ON Semiconductor®

LV8716QAGEVK
Evaluation Kit User Guide

NOTICE TO CUSTOMERS

The LV8716QA Evaluation Kit is intended to be used for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by ON SEMICONDUCTOR to be a finished end product fit for general customer use. Information contained in this document regarding the device application and the like is provided only for your convenience.

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The user indemnifies ON SEMICONDUCTOR fully in respect of any claim made against ON SEMICONDUCTOR arising from the use of the LV8716QA Evaluation Kit.

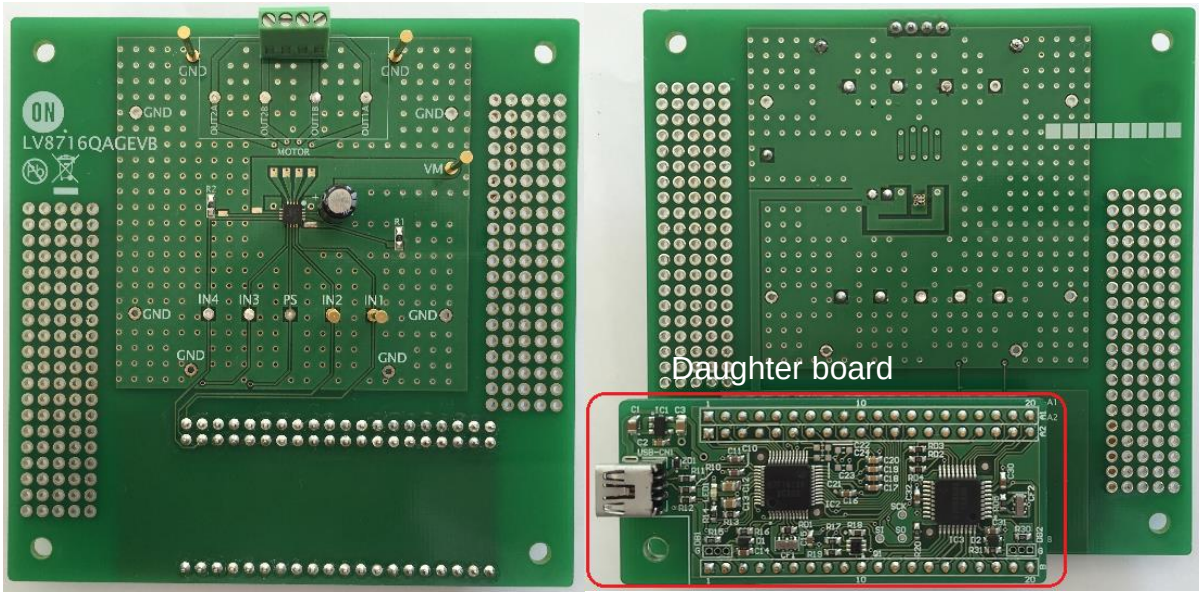
WARNING

The LV8716QA Evaluation Kit is referenced to the DC supply ground and is not earthed. Hence, it carries a risk of electric shock. Caution is required when the power is applied to the kit. Only qualified technicians and/or engineers should handle the kit. When the power is applied to the kit, it is absolutely must that users only probe provided test points and do not touch any other point on the kit.

1. Introduction

The LV8716QA Evaluation Kit is designed to provide an easy and quick development platform for a stepper motor and brush DC motor control applications using LV8716QA. The kit enables users to develop their customized system solution by utilizing various features of LV8716QA and provides real-time development capabilities. The kit consists of:

- LV8716QA Evaluation Board :
  LV8716QAGEVB with on-board microcontroller circuit (Daughter board)
- USB cable
- Stepper motor : MSCA020A55 (Bipolar Type)



LV8716QAGEVB top view LV8716QAGEVB bottom view

USB cable

Stepper motor

Figure 1. LV8716QA Evaluation Kit

2. Features

The kit provides an integrated development platform to drive a stepper motor and brush DC motor. Following are key features of the kit.

LV8716QA Evaluation Board: LV8716QAGEVB with the Daughter board

- LV8716QA for a stepper motor advancement of a step position, system control and drive or a brush DC motor drive system control and drive.
- Daughter board for communication with the PC based Graphical User Interface.
- Protections for safe operation (Thermal shout down, Under voltage lockout)

Graphical User Interface (GUI)

- Enables users to set/modify LV8716QA parameters in real-time

3. LV8716QA Evaluation Board (EVK) and attached motor Overview

The EVB consists of one connector to connect a motor as shown in Figure 3, and a daughter board to control signal. Refer Appendix A for the LV8716QAEVB schematic.

VM: DC power supply

The LV8716QAGEVB requires external power supply between VM (VM1, VM2) and GND for its operation. C1 is used as a bypass capacitor for the VM power supply.

Pin Name	Min [V]	Max [V]
VM1, VM2	2.7	10.5

VM1 (pin 15) and VM2 (pin 6) are connected on a board, and GND (pin 14) and PGND (pin5, pin16) are also connected on a board.

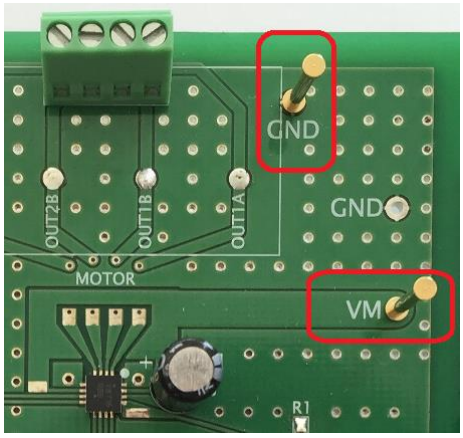
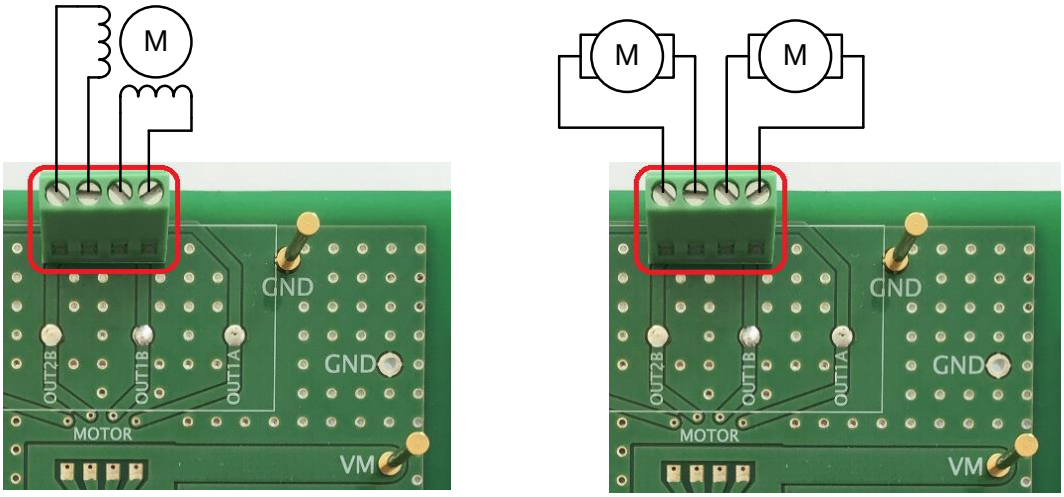


Figure 2. DC power supply

Motor winding connector

The LV8716QA can drive one stepper motor or two brush DC motors. Connect the motor wires to motor connector as shown in Figure 3.



Stepper motor Brush DC motor

Figure 3. Motor winding connector

USB connector

The regulator on the Daughter board generates VDD=3.3V output from USB power. When the external microcontroller is used, remove the Daughter board, and apply control signals to each pin.

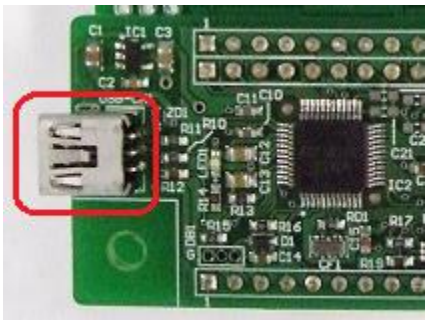


Figure 4. USB connector

R1, R2: RF resistance

The output current is determined by the RF resistance, the reference voltage (Vref) and constant value for the current setting in LV8716QA based on the following equation. RF resistance is connected between RCS1 (2) pin and GND.

$$I_{OUT} = \frac{0.2[V]}{R_{RF}[\Omega]} \times 4000 \text{.....(1)}$$

Where,

I_{OUT}: Motor current [A]

0.2: Reference voltage for current detection (Vref) [V]

4000: The constant value for the current setting in LV8716QA

R_{RF}: Resistance between RCS1 (2) and GND [Ω]

(Default setting value is 4300Ω.)

$$I_{OUT} = \frac{0.2}{4300} \times 4000 \approx 0.186[A]$$

4300Ω resistance is installed to RCS1 and RCS2 individually. It is not required of high-power resistor. Vref is a reference voltage which is determined by the IC, and cannot be changed.

The motor current can be adjusted by changing the resistance between RCS1 (2) and GND.

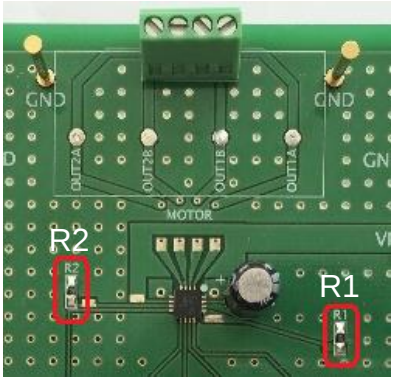


Figure 5. RF resistor

Stepper motor: MSCA020A55 (Bipolar Type)
Winding Res: 15±1.5Ω
Nidec Sankyo Corporation

Stepper motor MSCA020A55 is attached in the LV8716QAGEVK. LV8716QA has current drivability up to 1.0A per channel, the current limit of this evaluation board is set to 186mA to maintain the bundled reference stepper motor MSCA020A55 capability. The guaranteed temperature of MSCA020A55 motor windings is 115°C. In case of 25°C ambient temperature for example, the temperature-rise must be less than 90°C (115 – 25). From the plots below, 200mA or less is suitable for this motor. Figure 6 shows the winding temperature-rise characteristics of the motor, which is supplied by LV8716QAGEVK.

