EVAL6480H-DISC and EVAL6482H-DISC: high power stepper motor driver based on the L6480H/L6482H and STM32™
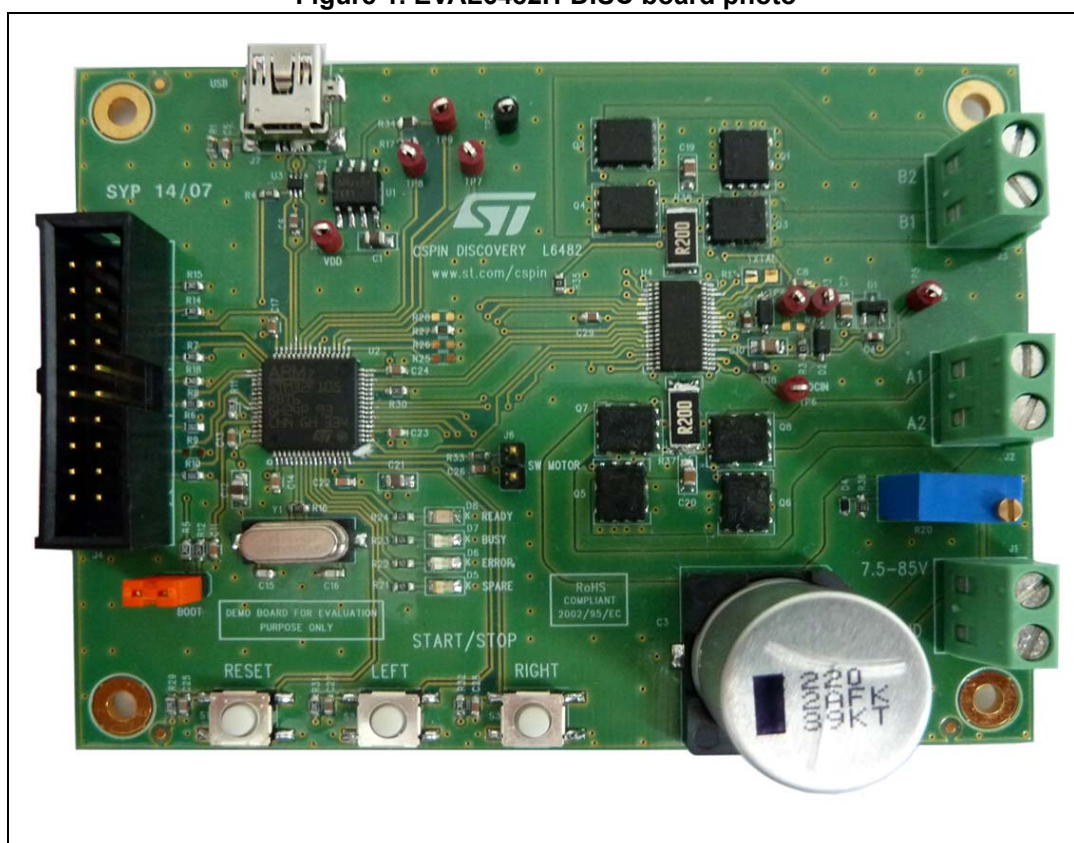
Introduction

The EVAL6480H-DISC and EVAL6482H-DISC are low cost development tools based on the L648xH controllers and STM32™.

The EVAL6480H-DISC/EVAL6482H-DISC is an ideal starter-kit for both beginners and experienced users, it is autonomous and can be used with a software interface, or it can be used with custom firmware thanks to the embedded microcontroller with the 128 kB Flash memory and 64 kB RAM.

Through the available GUI the user can easily set the full configuration of application parameters.

They are "Plug and Play" tools suitable for high power solutions thanks to the wide operating voltage range from 10.5 V to 85 V and the current capability up to 8 $A_{r.m.s}$.

Figure 1. EVAL6482H-DISC board photo

Contents

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1 Main features

The characteristics of the EVAL6480H-DISC and EVAL6482H-DISC boards are following:

- DC voltage range from 10.5 V to 85 V
- Maximum load phase current at 8 A $_{r.m.s.}$
- Footprint for external resonator or crystal
- Control interface through trimmer - user keys and limit switch input
- Control through LED indicators
- Interface control by USB and debug outputs
- Compatible with SPIN family evaluation tool
- Autonomous board thanks to the embedded firmware
- Up to 1/128 microstepping (EVAL6480H-DISC)
- Up to 1/16 microstepping (EVAL6482H-DISC)
- Optimized layout on 2-layer board - low cost and high thermal performance

The possibility with these boards is double:

- To adapt the settings with your specific application (motor - voltage) and exploring the device features by using the dedicated PC application.
- To use the board (with user parameters) directly on site - without a connected PC writing custom firmware.

2   Board specifications

2.1   EVAL6480H-DISC

Figure 2. EVAL6480H-DISC board
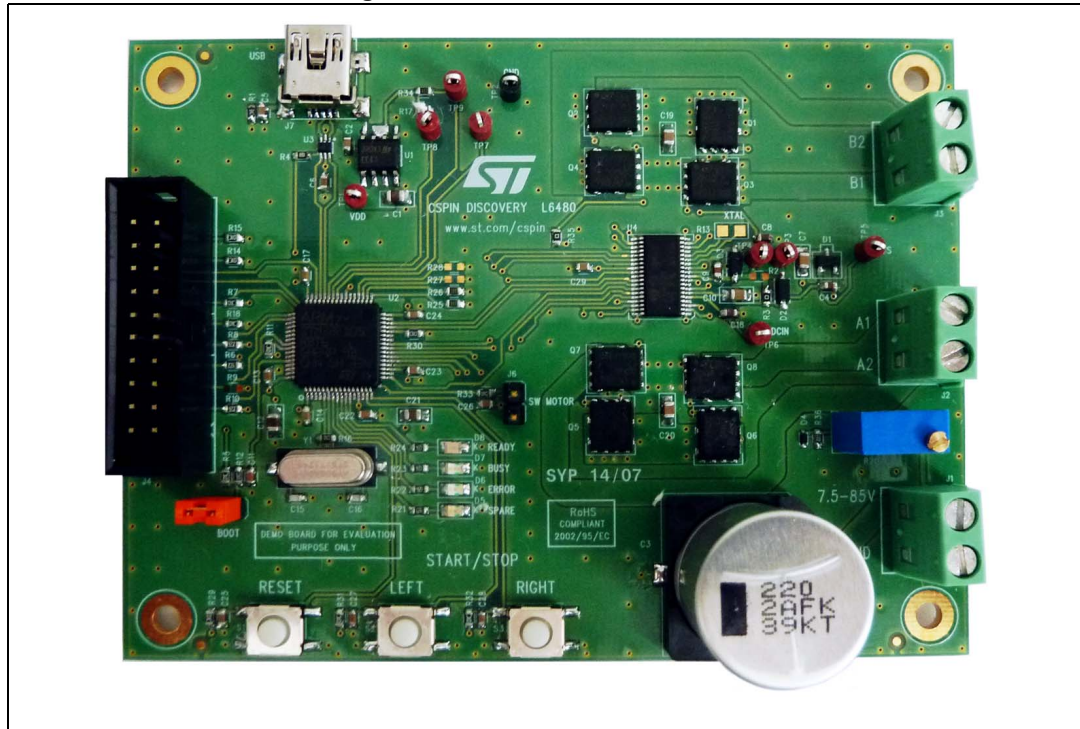
Table 1. EVAL6480H-DISC electrical specifications

Name	Value
Supply voltage (V_S)	10.5 to 85 V
Maximum output current (each phase)	8 A $_{r.m.s}$
Logic supply voltage (V_{REG})	3 V (L6480 regulator supply)
Logic interface voltage (V_{DD})	3.3 V (USB supply)
Low level logic inputs voltage	0 V
High level logic input voltage	V_{DD}
Stepping	Up to 1/128 microstepping
Operating temperature	0 to 85 °C

Figure 3. EVAL6480H-DISC schematic (microcontroller supply part)

Figure 4. EVAL6480H-DISC schematic (microcontroller part)

Figure 5. EVAL6480H-DISC schematic (motion driver part)
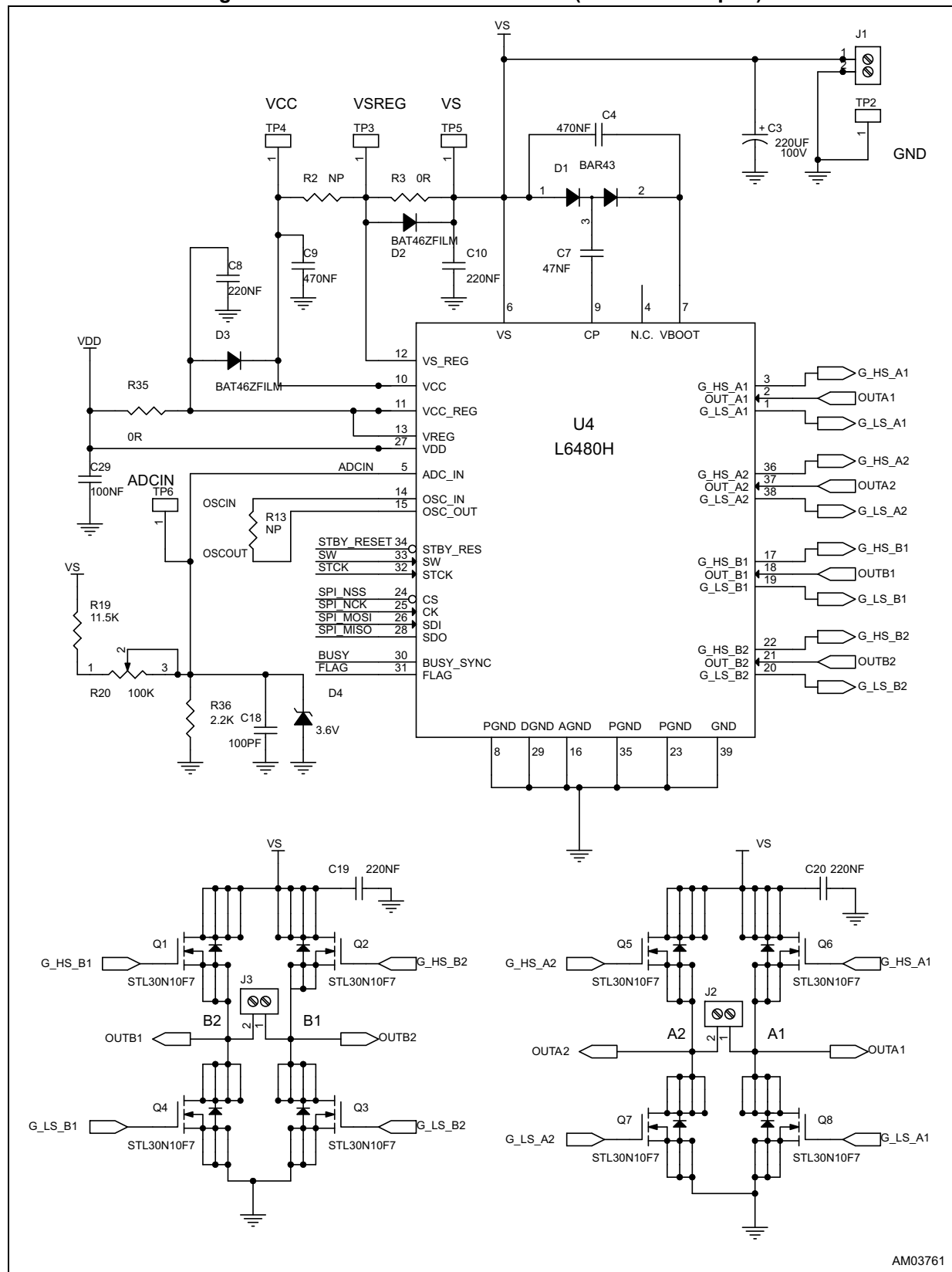
AM03761

Figure 6. EVAL6480H-DISC layout top layer and bottom layer

Table 2. EVAL6480H-DISC bill of material

Item	Qty.	Reference	Value	Package
C1, C12	2	CAP. CER. 10 µF 10 V X7R 0805	10 µF	0805
C2, C6, C13, C14, C17, C23 - C25, C27 - C29	11	CAP. CER. 100 nF 50 V X7R 0603	100 nF	0603
C3	1	CAP. ELEC. 220 µF 100 V	220 µF	CAPES-R18H17
C4, C9	2	CAP. CER. 470 nF 25 V X7R 0603	470 nF	0603
C5	1	CAP. CER. 4.7 nF 50 V X7R 0603	4.7 nF	0603
C7	1	CAP. CER. 47 nF 100 V X7R/X7S 0805	47 nF	0805
C8,	1	CAP. CER. 220 nF 35 V X7R 0603	220 nF	0603
C10, C19, C20	3	CAP. CER. 220 nF 100 V X7R 0805	220 nF	0805
C11, C22, C26	3	CAP. CER. 10 nF 50 V X7R 0603	10 nF	0603
C15, C16	2	CAP. CER. 20 pF 50 V COG 0603	20 pF	0603
C18	1	CAP. CER. 100 pF 50 V COG 0603	100 pF	0603
C21	1	CAP. CER. 1 µF 10 V X7R 0805	1 µF	0805
D1	1	Double diode - high speed switching diode	BAR43	SOT23
D2, D3	2	Diode Schottky 150 mA	BAT46ZFILM	SOD 123
D4	1	Zener regulator	3.6 V	SOD 523
D5	1	LED yellow - 0805 -6mcd - 588nm	Yellow	0805
D6	1	LED red - 0805 -2mcd - 621nm	Red	0805
D7	1	LED orange - 0805 -2mcd - 602nm	Orange	0805
D8	1	LED green - 0805 -6mcd - 569nm	Green	0805
FIX1 - FIX4	4	Hole		Diam. 3 mn

Table 2. EVAL6480H-DISC bill of material (continued)

