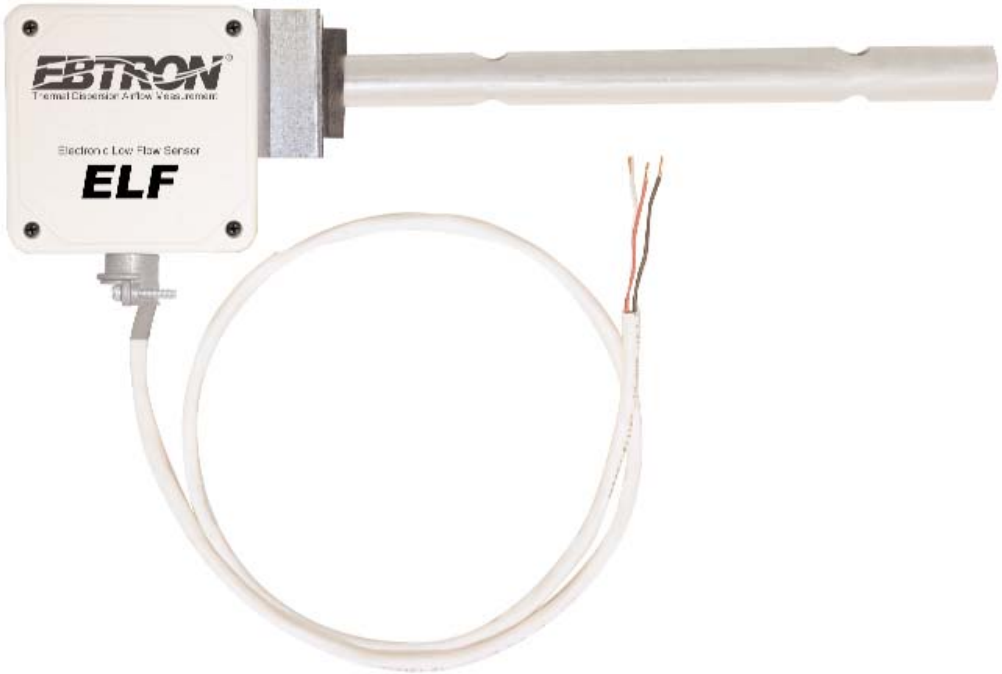
Installation, Operation and Maintenance Technical Manual

ELF

Electronic Low Flow Airflow Measurement Station

Model ELF-XXXX: 0-10/2-10VDC ANALOG OUTPUT
Model ELF-XXXX/F01: 0-5/1-5VDC ANALOG OUTPUT
Model ELF-XXXX/F02: STAEFA EQUIVALENT OUTPUT

Document Name: TM_ELF_R2A



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Part Number: 930-0170

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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Insert latest changed pages (in bold text); remove and dispose of superseded pages.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
1	**R2A**	**Change revision to R2A**	**05/03/2010**
2	**R2A**	**Updated List of Effective Pages, Table of Contents**	**05/03/2010**
3, 4, 8-11	**R2A**	**Added 2-10VDC output (standard ELF), 0-5/1-5VDC output (model /F01) and Staefa output (model F02) options and specifications.**	**05/03/2010**
4	R1G	Corrected sensor probe minimum operating temperature to 30°F	11/04/2009
4	R1F	Corrected resolution to 0.015%	08/19/2009
4	R1E	Revised Ordering Guide - changed 'model number' to 'order code'	07/21/2009
4	R1D	Revised Ordering Guide - common sizes for all duct shape sizes	07/16/2009
3	R1C	Added maximum duct size for accuracy	07/09/2009
4	R1C	Added note regarding accuracy and maximum duct size; and revised Ordering Guide to clarify sizes available	07/09/2009
1, 3	R1B	Updated product photo; change revision to R1B	06/25/2009
4 through 7	R1B	Re-issued as R1B without change	06/25/2009
8 through 12	R1B	Added new ELF Power and Signal Wiring Detail (Figure 5), and changed existing Figure references	06/25/2009
1 through 12	R1A	Initial Document Release	05/18/2009

