RPM AC™ Direct Drive Synchronous PM Cooling Tower Motor and Matched Controller Specification Guide

Motor
Motor Revision 2.0, January 7, 2011
Motor Revision 3.0, May 5, 2011
Motor Revision 4.0, June 24, 2011
Motor Revision 5.0, January 30, 2014
Motor Revision 6.0, August 28, 2015

Controller
Controller Revision 1.0, September 1, 2009
Controller Revision 2.0 January 30, 2014
Controller Revision 3.0, September 15, 2015

Part 1 – General

1.1 Purpose and Scope:

The purpose of this document is to clearly define the engineering specifications for direct drive variable speed control cooling tower fan using a synchronous RPM™ AC salient pole permanent magnet (PM) rotor motor with the fan mounted directly onto the motor shaft and the mating adjustable frequency controller. The main feature of this product is simplicity, reliability and safety of the cooling tower power train and to provide overall optimized system efficiency using adjustable speed control with reduced maintenance cost.

1.2 Application and Environment:

A. Field Erected Tower Application

Field erected towers are fabricated on site and are generally gear driven. For field erected towers the motor is coupled directly to the cooling tower fan eliminating the need for jack shaft, disc couplings and right angle gearing. Mounting configuration is typically shaft up with flange mounting on the opposite drive end of the motor.

B. Packaged Tower Applications

Packaged towers are manufactured units which are shipped to the job site for installation and are usually pulleys, drive belt, 300 series pillow block bearings, fan jack shaft and motor adjustable base plate. For packaged towers the motor will generally be foot

mounted either shaft up or shaft down and connected directly to the fan eliminating the need for the components listed above.

C. Environment

In both applications the motor is mounted directly underneath the cooling tower fan and is in the air stream. The motor is designed for outdoor severe duty service to handle the requirements of 100% humidity and chemical environments typically found in the cooling tower air stream.

Motor designed specifically for PWM adjustable frequency power control.
The companion adjustable frequency drive controller is to be mounted in an indoor control room environment or appropriate enclosure if outdoors.

Applications include cooling towers for HVAC systems for office buildings, municipal buildings, University buildings, shopping center complex and factories, as well as industrial process applications within Power Generation, Paper, Steel, Chemical processing and other heavy industrial applications.

RPMAC Direct Drive PM Cooling Tower Motor Specifications

Part 2 – Product

2.1 Salient Pole Interior Permanent Magnet Rotor Motor

2.2 Mounting Configuration

Cooling tower motors designs are provided in the FL250, FL280, FL320, FL360, FL400, FL440 and FL5800 frames utilizing a low profile finned laminated frame design for mounting the cooling tower fan directly onto the motor shaft with the mounted in a vertical shaft up or optional shaft down configuration.

2.3 General

A. RPM AC cooling tower motors designed specifically for use with PWM AC controllers using sensor-less PM speed control algorithms designed exclusively for cooling tower variable torque applications.
B. For use directly in the cooling tower air stream.

C. Optimum pole winding and rotor technology (rev 6.0)
FL250 and FL280 = 4 pole.
FL320 = 6 pole.
FL360 , FL400 & FL440 = 8 pole.
FL5800 either 8 or 12 pole.

D. Base speeds 100 to 600RPM as specified.

E. Torque ratings (horsepower and base speed) specific to fan load requirements as specified.

2.4 Agency Approval

A. U/L component recognition for ordinary applications,
B. CSA labeled.
C. CE marked for European safety compliance
D. Division 2 CSA certified available as an option

2.5 Quality

A. Manufactured under ISO 9001 approved quality assurance program.

2.6 Mechanical

- Enclosure Totally Enclosed Air Over (TEAO) IP66 (rev 3.0).
- Cast iron bracket construction on both ends of the motor.
- Opposite drive end special flange mount bracket for vertical shaft up installation designed for existing existing gearbox footprint. Suitable for shaft down mounting.
- Condiut box, oversized, cast iron or fabricated steel, rotatable in 90 degree increments, gasket between cover and box and gasket between the conduit box and frame.
- Inpro™ labyrinth bearing isolator (seal) on drive end.
- Shaft slinger on drive end covering the bearing isolator.
- Open ball bearings sized for minimum L-10 100,000 hours.
- Bearings sized to handle fan unbalanced loads based on an ISO Balance Grade of 6.3 (rev 4.0).
- Oversized opposite drive end bearing designed to handle fan thrust loading.
- Completely fill grease cavity, bearings and grease inlet to be free of voids.
- Re-greasable bearing system including stainless steel inlet fitting and grease drain provided with square stainless steel square head pipe plugs.
- Bearing re-lubrication 17,500 hours based upon 40C ambient and 750 feet per minute of air flow (rev 3.0). FL5800 re-lubrication once per year (rev 6.0).
- Exxon Mobilith; SHC220 for the FL250 frame and SHC460 for FL280, FL320, FL360, FL400 and FL440 (rev 6.0).

