UM1692
User manual

EVAL6472H-DISC: fully integrated stepper motor driver based on the L6472 and STM32™

Introduction

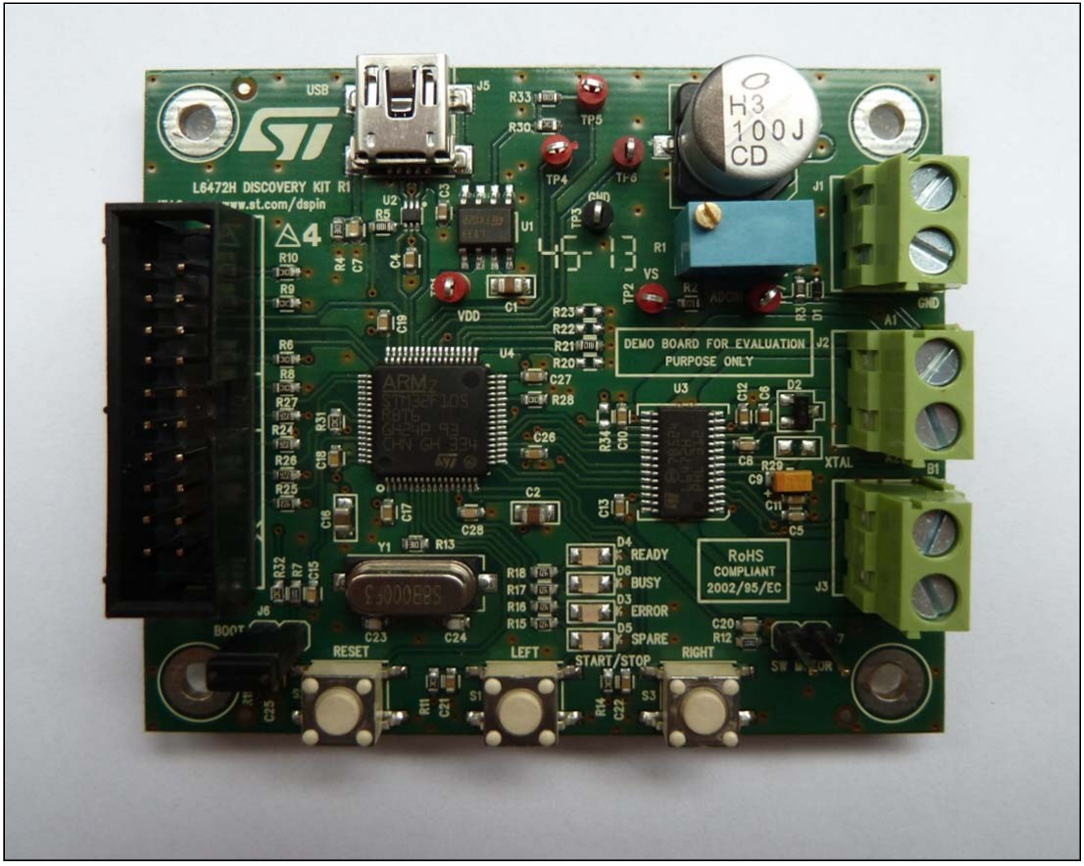
The EVAL6472H-DISC can be used together with the STM32™ firmware library V1.0 and constitutes a complete motor control evaluation and a development platform.

It is a demonstration board for motor control applications in the range of 8 V to 45 V of DC bus voltage using the STM32F105RB microcontroller with an internal 128 kB Flash size and a 64 kB internal RAM and the L6472 fully integrated solution suitable for driving two-phase bipolar stepper motors up to 1/16 microstepping.

The L6472 device integrates a dual DMOS full bridge with all of the power switches equipped with an accurate on-chip current sensing circuitry suitable for non-dissipative current control and overcurrent protection.

With dedicated hardware evaluation features, the EVAL6472H-DISC board is designed to help developers evaluate the device and develop their own applications.

Figure 1. Board image



Contents

List of figures

1 Main features

The characteristics of the EVAL6472H-DISC board are following:

- DC voltage range from 8 V to 45 V
- Maximum load phase current at 3 A $_{\text{r.m.s.}}$
- Footprint for external resonator or crystal
- Control interface through trimmer - user keys and switch motor input
- Control through LED indicators
- Interface control by USB and debug outputs
- Compatible with SPINFamily evaluation tool
- Autonomous board due to embedded firmware
- Up to 1/16 microstepping
- Optimized layout on 2-layer board - low cost and high thermal performance

1.1 Target applications

The demonstration board is designed to fit all typical stepper motor applications - it is an autonomous board due to embedded firmware.

1.2 Description

The EVAL6472_DISC is downloaded with embedded firmware.

The possibility with this board is double:

- To adapt the settings with your specific setup (motor - voltage) by using the dedicated PC application.
  - The user is able to save inside the board the specific parameters depending on a user setup.
- Using the board (with user parameters) directly on a site - without a connected PC.

2 Electrical characteristics of the board

Table 1. Electrical specifications

Name	Value
Supply voltage (V_S)	8 to 45 V
Maximum output current (each phase)	3 A $_{r.m.s}$
Logic supply voltage (V_{REG})	3 V (L6472 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

3 Schematic, layout and bill of material

Figure 2. Schematic (microcontroller supply part)

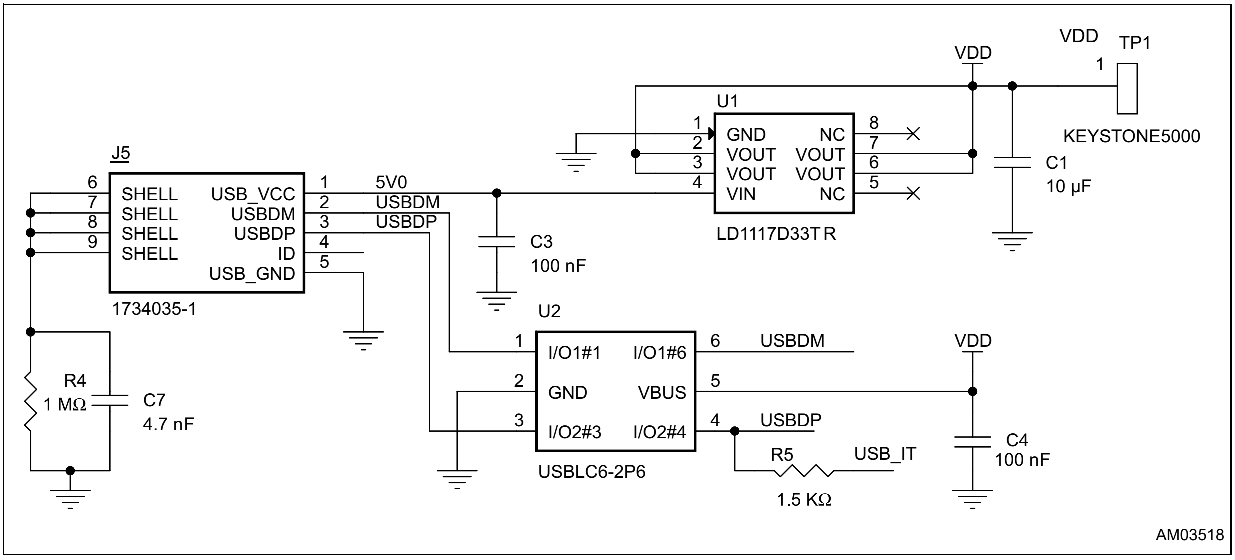


Figure 3. Schematic (microcontroller part)

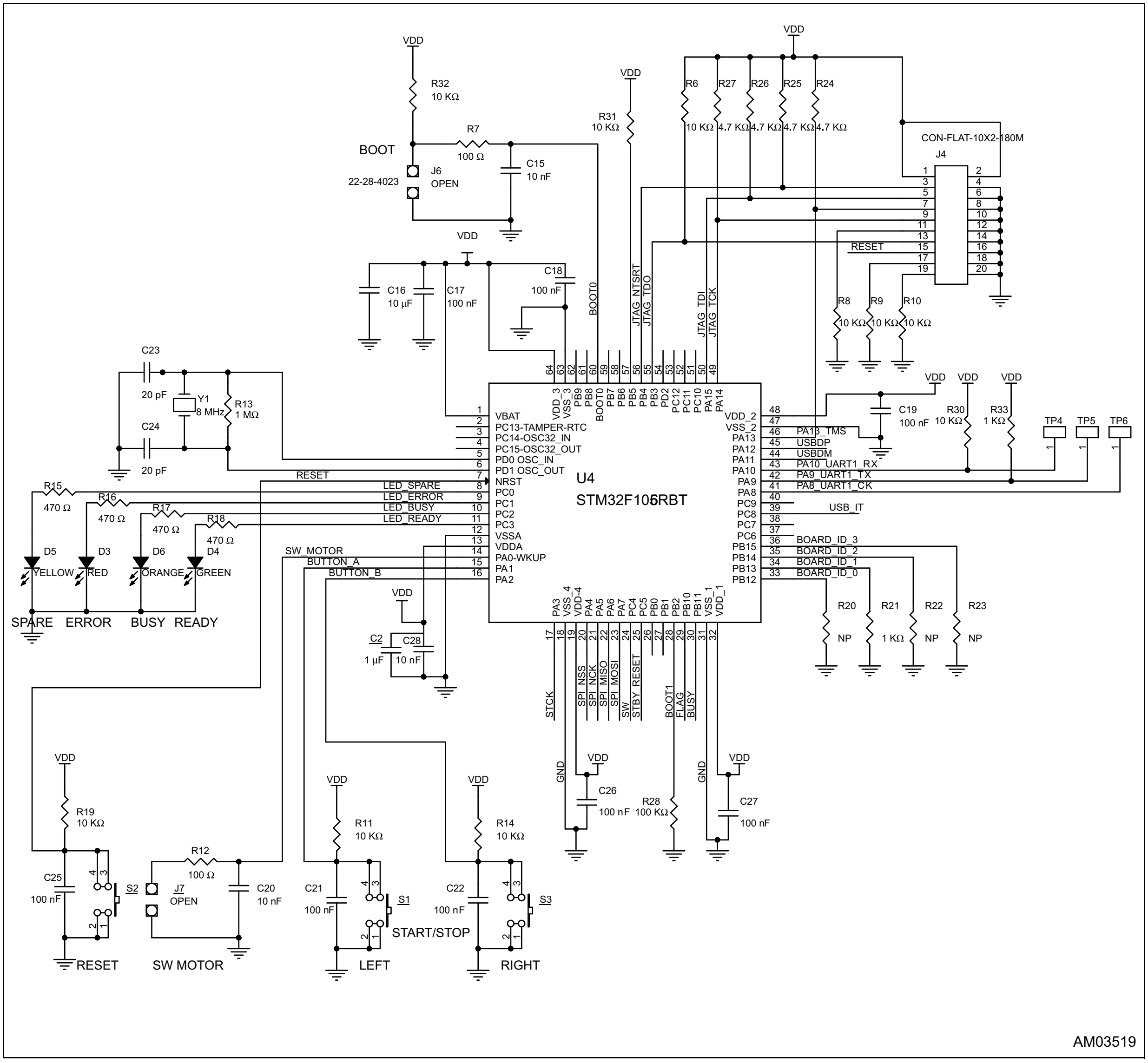


Figure 4. Schematic (motor driver part)