* R2A indicates an original page without change

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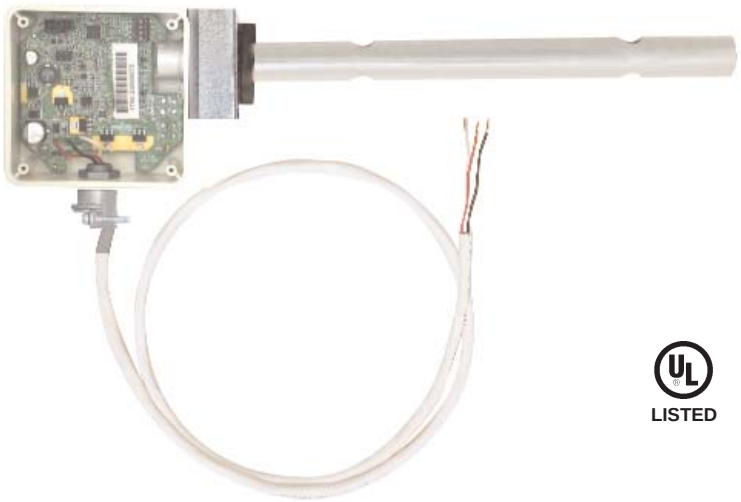

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Figure 1. EBTRON ELF Electronic Low Flow Measurement Station

OVERVIEW

The *EBTRON* ELF 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 uses a single factory calibrated probe equipped with one or two sensor nodes, depending on application.

ELF airflow sensors use "bead-in-glass" and precision 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. Models are available with analog outputs of 0-10/2-10VDC[1], 0-5/1-5VDC (ELF-XXXX/**F01** option) or Staefa equivalent output (ELF-XXXX/**F02** option). The linear airflow rate can easily be converted to equivalent volumetric flow 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.

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"** and precision 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.

[1] Minimum analog output in 0-10 or 0-5VDC mode is 30 mV.

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SPECIFICATIONS

General

Power Requirement: 24 VAC (22.8 to 26.4 VAC)
Power Consumption: 5 VA max.
Accuracy: ± 3% of reading from 0 to 3,000 FPM[1]
Repeatability: ±0.25%
Calibrated Ranges[1]:
- 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 (iWC) (12.45 Pascal)
- 0 to 0.15 iWC (37.36 Pascal).
- 0 to 0.25 iWC (62.27 Pascal)
- 0 to 0.5 iWC (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 (101.6-254 mm), in 1 inch (25.4 mm) increments; >10 to 16 inches (254-406.4 mm), in 2 inch (50.8 mm) increments.

Sensor Probes

Sensor housing: Glass-filled polypropylene (Kynar® with 316 SS option)
Sensor potting material: Marine grade, waterproof epoxy
Internal wiring: Kynar® 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 and precision thermistor devices bonded in housing with waterproof marine grade epoxy
Instrument cable: UL® Plenum Rated, PVC jacket;
3 feet (0.91 m) standard

Output to Host Controls

ELF Interface (Analog Output):
Non-isolated 0[2]-10/2-10VDC (0[2]-5/1-5VDC), linear airflow or equivalent velocity pressure.
Output Resolution[3]: 0.015% of full scale
0.03% of full scale for /F01 version

Specification Notes: [1] Accuracy for duct sizes up to 16 inches (406.4 mm). Consult factory for other sizes.
[2] The minimum analog output in 0-10 or 0-5 VDC modes is typically 30 mV.
[3] Resolution 0.015% FS for 0-10/2-10VDC output; 0.03% FS for 0-5VDC/1-5VDC output (/F01).

ORDERING GUIDE

E L F - ____ / ____ / ____

Probe Material Options
Blank (no slash) Aluminum Probe
/ SS Stainless Steel Probe

Firmware Output Options and Features
Blank (no slash) 0-10VDC/2-10VDC Output, Resolution: 0.15%
/ F01 0-5VDC/1-5VDC Output, Resolution: 0.03%
/ F02 Staefa SVP Output

Probe Sizes (inches)
0400 4 inches
0500 5 inches
0600 6 inches
0700 7 inches
0800 8 inches
0900 9 inches
1000 10 inches
1200 12 inches
1400 14 inches
1600 16 inches

Examples:
For a 9 inch duct, 0-10/2-10VDC Output and an aluminum probe, specify order code ELF-0900.
For a 9 inch duct, 0-5/1-5VDC Output and a stainless steel probe, specify order code ELF-0900/F01/SS.
For a 9 inch duct, Staefa SVP Output and an aluminum probe, specify order code ELF-0900/F02.

