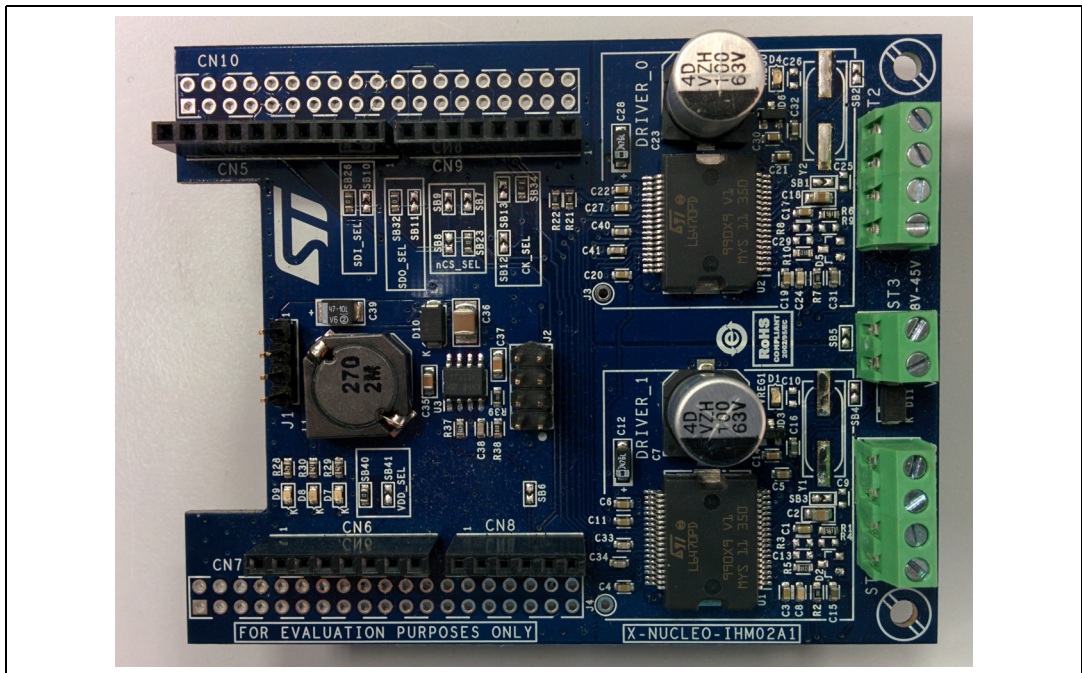


Getting started with X-NUCLEO-IHM02A1; two-axis stepper motor driver expansion board based on L6470 for STM32 Nucleo

Introduction

The X-NUCLEO-IHM02A1 is a two-axis stepper motor driver expansion board based on L6470. It provides an affordable and easy to use solution for driving low voltage motor control for stepper motors in your STM32 Nucleo project. The expansion board includes two L6470 fully integrated micro stepping motor drivers for motor stepper control through motors high-end motion control commands received via SPI. It is able to drive one or two stepper motors when plugged on an STM32 Nucleo board. This board is equipped with an Arduino™ UNO R3 connector and the layout is also compatible with ST morpho connectors. One or more of these expansion boards can be plugged on a STM32 Nucleo board to control one or more stepper motors. The SPI peripherals from each L6470 are connected in daisy chain configuration.

Figure 1. X-NUCLEO-IHM02A1; two-axis stepper motors driver expansion board based on L6470



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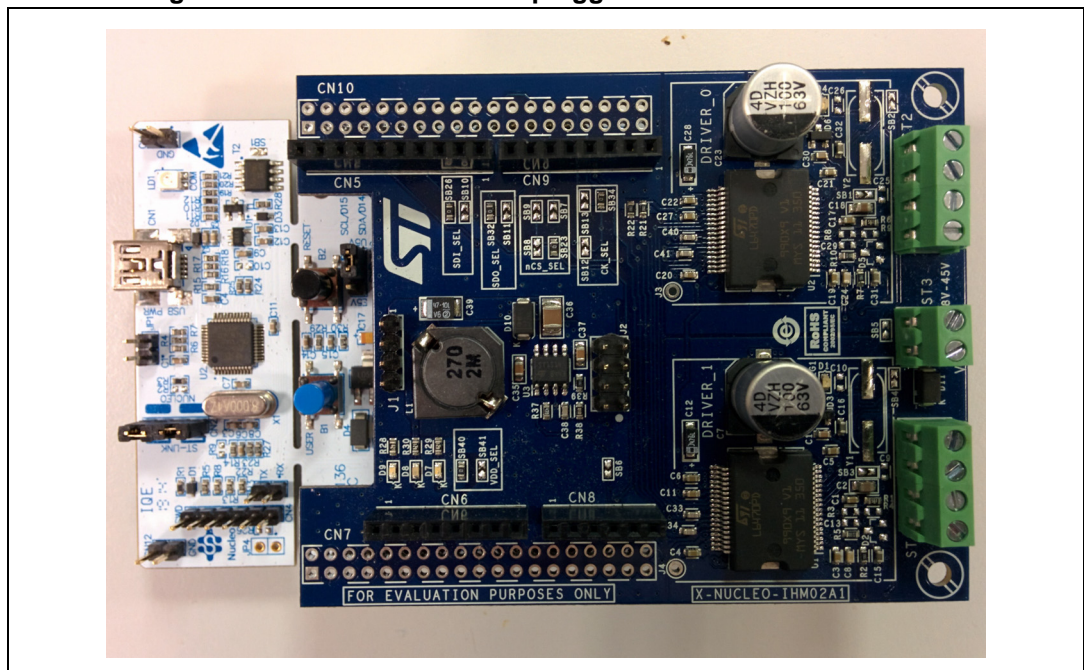
1 Getting started

