



## Manual setting of the motionless start mode parameters


In absence of an absolute position sensor, the drive needs to align the motor with a known position. This alignment is mandatory for an optimal vector control, where the internal angle of the motor is kept at 90 degrees to ensure maximal torque generation with minimum current consumption.

The trouble with this alignment is that it is a “blind” movement. The drive can’t control or at least determine neither the direction of the movement, nor the travel length – it all depends on how far and on which side of the start position (phase A of motor) is the rotor (in case of rotary motors) or the moving parts (in case of linear motors) when this procedure takes place. The procedure consist of energizing the motor in such a way so that the rotor/coil is attracted to the aligned position in 2 steps (first aligned with phase B and then with phase A to eliminate the potential condition where the rotor/coil is exactly aligned with –A phase and might not move at all) and the drive is therefore waiting for a predefined time until taking the reading from the encoder as “zero angle” position. The wait time is usefully for cases where significant inertia is involved and it takes time for the moving part of the motor to stabilize on the new position.

The motionless start was developed to alleviate the main drawback of the standard motor start procedure (called pole lock, or phase finding, or initial alignment etc.) – the sudden uncontrolled movement. To do this, an angle controller is used and the notions of “stator” and “rotor” are reversed – instead of physically moving the rotor/coil to align with the stator, the drive moves the electromagnetic field generated on the stator to “find” the actual position of the rotor/coil, so that the rotor/coil moves as little as possible (some amount of movement is still needed, but compared to the pole lock maximum travel of 240 electrical degrees, here we speak only of a few electrical degrees). To avoid rotor/coil movement the information from the encoder is read and to react automatically on the rotor/coil position change a controller – the angle controller – is used. This is the reason why the motionless start method is slightly more complex in setup than any of the other methods available.

This document presents detailed steps on how to perform the manual tuning of the motionless start procedure, for the cases where the motionless tuning test included in EasyMotion Studio is not enough to get valid/reliable results.

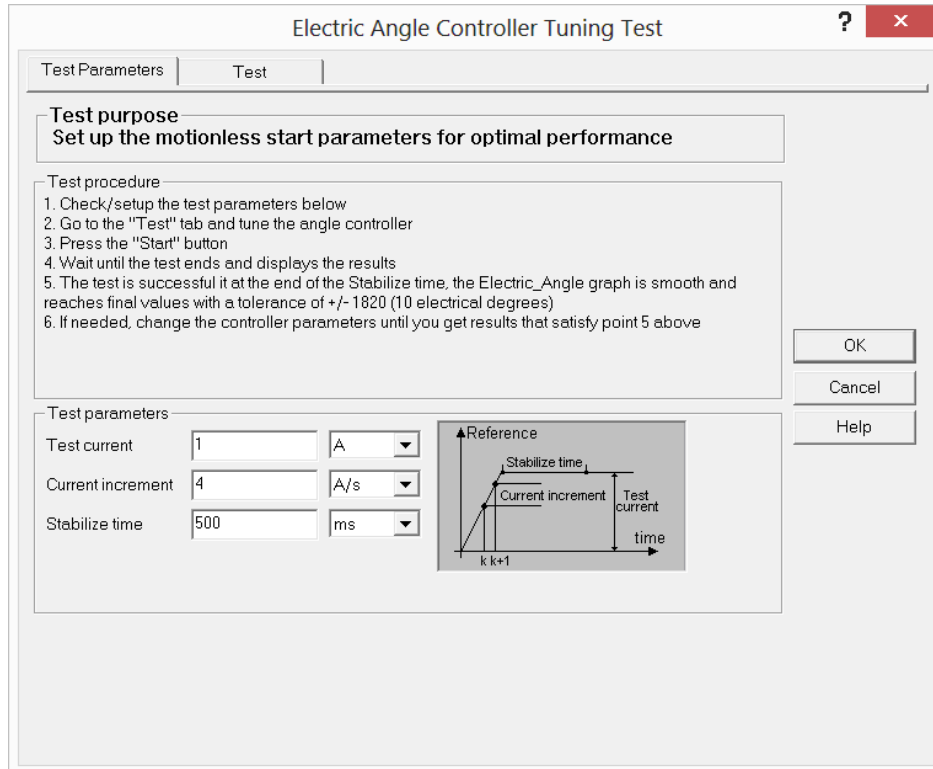
The manual tuning procedure will consist on repeated “live” motionless attempts and with the help of the logger tool, the motor behavior can be observed. Based on the readings both the angle controller  $K_p$  and  $K_i$  values and the motionless parameters are adjusted

<b>Created by</b> Alin Cristian Marin	<b>First edition</b> 18-Oct-19 10:43 AM	<b>Document template</b> P099.TQT.721.0003.10	<b>Verified by</b>	<b>Last edition</b> 18OCT2019	<b>Approved by</b>
 <b>TECHNOSOFT</b>		<b>Title of document</b> <b>P100 Manual setting of the motionless start mode parameters</b>		<b>N° document</b> <b>V181019-1</b> Page: 1 of 19	



## Step 1

The first thing to do is to set the drive for motionless start using the Electrical Angle Controller Tuning Test dialog. In this window we basically need to set the current used for the alignment itself (called "Test current"), the ramp of this current (called "Current increment") and as explained above, the stabilize time (called "Stabilize time").



In the picture above, the test current is set to 1 A, the ramp to 4 A/s and the stabilize time to 500 ms. These values have to be correlated with the parameters of the actual motor. In this case, a small rotary motor with 1 A nominal current, 1 pole pair and a 500 lines incremental encoder.

The **test current** should be equal with the nominal current of the motor. This will ensure that the motor can move, in case the nominal load is connected to the motor when it starts. Using a smaller current (and therefore less torque) might prevent the motionless start from working properly and it is especially important at this step (the beginning of the tuning) to be able to rely on the fact that the motor moves when energized (assuming not on a mechanical limit, case which will be handled in a special manner).

Usually the **current increment** can be set high so that the full torque is applied in a fast, step manner. This can help (especially in case of linear movements) with the static friction in the system. The current increment should not be changed during the tuning and afterward (changing too much this value might involve re-tuning the angle controller).

**Remark:** On the **2016031503** build of EasyMotion Studio version (and earlier) there's a scaling issue and the actual value used is 10 times higher.

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 2 of 19	



The **stabilize time** is the time that the drive waits (while torque is applied and angle controller is working) until reading and validating the motor/coil position. This parameter is application dependent (higher inertia, might imply higher stabilize times). In this case (small brushless motor with no load), 500 ms is more than enough.

Once the parameters are set, press “OK” and download the new setup to the drive (keep in mind that the purpose of this document is to treat the cases where the usage of the “Test” tab from the above picture is either not possible or doesn’t give valid results).

## Step 2

Next step is to compute the **START\_POS** and **FINAL\_POS** parameters for the motionless start procedure.

At the drive level, the motionless start procedure is the following:

1) Apply the set current with the set ramp (and an angle reference of zero degrees) and wait for the stabilize time (remember, the angle controller is active from the start). The stabilize time starts to flow from the moment the current has reached the imposed value (in other words, the ramp time is not part of the stabilize time).

2) Test the motor position, against the **START\_POS** parameter, to determine if the motor has moved or not. Although the user would like to have no movement at all on the motor, we still need to differentiate between the situation where the motor is exactly on the zero degrees case (and as such, theoretically no movement will occur) and where the zero degrees reference will result in the motor pushing against a mechanical limit, but not moving at all. From the motor displacement point of view, there is no movement all in both cases, but in the first case the alignment is perfect, on the second the alignment can be critically wrong. As such, the drive needs to see the motor moving a little (**START\_POS** defines this “a little” and is expressed in encoder counts) to make sure that the motor is actually getting aligned and is not stuck on a hard limit.

3) If above test fails (the motor has not moved), a new motionless procedure is started, with angle reference set to -90 electrical degrees instead of 0 degrees. After stabilize time elapses, the drive will check if the motor position is greater than **START\_POS**. If the motor position is smaller than **START\_POS** then the last motionless start try is initiated with a +90 electrical degrees reference. If this attempt fails to move the motor more than **START\_POS** then the drive will enter in fault state (MER.3 = 1, DER.11 = 1, SRH.15 = 1).

4) If the motor moves more than **START\_POS** during any of the attempts (0, -90 or +90 degrees) then the angle reference (0, -90 or +90) is updated (to take into account the motor position).

When the stabilize time elapses, the final condition is checked, against **FINAL\_POS**.


The check against **FINAL\_POS** is actually validating if the internal angle detection precision is within the desired limit.

The recommended starting values for **FINAL\_POS** and **START\_POS** are:

**FINAL\_POS** = 10 electrical degrees

**START\_POS** = 5 electrical degrees

Both **START\_POS** and **FINAL\_POS** are expressed in encoder counts (internal units). In order to determine their correct value, it is important to know the number of motor pole pairs and the number of encoder lines, for rotary motors and the magnetic pole pitch and the encoder resolution, for linear motors.

