AN3991
Application note

How to drive multiple stepper motors with the L6470 motor driver

Enrico Poli

Introduction

The L6470 is a flexible device for the driving of bipolar stepper motors in multiple motor systems. This application note describes how to drive three bipolar stepper motors in a daisy chain configuration. Each motor position and its velocity can be controlled individually or a sequence of position and velocity commands can be implemented by using the IronPython scripting language included in the dSPIN™ evaluation tool. With the dSPIN evaluation tool and STEVAL-PCC009V2 interface board, up to eight stepper motors can be controlled in a daisy chain configuration.

Contents

1 Hardware requirements 4

2 Software requirements 5

3 Software installation 5

4 Interconnection diagram 6

5 Stepper motor characterization 7

6 Running the motor evaluation 7

7 Controlling three motors individually 8

7.1 Individual motor position control 8

7.2 Individual motor speed control 8

8 Controlling three motors with scripts 9

Three_motors script text 10

Appendix A Additional instructions 12

Motor back EMF constant (Ke) measurement 12

9 References 15

10 Revision history 15

1 Hardware requirements

Each stepper motor being evaluated requires an EVAL6470H demonstration board. Also required is an STEVAL-PCC009V2 interface board that is connected between the PC USB port and the first EVAL6470H device. A 10-pin flat cable is needed for each EVAL6470H. A standard USB male to mini USB male cable connects the STEVAL-PCC009V2 to the PC.

In addition to the interface boards and cables, a DC power supply with a voltage output between 8 V and 45 V is required.

2 Software requirements

The software needed is the SPINFamily evaluation tool which can be downloaded at www.st.com/dspin.

3 Software installation

Uninstall any previous versions of the dSPIN evaluation tool.

Install the dSPIN evaluation software by clicking on setup Windows installer package.

After installation is complete, the dSPIN software tool is located at C:\Program Files\STMicroelectronics\ dSPIN evaluation tool.

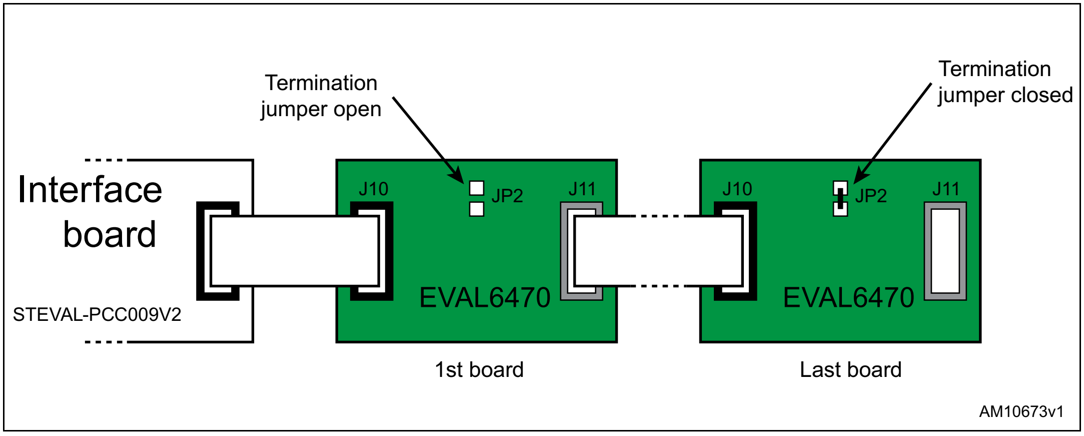
Download the Three_motors.py script from the same page where this application note can be found.

4 Interconnection diagram

With reference to the AN3103 application note, on each EVAL6470H connect the power supply to VS and ground and connect one stepper motor coil to OUT1A and OUT2A. Connect the other stepper motor coil to OUT1B and OUT2B.

Jumper connections: on the EVAL6470H, a jumper JP2 is located between the OUT1A/OUT2A and OUT1B/OUT2B screw connections, just below the VDD test point. In the daisy chain connection, JP2 must be open on all EVAL6470Hs except the last one. On the last EVAL6470H, JP2 is shorted. An additional EVAL6470H demonstration boards can be connected in daisy chain mode. Up to eight motors can be controlled using a single STEVAL-PCC009V2 interface board.

