EBTRON Airflow Measuring Technology

True performers can be recognized by the differences, not the similarities

by Leonard A. Damiano, *EBTRON, Inc.* February 2016

INTRODUCTION

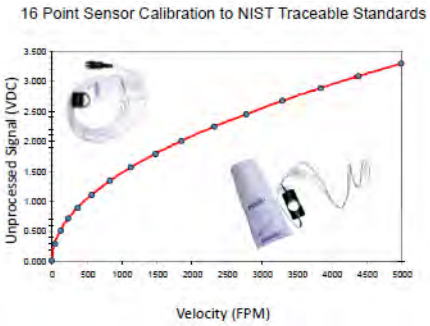
After 30 years of design innovations and pioneering many air control applications, *EBTRON* has established the high-watermark in performance for airflow measurement used in commercial HVAC controls. The basic design, manufacturing philosophy and commitment to product excellence are unchanged. We trust that the facts presented in this paper help to put the superiority of *EBTRON's* designs into perspective, compared to more than just competing alternatives, but with basic standards and methods that are still used as the basis for air performance determination.

This paper is an outline summary of the many differences and achievements that allow these products to outperform all others. The following facts and conclusions are summarized below, under appropriate categories.

UNIQUE DESIGN ADVANTAGES

Significant to the performance superiority of this technology for duct and plenum probes, include major differences between *EBTRON* and every other type of airflow measurement device:

- Independent sensor nodes. Determinations are made prior to averaging velocity and temperature. This helps make the measured duct average less sensitive to duct disturbances.
- Factory calibration of each sensor node at 16 velocity points, including zero, throughout the published range of operation (ducts = 0 – 5000 fpm or 25.4 m/s).



- The use of a high quality calibration standards provides users with direct performance traceability to the Laser Doppler Velocimeter reference standard at the NIST Air Speed Tunnel.
- The factory calibration of each and every sensor node for both temperature and air velocity, as used within an array of nodes, preserves and maximizes the accuracy of the individual sensors.

EBTRON Standard

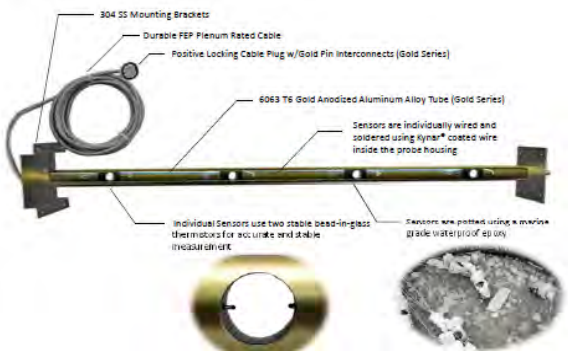
NIST Airspeed (VNIST), [fpm]	BTI Output (VBTI), [fpm]	Expanded Uncertainty, +/- [%]
115.92	116.03	1.43
175.56	175.83	1.09
219.59	219.83	0.81
266.35	266.31	1.18
316.32	314.61	1.03
366.59	365.41	0.82
419.39	417.92	0.76
462.72	462.39	0.67
506.95	506.91	0.71
744.49	743.96	0.68
1035.1	1033.5	0.73
1190.7	1187.8	0.67
1438.0	1434.1	0.67
1772.5	1765.7	0.65
2050.1	2040.6	0.64
2488.3	2476.0	0.64
2986.9	2975.0	0.67
3382.5	3367.2	0.68
3984.5	3963.2	0.70
4988.1	4959.6	0.67
5990.8	5965.3	0.88
6979.2	6941.6	0.87
7993.3	7937.7	0.65

Typical Production Unit Calibration Report

	Ref	UUT	Error	Error%
0	0.00	-0.01		
1	116.89	117.18	0.3	0.3%
2	157.40	157.34	-0.1	0.0%
3	227.43	227.89	0.5	0.2%
4	333.64	331.39	-2.3	-0.7%
5	453.03	447.86	-5.2	-1.1%
6	577.73	574.96	-2.8	-0.5%
7	740.80	737.85	-3.0	-0.4%
8	943.69	940.25	-3.4	-0.4%
9	1153.84	1165.31	11.5	1.0%
10	1414.55	1402.48	-12.1	-0.9%
11	1678.59	1687.86	9.3	0.6%
12	2024.89	2008.12	-16.8	-0.8%
13	2409.37	2399.48	-9.9	-0.4%
14	3342.61	3340.49	-2.1	-0.1%
15	4941.23	4923.32	-17.9	-0.4%