The X-NUCLEO-IHM02A1 expansion board extends the application landscape for STM32 Nucleo board user. It directly handles two-axis stepper motors driving, through the L6470, and can be used in a wide range of relevant applications.. The maximum ratings of the L6470 are the following:

- Power stage supply voltage (VS) from 8 V to 45 V DC;
- motors phase current up to 3 A r.s.m. (related to the L6470)

To function correctly, the X-NUCLEO-IHM02A1 (two-axis stepper motors driver expansion board based on L6470) has to be plugged on an STM32 Nucleo board as shown in [Figure 2](#).

Figure 2. X-NUCLEO-IHM02A1 plugged on STM32 Nucleo board



The interconnection between the STM32 Nucleo board and the X-NUCLEO-IHM02A1 is designed to permit the use of any STM32 Nucleo board. The firmware has been written and tested for the NUCLEO-F401RE, NUCLEO-F302R8 and NUCLEO-F072RB.

Note: For correct use of the NUCLEO-F401RE with the X-NUCLEO-IHM02A1, the solder bridge SB15 on the NUCLEO-F401RE has to be removed (see the NUCLEO-F401RE user manual for further information).

1.1 Hardware and software requirements

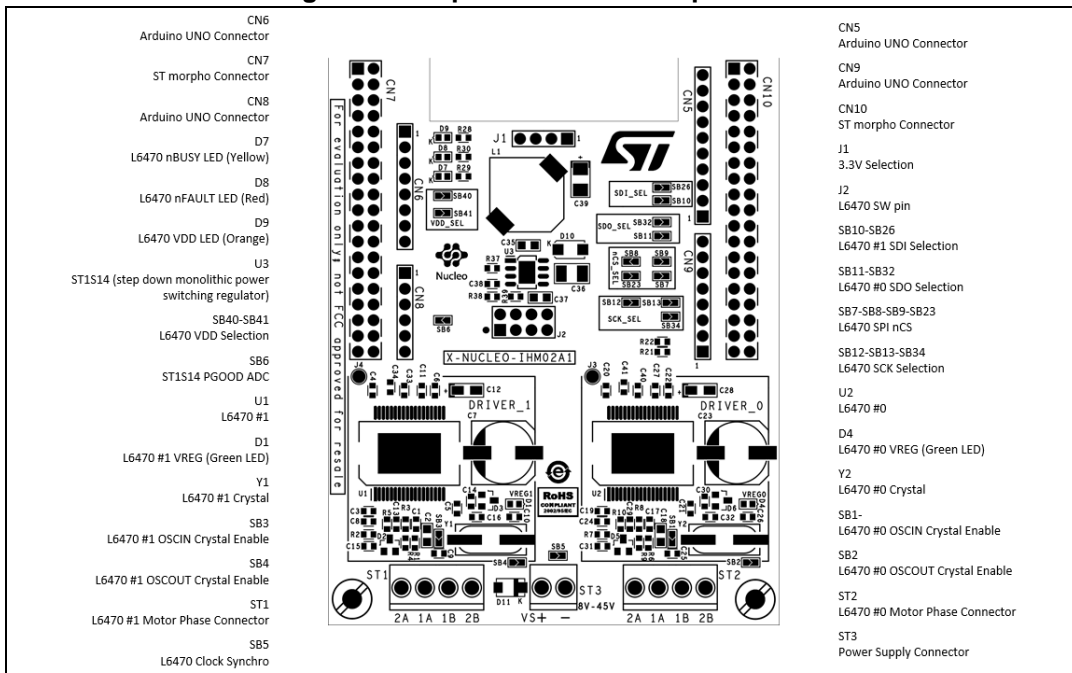
Using the STM32 Nucleo boards with the X-NUCLEO-IHM02A1 expansion board requires the following software and hardware:

- a Windows PC (XP, Vista, 7, 8) to install the software package;
- from one to four X-NUCLEO-IHM02A1 expansion boards;
- an STM32 Nucleo board chosen from among NUCLEO-F401RE, NUCLEO-F302R8 or NUCLEO-F072RB;
- a USB type A to Mini-B USB cable to connect the STM32 Nucleo board to the PC;
- the X-CUBE-SPN2 software package (available on www.st.com);
- an IDE chosen from among IAR Embedded Workbench for ARM (EWARM), keil microcontroller development Kit (MDK-ARM) and System Workbench for STM32 (SW4STM32);
- two-axis stepper motors with compatible voltage and current for the L6470;
- an external power supply able to provide the right voltage for the stepper motors used;
- (optional) a terminal emulator, serial console (i.e. PuTTY) to send commands via USART.