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
 <b>TECHNOSOFT</b>		<b>Title of document</b> <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 3 of 19	



In case of rotary motors the START\_POS and FINAL\_POS are computed as follows.

$$\text{Electrical angle [encoder counts]} = 4 \times \text{number of lines} / (360 \times \text{number of pole pairs}) \times \text{electrical angle [degrees]}$$

The motor used for this paper has 1 pole pair and an encoder with 500 lines. Hence, the values of FINAL POS and START POS are:

$$\text{FINAL\_POS [encoder counts]} = 500 \times 4 / (360 \times 1) \times 10 \text{ [electrical degrees]} = 55.55$$

**FINAL\_POS = 56**

$$\text{START\_POS [encoder counts]} = 500 \times 4 / (360 \times 1) \times 5 \text{ [electrical degrees]} = 27.77$$

**START\_POS = 28**

For a linear motor, the magnetic pitch represents 360 electrical degrees and the encoder resolution is exactly the internal unit for encoder counts.

$$\text{Electrical angle [encoder counts]} = \text{magnetic\_pole\_pitch} / \text{encoder resolution} / 360 \times \text{electrical angle [degrees]}$$

For example a linear motor with 18mm magnetic pole pitch equipped with a 1um resolution encoder, will have 18000 (1mm = 1000um) encoder counts for 360 electrical degrees and as such FINAL\_POS will be 18000 / 360 x 10 = 500 and START\_POS 18000 / 360 x 5 = 250.

### Step 3

Before starting the actual tests in EasyMotion Studio the following steps are needed.

1) Ensure that the AUTORUN is disabled (for EtherCAT version skip this step) by either selecting the CANOpen mode or by writing value 1 at address 0x4000 using the Memory window ("View | Memory").

Address	Data							
4000	0001	23BF	4011	2398	4009	74C0	09C0	4009
4008	0404	5A57	FFFF	8000	0020	7484	02FB	400D
4010	0102	24A2	0000	0001	24A0	0000	03E8	249E
4018	0000	8000	5909	DFFF	0000	5909	BFC1	8701
4020	5909	FFFF	4000	0108	700F	0408	0001	0000

2) Reset the drive (remember that earlier, after we had setup the current and stabilize time, we downloaded the setup to the drive – this reset is required to activate the last configuration downloaded on the drive set the drive to use motionless start at power on/reset).

3) Prepare the Logger to record the APOS and IQ variables and set the sampling time such that the record time is at least 3 times the stabilize time (for a 500 ms stabilize time the record time is at least 1500 ms).

**Remark:** The memory space reserved for the logger depends on the drive. So, if there is enough RAM memory the IQREF and MOVESTATE variables can be also recorded.

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 4 of 19	



The APOS variable contains the motor position (change the default measurement unit from "rot" to IU). The IQ variable is the motor current and the IQREF variable contains the motor current reference. In this case an 1 A current level with a ramp of 25ms will be plotted (remember 1A final value, 4 A/s ramp, wrong scaling in ESM gives an actual of 40A/s which means 1A will be reached after 25ms).

The MOVESTATE variable is the indicator that shows the moment when the START\_POS condition is satisfied (the drive has determined that the motor has moved enough and as such it is not stuck or pushing against a hard limit).

4) Enable the Logger during motionless start procedure

4.1. Check the value of the OSR register.

**Remark:** The OSR register value can be requested in Command Interpreter window with the „?OSR;” command.

```

Command Interpreter
TML>
TML>
TML>
TML>
TML>
TML>
TML>
TML> ?osr
OSR (uint@0x0302) = 24726 (0x6096)
TML>
  
```

4.2 Set OSR.11 to enable the Logger during start. In this case the new value of OSR is 0x6896. Type `OSR = 0x6896;` in Command Interpreter and press ENTER.

4.3 Save the new value of OSR by sending the `SAVE` command to the drive.

4.4. Reset the drive to activate the new value of OSR register with Application | Reset menu command.

```

Command Interpreter
OSR (uint@0x0302) = 24726 (0x6096)
TML> OSR = 0x6896;
TML> save
TML> reset
TML> ?osr
OSR (uint@0x0302) = 26774 (0x6896)
TML>
  
```

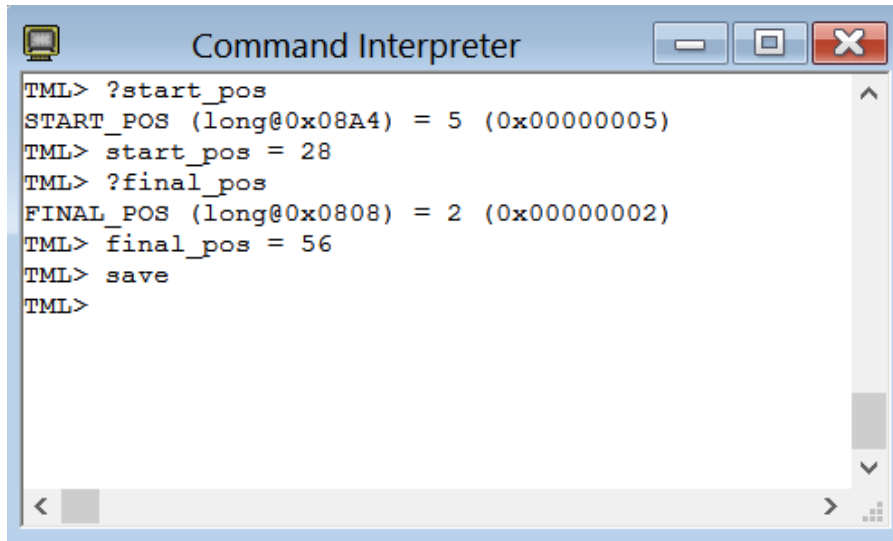
Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 5 of 19	



It is very important that from this moment on (during the tuning) to not open the drive setup window anymore (or download the setup to the drive).

If the drive/motor setup dialogs are opened, then even if these are closed with CANCEL button, EasyMotion Studio will compute a checksum of the parameters and it will request to download the new configuration before running the TML program. The parameters changed during the tuning will be saved with the SAVE command from command interpreter. At the end of the tuning procedure the parameters will be uploaded in EasyMotion Studio project.

5) Set the values of START\_POS and FINAL\_POS and save them.



**Remark:** Don't forget the "SAVE;" command, to store these parameters to the drive's EEPROM memory.

6) Reset the parameters of the angle controller. This can be done by writing zero in the following parameters: KPTHT, SFTKPTHT, KITHT and SFTKITHT followed by the SAVE instruction.

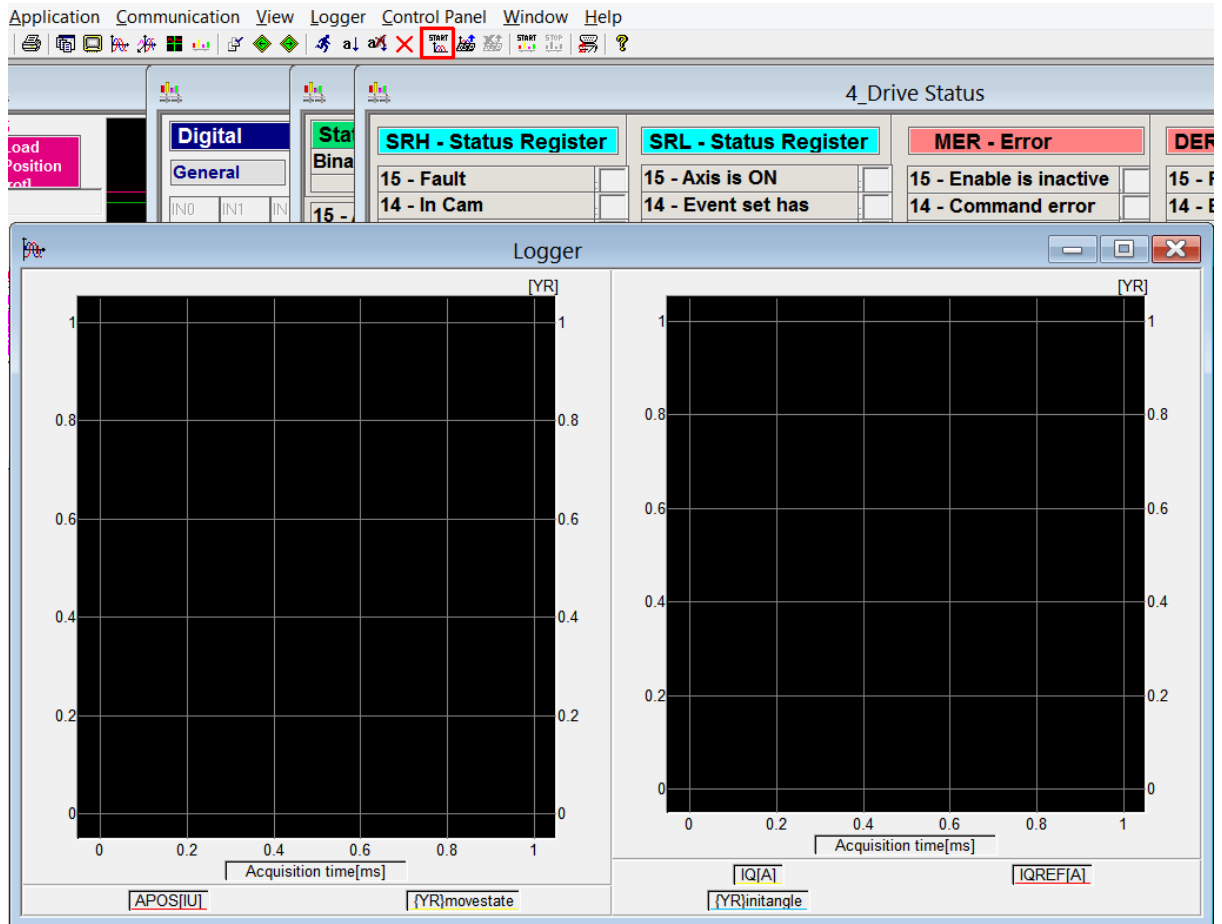
### Step 4

At this step everything is ready for the actual tuning process (which as explained is a repetitive process).

