

Technical Note 017

EC Titanium motor setup with ACH580 & ACH180

Commissioning EC Titanium motors

This document gives basic guidelines on how to identify motor data from the nameplate to enter the drive parameters as well as commissioning considerations for EC Titanium motors in HVACR applications. These instructions apply to the EC Titanium Motor and ACH580 & ACH180 drives.

The following technical note is based on the use of v2.18 firmware or later in the ACH580 drive and the use of 2.20.0.32 firmware or later in the ACH180 drive.

EC Titanium motor design overview

Like the traditional Electronically Commutated motor (ECM), the EC Titanium uses permanent magnets and requires an electronic drive for control. Both are synchronous and tend to be more efficient than their induction counterparts. EC Titanium motors use a synchronous reluctance rotor with imbedded ferrites magnets, known as a ferrite assisted synchronous reluctance (PMaSynRM) design. The application of ABB variable frequency drives with an EC Titanium motor enables the use of advanced motor control algorithms for higher efficiencies across the speed load range.

Proper entry of the nameplate values is critical to setting up an ABB drive with the EC Titanium to ensure the proper control and optimized performance of the system. Motor nameplate data provided on each motor should also be used to ensure proper setup of the ABB drive to control the motor.

Topics to be covered are:

1. Identifying the EC Titanium motor parameters
2. Importance of entering accurate motor data
3. Drive selection guidelines
4. EC Titanium motor commissioning using parameters
5. Tuning for high inertia applications
6. Demagnetization of PM motors
7. Conclusion

Identifying the EC Titanium motor parameters

The EC Titanium motor nameplate is located on the side of the motor and includes all applicable ratings, appropriate markings, a catalog number, and a serial number, which allow identification of each unit. The motor nameplate contains electrical information necessary for proper setup of the ABB drive. Figure 1 below highlights the key pieces of information that needs to be programmed into the drive.

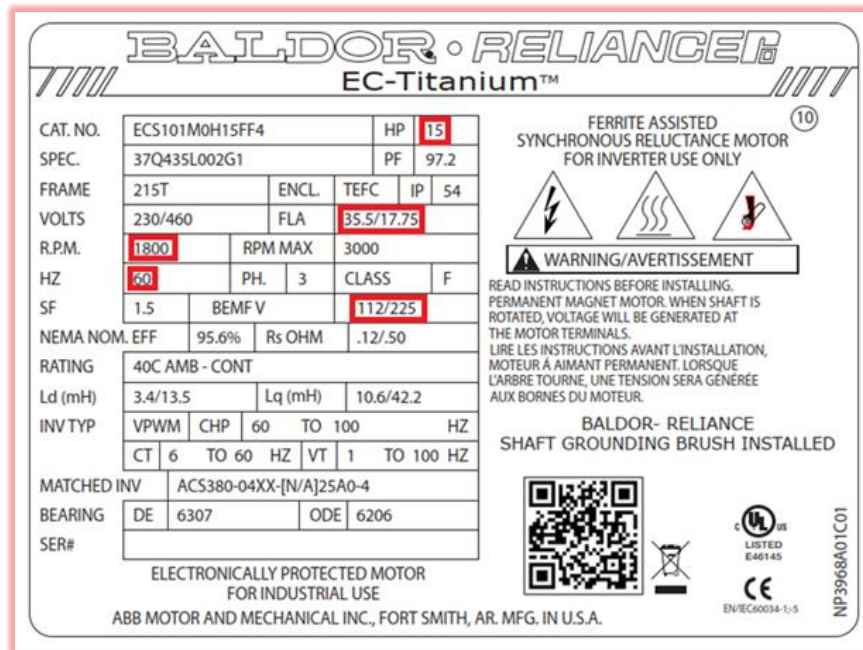


Figure 1 Motor data entered for Group 99 in the ACH180 or ACH580 drive

- HP is entered in 99.10 **Motor nominal power**.
- FLA is entered in 99.06 **Motor nominal current**.
- RPM is entered in 99.09 **Motor nominal speed**.
- HZ is entered in 99.08 **Motor nominal frequency**.
- **BEMF V is entered in 99.07 Motor nominal voltage.**
 - Note: 99.07 is the most missed setting in commissioning motor data. Do **not** enter 230 or 460 V.