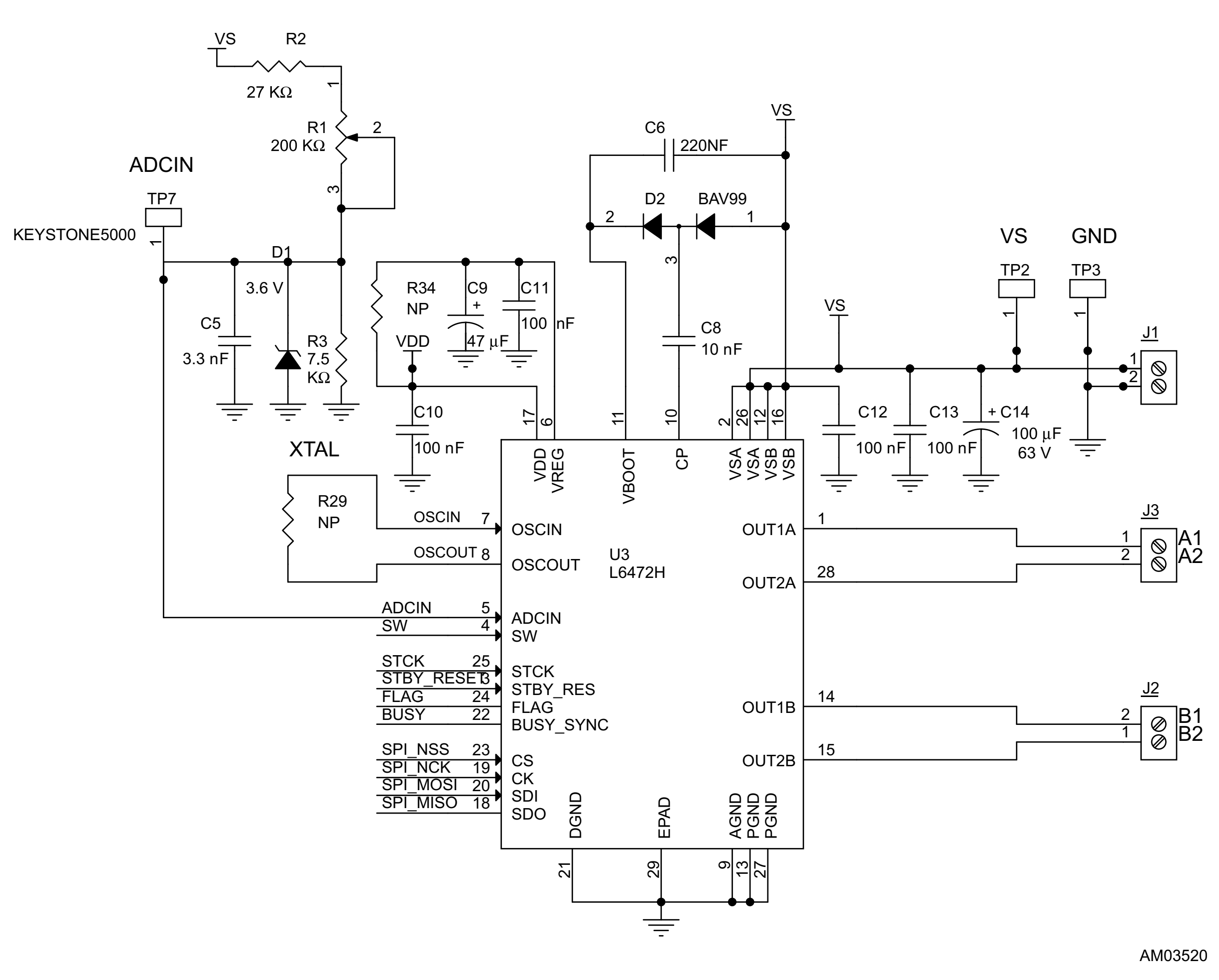


Figure 5. Layout top and bottom layer

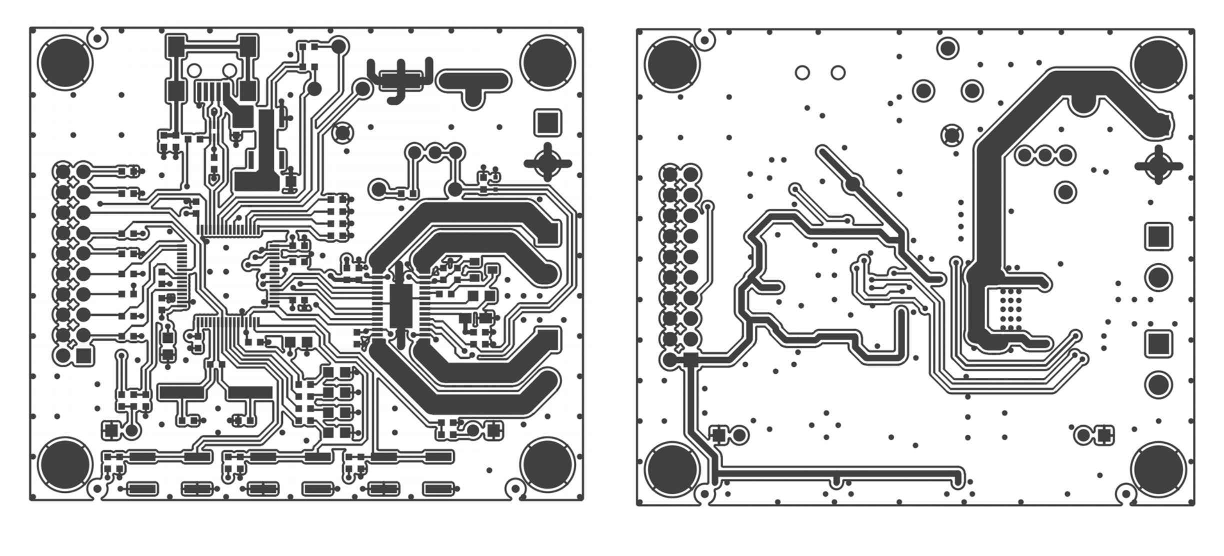


Table 2. Bill of material

Item	Qty.	Reference	Value	Package
C1, C16	2	Cap. cer. 10 µF 10 V X7R 0805	10 µF	0805
C2	1	Cap. cer. 1 µF 10 V X7R 0805	1 µF	0805
C3, C4, C10 - C13, C17 - C19, C21, C22, C25-C27	14	Cap. cer. 100 nF 50 V X7R 0603	100 nF	0603
C5	1	Cap. cer. 3.3 nF 50 V X7R 0603	3.3 nF	0603
C6	1	Cap. cer. 220 nF 35 V X7R 0603	220 nF	0603
C7	1	Cap. cer. 4.7 nF 50 V X7R 0603	4.7 nF	0603
C8, C15, C20, C28	4	Cap. cer. 10 nF 50 V X7R 0603	10 nF	0603
C9	1	Cap. tant. 47 µF 6.3 V10% PACK-A	47 µF	3216
C14	1	Cap. elec. 100 µF 63 V	100 µF	CAPES-R10HXX
C23, C24	2	Cap. cer. 20 pF 50 V COG 0603	20 pF	0603
D1	1	Zener regulator	3.6 V	SOD 523
D2	1	Double diode high speed switching diode	BAV99	SOT23
D3	1	LED red - 0805 -2 mcd - 621 nm	Red	0805
D4	1	LED green - 0805 -6 mcd - 569 nm	Green	0805
D5	1	LED yellow - 0805 -6 mcd - 588 nm	Yellow	0805
D6	1	LED orange - 0805 -2 mcd - 602 nm	Orange	0805
FIX1 - FIX4	4	Hole	3 mn	-
J1-J3	3	Screw connector 2 poles MKDSN 1.5 / 2 - 5.08	MKDSN 1.5 / 2 - 5.08	MKDSN 1.5 / 2 - 5.08
J4	1	JTAG CON-FLAT- 10 x 2 - 180 M	CON-FLAT- 10 x 2 - 180 M	CON-FLAT- 10 x 2 - 180 M
J5	1	USB_B_MINI_AMP_1734035-1	CN-USB	CMS mini USB
J6, J7	2	JUMP254P-M-2	OPEN	STRIP 2x2,54
MIRE1 - MIRE3	3	OPTICAL_TARGET	OPTICAL_TARGET	Diam 1mn
R1	1	Trimmer 200 KΩ	200 KΩ	Trimm. 100 x 50 x 110
R2	1	27 KΩ 5% 1/10 W	27 KΩ	0603
R3	1	Res. 7.5 KΩ 5% 1/10 W 0603 SMD	7.5 KΩ	0603
R4, R13	2	Res. 1 MΩ 1/10 W 5% 0603 SMD	1 MΩ	0603
R5	1	Res. 1.5 KΩ 1/10 W 5% 0603 SMD	1.5 KΩ	0603
R6, R8 - R11, R14, R19, R30 - R32	10	Res. 10 KΩ 5% 1/10 W 0603 SMD	10 KΩ	0603
R7, R12	2	Res. 100 Ω 5% 1/10 W	100 Ω	0603

Table 2. Bill of material (continued)

Item	Qty.	Reference	Value	Package
R15 - R18	4	Res. 470 Ω 5% 1/10 W 0603	470 Ω	0603
R21, R33	2	Res. 1 KΩ 5% 1/10 W 0603 SMD	1 KΩ	0603
R20, R22, R23, R34	4	Res. NP 0603	NP	0603
R24 - R27	4	Res. 4.7 KΩ 5% 1/10 W 0603 SMD	4.7 KΩ	0603
R28	1	Res. 100 KΩ 5% 1/10 W 0603 SMD	100 KΩ	0603
R29	1	Res. NP 0805	NP	0805
S1-S3	3	Switch button SMD	EVQQ2D03W	CMS 6.5 x 6 x 3.1
TP1, TP2, TP4 - TP7	6	Test point red	KEYSTONE-5000	TH
TP3	1	Test point black	KEYSTONE-5001	TH
U1	1	IC REG 1300MA LN 3.3 V	LD1117D33TR	SO8
U2	1	USBLC6-2P6	USBLC6-2P6	SOT 666
U3	1	L6472 microstepping motor driven	L6472	HTSSOP28
U4	1	IC, MCU, RISC, 72 MHz, 3.6 V, 32-bit, 64-pin, LQFP	STM32F105RBT6	LQFP64 10 x 10
Y1	1	XTAL 8 MHz-30PPM-20 pF	8 MHz	HC49/US-SM

4 General description

4.1 Power supply

The EVAL6472H-DISC board is designed to be powered via:

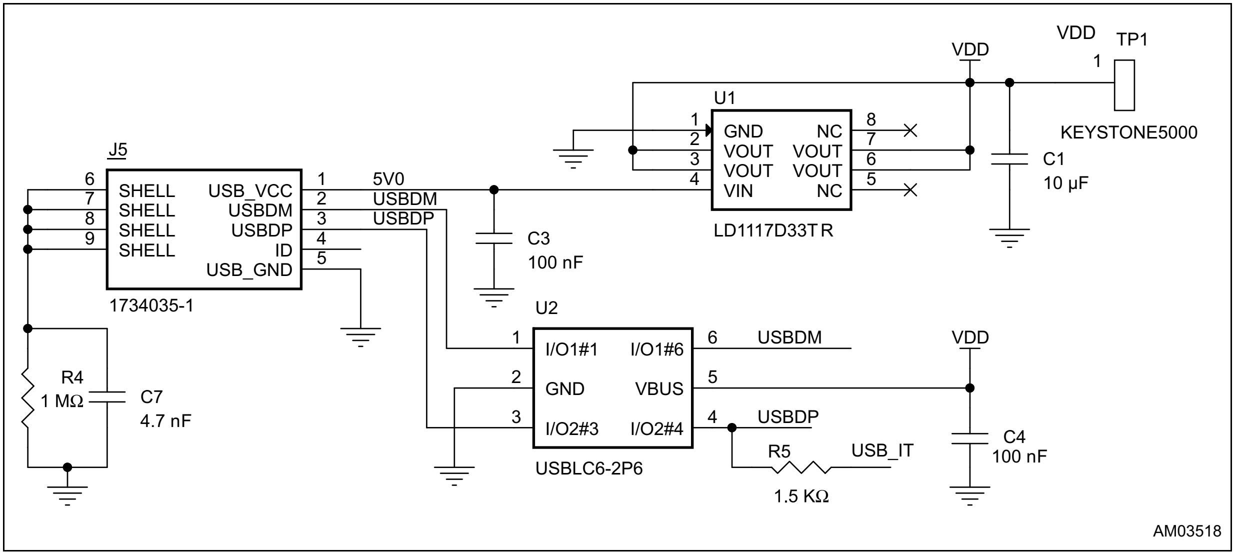
- Connector J1: power of the motor and also motor control driver.
- USB connector J5: power of the microcontroller and logic control.

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

The motor power 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 6. Microcontroller supply section



4.2 L6472 stepper motor driver

The L6472 is an advanced fully integrated solution suitable for driving two-phase bipolar stepper motors with microstepping. It integrates a dual low $R_{DS(on)}$ DMOS full bridge.