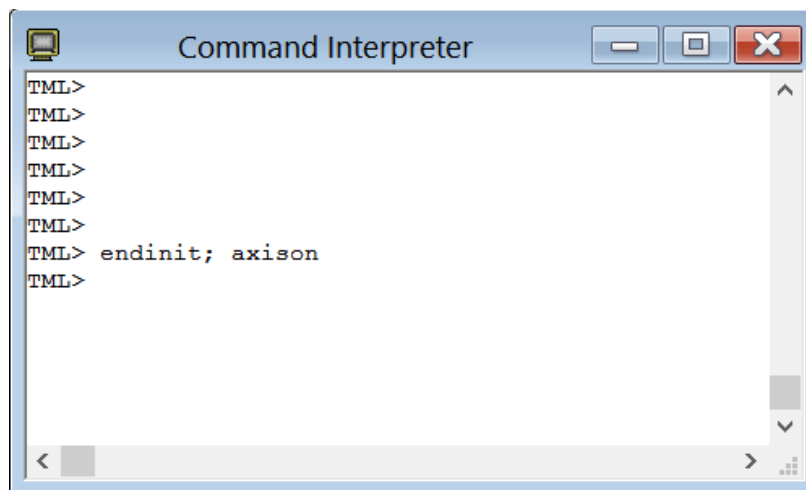
Each pass of the tuning process consists of the following (done after the drive reset in this order):

1) Select the logger and press START button (the logger will not record anything yet because the drive is not in AXISON state yet, but the recording will start as soon as the drive starts the motionless procedure).

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 6 of 19	

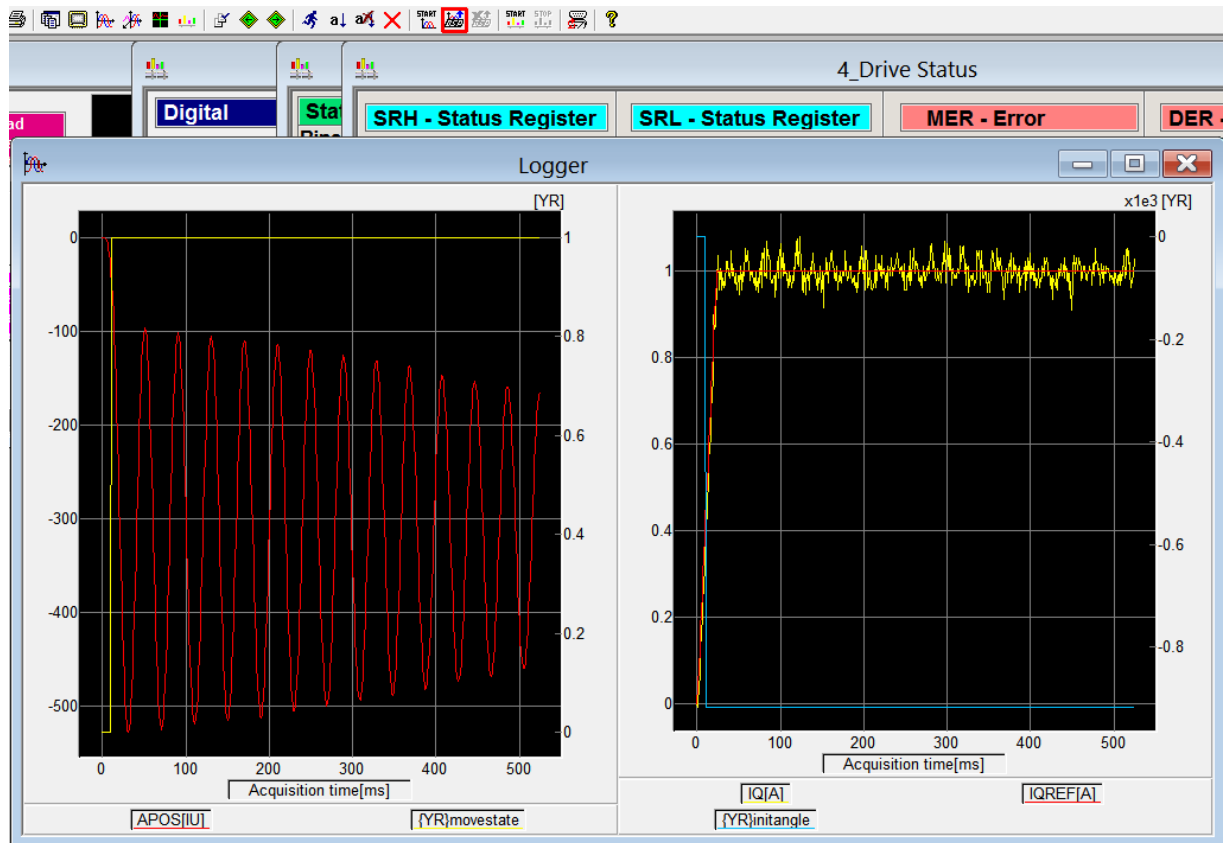


Type: "ENDINIT; AXISON;" in Command Interpreter, to trigger the motionless start on the drive.

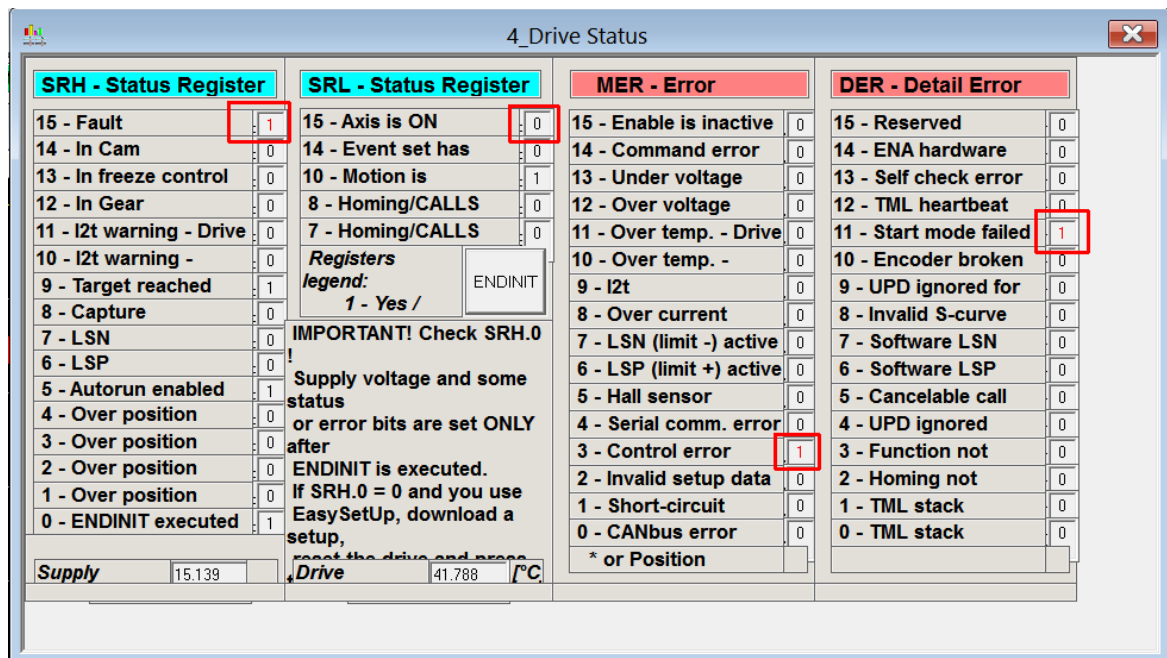


Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 7 of 19	


3) Go to the logger and press upload button to get the results.