The current limit should be changed to appropriate value to match an actual target motor.

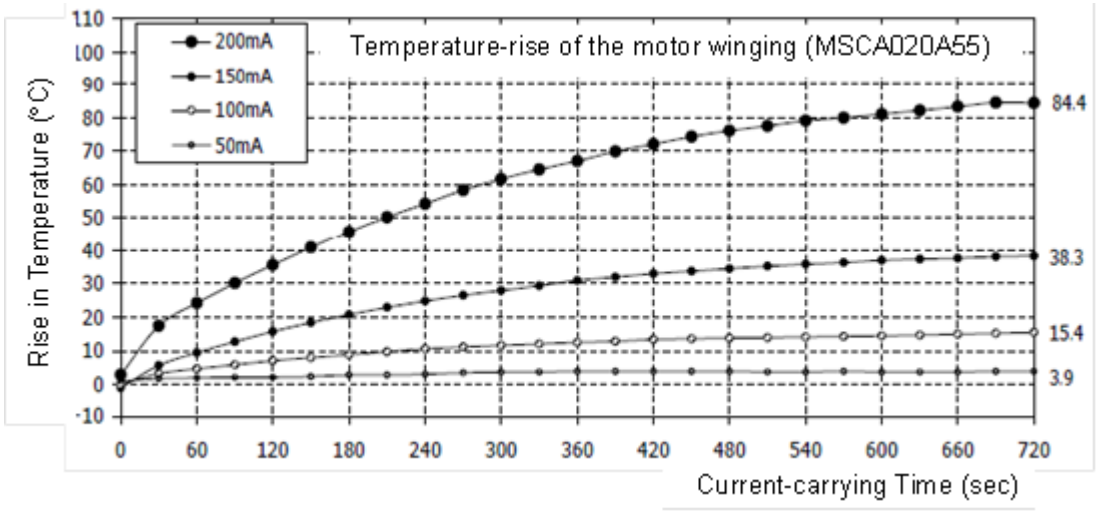


Figure 6. Temperature-rise characteristic of the motor winding

4. Graphical User Interface (GUI) Installation

An easy-to-use GUI is provided (*free of cost*) for real-time LV8716QA based solution development. Perform following steps to get started with the GUI. This GUI will work with the Windows 7 (32bit, 64bit) and Windows 8 (32bit).

(1) Unpack the zip file **"LV8716QAGEVK_SOFTWARE.zip"**, and confirm files as shown in below.
"M-DrAGON_version1135.exe", **"M-DrAGON_driver.inf"**, and
"LV8716QAGEVK_USER_GUIDE-D.rev0.pdf".
(2) Connect the LV8716QAGEVB to the PC using the USB cable.

Steps (3) to (11) show the USB driver installation procedure that refers to an expression on Windows 8 (32bit). This layout and procedure may vary with other operating system version. It is required only for the first time when the Daughter board of LV8716QAGEVK is connected to the USB port.

(3) The Windows OS will try to install driver on its own. Wait for a few minutes. Installation will fail.
(4) Click on the Start Menu, and open the Control Panel.
(5) Open the Device Manager.
(6) Either under "Ports (COM & LPT)" or "Other Devices", see an open port named "USB-MiconI/ O Controller".

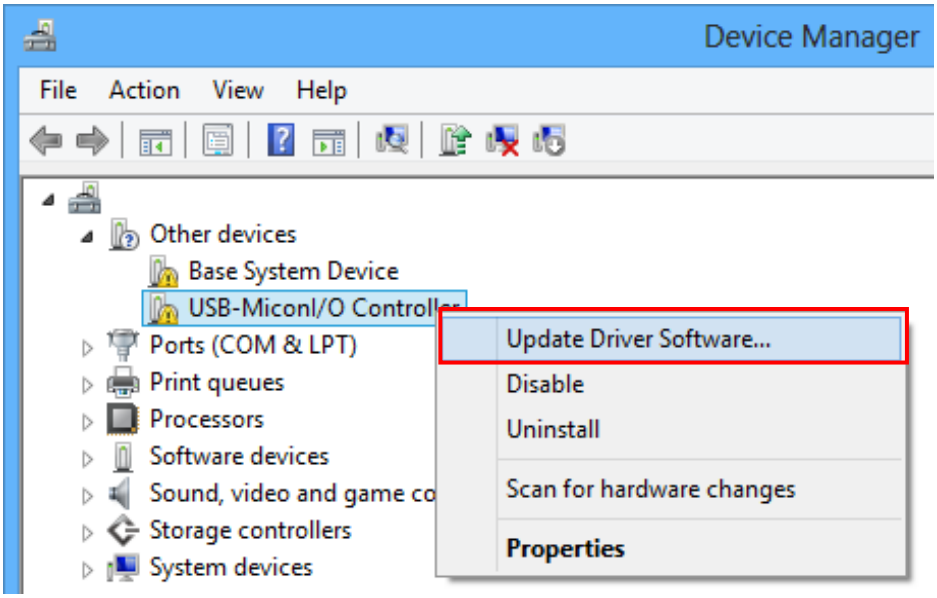


Figure 7. Device Manager 1

(7) Right click on the “USB-MiconI/ O Controller” port and choose the “Update Driver Software” option.

If the update driver software option is not available, then the Windows OS is still trying to install the driver on its own. Wait till the OS finishes self-try.

(8) Next, choose the "Browse my computer for Driver software" option.
(9) Finally, navigate to and select the driver file named **“M-DrAGON_driver.inf”**, located in the “M-DrAGON_driver” folder. And click “Next”.
(10) Windows will finish up the driver installation from there.

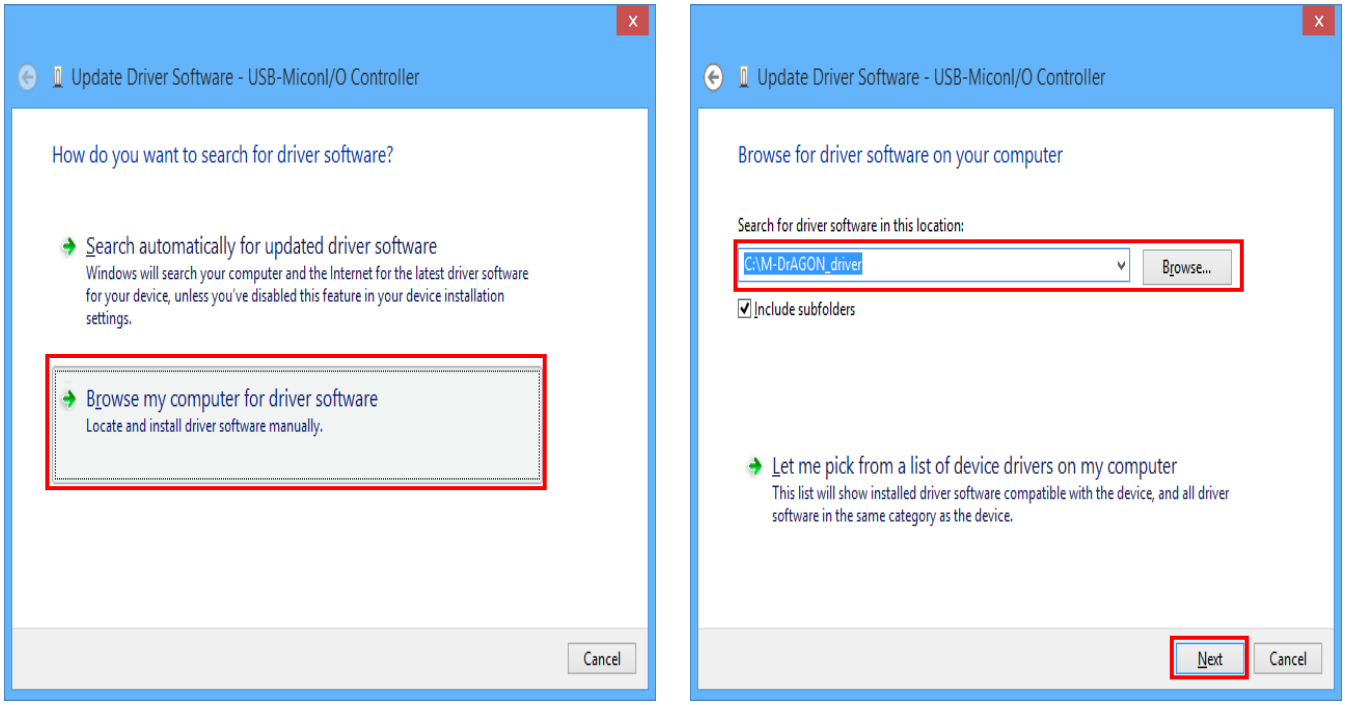


Figure 8. USB-MiconI/ O Controller 1

Note: When “Windows security” is shown, select “Install this driver software anyway”.

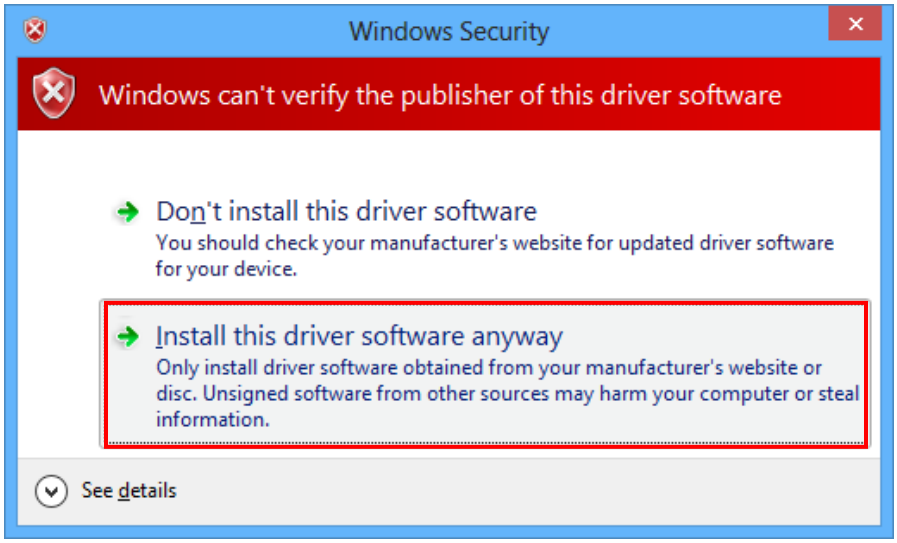


Figure 9. Windows Security

(11)When the installation is successful, the final window is shown. And the recognized M-DrAGON I/O Controller port with the port number is shown in the Device Manager.