Importance of entering accurate motor data

Induction motor control has historically been scalar (“Volts per Herz”) control which is relatively insensitive to the motor electrical parameters. Control of PM motors is done using vector control which requires accurate estimates of the motor electrical characteristics calculated from the nameplate values and obtained during the ID run. Entering incorrect nameplate values may allow the ID run to complete and even allow the motor to start and run during commissioning, but it can result in poor control, reduced efficiency, and nuisance faults later when the system is exposed to different operating conditions. Figure 2 shows the motor nameplate of an EC Titanium motor, along with an ACH580 drive.



Figure 2 EC Titanium Motor with an ACH580 drive

Drive selection guidelines

ABB basic drive selection criteria apply with Permanent Magnet assisted Synchronous Reluctance Motors. Select a drive so that all criteria below are met:

- Motor rated current is less than or equal to the rated current of the drive.
- Motor rated power is less than or equal to rated drive power (do not significantly oversize the drive, i.e. 6x)

EC Titanium motor commissioning using parameters

Table 1 lists the required parameter changes. Some values are changed automatically by selecting PMaSynRM in parameter 99.03. Enter the appropriate motor and application data into the parameters shown in Table 1.

Table 1 Parameters for commissioning an EC Titanium motor

Parameter	Name	Value examples	Description
99.03	Motor type	PMaSynRM	Permanent magnet assisted synch. reluctance motor
99.04	Motor control mode	Vector	Vector mode: required with PM motors
99.06	Motor current	17.8 Amps*	Motor nameplate FLA
99.07	Motor nominal voltage	225 V*	Motor nameplate Back EMF
99.08	Motor nominal frequency	60.0 Hz*	Verify and match motor value
99.09	Motor nominal speed	1800 rpm*	Enter synchronous speed
99.10	Motor nominal power	15 HP*	Motor nameplate HP (or kW for IEC motors)
99.13	ID run request	Standstill	Vector mode sets ID run to Standstill
21.01	Start mode	Automatic	Provides optimal starting
21.03	Stop mode	Coast or Ramp*	Application specific
21.13	Autophasing mode	Turning 2	Rotates motor to a known angle
30.11	Minimum speed	0.0 rpm*	Application based
30.12	Maximum speed	1800 rpm*	Max rpm for the application
30.17	Maximum current	26.7 Amps*	Max current limit which can be calculated using the motor's nameplate service factor

Table 1 programming notes:

"Value examples" marked with an * are provided as an example only, with motor data based on the label in Figure 1 and should be adjusted based on actual motor nameplate data or application requirements.

- Setting parameter 99.04 Control mode to Vector automatically sets 99.13 ID run requested to Standstill and initiates an ID run warning, indicating an ID run is to be performed the next time the drive is started. Press Hide and continue to enter changes. Note: after all entries are complete, pressing Hand on the control panel will start the drive ID run.
- After a successful motor ID run has been completed, values are populated in parameter group 98. This includes 98.02 Rs user, 98.06 Ld user, 98.07 Lq user, 98.08 PM flux user, 98.09 Rs user SI, 98.13 LD user SI, and 98.14 Lq user SI. This process also calculates and populates the autophasing current (227.20) needed for the autophasing process prior to each start.
- Automatic start is default for Vector mode.
- Vector mode operation means that analog input speed control scaling units are in RPM instead of Hz (12.17 to 12.20).
 - For example, set 12.20 AI1 scaled at AI1 max to 2000 RPM instead of 66.67 Hz, if to make a 10 V signal

correspond to a 2000 RPM speed reference on a 60 Hz / 1800 RPM nominal motor.

