

## SECTION 230923.14 FLOW INSTRUMENTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Duct and plenum airflow measurement device (AMD) with temperature measurement, optional integral humidity sensor, and remote transmitter.
- B. Small duct AMD with temperature measurement and remote transmitter.
- C. Fan inlet AMD with temperature measurement and remote transmitter.
- D. Probe AMD/control damper assembly for outdoor air intakes, return air intakes, and/or exhaust air intakes.
- E. Fan inlet AMD/backdraft damper assembly.

#### 1.2 REFERENCES

- A. UL-873, Temperature Reading and Indicating Equipment
- B. UL 60730-1, 60730-2-9, Automated Electrical Controls
- C. FCC Part 15

#### 1.3 SUBMITTALS

- A. Submit under the provisions of Section 013000
- B. Provide the following:
  - 1. Equipment schedule.
  - 2. Product overview and technical specification.
  - 3. Placement guide.
  - 4. Sensor density table.
  - 5. Probe installation guide.
  - 6. Wiring guide.
  - 7. Startup guide.
- C. Independent Test Reports: Provide a copy of each of the following test reports:
  - 1. NIST Report of Airflow Calibration
  - 2. CHEMIR Test Report on Sensor Exposure to Salts and Acids.
  - 3. UL Certificate Report
  - 4. CE Certification form (European shipments)
  - 5. FCC Part 15 compliance report.
  - 6. BTL Certification Report.
- D. Quality Assurance
  - 1. Manufacturer Qualifications: Company specializing in manufacturing thermal dispersion airflow measurement devices with minimum ten years documented experience.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products in an environment that is protected from rain, snow and/or condensing moisture.
- C. Handle with care during installation.

- D. Protect sensors from construction debris and remove all debris that may enter the air distribution system prior to system startup.

## 1.5 SYSTEM STARTUP AND VERIFICATION

- A. Startup and verify products in accordance with manufacturer's procedures in the operations and maintenance manual.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Approved Manufacturer: EBTRON, Inc. located at 1663 Hwy. 701 S, Loris, SC 29569, USA. Phone 1-800-232-8766. Fax: 1-843-756-1838. Web: EBTRON.com. Sales e-mail: [Sales@EBTRON.com](mailto:Sales@EBTRON.com)  
Local sales representative <https://ebtron.com/#rep-finder>.
- B. Substitutions: Not permitted.
- C. Requests for substitutions that meet the specification requirements will be considered in accordance with the provisions of Section 016000.

### 2.2 GENERAL REQUIREMENTS AND EXCLUSIONS

- A. Provide one thermal airflow measuring device (AMD) for each location indicated on the plans, schedules and/or control diagrams.
- B. Each AMD shall provide the velocity-weighted temperature of the airstream that may be used for temperature measurement when indicated on the plans, schedules, points list, or control diagrams.
- C. Each AMD shall use the principle of thermal dispersion to determine the actual or mass airflow rate of the airstream. Differential pressure-based devices, including pitot tubes, pitot arrays, fan inlet piezo-rings, and devices measuring the pressure drop across a louver, damper or obstruction are not acceptable.
- D. Each AMD shall be provided with one or more sensor probes having one or more sensor nodes per probe.
- E. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. The airflow of each sensor node shall be determined using one self-heated and ambient temperature sensing thermistor. Devices using indirectly heated thermistors to determine the airflow rate are not acceptable. Devices using chip thermistors of any type or packaging are not acceptable. Devices using platinum wire RTDs or similar "hot wire" devices are not acceptable.
- F. Thermistors shall be potted in an engineering thermoplastic assembly using water-proof, marine epoxy and shall not be damaged by moisture, direct contact with water or exposure to atmospheric acids. Provide a copy of an independent laboratory report to verify compliance with this requirement.
- G. All internal wiring in the probe tube shall be chemical and abrasion resistant Kynar® coated copper.
- H. All connections to internal wires in the probe tube shall be solder joints or welds. Connectors of any type in the probe tube are not acceptable.
- I. Each thermistor shall be independently calibrated to NIST traceable temperature standards to establish the resistance-temperature characteristics for the determination of airflow and temperature. Devices using interchangeable, curve-matched, thermistors are not acceptable.
- J. Each sensor node shall be independently processed by the transmitter prior to averaging and output.

