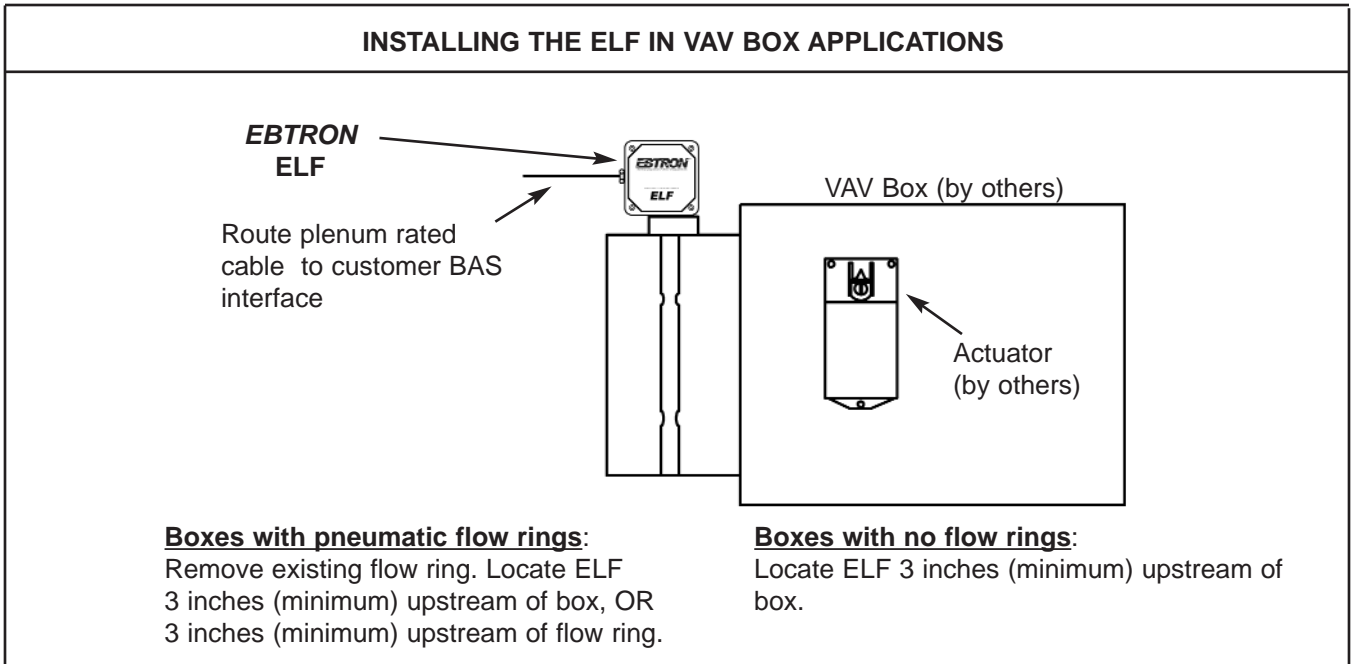
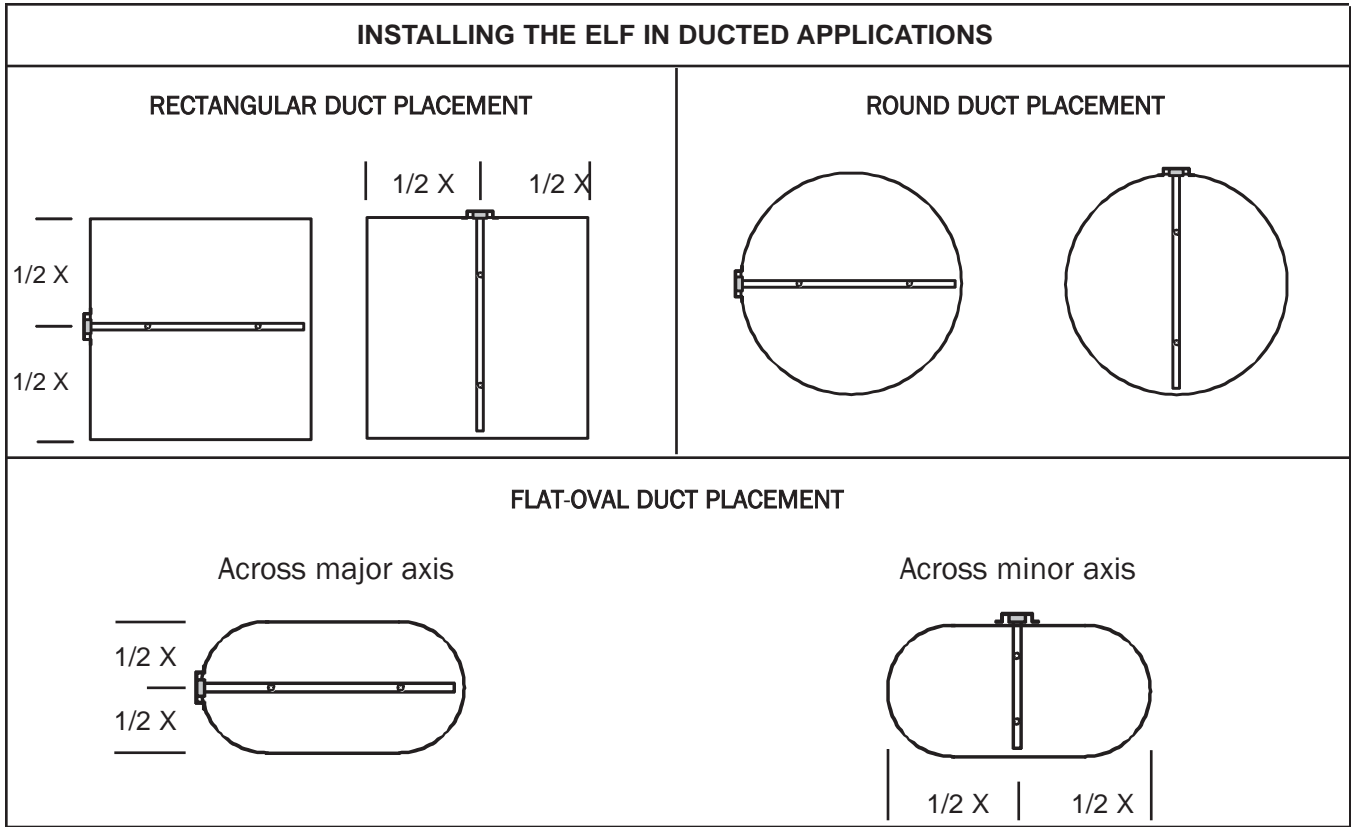
-  The installed location of the ELF is critical for proper performance. Refer to the previous Minimum Placement Guidelines section of this document to determine the exact location recommended for the ELF.
-  The installed accuracy of the ELF is ensured in applications where the maximum inside duct dimension is 16 inches or less. Applications in larger duct sizes may degrade accuracy. Consult factory for these applications.
-  Ensure that adequate clearance exists to permit insertion of the probe, and to allow clearance for the instrument enclosure.
-  External duct insulation that interferes with mounting should be temporarily removed prior to installation. Mounting requires a 0.875 inches (22.2 mm) hole on the insertion side of the duct.