- N Klubersynth® BH 72-42 Grease for FL5800 Frame
- O. E-coat primer on cast iron parts prior to top coat.
- P. Enhanced “Extreme Cooling Tower Duty” exterior paint system for industrial and power generation cooling tower applications (rev 3.0).
- Q. Epoxy wet paint bracket to frame sealed fits.
- R. Interior paint; rotor OD, stator ID and exposed shaft between bearing journals to prevent rusting.
- S. Opposite drive flange provided with multiple bolt hole mounting provisions per the table below.

Frame	Minimum. Bolt Hole Circle	Maximum Bolt Hole Circle
FL250	4 holes -14.0” BC	4 holes - 16.0” BC
FL280 (rev 2.0)	Slot 15.0” - 16.0” BC	4 holes - 20.0” BC
FL320 (rev 6.0)	4 holes - 16.0” BC	4 holes – 20.0” BC
FL360 (rev 6.0)	4 holes - 20.0” & 22.0” BC	4 holes – 25.0” BC
FL400 (rev 6.0)	4 holes - 22.0” BC	4 holes – 25.0” BC
FL440	4 holes - 22.0” BC	4 holes - 25.0” BC
FL5800 (rev 2.0)	N/A	8 holes – 34.0” BC

- Motors heights to be as short as possible as determined by rating requirements.
- Stainless steel Condensate T-drain at lowest point in bottom motor bracket.
- U. Insulated opposite drive end bearing on all FL440 and frames standard, optional on smaller frame size based upon customer specifications. Insulated drive end and opposite drive end bear on all FL5800 frames standard.
- V. Provisions for vibration sensor mounting pad located near the top of the motor with stainless steel mounting pad offered as kit (rev 3.0).
- W Optional; transition plates can be provided to match larger (non-standard) bolt circle mounting requirements as specified by customer.
- X Optional; standard foot mounted bracket construction in lieu of ODE flange bracket construction
- Y Optional; shaft down mounting when specified.
- Z Optional; paint color when specified.

1 Standard straight shaft construction per the table below.

Frame	Standard Options	Diameter	Usable Length
FL250	A	1.9995”	6.25”
FL280 (rev 6.0)	A	2.3745”	6.25””
FL280 (rev 6.0)	B	1.9995”	5.75”
FL320 (rev 6.0)	A	2.3745	6.38”
FL320 (rev 6.0)	B	1.9995	5.88
FL360	A	2.3745”	5.88”

FL360	B	2.6345”	6.38””
FL360	C	2.9995”	6.88”
FL400	A	2.3745”	5.88”
FL400	B	2.6245”	6.38”
FL400	C	2.9995”	6.88”
FL440	A	2.9995”	11.99”
FL440	B	2.3745”	5.88”
FL440	C	2.6245”	6.38”
FL440	D	2.9995”	6.88”
FL5800	A	3.9995” – 4.9995”	9.88”

2 Special shafts including tapered shafts per customer specification available. Requires engineering review and approval.

2.7 Electrical

A. Compliance with NEMA MG 1 part 31 standards for definite-purpose inverter-fed motors suitable for 2000 volt peak at 10,000 volt per microsecond.
B. Interior permanent magnet rotor construction synchronous design.
C. VPI insulation system designed specifically for severe high humidity applications.
D. 40 C ambient, 1.0 service factor, 3,300 ft. altitude.
E. Motor rating based upon 750 ft/minute minimum air flow for motor cooling. Custom motor ratings available based upon known linear air flow velocity over the motor.
F. Final routine test; open circuit test.
G. Provide three normally closed thermostats, one per phase.
H. One set of 3 winding RTD’s (rev 2.0).
I. Provisions for grounding inside the motor conduit box (rev 3.0).
J. Grounding hole in opposite drive end bracket (rev 3.0).
K. CSA Division 2 certification for Groups A, B, C & D with temperature T3 (rev 3.0).
L CSA Division 2 certification for Groups F&G with temperature T3 (rev 5.0).

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Adjustable Speed Drive Specifications
ACS880 with Cooling Tower Assistant Firmware

PART 1 - GENERAL

1.1 Summary

A. This Section includes solid-state transistorized, PWM, adjustable speed controller of the adjustable frequency drive type for speed control of three-phase interior permanent magnet rotor cooling tower motors.