- K. The specified sensor accuracy shall include the combined uncertainty of the sensor nodes and transmitter. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with the specified sensor accuracy over the entire operating range.
- L. Installed accuracy shall include the uncertainty of the AMD and the additional uncertainty that results from the placement of the AMD in the airstream. The specified installed accuracy is based on the AMD being installed in accordance with manufacturers published placement and installation guidelines.
- M. Transmitters shall be microprocessor-based and operate automatically after brownouts and/or transient power interruptions.
- N. All printed circuit boards shall have gold plated interconnects, edge fingers, and test points.
- O. Remote transmitters shall have an LCD and four-button user interface.
- P. Remote transmitters shall be mounted in a location protected from moisture, rain and snow with an ambient temperature between -20 and 120 °F [-28.9 to 48.9 °C] and a humidity range between 5 and 95% RH (non-condensing). Provide a weatherproof enclosure (by others) and mount away from direct sunlight when outdoor mounting is required.
- Q. Probes with remote transmitters shall be “plug and play”, not require matching to the transmitter, and be provided with a UL listed, FEP jacketed, plenum rated cable and connector plug. Devices using PVC jacketed cables to connect sensor probes to the transmitter are not acceptable.
- R. All components of each device shall be RoHS2 compliant.
- S. Each device shall be FCC-Part 15 compliant. Compliance shall be demonstrated by an independent test laboratory.
- T. Each AMD shall be UL/cUL listed as a final assembly.
- U. European shipments shall be CE marked. Compliance shall be demonstrated by an independent test laboratory.
- V. Devices with a BACnet network connection shall be BTL tested and listed.

### 2.3 DUCT AND PLENUM AMD WITH TEMPERATURE AND HUMIDITY MEASUREMENT AND REMOTE TRANSMITTER

- A. Basis of Design: EBTRON model GTx116e-PC.
- B. Provide an integral humidity sensor when indicated on the plans, schedules, points list, or control diagrams to determine the humidity, enthalpy, and/or dewpoint of the airstream. Humidity and enthalpy shall be calculated using the velocity-weighted temperature and on-board pressure sensor.
- C. Provide one to four gold anodized 6063 aluminum probes and one remote transmitter. Provide polished 316 stainless steel tubes when indicated on the plans or schedules.
- D. Probes shall have integral 304 stainless steel mounting brackets for insertion, internal, or standoff mounting.
- E. Each sensor node shall be individually wind-tunnel calibrated at 16 points to NIST traceable airflow standards and have an accuracy of  $\pm 2\%$  of reading over the entire operating range. Provide a copy of the NIST calibration report for the reference standard used to calibrate the production tunnels used to calibrate individual sensor nodes. Reference standards calibrated to third-party NIST traceable labs are not acceptable. Devices claiming AMCA certification are not acceptable.