- Autophasing mode (21.13) is changed to Turning 2 automatically.
- Adjust parameter 30.17 Maximum current to a value less than or equal to the motor service factor which can be calculated using the value listed on the nameplate. For example, reading the nameplate from Figure 2 shows an FLA of 17.75 A at the 480 V line voltage wiring and 36.5 A at the 230 V configuration and a service factor of 1.5. This means 30.17 could be set as high as $17.75 \text{ A} \times 1.5 = 26.6 \text{ A}$ for a 480 V configuration or $36.5 \text{ A} \times 1.5 = 54.7 \text{ A}$ for a 230 V configuration. Limiting the current to this value reduces the risk the motor is damaged. Do not set 30.17 equal to the motor FLA rating, 30.17 should be set above the motor's current rating.
- Parameter group 227 is visible automatically once motor type (99.03) is adjusted to PMaSynRM. If necessary, the troubleshooting related sections of this technical note will detail any adjustments to parameters in group 227.

The EC Titanium offers advantages in efficiency and control. It is important to understand that permanent magnet motors such as an EC titanium have different tuning steps than inductions motors. Having the correct motor data entered and understanding that vector control is based on rotor speed measured in RPM rather than electrical output frequency measured in Hz are important to keep in mind. The performance of this technology exceeds induction motor technology if these steps are followed.

Tuning for high inertia applications

The following section provides tuning direction if the drive has issues starting the EC Titanium motor. The first step in troubleshooting is to verify that motor data is entered correctly in Group 99 **Motor data**. The most common error is to enter a non-BEMF value into parameter 99.07 **Motor nominal voltage**. For all Permanent magnet motors, 99.07 **Motor nominal voltage** must be entered as the BEMF value from the motor nameplate. Another common error is entering incorrect values in 99.06 **Motor nominal current** which should be the motor's FLA on the nameplate.

Note: It is important to understand that from one EC Titanium motor to another with the same HP rating, there may be a different Back EMF value as well as a different FLA rating on the nameplate of the motor. The reason these values are often entered incorrectly is due to the assumption that when projects have a large number of the same hp motor installed, they will all have the same values on the motor label, which is not the case. It is critical to establishing the motor control for the drive and if entered incorrectly, could result in unstable motor control. Validate this information prior to taking any other troubleshooting steps.

Once information is input or changed in group 99 **Motor data**, the drive will automatically require a **Standstill ID run** to be completed. This process updates group 98 **User motor parameters** that are the basis of the motor control.

Assuming motor data is entered correctly, nuisance faults such as 7310 **Overspeed**, 2310 **Overcurrent**, and 7122 **Motor overload** could be related to load characteristics. Figure 3 shows a Drive Composer monitoring file that illustrates the current (blue), and torque (purple) being supplied to an EC titanium motor during the autophasing and starting process with a high inertia load. This is an example of a successful autophasing and starting process. When starting an EC Titanium or any permanent magnet motor using vector control, the drive will run an autophasing process which aligns the rotor permanent magnet to a known position prior to starting the motor. There may be some variation on the initial current being supplied to the motor to rotate the rotor into position, then it will steady toward the end of the autophasing process as it holds the rotor in position. The current will then dip to begin the start of the motor. Appendix A provides instruction on where to download Drive Composer software, the cables needed, and how to configure Drive Composer to monitor information in the regarding the starting process of the motor if needed.