Features

- Operating voltage: 8 - 45 V
- 7.0 A out peak current (3.0 $A_{r.m.s.}$)
- Low $R_{DS(on)}$ power MOSFETs
- Programmable speed profile
- Programmable power MOS slew rate
- Predictive current control with adaptive decay
- Non-dissipative current sensing
- Up to 1/16 microstepping
- Sensorless stall detection
- SPI interface
- Low quiescent and standby currents
- Programmable non-dissipative overcurrent
- Two levels of overtemperature protection

Figure 7. L6472 block diagram

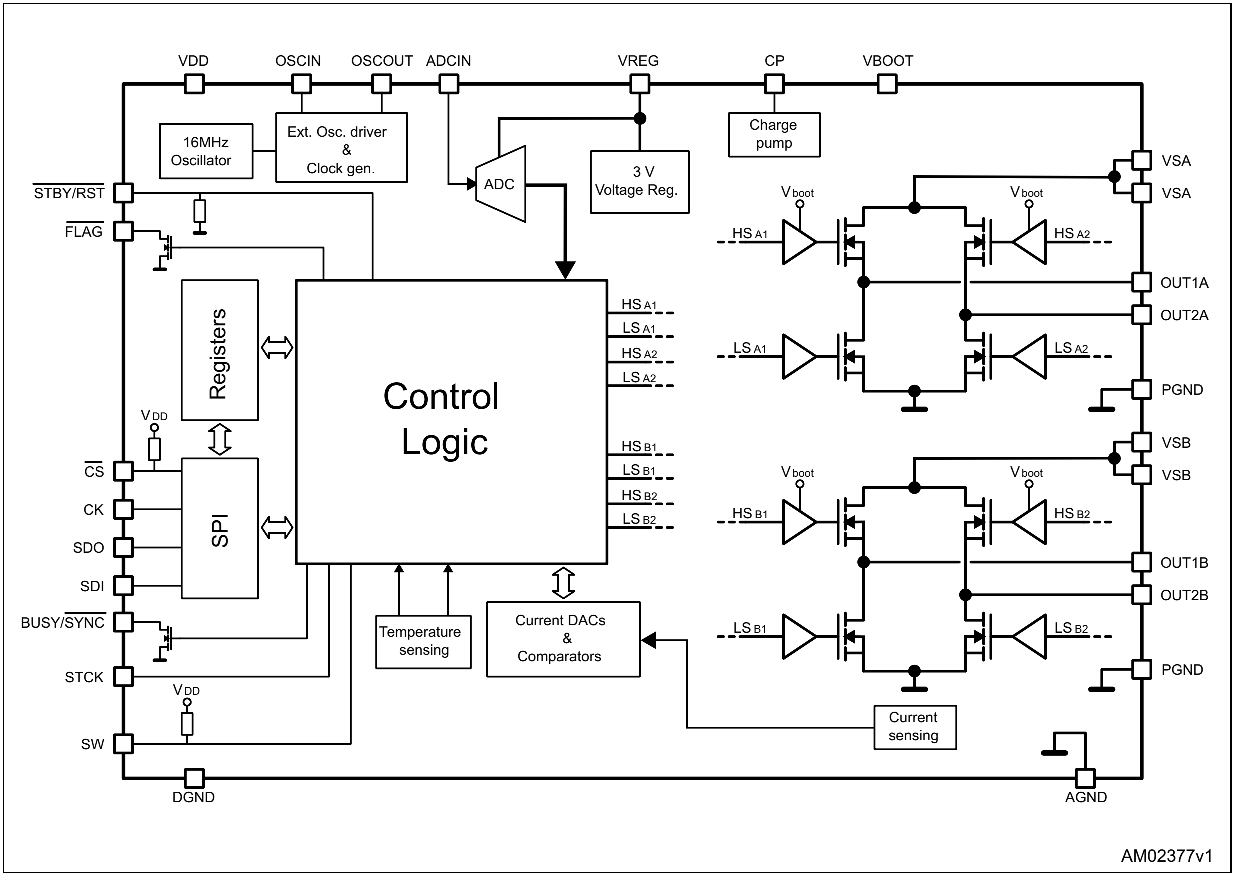


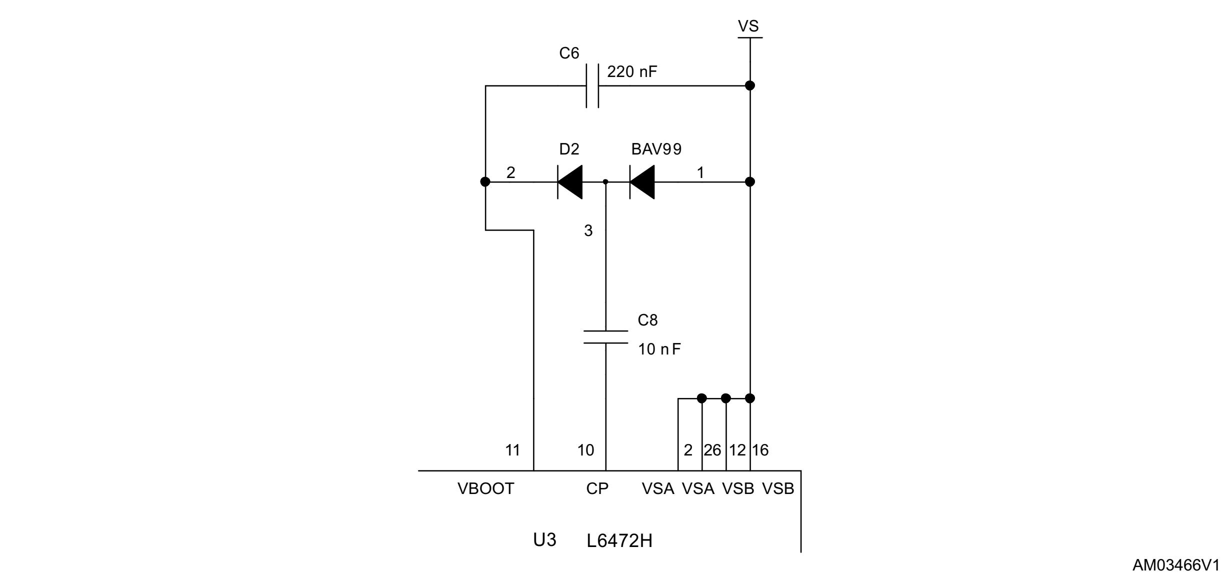
Table 3. L6472 Recommended operating conditions

Symbol	Parameter	Test condition	Value	Unit
V_{DD}	Logic Interface supply voltage		3.3	V
V_S	Motor supply voltage	$V_{SA} = V_{SB} = V_S$	8 ÷ 45	V
V_{OUT_diff}	Differential between voltage V_{SA}, OUTI1A, OUT2A, PGND and V_{SB}, OUT1B, OUT2B, PGND pins	$V_{SA} = V_{SB} = V_S$	Up to 45	V
$V_{REG\ in}$	Logic supply voltage	V_{REG} internal	3	V
V_{ADC}	Integrated ADC input voltage range (ADCIN pin)		0 ÷ V_{REG}	V

4.2.1 Charge pump

The L6472 device uses an internal charge pump for driving correctly the integrated MOSFETs, a voltage higher than the motor power supply. The charge pump is obtained through an oscillator and few external components.

Figure 8. Charge pump circuitry



4.2.2 Advanced current control

The following configuration gives good results with most of motors:

- Minimum ON time = 4 µs.
- Minimum OFF time = 21 µs.
- Max. fast decay = 10 µs.
- Max. fast decay at step change = 16 µs.
- Target switching time = 48 µs.
- Predictive current control enabled.

The impact 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”.

The target phase current is set through the TVAL registers. The TVAL determines the current corresponding to the peak of the sine wave (microstepping operation).

4.2.3 Overcurrent detection

The overcurrent protection detection is implemented by measuring the current flowing into each integrated MOSFET.

The overcurrent protection threshold should be set just above the current rating of the motor:

$$I_{OCDth} > I_{max,r.m.s.} \times \sqrt{2}$$

For example: if the maximum phase current of the motor is 2 $A_{r.m.s.}$, the overcurrent protection should be set to about 3 A.

Warning: Important - it is strongly discouraged to disable the overcurrent shutdown. It may result in critical failures.

4.2.4 Speed profile

The max. speed parameter is the maximum speed the motor will run. By default, it is about 1000 step/s. That means, if you send a command to run at 2000 step/s, the motor speed is limited at 1000 step/s.

This is an important safety feature in the final application, but not necessarily useful to evaluate the device performances. Setting the parameter to high values (e.g. 6000 step/s) allows evaluating the maximum speed which can be achieved by the application under test through the speed tracking command (Run), but it probably limits the possibility to use positioning commands (“Move”, “GoTo”, etc.).

The “Full step” speed parameter indicates the speed at which the system switches from microstepping to full step operation.

4.3 STM32F105RB microcontroller

The STM32F105xx 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^2Cs, three SPIs, two I^2Ss, five USARTs, a 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, a video intercom, HVAC and home audio equipment.

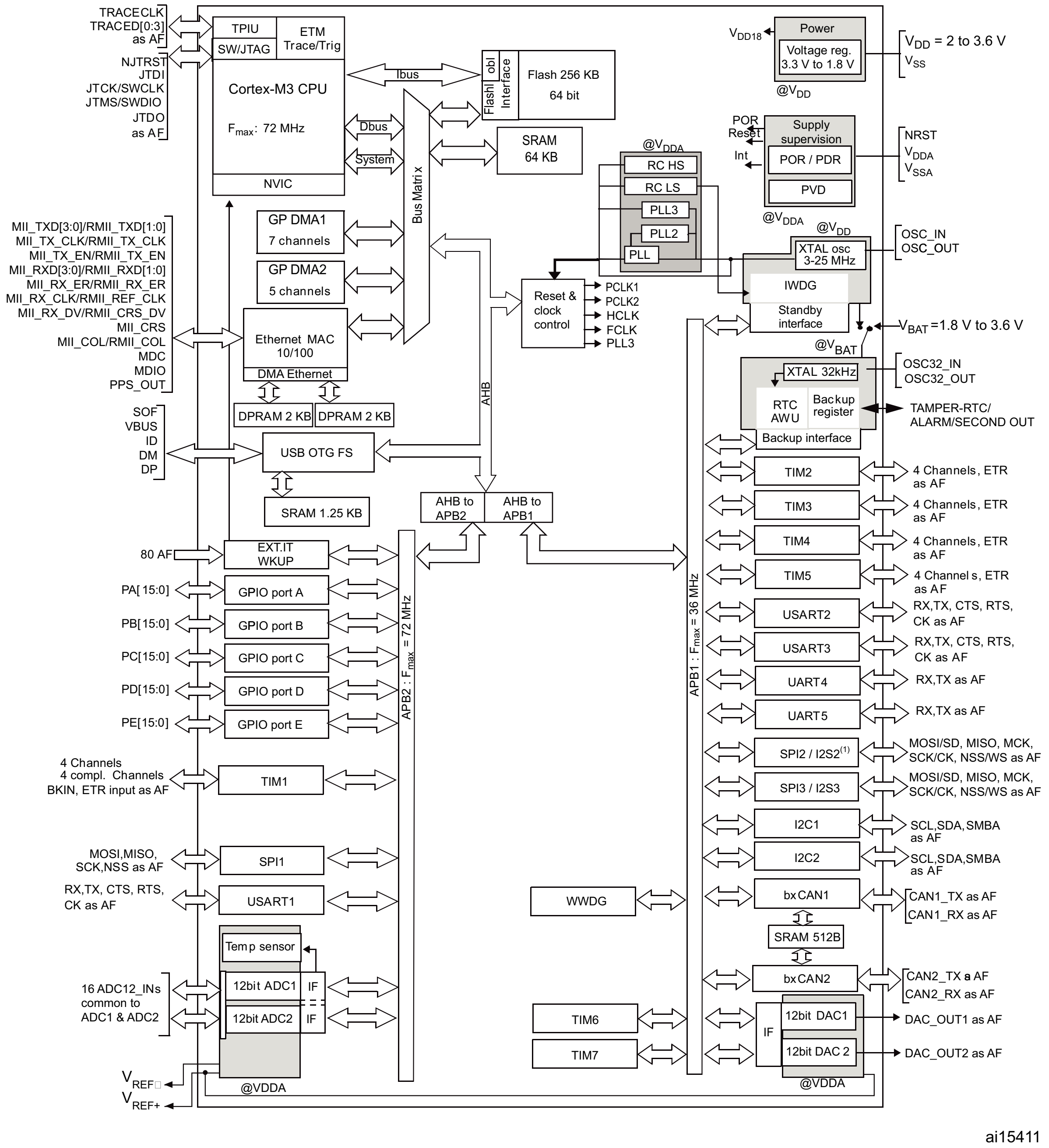
Please refer to the STM32F105xx datasheet for an overview of the complete range of peripherals proposed in this family.

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 9 shows the general block diagram of the STM32F105xx and STM32F107xx family.

Figure 9. STM32F105xx and STM32F107xx block diagram



4.4 Firmware loading

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

4.4.1 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 DfuSe are given in the UM0412 user manual.