B. Related drawings and general provisions of the Contract, including General and Supplementary Conditions are specified elsewhere.

1.2 Definitions

A. IGBT: Insulated gate bipolar transistor.

B. ASD: Adjustable speed drive, adjustable frequency controller, adjustable frequency drive.

C. PWM: Pulse width modulation.

D. BMS: Building management system.

1.3 Submittals

A. Product Data: For each type of ASD, provide dimensions, mounting arrangements, location and size for conduit entries, weights, and manufacturer's technical data on features, performance, electrical ratings, and characteristics.

B. Shop Drawings: For each type and size ASD.

1. Include dimensioned drawings with mountings details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, ratings and watts loss data. Include the following:

    a. Each installed unit's type and details.

    b. Short-circuit current ratings for drive and assembly of drive and over-current protection thresholds.

    c. UL listing.

2. Wiring Diagrams to include power, signal, and control wiring for the ASD.

C. Qualification Data: For testing agency and manufacturer.

D. Field Test Reports: Written reports specified in Part 3.

E. Manufacturer's field service report. Written reports specified in Part 3.

F. Operation and Maintenance Data: For ASD and all installed devices, and components to include the following:

1. Manufacturer’s instruction sheets.

2. Manufacturer’s installation instructions.

3. Manufacturer’s operation manual.

1.4 Quality Assurance

A. Manufacturer Qualifications:

1. ASD manufacturer shall have over 50 years experience in the industry and shall maintain active companywide quality assurance program.

2. ASD manufacturer shall have corporate quality policy based on the customer perceived value formula.

3. ASD manufacturer shall maintain an authorized service center capable of providing training, parts, and emergency maintenance and repairs. Distance between this center and the project site is specified elsewhere.

4. ASD manufacturer shall have the capability of providing additional packaged drive engineering and manufacturing support to integrate the ASD into non-standard enclosure and control configurations to support variances unique to the project.

5. Drives and packaged drive panels shall be UL listed and manufactured in ISO9000 certified facility.

B. Comply with NFPA 70 National Electric Code.

1.5 Delivery, Storage and Handling

A. Deliver ASD in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store ASD indoors in clean, dry space with uniform temperature to prevent condensation. Protect ASD from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 Coordination

A. Coordinate layout and installation of ASD with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases for floor mounted ASD and make proper provisions for wall mounted ASD.

C. Coordinate features of ASD, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each installed ASD unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - Products

2.1 Manufacturers

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB

2.2 Adjustable Speed Drives

A. Description: UL508C, IGBT, PWM, ASD, listed and labeled as a complete unit and arranged to provide variable speed of a 3-phase, interior permanent magnet rotor, laminated frame stator, premium efficiency cooling tower motor by adjusting direct and indirect current and voltage as required to provide smooth cog-free control at required speed range for fan.

B. Design and Rating: Matched performance ratings to provided cooling tower motor to ensure trouble-free commissioning and long-term operation. Designed to operate the matched motor in a sensorless direct torque control mode without the need of a speed feedback device.

C. Output Rating: 3-phase with adjustable minimum and maximum limits on operational RPM. Continuous current rating to meet or exceed the FLA of the cooling tower motor. Unit Operating Requirements:

1. Input ac voltage tolerance as follows:
    a. 208 to 240 V, +10% & -15%
    b. 380 to 500 V, +10% & -15%
    c. 525 to 690 V, +10% & -15%
2. Input frequency tolerance of 47 to 63Hz.
3. Capable of driving full load, under the following conditions, without derating:
    a. Ambient Temperature: -15°C to 55°C. (5°F-131°F.)
    b. Humidity: Less than 95 percent (non-condensing).
    c. Altitude: 3300 feet (1000 m) without de-rating.
4. Minimum Efficiency: 97 percent at full load and speed.
5. Minimum Displacement Primary-Side Power Factor: 96 percent.
6. Overload Capability:
    a. 1.1 times the rated output current for 60 seconds
7. Starting Torque: Drive shall be capable of separately adjustable acceleration and deceleration times that can be programmed to extended times (up to 1800 seconds in duration) so as to provide an appropriate “soft start” to the direct-coupled high inertia cooling tower fan. Separately adjustable acceleration and deceleration S-ramp capability shall exist to further soften the starting and stopping torque so as to minimize mechanical fatigue.
8. Speed Regulation: Plus or minus 0.1% of maximum speed while operating in sensor-less mode. ASD shall not require a speed feedback device to maintain the stated regulation.
9. Control interface to allow controller to follow control signal over a 30:1 speed range in sensor-less mode.