2 Hardware description and configuration

This section describes the X-NUCLEO-IHM02A1 features and provides useful information for understanding the board schematics. *Figure 3* shows the position of the connectors and the configuration board jumpers.

Figure 3. Jumper and connector positions



Below is the detailed pinout of the ST morpho and Arduino™ UNO R3 connectors.

Table 1. ST morpho connector table

Connector	Pin	Default	Signal	Solder bridge
CN7	1	PC10		
	2	PC11		
	3	PC12		
	4	PD2		
	5	VDD		
	6	E5V		
	7	BOOT0		
	8	GND		
	9	NC/PF6		
	10	NC		
	11	NC/PF7		

Table 1. ST morpho connector table (continued)

Connector	Pin	Default	Signal	Solder bridge
CN7	12	IOREF		
	13	PA13		
	14	RESET		
	15	PA14		
	16	+3V3	+3V3	SB40
	17	PA15		
	18	+5V	+5V	SB40
	19	GND		
	20	GND		
	21	PB7		
	22	GND		
	23	PC13		
	24	VIN		
	25	PC14		
	26	NC		
	27	PC15		
	28	PA0		
	29	PH0/PF0/PD0		
	30	PA1		
	31	PH1/PF1/PD1		
	32	PA4	L6470 nCS	SB23
	33	VLCD/VBAT		
	34	PB0	ST1S14 PGOOD	SB6
	35	PC2		
	36	PC1	L6470 nFLAG	
	37	PC3		
	38	PC0	L6470 nBUSY\SYNC	
	CIN10	1	PC9	
2		PC8		
3		PB8		
4		PC6		
5		PB9		
6		PC5		
7		AVDD		
8		U5V		

Table 1. ST morpho connector table (continued)

Connector	Pin	Default	Signal	Solder bridge
CIN10	9	GND		
	10	PD8/NC		
	11	PA5/PB13	L6470 SCK	SB12
	12	PA12		
	13	PA6/PB14	L6470 #0 SDO	SB32
	14	PA11		
	15	PA7/PB15	L6470 #1 SDI	SB26
	16	PB12		
	17	PB6	L6470 nCS	SB8
	18	PB11/NC		
	19	PC7		
	20	GND		
	21	PA9		
	22	PB2		
	23	PA8		
	24	PB1		
	25	PB10		
	26	PB15/PA7	L6470 #1 SDI	SB10
	27	PB4	L6470 nCS	SB9
	28	PB14/PA6	L6470 #0 SDO	SB11
	29	PB5	L6470 nSTBY\nRST	
	30	PB13/PA5	L6470 SCK	SB13
	31	PB3	L6470 SCK	SB34
	32	AGND		
	33	PA10	L6470 nCS	SB7
	34	PC4		
	35	PA2		
	36	NC/PF5		
	37	PA3		
	38	NC/PF4		

Table 2. Arduino UNO R3 connector table

Connector	Pin	Default	Signal	Solder bridge
CN5	1	D8		
	2	D9/PWM		
	3	D10/CS/PWM	L6470 nCS	SB8
	4	D11/MOSI/PWM	L6470 #1 SDI	SB26
	5	D12/MISO	L6470 #0 SDO	SB32
	6	D13/SCK	L6470 SCK	SB12
	7	NC		
	8	NC		
	9	D14/SDA		
	10	D15/SCL		
CN6	1	NC		
	2	IOREF		
	3	RESET		
	4	+3V3		
	5	+5V		
	6	GND		
	7	GND		
	8	VIN		
CN8	1	A0		
	2	A1		
	3	A2	L6470 nCS	SB23
	4	A3	ST1S14 PGOOD	SB6
	5	A4	L6470 nFLAG	
	6	A5	L6470 nBUSY\SYNC	
CN9	1	D0/RX		
	2	D1/TX		
	3	D2	L6470 nCS	SB7
	4	D3/PWM	L6470 SCK	SB34
	5	D4	L6470 nSTBY\nRST	
	6	D5/PWM	L6470 nCS	SB9
	7	D6/PWM		
	8	D7		

Table 3. Solder bridge table

Solder bridge	Function	Group	Sub group	Default condition
SB1	Connect L6470 #0 OSCIN to the crystal	External crystal	L6470 #0	Open
SB2	Connect L6470 #0 OSCOUT to the crystal			Open
SB3	Connect L6470 #1 OSCIN to the crystal		L6470 #1	Open
SB4	Connect L6470 #1 OSCOUT to the crystal			Open
SB5	Connect L6470 #0 OSCOUT with L6470 #1 OSCIN	Clock	Synchronism	Open
SB6	Connect ST1S14 PGOOD with CN7-34 and CN8-4	ST1S14	Power good	Open
SB10	Connect L6470 #1 SDI with CN10-26	SPI	SDI	Open
SB26	Connect L6470 #1 SDI with CN10-15 and CN5-4			Short
SB11	Connect L6470 #0 SDO with CN10-28		SDO	Open
SB32	Connect L6470 #0 SDO with CN10-13 and CN5-5			Short
SB12	Connect any L6470 SCK with CN10-11 and CN5-6		SCK	Open
SB13	Connect any L6470 SCK with CN10-30			Open
SB34	Connect any L6470 SCK with CN10-31 and CN9-4			Short
SB7	Connect any L6470 nCS with CN10-33 and CN9-3		nCS	Open
SB8	Connect any L6470 nCS with CN10-17 and CN5-3			Open
SB9	Connect any L6470 nCS with CN10-27 and CN9-6			Open
SB23	Connect any L6470 nCS with CN7-32 and CN8-3			Short
SB40	Connect any L6470 VDD to +3V3 of control board		VDD	Nucleo
SB41	Connect any L6470 VDD to +5V of control board	Arduino		Open