Figure 1. Daisy chain example



To drive two or more boards in daisy chain configuration:

1. Open the termination jumpers on all EVAL6470H demonstration boards except the last one.
2. Verify the termination jumper of the last evaluation board is closed.
3. Plug the interface board into the PC through the USB cable.
4. If requested, install interface board drivers.
5. Connect the interface board 10-pin connector to the SPI_IN connector of the first demonstration board.
6. Connect the SPI_OUT connector of the previous demonstration board to the SPI_IN connector of the next one.
7. Repeat item 6 until all the others boards in the chain are connected.

Information about the termination jumper and the SPI connectors can be found in the AN3103 application note.

Warning: Increasing the number of the devices connected in daisy chain configuration may degrade SPI communication performance. If communication issues are found, try to reduce SPI clock speed.

5 Stepper motor characterization

Determine Rph, the resistance per phase, and Lph, the inductance per phase for the stepper motor. These are available from the stepper motor datasheet. These parameters are needed to optimize the back EMF compensation. Also Ke, the motor back EMF constant is needed. This is easily measured as described in the evaluation software help file (see also dSPIN Ke measurement in *Section : Motor back EMF constant (Ke) measurement on page 11* of this document).

1.8 degree stepper motors are used in this evaluation.

6 Running the motor evaluation

After connecting the power supply and the stepper motors, and setting JP2 on each EVAL6470H, turn on the power supply. Run the dSPIN evaluation tool.

You can find the application shortcut in the Windows start menu: Start|Programs|STMicroelectronics|dSPIN evaluation Tool|dSPIN evaluation tool. Select the STEVAL-PCC009V2 interface board.

Connect the USB connector from the STEVAL-PCC009V2 to the PC’s USB port. Complete the driver installation as described in the dSPIN evaluation tool help file.

Click the “Connect Board” button in the toolbar (or select the menu item ToolsIConnect board). The board connection status is indicated in the lower left corner.

The positioning tab is highlighted.

The device 1 is highlighted at the top of the display. The device 1 is the motor 1, the first of three motors.

Physically move the shaft of the motor 1 to a position defined as “home” for demonstration purposes.

Next, implement the back EMF compensation. Click the BEMF icon (or Tools|BEMF compensation). Fill in the application parameters and motor parameters (Rph, Lph, Ke). Click “Evaluate”, and then “Write”.

7 Controlling three motors individually

7.1 Individual motor position control

Next to ABS_POS, check the “Autorefresh” box. Click “Home”, to write the home position into the registers.

To move a specific number of steps, e.g. 1000, type 1000 in the move box. Set the direction forward, FW, or backward, BW. Click “Move”. The motor moves the requested number of steps.

To move to an absolute position, enter the position in the GoTo box. Set the direction FW or BW, or AUTO for the shortest path. Click “GoTo”. The motor moves to the requested position.

7.2 Individual motor speed control

Click the “Speed” tab. Enter the speed desired in steps/sec., e.g. 500 in the run box. Click FW or BW. Verify “Autorefresh” is checked.

By default, the maximum allowed speed is 991.821 steps/sec. If it is necessary to run faster, click the “Device Configuration” icon (or Tools|Device configuration), change max. speed to a higher number, and click “Write Configuration” to write the new data into the registers.

Back on the home screen, click “Run” and confirm that the motor shaft is running at the desired speed. A measurement of the shaft speed can be found in the SPEED box.

To stop the motor, click “HardStop”, “HardHiZ”, “SoftStop” or “SoftHiZ”. HardStop immediately stops the motor and keeps the L6470 internal MOSFETs on. In this case, the shaft is locked. HardHiZ immediately stops the motor and the internal MOSFETs are off. The shaft can be freely turned. SoftStop stops the motor under programmed deceleration set in the device configuration section. (Tools|Device configuration). The L6470 internal MOSFETs are on and the shaft is locked. SoftHiZ stops the motor under controlled deceleration and the internal MOSFETs are off. The shaft can be easily turned.