Item	Qty.	Reference	Value	Package
J1 - J3	3	Screw connector 2 poles MKDSN 1.5/2-5.08	MKDSN1.5/2-5.08	MKDSN1.5/2-5.08
J4	1	JTAG CON. - STRAIGHT - 10 x 2-180 M	CON-STRAIGHT- 10 x 2 - 180 M	CON-FLAT - 10 x 2 - 180 M
J5, J6	2	JUMP254P-M-2	OPEN	2.54 mn
J7	1	USB_B_MINI_AMP_1734035-1	CN-USB	CMS mini USB
MIRE1-MIRE3	3	OPTICAL_TARGET	OPTICAL_TARGET	Diam 1mn
Q1 - Q8	8	N-channel 100 V, 27 mΩ, 8 A STripFET™ VII DeepGATE™ Power MOSFET in PowerFLAT™ 5 x 6 package	STL30N10F7	PowerFLAT 5 x 6
R1, R16	2	Res. 1 MΩ 1/10 W 5% 0603 SMD	1 MΩ	0603
R2, R27, R28	3	Res. NP 0603	NP	0603
R3, R35	2	Res. 0 Ω 5% 1/10 W 0603	0 Ω	0603
R4	1	Res. 1.5 KΩ 1/10 W 5% 0603 SMD	1.5 KΩ	0603
R5, R7, R11, R14, R15, R17, R18, R29, R31, R32	10	Res. 10 KΩ 5% 1/10 W 0603 SMD	10 KΩ	0603
R6, R8 - R10	4	Res. 4.7 KΩ 5% 1/10 W 0603 SMD	4.7 KΩ	0603
R12, R33	2	Res. 100 Ω 5% 1/10 W	100 Ω	0603
R13	1	Res. NP 0805	NP	0805
R19	1	Res. 11.5 KΩ 1% 1/10 W 0603	11.5 KΩ	0603
R20	1	Trimmer 100 KΩ 100 x 50 x 110 64 W	100 KΩ	Trimm. 100 x 50 x 110
R21 - R24	4	Res. 470 Ω 5% 1/10 W 0603	470 Ω	0603
R25, R26, R34	3	Res. 1 KΩ 5% 1/10 W 0603 SMD	1 KΩ	0603
R30	1	Res. 100 KΩ 5% 1/10 W 0603 SMD	100 KΩ	0603
R36	1	Res. 2.2 KΩ 1/10 W 5% 0603 SMD	2.2 KΩ	0603
S1 - S3	3	Switch button SMD	EVQQ2D03W	CMS 6.5 x 6 x 3.1
TP1, TP3 - TP9	8	Test point red	KEYSTONE-5000	TH
TP2	1	Test point black	KEYSTONE-5001	TH
U1	1	IC REG 1300 MA LN 3.3 V	LD1117D33TR	SO8
U2	1	IC, MCU, RISC, 72 MHz, 3.6 V, 32-bit, 64-pin, LQFP	STM32F105RBT6	LQFP64 10 x 10
U3	1	USBLC6-2P6 - TVS USB2	USBLC6-2P6	SOT 666
U4	1	L6480 motor controller	L6480H	HTSSOP38
Y1	1	XTAL 8 MHz - 30 PPM - 20 pF	8 MHz	HC49/US-SM

2.2 EVAL6482H-DISC

Figure 7. EVAL6482H-DISC board
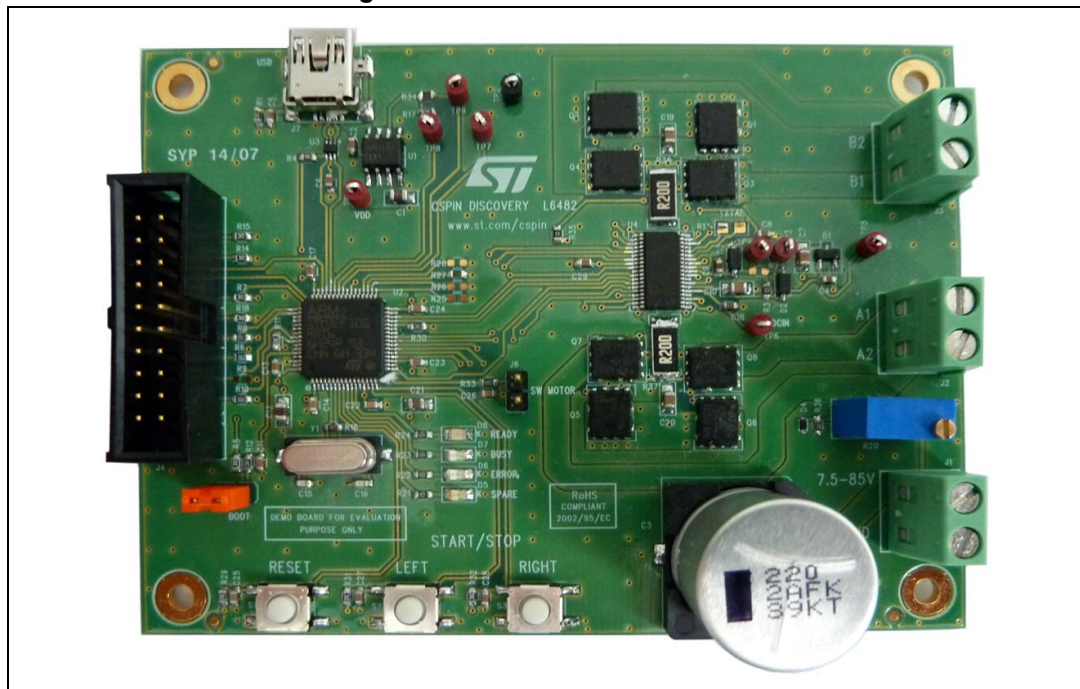
Table 3. EVAL6482H-DISC electrical specifications

Name	Value
Supply voltage (V_S)	10.5 to 85 V
Maximum output current (each phase)	8 A $_{r.m.s}$
Logic supply voltage (V_{REG})	3 V (L6482 regulator supply)
Logic interface voltage (V_{DD})	3.3 V (USB supply)
Low level logic inputs voltage	0 V
High level logic input voltage	V_{DD}
Stepping	Up to 1/16 microstepping
Operating temperature	0 to 85 °C

Figure 8. EVAL6482H-DISC schematic (microcontroller supply part)
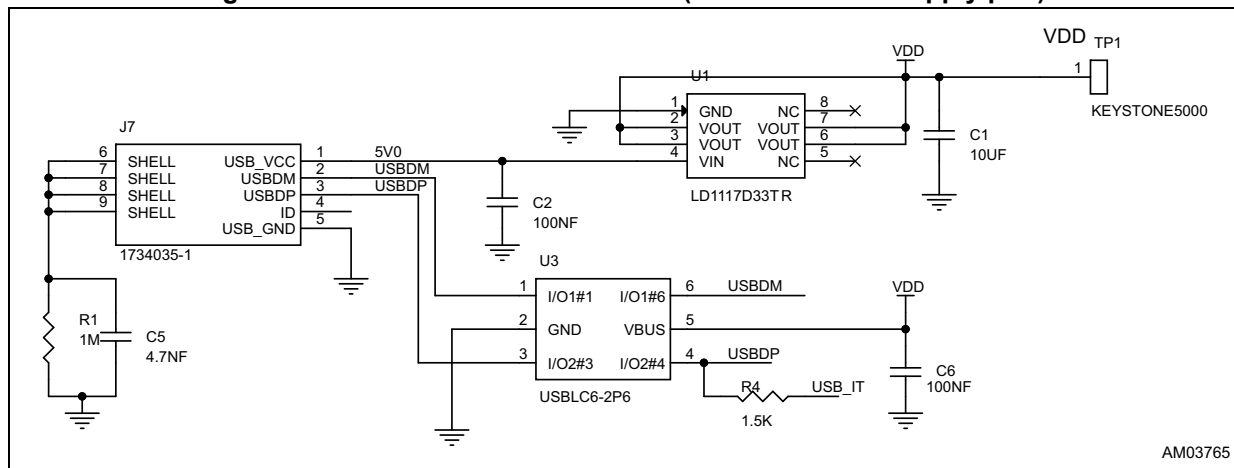
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Figure 9. EVAL6482H-DISC schematic (microcontroller part)
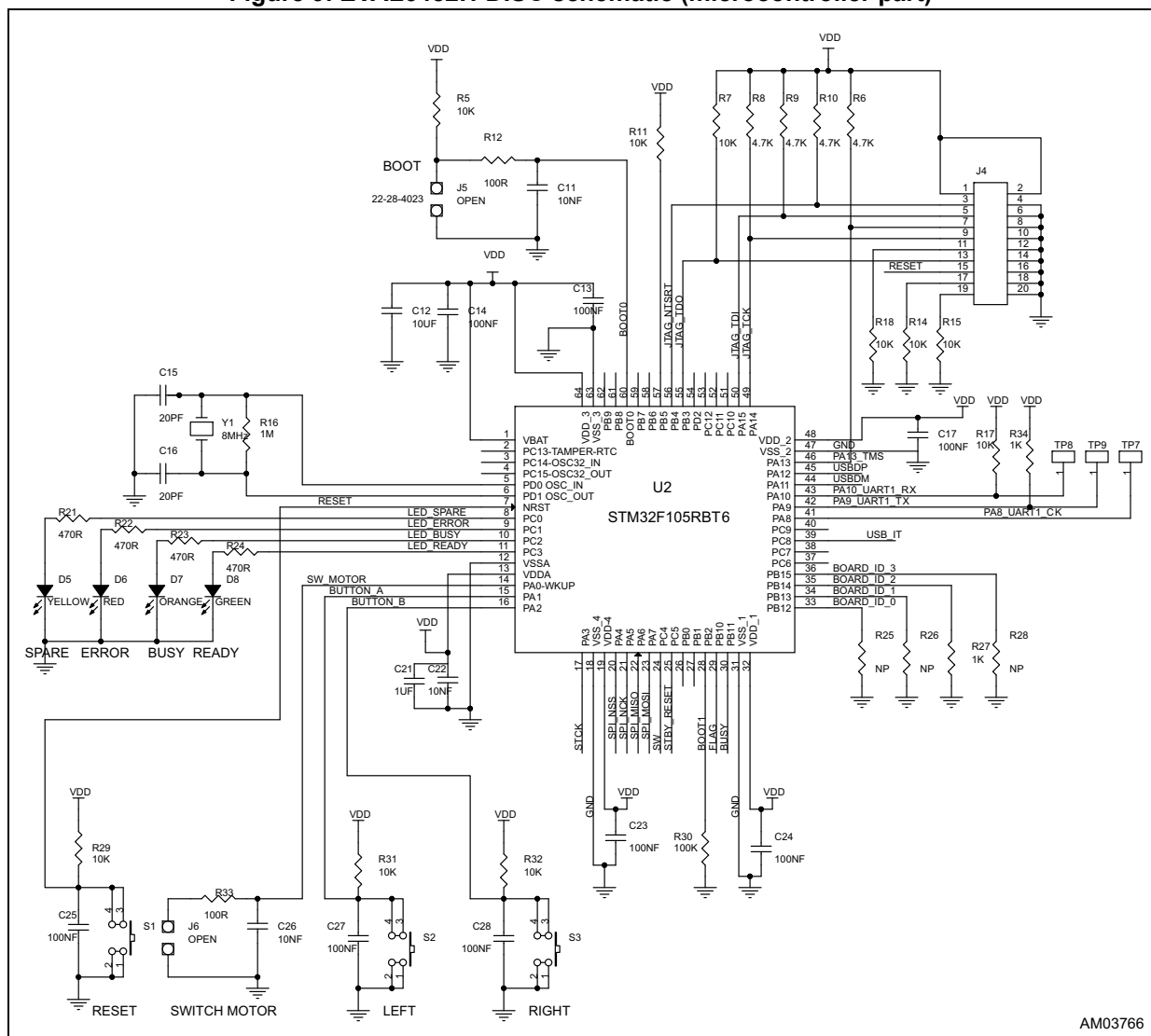
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Figure 10. EVAL6482H-DISC schematic (motor driver part)

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Figure 11. EVAL6482H-DISC layout top layer and bottom layer

Table 4. EVAL6482H-DISC bill of material

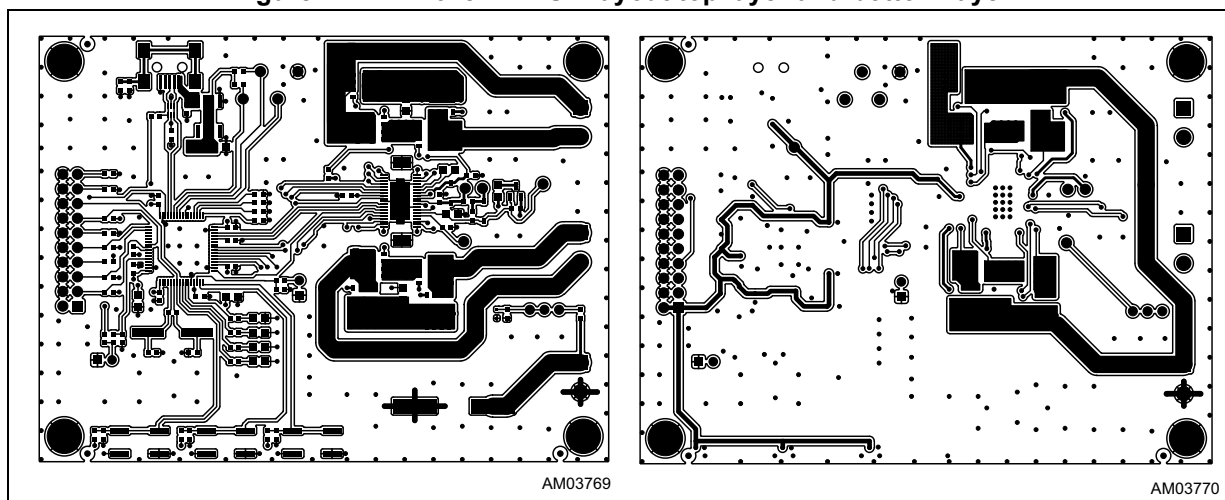| Item	Qty.	Reference	Value	Package
C1, C12	2	CAP. CER. 10 µF 10 V X7R 0805	10 µF	0805
C2, C6, C13, C14, C17, C23-C25, C27 - C29	11	CAP. CER. 100 nF 50 V X7R 0603	100 nF	0603
C3	1	CAP. ELEC. 220 µF 100 V	220 µF	CAPES-R18H17
C4, C9	2	CAP. CER. 470 nF 25 V X7R 0603	470 nF	0603
C5,	1	CAP. CER. 4.7 nF 50 V X7R 0603	4.7 nF	0603
C7,	1	CAP. CER. 47 nF 100 V X7R/X7S 0805	47 nF	0805
C8,	1	CAP. CER. 220 nF 35 V X7R 0603	220 nF	0603
C10, C19, C20	3	CAP. CER. 220 nF 100 V X7R 0805	220 nF	0805
C11, C22, C26	3	CAP. CER. 10 nF 50 V X7R 0603	10 nF	0603
C15, C16	2	CAP. CER. 20 pF 50 V COG 0603	20 pF	0603
C18	1	CAP. CER. 100 pF 50 V COG 0603	100 pF	0603
C21	1	CAP. CER. 1 µF 10 V X7R 0805	1 µF	0805
D1	1	Double diode - high speed switching diode	BAR43	SOT23
D2, D3	2	Diode Schottky 150 mA	BAT46ZFILM	SOD 123
D4	1	Zener regulator	3.6 V	SOD 523
D5	1	LED yellow - 0805 -6mcd - 588nm	Yellow	0805
D6	1	LED red - 0805 -2mcd - 621nm	Red	0805
D7	1	LED orange - 0805 -2mcd - 602nm	Orange	0805
D8	1	LED green - 0805 -6mcd - 569nm	Green	0805
FIX1 - FIX4	4	Hole		Diam 3mn
J1 - J3	3	Screw connector 2 poles MKDSN 1.5/2-5.08	MKDSN1.5/2-5.08	MKDSN1.5/2-5.08
J4	1	JTAG CON. - STRAIGHT - 10 x 2 -180 M	CON. - STRAIGHT - 10 x 2 - 180 M	CON. - FLAT - 10 x 2 - 180 M
J5, J6	2	JUMP254P-M-2	OPEN	2.54 mn
J7	1	USB_B_MINI_AMP_1734035-1	CN-USB	CMS mini USB
MIRE1-MIRE3	3	OPTICAL_TARGET	OPTICAL_TARGET	Diam. 1 mn
Item	Quantity	Reference	Value	Package
Q1 - Q8	8	N-channel 100 V, 27 mΩ, 8 A STripFET™ VII DeepGATE™ Power MOSFET in PowerFLAT™ 5 x 6 package	STL30N10F7	PowerFLAT 5 x 6
R1, R16	2	RES. 1 MΩ 1/10 W 5% 0603 SMD	1 MΩ	0603