Note:

- Only one among SB10 and SB26 can be short.*
- Only one among SB11 and SB32 can be short.*
- Only one among SB12, SB13 and SB34 can be short.*
- Only one among SB7, SB8, SB9 and SB23 can be short.*
- Only one among SB40 and SB41 can be short.*

Table 4. Jumper table

Jumper	Permitted configurations	Default condition
J1	Selection for L6470 VDD: – 2-3 short: ST1S14 is inhibited. 1-2 short and 3-4 short: ST1S14 is enabled, any L6470 VDD is connected to the +3.3V coming from the ST1S14 (step down monolithic power switching regulator). Note: short SB40 if you intend to supply the STM32 Nucleo board through the X-NUCLEO-IHM02A1; if so, refer to the section in the STM32 Nucleo board User Manual (available on www.st.com) regarding external power supply. SB40 open otherwise. SB41 must be open.	2-3 short
J2	Selection for L6470 external switch input pin: – Connect a limit switch between 1-2 or 3-4 for L6470 #1. – Connect a limit switch between 5-6 or 7-8 for L6470 #0	All open
J3	Step-clock input for L6470 #0.	Open
J4	Step-clock input for L6470 #1.	Open

Note: If SB41 is short then J1 pins 2 and 3 must also be shorted.

Table 5. Screw terminal table

Screw terminal	Function
ST1	To connect the two couples of wires connected to the two motors phases with the two full bridge output couples of L6470 #1.
ST2	To connect the two couples of wires connected to the two motors phases with the two full bridge output couples of L6470 #0.
ST3	motors power supply input (8V-45V).

2.1 Selecting the SPI lines

The lines of the SPI interface can be selected through the dedicated solder bridges. The following table ([Table 6](#)) shows the possible options for the STM32 Nucleo board and Arduino Uno R3.

Table 6. SPI lines table

SPI wire	Solder bridge	NUCLEO-F401RE	NUCLEO-F302R8	NUCLEO-F072RB	ARDUINO UNO R3	ST morpho connector	ARDUINO Connector
SDI	SB10	PB15 SPI2_MOSI	PA7 ⁽¹⁾	PB15 SPI2_MOSI	/	CN10-26	/
	SB26	PA7 SPI1_MOSI	PB15 SPI2_MOSI	PA7 SPI1_MOSI	D11 MOSI	CN10-15	CN5-4
SDO	SB11	PB14 SPI2_MISO	PA6 ⁽¹⁾	PB14 SPI2_MISO	/	CN10-28	/
	SB32	PA6 SPI1_MISO	PB14 SPI2_MISO	PA6 SPI1_MISO	D12 MISO	CN10-13	CN5-5
SCK	SB12	PA5 SPI1_SCK	PB13 SPI2_SCK	PA5 SPI1_SCK	D13 SCK	CN10-11	CN5-6
	SB13	PB13 SPI2_SCK	PA5 ⁽¹⁾	PB13 SPI2_SCK	/	CN10-30	/
	SB34	PB3 SPI1_SCK	PB3 ⁽¹⁾	PB3 SPI1_SCK	D3 ⁽¹⁾	CN10-31	CN9-4
nCS	SB7	PA10	PA10	PA10	D2 ⁽¹⁾	CN10-33	CN9-3
	SB8	PB6	PB6	PB6	D10 CS	CN10-17	CN5-3
	SB9	PB4	PB4	PB4	D5 ⁽¹⁾	CN10-27	CN9-6
	SB23	PA4	PA4	PA4	A2 ⁽¹⁾	CN7-32	CN8-3

1. Not applicable.

Note: Default shorted solder bridges are written in bold.

2.2 Multi-motors configuration

It is possible to synchronously drive two-axis stepper motors with one X-NUCLEO-IHM02A1 board only. However, up to four X-NUCLEO-IHM02A1 expansion boards can be stacked on a single STM32 Nucleo board, so it is possible to drive up to eight stepper motors. Each X-NUCLEO-IHM02A1 expansion board is addressable through the nCS pin that must be connected to one pin only of the microcontroller. So, when using more than one expansion board, the user must short a different solder bridge among SB7, SB8, SB9 and SB23, for each X-NUCLEO-IHM02A1. Be sure to align the firmware with any hardware change.

