

Division 23

ELECTRONICALLY COMMUTATED FANS and FAN ARRAYS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electronically Commutated (EC) fans with integrated power electronics for:
 - a. Air Handling Units (AHUs)
 - b. Computer Room Air Handlers (CRAH)
 - c. Computer Room Air Conditioners (CRAC)
 - d. Fan wall systems for commercial and industrial HVAC, healthcare, and data center applications
2. Integrated EC motor/drive systems, including:
 - a. Power electronics
 - b. Communication and control interfaces

1.2 DESIGN INTENT

A. Provide direct-driven EC fan systems designed for:

1. High electrical efficiency and low harmonic distortion
2. Continuous duty operation in mission critical environments
3. Stable operation over a wide speed range (turndown)
4. Reduced maintenance through elimination of belts and external drives
5. Fan array applications with redundancy capability

1.3 REFERENCES

Comply with the latest editions of:

- AMCA 204 – Balance Quality and Vibration Levels for Fans
- AMCA 205 – Energy Efficiency Classification
- AMCA 207 – Fan System Efficiency and Input Power Calculation
- AMCA 210 – Laboratory Methods of Testing Fans
- AMCA 214 – Fan Energy Index (FEI)
- AMCA 300 – Sound Testing of Fans
- AMCA 301 – Methods for Calculating Fan Sound Rating
- ASHRAE TC 9.9 – Data Center Cooling Guidelines
- ASHRAE 90.1 – Energy Standard for Buildings
- CSA C22.2 No.77 Motors with Inherent Overheating Protection
- IEC 60034-30-2 – Efficiency classes of Variable Speed AC motors
- NFPA 70 – National Electrical Code
- UL 1004-1 Rotating Electrical Machines
- UL 1004-7 Electronically Protected Motors
- UL 61800-5-1 Adjustable Speed Electrical Power Drive Systems

1.4 SUBMITTALS

A. Product Data:

1. Manufacturer's technical data sheets
2. Fan performance curves (airflow, static pressure, efficiency, input power)
3. Individual fan performance at scheduled operating point
4. Fan array performance at scheduled operating point, including defined redundancy condition (N+1 or as scheduled)
5. Sound data
6. Harmonic distortion data
7. Motor/drive electrical characteristics
8. Motor/drive efficiency data
9. Wiring diagrams (power and control)
10. Communication interface documentation, including points lists and register maps
11. Provide an Energy Savings and CO2 Reduction Report, or electronic means of report generation, for the selected model.

B. Shop Drawings:

1. Fan array arrangement and layout
2. Electrical connection diagrams
3. Control architecture diagram

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Comply with Division 01 requirements for handling, storage and protection.
- B. Protect equipment from moisture and environmental exposure; maintain factory protection until installation.
- C. For extended storage, store motor/drive components in a clean, dry environment per manufacturer requirements.

1.6 QUALITY ASSURANCE

A. Factory Testing:

- 1. Each fan/motor assembly shall undergo factory operational testing prior to shipment, including verification of rotation, electrical operation and fault-free run condition
- 2. Fan shall be manufactured in an ISO 9001 certified quality management system

1.7 WARRANTY

- A. Manufacturer shall provide a warranty for a minimum period of 12 months from date of installation or 18 months from date of shipment, whichever occurs first, covering the following:
 - 1. EC motors
 - 2. Integrated drives and power electronics
 - 3. Fan impellers

PART 2 – PRODUCTS

2.1 BASIS OF DESIGN

A. Acceptable manufacturer:

1. Infinitum

Substitutions must meet all performance and design requirements of this specification.

2.2 EC FAN ASSEMBLY

A. General:

1. Provide direct-driven plenum fans specifically designed for AHU or CRAH applications.

B. Fan Impeller Types:

1. Airfoil impeller suitable for high static, low to medium flow applications
2. Backward curved impeller suitable for low static, high flow applications
3. Inclined airfoil impeller suitable for low static, high flow applications

C. Materials:

1. Fan Assembly: Galvanized steel construction with powder-coated finish
2. Impeller: Aluminum construction

D. Balancing:

1. Fan and impeller shall be statically and dynamically balanced in accordance with AMCA 204. Balance quality shall be equivalent to ISO 14694 Grade BV-3 minimum.