To individually operate the motor 2 or motor 3, click the “Device 2” or “Device 3” buttons on the top of the form. Repeat the preceding procedure.

If, for example, the motor 1 is running at its programmed speed and control is given to the motor 2, the motor 1 continues under its existing program. The motor 1, motor 2 and motor 3 are all controlled independently.

8 Controlling three motors with scripts

The dSPIN evaluation tool includes a scripting environment where commands can be written in the program and immediately executed by running the script. In the scripting environment the devices (and then the motors) are numbered using a zero based indexing (i.e. motor 1 becomes motor 0, motor 2 becomes motor 1, etc.). As an example of how three motors can be controlled, the script Three_motors.py performs the following sequence:

1. Establishes the home position for all three motors wherever the shafts happen to be.
2. Spins motor 0 FW (forward) at 800 steps/sec. for 5 seconds.
3. Waits 2 seconds.
4. Moves motor 0 B 2 revs or 400 steps, or 51,200 microsteps.
5. Waits 2 seconds.
6. Spins motor 1 BW (in the opposite direction) at 500 steps/sec. for 8 seconds.
7. Waits 4 seconds.
8. Moves motor 1 FW 4 revs or 800 steps, or 102,400 microsteps.
9. Spins motor 2 at FW 750 steps/sec. for 2 seconds.
10. Waits 1 second.
11. Moves motor 2 FW 3.5 revs or 700 steps, or 89,600 microsteps.
12. Moves all three motors in the shortest direction to their home position.

- To run the script
  - Click the “Script Editor” icon (or select the menu item: Tools|Script editor)
  - Click the “Open” icon
  - Select Three_motors.py
  - Click “Open”
- Three_motors.py is loaded.
  - Click “Script”
  - Click “Run” script

All three motors execute their position and speed commands as previously described.

The text of Three_motors.py is attached as Three_motors.doc.

To run the motors at different speeds or move to different positions, save Three_motors.py under a different file name, edit the script to the new requirements and run the new script.

Three_motors script text

```
MOTOR_A = 0 # Motor A is the 1st one
MOTOR_B = 1 # Motor B is the 2nd one
MOTOR_C = 2 # Motor C is the 3rd one

#1.Establish the home position for all three motors wherever the shafts happen to be
# Set motor A home position
ResetPos(MOTOR_A)
# Set motor B home position
#ResetPos(MOTOR_B)
# Set motor C home position
ResetPos(MOTOR_C)

#2.Spin MOTOR_A FW (forward) at 800 steps/sec for 5 seconds
# Send the Run command
#   Device    Dir   Speed
Run(MOTOR_A, True, 0xD1B7)
# Wait (about) 5 seconds
Delay(5000) # milliseconds
# Stop the motor
HardStop(MOTOR_A)

#3.Wait (about) 2 seconds
Delay(2000) # milliseconds
#4.Move MOTOR_A BW 2 revs or 400 steps or 51,200 microsteps
# Send the Move command
#    Device   Dir     microSteps
Move(MOTOR_A, False, 0xC800)

Delay(2000)

#5.Spin MOTOR_B BW (in the opposite direction) at 500 steps/sec for 8 seconds
# Send the Run command
#   Device    Dir   Speed
Run(MOTOR_B, False, 0x8312)
# Wait (about) 8 seconds
Delay(8000) # milliseconds
# Stop the motor
HardStop(MOTOR_B)

#6.Wait (about) 4 seconds
Delay(4000) # milliseconds
#7.Move MOTOR_B FW 4 revs or 800 steps or 102400 microsteps
```

```
# Send the Move command
#    Device   Dir    microSteps
Move(MOTOR_B, True, 0x19000)

Delay(2000)

#8.Spin MOTOR_C at FW 750 steps/sec for 2 seconds
# Send the Run command
#   Device    Dir   Speed
Run(MOTOR_C, True, 0xC49B)
# Wait (about) 2 seconds
Delay(2000) # milliseconds
# Stop the motor
HardStop(MOTOR_C)

#9.Wait (about) 1 second
Delay(1000) # milliseconds

#10.Move MOTOR_C FW 3.5 revs or 700 steps or 89600 microsteps.
# Send the Move command
#    Device   Dir    microSteps
Move(MOTOR_C, False, 0x15E00)

print GetParam(MOTOR_A, "ABS_POS")
print GetParam(MOTOR_B, "ABS_POS")
print GetParam(MOTOR_C, "ABS_POS")

#11.Move all three motors in the shortest direction to their home position.
GoHome(MOTOR_A)
GoHome(MOTOR_B)
GoHome(MOTOR_C)

print GetParam(MOTOR_A, "ABS_POS")
print GetParam(MOTOR_B, "ABS_POS")
print GetParam(MOTOR_C, "ABS_POS")

print "End"
```