3 Set-up to try the provided example

Follow this sequence to start your project with the board:

1. Choose an STM32 Nucleo board from among NUCLEO-F401RE, NUCLEO-F302R8 and NUCLEO-F072RB.
2. Get the right firmware from the X-CUBE-SPN2 (available on www.st.com) for the chosen STM32 Nucleo board and program it properly.
 - X-CUBE-SPN2_F401.bin for NUCLEO-F401RE
 - X-CUBE-SPN2_F302.bin for NUCLEO-F302R8
 - X-CUBE-SPN2_F072.bin for NUCLEO-F072RB
3. Disconnect the STM32 Nucleo board from the PC.
4. Put a jumper between pin 2 and 3 of J1.
5. Leave all J2 pins open.
6. Check the solder bridges meet the default configuration (see [Table 3](#)).
7. Connect two stepper motors to ST1 and ST2.
8. Stack the X-NUCLEO-IHM02A1 expansion board on an STM32 Nucleo board through ST morpho or Arduino UNO R3 connectors.
9. Supply the board through the pin 1 (GND) and 2 (VS) of the connector ST3 with 9.0 V DC. The green LEDs D1 and D4 will turn on to show each L6470 VREG is on.
10. Connect the STM32 Nucleo board to the PC via USB type A to Mini-B USB cable. The orange LED D9 will turn on to show the digital voltage is on.
11. The two connected stepper motors will perform a few movements.

Note: The example is set to use motors such as the hybrid stepping motor 42BYGHM809 by Wantai Motor. If your motors have different parameters, modify the array named "MotorParameterInitData" in the "params.c" source file accordingly.

You can now proceed to develop your application using the examples provided with the firmware library (X-CUBE-SPN2) with your preferred IDE among IAR EWARM, Keil MDK-ARM and Open STM32 SW4STM32.

Note: Further support material regarding L6470, X-NUCLEO-IHM02A1, X-CUBE-SPN2 and STM32 Nucleo board is available on www.st.com.