1. Determine where the ELF airflow measuring station is to be located as indicated on the engineer's plans.
2. Carefully open the ELF package and inspect for damage. If damage is noted, immediately file a claim with carrier.
3. Locate and mark the point on the duct or VAV box where the probe will be inserted, using the previous Minimum Placement Guidelines section of this document. Refer to Figures 3 and 4 for ELF dimensions and probe orientation.
4. Using a 0.875 inches (22.2 mm) hole saw, drill the insertion side hole where marked.
5. Place the probe through the mounting hole, making sure that the gasket is seated firmly against the integral mounting bracket. Ensure that the edge of the ELF mounting bracket is parallel to the edge of the duct or VAV terminal box, and that the airflow arrow printed on it is oriented in the direction of actual airflow. Ensure that the gasket is firmly seated against the bracket, and then fasten the mounting bracket at the four mounting holes using appropriate sheet metal screws.
6. Route the ELF instrument cable to the customer provided BAS interface. Refer to the following sections of this document for instrument set up and operation.



**Figure 3. ELF Installation Dimensions**





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Figure 4. ELF/F Probe Typical Applications

## ELF/F PREPARATION FOR USE

The ELF/F provides a single linear analog output corresponding to measured airflow or equivalent velocity pressure. The analog output is field selectable for either air flow or equivalent velocity pressure measurement with four output full scale range options and 0-10/2-10VDC, 0-5/1-5VDC or Staefa equivalent analog output depending on model selected.

Preparation for use consists of connecting 24VAC input power and analog output signal wires from the ELF/F to the BAS interface, and if required, setting the ELF/F analog output CONFIG switch options (measurement mode, analog output signal type and full scale measurement range options).

## ELF/F INTERCONNECTIONS

The ELF/F is equipped with a 3-conductor plenum rated 18 AWG interconnecting cable for power and analog output interface to customer equipment. Connect 24 VAC power and analog output to customer interface as outlined in the following paragraphs. Refer to Figure 5 and the following ELF/F cable color code descriptions:

- Red** 24 VAC power
- Black\*** Common ELF Power/Signal Ground (for 24 VAC and for analog output)
- White** Analog output signal

### \*CAUTION



The ELF is equipped with a common 24VAC ground and analog output signal return. EBTRON strongly recommends that the BAS control interface be connected to the ELF analog output using TWO separate wires (twisted shielded pair) in order to eliminate any potential voltage drop on the common (from the 24VAC return) that would otherwise cause inaccurate readings.

### CAUTION



To prevent damage to the ELF, deactivate 24 VAC power source until all connections to the instrument are completed.

### NOTE



The 24 VAC input ground (GND) connection is shared with the analog output signal ground. If an isolated output is desired, a dedicated isolation transformer is required to power the ELF.

## ELF/F 24 VAC Power Connections



### CAUTION

24 VAC power must be deactivated before making connections to the instrument.

The ELF requires a power source capable of providing 22.8 to 26.4 VAC at 5 VA. Connect 24VAC power between the red wire and black wire as shown in Figure 5.



**ELF/F Analog Output Connections**

The ELF/F provides an analog output corresponding to airflow or equivalent velocity pressure. Analog outputs available from the ELF standard /F00 and /F03 versions are 0-10/2-10 VDC; or 0-5/1-5 VDC from the /F01 and /F04 versions. The /F02 version provides an equivalent Staefa output. The output is capable of driving a 20mA load. The analog output is not isolated from the input power. The 24VAC input ground connection is shared with the analog signal ground (black wire - GND). If isolated output is desired, the ELF must be powered by a dedicated isolation transformer.

Connect the analog output at the white wire and the signal common at the black wire to the BAS monitor/control interface using shielded twisted pair cable as shown in Figure 5.

**Converting the ELF/F Analog Output from 2-10VDC or 1-5VDC to an equivalent 4-20mA output (Not for Staefa output model with /F02 suffix)**

The analog output voltage can be converted to an equivalent analog output current by setting the ELF analog output switch SW2 to 2-10VDC for the standard /F00 and /F03 versions (or 1-5VDC for the /F01 and /F04 versions), and placing the proper value of resistor R1 across the ELF analog output signal lines **at the BAS control interface** as shown in Figure 5.

For example, on a standard ELF/F00 (0-10VDC), set SW2 set for 2-10VDC (ON), and use an R1 value of 500 ohms at the BAS control input interface to produce a corresponding control signal of 4-20mA. Similarly, for an ELF-xxx/F01 or /F04 version (0-5VDC), set SW2 for 1-5VDC output, and R1 value of 250 ohms to produce a 4-20 mA control signal.

