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Getting started with the X-NUCLEO-IHM09M1 motor control connector expansion board for STM32 Nucleo

Introduction

The X-NUCLEO-IHM09M1 is a motor control connector expansion board for STM32 Nucleo. It provides an easy way to evaluate motor control solutions for three-phase motors by adapting the STM32 Nucleo board with an external ST motor control power board, thanks to ST morpho and motor control connector. The 34-pin motor control connector is compatible with all major ST motor control power boards, requiring an external digital section (MCU) to drive a three-phase motor. The DAC connector supports user code development and testing with easy access to the MCU peripherals. An LED is available for fault condition signaling or status indication.

This document describes the procedure for configuring this STM32 NUCLEO expansion board to operate with the STM32 Nucleo board and run a voltage 3-phase brushless motor. The board is fully compatible with the ST Six-Step and FOC (field oriented control) firmware library.

Figure 1: X-NUCLEO-IHM09M1 motor control connector expansion board
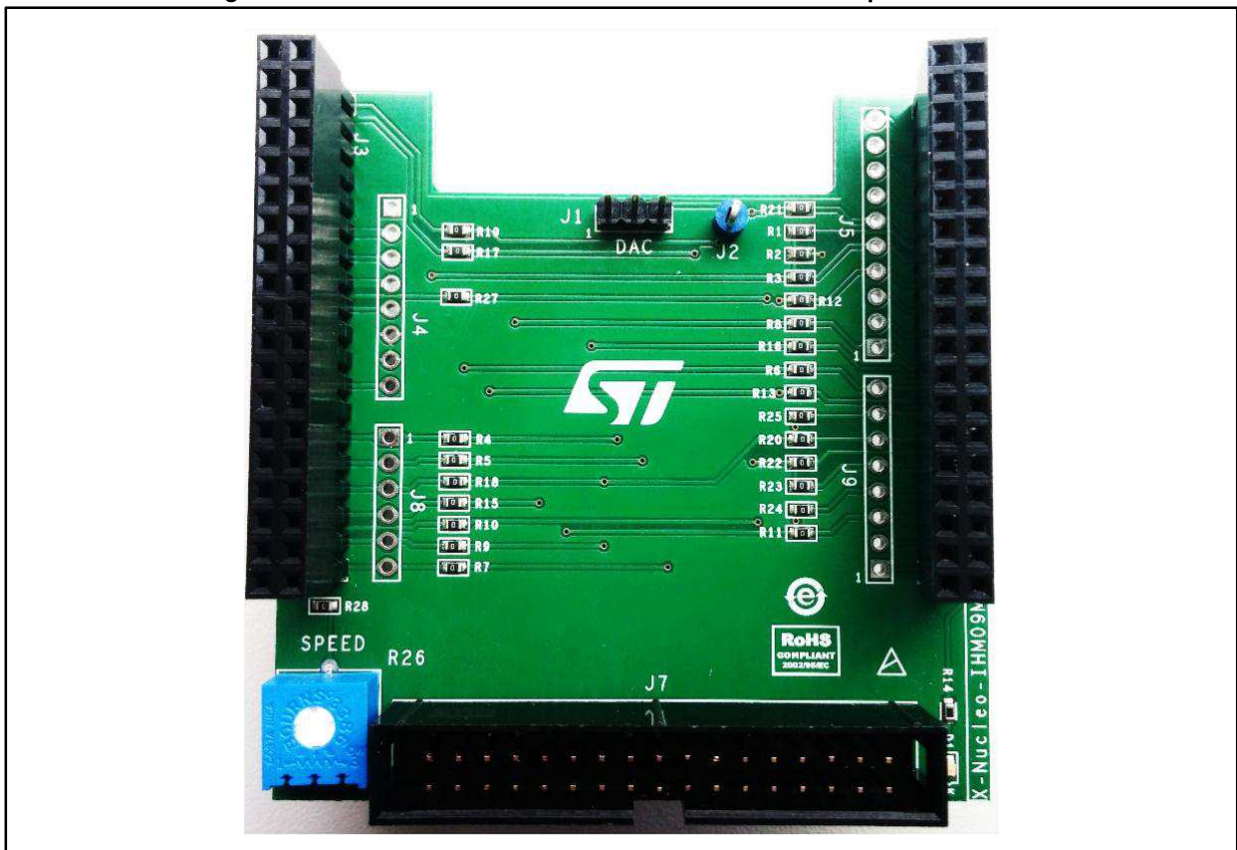
Contents

1 System overview

1.1 Main characteristics

The information listed below shows the board specification data and the main parameters set for the X-NUCLEO-IHM09M1 expansion board for STM32 Nucleo:

- ST motor control connector (34 pins) compatible with major ST motor control power boards
- STM32 Nucleo support, thanks to ST morpho connectors
- Compatible with six-step and FOC motor control firmware library by ST
- Debug connector for DAC, GPIOs, etc.
- Fully populated board conception with test points
- LED for fault signaling or status indication
- Potentiometer available (i.e. for speed reference)
- PCB type and size:
  - PCB material - FR-4
  - layout - double layer
  - copper thickness - 35 µm
  - overall board dimensions - 70 mm x70 mm
- RoHS compliant

1.2 Target application

- 3-phase motor driver

2 Getting started

2.1 System architecture

A generic motor control system can be broken down into the following three major blocks:

1. **Control block** - accepts user commands and provides motor control signals to drive a motor. The X-NUCLEO-IHM09M1 adapter connects an STM32 Nucleo board with a power board requiring an external digital section.
2. **Power block** - is normally in a 3-phase inverter topology and contains all the necessary active power and analog components to perform low voltage PMSM/BLDC motor control.
3. **Motor** - 3 phase brushless motor.

Figure 2: System architecture
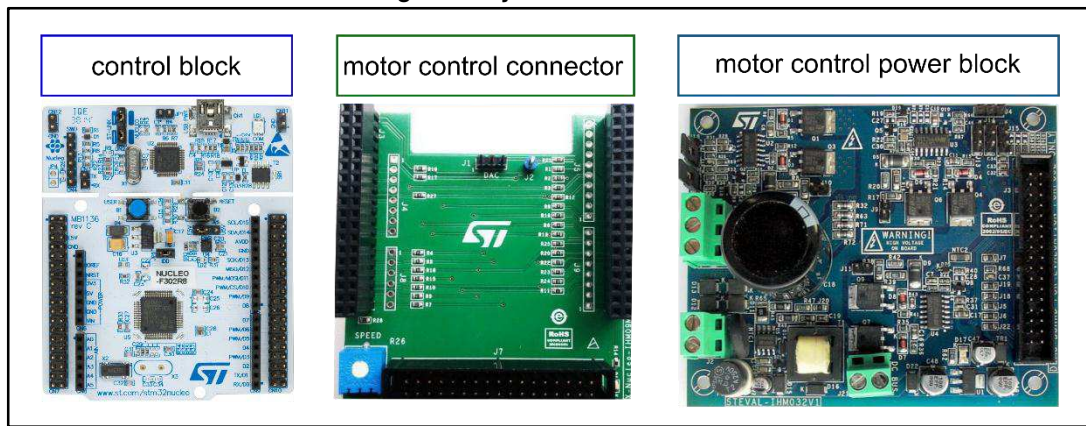
2.2 Building the system

The X-NUCLEO-IHM09M1 adapts the STM32 Nucleo to ST motor control power boards requiring an external digital section to perform three-phase PMSM/BLDC motor control. For regular board operation, it must be plugged on top of an STM32 Nucleo board (control block) via the ST morpho connector as shown below.

Figure 3: X-NUCLEO-IHM09M1 plugged on STM32 Nucleo
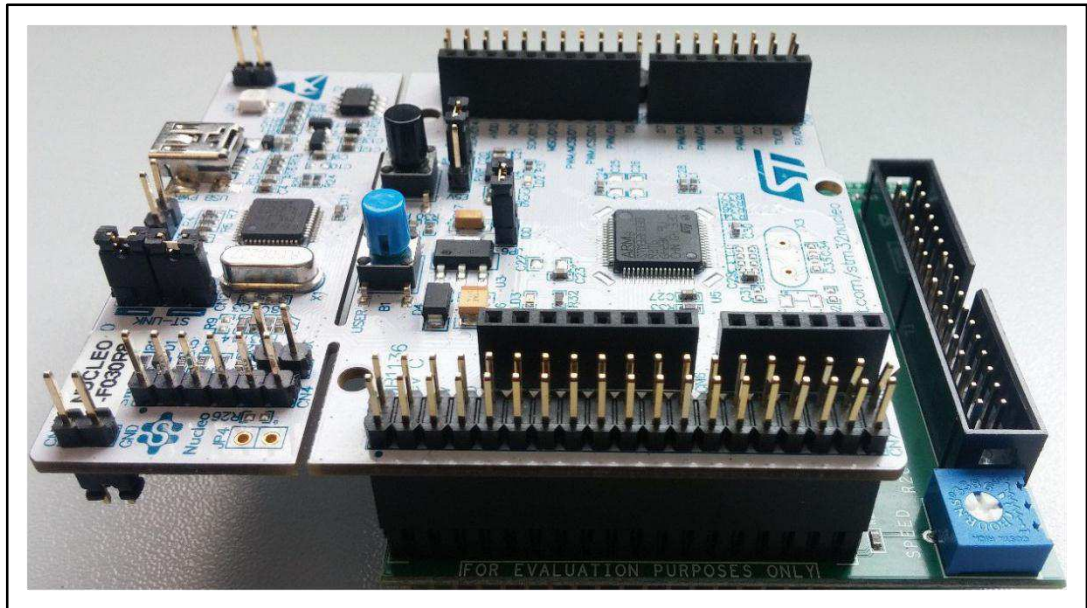
The interconnection between the STM32 Nucleo board and the X-NUCLEO-IHM09M1 expansion board is designed for full compatibility with a wide range of STM32 Nucleo boards, with no solder bridge modification required. The stacked solution is ready to operate in connection with a power board compatible with a standard 34-pin flat cable.