Table 4. EVAL6482H-DISC bill of material (continued)

Item	Qty.	Reference	Value	Package
R2, R25, R26, R28	4	RES. NP 0603	NP	0603
R3, R35	2	RES. 0 Ω 5% 1/10 W 0603	0 Ω	0603
R4	1	RES. 1.5 KΩ 1/10 W 5% 0603 SMD	1.5 KΩ	0603
R5, R7, R11, R14, R15, R17, R18, R29, R31, R32	10	RES. 10 KΩ 5% 1/10 W 0603 SMD	10 KΩ	0603
R6, R8 - R10	4	RES. 4.7 KΩ 5% 1/10 W 0603 SMD	4.7 KΩ	0603
R12, R33	2	RES. 100 Ω 5% 1/10 W	100 Ω	0603
R13	1	RES. NP 0805	NP	0805
R19	1	RES. 11.5 KΩ 1% 1/10 W 0603	11.5 KΩ	0603
R20	1	Trimmer 100 KΩ 100 x 50 x 110 64 W	100 KΩ	Trimm. 100 x 50 x 110
R21 - R24	4	RES. 470 Ω 5% 1/10 W 0603	470 Ω	0603
R27, R34	2	RES. 1 KΩ 5% 1/10 W 0603 SMD	1 KΩ	0603
R30	1	RES. 100 KΩ 5% 1/10 W 0603 SMD	100 KΩ	0603
R36	1	RES. 2.2 KΩ 1/10 W 5% 0603 SMD	2.2 KΩ	0603
R37, R38	2	RES. 0.02 Ω 5% 3 W 2512	0.02 Ω	2512
S1 - S3	3	Switch button SMD	EVQQ2D03W	CMS 6.5 x 6 x 3.1
TP1, TP3 - TP9	8	Test point red	KEYSTONE-5000	TH
TP2	1	Test point black	KEYSTONE-5001	TH
U1	1	IC REG 1300 MA LN 3.3 V	LD1117D33TR	SO8
U2	1	IC, MCU, RISC, 72 MHz, 3.6 V, 32-bit, 64-pin, LQFP	STM32F105RBT6	LQFP64 10 x 10
U3	1	USBLC6-2P6 - TVS USB2	USBLC6-2P6	SOT 666
U4	1	L6482 motor controller	L6482H	HTSSOP38
Y1	1	XTAL 8 MHz-30 PPM-20 pF	8 MHz	HC49/US-SM

3 General description

3.1 Power supply

The EVAL6480H-DISC and EVAL6482H-DISC boards are designed to be powered via:

- Connector J1: power of the power stage and motor controller.
- USB connector J5: power of the microcontroller and the logic control.

The USB cable supplies the digital part through a dedicated LDO (U1) providing 3.3 V.

The V_S supply (J1) must be set according to the voltage required by the user motor.

Note: ***Both the supply sources (USB connector and J1 connector) must be present to make the board operative.***

Figure 12. Power supply section
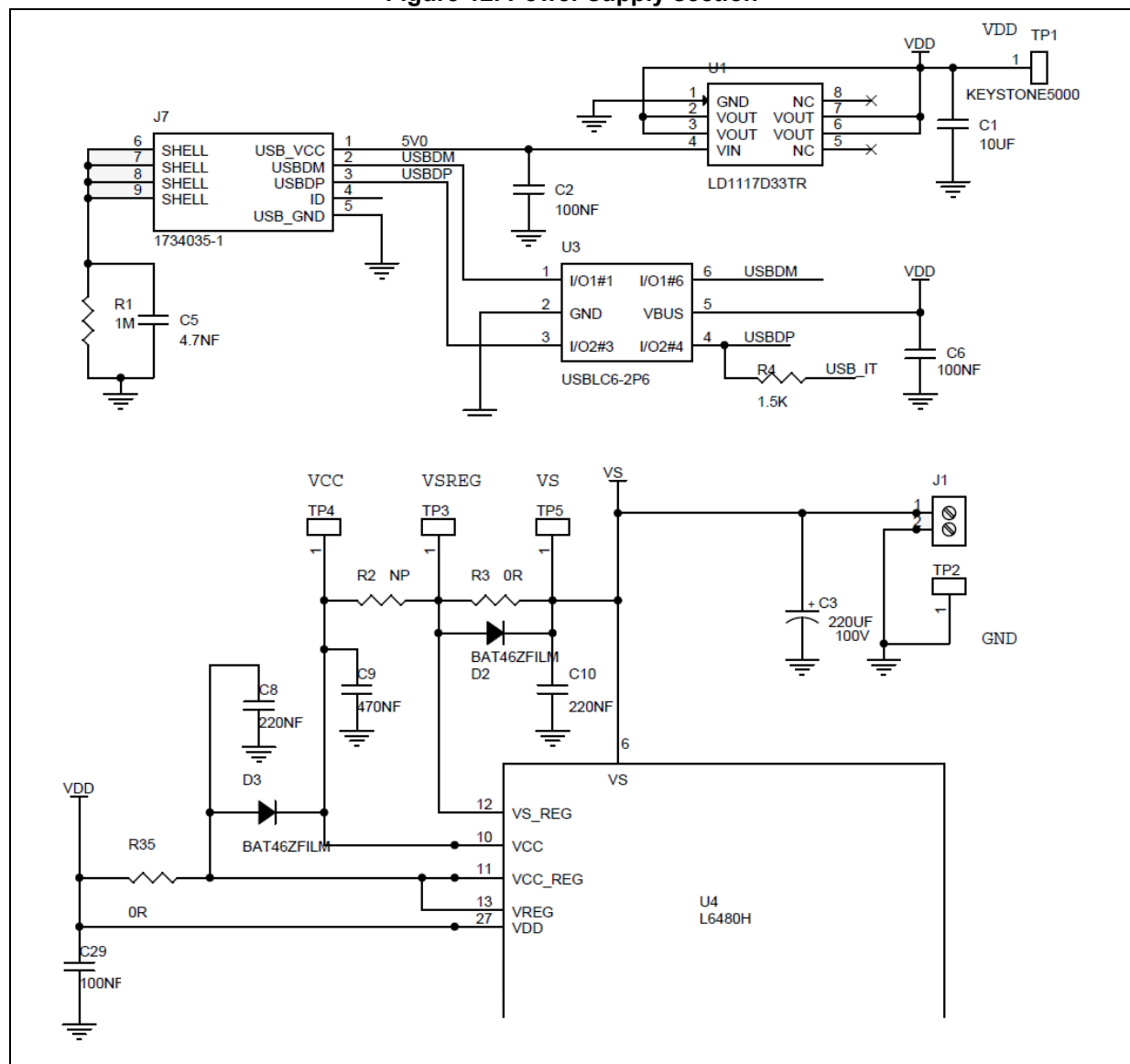
3.2 L6480 and L6482 stepper motor controller

Features

- Operating voltage: 7.5 - 85 V
- Dual full-bridge gate driver for N-channel MOSFETs
- Fully programmable gate driving
- Programmable speed profile
- Integrated voltage regulators
- SPI interface
- Low quiescent standby currents
- Programmable non-dissipative overcurrent
- Overtemperature protection
  Only for L6480H
- Up to 1/128 microstepping
- Sensorless stall detection
  Only for L6482H
- Up to 1/16 microstepping
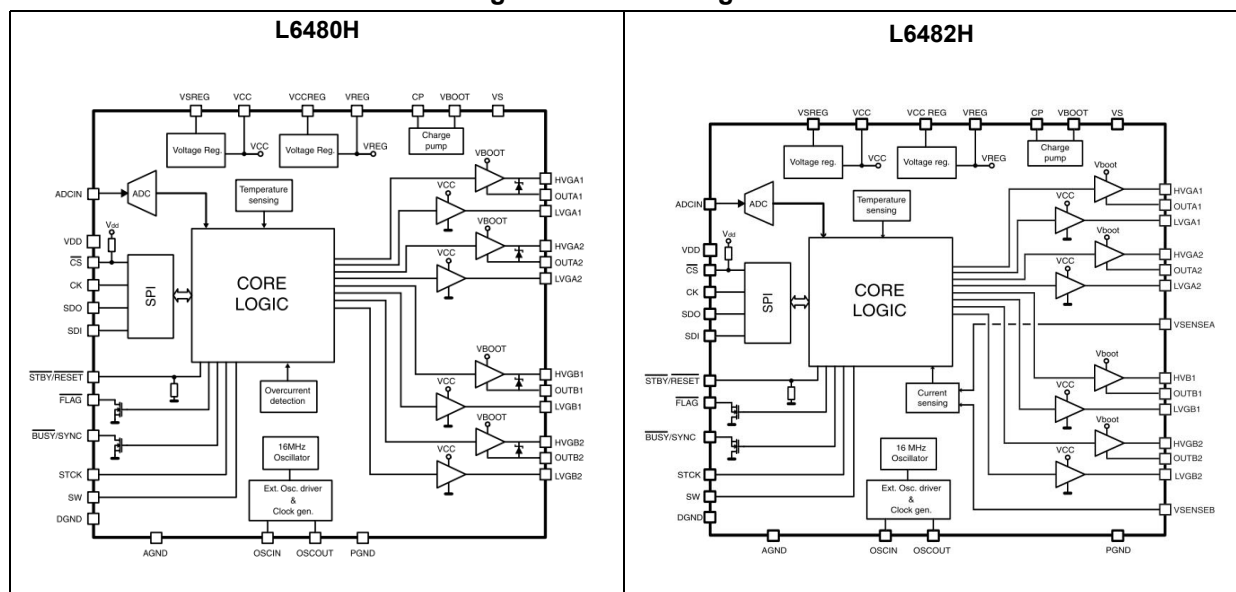- Advanced current control with auto-adaptive decay mode.

Figure 13. Block diagram

Table 5. L6480 and L6482 recommended operating conditions

Symbol	Parameter	Test condition	Value	Unit
V_{DD}	Logic interface supply voltage		3.3	V
V_{REG}	Logic supply voltage		3.3	V
V_S	Motor supply voltage		Mini: V_{SREG} Maxi: 85	V
V_{SREG}	Internal V_{CC} voltage regulator		Mini: V_{CC} +3 Maxi: V_S	V
V_{CC}	Gate driver supply voltage	V_{CC} voltage imposed by external source ($V_{SREG} = V_{CC}$)	Mini: 7.5 Maxi: 15	V
V_{CCREG}	Internal V_{REG} voltage regulator supply voltage	V_{REG} voltage internally generated	Mini: 6.3 Maxi: V_{CC}	V
V_{ADC}	Integrated ADC input voltage range (ADCIN pin)		Mini 0 Maxi: V_{REG}	V

3.3 Charge pump

The L6480H and L6482H devices use an internal charge pump for driving correctly the external high-side MOSFETs. The charge pump is obtained through an oscillator and few external components.

Figure 14. Charge pump section
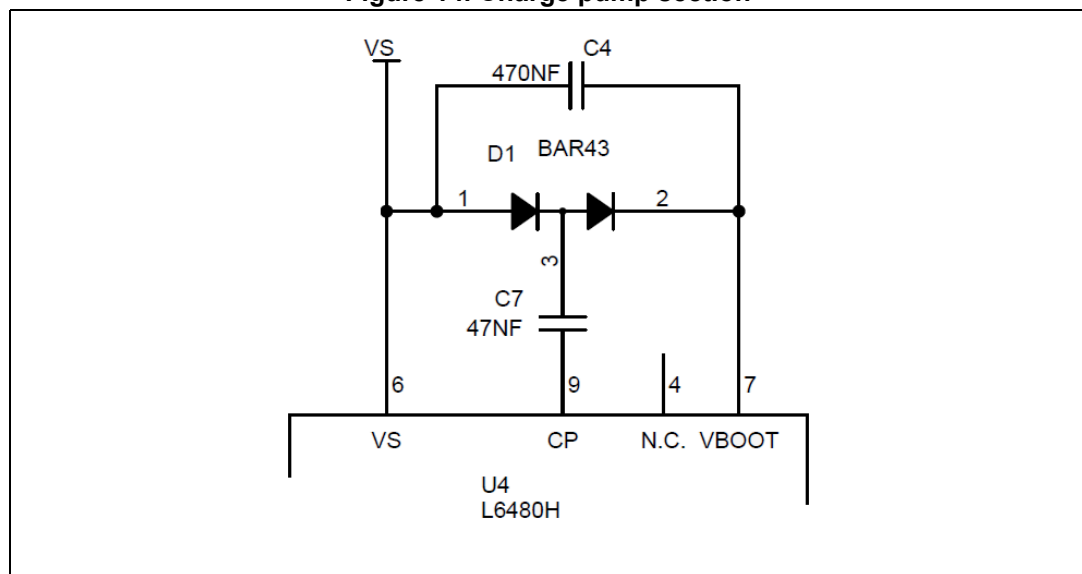
4   Device configuration

This section offers an overview of the basic configuration steps which are required to make the demonstration board operative.