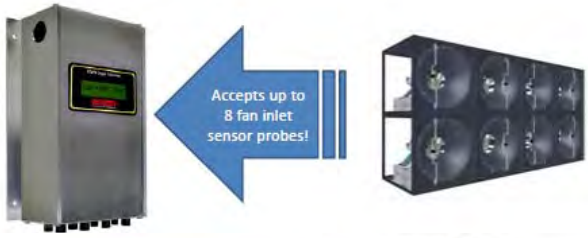
- The use of automated (proprietary) factory calibration equipment ensures higher quality results, repeatability, reliability and overall accuracy in the field.

- The exclusive use of water-proof, pre-stabilized, and custom designed 'bead-in-glass' type thermistors are proven to have insignificant 10-year drift potential (maximum <0.75% of reading uncertainty @ 100 fpm) in mathematical modeling and validated by empirical testing. This helps to assure long term reliability.
- The use of periodic physical testing validates the sufficiency of production designs or design changes, e.g. documented testing for rapid aging in salt brine bath, water immersion, acid spray, etc.

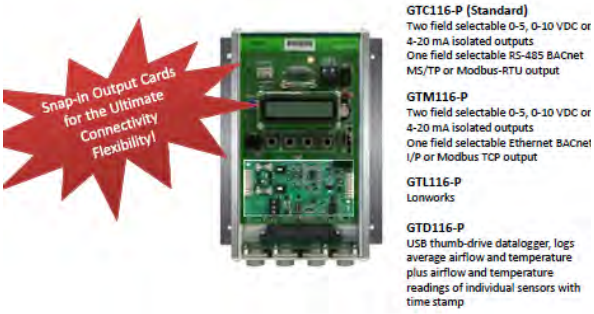


- The availability of multiple mounting and communications options makes field set up and installation easier than that of any other product of the type.

- Engineered solutions are available not only for ducts and plenums, but also for fans, large/small packaged or custom air handling equipment, and price-sensitive application-specific products. At least one *EBTRON* product is able to satisfy most commercial design requirements and budgets.



- An unequaled list of features is built into every multiplexing transmitter and available to all user, most providing field-selectability between alternatives in communications, thereby offering superb flexibility.



As a result of these advantages and the overall superiority of the design, *EBTRON* has established a long list of industry 'firsts' for commercial HVAC air measurement devices (AMDs):

- ✓ **First concept for thermistor-based AMD** (1983)
- ✓ **First production thermistor-based AMD** *(TAMS, 1983)*
- ✓ **First microprocessor-based AMD** *(Digitron, 1985)*
- ✓ **First** to apply airflow measurement **for outdoor air delivery monitoring and control** *(ETR & SB-2650, 1988)*
- ✓ **First thermistor-based insertion probe** *(Eliminator 3000, 1992)*
- ✓ **First fan inlet thermistor-based AMD** *(Eliminator 4000, 1994)*
- ✓ **First multi-location AMD system** *(IAQ Enforcer, 1995)*
- ✓ **First "plug and play"** thermistor-based AMD *(Advantage Gold & Silver, 2001)*
- ✓ **First network AMD** *(GTN116-P, 2002)*
- ✓ **First remote IR interface** for handheld cell phones *(EB-Link, 2004)*
- ✓ **First "no-frills"** thermistor-based AMD for small ducts *(ELF, 2007)*
- ✓ **First thermistor-based AMD/damper package** *(AIR-IQ, 2011)*
- ✓ **First fan array** thermistor-based AMD (GTx108-F/An, 2014)

'THE PROOF IS IN THE PUDDING'

The performance of *EBTRON* products is light-years ahead of technologies and methods that are still relied upon today and still the basis of most HVAC measurement standards. When compared to the mandatory instrument performance requirements of the national Test and Balance associations, *EBTRON* performance in mandatory categories **far exceeded** that of the instruments required to perform 'certified' TAB activities in both velocity and temperature measurement. Here is one example.