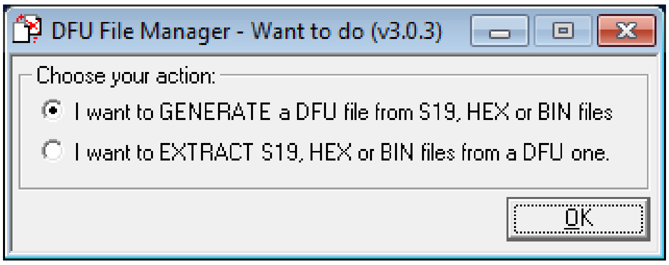
4.4.2 Generate a DFU file from a HEX file

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 10. DFU file manager (action)



DFU File Manager - Want to do (v3.0.3)

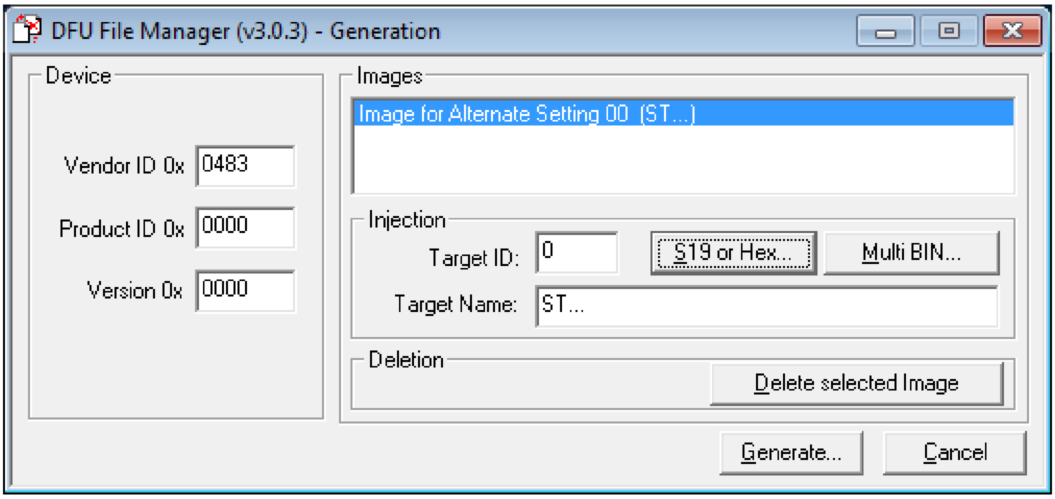
Choose your action:

● I want to GENERATE a DFU file from S19, HEX or BIN files

○ I want to EXTRACT S19, HEX or BIN files from a DFU one.

- Click on 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 11. DFU file manager (generation)



DFU File Manager (v3.0.3) - Generation

Device

Vendor ID 0x 0483

Product ID 0x 0000

Version 0x 0000

Images

Image for Alternate Setting 00 (ST...)

Injection

Target ID: 0

Target Name: ST...

Deletion

4.4.3 Board settings

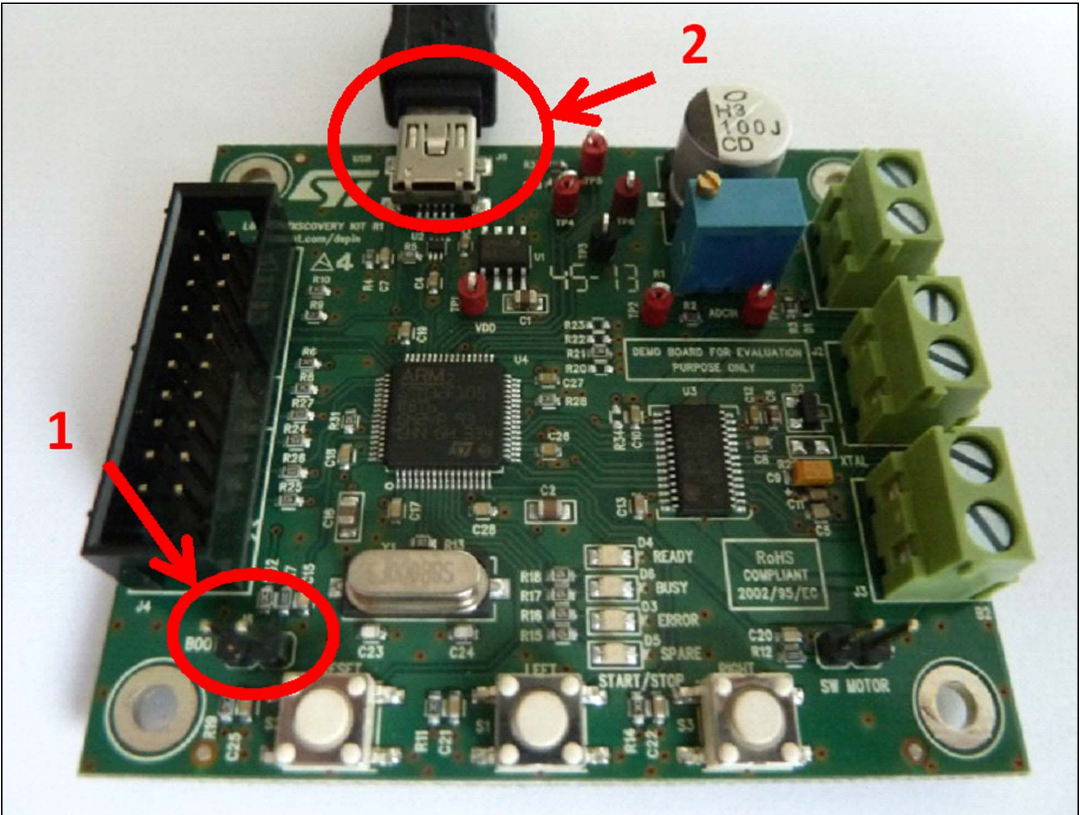
To be able to download firmware, the discovery board should be started in the “DFU” mode.

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 VS connector is plugged or not to a supply voltage.

Figure 12. Board settings

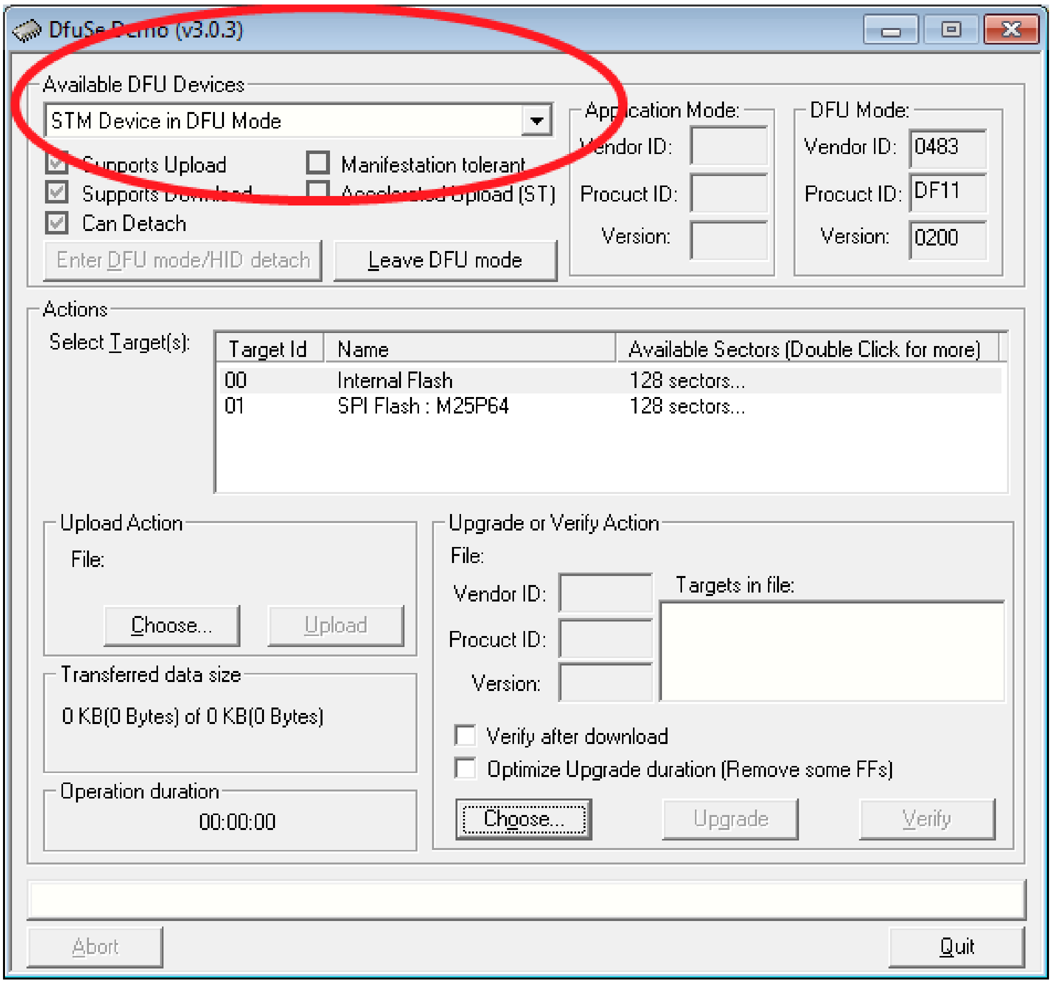


4.4.4 DFU loading

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 13. DFU loading



DfuSe Demo (v3.0.3)

Available DFU Devices: STM Device in DFU Mode

☑ Supports Upload
☑ Supports Download
☑ Can Detach
□ Manifestation tolerant
□ Accelerated Upload (ST)

Application Mode: Vendor ID: Procuct ID: Version:

DFU Mode: Vendor ID: 0483 Procuct ID: DF11 Version: 0200

Actions

Select Target(s):

Target Id	Name	Available Sectors (Double Click for more)
00	Internal Flash	128 sectors...
01	SPI Flash : M25P64	128 sectors...

Upload Action: File:

Transferred data size: 0 KB(0 Bytes) of 0 KB(0 Bytes)

Operation duration: 00:00:00

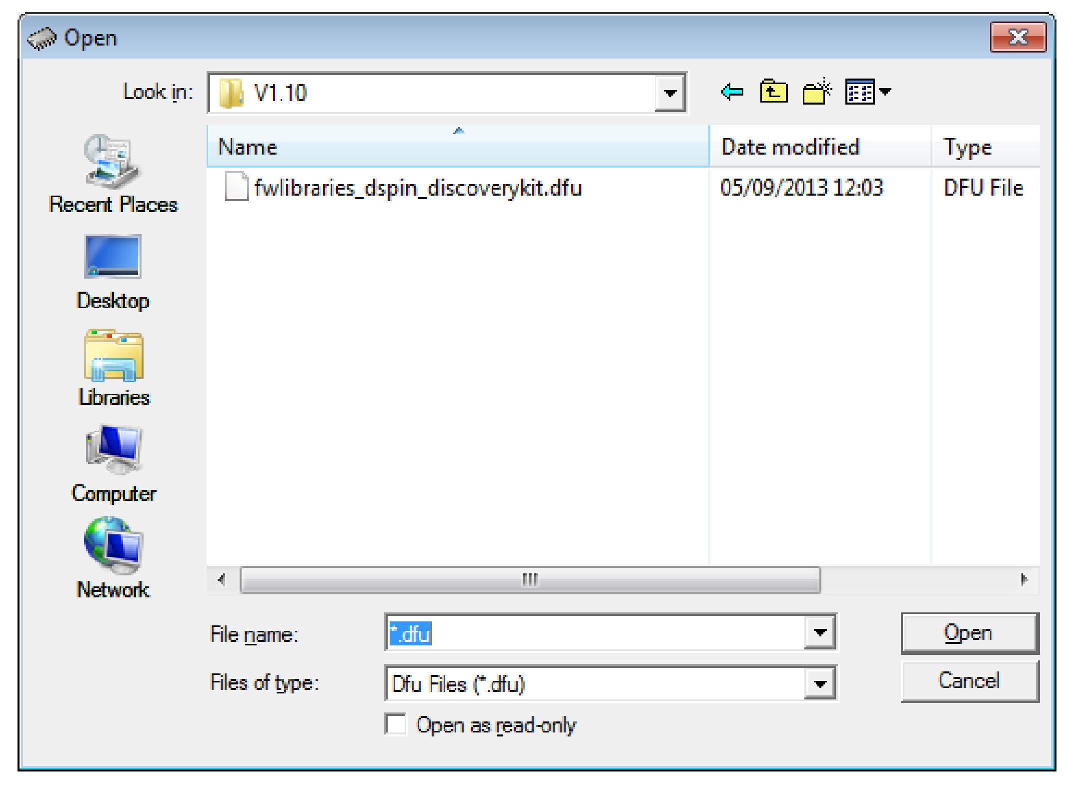
Upgrade or Verify Action: File: Vendor ID: Procuct ID: Version: Targets in file:

□ Verify after download
□ Optimize Upgrade duration (Remove some FFs)