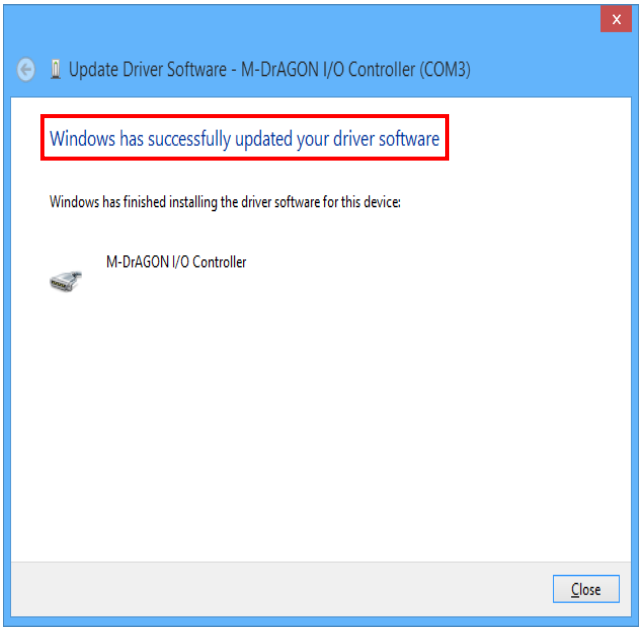


Figure 10. USB-MiconI/ O Controller 2

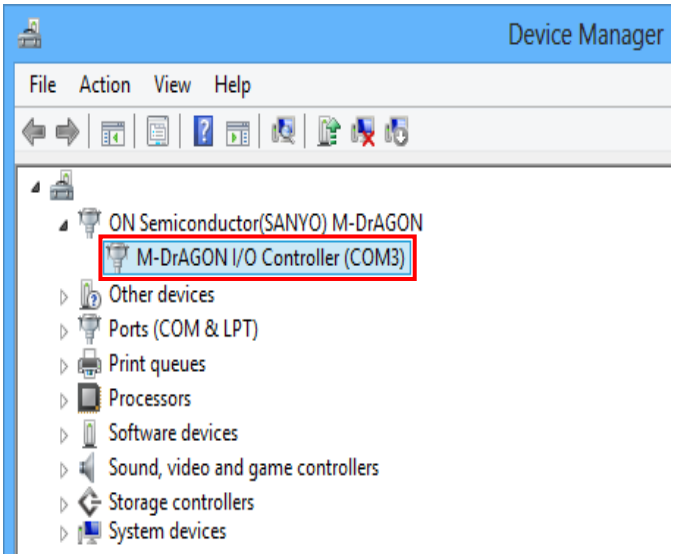


Figure 11. Device Manager 2

(12)Start **"M-DrAGON_version1135.exe"**. When driving a stepper motor, select "Stepper" in Motor type. Since the Driver type is displayed device that can drive the stepper motor by selecting "Stepper", select "LV8716QA(Stepper)" from the drop-down list of Driver type, and then click "OK".
When driving a brush DC motor, select "DC" in Motor type. Since the Driver type is displayed device that can drive the brush DC motor by selecting "DC", select "LV8716QA(DC)" from the drop-down list of Driver type, and then click "OK".

Stepper is selected

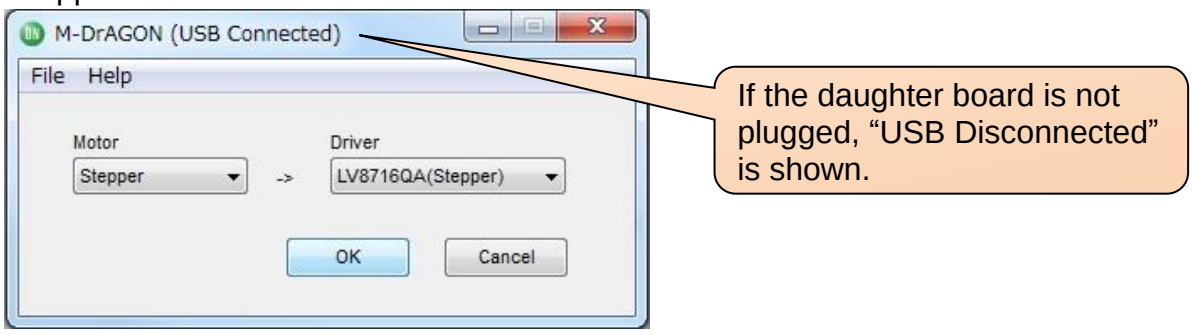


Figure 12. Motor type and Driver setting window 1

DC is selected

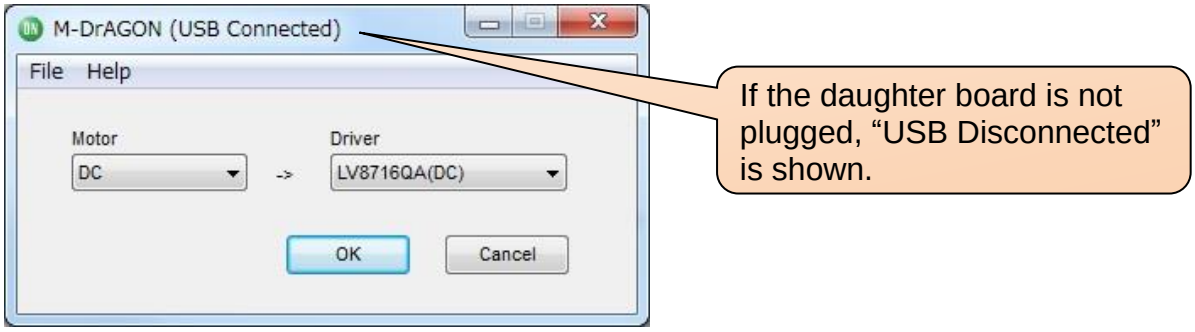


Figure 13. Motor type and Driver setting window 2

(13)The following windows should appear when “Stepper” is selected

- Controller (Figure 14)
- Tachometer (Figure 15)
- Graph (Figure 16)

‘Tachometer’ and ‘Graph’ of sub window are displayed only in the stepper type.

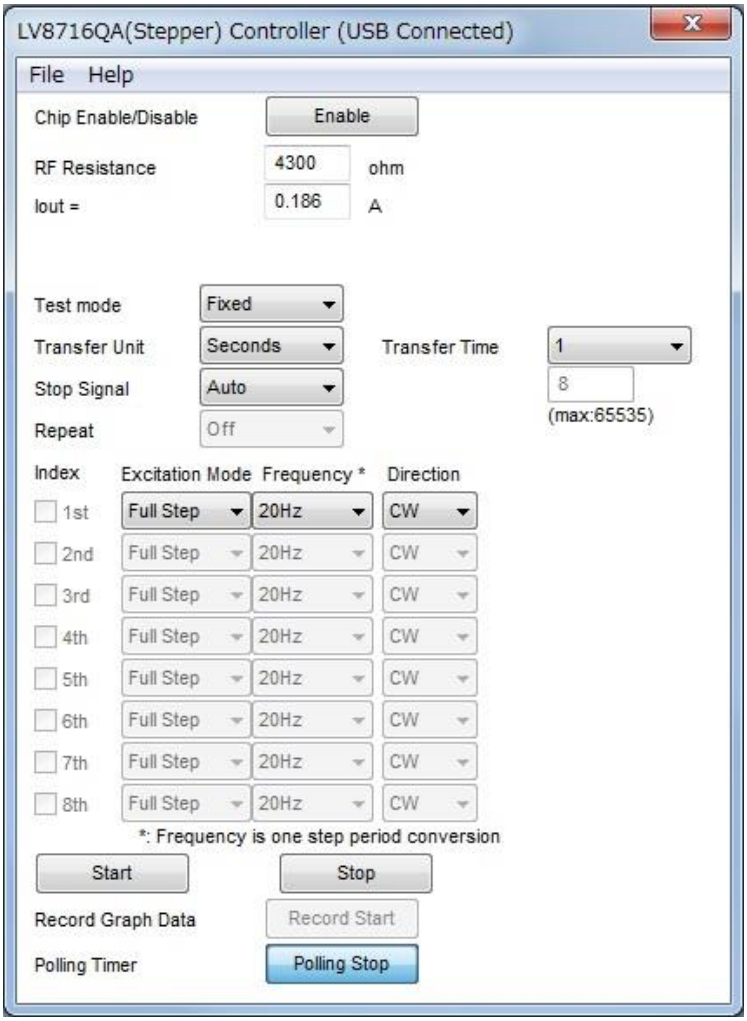


Figure 14. Controller window for stepper

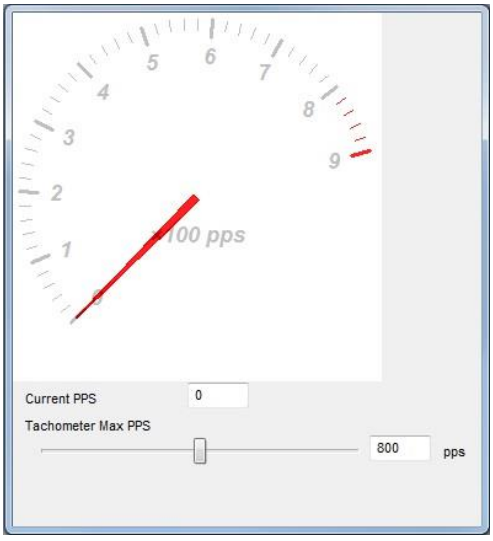


Figure 15. Tachometer window

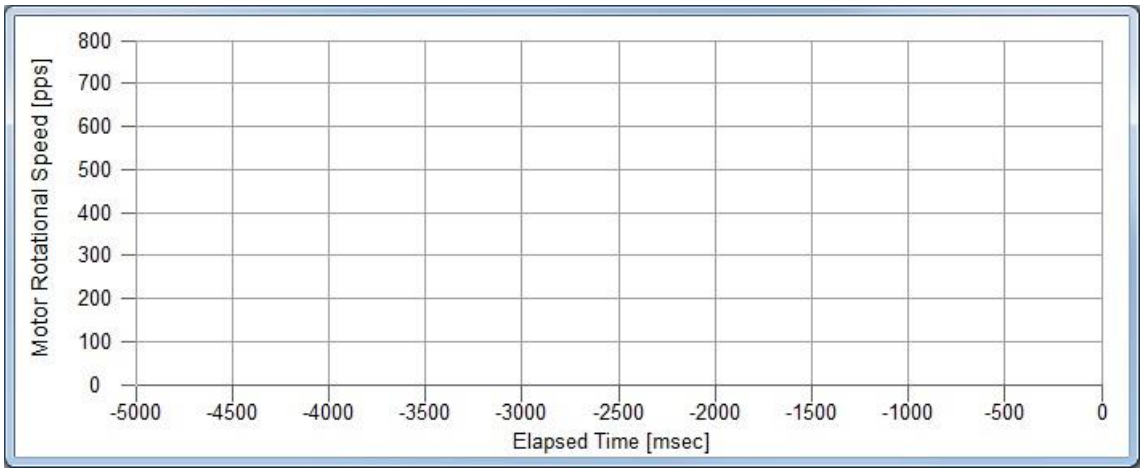


Figure 16. Graph window

(14)The following windows should appear when “DC” is selected

- Controller (Figure 17)