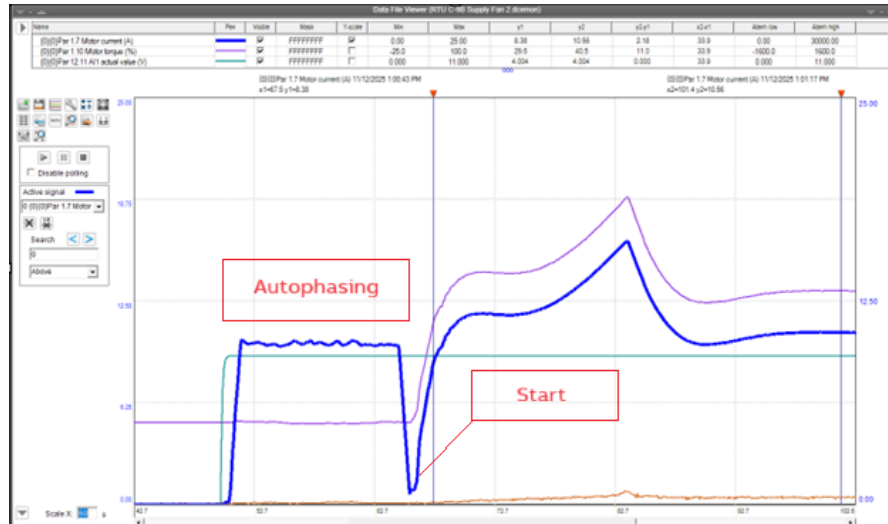


Figure 3 Autophasing and starting of an EC Titanium

In some cases, there is high load inertia or resistance torque that requires higher than typical motor torque to successfully align the rotor. Examples include a steel fan hub that has air dynamics acting on it during the autophasing and starting process, or mechanical resistance from belt and pulley system.

When there is high inertia load, it may result in the drive being unable to correctly execute the autophasing process prior to the start and create a nuisance 7310 **Overspeed** or 2310 **Overcurrent** fault. In this case, instead of the steady current supplied at the end of autophasing in Figure 3, there would be fluctuation in current at the end of the autophasing process prior to the dip in current for the starting process. If this occurs, more time may be necessary for the autophasing process to take place. The default autophasing time for both the ACH580 and the ACH180 drive is 5 seconds. This can be adjusted in parameter 227.21 **Autophasing time**. Update 227.21 **Autophasing time** to 10 seconds and identify whether the drive can complete this autophasing process prior to the start with the forces acting on motor shaft.

Use drive parameters 1.01 **Motor speed used** and 1.10 **Motor torque** and observe if these values are allowed to settle by the end of this 10 second autophasing time prior to the start of the motor. Continued variation in 1.10 **Motor torque** indicates the shaft has not come to a standstill state prior to starting. Note that the shaft only rotates in one direction during the autophasing process. If 1.01 **Motor speed used** is alternating between positive and negative values at the end of this 10 seconds autophasing time, there are forces acting on the rotor moving it out of the fixed position it needs to start in.

The autophasing current established in the standstill motor ID run is in parameter 227.20 **Autophasing current**. This should not be adjusted unless the forces acting on the motor shaft do not allow the autophasing process to complete. Consult your Drive Specialist for the update to this autophasing current.

In vector control the drive's torque reference is set by a PID speed controller which is configured in parameter group 25. If 7310 **Overspeed** or 2310 **Overcurrent** nuisance faults continue after insuring the Autophasing process is completed, it may be a result of high load inertia or resistance torque and relatively low drive default speed controller gains. The proportional gain is in parameter 25.02 **Speed proportional gain**. The default for EC Titanium motors in both the ACH180 and the ACH580 is 3. To increase the responsiveness to the start after the autophasing process with a higher inertia load, it is suggested to increase this value to 5, then increments of 1 up to a maximum of 10 if necessary. Table 2 identifies the parameters used in addressing 7310 **Overspeed** and 2310 **Overcurrent** nuisance faults.

It may also be necessary to modify overspeed trip margin in group 30 **Limits** in the drive's parameters. The default value for parameter 31.30 **Overspeed trip margin** is 500 RPM. This can be changed to 1000 RPM to allow for more operational range to manage that high inertia load.