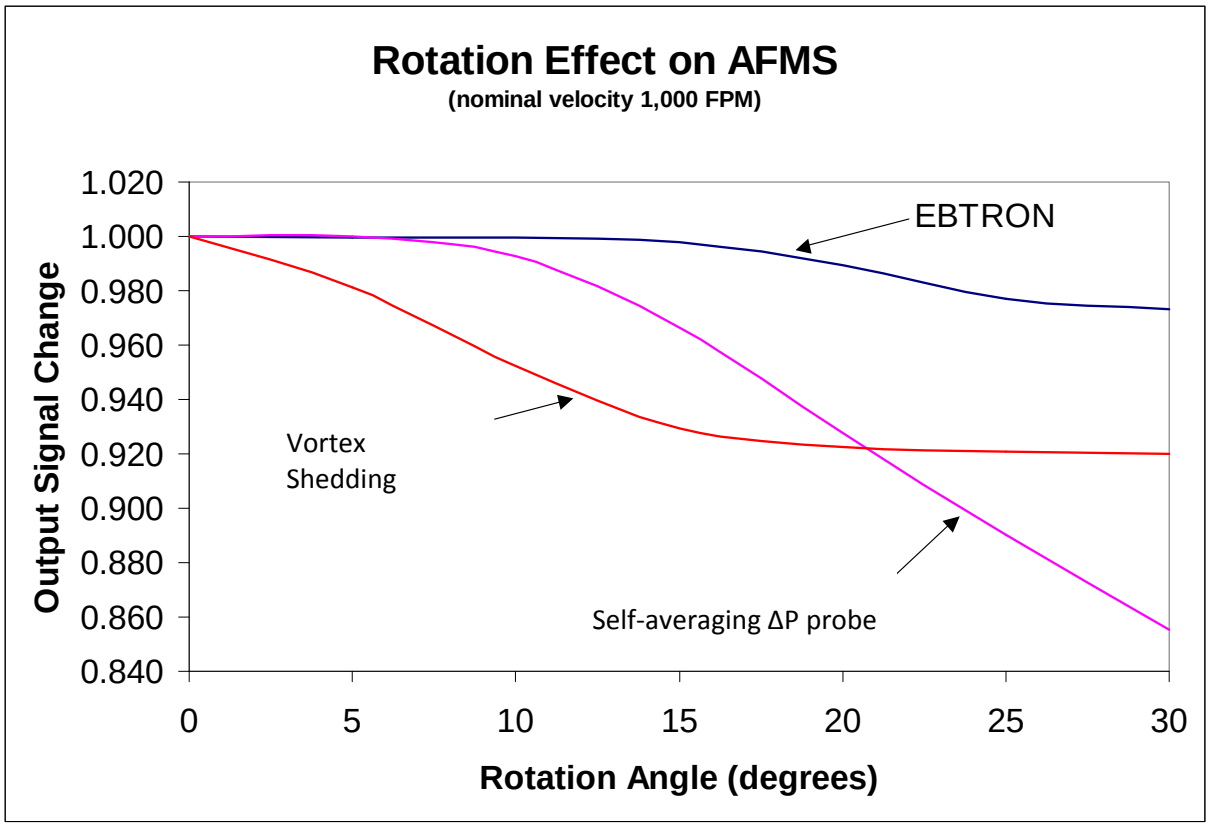
***EBTRON* Performance vs TAB instrument Min.**	**Velocity**	**Temperature**
range	**100% greater,** 0-5,000 fpm (25.4 m/s)	*EBTRON* is designed and tested to operate between -20 to +160 °F– in excess of operating requirements.
accuracy	**250% greater**	**550% greater** (approx.)
output resolution	**> 14 times greater**	**> 4 times greater**
output	duct average velocity or volume – fpm or cfm (m/s or L/s)	duct average arithmetic or **velocity-weighted**, field selectable
repeatability	0.25% of reading	0.25% of reading
stability / zero drift	**max worst-case uncertainty** +0.41 to -0.75% @100 fpm, 10 years	**max** 10 years **drift 0.015°F**
calibration interval	**periodic recalibration not recommended**	**periodic recalibration not recommended**

Thermal dispersion technology should not be confused with or compared to thermal anemometers, hot-wire devices or any other form of analog electronic velocity measurement. The term "hot-wire anemometer" has been incorrectly used for many years as a generic term for any thermal instrument. The negative impact in using a generic term implies to the reader that all products in the group share similar properties and also their limitations. This association is only advantageous for manufacturers of lesser performing instruments who benefit from the superior characteristics of the better performing devices. At the same time, this is clearly a disadvantage for the manufacturers of superior instruments who then suffer from the inferior characteristics of products from other manufacturers.