Warning: **Important - the device configuration is mandatory. The default configuration is not operative.**
                 Before changing the device configuration verify that the device is in high impedance status (power stage is disabled).

4.1   Gate drivers

The system allows controlling a wide range of motors - thanks to a large driver's settings choice.

For details please refer to the AN4354: "L648x devices: gate drivers setup" - application note available on www.st.com.

The board includes 2 STL30N10F7 - half bridge N-channel MOSFETs. These MOSFETs presents low R_{DSon} adding high switching performance. Few several settings could by applied depending on choice of supply voltage motors, EMI tolerance vs. speed of the communication.

We propose two configurations according to the user choice:

- Performance: low power dissipation vs. fast commutation - high electromagnetic interference.
- Recommended: medium power dissipation, commutation and electromagnetic interference.

Table 6. Settings gate driving

Parameter	Performance solution (value)	Recommended solution (value)	Unit
Gate current	96	32	mA
VCC value	7.5	7.5	V
UVLO thresholds	7	7	V
Turn OFF boost time	Disabled	Disabled	ns
Controlled current time	250	750	ns
Blanking time	250	250	ns
Deadtime	125	125	ns

4.2 Voltage mode driving (EVAL6480H-DISC)

The configuration parameters of the voltage mode driving can be obtained through the BEMF compensation tool embedded into the SPIN family software.

A wrong setup of these parameters could cause several issues, in particular:

- The phase current decreases with the speed and the motor is stall.
- The wrong voltage is applied to the motor and the system is very noisy.
- The phase current reaches the overcurrent limit.

The BEMF compensation form uses the application parameters as inputs in order to evaluate the proper device setup.

The required inputs are:

- Supply voltage.
- Target phase current (r.m.s. value) at different motion conditions (acceleration, deceleration, constant speed and holding).
- Target operating speed (maximum speed).
- Motor characteristics.

The motor characteristics are: the electrical constant (Ke), phase inductance and resistance. The inductance and the resistance of the phase are given in the motor datasheet. The Ke is rarely given in the specification and must be measured.

In the help section of the SPIN family software, a step by step procedure is explained. The same procedure can also be found in the application note AN4144: "Voltage mode control operation and parameter optimization" on www.st.com.

Click on the "evaluate" button to get the suggested setup for the voltage mode driving. Then click on the "write" button to copy the data into the registers of the device.

Figure 15. B.E.M.F compensation - SPIN family evaluation software

Advanced current control (EVAL6482H-DISC)

The following configuration gives good results with most of motors:

Table 7. Voltage mode driving

Parameter	Value	Unit
Minimum ON time	4	µs
Minimum OFF time	21	µs
Maximum fast decay (TOFF_FAST)	10	µs
Maximum fast decay at step change (FAST_STEP)	16	µs
Target switching time	48	µs

The impacts of the timing parameters are explained in the application note AN4158: "Peak current control with automatic decay adjustment and predictive current control: basics and setup".

4.3   Overcurrent protection

The overcurrent protection monitors the drain-source voltage drop of all the external Power MOSFETs and disables the power stage when the programmed threshold is reached.

**Warning: The overcurrent protection can be disabled setting the flag "Over-current- shutdown".
However it is not recommended to disable this protection.**

The stall detection threshold should be just above the operating peak current of the application. During the preliminary stages of evaluation, it can be set to the maximum value.

Figure 16. Overcurrent protection

4.4 Stall detection (EVAL6480H-DISC)

The L6480 device also includes a sensorless stall detection system. This feature allows the device to detect the stall condition of the motor measuring the increase of the phase current caused by the sudden cancellation of the back electromotive force.

The stall detection threshold must be set above the nominal peak current.

Figure 17. Example of stall detection

5 Programming section

5.1 STM32F105RB microcontroller

The STM32F105xx device incorporates the high-performance ARM® Cortex™-M3 32-bit RISC core operating at a 72 MHz frequency, high-speed embedded memories (Flash memory up to 256 Kbytes and SRAM 64 Kbytes), and an extensive range of enhanced I/O and peripherals connected to two APB buses. All devices offer two 12-bit ADCs, four general-purpose 16-bit timers plus a PWM timer, as well as standard and advanced communication interfaces: up to two I^{2}Cs, three SPIs, two I2Ss, five USARTs, an USB OTG FS and two CANs.

The STM32F105xx operates in the -40 to +105 °C temperature range, from a 2.0 to 3.6 V power supply. A comprehensive set of power-saving mode allows the design of low-power applications.

The STM32F105xx offers devices in three different package types: from 64 pins to 100 pins. Depending on the device chosen, different sets of peripherals are included.

These features make the STM32F105xx and STM32F107xx connectivity line microcontroller family suitable for a wide range of applications such as motor drives and application control, medical and handheld equipment, industrial applications, PLCs, inverters, printers, and scanners, alarm systems, video intercom, HVAC and home audio equipment.

Please refer to the STM32F105xx datasheet for an overview of the complete range of peripherals proposed in this family.

Please refer to the STM32F105xx reference manual RM0008 to get more information on the microcontroller operation.

The STM32F105RBT6 has a 64-pin LQFP package with 128 KBytes Flash memory and operates in the -40 to +85 °C temperature range.

Figure 18 shows the general block diagram of the STM32F105xx and STM32F107xx family.

Figure 18. STM32F105xx and STM32F107xx block diagram
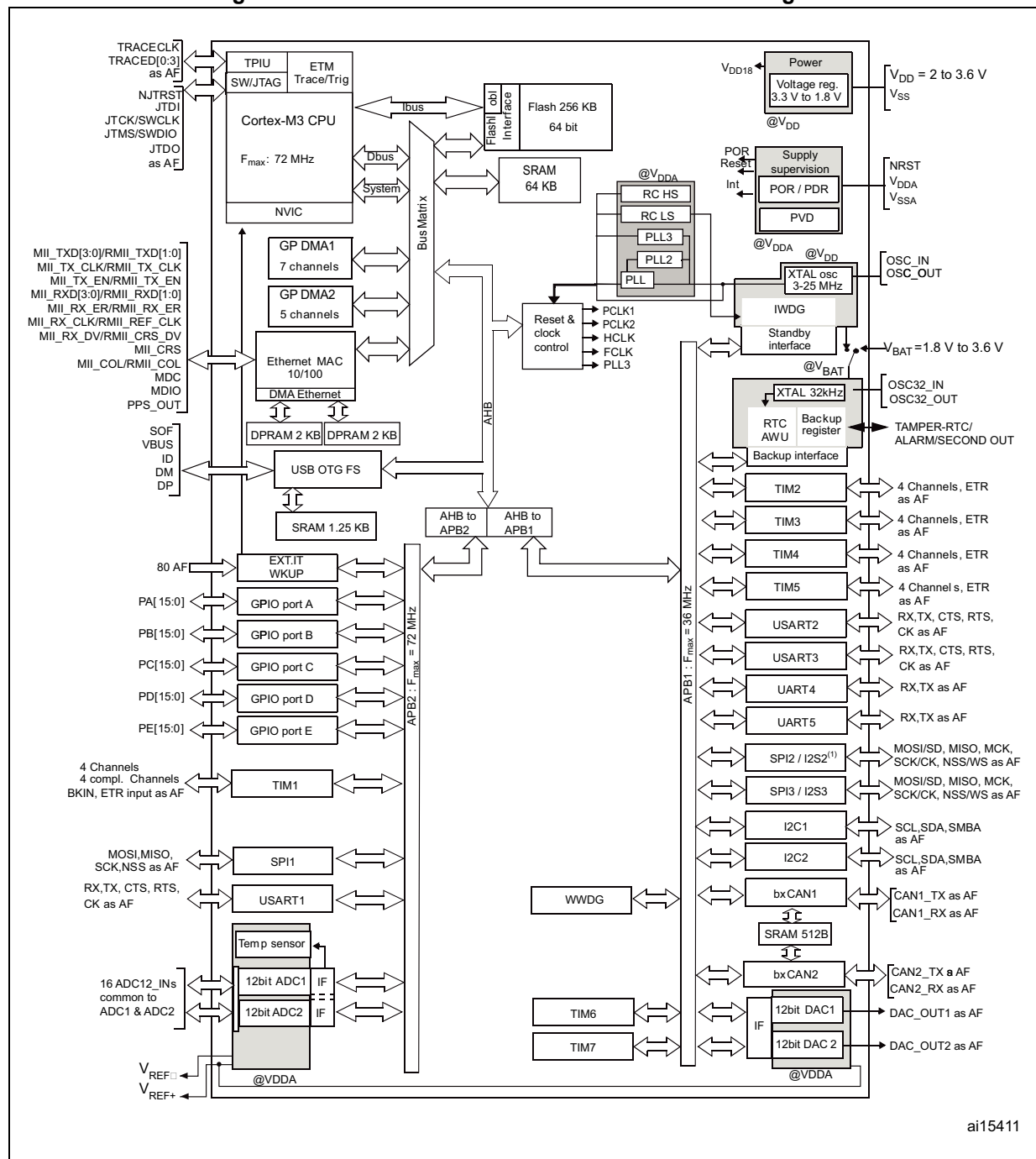
5.2 Firmware loading

This section describes how to load firmware into the board by using the DfuSe demonstration software.

5.2.1 DfuSe installation

You need first to download the DfuSe demonstration software from www.st.com.

The DfuSe tool is referenced under the development suite STSW-STM32080.

Once downloaded, run the setup.exe file.

More details on the DfuSe are given in the UM0412: "Getting started with DfuSe USB device firmware upgrade STMicroelectronics extension" user manual.
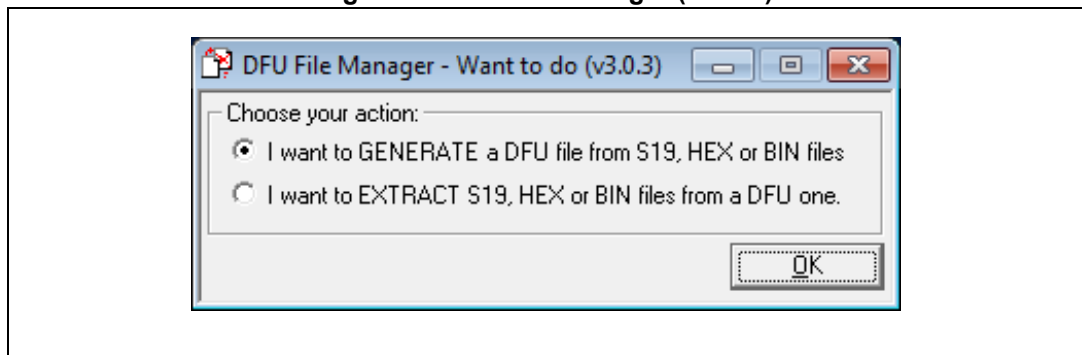
5.2.2 Generate a DFU file from a HEX file

If the file you want to download to the discovery board is not a DFU file but a HEX file, you will need first to convert it.

In this purpose:

- Start the DFU file manager (V3.0.3 or greater) which has been installed with the DfuSe.
- Choose "I want to GENERATE a DFU file from S19, HEX or BIN files".

Figure 19. DFU file Manager (action)

- Click the "S19 or Hex"… button
- Select in the open dialog box the file of type "hex Files", select the HEX file and click "OK".
- Click on the "Generate …" button
- Give a name to the *.DFU file and click on the "Save" button.

Figure 20. DFU file Manager (Generation)
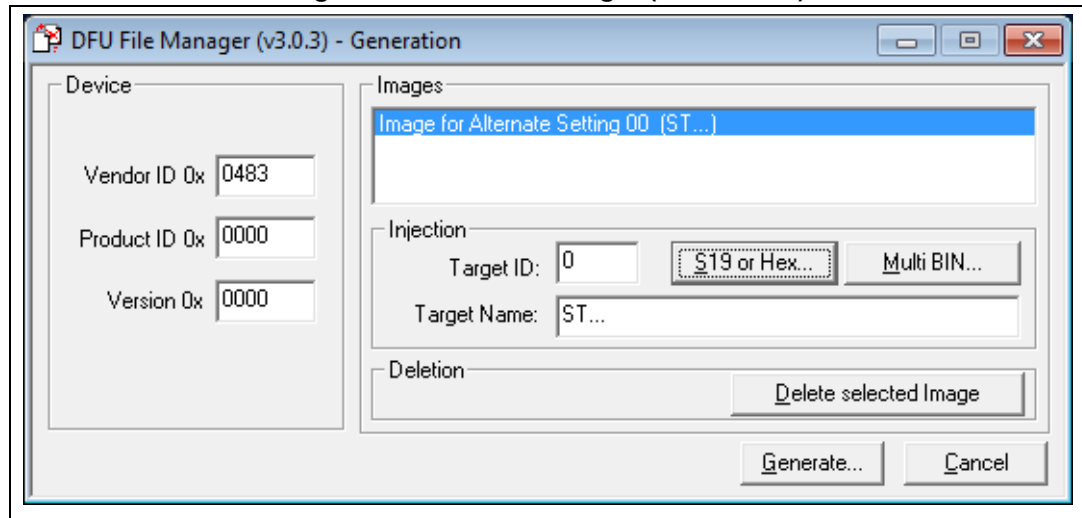
5.2.3 Board settings

To be able to download firmware, the discovery board should be started in the "DFU" mode.

In this purpose:

1. Remove the jumper from the "Boot" pins.
2. Plug a USB cable between the discovery board and the PC.

It does not matter if the discovery board is plugged or not to a 5 - 45 V DC supply.