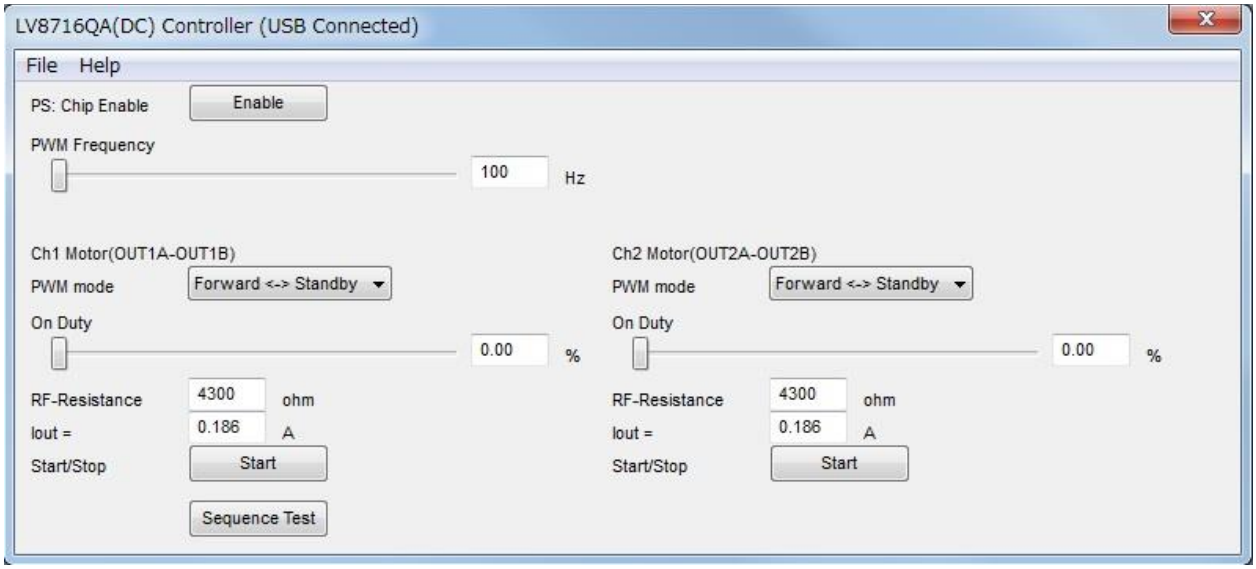


Figure 17. Controller window for brush DC

5. Usage of the GUI

(1) Stepper motor

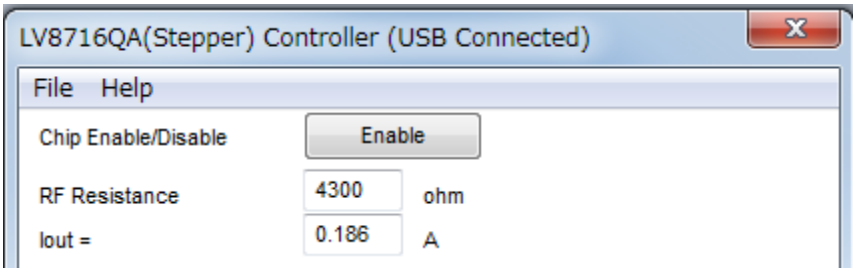


Figure 18. GUI field description of stepper controller window 1-1

Chip Enable / Disable

"Enable": IC will be enabled state. The indicator changed to "Disable".
"Disable": IC will be disabled state. The indicator changed to "Enable".

RF Resistance

Set the detection resistance value of the motor current. It must be same value between RCS1 and GND, RCS2 and GND. Default setting value is 4300Ω.

Iout

Iout is calculated by setting RF resistance after "Polling start" button is clicked. This value is calculated value from equation (1), not actual value.
Iout will become the red characters at more than 0.2A for attention of attached motor in LV8716QA Evaluation Kit.

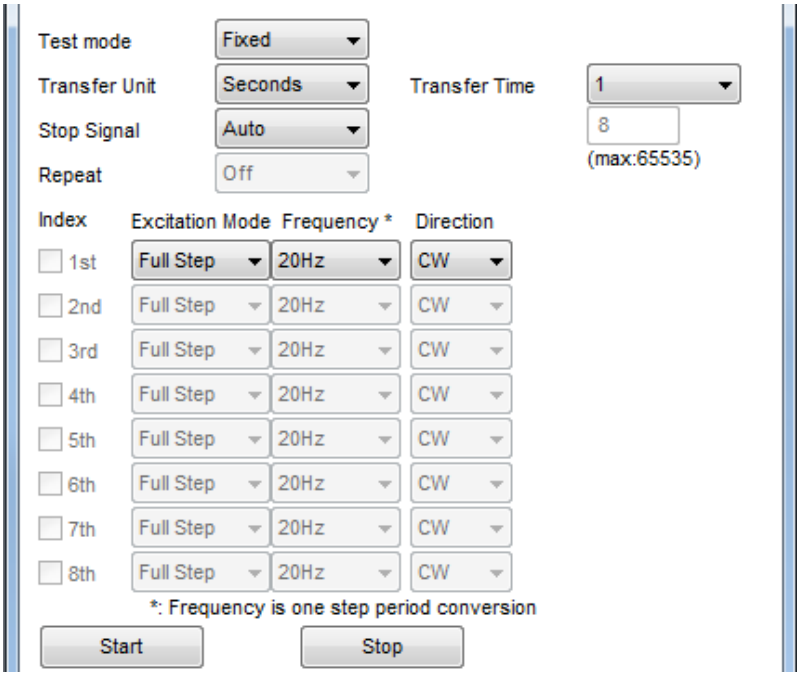


Figure 19. GUI field description of stepper controller window 1-2

Test mode

"Fixed": Sending fixed signal (one pattern only) means sending one Excitation Mode, one Frequency, and one Direction.

"Sequence": Sending sequential pattern means sending the three parameters (Excitation Mode, Frequency and Direction) at maximum of eight patterns.

To reset all parameters back to default values, select "File" in the menu bar at the top of GUI, and then select "Rollback to Initial value".

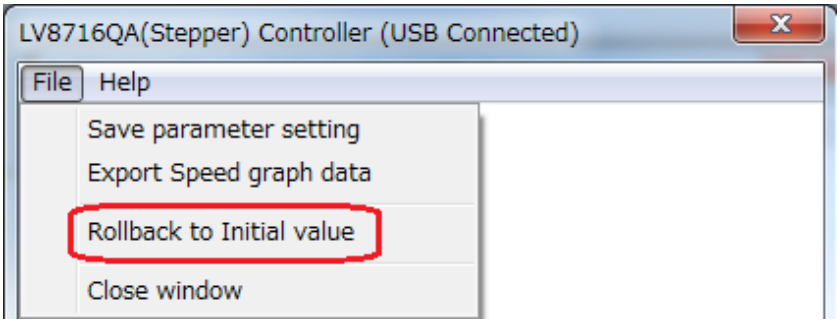


Figure 20. GUI field description of stepper controller window 1-3

Transfer Unit

"Seconds": A unit is a second. A motor is driven during the number of seconds set in "Transfer Time".

"Steps": A unit is a step. A motor is driven the number of steps set in "Transfer Time". When "Steps" is selected, start motor rotation from the previous step of the initial position. Refer to the Figure 21 and Figure 22 concerning initial position.

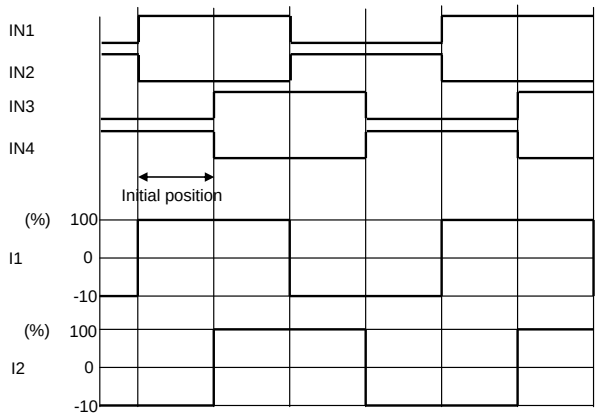


Figure 21. Full step (CW)

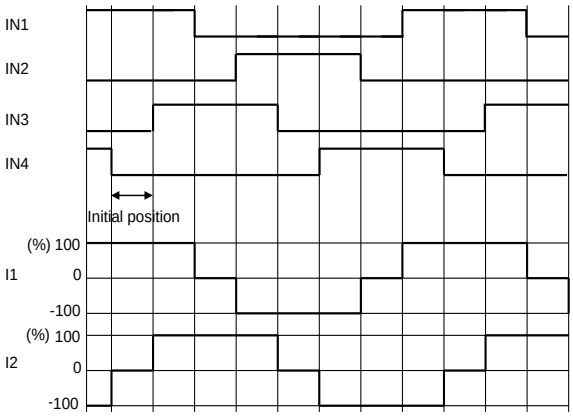


Figure 22. Half step (CW)

Transfer Time

The value can be selected from drop-down list or select “other…” and input the value into the textbox. The maximum value that can be set is up to 65535.
This set value is common value for all sequence stage.