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 14. DFU file (open)



fwlibraries_dspin_discoverykit.dfu 05/09/2013 12:03 DFU File

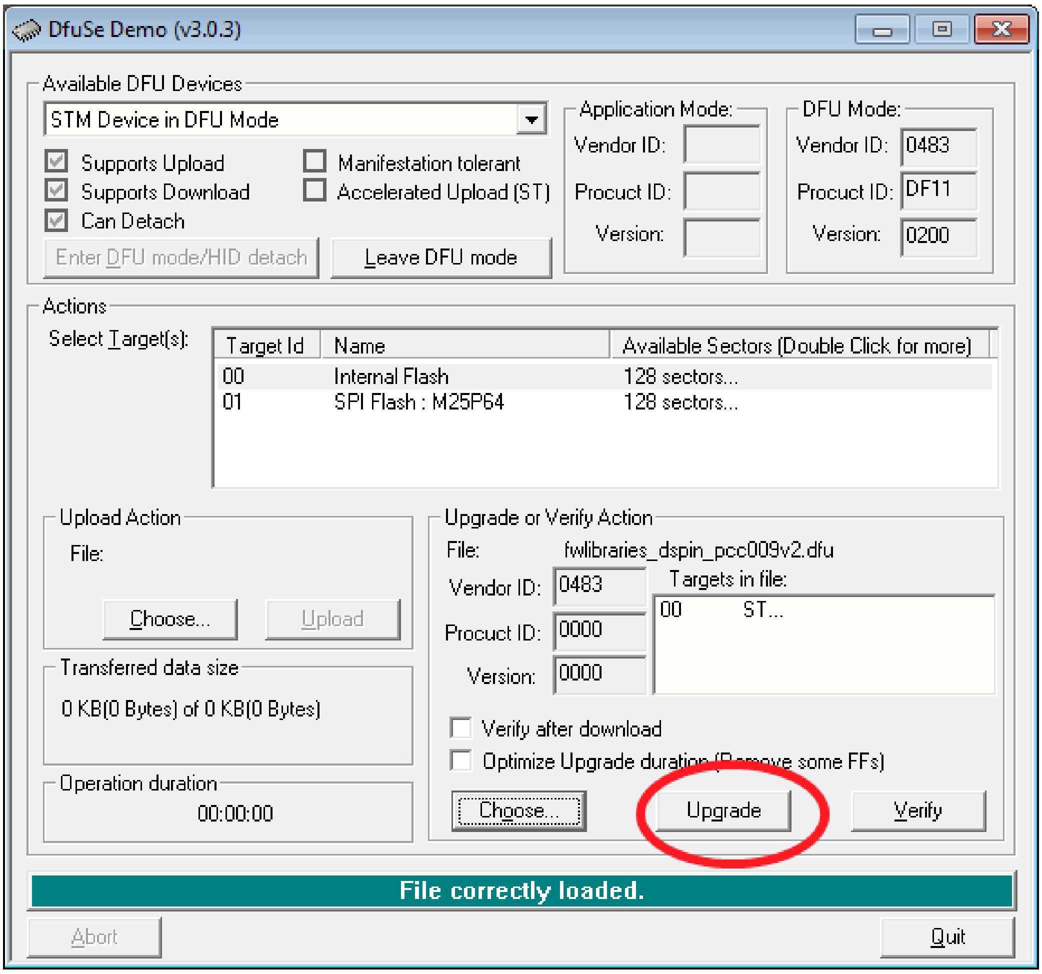
File name: *.dfu

Files of type: Dfu Files (*.dfu)

□ Open as read-only

5. Click on the “Upgrade” button.

Figure 15. DFU file (upgrade)



DfuSe Demo (v3.0.3)

Available DFU Devices: STM Device in DFU Mode

☑ Supports Upload ☐ Manifestation tolerant
☑ Supports Download ☐ Accelerated Upload (ST)
☑ Can Detach

Application Mode: Vendor ID: Procuct ID: Version:

DFU Mode: Vendor ID: 0483 Procuct ID: DF11 Version: 0200

Target Id	Name	Available Sectors (Double Click for more)
00	Internal Flash	128 sectors...
01	SPI Flash : M25P64	128 sectors...

Upload Action File:

Transferred data size: 0 KB(0 Bytes) of 0 KB(0 Bytes)

Operation duration: 00:00:00

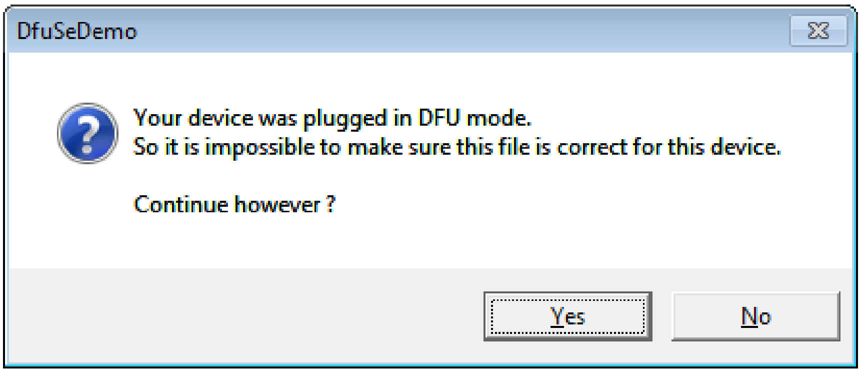
Upgrade or Verify Action
File: fwlibraries_dspin_pcc009v2.dfu
Vendor ID: 0483
Procuct ID: 0000
Version: 0000
Targets in file: 00 ST...

☐ Verify after download
☐ Optimize Upgrade duration (Remove some FFs)

File correctly loaded.

6. If this dialog box appears, click “Yes”.

Figure 16. DFU file (confirmation)



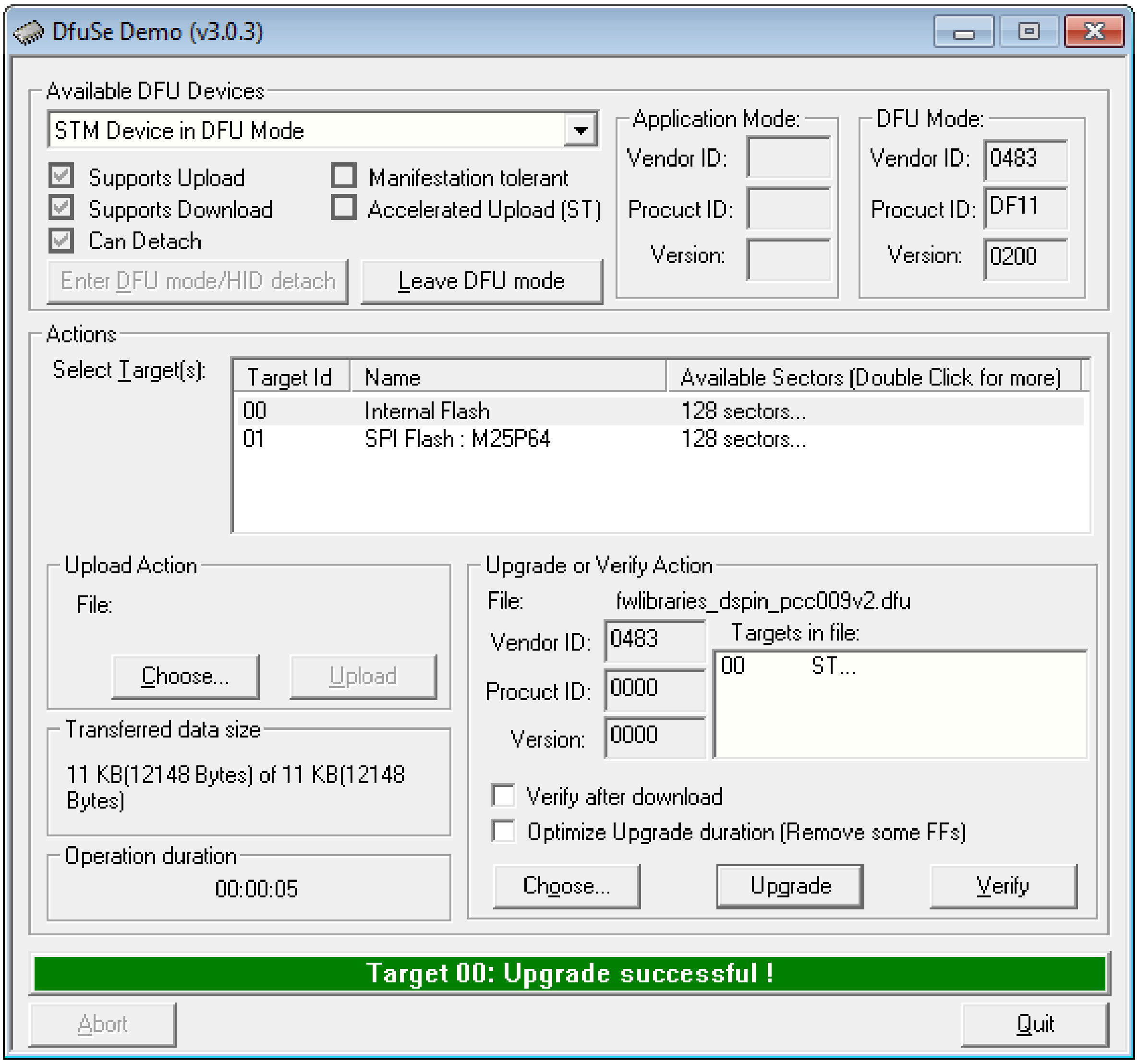
DfuSeDemo

Your device was plugged in DFU mode.
So it is impossible to make sure this file is correct for this device.

Continue however ?

7. Once the download is performed, you should have:

Figure 17. DFU file (download OK)



DfuSe Demo (v3.0.3)

Available DFU Devices: STM Device in DFU Mode

☑ Supports Upload
☑ Supports Download
☑ Can Detach
☐ Manifestation tolerant
☐ Accelerated Upload (ST)

Application Mode:
Vendor ID:
Procuct ID:
Version:

DFU Mode:
Vendor ID: 0483
Procuct ID: DF11
Version: 0200

Actions

Select Target(s):

Target Id	Name	Available Sectors (Double Click for more)
00	Internal Flash	128 sectors...
01	SPI Flash : M25P64	128 sectors...

Upload Action
File:

Transferred data size
11 KB(12148 Bytes) of 11 KB(12148 Bytes)

Operation duration
00:00:05

Upgrade or Verify Action
File: fwlibraries_dspin_pcc009v2.dfu
Vendor ID: 0483
Procuct ID: 0000
Version: 0000
Targets in file:
00 ST...

☐ Verify after download
☐ Optimize Upgrade duration (Remove some FFs)

Target 00: Upgrade successful !

8. Do no forget to put the jumper back on the BOOT pins in order to restart the discovery board to the normal mode!

4.5 Using the EVAL6472H-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 SPINFamily evaluation tool. This GUI provides direct access to all L6472 registers and allows sending application commands.

Both the FWGUI and the GUI can be downloaded from the “Design Resources” page of the L6472:

The FWGUI can be downloaded to the discovery board as detailed in *Section 4.4*.

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

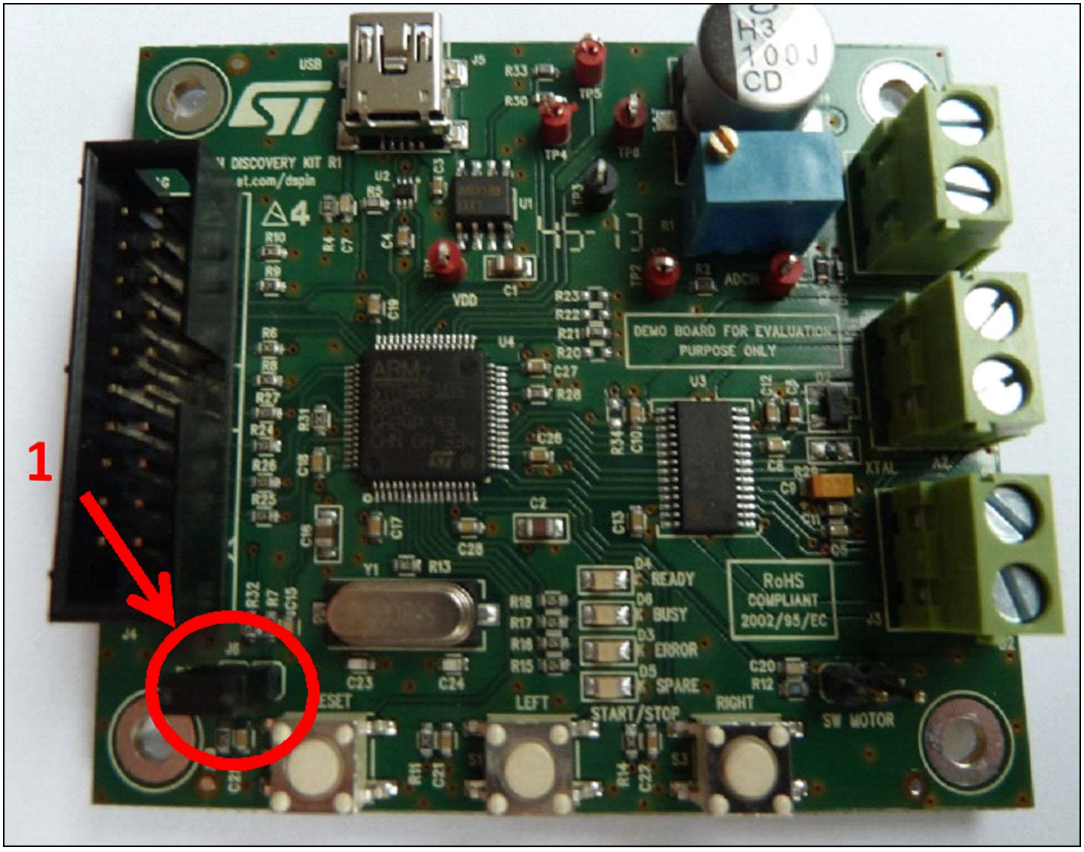
4.5.1 Sanity check of the board with the firmware for the GUI (FWGUI)