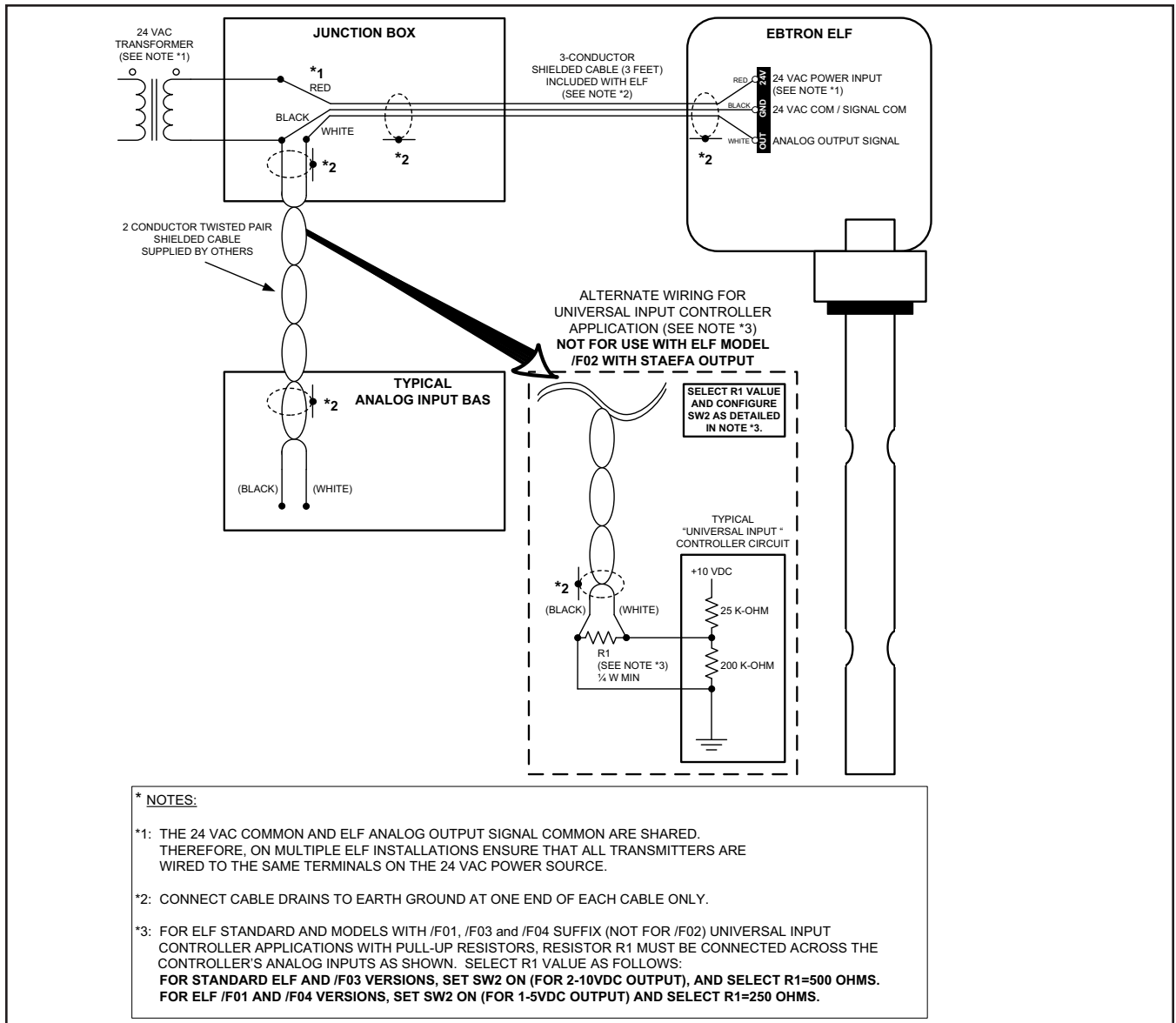


Figure 5. ELF/F Power and Signal Wiring Interconnections

**ELF/F ANALOG OUTPUT CONFIGURATION OPTIONS (CONFIG SW1 - SW4)**

To access the field selectable analog output configuration switches, remove the four retaining screws at each corner of the ELF enclosure cover. Configuration selector switches SW1 through SW4 are part of a four-switch DIP package labeled CONFIG. Figure 4 shows the ELF main circuit board and the individual switches for setting the output measurement mode, analog output voltage range and output full scale measurement values. Factory default switch settings are all OFF. The table below shows the CONFIG switch settings and resulting operation for each of the ELF/F model versions.