- F. Provide up to 16 sensing nodes per measurement location as required for the opening size and published sensor density tables to achieve an installed airflow accuracy of  $\pm 3\%$  of reading ( $\pm 5\%$  of reading on close coupled outdoor air intakes) between 0 and 5,000 fpm [0 to 25.4 m/s] over a temperature range of -20 to 160 °F [-28.9 to 71.1 °C] and a humidity range between 0 and 100% RH (non-condensing).
- G. Velocity-weighted temperature accuracy shall be better than  $\pm 0.15$  °F [0.08 °C].
- H. Humidity accuracy, when provided, shall be better than  $\pm 2\%$  of reading between 20 and 80% RH and better than  $\pm 4\%$  of reading at all other % RH at 77 °F [25.0 °C].
  - 1. The humidity sensor shall have a temperature coefficient of 0.07% RH/ °F [0.13% RH/ °C].
  - 2. The annual drift of the humidity sensor shall not exceed 0.5% RH/year.
- I. Provide low and high airflow alarms with a user defined setpoint and tolerance.
- J. Transmitters shall be provided with a 16-character by two-line, backlit, alpha-numeric LCD.
  - 1. The airflow rate, temperature, airflow alarm, system status alarm, and active trouble codes shall be visible on the transmitter display. Humidity and either enthalpy or dewpoint shall be visible on the transmitter display when the humidity sensor is provided.
- K. Building Automation System Analog Signal Connections:
  - 1. Provide three isolated, field selectable (4-20mA, 0-5/0-10 VDC) analog output signals.
  - 2. Analog output signals shall provide:
    - 1) One output signal for airflow (linear)
    - 2) One output signal shall be field configurable for
      - (i) velocity-weighted temperature (linear), or
      - (ii) airflow alarm (binary), or
      - (iii) system status alarm (binary)
    - 3) One output signal that shall be field configurable for
      - (i) velocity-weighted humidity (linear), or
      - (ii) velocity-weighted enthalpy (linear), or dewpoint (linear), when the humidity option is provided.
- L. Building Automation System Network Connection Options:
  - 1. Provide one of the following when required:
    - 1) One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection.
    - 2) One isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
    - 3) One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection and one isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
    - 4) Two isolated Ethernet, field selectable for
      - (i) Single connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP), or
      - (ii) Daisy-chain connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP)
    - 5) One isolated Lonworks Free Topology network connection.
    - 6) One USB Flash Drive (Thumb drive) memory device for logging average and individual airflow rates, temperatures, and psychrometric measurements at user specified time intervals.

2. Network connections shall provide the airflow, velocity-weighted temperature, velocity-weighted-humidity, velocity-weighted-enthalpy, dewpoint, airflow alarm status, individual sensor node airflow and temperature data, and device fault status.
- M. Provide a Bluetooth, low-energy interface and free Android® or iOS® software that allows real-time airflow, temperature and humidity monitoring and airflow and temperature traverses. Software shall capture, save and/or e-mail airflow/temperature/humidity data, transmitter settings and diagnostics information. *[replace section with the following for installations that do not allow any radio devices: Transmitters shall not be provided with any radio transmitter or receiver.]*
  - N. Each AMD shall be powered by 24 VAC (22.8 to 26.4 VAC under load) and have a maximum power requirement of 22 V-A.

#### 2.4 SMALL DUCT AND AIR TERMINAL AMD WITH TEMPERATURE MEASUREMENT AND REMOTE TRANSMITTER

- A. Basis of Design: EBTRON model EF-x2000-T.
- B. Provide one mill finish 6063 aluminum probes and one remote transmitter. Provide one 316 stainless steel tube when indicated on the plans or schedules.
- C. Probes shall have an integral 304 stainless steel mounting bracket for insertion mounting.
- D. Each probe shall be individually wind-tunnel calibrated at 7 points to NIST traceable volumetric airflow standards. Devices claiming AMCA certification are not acceptable.
- E. Provide up to 2 sensing nodes per measurement location as required for the opening size and published sensor density tables to achieve an installed airflow accuracy of  $\pm 3\%$  of reading between 0 and 2,000 fpm [10.16 m/s] over a temperature range of -20 to 160 °F [-28.9 to 71.1 °C] or between 0 and 3,000 fpm [15.24 m/s ] over a temperature range of 0 to 160 °F [-17.8 to 71.1 °C] and a humidity range between 0 and 100% RH (non-condensing).
- F. Temperature accuracy shall be better than  $\pm 0.15$  °F [0.08 °C].
- G. Provide low and high airflow alarms with a user defined setpoint and tolerance.
- H. Transmitters shall be provided with a 16-character alpha-numeric LCD.
  1. The airflow rate and temperature, airflow alarm, and system status alarm shall be visible on the transmitters display.
- I. Provide one of the following output configurations:
  1. Two non-isolated, field selectable (4-20mA, 0-5/0-10 VDC) analog output signals.
  2. One non-isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection.
- J. Transmitters with analog output signals shall provide:
  1. One output signal for airflow (linear)
  2. One output signal shall be field configurable for
    - 1) velocity-weighted temperature (linear), or
    - 2) airflow alarm (binary), or
    - 3) system status alarm (binary)
- K. Transmitters with network capability shall provide the airflow, velocity weighted temperature, airflow alarm status, individual sensor node airflow and temperature data, and device fault status.
- L. Provide a contact closure relay that can be assigned to the airflow alarm or system status alarm. The relay shall be capable of passing 3 Amps at 24 VAC or 30 VDC or be configured to drive an LED.