Figure 21. Board settings
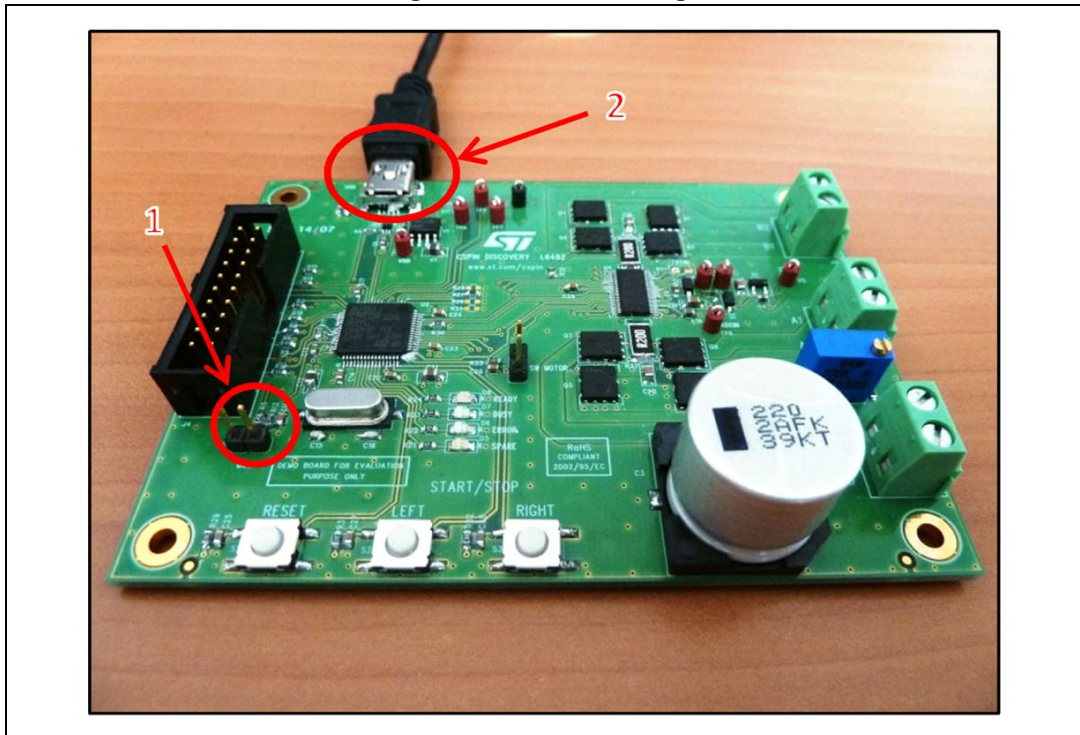
5.2.4 DFU loading

At this step, you are now ready to perform the firmware upgrade.

1. Start the "DfuSeDemo.exe".

2. You must have an "STM Device in DFU Mode" in the list of the "Available DFU Devices". Else, it means that your board is not correctly configured or not connected to the PC.

Figure 22. DFU loading
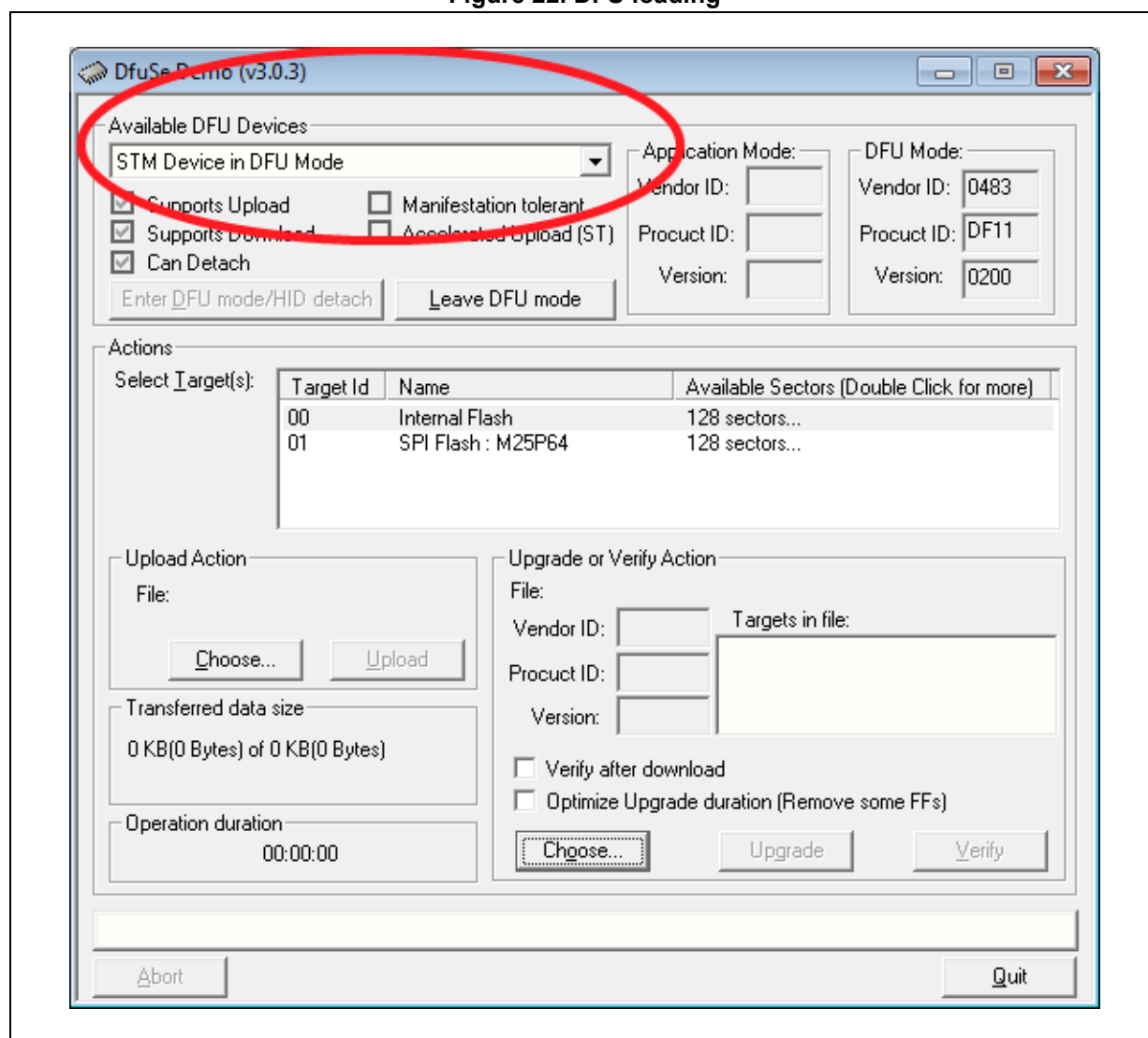
3. In the "Upgrade or Verify Action group", click on the "Choose…" button.

4. Select the *.dfu file of your choice in the "Open" dialog box and click on the "Open" button.

Figure 23. DFU file (open)
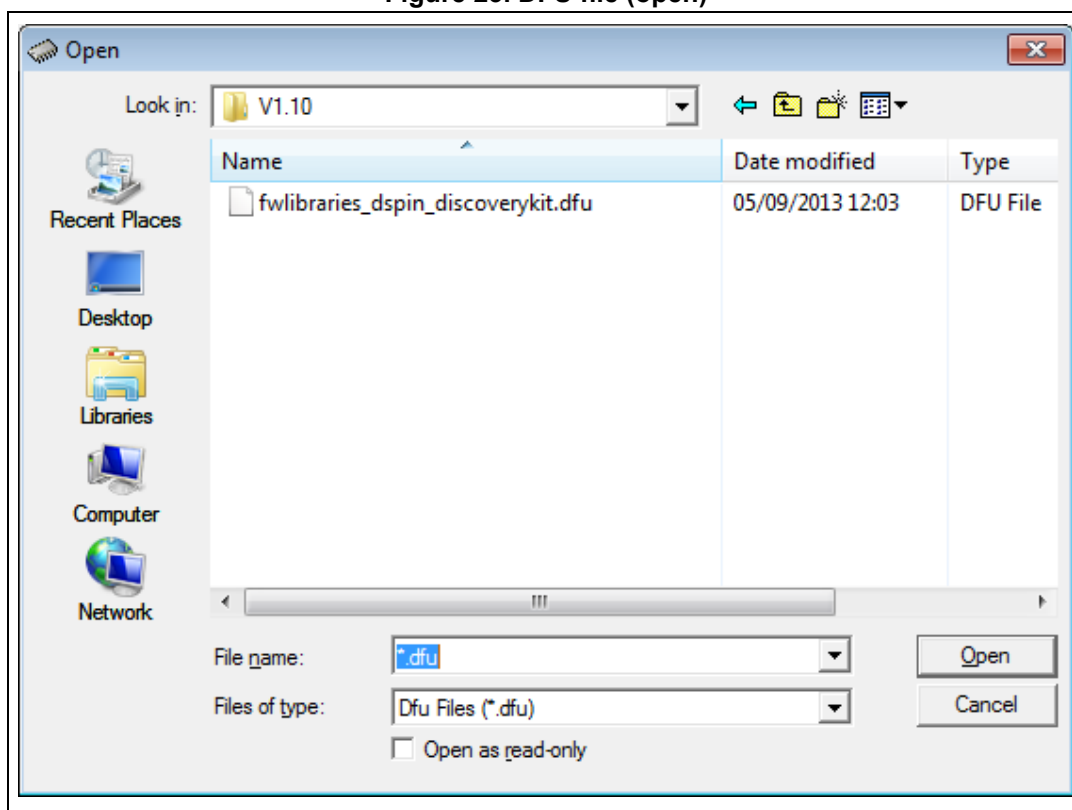
5. Click on the "Upgrade" button

Figure 24. DFU file (upgrade)
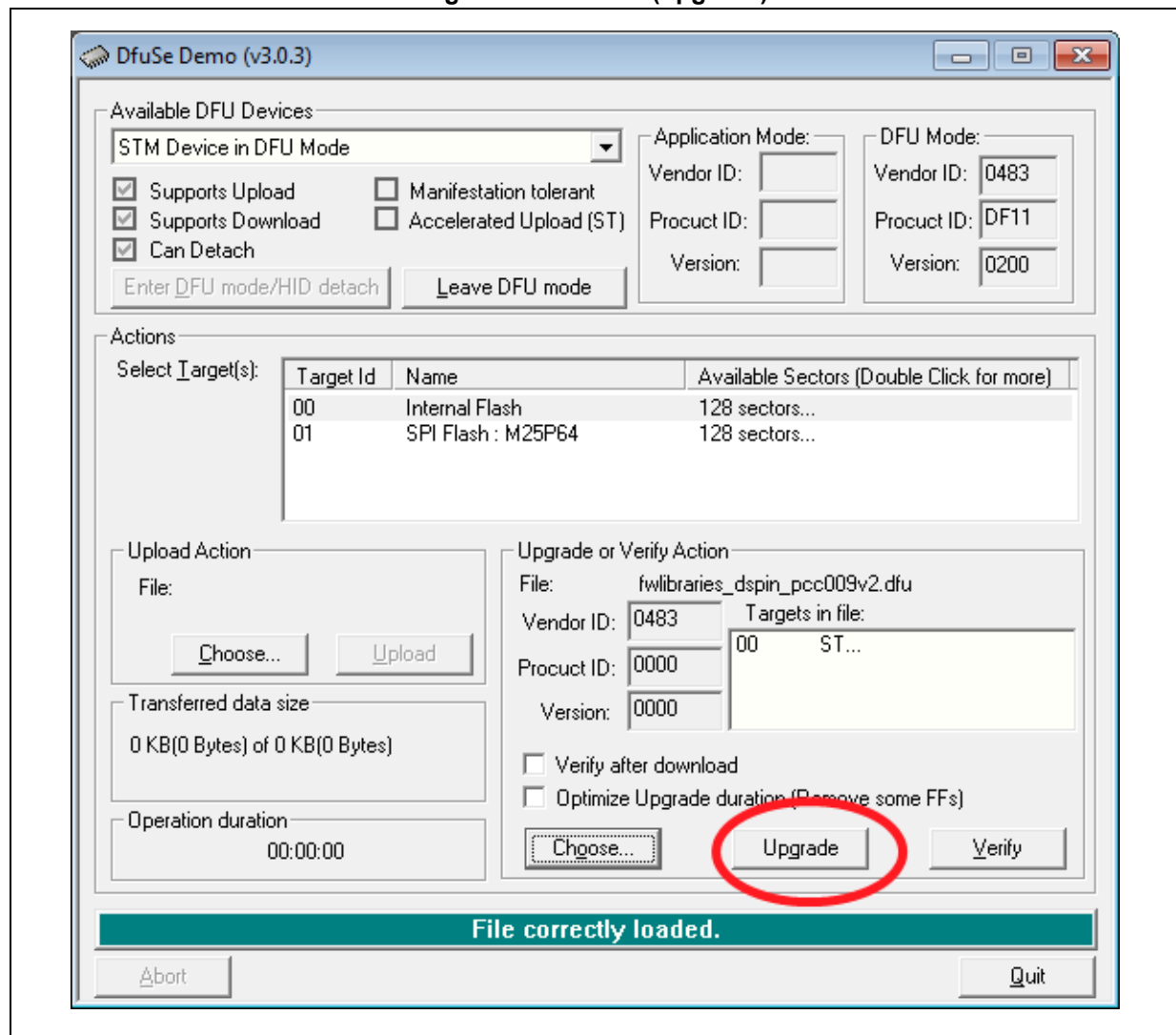
6.   If this dialog box appears, click "Yes".