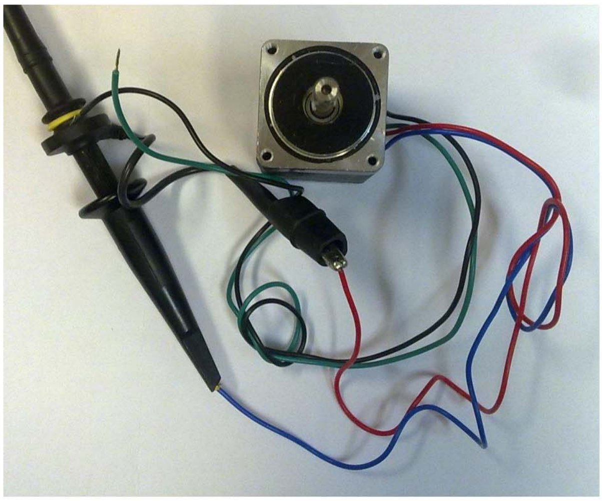
Appendix A Additional instructions

Motor back EMF constant (Ke) measurement

Motor back EMF constant is the coefficient that relates the motor speed to the BEMF amplitude. This value is not usually present on stepper motor datasheets, but it can be easily measured by means of an oscilloscope.

1. First of all, connect one of the motor phases to an oscilloscope channel.

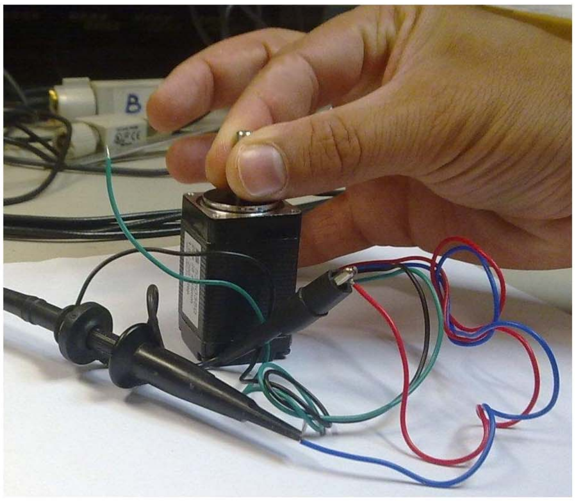
Figure 2. Motor back EMF constant measurement - step 1



AM10679v1

2. Set the oscilloscope trigger value to the rising or falling edge of the channel and set the threshold value close to zero (few mV above or below zero).
3. Quickly turn the motor shaft (this can also be done by hand).