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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. Three placement ranges (**A**, **B** and **C**) are shown for each application. The placement ranges are based upon the 'Simple Equivalent Duct Diameter - '*D*', which is determined as follows:

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

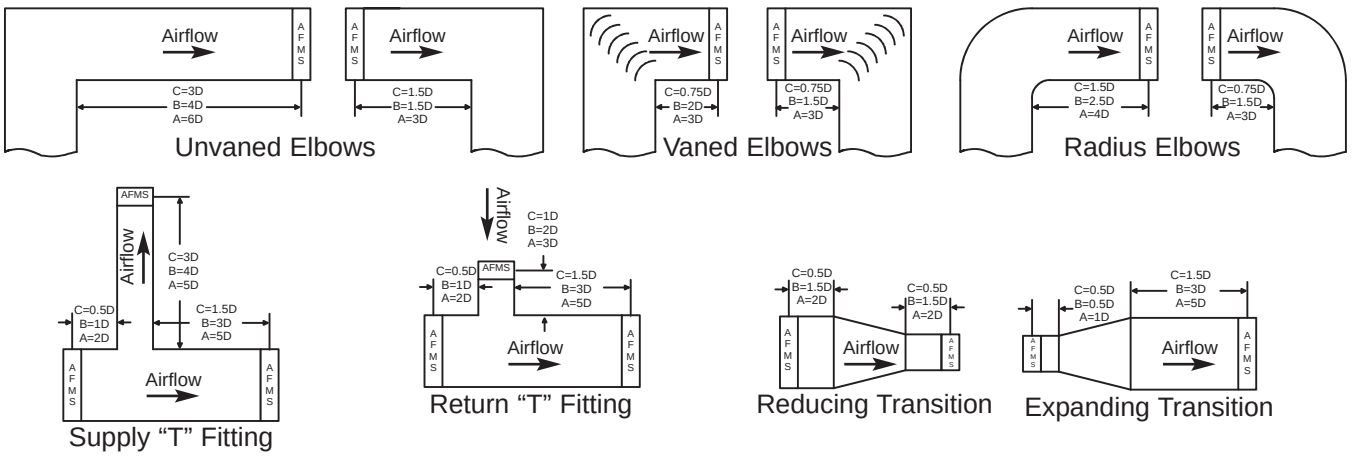
Determine placement as follows:

1. Calculated the value of *'D'* from above, and determine the minimum placement range (A, B or C) as follows:
   For '*D*' = ≥4" to ≤12" (101.6 to 304.8 mm) use Placement Reference '**C**' in Figure 2.
   For '*D*' = ≥12" to ≤15", (304.8 to 381 mm) use Placement Reference '**B**' in Figure 2.
   For '*D*' = ≥15" to ≤16", (381 to 406.4 mm) use Placement Reference '**A**' in Figure 2.

2. Using the illustration in Figure 2 that most closely matches the installation, multiply the the calculated 'D' value from step 1 by the value indicated (for placement reference A,B or C) in the application illustration. This is the calculated ELF location.

3. Mark duct location and install the ELF at the calculated location.

MINIMUM PLACEMENT GUIDE



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Consult ***EBTRON*** for configurations not indicated in the diagrams above.

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.

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.