Figure 25. DFU file (confirmation)
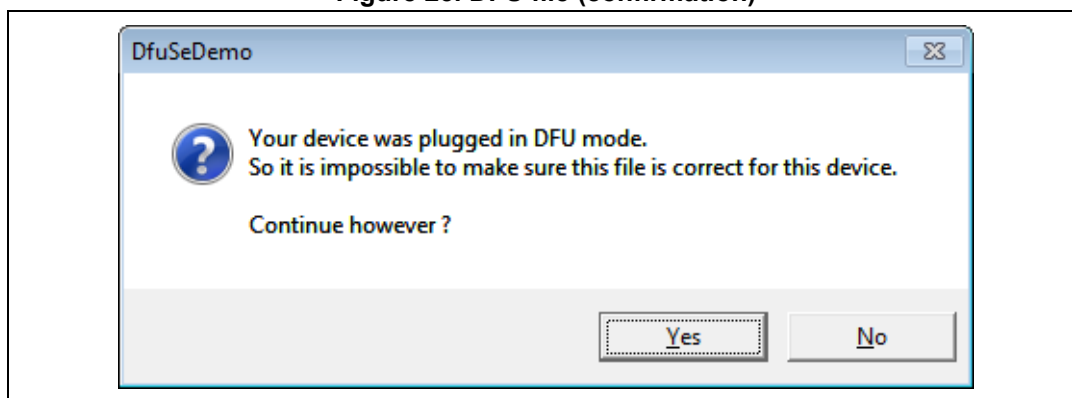
7.   Once the download is performed, you should have:

Figure 26. DFU file (download OK)
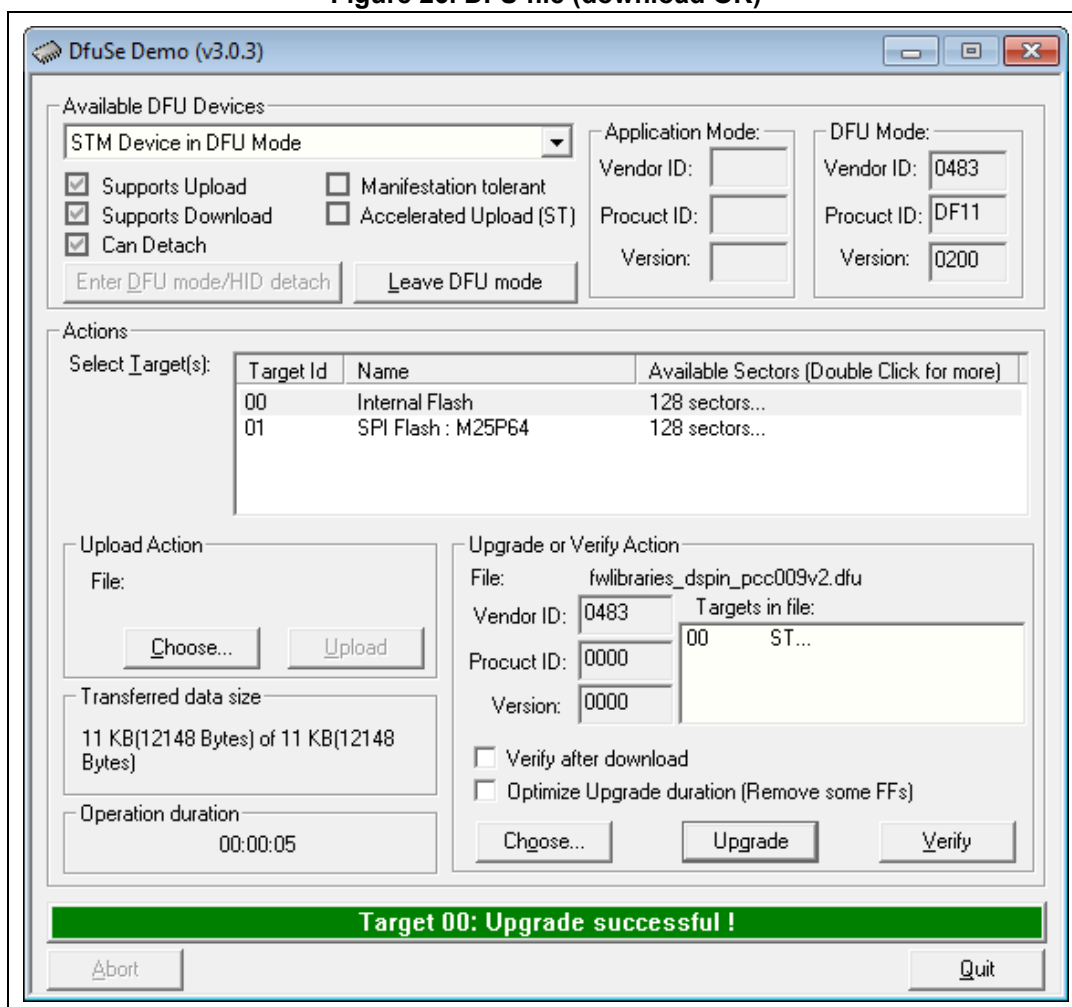
8.   Do no forget to put the jumper back on the "Boot" pins in order to restart the discovery board to the normal mode!

5.3 Using the EVAL6480H-DISC or EVAL6482H-DISC with the firmware for the GUI (FWGUI)

By default the discovery board is loaded with the FWGUI. This firmware offers the capability to connect the board with a GUI: the SPIN family evaluation tool. This GUI provides direct access to all device registers and allows sending application commands.

Both the FWGUI and the GUI can be downloaded on the "Design Resources" page of the board.

The FWGUI can be downloaded to the discovery board as detailed in *Section 5.2 on page 27*.

The behavior of the GUI is detailed in the Help.chm file which is provided with the setup file of the GUI.

5.3.1 Sanity check of the board with the firmware for the GUI (FWGUI)

At the startup of the FWGUI, a sanity check is performed to confirm the discovery board is working correctly. The status is returned via the board LEDs.

To have a correct execution of the sanity check, please follow the steps below:

1. Place a jumper on the boot pins (bottom left corner of the board):

Figure 27. Starting board (boot mode)
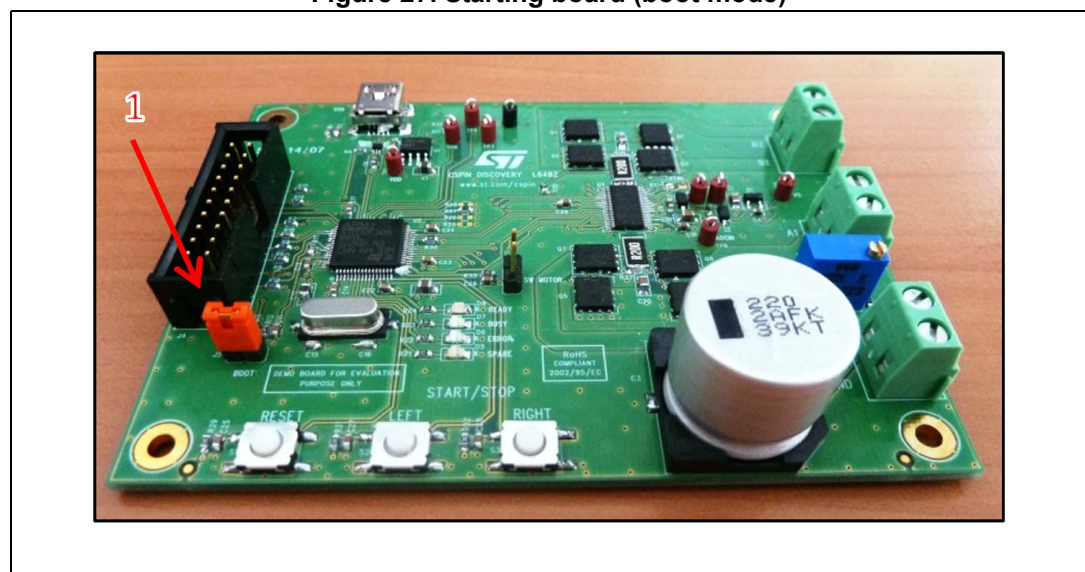
2. Connect the board to a 5 V - 45 V DC power supply:

Figure 28. Starting board (motor power supply)
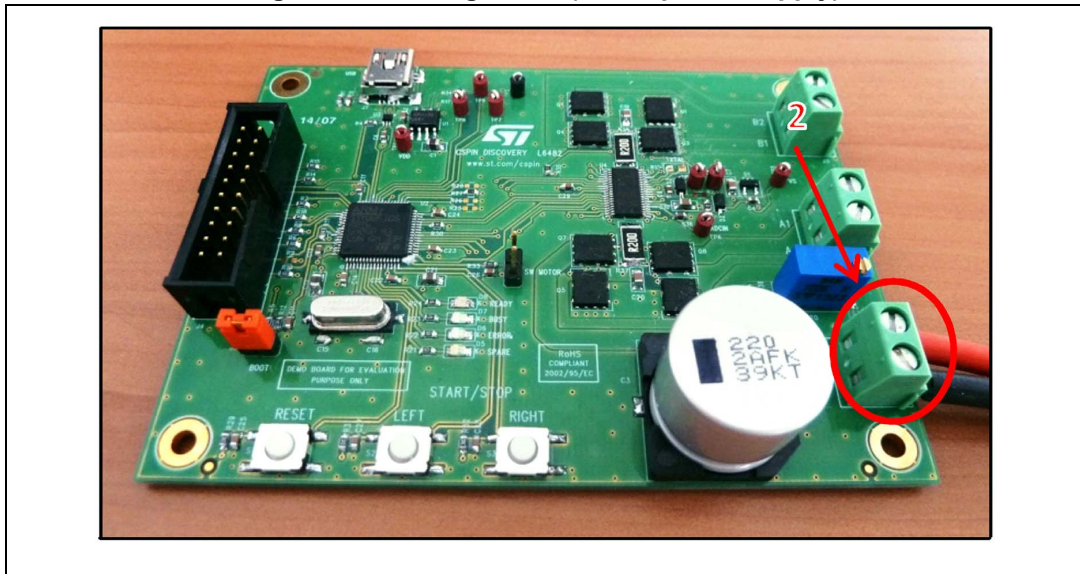
3. Plug a USB cable (which must at least provides a power supply).

Figure 29. Starting board (USB connection)
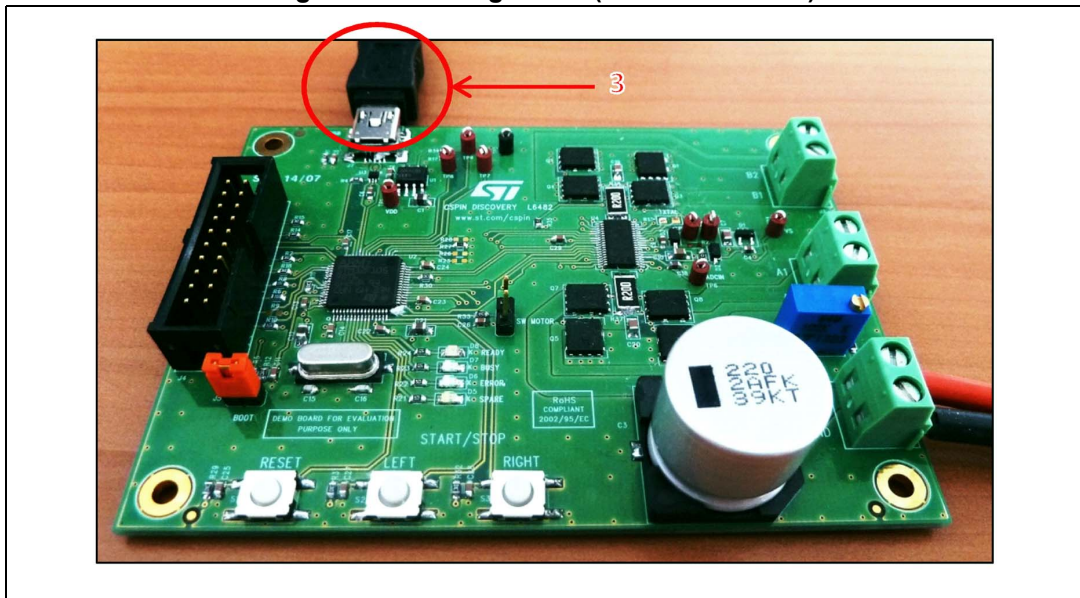
4. The board should switch on automatically.

5. At this step:

   a) **If a problem is detected**, the "ready" LED (green) and the "error" LED (red) will switch on without blinking. This means that:

   – Either the board ID is no recognized by the FW (bad FW versions used).

   – Or there is a problem with the SPI (no connection between the MCU and the L648x via the SPI).

   – Or there is no 5 V - 45 V DC power supply.

Figure 30. Starting board (error case)
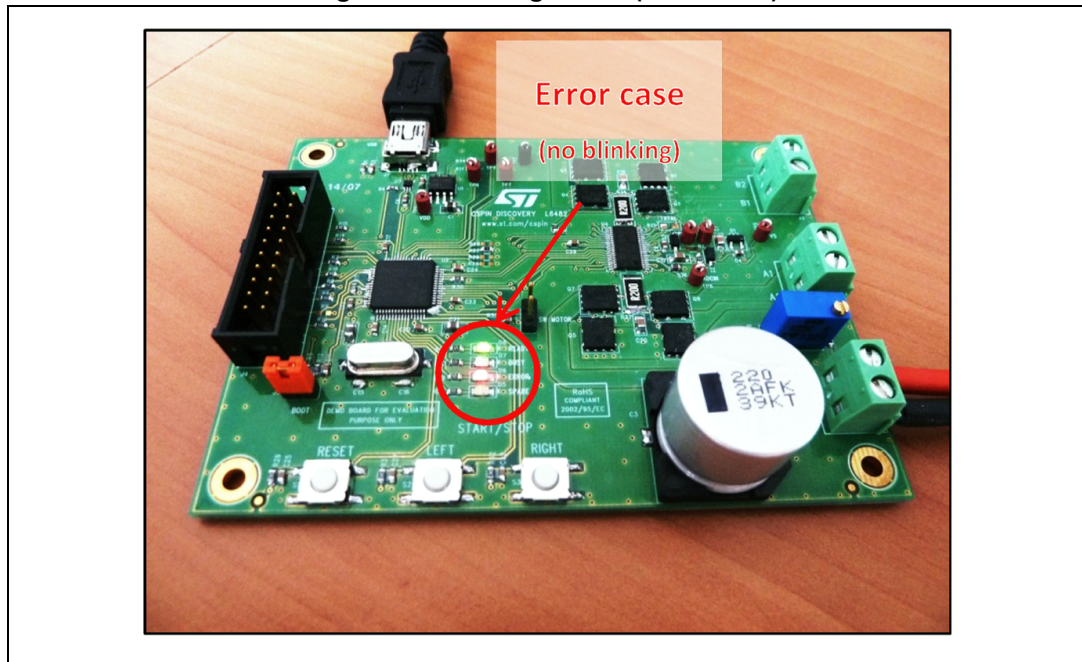
b) **If no problem is detected**, the LEDs will start an infinite two-step loop:

– In the first step, the four LEDs will switch on one after the other by starting by the green one and ending by the yellow one.