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:

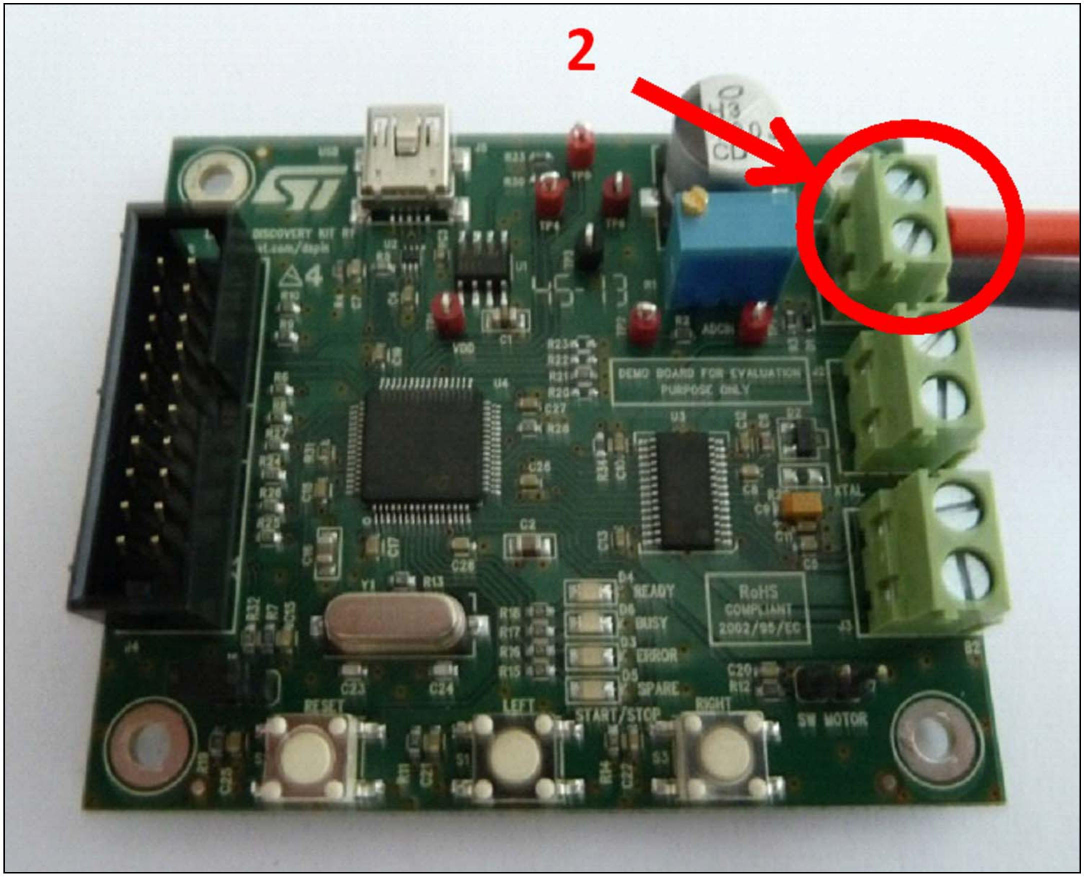
1. Place a jumper on the BOOT pins (bottom left corner of the board):

Figure 18. Starting board (BOOT mode)



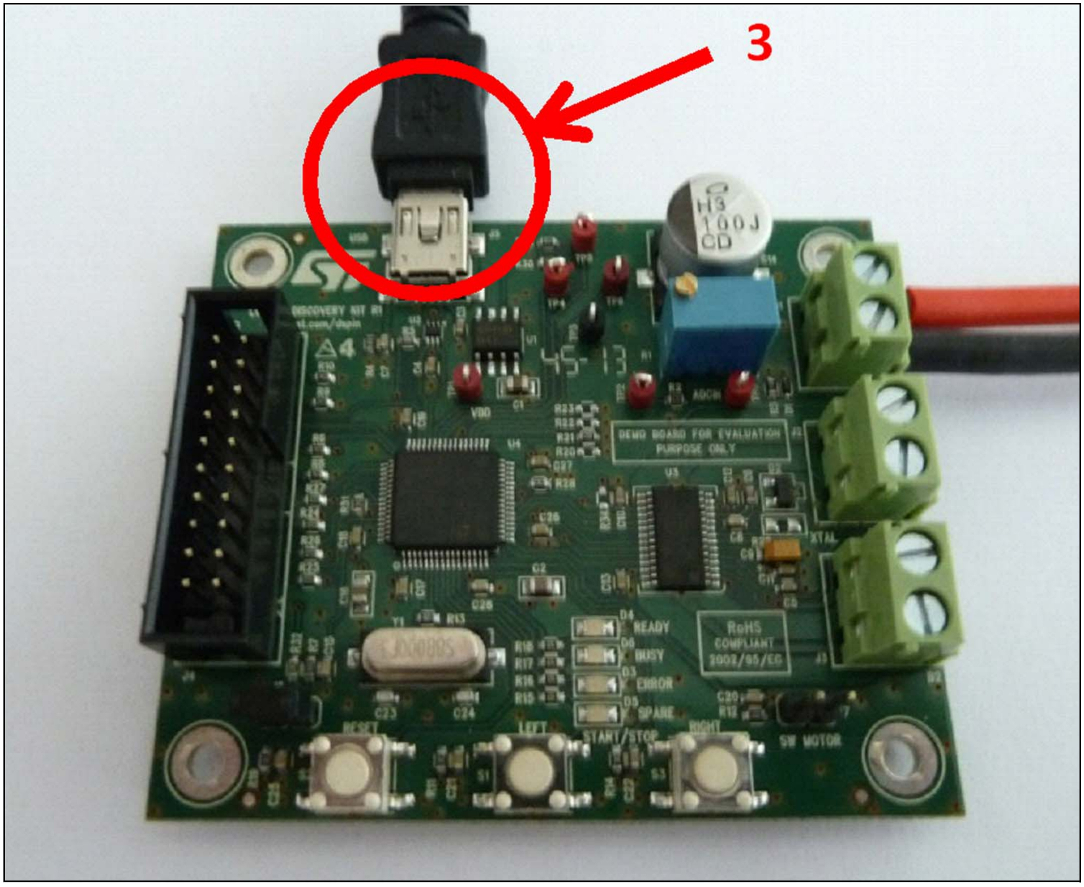
2. Connect the board to a 5 V - 45 V DC power supply:

Figure 19. Starting board (motor power supply)



3. Plug a USB cable (which must at least provide a power supply).

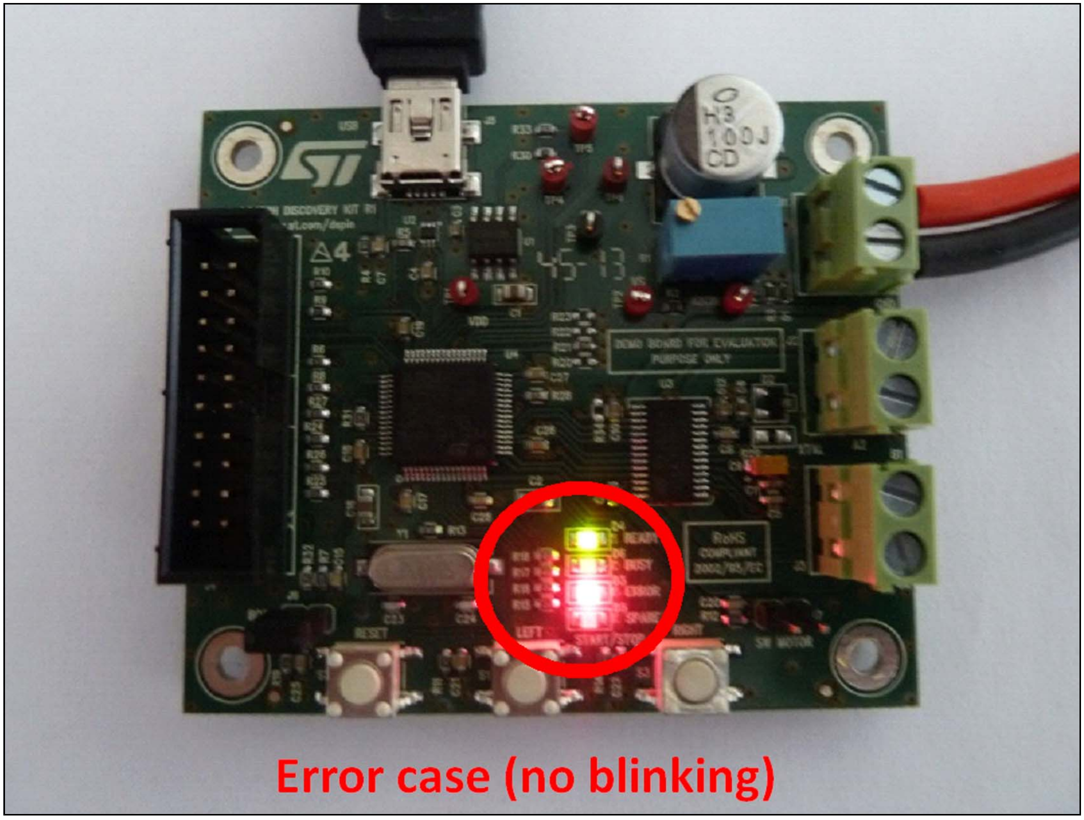
Figure 20. Starting board (USB connection)



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 not recognized by the FW (bad FW versions used)
   – or there is a problem with the SPI (no connection between the MCU and the L6472 via the SPI)
   – or there is no 5 V - 45 V DC power supply.

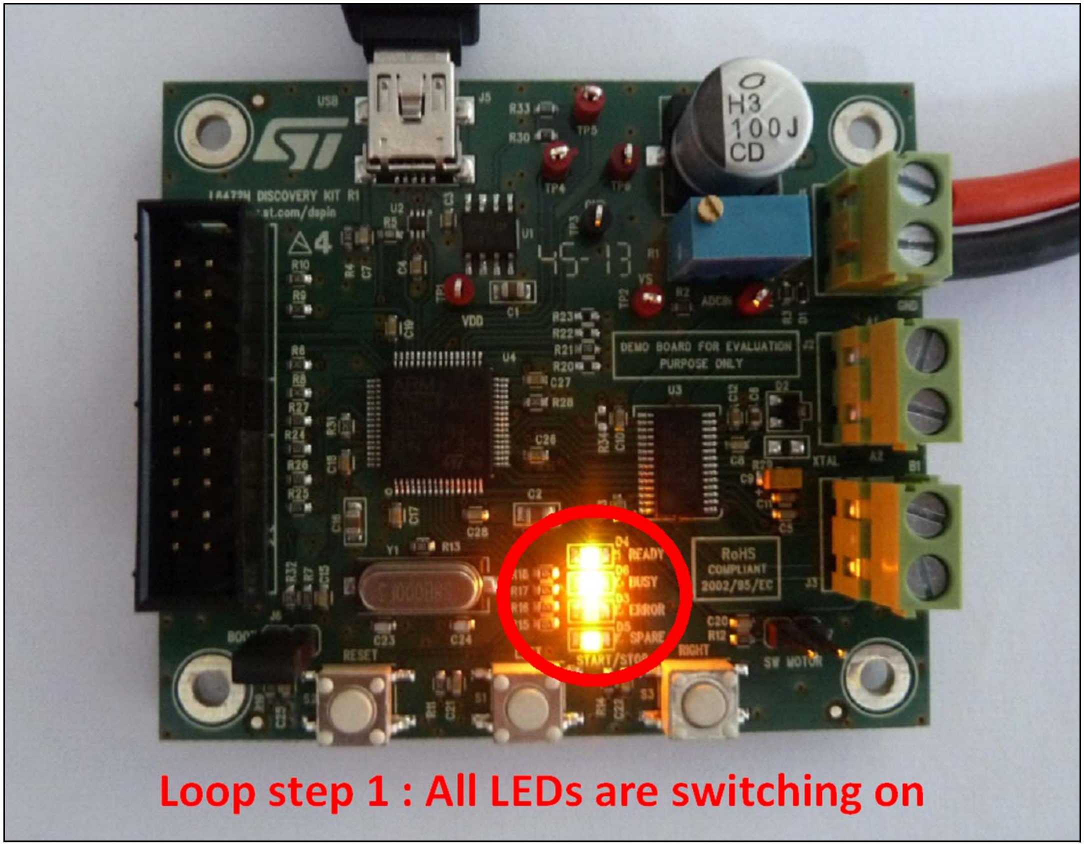
Figure 21. Starting board (error case)



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 22. Starting board (board OK)