2.2.1 Hardware settings

J1 - jumper OFF

R26 - potentiometer

D1 – LED for fault or status indication

Table 1: Connectors

Part name	Function
J7	34-pin motor control connector
J1	DAC/GPIO output
CN7	ST morpho connector
CN6	Arduino UNO R3 Connector
CN8	Arduino UNO R3 Connector
CN10	ST morpho connector
CN5	Arduino UNO R3 Connector
CN9	Arduino UNO R3 Connector
D1	LED

Figure 4: X-NUCLEO-IHM09M1 – top layer with silk-screen
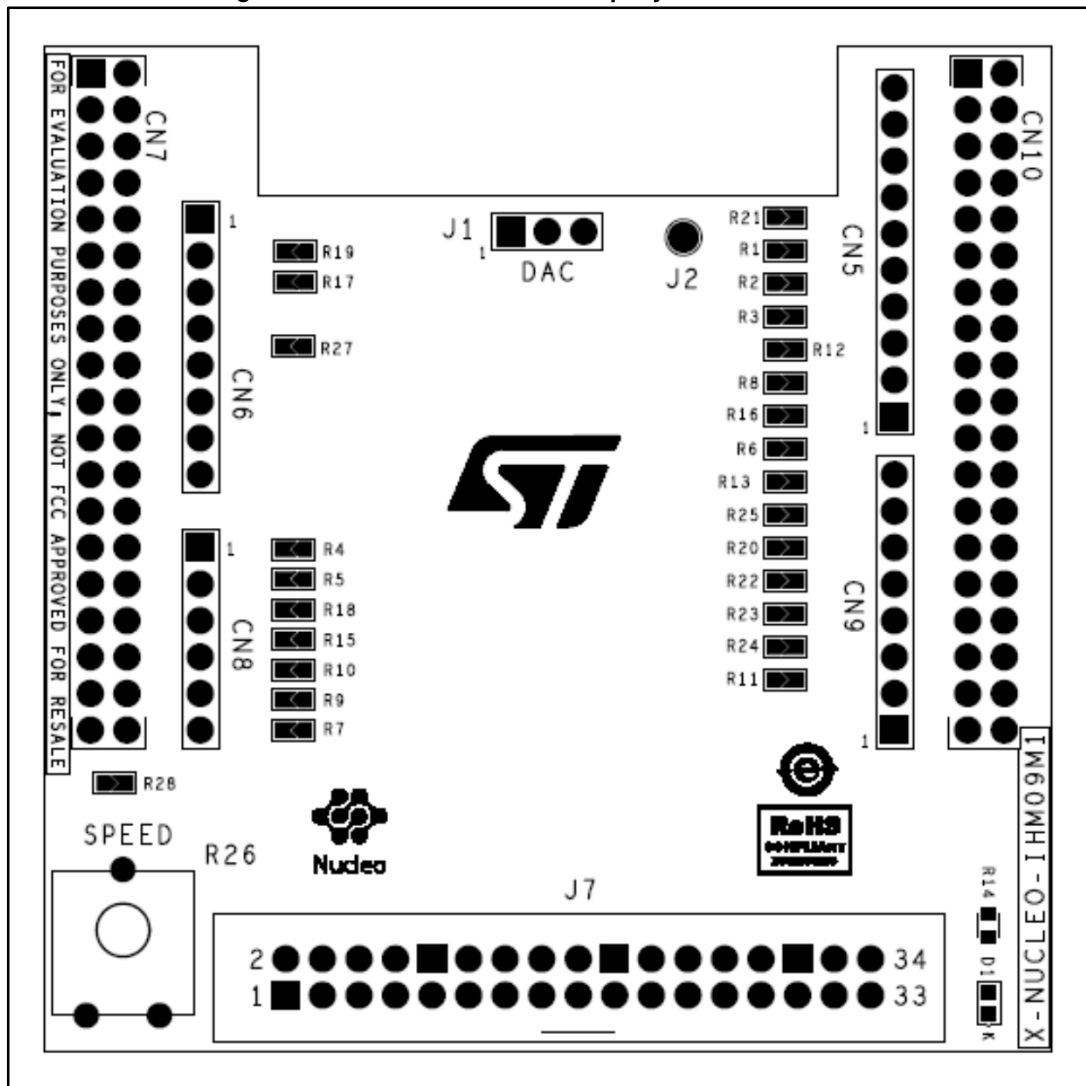
The X-NUCLEO-IHM09M1 is equipped with ST morpho connectors - male pin headers (CN7 and CN10), which can be used to connect expansion boards to the STM32 Nucleo board. All signals and power pins of the MCU are available on the STMicroelectronics morpho connector. For further details please refer to user manual UM1724, section 5.12 - STMicroelectronics morpho connector available on website *www.st.com*.