Figure 5. Schematic - L6470_1

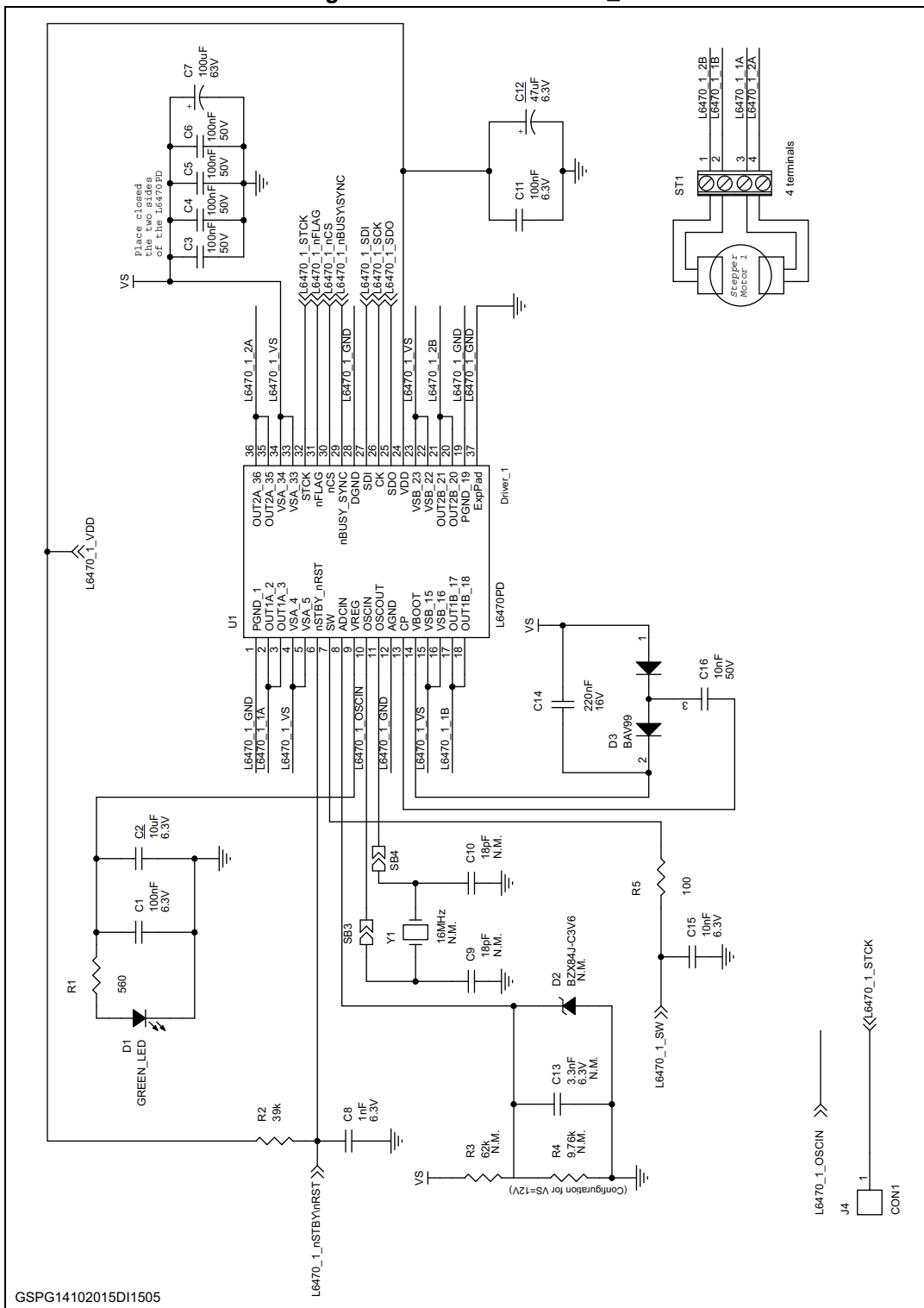
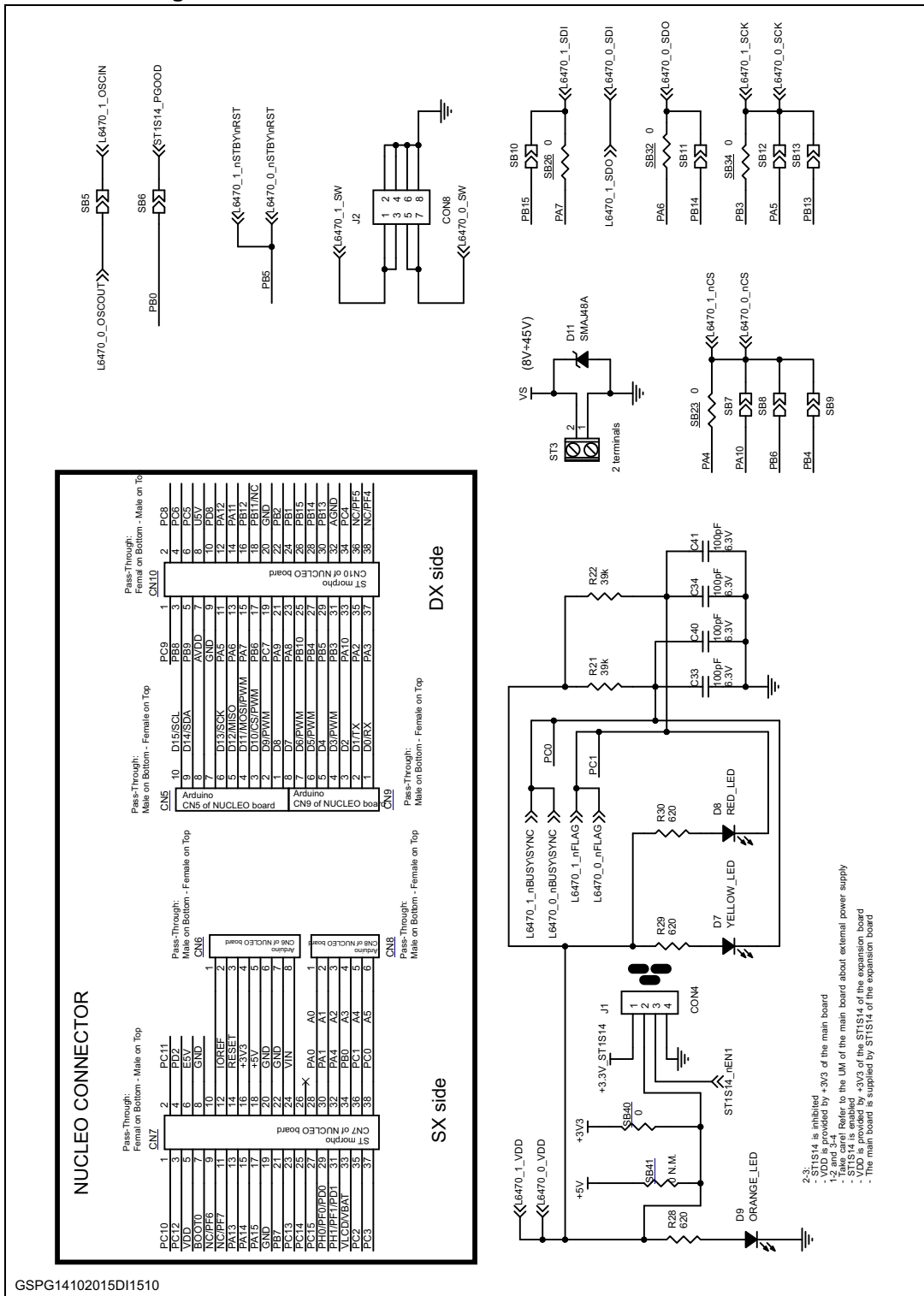
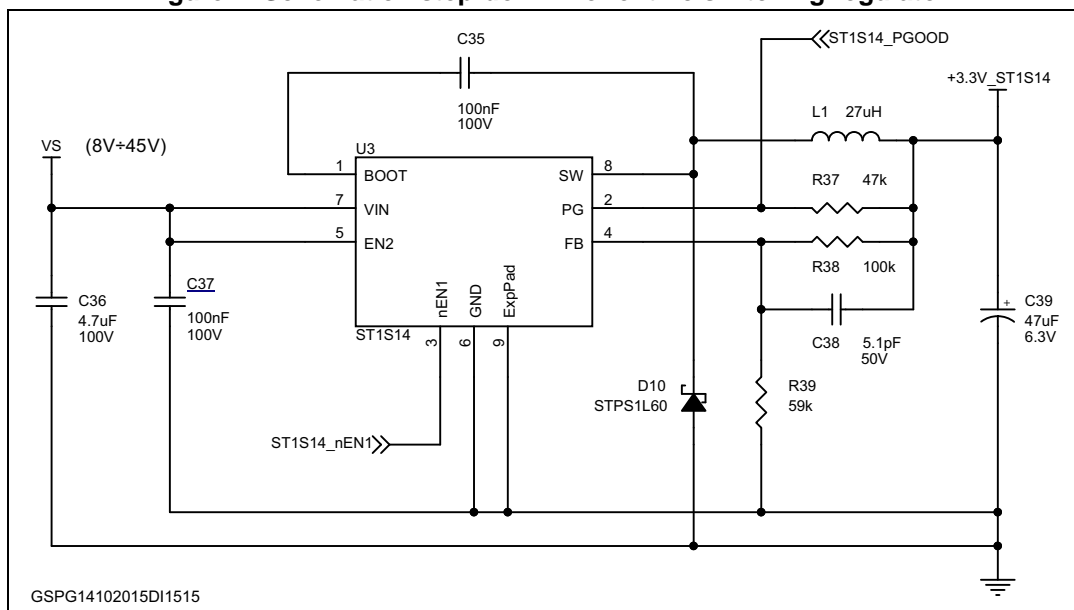