- M. Each AMD shall be powered by 24 VAC (22.8 to 26.4 VAC under load) and have a maximum power requirement of 8 V-A.

## 2.5 FAN INLET AIRFLOW AND TEMPERATURE MEASUREMENT WITH REMOTE TRANSMITTER

- A. Basis of Design: EBTRON models GTx108e-F
- B. Provide throat, face, forward or flare mount adjustable brackets for each sensor node.
- C. Each mounting bracket shall have integral 304 stainless steel mounting feet for mounting in or on the fan inlet.
- D. The AMD shall not affect the airflow or sound performance of plenum fans.
- E. Provide the following number of sensor nodes based on fan type. All sensors shall be connected to a single, remote transmitter. Fan array models shall calculate the airflow of each fan individually prior to outputting the total airflow rate and have a built-in alarm capable of removing a failed fan from the total airflow calculation.
  - 1. SWSI Fans: 2
  - 2. DWDI Fans: 2 per inlet
  - 3. Fan Arrays:
    - 1) Two to four fans: 2 per inlet
    - 2) Five to eight fans: 1 per inlet
- F. Each sensor node shall be individually wind-tunnel calibrated at 16 points to NIST traceable airflow standards and have an accuracy of  $\pm 2\%$  of reading over the entire operating range of 0 and 10,000 fpm [50.8 m/s] over a temperature range of -20 to 160 °F [-28.9 to 71.1 °C] and a humidity range between 0 and 100% RH (non-condensing).
- G. Velocity-weighted temperature accuracy shall be better than  $\pm 0.15$  °F [0.08 °C].
- H. Provide low and high airflow alarms with a user defined setpoint and tolerance.
- I. Provide a fan fault alarm when installed on fan arrays.
- J. Transmitters shall be provided with a 16-character by two-line, backlit, alpha-numeric LCD.
  - 1. The airflow rate, temperature, airflow alarm, fan fault alarm, and system status alarm shall be visible on the transmitters display.
- K. Building Automation System Analog Signal Connections:
  - 1. Provide three isolated, field selectable (4-20mA, 0-5/0-10 VDC) analog output signals.
  - 2. Analog output signals shall be configurable to provide:
    - 1) One output signal for airflow (linear)
    - 2) One output signal shall be field configurable for
      - (i) velocity-weighted temperature (linear), or
      - (ii) airflow alarm (binary), or
      - (iii) fan array alarm (multi-state), or
      - (iv) system status alarm (binary)
- L. Building Automation System Network Connection Options:
  - 1. Provide one of the following when required:
    - 1) One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection.

- 2) One isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
  - 3) One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection and one isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
  - 4) Two isolated Ethernet, field selectable for
    - (i) Single connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP), or
    - (ii) Daisy-chain connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP)
  - 5) One isolated Lonworks Free Topology network connection.
  - 6) One USB Flash Drive (Thumb drive) memory device for logging average and individual airflow rates, temperatures, and psychrometric measurements at user specified time intervals.
2. Network connections shall provide the airflow, velocity-weighted temperature, airflow alarm status, fan array alarm status, individual sensor node airflow and temperature data, and device fault status.
- M. Provide a Bluetooth, low-energy interface and free Android® or iOS® software that allows real-time airflow, temperature and humidity monitoring and airflow and temperature traverses. Software shall capture, save and/or e-mail airflow/temperature/humidity data, transmitter settings and diagnostics information. *[replace section with the following for installations that do not allow any radio devices: Transmitters shall not be provided with any radio transmitter or receiver.]*
- N. Each AMD shall be powered by 24 VAC (22.8 to 26.4 VAC under load) and have a maximum power requirement of 16 V-A.