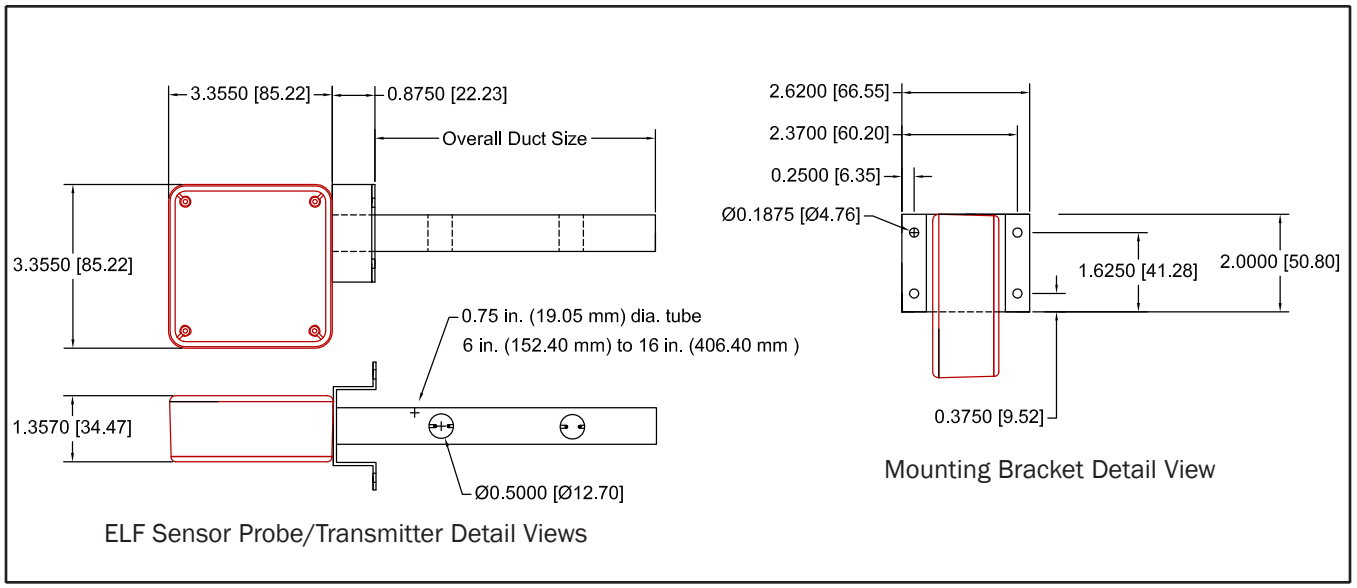
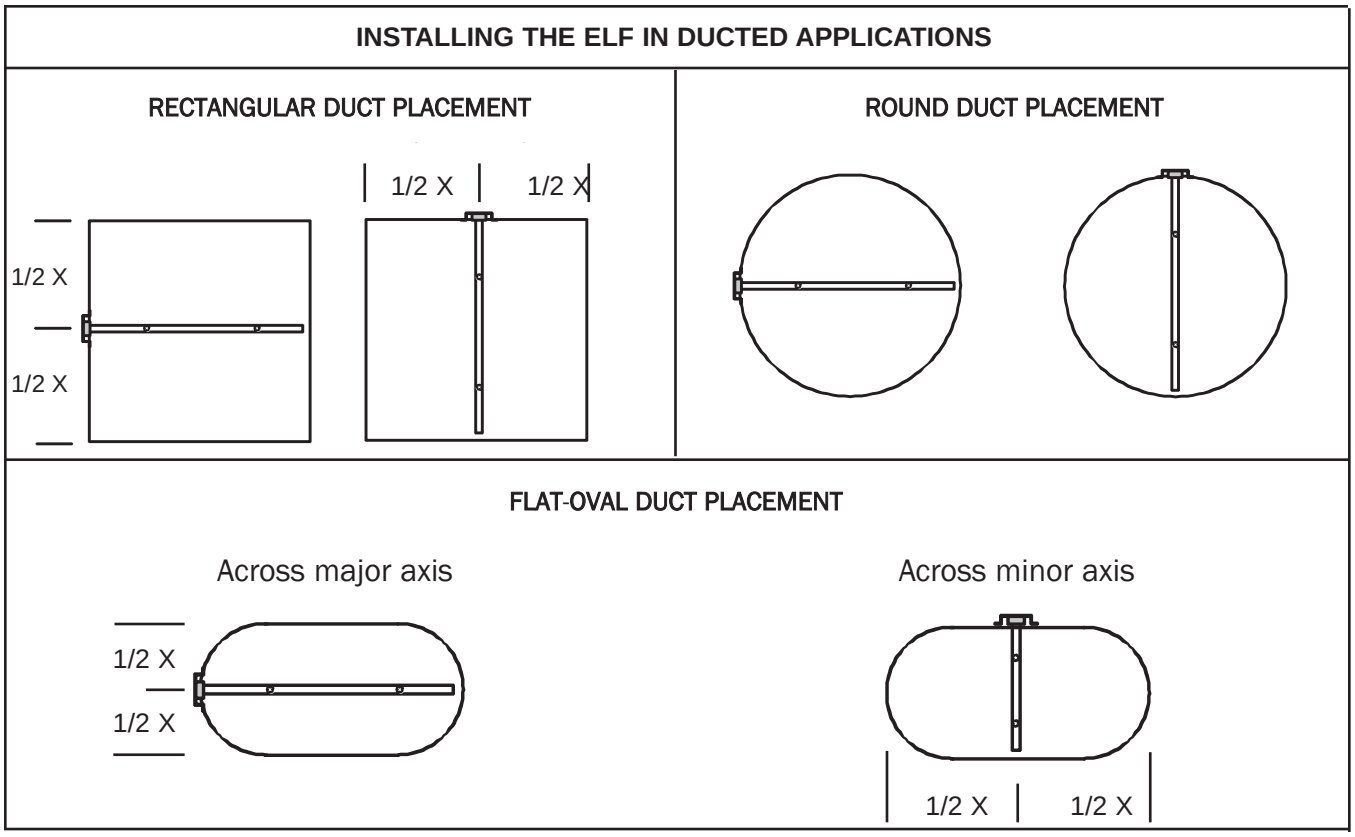