D. Internal Adjustability Capabilities:

1. Minimum Speed: 0 to 100 percent of maximum RPM.
2. Maximum Speed: 0 Hz to 100 percent of maximum RPM.

3. Acceleration: 0 to a maximum of 1800 seconds with independently adjustable S-ramp.

4. Deceleration: 0 to a maximum of 1800 seconds with independently adjustable S-ramp.

5. Current Limit: 0 to 120 percent of rated current.

E. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.

2. Snubber networks to protect against malfunction due to system voltage transients.

3. Undervoltage and overvoltage trips; inverter overtemperature, drive overload, motor overload, motor over temperature, motor overcurrent and ground fault trips.

4. Three skip frequency bands to prevent continuous operation of the controller-motor-load combination at a natural frequency of the combination.

5. Instantaneous line-to-line and line-to-ground overcurrent trips and continually monitor to detect ground faults.

6. Short circuit protection on the output to the motor.

7. Fault log retained in non-volatile memory per the below:

a. 32 most recent events logged in non-volatile memory

b. Each event stored using fault name and time stamp. Help text shall be immediately available on the drive keypad/display to aid in trouble-shooting the event without the need to refer to the user manual

c. Detailed documentation in user manual for describing and trouble-shooting the event in depth

d. Real-time-clock (RTC) value stored with event so that the actual calendar date and time of day is recorded for coordinating the event with external disturbances

e. Snapshot of the critical drive parameters such as motor current, motor torque, DC voltage, flux actual, main control word, main status word, speed reference, limit word, limit status and motor speed for control shall be stored with the event so that operational conditions can be evaluated at the time the event occurred.

f. PC based drive support software that is capable of downloading and e-mailing the diagnostic information to scope data with the values of all critical drive parameters to technical support personnel within the ASD manufacturer's technical support group.

F. Automatic Reset and Restart: Programmable for up to 5 restart attempts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction..

G. ASD Output Filtering: Cable from ASD to motor shall be less than 1640 (492 if complying with EMC directive) wire feet**;** otherwise output reactor or suitable filtering shall be added to protect the motor.

H. Operator Keypad and Display: Backlit graphic LCD display for displaying operating conditions; keypad for programming and troubleshooting diagnostics; ability to make a backup copy of drive parameters; ability of providing help text at any time with usage of a dedicated help key. Operator keypad shall be capable of being removed from ASD for remote mounting up to 200' away using ASD manufacturer supplied cable. When mounted remote, operator keypad shall meet NEMA 4 enclosure ratings.

I. Control Signal Interface: Provide ASD with the following:

1. Electric Input Signal Interface: A minimum of 2 analog inputs with both selectable for bipolar or 4-20mA operation; fixed drive enable digital input; 9 programmable digital inputs. Ability shall exist to perform mathematical and logical modification of either or both analog inputs to derive a new modified speed command to the control.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from a BMS, PLC or other control system:

a. 0 to 10-V dc.

b. 0/4-20mA.

c. A fixed preset speed using a digital input.

d. USB 2.0 and Modbus RTU (RS-485) standard.

e. Keypad display for local (hand) operation.

3. Output Signal Interface:

a. A minimum of 2 analog output signals that can be programmed to the following:

1) Output frequency (Hz).

2) Output current (load).

3) DC-link voltage (VDC).

4) Motor torque (percent).

5) Motor speed (RPM).

6) Set-point frequency (Hz).

7) Power

b. Outputs can be scaled to the following ranges:

1) 4-20mA

2) 0-20mA

4. Remote Indication Interface: A minimum of 2 dry contact (230VAC, 3A) relay outputs and 2 Opto-Isolated outputs (24VDC, 50mA) for remote indication of the following:

a. Motor running.

b. Set-point speed reached.

c. Fault indication.

d. Ready.

e. Enabled.

f. Reverse.

g. Warning.

h. Zero speed.

J. Communications: Provide an optional communication interface allowing ASD to be used with an external system within a multi-drop LAN configuration. Interface shall allow all parameter settings of ASD to be programmed via BMS or PLC control. Provide capability for ASD to retain these settings within the nonvolatile memory.

K. Internal process control loop (PID) for regulating an external condition such as temperature, flow or pressure by automatically controlling the motor speed.

L. Optional Drive Isolation Contactor: Arrange magnetic contactors to safely isolate motor from controller output circuit when power is not applied.