Stop Signal

“Auto”: An input signal is stopped automatically when the set “Transfer Time” is completed, and the last step will be continued.
“Stop Button”: The drive of a motor stops by “Stop” button. Clicking “Stop” button, the signal transfer will stop immediately. In case of “Fixed” Test mode, “Transfer Time” text box will gray out after “Stop Button” is selected in the Stop Signal. In case of “Sequence” Test mode, “Stop” button must be clicked to stop the signal transfer at the end of the last stage. IN1, IN2, IN3 and IN4 input signal becomes all Low state by clicking “Stop” button.

Repeat

“On”: Sequence pattern repeats while test mode is selected “Sequence” mode.
“Off”: Last set sequence stage will be kept until the signal transfer is manually stopped. A repeat function can set up when “Sequence” mode and “Stop button” are chosen.

Excitation Mode

The step resolution can be selected from Full Step and Half Step, and can update the parameter while a motor is operating in “Fixed” mode by clicking “Start” button.

Frequency

The frequency can be selected from 20Hz to 1200Hz by drop-down list and can update the parameter while a motor is operating in “Fixed” mode by clicking “Start” button. In case of start-up or acceleration of motor drive, pay attention to the frequency rapid variation.
This frequency is expressed as equivalent to one step of each excitation.

Direction

“CW”: Clockwise (CW).
“CCW”: Counter-clockwise (CCW).
The direction can update the parameter while a motor is operating in “Fixed” mode by clicking “Start” button.

Start

When “Start” button is clicked, send stepper control signals to IN1, IN2, IN3 and IN4 pin. “Transfer time” is reset each time the “Start” button is pressed, and “Excitation Mode”, “Frequency” and “Direction” can be set again at that time.

Stop

Regardless of the test mode, transfer of stepper control signals is stopped by this button. IN1, IN2, IN3 and IN4 signals become all Low state and a motor doesn't keep its position.

Figure 23. GUI field description of stepper controller window 1-4

Record Graph Data

It is necessary to choose a file to save Excel data.
When "Record Start" button is clicked after a file was chosen, the Excel data of "Time" - "Motor Rotational speed (Clock frequency: pps)" is outputted to selected file. When "Record End" button is clicked, this GUI stops the output of Excel data. Refer to "Export Speed graph data" for the details.

Polling Timer

When "Polling Start" button is clicked, "Tachometer" and "Graph" are updated in real-time. The default setting is that the polling operation works, and the button changed to "Polling Stop".

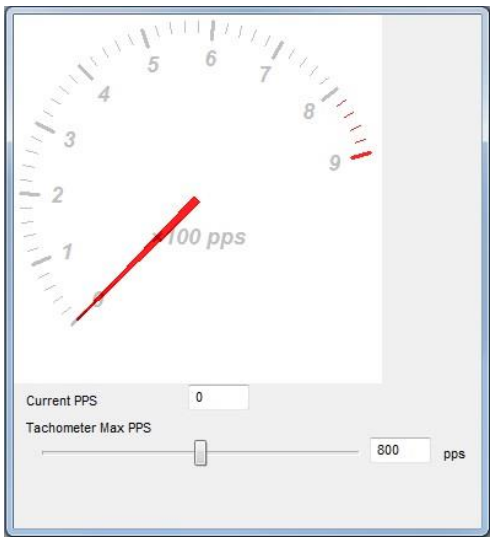


Figure 24. GUI field description of tachometer window

Current PPS/ Tachometer Max PPS

When “Polling Start” button is clicked, “Tachometer” and “Graph” are updated in real-time. The default setting is that the polling operation works, and the button changed to “Polling Stop”.
The velocity of stepper motor is usually described by [pps] pulse per second. In other words, it is the number of steps per second.

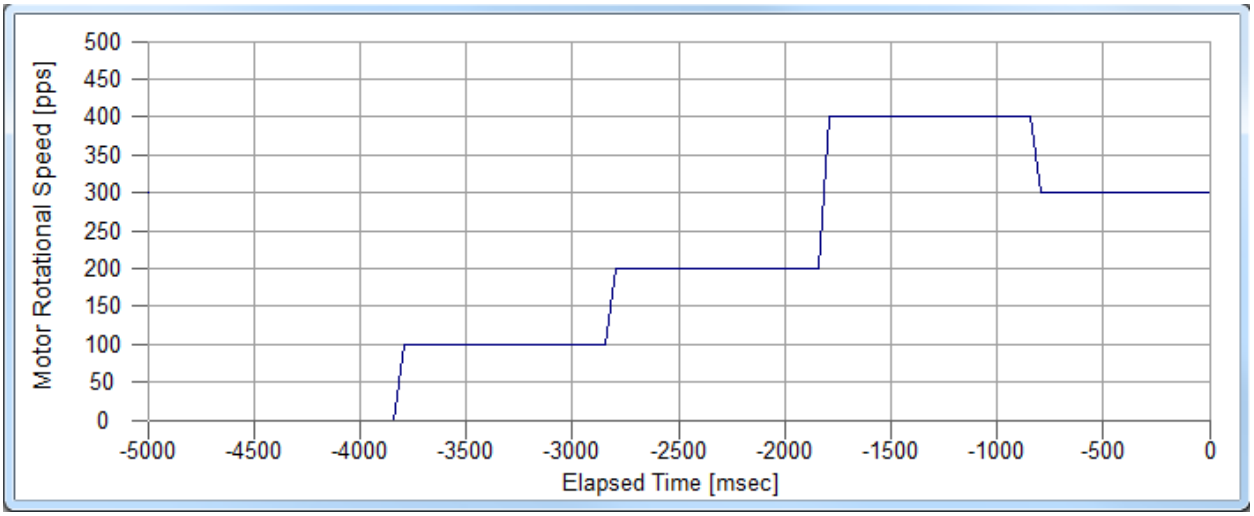


Figure 25. GUI field description of graph window

This graph shows the relationship between elapsed time (X-axis) and motor pulse rate (Y-axis). Pulse rate value is as same as tachometer value.
Maximum level of Y-axis is adjusted by “Tachometer Max PPS” with tachometer.
The scale of X-axis is 500msec/div. Graph is automatically scrolled according to elapsed time.

(2) Brush DC motor

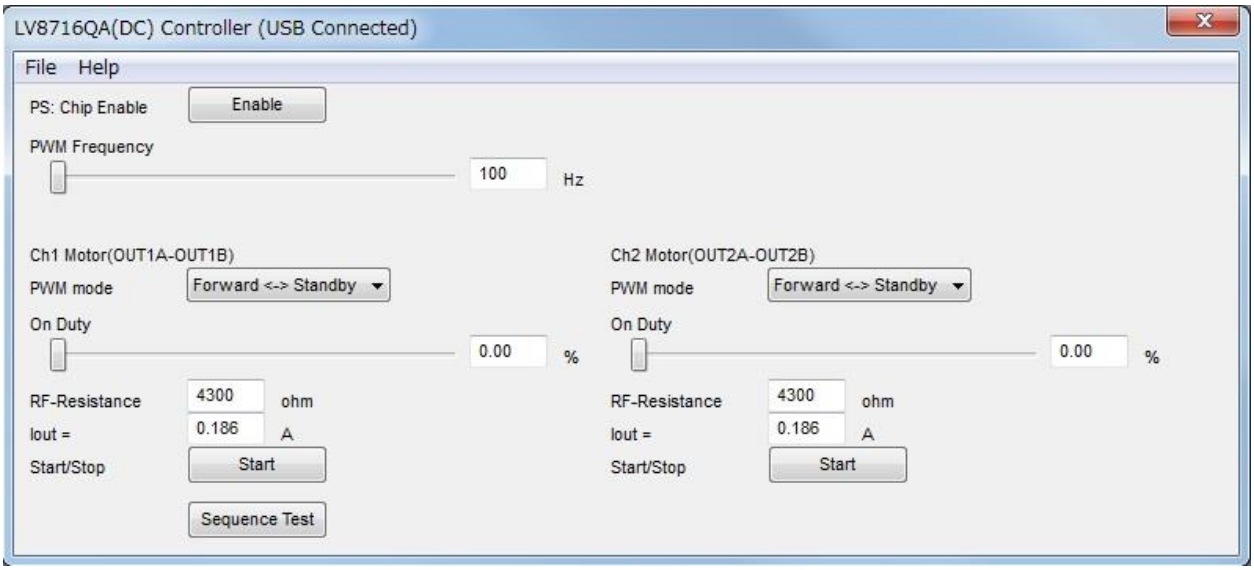


Figure 26. GUI field description of DC controller window 2-1

Chip Enable

"Enable": IC will be enabled state. The indicator changed to "Disable".
"Disable": IC will be disabled state. The indicator changed to "Enable".

PWM Frequency

This value is PWM frequency to drive brush DC motor. It can be selected from 100Hz to 10000Hz by slider, and is common value in Ch1 Motor and Ch2 Motor.

PWM mode

PWM mode can be selected four modes as shown in below by drop-down list:

- Forward <-> Standby
- Forward <-> Brake
- Reverse <-> Standby
- Reverse <-> Brake

It can be selected Ch1 Motor and Ch2 Motor individually.

On Duty

This value is the period of "Forward" or "Reverse" to drive brush DC motor. The value can be selected from 0% to 100% by slider of Ch1 Motor and Ch2 Motor individually.

RF Resistance

Set the detection resistance value of the motor current. It can be set different value between RCS1 and GND, RCS2 and GND. Both default values are 4300Ω.

Iout

Iout is calculated by setting RF resistance after “Polling start” button is clicked. This value is calculated value from equation (1), not actual value.
Iout will become the red characters at more than 0.2A for attention of attached motor in LV8716QA Evaluation Kit.

Start / Stop

“Start”: When “Start” button is clicked, sending the set parameter with PWM signal, and then a motor rotate. The indicator changed to “Stop”.
“Stop”: When “Stop” button is clicked, PWM signal transfer is stopped. PWM signal corresponding to the motor channels become Low level. The indicator changed to “Start”. Ch1 motor and Ch2 motor can be driven individually by each “Start” and “Stop” button.