Figure 3. ELF Installation Dimensions



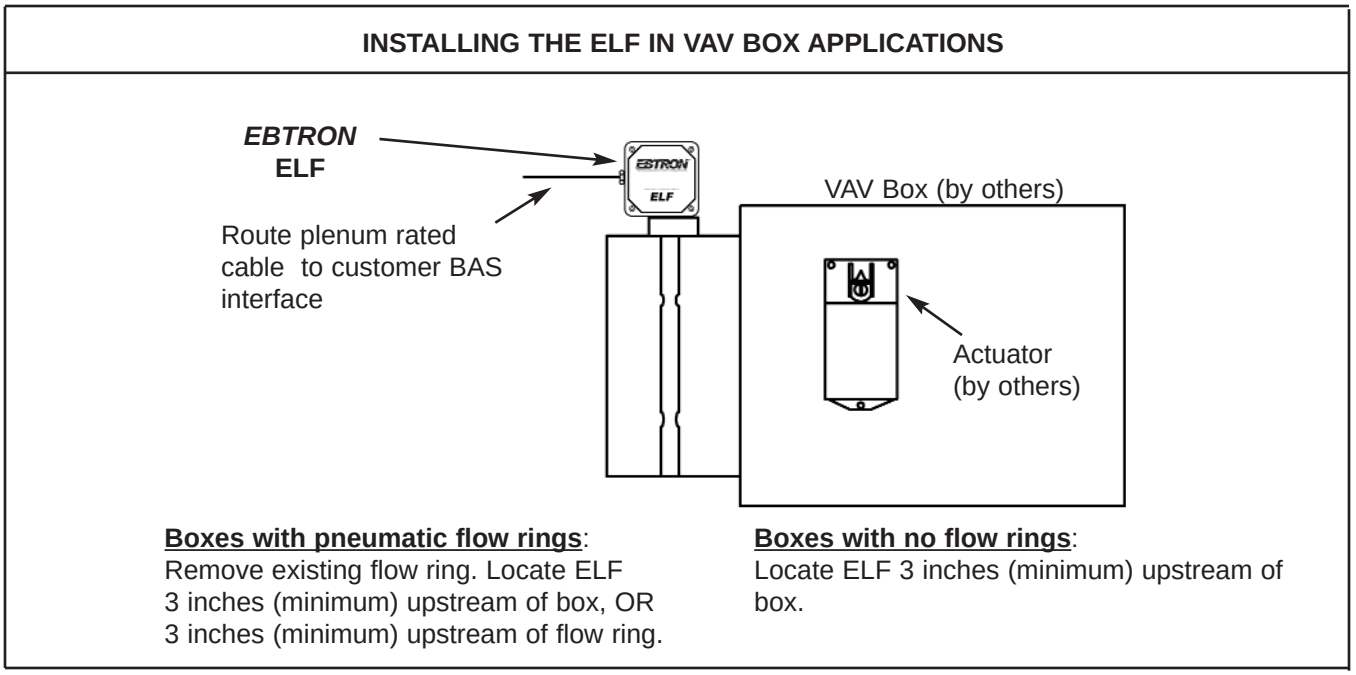


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Figure 4. ELF Installation Applications and Orientation

ELF - PREPARATION FOR USE

The ELF 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 to the BAS interface, and if required, setting the ELF analog output switch options (measurement mode, output signal type and full scale range options).