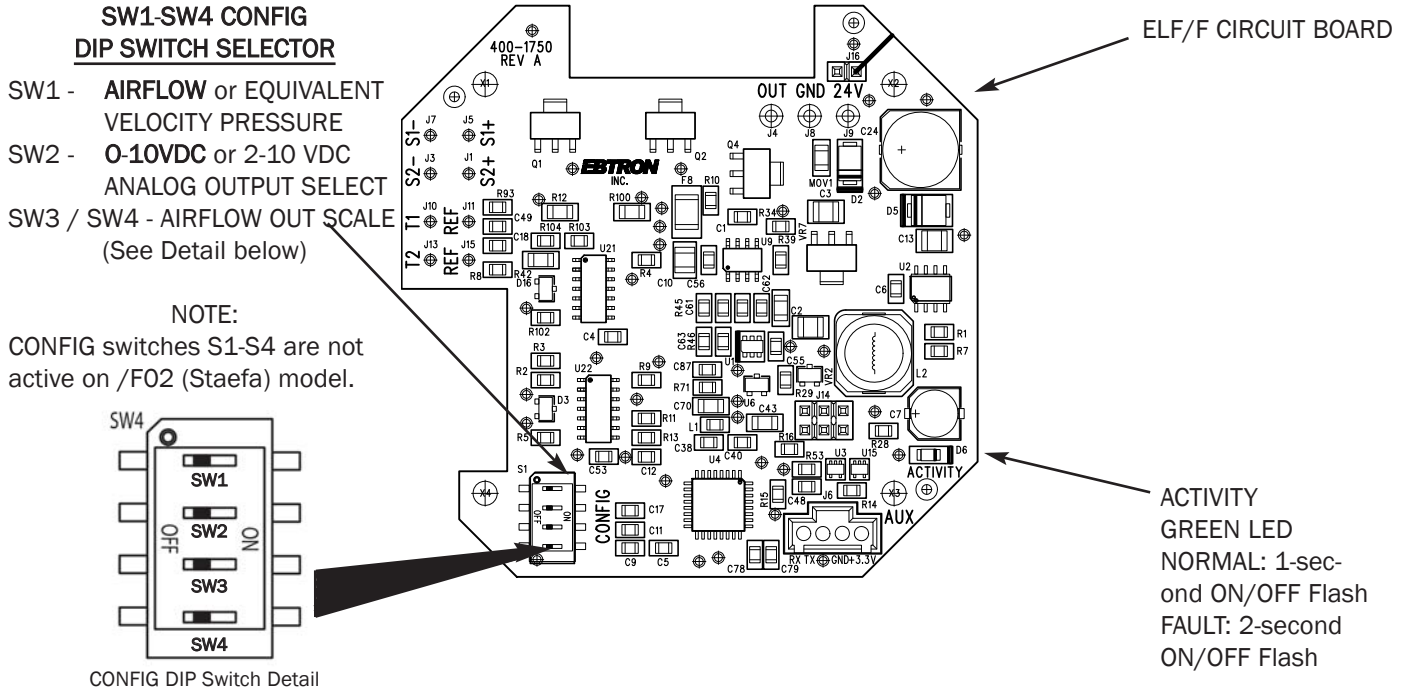


Figure 6. ELF/F Circuit Board Detail

SW POSITION -----> ELF MODEL ↓	SW1 POSITION MEASUREMENT MODE		SW2 POSITION ANALOG OUT SELECT		SW3/SW4 POSITION MEASUREMENT RANGE SELECT			
	OFF	ON	OFF	ON	OFF/OFF	ON/OFF	OFF/ON	ON/ON
/F00 MODEL (OR NO SLASH)	<b>AIRFLOW</b>	VEL PRESSURE	<b>0-10VDC</b>	2-10VDC	<b>3000 FPM</b> 0.5 lwc	2000 FPM 0.25 lwc	1000 FPM 0.15 lwc	500 FPM 0.05 lwc
/F01 MODEL	<b>AIRFLOW</b>	VEL PRESSURE	<b>0-5VDC</b>	1-5VDC	<b>3000 FPM</b> 0.5 lwc	2000 FPM 0.25 lwc	1000 FPM 0.15 lwc	500 FPM 0.05 lwc
/F02 MODEL	<b>SWITCHES ARE INACTIVE ON /F02 (STAEFA OUTPUT) MODEL</b>		<b>STAEFA OUTPUT</b>		<b>SWITCHES ARE INACTIVE ON /F02 (STAEFA OUTPUT) MODEL</b>			
/F03 MODEL	<b>AIRFLOW</b>	VEL PRESSURE	<b>0-10VDC</b>	2-10VDC	<b>3000 FPM</b> 0.5 lwc	2000 FPM 0.25 lwc	1000 FPM 0.15 lwc	500 FPM 0.05 lwc
/F04 MODEL	<b>AIRFLOW</b>	VEL PRESSURE	<b>0-5VDC</b>	1-5VDC	<b>3000 FPM</b> 0.5 lwc	2000 FPM 0.25 lwc	1000 FPM 0.15 lwc	500 FPM 0.05 lwc