**Remark:** Alternatively you can start the control panels and check the drive status



SRH - Status Register	SRL - Status Register	MER - Error	DER - Detail Error
15 - Fault: 1	15 - Axis is ON: 0	15 - Enable is inactive: 0	15 - Reserved: 0
14 - In Cam: 0	14 - Event set has: 0	14 - Command error: 0	14 - ENA hardware: 0
13 - In freeze control: 0	10 - Motion is: 1	13 - Under voltage: 0	13 - Self check error: 0
12 - In Gear: 0	8 - Homing/CALLS: 0	12 - Over voltage: 0	12 - TML heartbeat: 0
11 - I2t warning - Drive: 0	7 - Homing/CALLS: 0	11 - Over temp. - Drive: 0	11 - Start mode failed: 1
10 - I2t warning - : 0	Registers legend: ENDINIT	10 - Over temp. - : 0	10 - Encoder broken: 0
9 - Target reached: 1	IMPORTANT! Check SRH.0	9 - I2t: 0	9 - UPD ignored for: 0
8 - Capture: 0	Supply voltage and some status or error bits are set ONLY after	8 - Over current: 0	8 - Invalid S-curve: 0
7 - LSN: 0	ENDINIT is executed. If SRH.0 = 0 and you use EasySetUp, download a setup, reset the drive and press	7 - LSN (limit -) active: 0	7 - Software LSN: 0
6 - LSP: 0	Drive	6 - LSP (limit +) active: 0	6 - Software LSP: 0
5 - Autorun enabled: 1		5 - Hall sensor: 0	5 - Cancelable call: 0
4 - Over position: 0		4 - Serial comm. error: 0	4 - UPD ignored: 0
3 - Over position: 0		3 - Control error: 1	3 - Function not: 0
2 - Over position: 0		2 - Invalid setup data: 0	2 - Homing not: 0
1 - Over position: 0		1 - Short-circuit: 0	1 - TML stack: 0
0 - ENDINIT executed: 1		0 - CANbus error: 0	0 - TML stack: 0

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
 <b>TECHNOSOFT</b>		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 8 of 19	





The motionless start had failed after the first start because the angle controller was basically deactivated when its parameters were set to zero.

4) Adjust the angle controller parameters, execute SAVE command and then reset the drive thus preparing the new manual tuning pass.

The target of the tuning process is to find a set of parameters, for the angle controller, that will get the motor to move at least the START\_POS (28 encoder counts, in this case) and then stabilize (inside those 500ms defined) to a value which is less than +/- FINAL\_POS (56 encoder counts, in this case) around the first recorded value of APOS, that was higher or equal than START\_POS, for any given start position.

It is important to understand that every time the drive is reset and the "ENDINIT; AXISON" command line is sent, the same motionless procedure will be executed, which results in applying the same angle reference. This means, that even if the electrical angle controller parameters are not correct, given enough iterations, it is very likely that at a point the procedure will be executed correctly (with each failed start attempt, the motor actually gets closer and closer to the required position). This why it is strongly recommended to manually change the motor starting position, when a good considered set of parameters are found, and see that the drive acts properly even the angle controller is exposed to different starting conditions.

Keep also in mind that these "different starting conditions" are relative to the electrical revolution/magnetic pitch. For the 1 poles pair motor in this example, this means the rotor is manually moved to different positions (reference to an arbitrary rotor position: 0 rot, 1/4 rot, 1/2 rot and 3/4 rot).

**Remark:** For the 18 mm magnetic pitch motor, given as example in the pages above, this means that the coil position should be marked when the motionless start is succeeded for the first time and then move the coil 9 mm away (positive or negative), then move it 3.5 mm away (on the next try) and so on. Beside this "middle movement" tests, also move the motor to each of the mechanical limits (if present) to see if the motor is still starting correctly.

Returning to the angle controller, it is a PI controller with the proportional part defined by the KPTHT and SFTKPTHT parameters and the integral part defined by the KITHT and SFTKITHT parameters.

$$Kp = KPTHT/32767 * 2^SFTKPTHT$$
$$Ki = KITHT/32767 * 2^SFTKITHT$$

- KPTHT and KITHT can go from 0 to 32767, only positive integers.
- SFTKPTHT and SFTKITHT can go from 0 to 14, only positive integers.

For the tuning beginning, the KPTHT and FTKPTHT parameters will be set to 0, and then the KPTHT parameter will be slovenly increased.

**Remark:** If by setting the KPTHT parameter to 32767 is still not enough, the SFTKPTHT will be increased one unit at a time. At some point should be visible that there's simply too much proportional part. At that moment start to reduce KPTHT (while keeping the last SFTKPTHT value in place) until a good answer will be received.

The same idea applies for the KITHT and SFTKITHT (with the remark, that the integral part shouldn't be too high)

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 9 of 19	



## Tuning tips

1. The first run (with KPTH = KITHT = 0) gives a good impression on the “natural” system response to the torque reference. The angle controller is not active so the motor (being subjected all of a sudden to a nominal torque step), depending on its position, will oscillate more or less until will stabilize on that position.

**Remark:** At this step the recorded oscillations may be very high (amplitude of ~600 IU, more than ¼ of revolution). This means, that the start was made from a “good position”. The motor is actually quite far away from the starting angle (0 degrees) and as such doing the tuning starting from this position will require from the start reliable proportional and integral. That will also have the advantage that repeating the tests with different starting positions, there will be good change to don't have to change the parameters again.

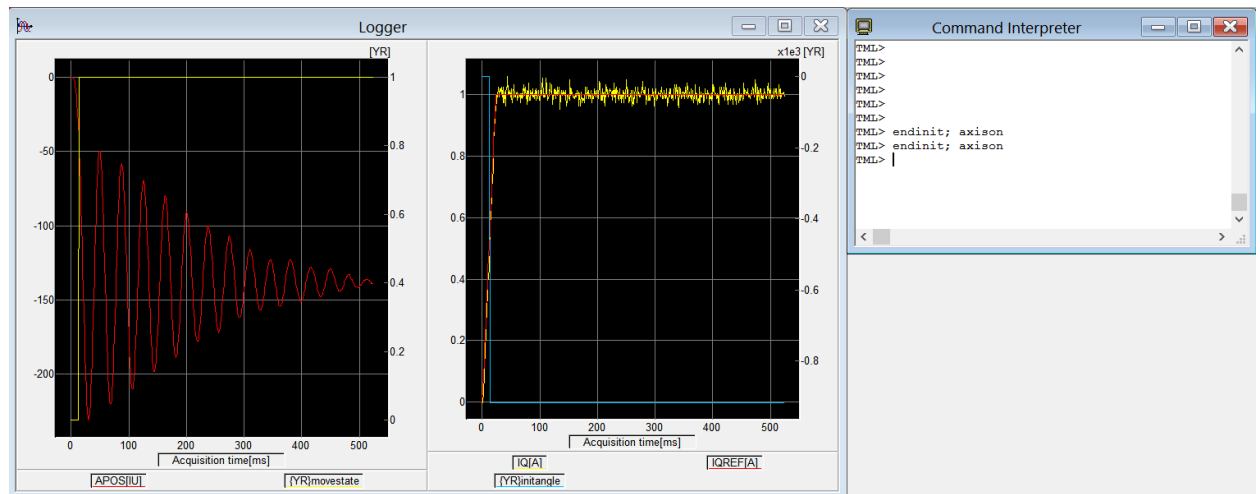
2. Repeat the tuning process by increasing only the proportional part until an answer like a step response of a P type controller (the motor jumps toward the imposed position, but doesn't quite reach it due to the lack of the integral part, but instead has high frequency vibrations) is returned.

At this point very little integral part can be added too, to see if the answer gets inside the required band.

The frequency of the vibrations has no meaning from the tuning point of view – it something that only the customer can decide if is acceptable for its application or not.

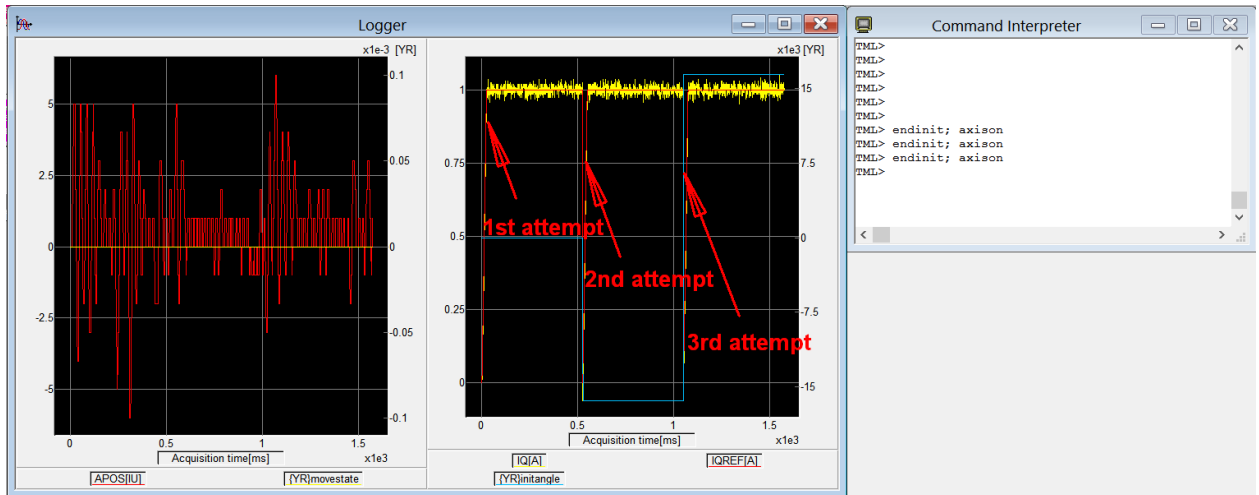
The graphs below shows some intermediate results of the tuning, for the mentioned motor (small BLDC rotary motor, 1 A, 1 pole pair, 500 encoder lines, no load), to give an idea of the process.