Figure 6. Schematic - L6470 Interfaces with STM32 Nucleo



GSPG14102015D11510

Figure 7. Schematic - step-down monolithic switching regulator



4.1 Bill of material

Table 7. BOM (part 1)

Item	Qty	Reference	Part/value	Tol %	Voltage / current	Watt
1	1	CN5	ARDUINO_10x1			
2	2	CN6, CN9	ARDUINO_8x1			
3	2	CN7, CN10	ST_MORPHO_19x2			
4	1	CN8	ARDUINO_6x1			
5	4	C1, C11, C17, C27	100nF	0.1	6.3V	
6	2	C2, C18	10uF	0.1	6.3V	
7	8	C3, C4, C5, C6, C19, C20, C21, C22	100nF	0.1	50V	
8	2	C7, C23	100uF	0.2	63V	
9	2	C8, C24	1nF	0.1	6.3V	
10	4	C9, C10, C25, C26	18pF	0.05	6.3V	
11	2	C12, C28	47uF	0.1	6.3V	
12	2	C13, C29	3.3nF	0.1	6.3V	
13	2	C14, C30	220nF	0.1	16V	

Table 7. BOM (part 1) (continued)

Item	Qty	Reference	Part/value	Tol %	Voltage / current	Watt
14	2	C15, C31	10nF	0.1	6.3V	
15	2	C16, C32	10nF	0.1	50V	
16	4	C33, C34, C40, C41	100pF	0.05	6.3V	
17	2	C35, C37	100nF	0.1	100V	
18	1	C36	4.7uF	0.2	100V	
19	1	C38	5.1pF	0.1	50V	
20	1	C39	47uF	0.1	6.3V	
21	2	D1, D4	GREEN_LED			
22	2	D2, D5	BZX84J-C3V6	0.05	3.6V	0.25W
23	2	D3, D6	BAV99		215mA/100V	
24	1	D7	YELLOW_LED			
25	1	D8	RED_LED			
26	1	D9	ORANGE_LED			
27	1	D10	STPS1L60		60V / 2A	
28	1	D11	SMAJ48A		48V	
29	1	J1	CON4			
30	1	J2	CON8			
31	2	J3, J4	CON1			
32	1	L1	27uH	0.2	2.3A	
33	2	R1, R6	560	0.01		0.1W
34	4	R2, R7, R21, R22	39k	0.01		0.1W
35	2	R3, R8	62k	0.01		0.1W
36	2	R4, R9	9.76k	0.01		0.1W
37	2	R5, R10	100	0.01		0.1W
38	3	R28, R29, R30	620	0.01		0.1W
39	1	R37	47k	0.01		0.1W
40	1	R38	100k	0.01		0.1W
41	1	R39	59k	0.01		0.1W

Table 7. BOM (part 1) (continued)

Item	Qty	Reference	Part/value	Tol %	Voltage / current	Watt
42	13	SB1, SB2, SB3, SB4, SB5, SB6, SB7, SB8, SB9, SB10, SB11, SB12, SB13	0	0.01		0.1W
43	5	SB23, SB26, SB32, SB34, SB40	0	0.01		0.1W
44	1	SB41	0	0.01		0.1W
45	2	ST1, ST2	4 terminals		400V	
46	1	ST3	2 terminals		400V	
47	2	U1, U2	L6470PD			
48	1	U3	ST1S14			
49	2	Y1, Y2	16MHz			

Table 8. BOM (part 2)

Item	Technology information	Package	Manufacturer
1	ELEVATED SOCKET	TH	4UCONN
2	ELEVATED SOCKET	TH	4UCONN
3	ELEVATED SOCKET	TH	4UCONN
4	ELEVATED SOCKET	TH	4UCONN
5	X7R Ceramic Multilayer Capacitors	SMD 0603	any
6	X5R Ceramic Multilayer Capacitors	SMD 0805	TDK
7	X7R Ceramic Multilayer Capacitors	SMD 0603	any
8	Aluminium Electrolytic Capacitor	SMD 10mm x 10.5mm	Nichicon
9	X7R Ceramic Multilayer Capacitors	SMD 0603	any
10	C0G Ceramic Multilayer Capacitor	SMD 0603	any
11	Tantalum capacitor	SMD 1206	AVX
12	X7R Ceramic Multilayer Capacitors	SMD 0603	any
13	X7R Ceramic Multilayer Capacitors	SMD 0603	any
14	X7R Ceramic Multilayer Capacitors	SMD 0603	any
15	X7R Ceramic Multilayer Capacitors	SMD 0603	any
16	C0G Ceramic Multilayer Capacitors	SMD 0603	any