**BOLD TYPEFACE INDICATES FACTORY DEFAULT SWITCH SETTINGS**

Table 1. ELF/F CONFIG Switch Settings

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## **ELF/F INITIAL START UP / NORMAL OPERATION**

The following procedure is intended for initial start up of the instrument. Following the initial set up, no further user activity is required during normal operation.

1. Remove the cover to the electronics enclosure by removing the four screws on the cover.
2. Make sure that the 24VAC circuit breaker used to power the ELF is turned OFF until all wiring is complete!
3. Confirm 24VAC connection from the power source to the ELF 24VAC wire (red wire) as outlined in the ELF 24VAC Power Connections section of this document.
4. Confirm common ground 24VAC and signal ground connection from the power source to the ELF at the black wire.
5. Confirm ELF/F analog signal output connection at the white wire, to the analog input of the BAS as outlined in ELF Analog Output Connections section of this document. Note that the ground of the BAS must be at the same voltage reference as the ground of the ELF and the power source.
6. Set the desired analog output options using CONFIG switches SW1 to SW4 as outlined in the ELF Analog Output Option Switch Settings section of this document.
7. Activate the 24VAC power source to power on the ELF.
8. Following a brief instrument initialization, the green Activity LED will continuously flash ON for 1 second, then OFF for 1 second. This indicates normal operation. In the event of a sensor fault, the LED will produce longer continuous flashes ON for 2 seconds, and OFF for 2 seconds.
9. Confirm that the BAS is receiving the analog output signal that indicates instrument airflow or equivalent velocity pressure.
10. Replace the ELF electronics enclosure cover and secure with the four screws removed in step 1.

### **Converting the Analog Airflow Output Signal from Linear to Volumetric flow - FPM to CFM**

The analog airflow output can be converted from velocity (FPM) to an equivalent volumetric flow (CFM) by multiplying the indicated flow velocity by the free area of the sensor installed location (in square feet). For example, with a standard ELF/F00 installed in a 12 inch round duct, using the 0-10VDC scale and 3,000 FPM full scale output range options; an output of 5VDC indicates a flow velocity of 1,500 FPM (5VDC is one-half of the 0-10VDC output, corresponding to half of the 0-3,000 FPM scale; and equals 1,500 FPM). The ELF installed duct location area in this example is calculated at **0.785 ft<sup>2</sup>** (using  $\text{Pi} \times \text{duct radius}^2$ , or  $3.14 \times 0.5\text{ft}^2$ ). Multiplying the indicated instrument output of **1,500 FPM** by the duct free area of **0.785 ft<sup>2</sup>** yields an equivalent volumetric flow of **1,177.5 CFM**.

## **ELF MAINTENANCE**

In most HVAC environments, periodic maintenance and calibration is not required or recommended\*.

\*Depending on the application, it may be necessary to periodically inspect and clean sensors using compressed air or a small brush. Factory performance returns immediately after cleaning. Recalibration is NOT required. Periodic inspection of the sensors is always advised, and accessibility must be considered in these applications.

## **ELF STANDARD LIMITED PARTS WARRANTY**

If any **EBTRON** product fails within 36 months from shipment, **EBTRON** will repair/replace the device free of charge as described in the company's warranty contained in **EBTRON's** Terms and Conditions of Sale. Defective equipment shall be shipped back to **EBTRON**, freight pre-paid, for analysis.