Repeating the same start (KPTH = KITHT = 0) for two times the oscillations will be much reduced due to the fact that the motor was actually closer to the imposed position (as a result of the first try).



Third repeat of the same start (KPTH = KITHT = 0 and motor was not moved externally) will not cause any deviation of the motor position, when torque is applied (deviation amplitude +/- 10 encoder counts – less than 0.005 rot), because the motor was very closely aligned with the required position.

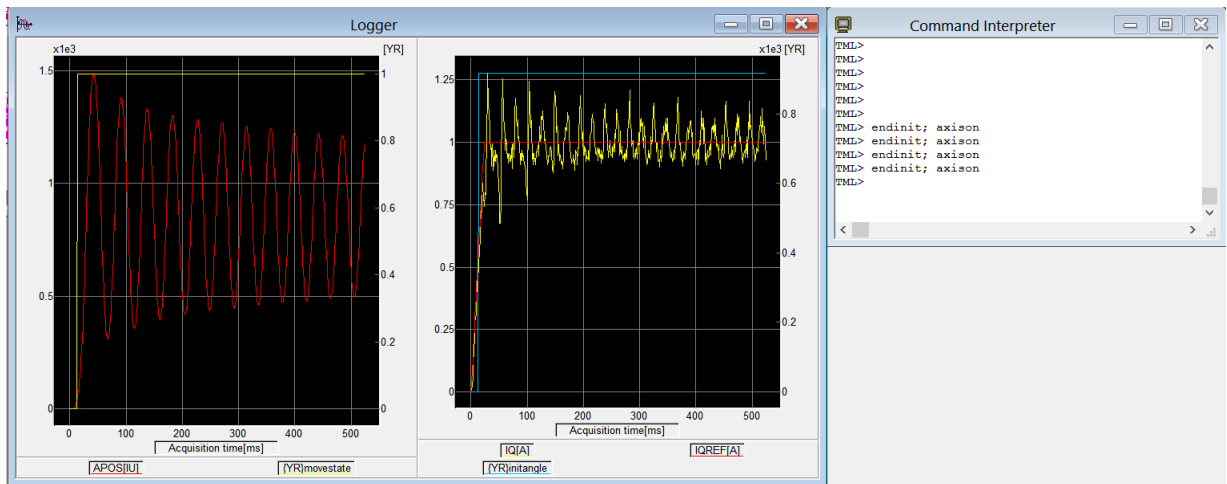
Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 10 of 19	



The procedure is also executed in ~1.5 ms (3x500ms), not ~500 ms as in the first 2 cases. This is happening due to the fact the START\_POS condition is not met. The detected motor movement is less than 28 IU and the drive considers that the motor is on the hard limit (the yellow line, MOVESTATE, from the left graph remains on 0 all the time). As a result, the drive changes the angle reference to -90 degree but the procedure fails again, so the angle reference is set to +90 degree movement. The blue line (INITANGLE) shows these 3 angle values (0 degrees, -90 degrees and +90 degrees).

In this case the motionless start was failed, but the given diagnostic will be: “motor stuck” (START\_POS failed 3 times).

At this point the mechanical position of the rotor was marked and then it was moved by hand with 180 degrees away (worst case possible – farthest possible distance from the alignment angle) and the test was repeated.

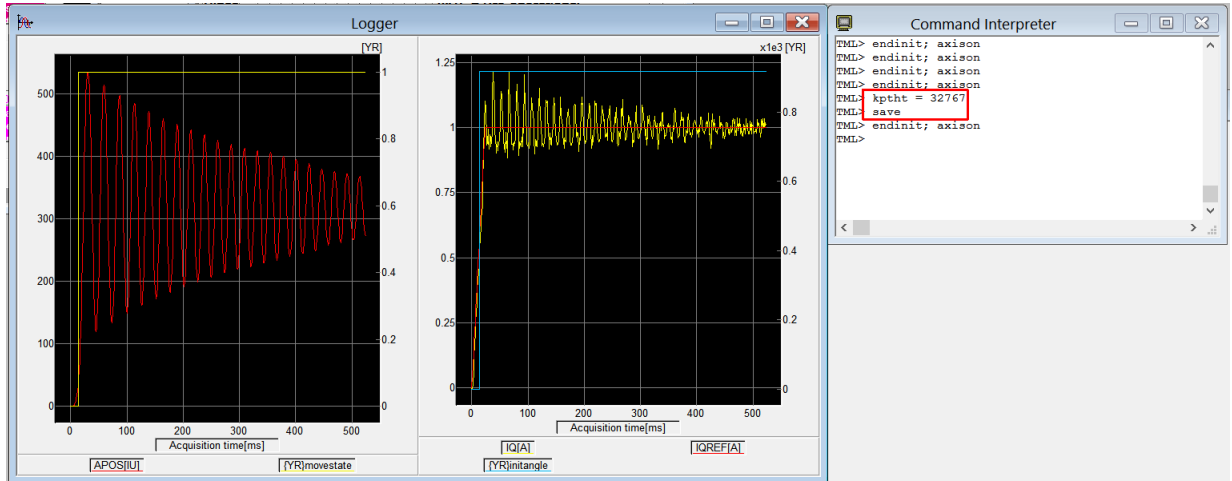


The KPTHT and KITHT parameters are still 0 so, as expected, a maximum amplitude on the oscillations is recorded (1500IU = 3/4 revs).

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 11 of 19	



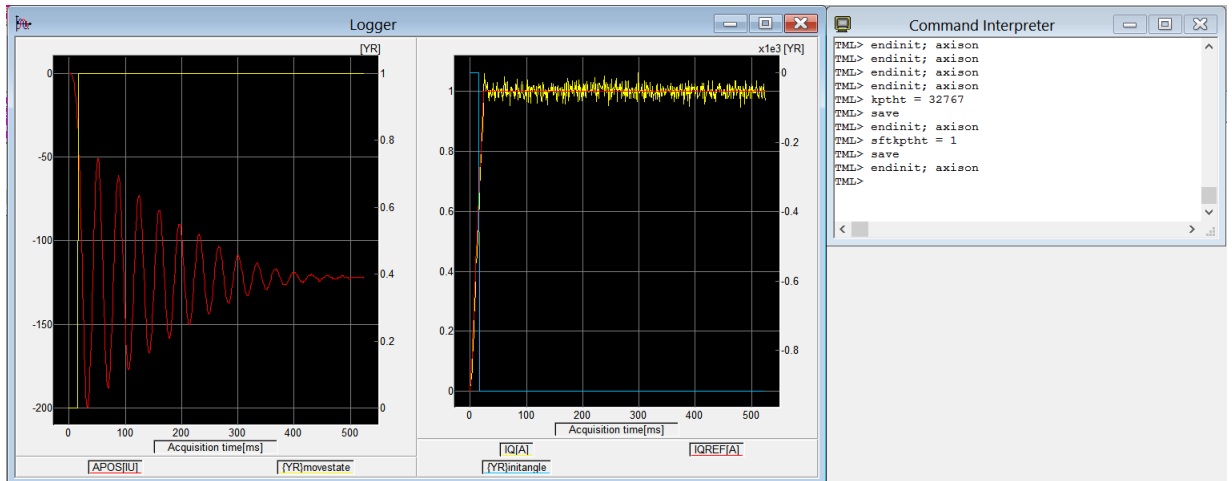
To get the most robust tuning parameters from the first tuning session, the motor will be moved again (manually) to the worst starting position and some proportional gain will be added to the angle controller: "KPTH = 32767; SAVE;".



The test is still failing because the FINAL\_POS = 56 condition is not met. The motor position was around 300 IU (when the stabilize time expired), which is outside the +/-56 IU around something close to 28 IU.

On the other hand, the presence of the angle controller is now visible. The amplitude of the oscillations wasn't that higher anymore (1500 IU).

