Technical Note Number 119

Multiple EC Titanium motors

One ACH580 controlling multiple PMaSynRM motors

There are presently many applications in the existing HVAC market where one drive runs multiple motors. One typical application is fan arrays. The main reason for this drive and multiple motor packaging is reduced cost. Installation of one large VFD running multiple smaller motors is usually less expensive than one drive per motor. Additional benefits include lower cost for wiring and installation, less physical space required and fewer drives for the BMS to manage. This technical note will discuss the commissioning of one ACH580 drive to operate multiple EC Titanium motors.

Asynchronous induction motors have been the standard motor in these applications. With the increased demand for higher efficiency, ABB/Baldor has developed a new motor design for the HVAC market. This motor is called a "Permanent Magnet assisted Synchronous Reluctance" design. This design meets IE5 efficiency. That is, the motor uses up to 40% less energy than existing IE3 (premium-efficient) designs. Baldor markets this product as their "EC Titanium motor".

Most other PM motor designs require the use of one VFD per motor. Now one ACH580 drive can operate multiple EC Titanium motors.

Motor considerations

There are many unique aspects of the EC Titanium motor. A basic understanding of this design will be helpful when applied to multiple-motor applications.

Figure 1 shows an innovative rotor design.

- The shape of the rotor slots and embedded magnets make this rotor a low loss design. That results in different operating characteristics than a standard NEMA B design motor.
- This motor does not have any slip, which becomes significant in multiple motor applications. Therefore, the ACH580 uses vector motor control instead of scalar mode.
- Motor efficiency is maintained well above base speed. In fan arrays that run above base speed, this will provide additional savings.

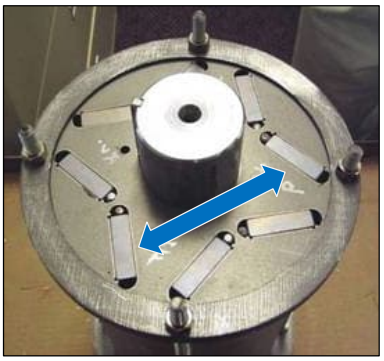


Figure 1: Rotor with magnets

Additional considerations

To successfully run more than one EC Titanium motor, there are some requirements to consider. In most cases, the equipment OEM incorporates these requirements into their design.

- All motors must be the same type. That is: the same model, Hp, and FLA.
- All loads must be of the same kind or type. For example, all the load curves in a fan array must be the same. Different loads or inertias may cause oscillations and loss of synchronization in motor magnetic fields.
- The ACH580 must be sized to satisfy both the total Hp rating and the total FLA of the applied motors.
- Separate motor overloads/protectors (MMPs) are required to provide individual motor protection. Either thermal or electronic designs can be used. See Figure 2.

- Startup and commissioning of multiple motor applications requires that all motors are connected to the VFD. This requirement is essential to complete the motor ID run. It ensures the drive has an accurate record of the complete motor load.
- An EC Titanium motor cannot be started or run across the line. A VFD is always required.
- Figure 3 shows a typical EC Titanium nameplate

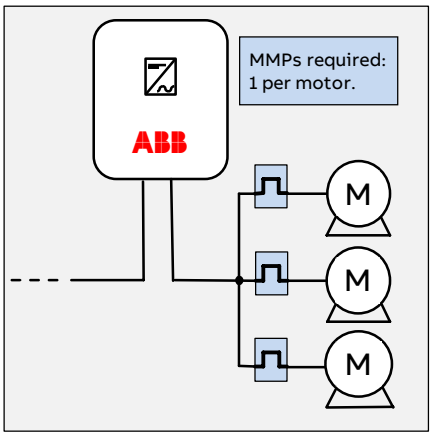


Figure 2: One-line drawing

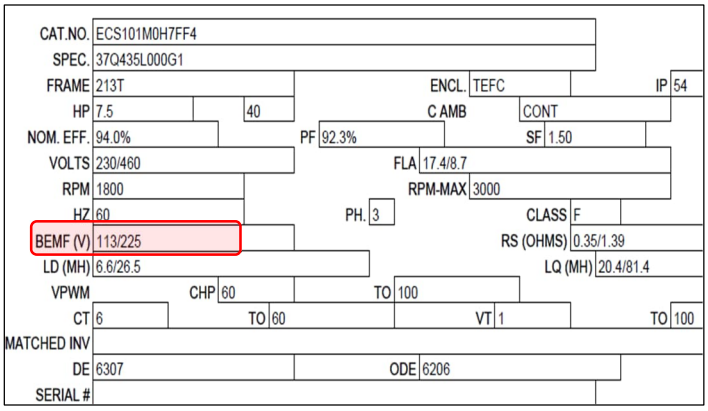


Figure 3: Motor nameplate

Commissioning of multiple motor applications

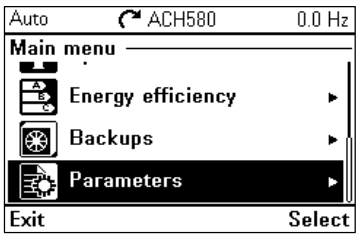
A quick look at the EC Titanium nameplate shows an important new rating. In addition to nominal line voltage, Back EMF Voltage is critical, Figure 3 has that information accented. BEMF is entered into the motor parameter group at 99.07. Improper entry usually causes an ID run to fail. Even if the VFD does manage to complete the run, there is little chance the motor(s) will actually run.