Figure 31. Starting board (board OK)
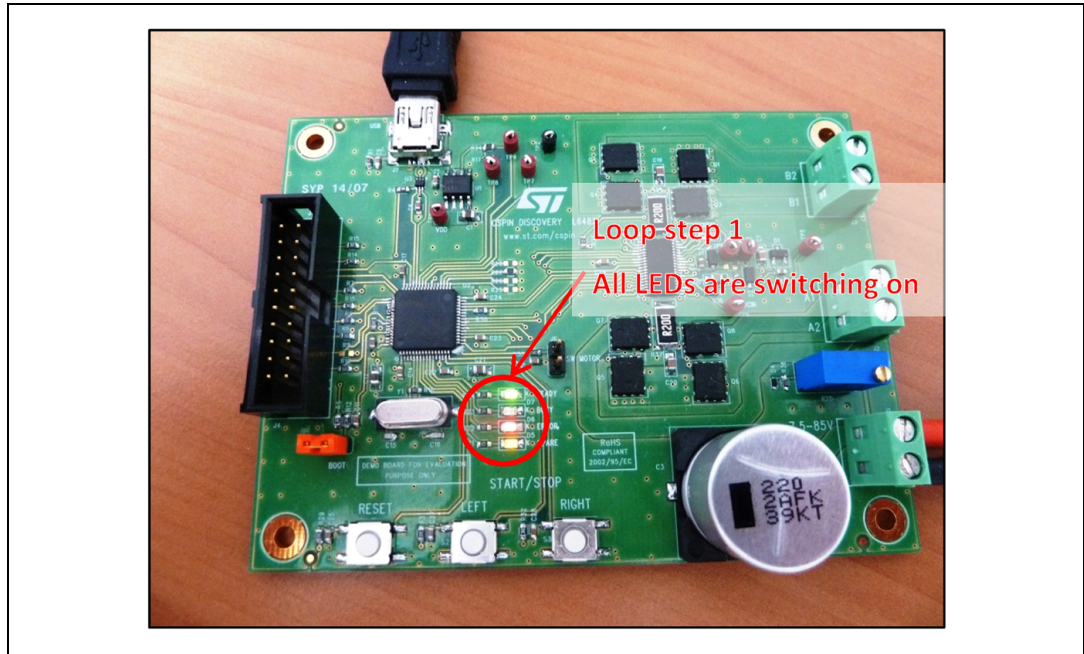
– In the second step, only the LEDs which correspond to the board Id are switched on all in the same time.

For the L6480 device, there are the green and orange LEDs.

For the L6482 device, there are the green, red, and yellow LEDs.

Figure 32. Starting board (display board ID)
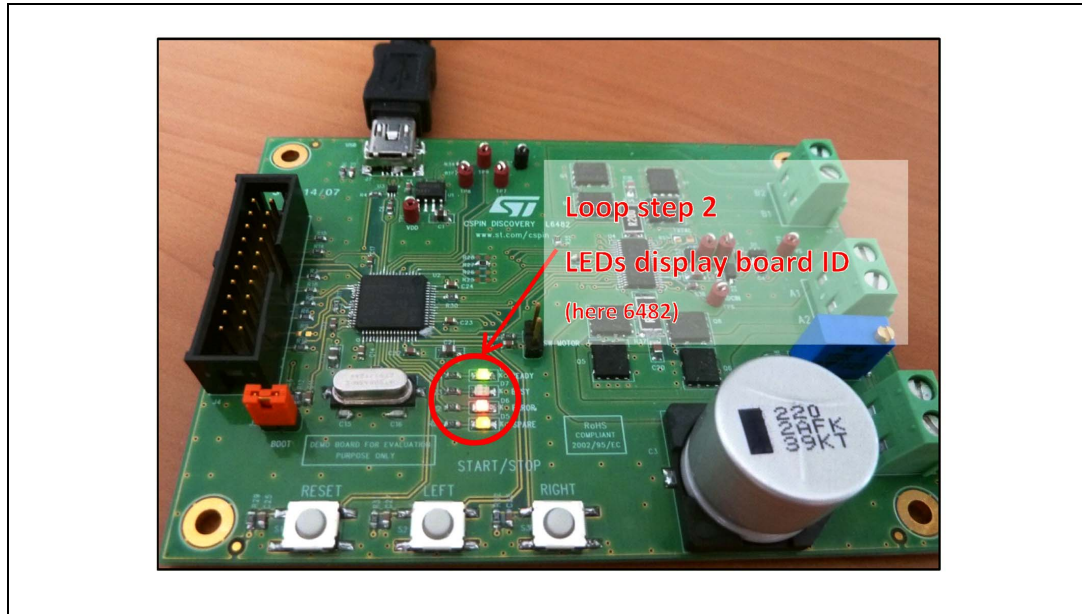
6. Press the "Left" button and check the two-step loop stops after a few seconds. Only the green LED remains switched on

Figure 33. Starting board (action left key)
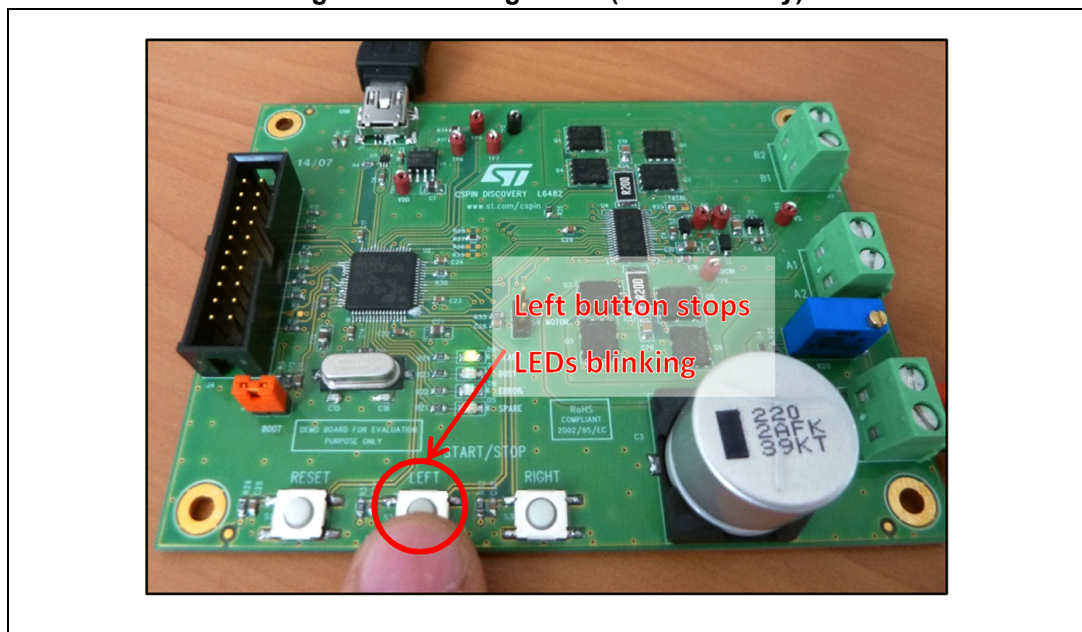
7. Press the "Right" button and check the two-step loops restarts.

Figure 34. Starting board (action right key)
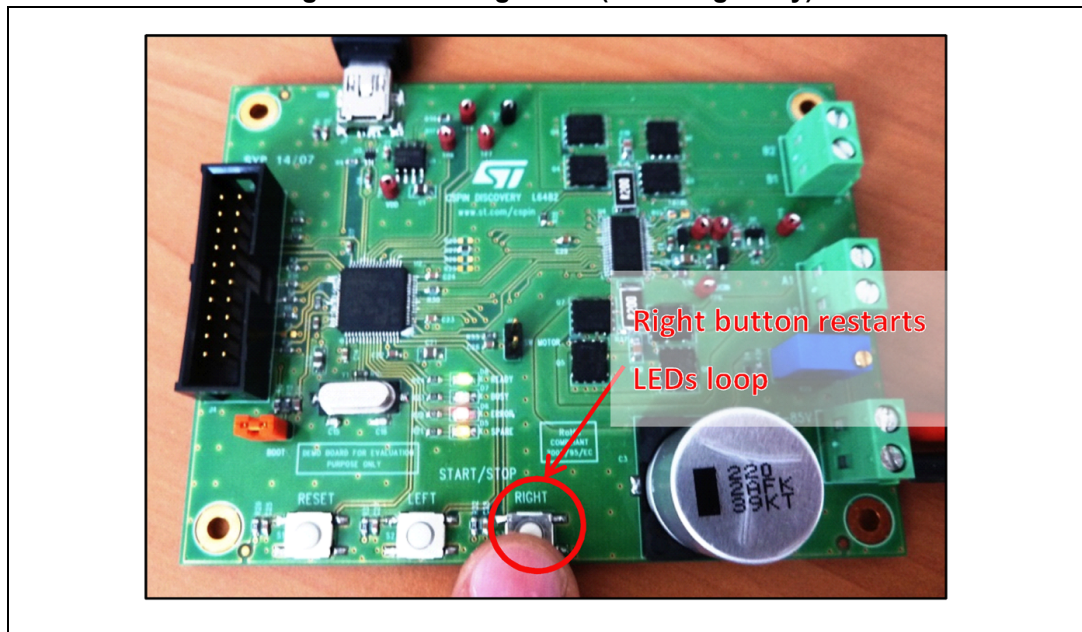
8. Press the "Reset" button and check that the LEDs restart there two-step loop after the board reset.

Figure 35. Starting board (action reset key)
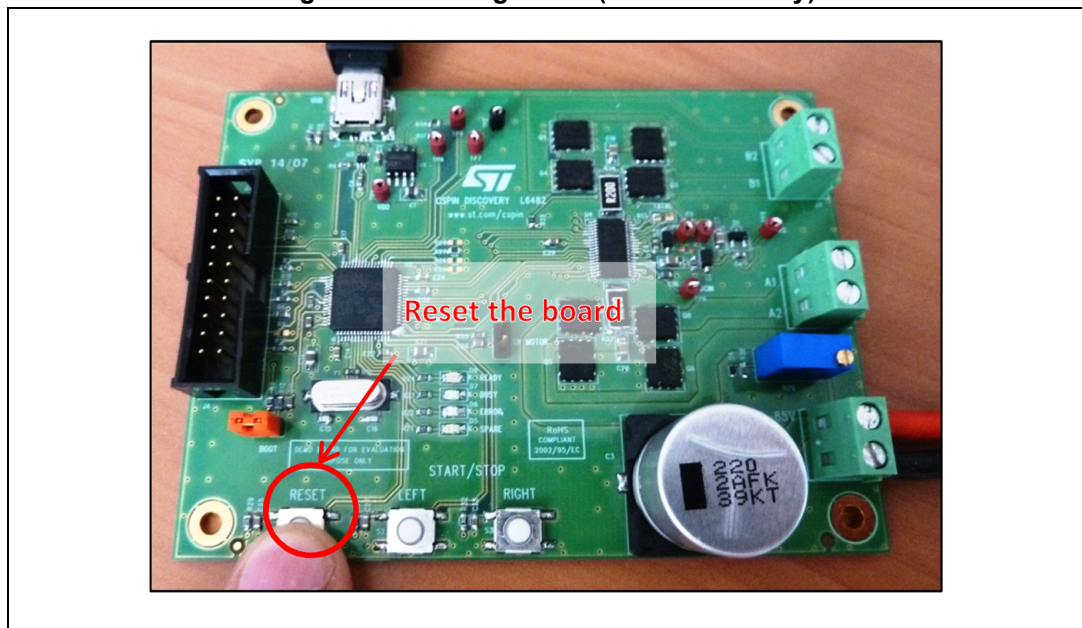
Note: *Please note that once you have connected the discovery board to the GUI, the LEDs meaning is different. You then need to restart the board to perform a new auto-check and to have a valid status from the LEDs.*

5.3.2 Parameters exportation from the GUI to the FW library

Once you have customized the L6480/L6482 parameters with the GUI, you can export them to a header file in order to use it with the FW demonstration library.

In this purpose:

1. Press the "header file" button on the main window of the GUI.

Figure 36. Parameters exportation
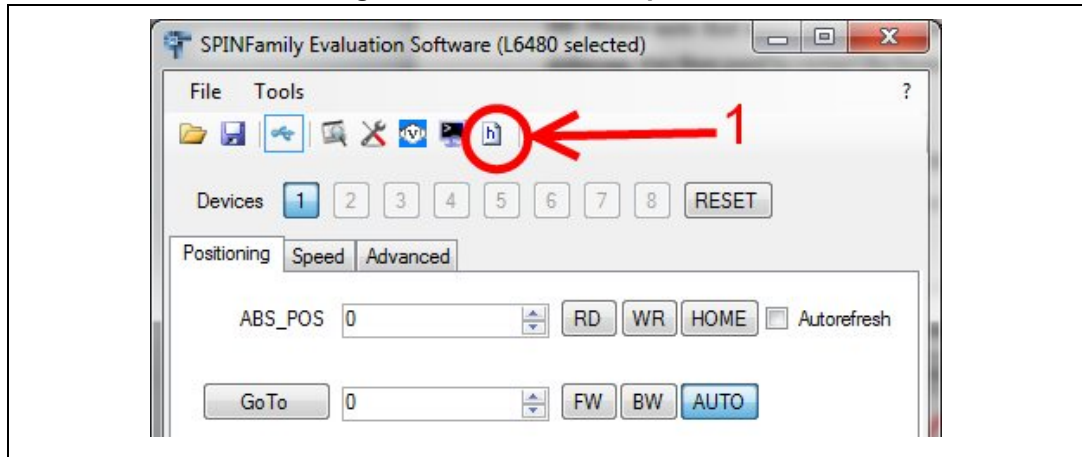
2. Replace the existing "cspin_config.h" of your current demonstration FW library by the new one.

Figure 37. Parameters exportation (save file)
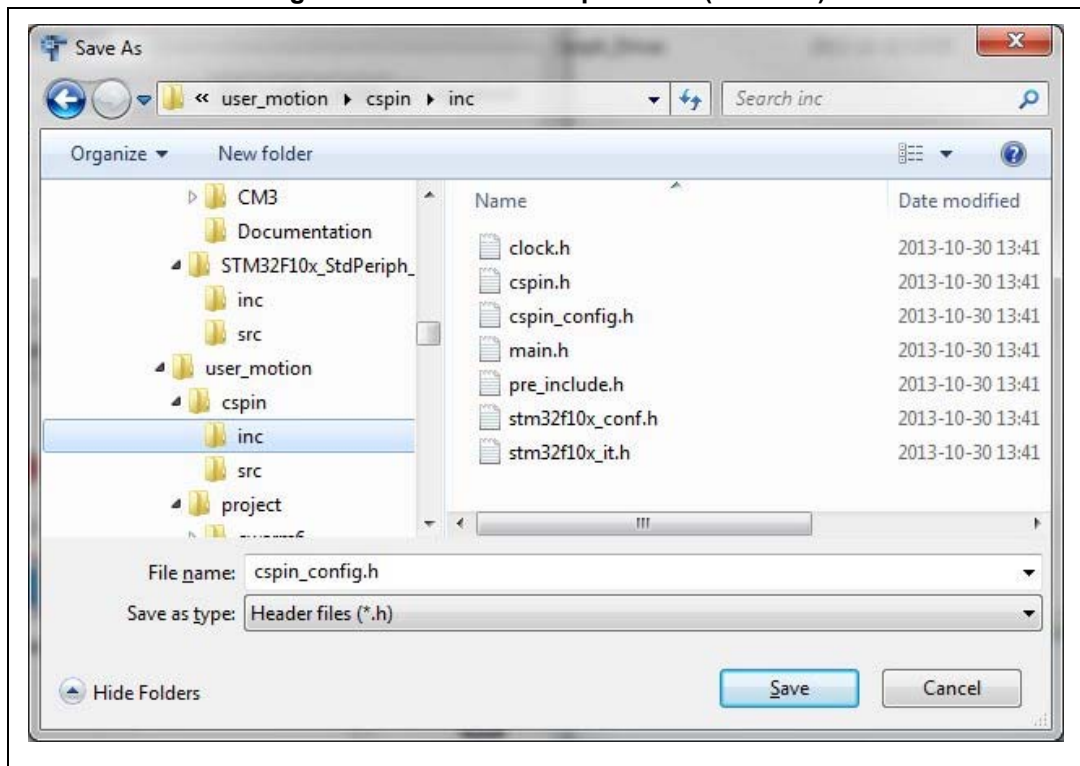
3. Then you only need to recompile your project "demo FW library" as usual to use the exported parameters.