The motor is repositioned (by hand) to the worst position and before doing the test, the proportional part of the angle controller is increased by setting the SFTKPTH to 1;

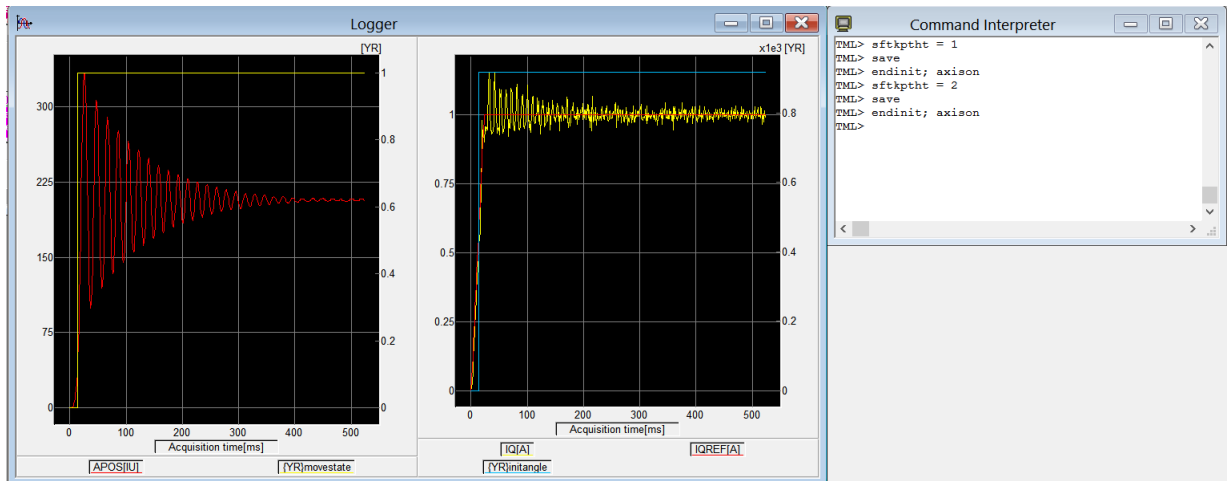


By sending the "SFTKPTH = 1; SAVE;" command to the drive, the proportional effect was doubled. Due to this there's smaller amplitude and stronger oscillation decay. It was actually almost fully stable at the end of those 500 ms, but of course the FINAL\_POS condition failed. The motor has also moved in the negative direction. This is another nice indication that the motor is positioned on the worst case scenario (exactly opposite to the reference angle). So, it might go left or right with the same probability.

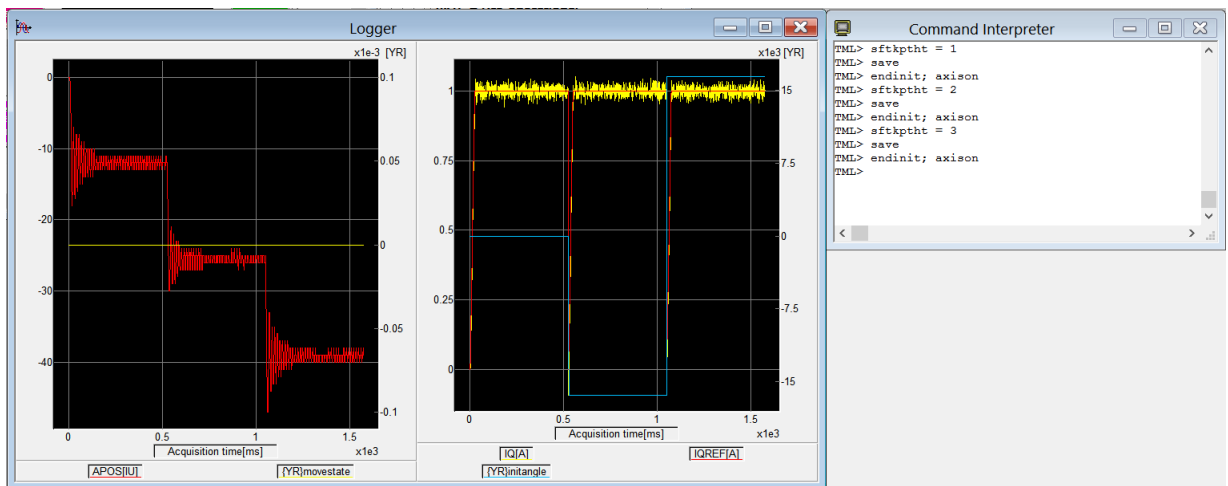
Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 12 of 19	



For the next iteration, the SFTKPTHT parameter is increased to 2.



As a result, the frequency of the oscillations has increased, but the motor still stabilizes, so for the next test the proportional part will be increased again (“SFTKPTHT=3;”).



Following the increase of the proportional part (KPTHT=32767 and SFTKPTHT=3) the results seems very good. There are very small amplitude and very high frequency oscillations. The stabilize time is also small (only 150 ms, till self sustained oscillations) and the self sustained oscillations area (from 150ms up to ~500ms) is very small in amplitude. A logger zoom will show that the motor is doing +/-1IU around the value -12IU) and very “stable”.

This is good indication that the drive has found a good electromagnetic position for the stator field that is matching very close (+/-1IU) the actual motor position.

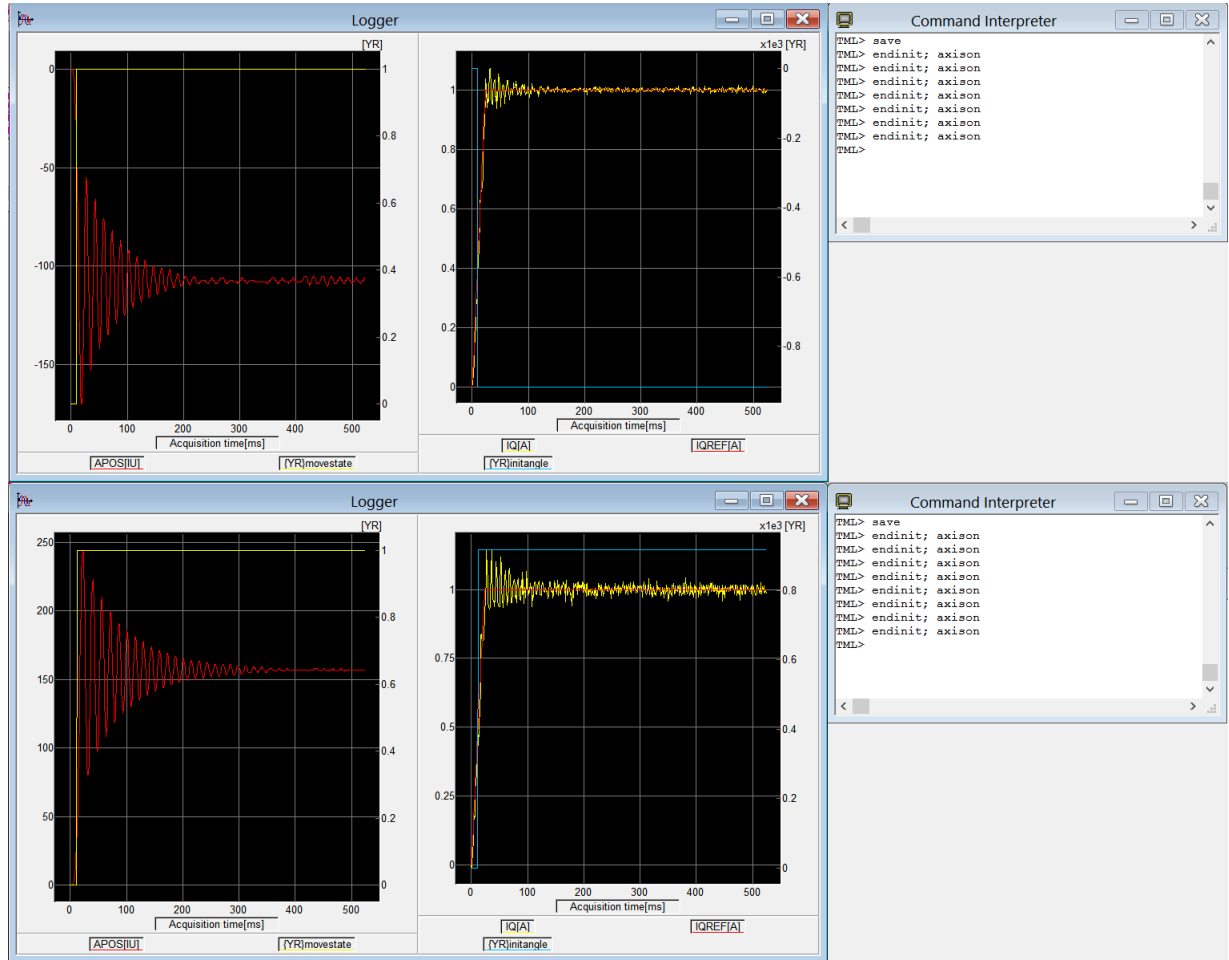
It's also very important to notice that now the drive didn't detected any motor movement (START\_POS=28 IU), but beside the previous situation, the angle controller is now active and it is doing its job very well (at least for this starting position). Our initial setting for START\_POS appears to be too relaxed.