2.3 MOTOR / DRIVE SYSTEM

2.3.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Description: High-efficiency, permanent magnet synchronous motor suitable for direct drive fan applications, complete with integrated variable frequency drive
- B. Motor systems, furnished separately or as an integral part of the mechanical system, shall be selected and coordinated with the driven equipment such that required brake horsepower (BHP), including all system losses, does not exceed the motor nameplate rating at design conditions
- C. Efficiency: Motor system efficiency shall comply with AMCA 207 requirements

- D. Temperature Rise: Temperature rise shall not exceed limits corresponding to the motor insulation class in accordance with NEMA MG 1
- E. Insulation: Withstand a maximum of 150 deg-C Operating Temperature
- F. Bearings: Provide heavy-duty, hybrid ceramic type bearings, suitable for the intended operating speed, loading, and service life
- G. Stator: Printed circuit board (PCB) stator, FR4 material, with etched copper
- H. Rotor: Two disc-shaped rotors containing permanent magnets
- I. Motor/drive system shall include integral thermal monitoring and protection. Temperature sensors shall be provided for critical components, including at minimum:
 - 1. Motor stator
 - 2. Control interface module (CIM)
 - 3. Inverter assembly
 - 4. VFD heatsink
- J. Temperature data shall be available for external monitoring. Thermal protection shall initiate appropriate protective action to prevent damage to equipment.
- K. Motor system shall be provided in a sealed construction suitable for continuous duty operation in the installed environment and shall be IP54 minimum.
- L. Enclosure Material: Cast aluminum housing
- M. Shaft and Mounting: Motor shall be provided with C-face mounting compatible with the driven equipment. Peripheral mounting shall be permitted where required by the fan assembly design.
- N. Lifting: Motor systems shall have threaded holes for eyebolts
- O. Integrated power electronics shall be field replaceable and serviceable as a modular assembly where supported by manufacturer design
- P. Control and Communication: Motor system shall support the following interfaces for control and monitoring:
 - 1. Modbus RTU (RS-485)
 - 2. BACnet MS/TP
 - 3. 0-10 vdc analog speed reference
 - 4. 4-20 mA analog speed reference

2.3.2 MOTOR SYSTEM CHARACTERISTICS

- A. Duty: Rated for continuous duty from -25°C to 40°C ambient temperature at 3,300 ft (1,000 m) elevation.
 - 1. Altitude Derating: Motor system shall be suitable for operation at elevations above 3,300 ft (1,000 m). Power output shall be derated at a rate not less than 9% per 1,000 m of elevation up to 4,000 m above sea level.
 - 2. Ambient Temperature Derating: Motor system shall be suitable for operation in ambient temperatures up to 50°C . Power output shall be derated at a rate not less than 2% per $^{\circ}\text{C}$ increase above 40°C ambient.

- B. Capacity and Torque Characteristics: Motor systems shall be selected such that the motor system is sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- C. The service factor shall be 1.0.

2.3.3 POWER SUPPLY

- A. Motor/drive systems shall be suitable for operation on 3-phase 460V/60Hz, 415V/60Hz, or 575V/60Hz power supply as scheduled.

2.3.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motor system shall not be operated continuously above nameplate speed.
- B. Motors driven by a VFD shall be provided with internal shaft grounding to protect bearings from shaft currents.
- C. Motor system shall support at least two (2) Digital Outputs and four (4) Digital Inputs, in addition to a relay for faults.