Loop step 1 : All LEDs are switching on
READY
BUSY
ERROR
SPARE
START/STOP
RESET
RIGHT
DEMO BOARD FOR EVALUATION PURPOSE ONLY
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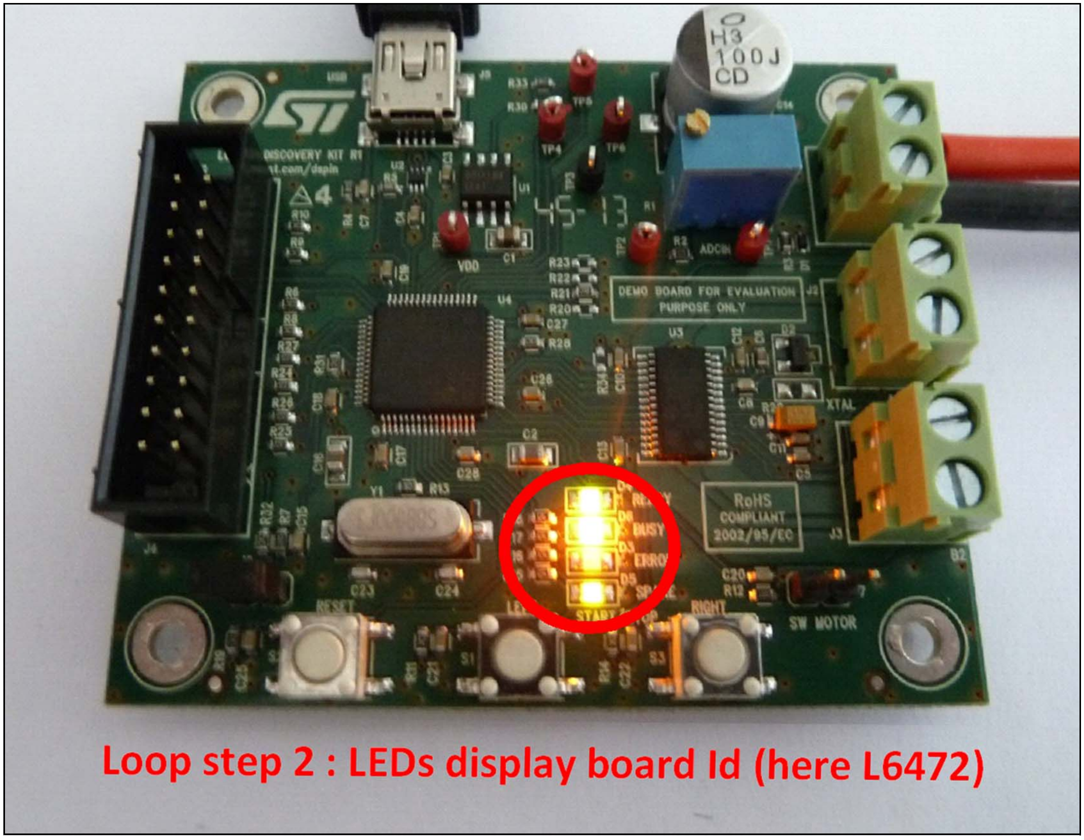
– In the second step, only the LEDs which correspond to the board ID are switched on all at the same time.

For the L6472 device, there are the green, red, yellow LEDs.

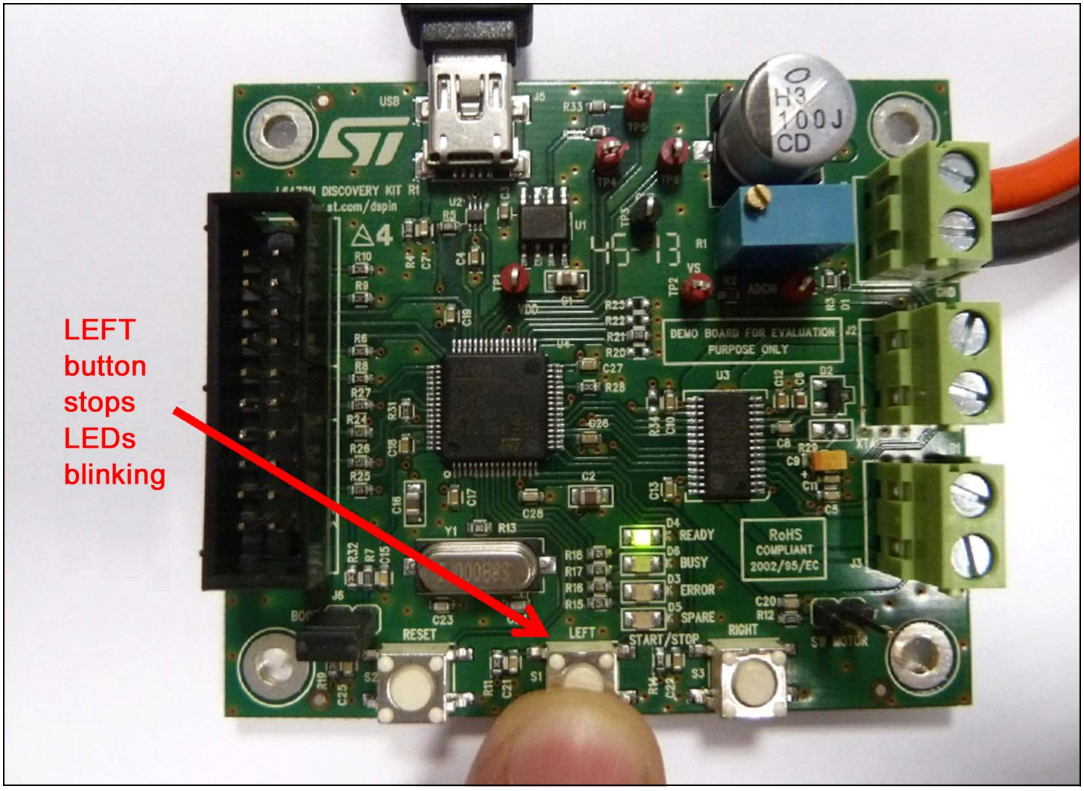
Figure 23. Starting board (display board ID)



Loop step 2 : LEDs display board Id (here L6472)

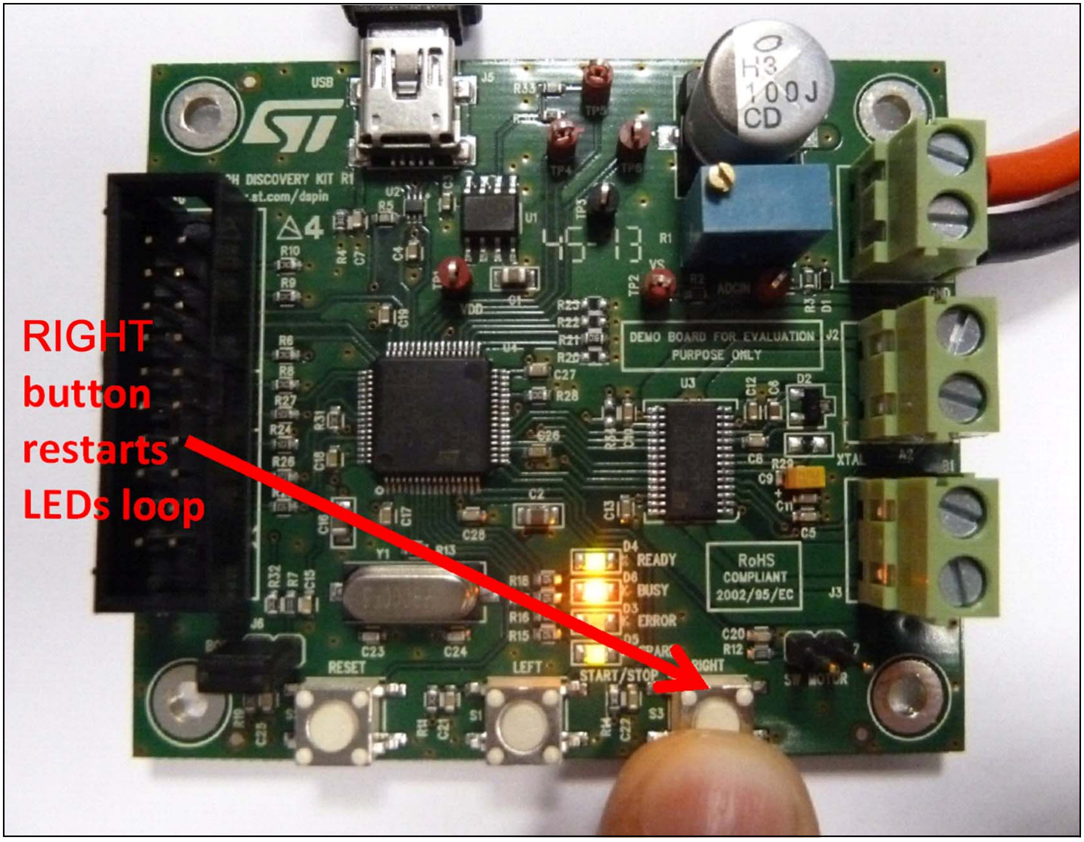
6. Press the LEFT button and check the two-step loop stops after a few seconds. Only the green LED remains switched on.

Figure 24. Starting board (action LEFT key)



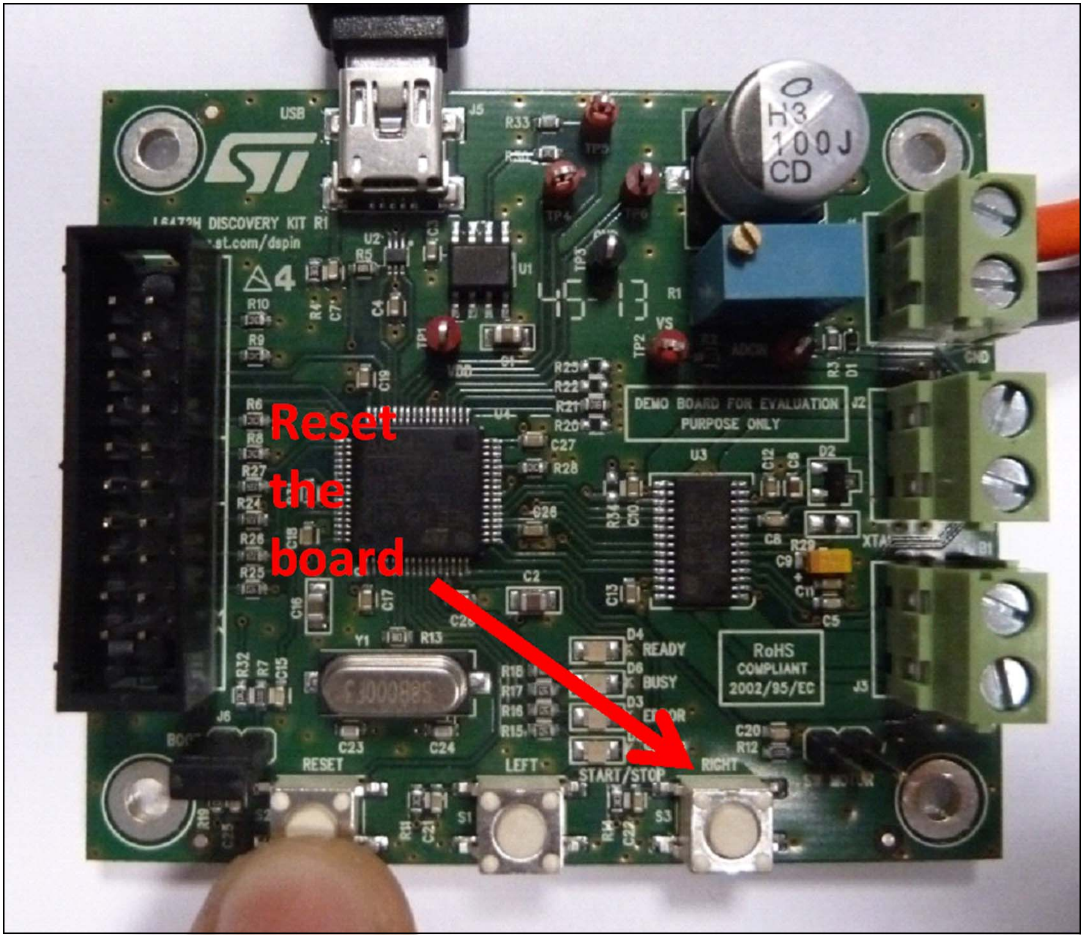
7. Press the “RIGHT” button and check the two-step loops restarts.

Figure 25. 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 26. Starting board (action RESET key)


Reset the board
RESET
LEFT
START/STOP
RIGHT
READY
BUSY
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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 of the LEDs.