ELF INTERCONNECTIONS

The ELF 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 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 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.

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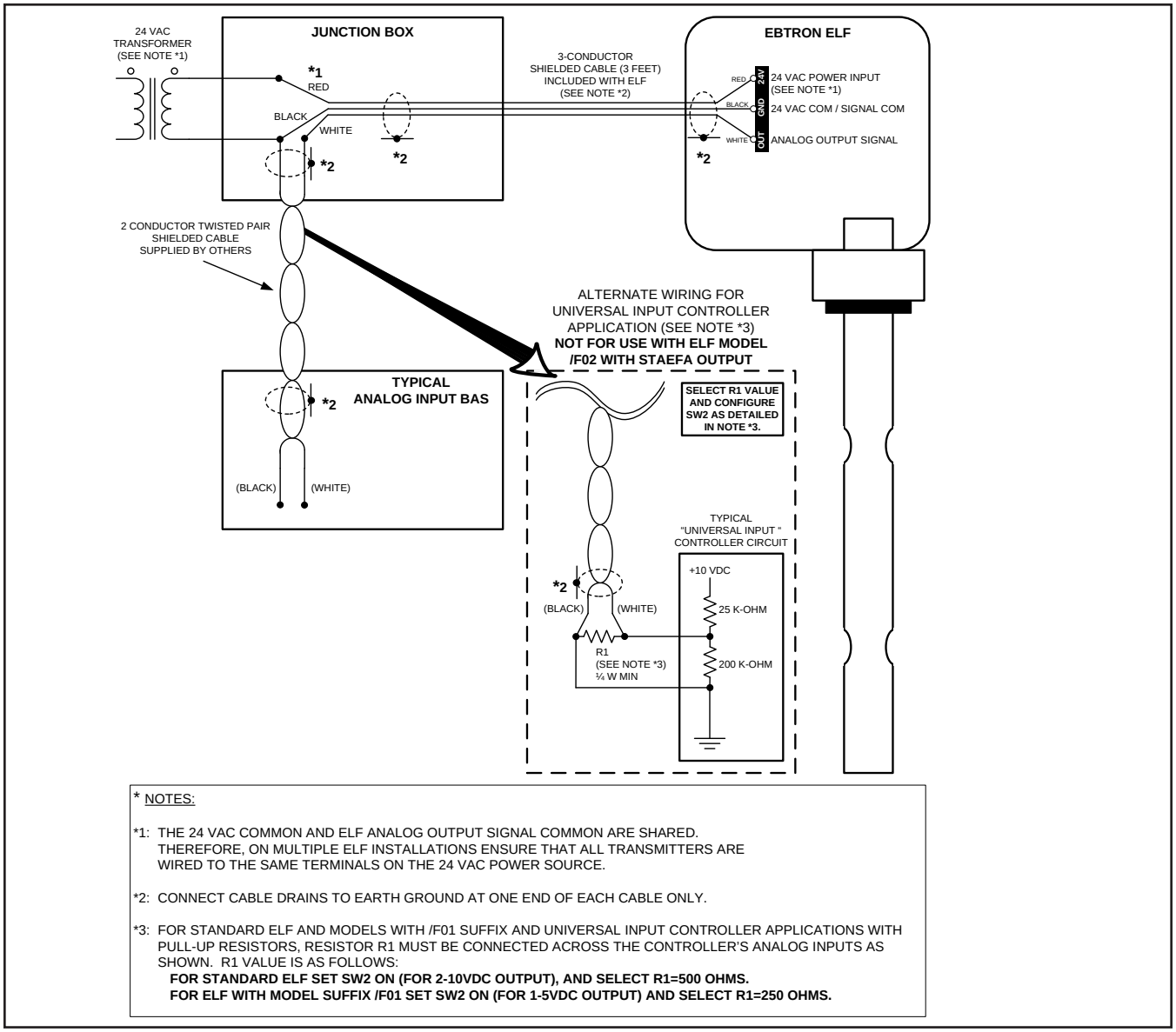
ELF Analog Output Connections