Table 2 Parameters for tuning if experiencing Overcurrent, Overspeed, or Motor overload at start

Parameter	Description	Default value	Tuning suggestion
227.21	Autophasing time	5	Increase to 10 to allow more time to the autophasing process to complete.
25.02	Speed proportional gain	3	Increase to 5 for more aggressive response to the start process after autophasing is complete. Can increase in increments of 1 up to 10.
31.30	Overspeed trip margin	500 RPM	Increase to 1000 RPM.
227.20	Autophasing current	Calculated at motor ID run	This value should not be changed unless there are dynamic forces working against the rotor not allowing it to complete the autophasing process. If this observed, consult your Drive Specialist.

Output phase loss

In rare cases, after increasing values related to the autophasing process as well as the speed control there is the possibility of seeing a nuisance output phase loss fault. This is a result of the momentary drop in current between the autophasing process and the starting of the motor.

When troubleshooting any Output phase loss fault, the first step is to verify the motor is connected to the drive and that any motor disconnects, contactors, or overloads are closed. Once the motor connection has been verified drive parameter changes can help resolve the problems.

In Figure 4 below there is Drive Composer monitoring file depicting a 3381 **Output phase loss** occurring after the autophasing process has completed. The drive is supplying current to align the rotor to a fixed position and when the drive transitions from the autophasing process to start, the current drops to zero resulting in a 3381 **Output phase loss** fault.

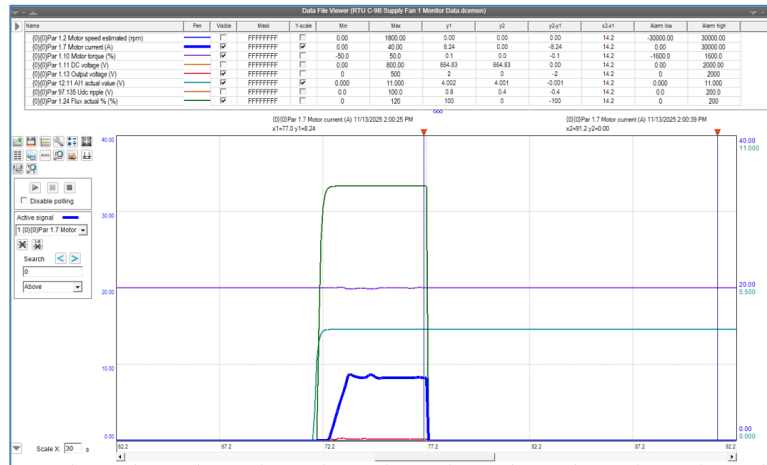


Figure 4 Autophasing and Output phase loss fault condition

Parameter 227.08 **Flux boost** is the current that is being used to hold the rotor between the autophasing process and the start of the motor operation. A slight increase in this value may be needed if there is an output phase loss fault during the current lag between the autophasing and starting of the motor. Beginning with the default value in parameter 227.08 **Flux boost**, increase the number in increments of 0.01.

Demagnetization of PM motors

If you supply current above 1.5 the rated current for the motor repeatedly or continuously, it is possible to demagnetize the motor.

A way to detect a demagnetized motor in the field is to decouple the motor from the load and perform a rotating motor ID run by setting parameter 99.13 **ID run requested** to Normal or Advanced. If you see a resultant value in 98.08 **PM flux user** that is lower than 0.9, the motor is demagnetized to the point where motor efficiency and power consumption are significantly impacted. The drive internally updates its record of the new back-EMF following the rotating motor ID run which resolves control issues resulting from moderate demagnetization. Control performance may be permanently diminished in cases of significant demagnetization. Consult your Drive Specialist about any value below 0.9 in parameter 98.08 after executing a rotating motor ID run.

Conclusion

Commissioning of an EC Titanium with an ACH180 or ACH580 drive is a simple and efficient process. The EC Titanium is a ferrite assisted synchronous reluctance motor, which provides exceptional efficiency and motor control. This permanent magnet motor technology needs accurate motor data in the drive to operate correctly, and in the rare cases where there are dynamic high inertia loads, they have different steps to tune them than traditional induction motors.