Sequence Test

Controller window for DC Motor sequence test will come up the picture as shown in below when “Sequence Test” button is clicked.

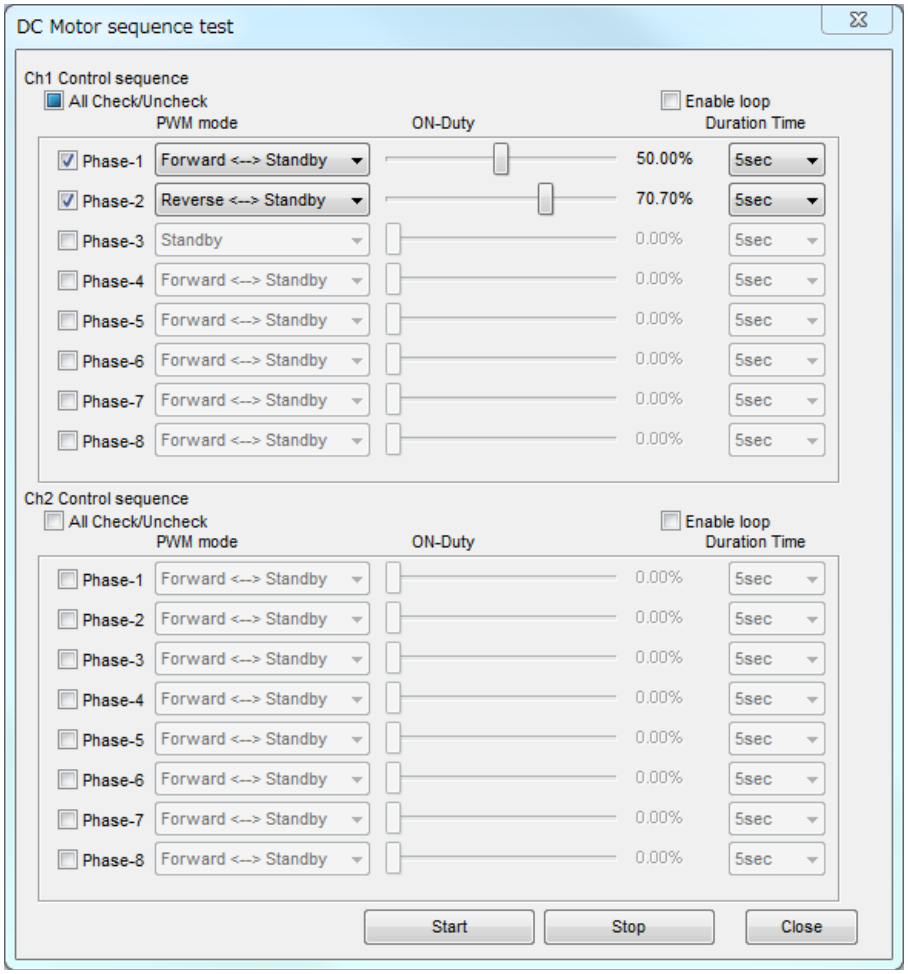


Figure 27. GUI field description of DC controller window 2-2

Ch1/ Ch2 Control sequence

Sequence test can send PWM signal of CH1 and Ch2 individually by setting PWM mode, ON Duty and Duration time with maximum of eight patterns. It is possible to select from phase-1 to phase-8 by clicking the check box. Last set sequence stage will be kept until the signal transfer is manually stopped. To reset all parameters back to default values, select “File” in the menu bar at the top of GUI, and then select “Rollback to Initial value”.

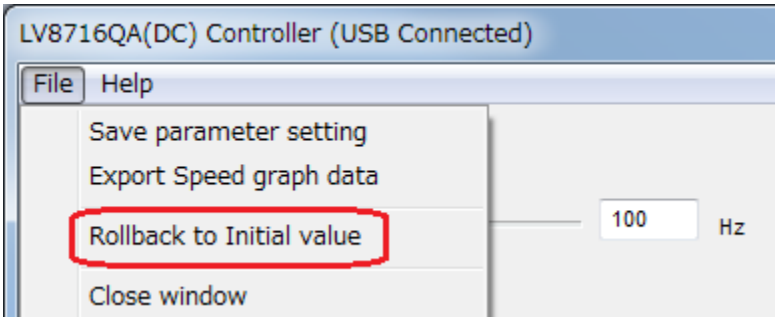


Figure 28. GUI field description of DC controller window 2-3

PWM mode/ ON Duty/ Duration time

“PWM mode” can be selected six modes (Forward <-> Standby, Forward <-> Brake, Reverse <-> Standby, Reverse <-> Brake, Standby and Brake)
It can be selected in Ch1 Motor and Ch2 Motor individually.
The value of “ON Duty” is the period of “Forward” or “Reverse” to drive brush DC motor. The value can be selected from 0% to 100% by slider in Ch1 Motor and Ch2 Motor individually. When standby and Brake is chosen, it is 100% Standby or Brake state regardless of the number of "ON Duty”.
“Duration time” can be selected from 5sec to 60sec by drop-down list.

When ”Forward -> Reverse” or "Reverse -> Forward" has been set, Brake or Standby state is added for 200ms in the switching timing of the "Forward" and "Reverse". Standby state or Brake state is selected by the next Phase.

All Check/ Uncheck

When this check box is checked, all phases are selected.
When this check box is unchecked, all phases aren’t selected.

Enable loop

When this check box is checked, selected sequence pattern is repeated until “Stop” button is pressed.

(3) Other functions

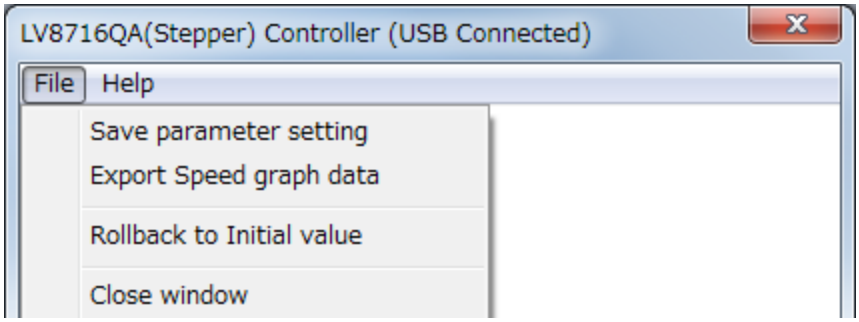


Figure 29. GUI field description of stepper controller window 1-5

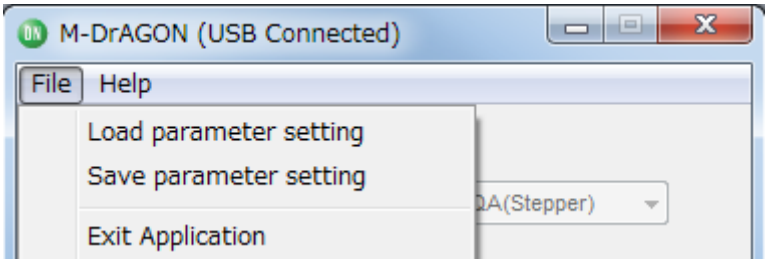


Figure 30. GUI field description of stepper controller window 1-5

Save parameter setting

Output the setting data of GUI. Select “File” in the menu bar at the top of GUI Controller window (Figure 29) or Motor and Drivers setting window (Figure 30), then select “Save parameter setting”.
This is not effective in Sequence Test of DC mode.

Export Speed graph data (Only Stepper mode)

Output the Excel data of “Time” - “Motor Rotational speed (Clock frequency: pps)”. Select “File” in the menu bar at the top of GUI Controller window, then select “Export Speed graph data”, and then input file name, and start preservation of data after “Record Start” is clicked, and stop it when “Record End” is clicked. When the file which already exists is chosen, newest data is appended under a previous data. The data format is CSV as follows; “time”, “raw data” and “pps”. The data of “rpm” is not outputted.

Load parameter setting

Load the file which is saved the setting data of GUI with “Save parameter setting”. Select “File” in the menu bar at the top of Motor and Driver setting window, then select “Load parameter setting”.

Rollback to Initial value

When “Rollback to Initial value” is clicked, all parameters of the Controller window are returned to initial values.

6. Operation

(1) Stepper motor drive by parallel control

Following steps describe a typical operating procedure. It is assumed that the device driver has been already installed.

Step 1. Connect the LV8716QAGEVB to the PC using the USB cable.
Step 2. Connect a motor to motor winding connector and power supply to VM pin.

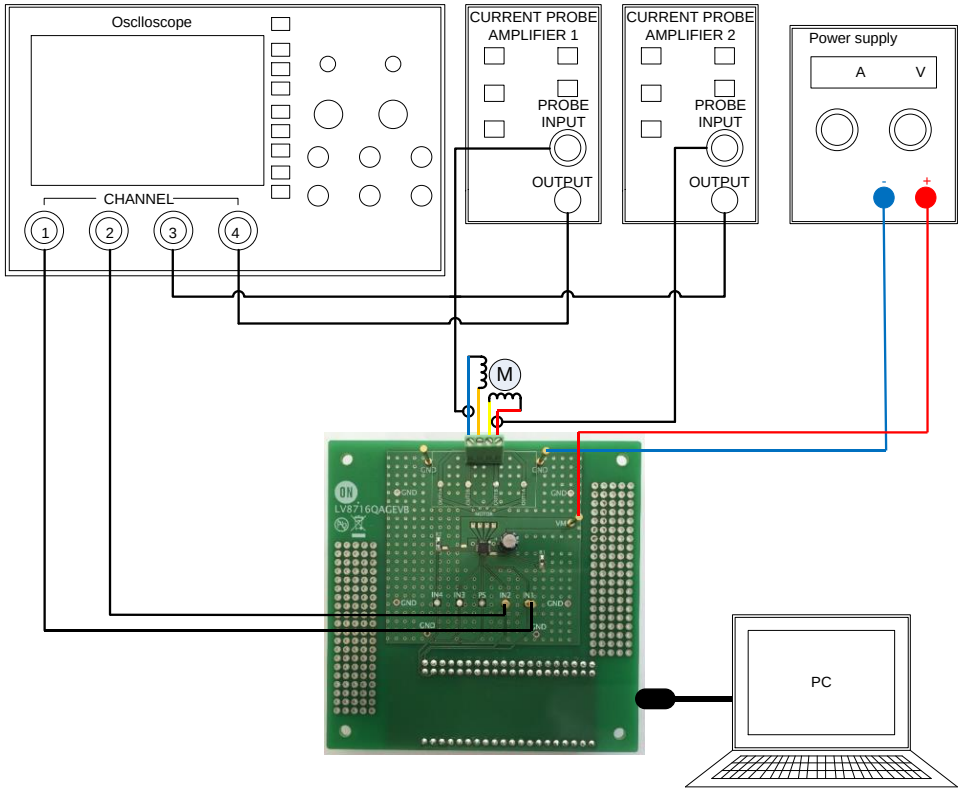


Figure 31. Setup for a stepper motor

Step 3. Turn-on VM=7.2V (2.7V: min to 10.5V: max) power supply.
Step 4. Run **"M-DrAGON_version1135.exe"**.
Step 5. Set "Motor" type and "Driver" setting window as shown in below figure.