- Technical Note 017 contains a list of parameter changes for single PMaSynRM motor commissioning.
- Firmware 2.15.0.17 and newer supports single EC Titanium motor using Primary settings. The motor type EC Titanium is replaced with type PMaSynRM
- At the time of this document's publishing (2.18.0.0 firmware), Primary settings does not support multiple EC Titanium motor functions, thus parameters should be used for commissioning. However, this feature will be added in a future firmware revision.
- Table 1 lists the parameter changes for multiple-motor commissioning.
  Note: some of the listed changes are already set by 99.03 and 99.04.

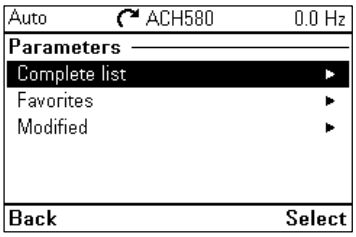
Start with the control panel at the home screen

Press Menu > Parameters > Complete list > Group 99 Motor Data

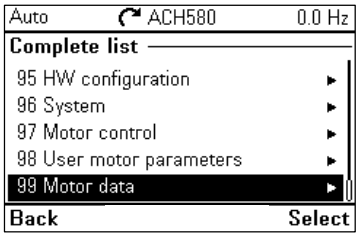
- Select 99.03 (Screen 4) > [3] PMaSynRM > Save
- Continue to enter the parameter changes shown in Table 1.



Screen 1

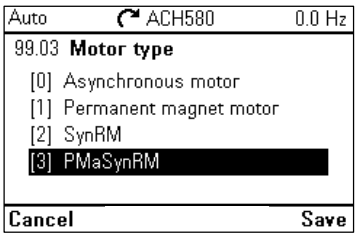


Screen 2

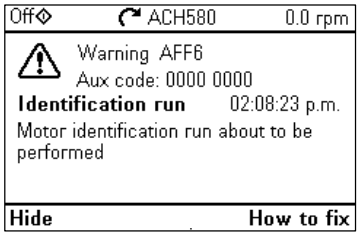


Screen 3

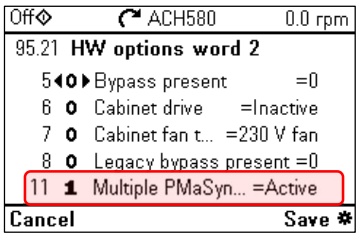
- Selecting Vector control mode (99.04) initiates an ID run message (Screen 5). Press Hide and continue to enter changes. After all entries are complete, pressing Hand on the control panel will start the drive ID run.
- Informational note: selection of motor type PMaSynRM makes bit 11 of 95.21 accessible (Screen 6).



Screen 4



Screen 5



Screen 6

Table 1: Parameter changes

Parameter	Name	Value Examples	Description
99.03	Motor type	PMaSynRM	Permanent Magnet assisted Reluctance Motor
99.04	Motor control mode	Vector	Vector mode must be used with PM machines
99.06	Motor nominal current	34.8 Amps	FLA of one motor × total number of motors. From Figure 3: 8.7 A (each) × 4 motors = 34.8 total Amps
99.07	Motor nominal voltage	225 Volts	Enter Back EMF from motor nameplate
99.08	Motor nominal frequency	60 Hz	Default is 60.0 Hz, verify nameplate value
99.09	Motor nominal speed	1800 rpm	Enter synchronous speed or Max rpm for application
99.10	Motor nominal power	30 Hp	Single motor HP × total quantity of motors Example: 7.5 Hp × 4 motors = 30 total Hp
99.13	ID run requested	Standstill	Vector mode sets ID run to Standstill
95.21.11	HW options word 2, bit 11	[1] = Active	Enables multiple-motor functionality
21.01	Start mode	Automatic	Default mode, best for most PM applications
21.03	Stop mode	Coast or Ramp	Default is coast, application specific
21.13	Auto phasing mode	Turning 2	Rotates motor to a known angle, leave as set by 95.21.11
30.11	Minimum speed	0.0 rpm	Application based
30.12	Maximum speed	1800 rpm	Synchronous speed or Max rpm for application

Programming Notes:

Selecting PMaSynRM (99.03) makes group 227 visible.

Selecting Vector (99.04) mode sets 99.13 to standstill.

95.21.11 sets 21.13 to Turning 2.

Application Specific Observations

While there are some service/maintenance related aspects of permanent magnet (PM) motors that are similar to an induction motor, there are others that are different.

- When a PM motor coasts to a stop, its magnets create a voltage potential in the motor windings. Voltage potential is present in the motor wiring until all rotation is completely stopped. This is true for all PM motors, in single or multiple motor scenarios. Service technicians should be aware that voltage from the motors, will be produced whenever the motor is rotating (such as a leaky backdraft damper on a fan array).
- A motor should never be added to the output of a VFD while the VFD is already modulating (i.e., running the other motors). This is true for both induction and PM motors. In the case of PM motors, this also risks demagnetizing the magnets.
- To add a motor back into the fan array after service/maintenance, first stop the VFD and bring all the motors to a stop. Then add the motor back into the circuit (i.e., close the MMP). Then provide a VFD start command.

Conclusions

The desire for higher efficient equipment continues to encourage new motor designs and improved VFD motor control algorithms to run the motors efficiently. EC Titanium motors leverage a synchronous reluctance design combined with ferrite magnets to achieve high efficiency. ACH580 firmware is optimized for multiple (up to 16) EC Titanium motors on a single drive. This allows a fan array designer to achieve the best efficiency results possible. Note that running multiple EC Titanium motors requires an add-on to the standard ACH580 firmware. Drives with that add-on included have +N3022+N8059 included in the part number.