Hand-held thermal (single-point) instruments generally use unshielded chip-type thermistors, which are very sensitive to airflow and omnidirectional. They typically use analog mechanisms to estimate velocity, and as such, have a tendency to drift from zero. They usually require regular recalibration and 'zeroing.' They also tend to perform satisfactorily only when applied within a narrow operating temperature band, but can provide acceptable performance when used carefully as directed at favorable duct locations. They tend not to do well when exposed to liquid water and one manufacturer told customers not to use it in outdoor air intake openings. Their generally larger sizes, mass takes longer to shed heat and therefore is slower in detecting changes in air velocity or temperature.

On the other hand, *EBTRON's* thermal dispersion products generally have a published operating range of -20 to +160 deg F (-28.9°C to 71.1°C) and a sensor design that limits the impact of rotational misalignment from

improper installation. Due to the lack of applicable test standards, experiments performed by the *EBTRON* factory confirm the device's immunity to improper installation (rotation to airflow angle). The test was conducted by monitoring the output signal while rotating the sensing device up to 30 deg from optimum (perpendicular to airflow). The results clearly demonstrate the thermal dispersion device's superior performance as compared to the two other significant measurement technologies used in commercial HVAC, and contradicted the claims of one manufacturer.



Thermal dispersion instruments are not totally immune to all operating conditions found in today's buildings. Thermal dispersion performance is dependent upon the thermal transfer of energy (heat) from the sensing element to the measured airstream, as well as the precise determination of airstream temperature at the point of measurement. Although they are comparatively superior to Pitot arrays and Vortex Shedding in almost every regard, there are some conditions that could affect thermal transfer (materials that insulate the thermistor or liquid water exposure) which could also impact the ability of the instrument to function as designed. However, these conditions will also affect the ability of ANY instrument to function as designed. Conditions detrimental to measurement are not exclusive to thermal dispersion devices. The important take-away here is that the output from *EBTRON* products will return to normal immediately after a light cleaning, when fouled, or after the thermistor has dried.

***EBTRON* is preferred to most other AFMS products, because they are…….**

Easy to Apply

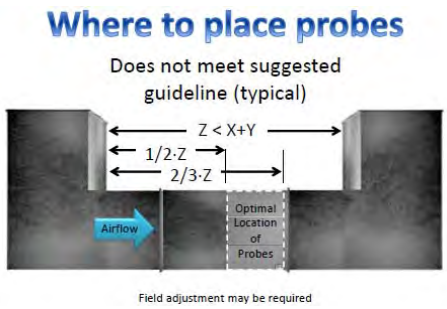
- Wide Product Range – Gold, Hybrid and EB-Flow Series models are available to meet any performance requirement and budget.
- Wide Calibrated Range:
  - Small Duct/AHU Probes: 0 to 3,000 fpm
  - Duct/Plenum Probes: 0 to 5,000 fpm

  - Fan Inlet Sensors: 0 to 10,000 fpm
- Percent-of-Reading Accuracy at any airflow rate within ranges
  - High performance, even with turndown
  - Easy to select. Full scale output does not affect performance potential at lower velocities.
- Connectivity Flexibility
  - Analog outputs are standard with RS-485 or Ethernet combination models on Gold Series products
  - Lon is a solitary communication option and only available with Gold Series products
  - Analog is the only output currently available for the EB-Flow models
  - Analog and RS-485 outputs are available with separate Hybrid models
  - New USB Drive and EB-Link Reader interface are also available on select models.
- Flexible Mounting Options
  - Insertion, Internal and Stand-off mounting hardware are available with all – P models
  - Throat, Face-mount, Forward-mount hardware are available with all – F models
  - Fixed length probes with hat-channel brackets are available with all – T models
  - Adjustable insertion mounting or Universal brackets are available with – U models

Easy to Purchase

- Local Representation with Factory Application Engineering Support.
  - Model selection and placement recommendations.
  - Application support (not just the airflow station).
- 3 weeks or less lead time for most typical order-quantities (less than 1 week on fan inlet sensors).
- Expediting is often available for an additional fee (check and confirm with factory before ordering).