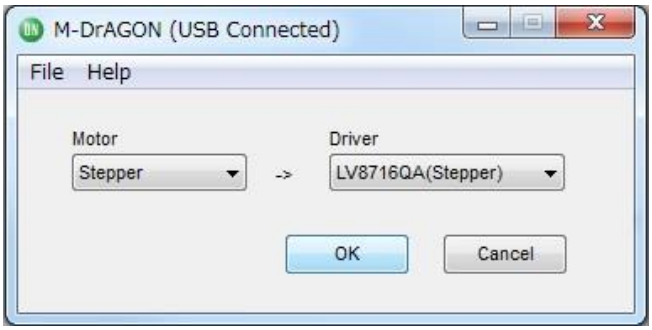


Figure 32. Motor type and Driver setting window 1-1

Step 6. Set the GUI parameters as shown in below figure for example.

INPUT	OUTPUT
RF resistance: 4300Ω Transfer Time: 5 Excitation Mode: Full or Half Step Frequency: 100Hz Direction: CW	Iout≈0.186A

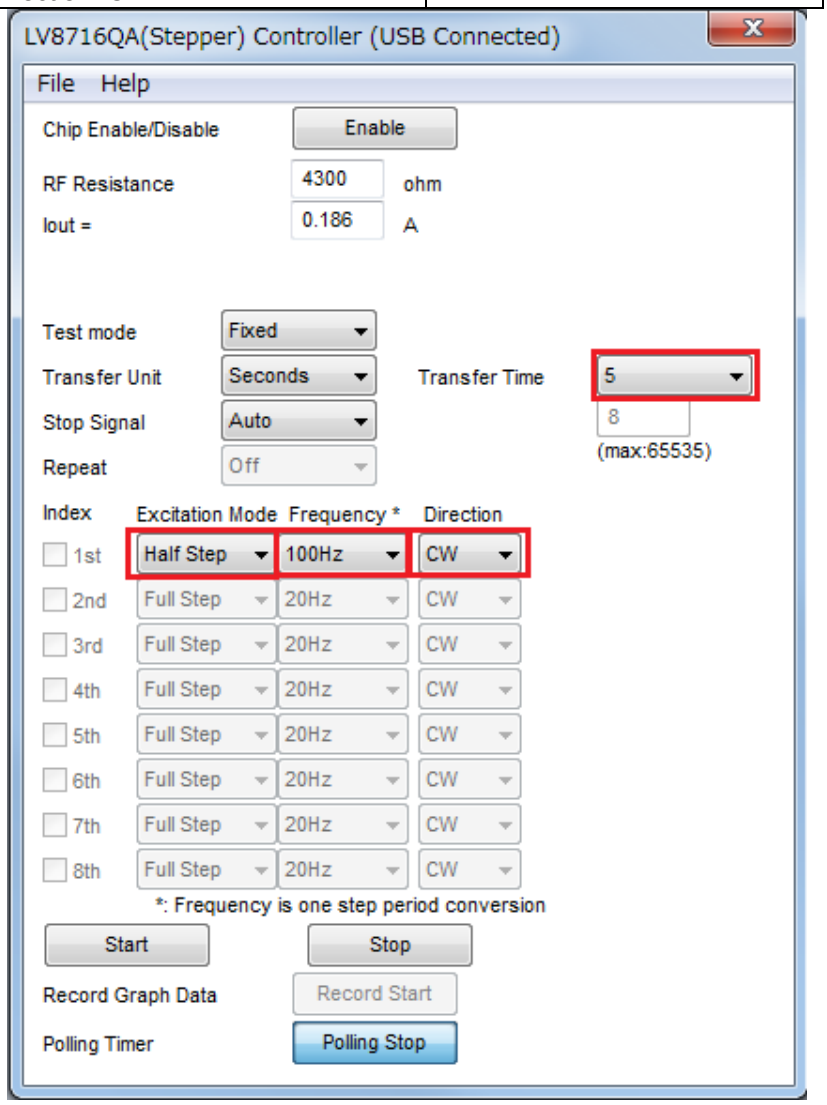


Figure 33. Setting parameter of GUI for Stepper mode

Step 7. Click “Enable” button. The indicator changed to “Disable”.
Step 8. Click “Start” button and then the motor begin to rotate.

- Monitor IN1 and IN2 terminal voltages using CH1 and CH2 of the scope. Monitor OUT1A and OUT2A output current using CH3 and CH4.

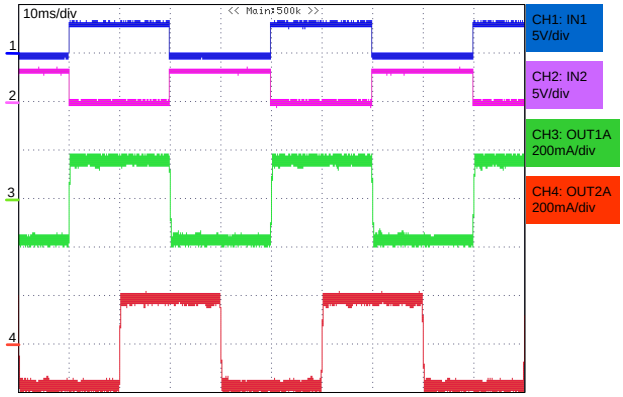


Figure 34. Full step setting waveform

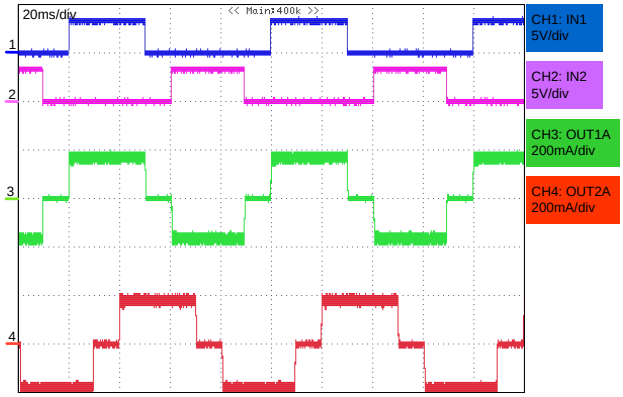


Figure 35. Half step setting waveform

Step 9. Click “Stop” button and then the motor stop.
Step 10. Click “Disable” button. The indicator is changed to “Enable”.

(2) Brush DC motor by PWM control

Following steps describe a typical operating procedure. It is assumed that the device driver has been already installed. Refer to “6-(1) Stepper motor drive by parallel control” for Step 1-4.

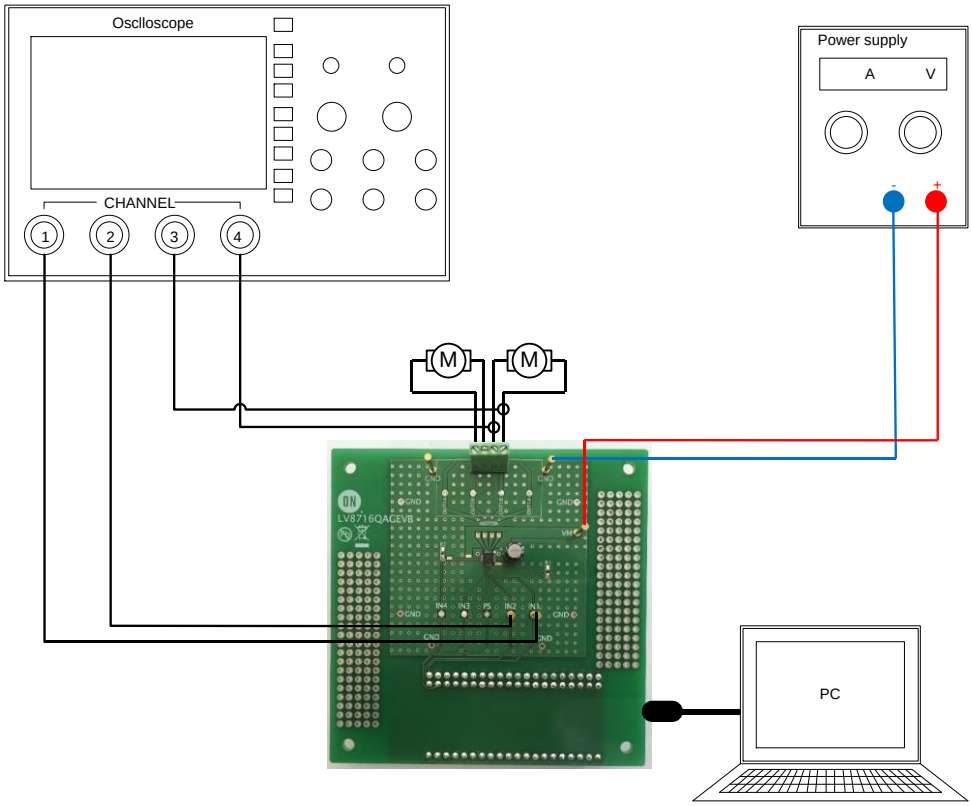


Figure 36. Setup for a brush DC motor

Step 5. Set “Motor” type and “Driver” setting window as shown in below figure.