2.3.5 MOTOR AND POWER ELECTRONICS SYSTEM REQUIREMENTS

Motors shall utilize air-core or equivalent high-efficiency technologies designed to meet the performance and all other specified criteria, including:

- A. Motors shall be capable of supplying sufficient torque capacity to start, accelerate, and continuously operate the connected load under all specified operating conditions without exceeding nameplate ratings.
- B. Drive system shall be designed such that harmonic performance is suitable for compliance with IEEE 519 at the point of common coupling under the installed system configuration at nominal conditions. Optional harmonic mitigation configurations shall be available to reduce input current distortion and support system compliance with IEEE 519. For drive configurations incorporating active front end (AFE) or equivalent harmonic mitigation, THDi shall not exceed 8% at BHP down to 25% of rated load, across the full operating speed range defined by the driven equipment curve.
- C. Part-load efficiency shall not fall below manufacturer-certified performance curves submitted with bid documentation. Minimum efficiency values at 75%, 50%, and 25% load points shall be provided for review.
- D. Motor efficiency shall comply with the efficiency classification defined in IEC 60034-30-2 for the specified motor size and configuration.
- E. Motor system efficiency at design operating point shall be not less than 90% inclusive of power electronics losses where applicable. Manufacturer shall clearly indicate whether efficiency values are motor-only or motor/drive system combined.

- F. Motor system shall be provided in sealed construction suitable for continuous duty operation in the specified environment.

2.4 PERFORMANCE REQUIREMENTS

A. Fan Efficiency

Fans shall have a minimum Fan Efficiency Index (FEI) of 1.3 at the specified design operating point, when rated in accordance with ANSI/AMCA 214 and AMCA 210, including installation category and system effects per AMCA 210/214 methodology.

B. Operating Range

Fans shall operate from 20% to 100% speed without instability.

C. Sound

Fan sound power levels shall not exceed the sound levels scheduled for each operating condition when tested in accordance with AMCA 300 and rated in accordance with AMCA 301.

2.5 ACCESSORIES

Provide the following:

- A. Fan structure: G90 hot-dip galvanized steel in accordance with ASTM A653. Mechanically applied or spray-applied zinc coatings are not acceptable. Structure shall be designed to withstand operating loads, startup torque, and transient vibration without permanent deflection.
- B. Inlet guards: Where required, inlet guards shall be provided where fans are exposed to personnel access or as required for safety compliance. Guards shall be constructed of corrosion-resistant steel or engineered polymer material suitable for the application, with material selection determined by the manufacturer and subject to Engineer approval. Guard design shall prevent finger or probe access to rotating components, shall be rigid under operating and service loads, and shall be securely fastened to prevent vibration or displacement during operation. Guards shall include a durable corrosion-resistant finish compatible with the fan assembly.
- C. Cord-grip cable glands: factory-supplied cord-grip cable glands, two M20 glands for control wiring and one M25 gland for power wiring, for installation per manufacturer requirements to maintain specified ingress protection rating. All unused entries shall be sealed with IP-rated fittings matching motor IP-rating.
- D. Network communication gateway: Motor/drive shall support integration with the Building Automation System (BAS) via ModBus RTU (serial) and BACnet MS/TP (serial). Modbus TCP, if provided, shall be limited to configuration and commissioning functions via static IP and shall not be used for BAS integration. Where BAS architecture requires IP-based protocols (e.g., BACnet/IP or Modbus TCP/IP), the required protocol gateway shall be provided by others.

PART 3 – EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer instructions and project requirements. Equipment shall be installed plumb, level and free of distortion. Maintain required service and maintenance clearances as indicated on approved shop drawings and coordinated equipment layouts.

3.2 TESTING AND BALANCING

Fans shall be tested and balanced in accordance with NEBB or AABC procedures. Reported airflow, pressure, and power shall be verified at the design operating condition with allowable tolerances as specified in the commissioning requirements.

3.3 FUNCTIONAL PERFORMANCE TESTING

Perform functional performance testing under the direction of the Commissioning Authority to verify:

- A. Fan speed control and modulation
- B. Lead/lag and redundancy operation (where applicable)
- C. Alarm and fault conditions
- D. BAS communication and point mapping

Acceptance shall be based on successful completion of documented test procedures without unresolved deficiencies.

3.4 TRAINING

Provide on-site training for Owner's personnel covering system operation, maintenance and BAS interface. Training shall be conducted at the installed equipment location, or at a closely equivalent site mutually agreed upon by the Owner and Engineer where jobsite conditions do not permit effective training. Training shall include demonstration of normal operation, control functions, alarms, and basic troubleshooting. Training shall be documented with attendance records and training materials provided to the Owner.