Easy to Install – Duct/Plenums



1. Install **after** ductwork is in place. *EBTRON* guidelines are the least restrictive in the industry.
2. Mount probe
   a. Insertion: Drill 1.1” dia. hole(s) for –P probe(s), insert in duct and fasten to duct with sheet metal screws.
   b. Internal or stand-off: Fasten mounting brackets with sheet metal screws.
3. Connect cable(s) to transmitter (plenum rate cables included, verify lengths prior to ordering).
4. Connect low voltage power (24 VAC) and signal wiring.
5. UL Listed Product as an assembly (UL873 or UL 60730-1; UL 60730-2-9 Airflow & Temperature Indicating Device) with continuous UL Follow-up Service.

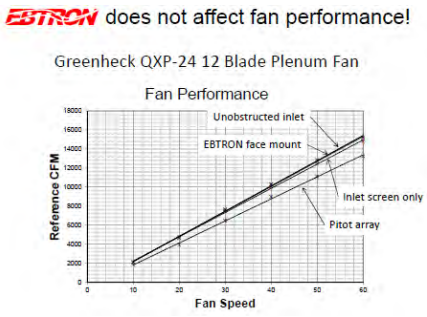
Easy to Install – Fan Inlets

- Mounts at the inlet bell of single or dual inlet fans or vane axial fans.
  - **Throat mount:** traditional mounting in small diameter of inlet bell (may affect performance of plenum fans and other performance sensitive fans).
  - **Face mount:** mounts on face of inlet bell

(will not perceptibly affect performance of any fan)

- **Forward mount:** helps avoid interference to measurement by screens or other devices at the inlet

- All have adjustable mounting brackets)
- Simple cable connections to transmitter (plenum rated cables with fixed length are included, verify field lengths needed prior to ordering)

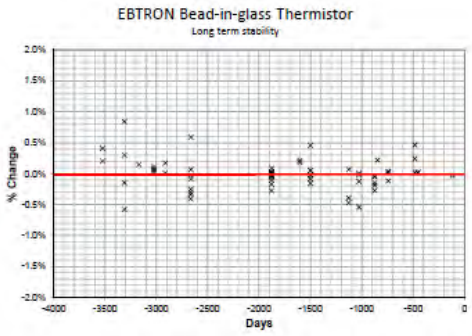


Easy to Startup

- Turn power switch to "ON" position.
- Configure the output signal.
  - Select voltage or current output on analog output transmitters.
  - Configure network parameters on network transmitters.
- Check conversion at host control system.
  - Use output test feature on *EBTRON* Gold & Hybrid transmitters.
- Adjustments?
  - No adjustments are required to EBTRON ducted sensors when installed in accordance with published guidelines (3% of reading for 'P+' density).
  - Use Field-Cal Wizard or set Gain/Offset when field adjustment is required.

Very Low to No Maintenance, because…..

- ….because specific, **custom manufactured thermistor sensors were selected** for their quality, accuracy and stability over long periods of time; their glass encapsulation insulates and protects from damaging environments.
- Unless damaged from external sources, there is normally nothing in the transmitter to calibrate, adjust or repair - ever. **Drift potential minimized** to insignificance by application of these thermistors for measuring velocity.



- Calibration Intervals
  - Periodic field calibration in **not required**.
    - Validation probes are available for applications requiring periodic verification.
- Cleaning
  - Cleaning is **not required** in most environments
    - ***Exception****: Cleaning may be required in healthcare facilities where return air lint may be of concern to the operation of all duct accessories. Intervals vary from facility to facility, from not required to monthly. Coarse Filtering return air will eliminate cleaning requirements.*
- Lower maintenance costs on building structure repairs and maintenance
  - Reduce damage from moisture and mold in the building envelope that can result from improper pressurization
  - Reduce damage from condensing moisture on window and door frames that can result from improper pressurization.
  - Reduction of water damage to the building, AHU, ductwork and plenums that can result from excess outdoor air during periods of dehumidification
  - Avoid damage to the building envelope and/or roof systems that can result from improper pressurization or poor control
- Extend HVAC system life cycle
  - Reduced Load -> Extended Life