Appendix A – Monitoring a start

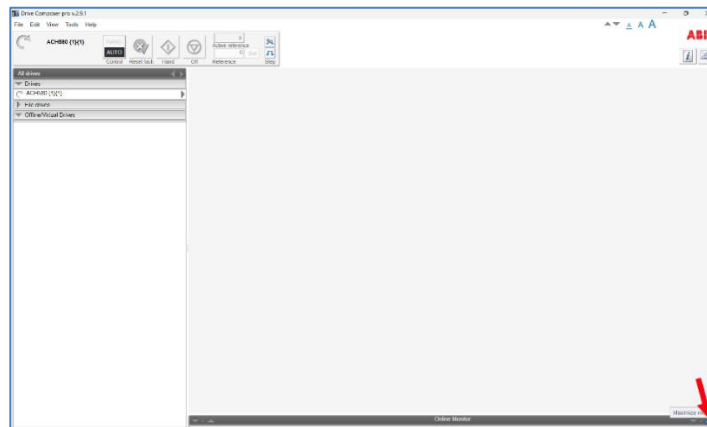
If there are starting issues with a PM motor, it may be necessary to monitor the drive during the autophasing and start process. This can be done using Drive Composer Entry or Drive Composer Pro. Drive Composer Entry can be downloaded for free to your PC at <https://new.abb.com/drives/software-tools/drive-composer>.

With the ACH180, an RJ45 to USB C or USB A adapter is required to connect the drive to the PC to use Drive Composer. With the ACH580, a USB mini to USB C or A adapter is required.

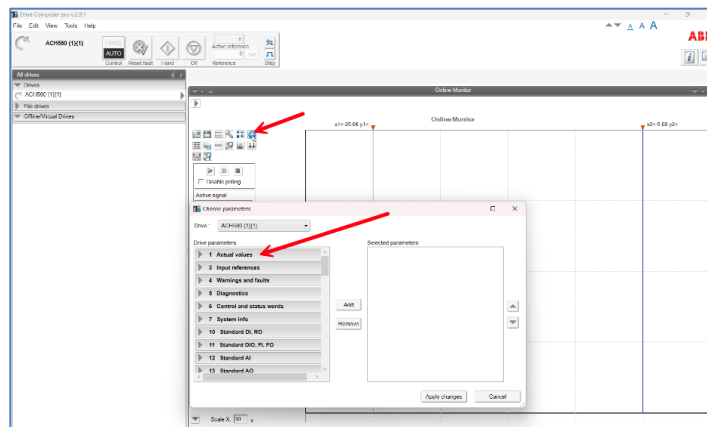


After downloading Drive Composer to your PC, use the cable to connect to your computer using the USB C or USB A, then connect to the ACH180 drive with RJ45. If connecting to the ACH580, use the USB C or USB A to connect to the computer, and connect the USB mini to the ACH580 control panel.

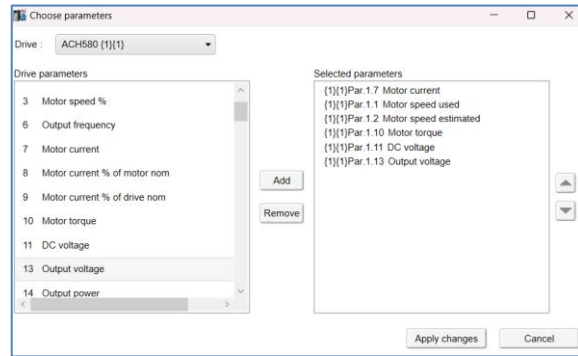
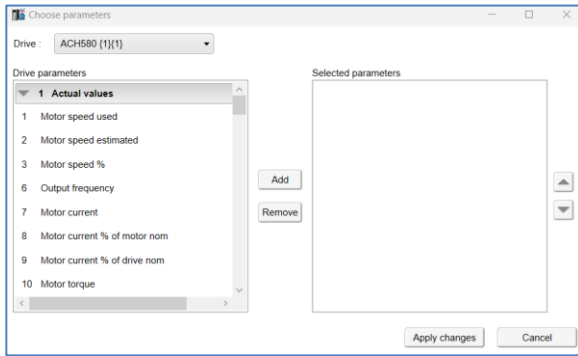
1. Open Drive Composer
2. Select the up arrow located in the bottom right corner.