Figure 37. Motor type and Driver setting window 2-1

Step 6. Set the GUI parameters as shown in below figure for example.

INPUT	OUTPUT
PWM Frequency: 2000Hz PWM mode: Forward <-> Standby or Forward <-> Brake On Duty: 50% RF resistance: 4300Ω	Iout≈0.186A

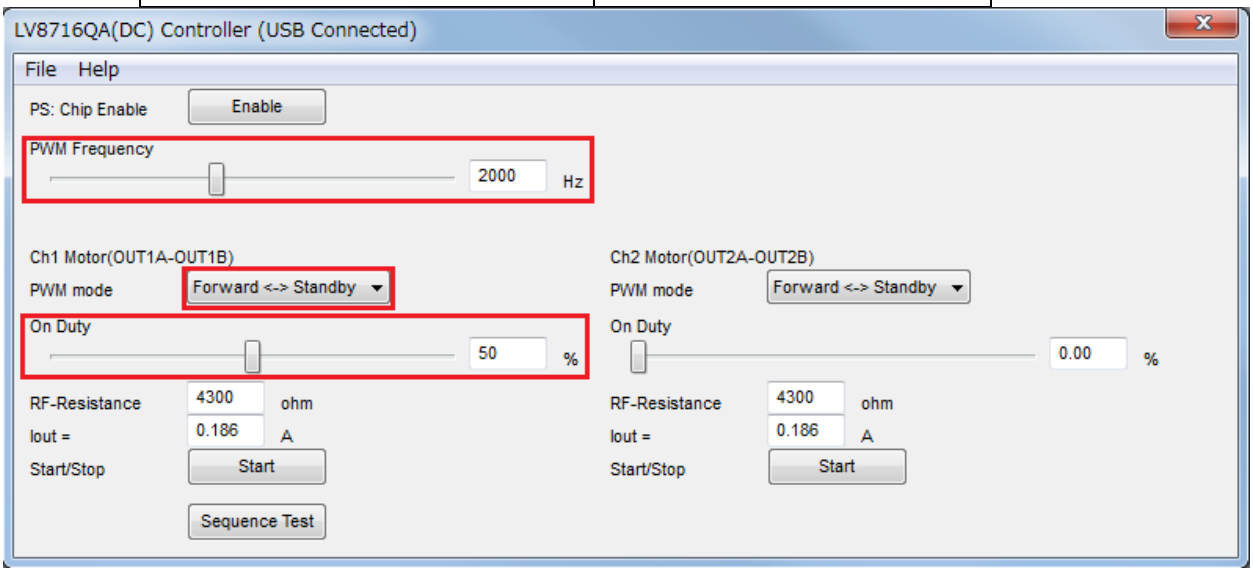


Figure 38. Setting parameter of GUI for brush DC motor

Step 7. Click “Enable” button. The indicator changed to “Disable”.
Step 8. Click “Start” button and then the motor begin to rotate. The indicator changed to “Stop”.

- Monitor IN1 and IN2 terminal voltages using CH1 and CH2 of the scope. Monitor OUT1A and ONT1B output voltage using CH3 and CH4.

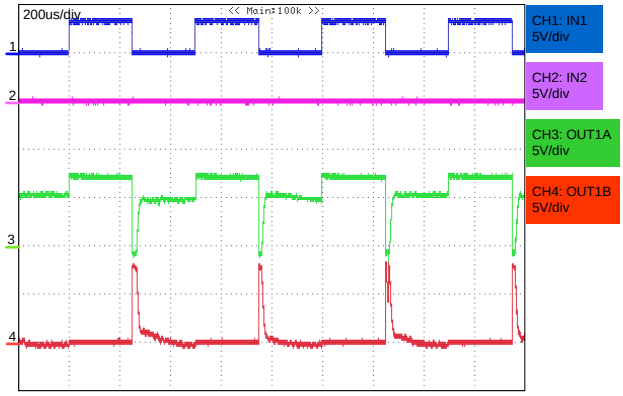


Figure 39. Forward<->Standby

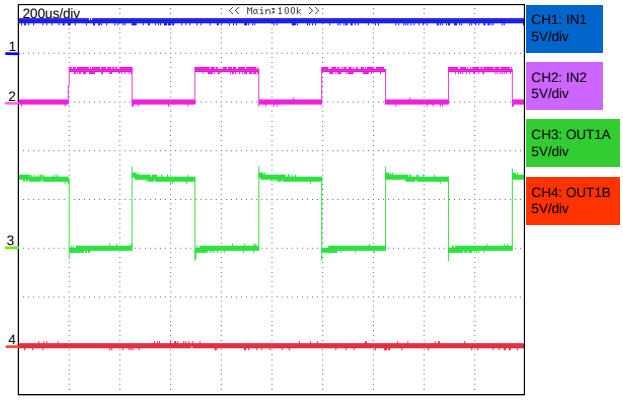
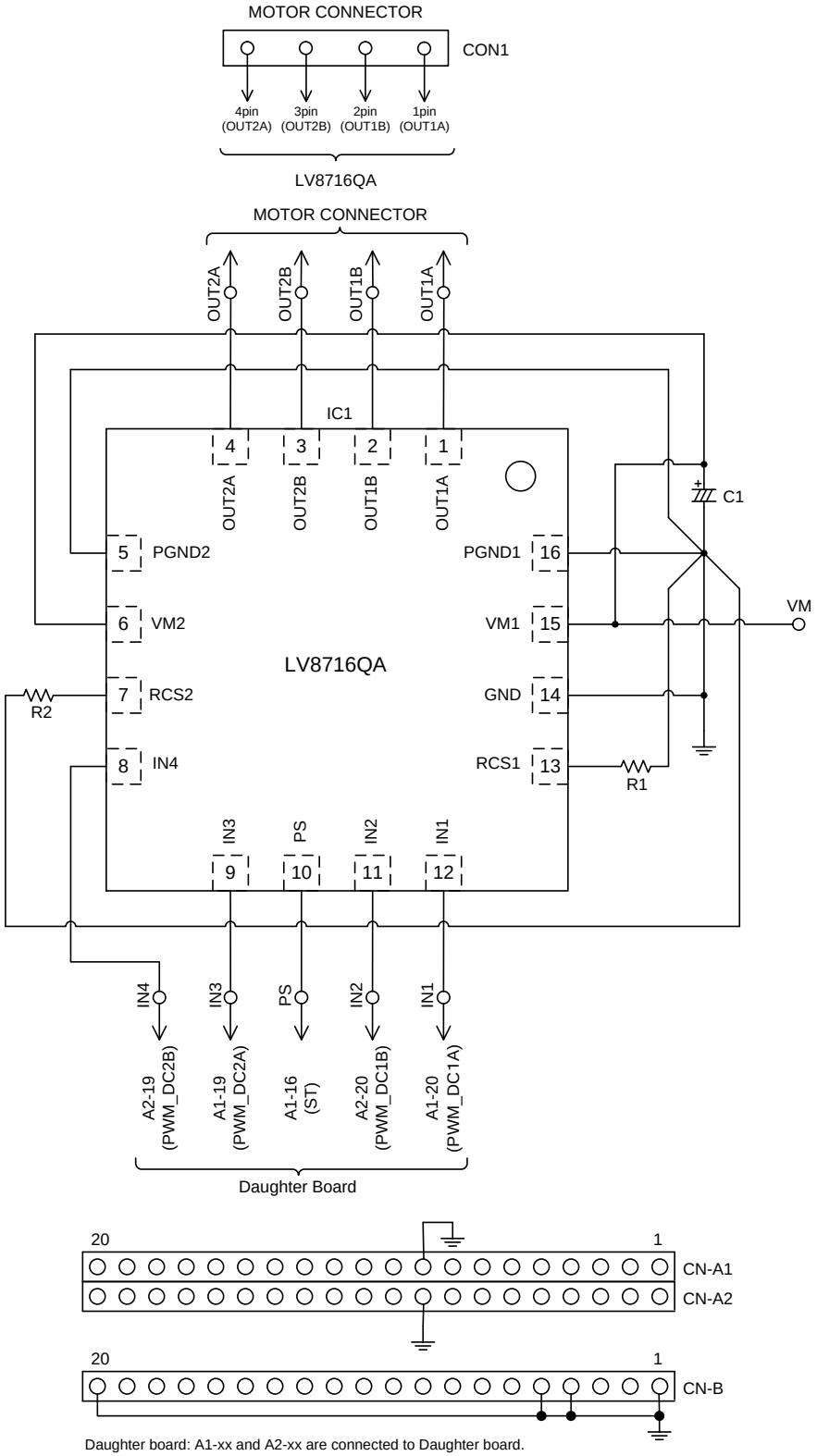


Figure 40. Forward<->Brake

Step 9. Click “Stop” button and then the motor stop. The indicator changed to “Start”.
Step 10. Click “Disable” button. The indicator changed to “Enable”.

APPENDIX A. SCHEMATIC - LV8716QAGEVK



APPENDIX B. BILL OF MATERIAL - LV8716QAGEVK

Bill of Materials for the LV8716QAGEVK Evaluation Board

ON Semiconductor®

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver	-	-	QFN16(3.0*3.0)	ON semiconductor	LV8716QA	No	Yes
R1	1	Ch1 output current detective Resistor	4.3kΩ,0.1W	±5%	1608(0603Inch)	KOA	RK73B1JT432J	Yes	Yes
R2	1	Ch2 output current detective Resistor	4.3kΩ,0.1W	±5%	1608(0603Inch)	KOA	RK73B1JT432J	Yes	Yes
C1	1	VM bypass Capacitor	10µF, 50V	±20%	-	SUN Electronic Industries	50ME10HC	Yes	Yes
Daughter Board	1	Interface board	-	-	-	ON semiconductor	-	No	Yes
CN-A1,A2,B	3	Female Socket	-	-	-	MAC8	PM-61	Yes	Yes
CON1	1	Motor Connector	-	-	-	PHOENIX CONTACT	MPT 0,5/4-2,54	Yes	Yes
TP1-5	5	Test Point	-	-	-	MAC8	ST-1-3	Yes	Yes
USB cable	1	A-MiniB	-	-	-	-	-	Yes	Yes
Ref Motor	1	Stepper Motor	-	-	-	NIDEC SANKYO Corporation	MSCA020A55	Yes	Yes