- Increased facility personnel performance
  - Decreased occupant complaints about thermal comfort and air quality – saving time and money
  - Improved HVAC mechanical system diagnostics due to increased monitoring, alarming and control
  - Overall reduction in man-hour requirements for repairs and maintenance (all areas)

Lower Operating Costs

- Energy Efficiency
  - Only condition the outdoor air required to provide acceptable IAQ and/or pressurization during minimum OA operation (heating and cooling).
  - Eliminate the additional energy cost required to condition outdoor air that enters the building from negative pressurization
  - Stop blowing conditioned air out of the building during minimum OA operation (heating and cooling) because of over-pressurization
  - Eliminate the additional energy cost required when elevated humidity levels require lower temperature set points to satisfy occupant thermal comfort.
  - Eliminate the increased heating (or reheat) load that result in perimeter zones of negatively pressurized buildings during heating and economizer modes.
- Facility Operations and Maintenance

Reduced Service Needs (compared to alternatives)

- 48 hour electrical burn-in prior to testing and calibration assures devices work properly when powered up in the field.
- 30+ step computer controlled QC system assures all shipped product performs to specifications.
- UL Listing as an assembly and Follow-up services provide random third-party inspections for quality and compliance.
- High performance bead-in-glass thermistors are extremely rugged with long term stability and long life.
- Products are tested during development under rigorous environmental conditions (temperature, moisture, etc.) so that performance is maintained under real-world conditions.
- Fused and protected power supply and output signals minimize damage potential from improper field wiring.
- "Watch-dog" circuitry results in continuous operation after severe brown-outs and power disruptions.

3-Year Warranty

- Very low warranty claims.
  - Reported "problems" generally point to an HVAC system or control component problem that the measuring device has detected.
- Smart sensor fault detection allows transmitter to continue and average remaining sensors if one or more sensors is damaged in the field.
- Life-time phone support. Have a question or a problem? Call us. Most of our "service" calls do not even involve issues with our products.

In summary, *EBTRON* is proud to be UNIQUE. Many market participants have attempted to equate different types of permanently installed instruments to *EBTRON*, and as persistent as a few of our competitors are in their attempt to ride the coat-tails of *EBTRON* specifications; *EBTRON* products continue to be UNIQUE. Any engineer that wants honest quality and high performance should have no trouble distinguishing these products from imitations that claim to be "just like *EBTRON*" – as there are NONE. Regardless how creative the wording is on submittals, it is an attempted deception. It is a dishonest attempt to take advantage of some inattentive engineers and gain acceptance for something that is not what was requested. There is no way to compare *EBTRON* to other measurement alternatives, except by pure performance and experience. Because so much of *EBTRON's* abilities lie in unique components, processes or trade secrets; a more detailed

specification and submittal review may be required to make sure you get what you want. Ask us. We can help.

Our competition has consistently refused to elevate their product designs and performance as a way to approach *EBTRON's* performance or reliability, because they refuse to reduce the profits being made on the additional margins available to them on the values between their very inexpensive components and their pricing, which turns out to be close to EBTRON, the higher quality competition. They do not want to bear the increased costs of manufacturing and materials required to become honest competition. They would prefer to deceive engineers, contractors and building owners about the reality of their products' capabilities, than to compete head-to-head on a level playing field with *EBTRON's* products.

It is up to the engineering community to force those manufacturers capable of making better AFMS products to do so, and not try to indirectly force *EBTRON* to cheapen its design, lower its performance with lower cost components and thereby meet the lowest common price denominator. That would not be in the best interest of your design or the project or the reputation of your firm. Only the design engineering authority can uphold the integrity of his company's services, evidenced by the end product that results.

Even within EBTRON's own product catalog are models that use the same technology, but are implemented for different applications. Lower cost-price objectives are possible (e.g. EB-Flow EF-x2000-U or T)), but are not appropriate for and will not perform equal to models designed specifically for larger intake ducts and flow rates (e.g. Gold Series GTx116-P+).

Questions? Call us. We can help.

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