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 13 of 19	

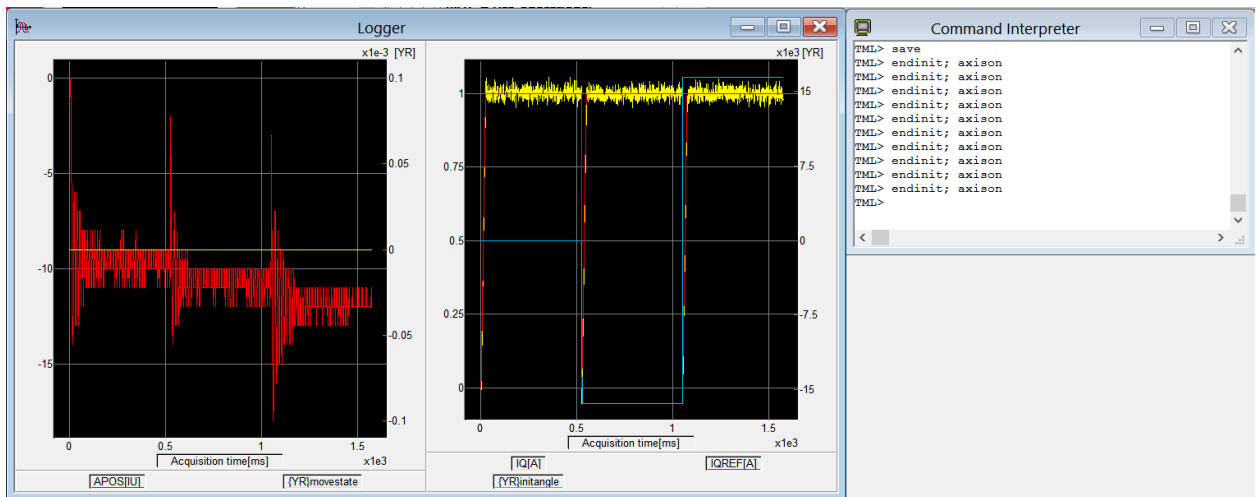
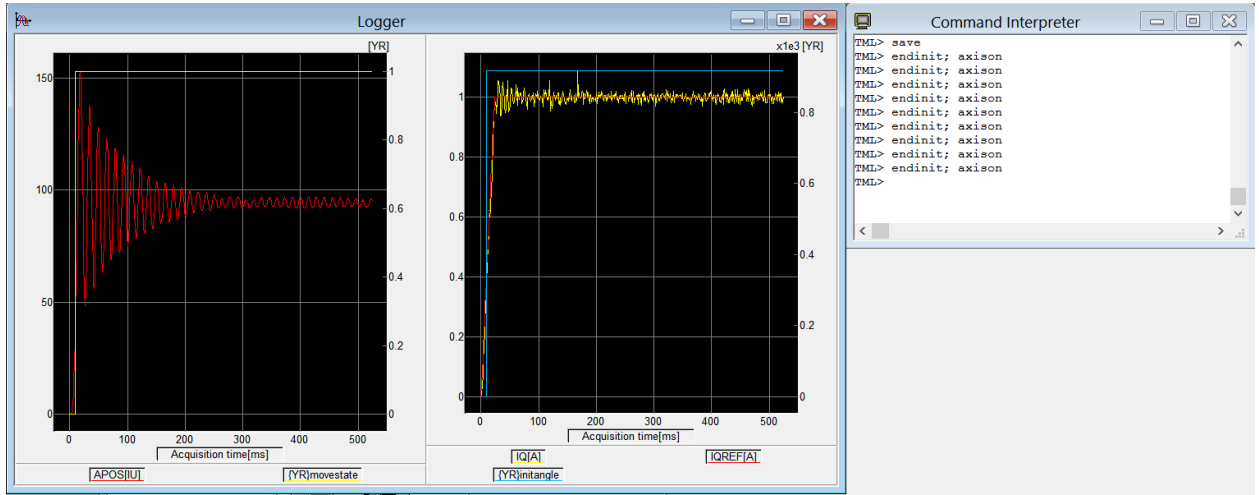


This test shows that the angle controller can limit the motor movement to less than 5 electrical degrees as was previously allowed (from the moment the motor is energized until the electrical angle controller matches the rotor/coil electromagnetic position, the displacement of the motor is less than 5 degrees (28IU) for all the 3 attempts).

However, it's recommended that before changing the START\_POS parameter to repeat the test (with the same angle controller parameters) from different motor starting positions and see if similar results will be obtained.



Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 14 of 19	



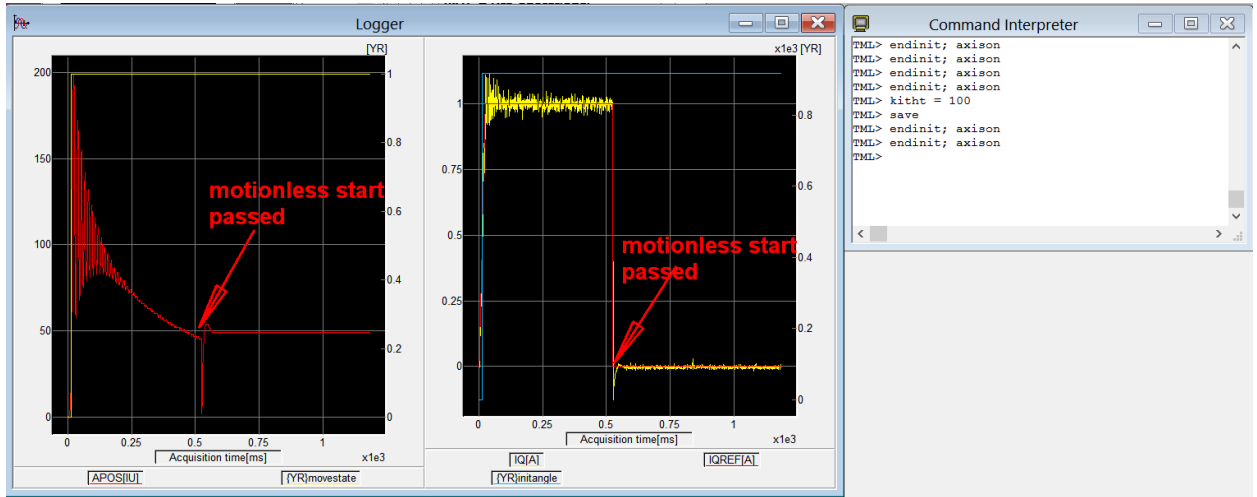
In the four tests above the motor start position was manually changed to 1/4, 2/4, 3/4 and 4/4 (basically a repeat of the initial positioning).

Now the tuning worked well for the “worst initial position” (180 degrees away from the imposed starting angle) but not so good for the other positions where the motor movement is detected but the FINAL\_POS condition is not bet.

There’s good news too. Similar behaviors (oscillation frequency / oscillation decay / time and shape / stabilized oscillations) are noticed on almost all the tries.

At this moment some integral part can be also added in an effort to get the motor position to be “pushed” inside the allowed band (FINAL\_POS).

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 15 of 19	

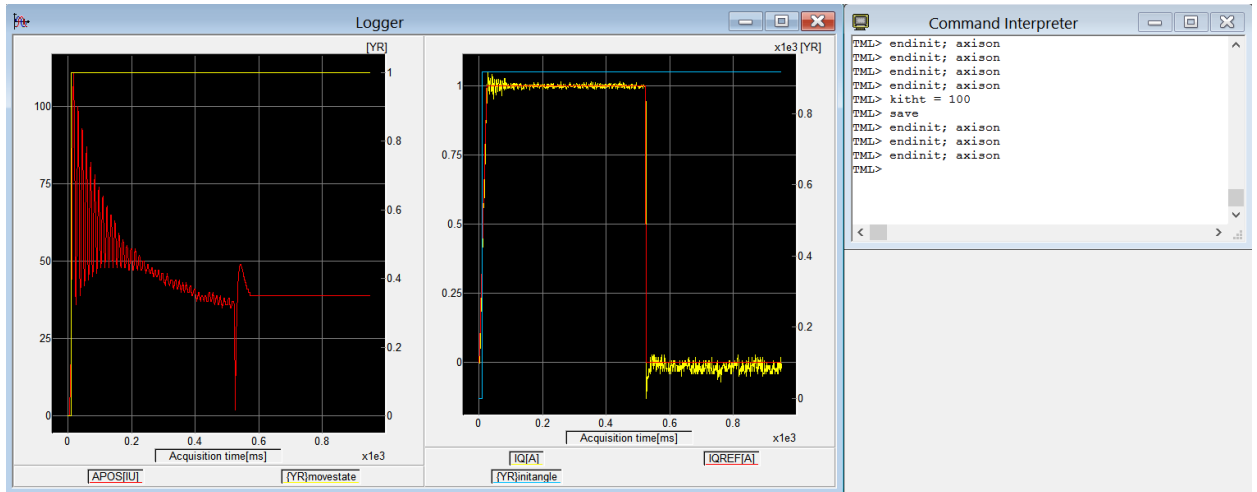


The picture above was obtained for  $KITHT=100$  and  $SFTKITHT=0$ .  
 The starting point was the initial position (worst case) was already got a valid motionless start.

The integral effect is also visible in the picture above. The stabilized oscillations no longer remain close to the middle of the peak amplitude. They are “pulled” closer to  $START\_POS$  condition.