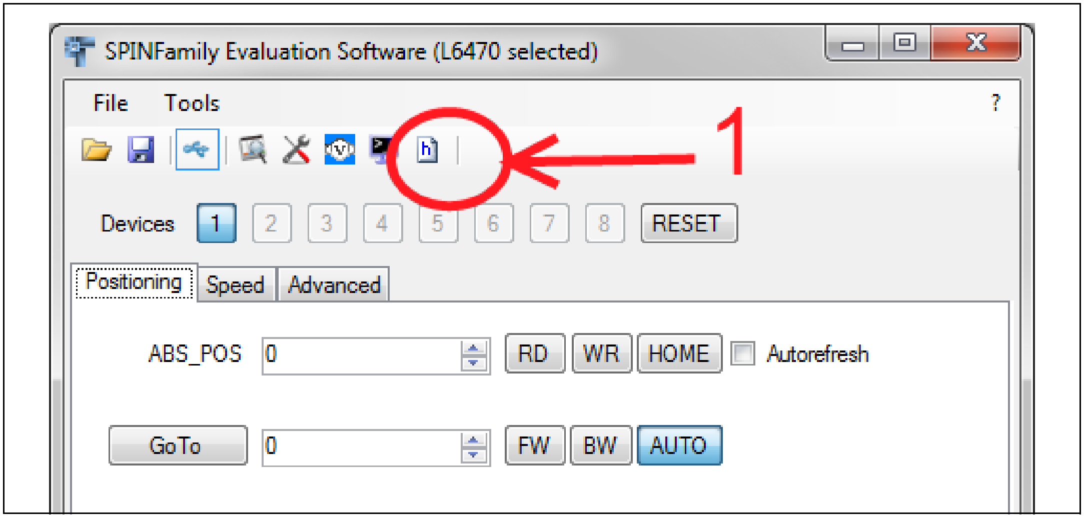
4.5.2 Parameters exportation from the GUI to the FW library

Once you have customized the L6472 parameters with the GUI, you can export them to a header file in order to use it with the FW library.

In this purpose:

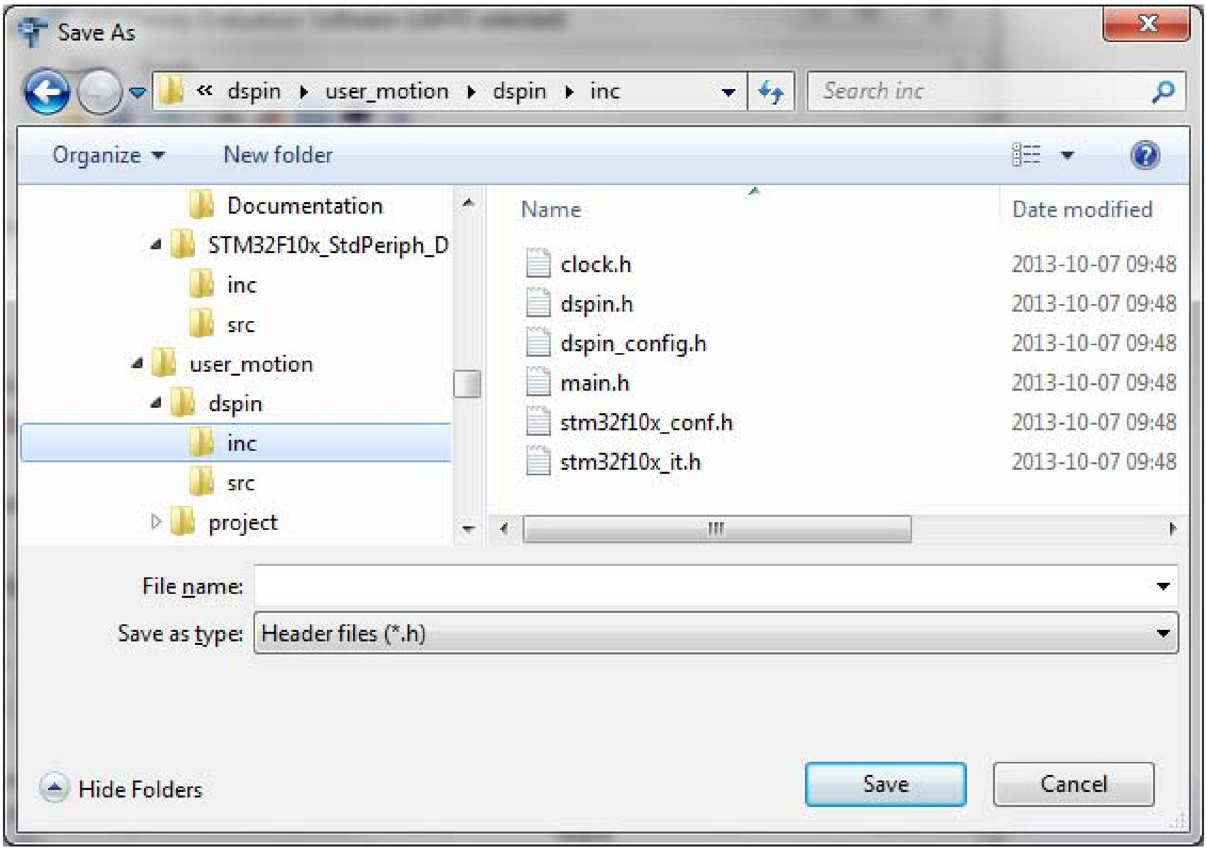
1. Press the “header file” button on the main window of the GUI.

Figure 27. Parameters exportation



2. Replace the existing “dspin_config.h” of your current FW library by the new one.

Figure 28. Parameters exportation (save file)



Name	Date modified
clock.h	2013-10-07 09:48
dspin.h	2013-10-07 09:48
dspin_config.h	2013-10-07 09:48
main.h	2013-10-07 09:48
stm32f10x_conf.h	2013-10-07 09:48
stm32f10x_it.h	2013-10-07 09:48

File name:

Save as type: Header files (*.h)

3. Then you only need to recompile your project as usual to use the exported parameters.

4.6 Using the EVAL6472H-DISC with the firmware library

The L6472 firmware library is supplied as an IAR workspace with a source, include project files. If you are using an IAR design environment, you just need to load the “dspin.eww” file and use the “fwlibrairies_dspin_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 L6472 firmware library is also supplied as an executable in a HEX and in a DFU format. It can be loaded into the EVAL6472H-DISC board as explained in *Section 4.4 on page 17*.

4.6.1 FW library package contents

- FW L6472 library
  - Described in *Section 4.6.2*.
- CMSIS library
  - /stm32f10x/CMSIS Library used by the L6472 FW library
- STM32F10x Standard Peripherals Library Drivers
  - /stm32f10x/STM32F10x_StdPeriph_Driver Library used by the L6472 FW library
- IAR workspace files
  - /user_motion/project/ewarm6/fwlibraries/dspin/dspin.eww
    - a workspace file
  - /user_motion/project/ewarm6/fwlibraries/dspin/settings/dspin.wsdt
    - a workspace settings file
  - /user_motion/project/ewarm6/fwlibraries/dspin/discoverykit
    - a directory containing L6472 discovery board project files and subdirectories
  - /user_motion/project/ewarm6/fwlibraries/dspin/discoverykit/Debug/Exe/
    - a directory containing the *.hex and *.dfu executable files
  - /user_motion/project/ewarm6/fwlibraries/dspin/pcc009v2
    - a directory containing PCC009V2 board project files and subdirectories.

4.6.2 FW L6472 library description

The FW L6472 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 FW L6472 library has been tested on the L6472H DISCOVERY board R1. The main program contains a commented demonstration sequence which uses all the FW L6472 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 L6472 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 L6472 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 L6472 FW library, the L6472 Discovery board HW does not allow it. Please contact ST support if you want more information on the “Daisy Chain” mode testing or implementation.

The FW L6472 library consists of the following files

• user_motion/dspin/inc/stm32f10x_conf.h	Library configuration file
• user_motion/dspin/src/stm32f10x_it.c	Interrupt handlers
• user_motion/dspin/inc/stm32f10x_it.h	Header for stm32f10x_it.c
• user_motion/dspin/inc/clock.h	System clock setup related header
• user_motion/dspin/src/clock.c	System clock source file
• user_motion/dspin/inc/dspin.h	L6472 definitions header
• user_motion/dspin/src/dspin.c	L6472 routines source file
• user_motion/dspin/inc/dspin_config.h	L6472 configuration parameters (this file can be generated by the GUI)
• user_motion/dspin/inc/main.h	Main header file
• user_motion/dspin/src/main.c	Main program
• user_motion/dspin/inc/pre_include.h	First header file included by the preprocessor
• user_motion/dspin/readme.txt	Information on the files

4.6.3 Demonstration sequence description

The demonstration sequence description is for one L6472 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 used by L6472.
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 L6472 into the standby mode. The L6472 STBY_RESET pin goes low for a few hundreds of µs and then goes high.
5. Program all L6472 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 a 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 (L6472 pin 22).

Busy signal management

13. Interrupt configuration for BUSY signal
14. Motor moves by 100,000 steps in a reverse direction | **Move (DIR, N_STEP)**
15. *During busy time the LED_BUSY (ORANGE) is switched ON*
16. L6472 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 (L6472 pin 22).
20. Sends L6472 command setting hold duty cycle to 0.5%, sends L6472 command changing run duty cycle to 5% | **SetParam (PARAM, VALUE)**
21. Motor runs at constant speed of 50 steps/s in a reverse direction | **Run (DIR, SPD)**
22. Motor softly stops after a few seconds | **SoftStop**
23. RESET KVAL_HOLD to initial value, RESET KVAL_RUN to initial value | **SetParam (PARAM, VALUE)**
24. Wait until not busy - busy status check in “Status” register | **GetStatus**
25. Motor moves by 100,000 steps forward | **Move (DIR, N_STEP)**
26. Wait until not busy - busy status check in “Status” register | **GetStatus**
27. Test of the Flag pin (L6472 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 (L6472 pin 22).
30. Motor goes to absolute position 65535 through the shortest path | **GoTo (ABS_POS)**
31. Wait until not busy - busy pin test (L6472 pin 22).
32. Motor goes in a forward direction to absolute position 131071 | **GoTo_DIR (DIR, ABS_POS)**
33. Wait until not busy - busy pin test (L6472 pin 22).
34. Read run duty cycle (dSPIN_KVAL_RUN) parameter from L6472, read intersect speed (dSPIN_INT_SPD) parameter from L6472 | **GetParam(PARAM)**
35. “Read Status” register content | **GetStatus**
36. Read absolute position (dSPIN_ABS_POS) parameter from L6472 | **GetParam(PARAM)**
37. Reset position counter, actually | **ResetPos**
38. Read absolute position (dSPIN_ABS_POS) parameter from L6472 | **GetParam(PARAM)**
39. L6472 disable power stage (high impedance) immediately, as a consequence the L6472 supply current drops | **HardHiZ**.

“Go Until” example

40. Interrupt configuration for the SW MOTOR
41. Motor motion in a 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 (L6472 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 (L6472 pin 22).
48. Nothing happens during a few seconds.

Release SW example

49. Motor motion in a 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 (L6472 pin 22).
53. Motor goes to home position set by the “ReleaseSW” command | **GoHome**
54. Wait until not busy - busy pin test (L6472 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 the step clock mode at 2000 steps/s in a forward direction for a few seconds while a 2 kHz clock signal from the MCU is applied to the L6472 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)**.

4.6.4 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_DSPIN_L6472H_DISCOVERY

Edit the preprocessor including directories and add:

- $PROJ_DIR$\…\…\…\…\…\…\stm32f10x\CMSIS\CM3\DeviceSupport\ST\STM32F10x
- $PROJ_DIR$\…\…\…\…\…\…\stm32f10x\STM32F10x_StdPeriph_Driver\inc
- $PROJ_DIR$\…\…\…\…\…\dspin\inc

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.

5 References

This user manual provides information on the hardware features and use of the EVAL6472H-DISC board along with the demonstration firmware and software. For additional information, refer to the following:

1. STM32F105xx/STM32F107xx datasheet (CD00220364)
2. STM32F101xx, STM32F102xx, STM32F103xx, STM32F105xx and STM32F107xx advanced ARM®-based 32-bit MCUs reference manual (RM0008).

6 Revision history

Table 4. Document revision history

Date	Revision	Changes
12-Dec-2013	1	Initial release.
17-Apr-2015	2	Updated *Section : Introduction on page 1*, *Table 2 on page 9* and *Section 4.2.1 on page 13* (replaced “L6472H” by “L6472”). Removed Figure 5. Layout (silk screen) from page 9. Replaced “dSPIN” by “L6472” and/or “motor” in the whole document. Updated *Table 3 on page 13* (minor modifications). Updated *Section 4.5 on page 24* (replaced “FWPSPIN” by “FWGUI”, removed “dSPIN” and web link). Updated text above *Figure 23 on page 29* (removed L6470 device step). Updated *Section 4.5.2 on page 33* and *Section 4.6.2 on page 35* ((removed L6470 device/board). Updated *Section 4.6.4 on page 40* (replaced “L6470H” by “6472H”). Updated *20.* in *Section : Various application commands examples on page 38* (minor modifications). Updated *1.* and *2.* in *Section 5 on page 41*. Minor modifications throughout document.

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