The ELF provides an analog output corresponding to airflow or equivalent velocity pressure. The analog output from the standard ELF is 0-10VDC/2-10VDC; 0-5VDC/1-5VDC from the model ELF-xxxx/F01; and a Staefa equivalent output from the model ELF-xxxx/F02. The output is capable of driving a 20mA load. The analog output is not isolated from the power input. The 24VAC input ground connection is shared with the analog output signal ground (black wire - GND). If an isolated output is desired a dedicated isolation transformer is required to power the ELF.

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 Analog Output from 2-10VDC or 1-5VDC to 4-20mA (Standard ELF and Staefa output model with /F01 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 ELF (or 1-5VDC for the ELF-xxxx/F01), 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, a standard ELF with 0-10VDC output and SW2 set for 1-5VDC (ON), an R1 value of 250 ohms at the BAS control input interface will produce a corresponding output control signal of 4-20mA. Similarly, for an ELF-xxxx/F01 with 1-5VDC output, an R1 value of 500 ohms will produce a 4-20 mA control signal.



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* NOTES:

*1: THE 24 VAC COMMON AND ELF ANALOG OUTPUT SIGNAL COMMON ARE SHARED. THEREFORE, ON MULTIPLE ELF INSTALLATIONS ENSURE THAT ALL TRANSMITTERS ARE WIRED TO THE SAME TERMINALS ON THE 24 VAC POWER SOURCE.

*2: CONNECT CABLE DRAINS TO EARTH GROUND AT ONE END OF EACH CABLE ONLY.

*3: FOR STANDARD ELF AND MODELS WITH /F01 SUFFIX AND UNIVERSAL INPUT CONTROLLER APPLICATIONS WITH PULL-UP RESISTORS, RESISTOR R1 MUST BE CONNECTED ACROSS THE CONTROLLER'S ANALOG INPUTS AS SHOWN. R1 VALUE IS AS FOLLOWS:
FOR STANDARD ELF SET SW2 ON (FOR 2-10VDC OUTPUT), AND SELECT R1=500 OHMS.
FOR ELF WITH MODEL SUFFIX /F01 SET SW2 ON (FOR 1-5VDC OUTPUT) AND SELECT R1=250 OHMS.

Figure 5. ELF Power and Signal Wiring Interconnections

ELF ANALOG OUTPUT OPTION SWITCH SETTINGS

To access the field selectable analog output option switches, remove the four retaining screws at each corner of the ELF enclosure cover. The option selector switches are part of a four-switch DIP package labeled CONFIG. Figure 6 shows the ELF circuit board and individual switches for setting ELF measurement mode, output voltage and output full scale values. Factory default switch settings are all OFF, resulting in airflow measurement mode, 0-10VDC (0-5VDC for ELF /F01 option) analog output and 0-3,000 FPM full scale range. If desired, these settings can be changed using the CONFIG switch as shown in Figure 6 and as described in the following paragraphs:

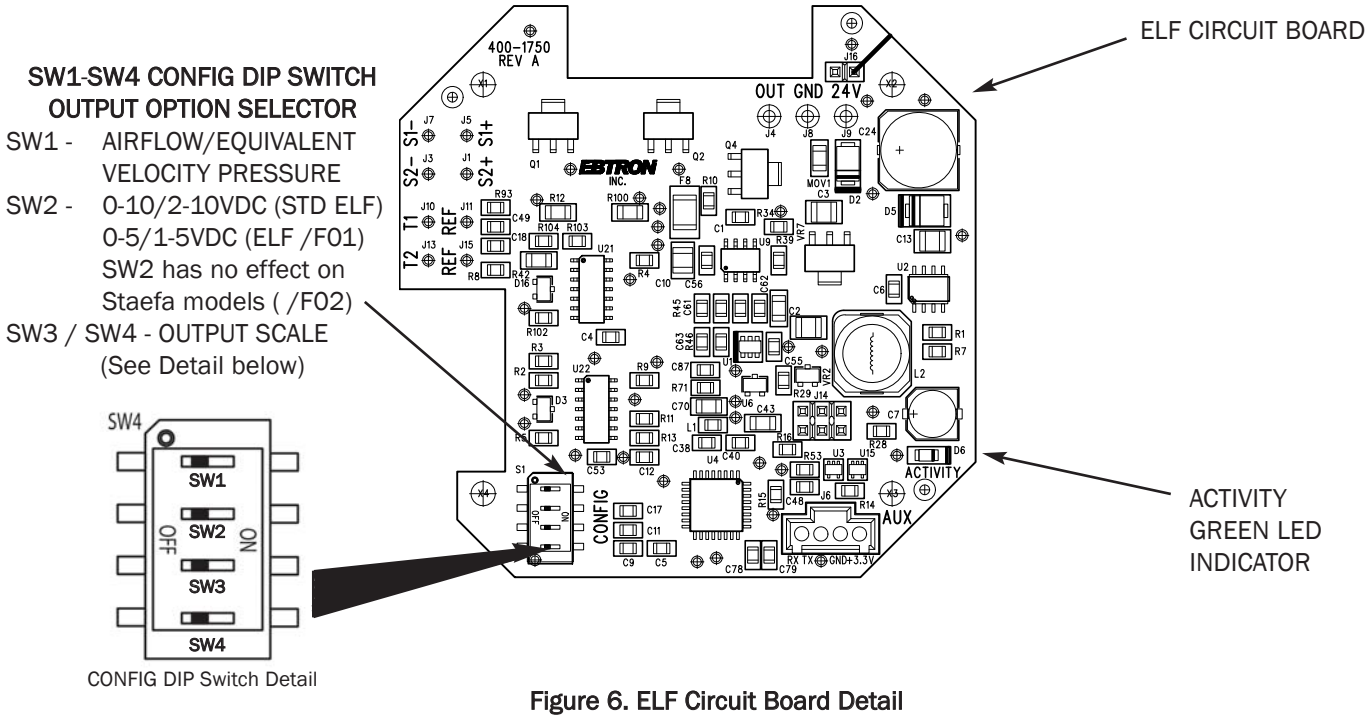

Figure 6. ELF Circuit Board Detail

SW1 - Airflow / Equivalent Velocity Pressure Measurement Mode Selector

The ELF is preset at the factory for airflow measurement. To change to the measurement mode, set selector **SW1** to **ON** for **equivalent velocity pressure**, or **OFF** for **airflow** (factory default) as shown in Figure 6.

SW2 - 0-10 VDC/2-10VDC (0-5VDC/1-5VDC) Output Selection (ELF Standard and /F01 models only)

The ELF is set at the factory with **SW2** set to **OFF** for 0-10 VDC output (0-5 VDC for ELF /F01). To change the output signal type, set **SW2** to the **ON** position for **2-10 VDC** for the standard ELF (or 1-5 VDC for ELF /F01) as shown in Figure 6. SW2 has no effect on ELF models with the Staefa output option (/F02)

SW3 / SW4 - Output Signal Full Scale Range Selection

The ELF is set at the factory for 0-3,000 FPM output full scale. The output scale can be set to four scale values for air flow (or equivalent velocity pressure - see SW1 above) using **SW3** and **SW4**. Set **SW3** and **SW4** to the output scaling desired as shown below:

SW3 OUTPUT SCALE	SW4 OUTPUT SCALE	OUTPUT FULL SCALE RANGE IN FPM (SW1 SET TO OFF)	OUTPUT FULL SCALE RANGE IN iWC (SW1 SET TO ON)
OFF	OFF	3,000	0.5
ON	OFF	2,000	0.25
OFF	ON	1,000	0.15
ON	ON	500	0.05

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ELF 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 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. Confirm that the BAS is receiving the analog output signal indicating instrument airflow or equivalent velocity pressure.
9. 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.

Converting the Output Signal from Linear to Volumetric flow - FPM to CFM

The analog 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 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 ft²** (using Pi x duct radius², or 3.14 x 0.5ft²). Multiplying the indicated instrument output of **1,500 FPM** by **0.785 ft²** 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

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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.

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