3. After expanding the window, select the blue cross.



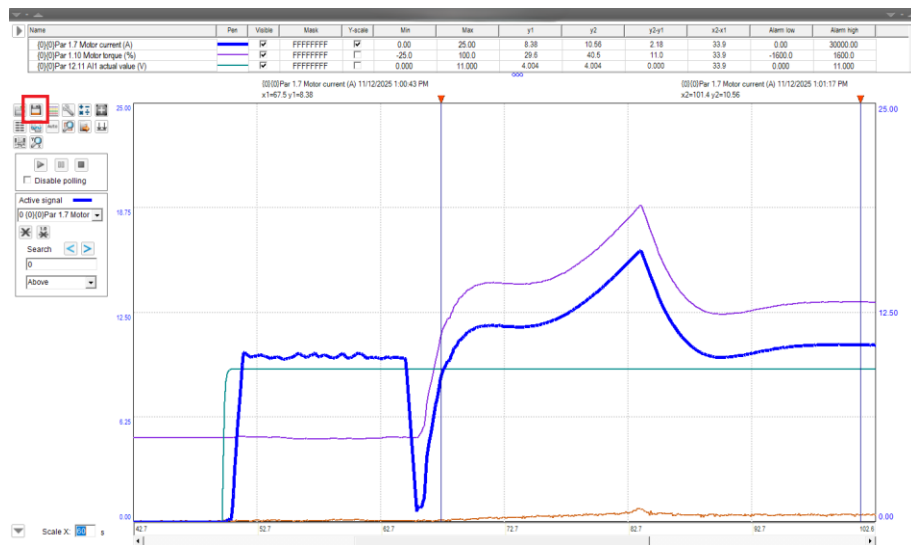
4. Highlight value and select add.



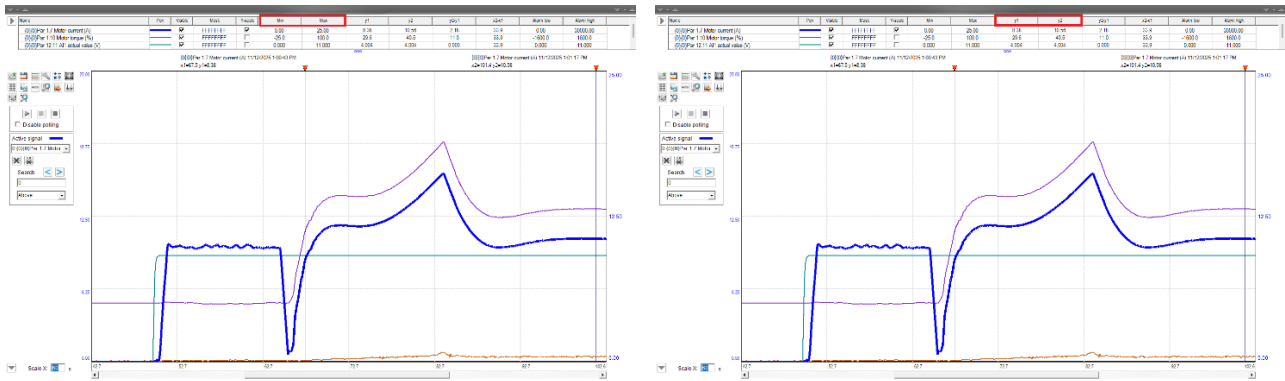
Example of values that might be used to trouble shooting a starting issue:

- *Motor speed estimated 1.02*
- *Motor current 01.07*
- *Motor torque 01.10*
- *DC Bus Voltage 01.11*
- *Output voltage 01.13*
- *Reference value – example: AI1 scaled value 12.11*
- *Flux actual % 1.24*
- *Udc ripple 97.135*