Table 8. BOM (part 2) (continued)

Item	Technology information	Package	Manufacturer
17	X7R Ceramic Multilayer Capacitor	SMD 0805	TDK
18	X7S Dielectric Ceramic Multilayer	SMD 1210	TDK
19	C0G Ceramic Multilayer Capacitor	SMD 0603	any
20	Tantalum Electrolytic Capacitor	SMC 3528-21	AVX
21	LED	SMD 0603	Lite-On
22	Zener diode	SOT23	NXP
23	Switching diode	SOT23	NXP
24	LED	SMD 0603	Lite-on
25	LED	SMD 0603	Lite-on
26	LED	SMD 0603	Lite-on
27	Power Schottky rectifier	SMA	ST
28	Transil	JEDEC DO-214AC	ST
29	2.54 PIN HEADER SINGLE ROW 4 PIN	TH 2.54 mm pitch	4UCONN
30	2.54 PIN HEADER DUAL ROW 2x4 PIN	TH 2.54 mm pitch	4UCONN
31			
32	Shielded Wire-wound SMD Inductor	SMD 12x12mm	Panasonic
33	metal film SMD resistor	SMD 0603	any
34	metal film SMD resistor	SMD 0603	any
35	metal film SMD resistor	SMD 0603	any
36	metal film SMD resistor	SMD 0603	any
37	metal film SMD resistor	SMD 0603	any
38	metal film SMD resistor	SMD 0603	any
39	metal film SMD resistor	SMD 0603	any
40	metal film SMD resistor	SMD 0603	any
41	metal film SMD resistor	SMD 0603	any
42		SMD 0603	any
43		SMD 0603	any
44		SMD 0603	any

Table 8. BOM (part 2) (continued)

Item	Technology information	Package	Manufacturer
45	Through Hole 4 Way Screw Terminal (2x 2way connector)	TH 3.81 mm pitch	4UCONN
46	Through Hole 2 Way Screw Terminal	TH 3.81 mm pitch	4UCONN
47	dSPIN Microstepping Driver with Motion Engine and SPI	POWERSO36	ST
48	step-down switching regulator	HSOP8	ST
49	Crystal / Ceramic Resonator	HC-49-US SMD	Abracon

Table 9. BOM (part 3)

Item	Manufacturer code	Supplier	Supplier code	More info
1	15286			Alternative: Samtec ESQ-110-24-T-S Mounting info: female on top, male on bottom
2	15284			Alternative: Samtec ESQ-108-24-T-S Mounting info: female on top, male on bottom
3	8413			Alternative: Samtec: ESQ-119-24-T-D Mounting info: male on top, female on bottom Not Mounted
4	15282			Alternative: Samtec ESQ-106-24-T-S Mounting info: female on top, male on bottom
5				
6	C2012X5R0J106K125AB	Digi-Key	445-4113-2-ND	Alternative: Murata GRM21BR60J106KE19L
7				
8	UUX1J101MNL1GS	Digi-key	493-7453-2-ND	Alternative: Panasonic EEEFK1J101P, Farnell 2254433
9				
10				Not Mounted
11	TAJA476K006RNJ	Farnell	2217224	
12				Not Mounted
13				
14				
15				
16				
17	C2012X7R2A104K125AA	Digi-Key	445-1418-2-ND	Alternative: Murata GCM21BR72A104KA37L

Table 9. BOM (part 3) (continued)

Item	Manufacturer code	Supplier	Supplier code	More info
18	C3225X7S2A475M200AB	Digi-Key	445-6043-2-ND	
19				
20	TPSB476M006R0350	Digi-Key	TPSB476M006R0350-ND	
21	LTST-C191KGKT	RS	692-1010	
22	BZX84J-C3V6	RS	436-8215	Not Mounted
23	BAV99	RS	792-0796	
24	LTST-C193KSKT-5A	RS	692-1054	
25	LTST-C193KRKT-5A	RS	692-1041	
26	LTST-C193KFKT-5A	RS	692-1032	
27	STPS1L60A			
28	SMAJ48A-TR			
29	2099			Alternative RS:156-049
30	19670			Alternative: MULTICOMP 2213S-08G, Farnell 1593441
31				Not Mounted
32	ELL-CTV270M	Digi-Key	PCD2157CT-ND	
33				
34				
35				Not Mounted
36				Not Mounted
37				
38				
39				
40				
41				
42				Not Mounted
43				
44				Not Mounted

Table 9. BOM (part 3) (continued)

Item	Manufacturer code	Supplier	Supplier code	More info
45	12342			Alternative: Phoenix Contact MKDS 1/ 4-3,81
46	12342			Alternative: Phoenix Contact MKDS 1/ 2-3,81
47	L6470PD			
48	ST1S14			
49	ABLS-16.000MHz-B2	RS	703-1818	Not Mounted

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
15-Oct-2015	1	Initial release.

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