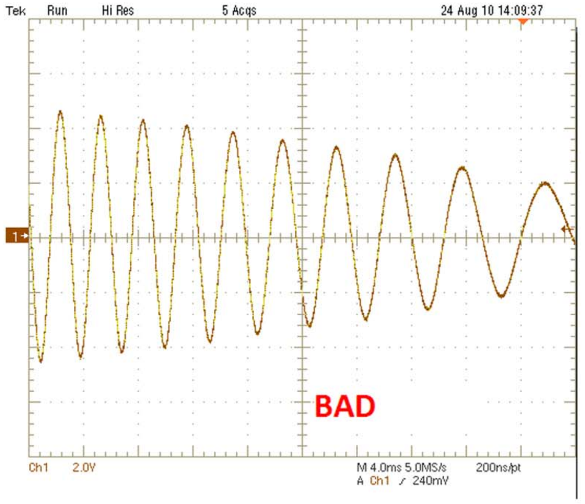
Figure 3. Motor back EMF constant measurement - step 3



AM10680v1

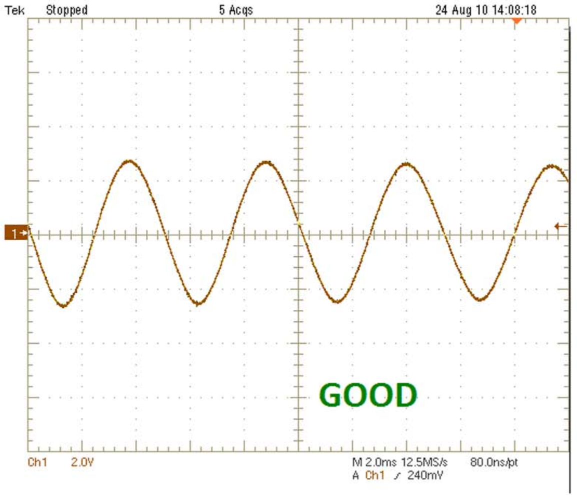
4. Set the oscilloscope time and voltage scales in order to display a sine wave during the motor rotation.
5. Turn the motor until a “good” sine wave is obtained: a good sine wave keeps its amplitude constant for at least 2 or 3 cycles.
6. This operation may require some attempts.

Figure 4. Motor back EMF constant measurement: bad back EMF waveform



AM10681v1

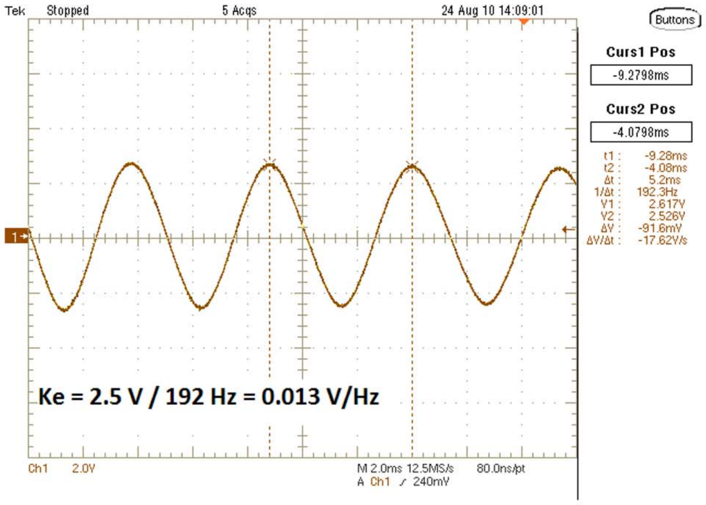
Figure 5. Motor back EMF constant measurement: good back EMF waveform



AM10682v1

7. Measure the peak voltage to frequency ratio of the “good” sine wave. The resulting value is the motor electric constant expressed in V/Hz.

Figure 6. Motor back EMF constant measurement - step 7



Ke = 2.5 V / 192 Hz = 0.013 V/Hz

AM10683v1

9 References

1. L6470 datasheet
2. AN3103 application note.

All documentation is available at www.st.com/dspin.

10 Revision history

Table 1. Document revision history

Date	Revision	Changes
28-Mar-2012	1	Initial release.
08-Jan-2014	2	Updated *Section 2: Software requirements on page 4* (updated tool name, removed last sentence). Updated *Section 5: Stepper motor characterization on page 6* [removed "(Schneider Electric M-2222-2.4S)"]. Removed Section A.1 Communication board driver installation procedure. Minor modifications throughout document.

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan -
Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com