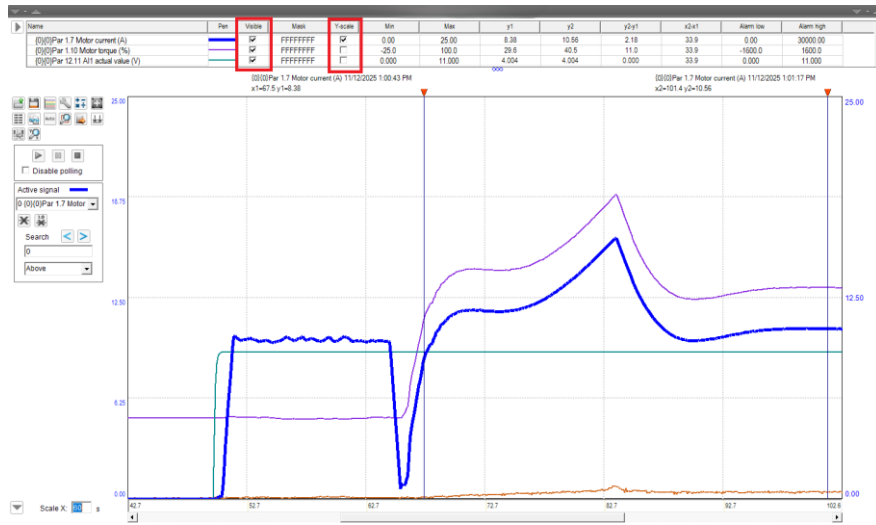
5. Start the monitor prior to starting up the drive. Manage the logging time to minimize the file size. Hit the stop button to the right of the start recording when done.
6. Save file to your desktop for analysis.



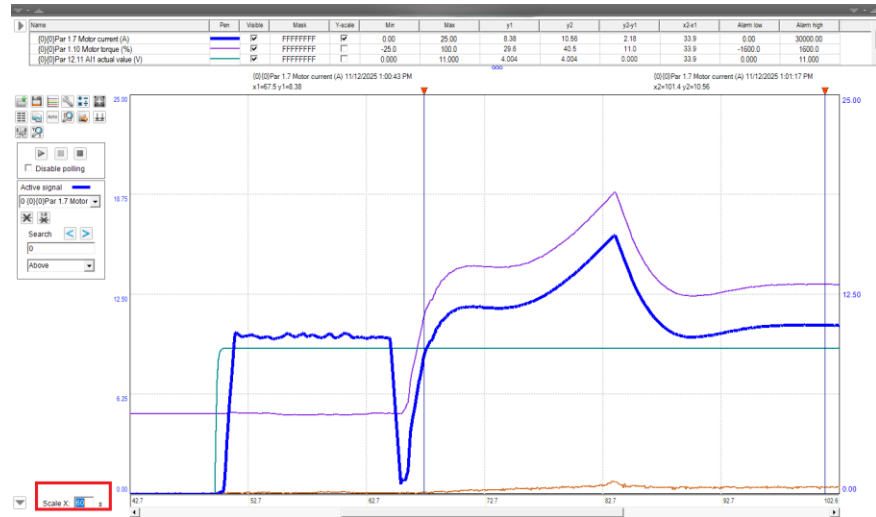
- To modify the view of the graph, select and adjust the minimum and maximum values displayed on the bar above the graph. It is suggested that you consider the recorded range values in y1 and y2.



- Select the values you want visible and the Y-scale you would like displayed.



- To modify the time frame displayed, select scale X selection on the bottom left of the screen. You can adjust the period you are viewing from 0 to 120 seconds. The example shown below is set at 60 seconds.



- To select the value displayed in the cursor reference, select drop down menu to the left of the graph and select the specific monitoring value. This allows for a more resolution on the value at specific points.