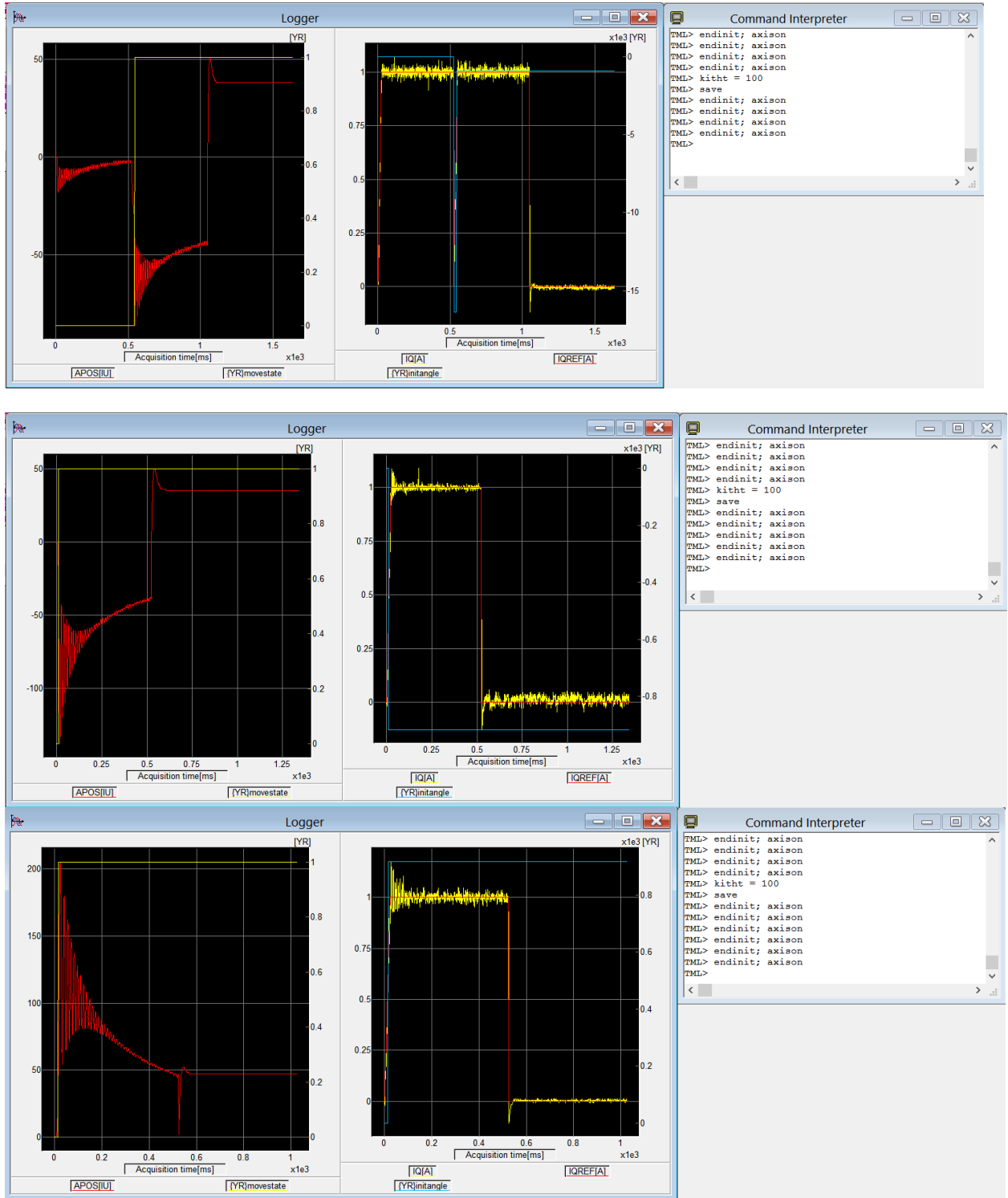
The fact that the current was switched off after the 500ms (right graph) shows that the start mode was succeeded. Both the  $START\_POS$  and  $FINAL\_POS$  conditions were passed.

To see if the angle controlled reacts properly, the test will be repeated from different motor positions.



Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 16 of 19	





As in case of the previous tests, the 4 tries were done with an initial positioning of 1/2, 2/4, 3/4 and 4/4 and all of them have successfully passed the starting conditions.

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 17 of 19	



It is worth to notice that in the 2<sup>nd</sup> test, the drive had to do a retry because on the first start, the motor displacement was lower than START\_POS and the drive considered that the motor hasn't moved. On the second attempt the displacement was high enough and the test was successfully ended.

Since the results returned by the last tests were good we can be considered that the motionless configuration and tuning is done properly.

As a recap, the used parameters are: 1 A current step with 4 A/s current ramp, 500 ms stabilize time, START\_POS=28 (5 electrical degrees), FINAL\_POS=56 (10 electrical degrees), KPTHT=32767, SFTKPTHT=3, KITHT=100 and SFTKITHT=0

**Remark:** The OSR register value is not needed and as a matter of fact, OSR should be returned to its original value in order not to interfere with the loggings of the position profiles.

### Step 5

The last step, to finish with the motion less starting parameters setting, is to put the values above inside the EasyMotion Studio project (the SAVE command used above, just stores the parameters at the drive level).

For the moment, the safest way to do this is to add them manually inside the "parameters.cfg" file from the current project folder, after the project was saved and closed.

The current project folder is located in the EasyMotion Studio install folder. By default it is located on "C:\Program Files\Technosoft\ESM\Projects\".

The "paramters.cfg" file will be present inside the project folder. It can be open using any text editor (Notepad, for example) and the START\_POS, FINAL\_POS, KPTHT, KITHT, SFTKPTHT and SFTKITHT parameters values can be adjusted manually according to the values obtained following the tests above.

Search also for a parameter named FINAL\_POS\_HALLFILT and if present set it with the same value as FINAL\_POS (if this parameter is present, it must be set otherwise the drive will have wrong value for FINAL\_POS)

**Remark:** The hex values are not mandatory. It's enough to put the decimal value (see the example in the picture below).

```

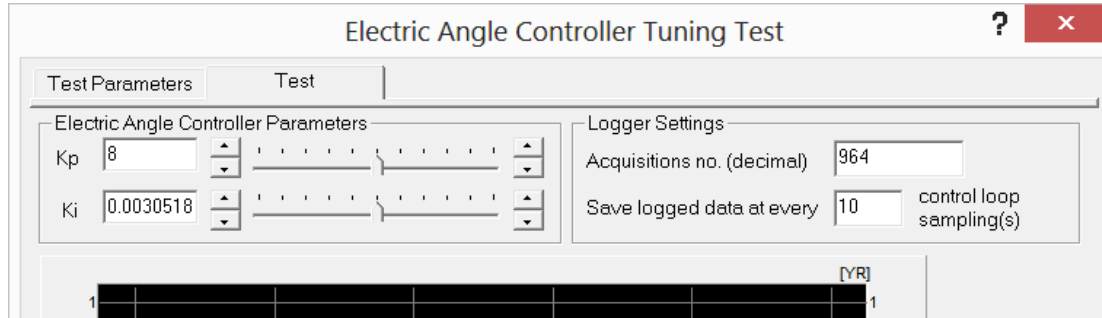
parameters - Notepad
File Edit Format View Help
INT isSpeedEstimator @0xC0B0 =1(0x0001) >0(0x0000) <1(0x0001)
INT MAX_CURRENT [A] @0x089B =1 >0 <1
INT KPTHT @0x0892 =32767
INT KITHT @0x0893 =100
INT SFTKPTHT @0x0894 =3
INT SFTKITHT @0x0895 =0
FIXED FILT_A @0x089E =0.99001(0x0000FD71) >0(0x00000000) <1(0x00010000)
FIXED FILT_B @0x08A0 =0.00999(0x0000028F) >0(0x00000000) <1(0x00010000)
UINT TIME_LIMIT [ms] @0x0896 =5e+002
INT REF_INC [A/s] @0x0888 =4.2735 >0
LONG START_POS @0x08A4 =28
FIXED Kp_T_scl @0xC095 =2(0x00020000) >0(0x00000000) <16384(0x40000000) %5
FIXED Ki_T_scl @0xC096 =0.005(0x00000148) >0(0x00000000) <16384(0x40000000) %5
INT SamplingRate @0xC097 =10(0x000A) >0(0x0000) <100(0x0064)
INT AquisitionsNo @0xC098 =964(0x03C4) >0(0x0000) <964(0x03C4)

```

Created by Alin Cristian Marin	First edition 18-Oct-19 10:43 AM	Document template P099.TQT.721.0003.10	Verified by	Last edition 18OCT2019	Approved by
TECHNOSOFT		Title of document <b>P100 Manual setting of the motionless start mode parameters</b>		N° document <b>V181019-1</b> Page: 18 of 19	



After the new parameters are inserted, the file should be saved. Now the EasyMotion Studio project can be re-open and used as usually. The motion-less starting parameters are already there. This can be checked through the “Test” tab in the “Electric Angle Controller Tuning Test” dialog.



The Kp and Ki values are computed based on the KPTHT, SFTKPTHT, KITHT and SFTKITHT values, in the following way:

$$Kp = KPTHT/32767 * 2^{SFTKPTHT} = 32767/32767 * 2^3 = 8$$

$$Ki = KITHT/32767 * 2^{SFTKITHT} = 100/32767 * 2^0 = 0.0030518$$

At this point the setup can be downloaded to the drive (this will restore the OSR value back to default value) and the motionless start mode can be successfully used.

<b>Created by</b> Alin Cristian Marin	<b>First edition</b> 18-Oct-19 10:43 AM	<b>Document template</b> P099.TQT.721.0003.10	<b>Verified by</b>	<b>Last edition</b> 18OCT2019	<b>Approved by</b>
TECHNOSOFT		<b>Title of document</b> <b>P100 Manual setting of the motionless start mode parameters</b>		<b>N° document</b> <b>V181019-1</b> Page: 19 of 19	