5.4 Using the EVAL6480H-DISC or EVAL6482H-DISC with the firmware library

The L648x firmware library is supplied as an IAR workspace with source, include and project files. If you are using the IAR design environment, you just need to load the "cspin.eww" file and use the "fwlibrairies_cspin_discoverykit" project which is already active.

If you are using a different design environment, you will find instructions in this user manual to build a new project on your preferred IDE.

The L648x firmware library is also supplied as an executable file in a HEX and in a DFU format. It can be loaded into the EVAL6480H-DISC or the EVAL6482H-DISC board as explained in *Section 5.2 on page 27*.

5.4.1 Package contents

- L648x FW library
    - Described in *Section 5.4.2*.
- CMSIS library
    - /stm32f10x/CMSIS   Library used by the L648x FW library
- STM32F10x standard peripherals library drivers
    - /stm32f10x/STM32F10x_StdPeriph_Driver   Library used by the L648x FW library
- IAR workspace files
    - /user_motion/project/ewarm6/fwlibraries/cspin/cspin.eww
        - a workspace file
    - user_motion/project/ewarm6/fwlibraries/cspin/settings/cspin.wsdt
        - a workspace settings file
    - /user_motion/project/ewarm6/fwlibraries/cspin/discoverykit
        - a directory containing discovery board project files and subdirectories
    - /user_motion/project/ewarm6/fwlibraries/cspin/discoverykit/Debug/Exe/
        - a directory containing the *.HEX and *.DFU executable files
    - /user_motion/project/ewarm6/fwlibraries/cspin/pcc009v2
   - a directory containing the PCC009V2 board project files and subdirectories.

5.4.2 L648x FW library description

The L648x FW library has the following features:

- Register read, write and check
- Register values conversion
- Device configuration
- Motion commands
- FLAG and BUSY interrupts management
- Button interrupts management
- Step "Clock mode" management
- Initialization routine using "GoUntil: and "ReleaseSW" commands
- "Daisy Chain" mode.

The L648x FW library has been tested on the L6480H Discovery board R1 and the L6482H Discovery R1. The main program contains a commented demonstration sequence which uses all the library supported features. This sequence is interactive and to proceed to the end some user action is necessary.

For the "GoUntil" feature demonstration, when the LED SPARE is blinking for the first time, the user shall close the SW MOTOR jumper J8. This triggers a switch turn-on event at the L648x SW pin.

For the "ReleaseSW" feature demonstration, when the LED SPARE is blinking again, the user shall open the SW MOTOR jumper J8. This triggers a L648x SW pin release.

At the end of the demonstration sequence, the GPIO connected to the LEFT and RIGHT buttons are configured to trigger interrupts on the microcontroller:

On a LEFT button press, the microcontroller starts the motor at quarter of max. speed if it is stopped, or doubles the motor speed if it is already running.

On a LEFT button press, the microcontroller disables the power bridges after a smooth stop if the motor is running at minimum speed, or halves the motor speed if the motor is running above minimum speed.

Even if the "Daisy Chain" mode is supported in the L648x FW library, the board HW does not allow it. Please contact ST support if you want more information on "Daisy Chain" mode testing or implementation.

The L648x FW library consists of the following files:

- user_motion/cspin/inc/stm32f10x_conf.h Library configuration file
- user_motion/cspin/src/stm32f10x_it.c Interrupt handlers
- user_motion/cspin/inc/stm32f10x_it.h Header for stm32f10x_it.c
- user_motion/cspin/inc/clock.h System clock setup related header
- user_motion/cspin/src/clock.c System clock source file
- user_motion/cspin/inc/cspin.h Definitions header
- user_motion/cspin/src/cspin.c Routines source file
- user_motion/cspin/inc/cspin_config.h Configuration parameters (this file can be generated by the GUI)
- user_motion/cspin/inc/main.h Main header file
- user_motion/cspin/src/main.c Main program
- user_motion/cspin/inc/pre_include.h First header file included by the preprocessor
- user_motion/cspin/readme.txt Information on the files

5.4.3 Demo sequence description

The demonstration sequence description is for one L6480 or L6482 device without daisy chaining. The application commands used are noted after the pipe character. The application commands traffic can be seen on the SPI interface, pins 18, 19, 20 and 23 which are respectively SDO, CK, SDI and CS.

Initialization and configuration

1. Initialize peripherals
2. *LED_READY (GREEN) is lighted up, other LEDs are switched off.*
3. LED check sequence:
    a) *LED_ERROR (RED) is switched ON*
    b) *LED_BUSY (ORANGE) is switched ON*
    c) *LED_SPARE (YELLOW) is switched ON*
    d) *LED_ERROR (RED)*, *LED_BUSY (ORANGE)* and *LED_SPARE (YELLOW)* are switched OFF
4. Resets and puts device into standby mode. The STBY_RESET pin goes low for a few hundreds of μs and then goes high.
5. Program all registers | **SetParam (PARAM, VALUE)**.

Flag signal management

6. Read Status register content | **GetStatus**
7. Interrupt configuration for FLAG signal
8. Motor runs at constant speed of 400 steps/s forward direction | Run (DIR, SPD)
9. Tentative to write to the current motor absolute position register while the motor is running, *as a consequence the LED_ERROR (RED) is lighted up* | **SetParam (PARAM, VALUE)**
10. Get Status to clear FLAG due to non-performable command, *as a consequence the LED_ERROR (RED) is switched off* | **GetStatus**
11. Motor stops smoothly | **SoftStop**
12. Wait until not busy - busy pin test (L648x pin 22).

Busy signal management

13. Interrupt configuration for BUSY signal
14. Motor moves by 100,000 steps in reverse direction | **Move (DIR, N_STEP)**
15. *During busy time the LED_BUSY (ORANGE) is switched ON*
16. Device disables the power bridges after a deceleration to zero phase | **SoftHiZ**
17. *LED_BUSY (ORANGE) is switched OFF.*

The LED_BUSY after the point 7 and the LED_ERROR after the point 13 are tied respectively to the BUSY/SYNC pin and the FLAG pin. So for example they are lighted up when the motor accelerates or decelerates. This is happening in the remaining part of the demonstration although not mentioned.

Various application commands examples

18. Motor moves by 60,000 steps forward | **Move (DIR, N_STEP)**
19. Wait until not busy - busy pin test (pin 22).
20. **The L6480 only**: sends the device command setting hold duty cycle to 0.5%, sends the device command changing hold current to 40 mA.
    The L6482 only: sends the device command setting hold current to 40 mA, sends the device command setting run current to 200 mA.| **SetParam (PARAM, VALUE)**.

21. Motor runs at constant speed of 50 steps/s in reverse direction | **Run (DIR, SPD)**.

22. Motor softly stops after a few seconds | **SoftStop**.

23. **The L6480 only**: RESET KVAL_HOLD to initial value, RESET KVAL_RUN to initial value.
    The L6482 only: RESET TVAL_HOLD to initial value, RESET TVAL_RUN to initial value. | **SetParam (PARAM, VALUE)**.

24. Wait until not busy - busy status check in the Status register | **GetStatus**.

25. Motor moves by 100,000 steps forward | **Move (DIR, N_STEP)**.

26. Wait until not busy - busy status check in the Status register | **GetStatus**.

27. Test of the Flag pin (pin 24) by polling, wait in endless cycle if problem is detected.

28. Motor moves to its home position | **GoHome**.

29. Wait until not busy - busy pin test (pin 22).

30. Motor goes to the absolute position 65535 through the shortest path | **GoTo (ABS_POS)**.

31. Wait until not busy - busy pin test (pin 22).

32. Motor goes in forward direction to the absolute position 131071 | **GoTo_DIR (DIR, ABS_POS)**.

33. Wait until not busy - busy pin test (pin 22).

34. **The L6480 only**: read run duty cycle (cSPIN_KVAL_RUN) parameter from device, read intersect speed (cSPIN_INT_SPD) parameter from device.
    The L6482 only: read run current (cSPIN_TVAL_RUN) parameter from device. | **GetParam(PARAM)**.

35. Read Status register content | **GetStatus**.

36. Read absolute position (cSPIN_ABS_POS) parameter from device | **GetParam(PARAM)**.

37. Reset position counter, actually | **ResetPos**.

38. Read absolute position (cSPIN_ABS_POS) parameter from device | **GetParam(PARAM)**.

39. Device disable power stage (High Impedance) immediately, as a consequence the supply current drops | **HardHiZ**.

"Go until" example

40. Interrupt configuration for the SW MOTOR.

41. Motor motion in forward direction at speed 400 steps/s until the user puts a jumper on J8, *the LED_SPARE (YELLOW) toggles until the user puts a jumper on J8* | **GoUntil (ACT, DIR, SPD)**

42. Motor stops.

43. *The LED_SPARE (YELLOW)* is switched off.

44. Wait until not busy - busy pin test (pin 22).

45. Motor moves by 50,000 steps reverse | **Move (DIR, N_STEP)**

46. Motor moves to the position saved by the GoUntil command into the MARK register, so 50000 steps forward | **GoMark**.

47. Wait until not busy - busy pin test (pin 22).

48. Nothing happens during a few seconds.

Release SW example

49. Motor motion in reverse direction at minimum speed until the user removes the jumper on J8, *the LED_SPARE (YELLOW) toggles until the user removes the jumper on J8* | **ReleaseSW (ACT, DIR).**

50. *The LED_SPARE (YELLOW) is switched off.*

51. Motor moves by 100,000 steps forward | **Move (DIR, N_STEP)**.

52. Wait until not busy - busy pin test (pin 22).

53. Motor goes to the home position set by the ReleaseSW command | **GoHome**.

54. Wait until not busy - busy pin test (pin 22).

Step clock mode example

55. Get Status to clear FLAG due to switch turn-on event (falling edge on the SW pin) | **GetStatus**.

56. Motor runs in step clock mode at 2000 steps/s in forward direction for a few seconds while a 2 kHz clock signal from the MCU is applied to the STCK pin (25) | **StepClock (DIR)**.

57. The above cited clock is stopped.

Buttons interrupt example

58. Buttons interrupt configuration
    a) Button_A
    – Starts the motor at quarter of max. speed if it is stopped | **Run (DIR, SPD)**.
    – Doubles the motor speed if it is already running | **Run (DIR, SPD)**.
    b) Button_B
    – Disables the power bridges after a smooth stop if the motor is running at minimum speed | **SoftHiZ**.
    – Halves the motor speed if the motor is running above minimum speed | **Run (DIR, SPD)**.

5.4.4 Create a project using the FW library package

Using your preferred IDE, create a new project.

In project options, properties or settings:
- Select for the device, the ST STM32F105xB.
- Use the CMSIS library.

Edit the preprocessor defined symbols and add:
- STM32F10X_CL
- USE_STDPERIPH_DRIVER
- ST_CSPIN_6480H_DISCOVERY

The flag ST_CSPIN_6480H_DISCOVERY is used for both L6480 and L6482 chips. It is used to distinguish boards (i.e. the DISC board from the PCC009V2 board).

Edit the preprocessor including directories and add:

- $PROJ_DIR$\....\...\...\...\...\...\stm32f10x\CMSIS\CM3\DeviceSupport\ST\STM32F10x
- $PROJ_DIR$\...\...\...\...\...\...\stm32f10x\STM32F10x_StdPeriph_Driver\inc
- $PROJ_DIR$\...\...\...\...\...\cspin\inc

Edit the "Linker" configuration file:

    - $PROJ_DIR$\config\stm32f10x_flash.icf

Where $PROJ_DIR$ is a variable containing the path to the project directory.

Add the required library source files:

- startup_stm32f10x_cl.s
- system_stm32f10x.c
- misc.c
- stm32f10x_exti.c
- stm32f10x_flash.c
- stm32f10x_gpio.c
- stm32f10x_rcc.c
- stm32f10x_spi.c
- stm32f10x_tim.c

For the debugger, for example, select the ST-LINK and configure it to run to main, to verify download, to use the Flash loader and to override the "default.board" file with the "FlashSTM32F105xB.board".

6 References

This user manual provides information on the hardware features and use of the EVAL6480H-DISC board along with the demonstration firmware and software. For additional information, refer to the following:

1. STM32F105xx datasheet (CD00220364).
2. STM32F105xx reference manual (RM0008).
3. Voltage mode control operation and parameter optimization application note (AN4144).
4. L648x devices gate drivers setup application note(AN4354).
5. L648x devices: high power stepper motor controllers application note (AN4355).
6. L647x, L648x and powerSTEP01 family communication protocol application note (AN4290).

7 Revision history

Table 8. Document revision history

Date	Revision	Changes
30-May-2014	1	Initial release.
09-Mar-2015	2	Updated whole document (removed/replaced "cSPIN™" "cSPIN", and "cSPIN™ microstepping motor driven" by "L648x"/"L648xH controllers"/"L6480 motor controller"/"L6482 motor controller"/"device"/"motor"/"board". Removed "Figure 6. EVAL6480H-DISC layout (silk screen)" from page 10 and "Figure 12. EVAL6482H-DISC layout (silk screen)" from page 16. Replaced "FWPSPIN" by "FWGUI" and removed web link from *Section 5.3 on page 34*. Removed "FW cSPIN", "FW library", and "cSPIN Discovery" from *Section 5.4 on page 42*. Updated *Section : Various application commands examples on page 44*. Updated *Section 6 on page 48* (updated title of AN4354, AN4355, and AN4290). Minor modifications throughout document.

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