M. Anti-condensation provisions: The ASD shall be capable of maintaining the motor at zero speed when operation of the fan is not required and shall provide trickle current to the motor windings to help heat the windings eliminating the need for motor space heaters.

2.3 Enclosures

A. NEMA enclosures to be determined by the location of the installed drive; NEMA 1 for indoor installation, clean air spaces, NEMA 12 ventilated for indoor installation, dirty air spaces, and NEMA 3R for outdoor locations, cooling is required if ambient is above 45 deg. C.

2.4 Information Display

A. Output frequency (Hz).

B. Set-point speed (Hz or RPM).

C. Motor current (amperes).

D. DC-link voltage (VDC).

E. Motor torque (N-M).

F. Motor speed (RPM).

G. Motor output voltage (VAC).

H. Drive heatsink temperature

I. Estimated power, energy usage and cost based upon a user adjustable $/kW-hr rate

J. Historical Logging Information and Displays:

1. Total run time.

2. Fault log, maintaining last 32 faults with real time stamp for each. A fault trace snapshot of critical operating parameters shall be captured and stored with each entry in the fault log.

2.5 Optional Accessories

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type or IEC 22 mm type.

C. Control Relays: Auxiliary and adjustable time-delay relays.

2.6 Factory Finishes

A. Finish: Manufacturer's standard finish paint applied to factory assembled ASD before shipping.

PART 3 - Execution

3.1 Examination

A. Examine areas, surfaces, and substrates to mount ASD for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine rough-in for conduit systems to verify actual locations of conduit connections before ASD installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Applications

A. Select features of each ASD to coordinate with ratings and characteristics of supply circuit and ensure that the drive and motor are supplied as a “matched performance” offering; ASD manufacturer to have capability of applying the drive and motor properly in a direct-drive cooling tower fan application.

B. Select rating of controllers that take into account environmental derating factors where applicable.

3.3 Installation

A. Anchor each ASD assembly to load bearing surface by carriage grade 5 steel bolts arranged and sized according to manufacturer's written instructions.

3.4 Identification

A. Identify ASD, components, and control wiring as specified in Engineer’s requirements.

3.5 Control Wiring Installation

A. Install wiring between ASD and remote devices as specified in Engineer's requirements. All ASD wiring shall be run in separate conduits: one for power in, one for power out, one for control wiring, all in separate conduit runs end to end. Output power wiring shall be continuous runs of wire with no intermediate splices or junctions and shall include an appropriately sized grounding conductor terminated at both the controller and motor. Motor thermostat and vibration switch wiring shall not be run in motor power conduit.

B. Good wiring practices shall be followed at all times.

C. Connect Hand-Off-Automatic switch and other automatic-control devices where available.

3.6 Connections

A. Conduit installation requirements are as specified in Engineer's requirements. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Properly ground all equipment according to manufacturer's recommendations regarding equipment grounding and noise attenuation practices for electrical and electromagnetic interference.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.7 Field Quality Control

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each ASD element, component, connecting supply, feeder, and control circuit. ASD must not be connected to the circuit while such tests are conducted to eliminate the possibility of damaging test voltages backfeeding sensitive electronic components.

2. Test continuity of each circuit.

B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test as recommended by ASD manufacturer.

2. Perform visual and mechanical inspection as recommended by ASD manufacturer. Certify compliance with test parameters.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Manufacturer's Field Service: Engage factory-authorized service to inspect field-assembled components and equipment installation, including pretesting and adjusting ASD.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 Startup Service

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.9 Adjusting

A. Set field-adjustable switches and circuit-breaker trip ranges. Adjust the ASD as necessary to match the application requirements.

3.10 Cleaning

A. Clean ASD internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.11 Archiving

A. All ASD operational parameters at completion of startup to be documented in writing or saved via a manufacturer supplied PC utility.

B. All field wiring diagrams to be verified as correct and modified as necessary to properly reflect the final installation.

3.12 onDemonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ASD.

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Revision Log (rev 6.0)

Motor Revision 2.0; Electrical 2.7 H.
Motor Revision 3.0; Mechanical 2.6, Electrical 2.7 I, J & K.
Motor Revision 4.0; Mechanical 2.6.
Motor Revision 5.0; Remove reference to VS1CTD controller, Electrical 2.7 L.
Motor Revision 6.0; Added FL320 frame size information, Mechanical 2.6 lubrication cycle, Added revision log on last page.

Controller Revision 1.0; Original
Controller Revision 2.0; Removed reference to VS1CTD controller.
Controller Revision 3.0; Conversion to ACS880 with DTC and CT assistant