## 2.6 PROBE AMD/CONTROL DAMPER ASSEMBLY FOR OUTDOOR AIR INTAKES, RETURN AIR INTAKES, AND EXHAUST AIR INTAKES

- A. Basis of Design:
1. Outdoor Air Intakes: EBTRON Model AIR-IQ2
  2. Non-ducted Return Air and Exhaust Air Intakes: EBTRON Model AIR-IQ
- B. Provide one GTx116e-PC AMD in a factory assembled control damper assembly.
- C. Control Damper Assembly:
1. Provide an extruded aluminum (6063T5) sleeve, not less than .080" [2.03 mm] thick, for factory mounting of the specified duct and plenum AMD.
  2. Provide an aluminum radiused entry flare not less than .060" [1.52 mm] thick.
    - 1) AIR-IQ2: Provide a 1-inch [25.4 mm] radius flare.
    - 2) AIR-IQ: Provide a 3-inch [76.2 mm] radius flare.
  3. Provide extruded aluminum (6063T5) damper frames, not less than .080" [2.03 mm] thick and 4" [102 mm] deep. Frame to be assembled using mounting fasteners. Welded frames are not acceptable.
  4. Provide extruded aluminum (6063T5) damper blade profiles.
  5. Blade and frame seals shall be extruded silicone. Seals shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals are not acceptable.
  6. Provide a dual bearing system composed of Celcon inner bearings, fixed around a 7/16" [11.1 mm] aluminum hexagon blade pivot pins, rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole are not acceptable.
  7. Provide a hexagonal, adjustable length, 7/16" [11.1 mm] control shaft that is an integral part of the blade axle. A field-applied control shaft is not acceptable.

8. Linkage hardware shall be installed in the frame side, complete with stainless steel trunnions and cup-point trunnion screws for a slip-proof grip. Dampers that do not provide stainless steel trunnions are not acceptable.
9. Control Dampers shall be AMCA rated for Leakage Class 1A at 1 in w.g. [0.25 kPa] static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
10. Provide either opposed blade action or parallel blade action.
11. Control dampers shall be custom made to required size, with blade stops not exceeding 1¼" [31.7 mm] in height.
12. Dampers shall be designed for operation in temperatures ranging between -72 °F (-57.8 °C) and 212 °F [100 °C].

## 2.7 FAN INLET AMD/BACKDRAFT DAMPER ASSEMBLY

- A. Basis of Design: EBTRON Model FAN-IQ
- B. Provide one GTx108e-F AMD mounted in a factory assembled Backdraft Damper Assembly.
- C. Backdraft Damper Assembly:
  1. Provide a 1-inch aluminum radiused entry flare, not less than .060" [1.52 mm] thick, for factory mounting of the specified fan inlet AMD.
  2. Provide extruded aluminum (6063T5) damper frames, not less than .080" [2.03 mm] thick and 8" [203 mm] deep. Frame to be assembled using mounting fasteners. Welded frames are not acceptable.
  3. Provide extruded aluminum (6063T5) damper blade profiles, not less than 0.09" [2.28 mm] thick. Blades shall be designed with a rounded head to reduce pressure loss.
  4. Blade and frame seals shall be extruded silicone. Seals shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals are not acceptable.
  5. Provide a dual bearing system composed of Celcon inner bearings, fixed around a 7/16" [11.1 mm] aluminum hexagon blade pivot pins, rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall are not acceptable.
  6. Provide a hexagonal, adjustable length, 7/16" [11.1 mm] control shaft that is an integral part of the blade axle. A field-applied control shaft is not acceptable.
  7. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
  8. Backdraft dampers shall be custom made to required size, with blade stops not exceeding 1¼" [31.7 mm] in height.
  9. Dampers shall be designed for operation in temperatures ranging between -72 °F [-57.8 °C] and 212 °F [100 °C].