Table 2: ST morpho connector – CN7

Pin	Default	Signal	Solder Bridge	Notes
1	PC10	NTC bypass	R17	
2	PC11	Dissipative Brake/OCP disable	R19	
3	PC12			
4	PD2			
5	VDD			
6	E5V			
7	BOOT0			

Pin	Default	Signal	Solder Bridge	Notes
8	GND			
9	NC/PF6			
10	NC			
11	NC/PF7			
12	IOREF			
13	PA13			
14	RESET			
15	PA14			
16	+3V3			
17	PA15	Encoder A/ Hall H1	R27	
18	+5V			
19	GND			
20	GND			
21	PB7			
22	GND			
23	PC13			
24	VIN			
25	PC14			
26	NC			
27	PC15			
28	PA0	Curr_fdbk_PhA	R4	
29	PH0/PF0/PD0			
30	PA1	VBUS_sensing	R5	
31	PH1/PF1/PD1			
32	PA4	DAC_Ch	R18 N.M.	
33	VLCD/VBAT			
34	PB0	VL_PWM	R15	
35	PC2	Temperature feedback	R10	
36	PC1 or PB9	Curr_fdbk_PhB	R9	Refer to UM1724 Table 9: Solder bridges for further details
37	PC3	Potentiometer	R28	
38	PC0 or PB8	Curr_fdbk_PhC	R7	Refer to UM1724 Table 9: Solder bridges for further details

Table 3: ST morpho connector – CN10

Pin	Default	Signal	Solder Bridge	Notes
1	PC9			
2	PC8			
3	PB8			
4	PC6			
5	PB9			
6	PC5			
7	AVDD			
8	U5V			U5V is 5 V power from ST-LINK/V2-1 USB connector and it rises before +5 V
9	GND			
10	NC			
11	PA5	GPIO/DAC/PWM	R21	For NUCLEO-F302R8 only: pin PA5 is on CN10/pin 30 and PB13 is on CN10/pin 11
12	PA12			
13	PA6	DIAG/ENABLE/BKIN1	R3	For NUCLEO-F302R8 only: pin PA6 is on CN10/pin 28 and PB14 is on CN10/pin 13
14	PA11	DIAG/ENABLE/BKIN2	R1	
15	PA7	UL_PWM	R12	For NUCLEO-F302R8 only: pin PA7 is on CN10/pin 26 and PB15 is on CN10/pin 13
16	PB12			
17	PB6			
18	PB11/NC			
19	PC7			
20	GND			
21	PA9	VH_PWM	R8	
22	PB2	LED RED	R14	
23	PA8	UH_PWM	R6	
24	PB1	WL_PWM	R16	
25	PB10	Encoder Z/ Hall H3	R25	
26	PB15			For NUCLEO-F302R8 only: pin PA7 is on CN10/pin 26 and PB15 is on CN10/pin 13
27	PB4	PWM/DEBUG	R20	

Pin	Default	Signal	Solder Bridge	Notes
28	PB14	DIAG/ENABLE/BKIN1	R2	For NUCLEO-F302R8 only: pin PA6 is on CN10/pin 28 and PB14 is on CN10/pin 13
29	PB5	GPIO/DAC/PWM	R23	
30	PB13	GPIO/DAC/PWM	R22	For NUCLEO-F302R8 only: pin PA5 is on CN10/pin 30 and PB13 is on CN10/pin 11
31	PB3	Encoder B/ Hall H2	R24	
32	AGND			
33	PA10	WH_PWM	R11	
34	PC4			
35	PA2			
36	NC/PF5			
37	PA3			
38	NC/PF4			

2.2.2   Motor control connector pinout

Figure 5: Motor control connector J7 (top view)
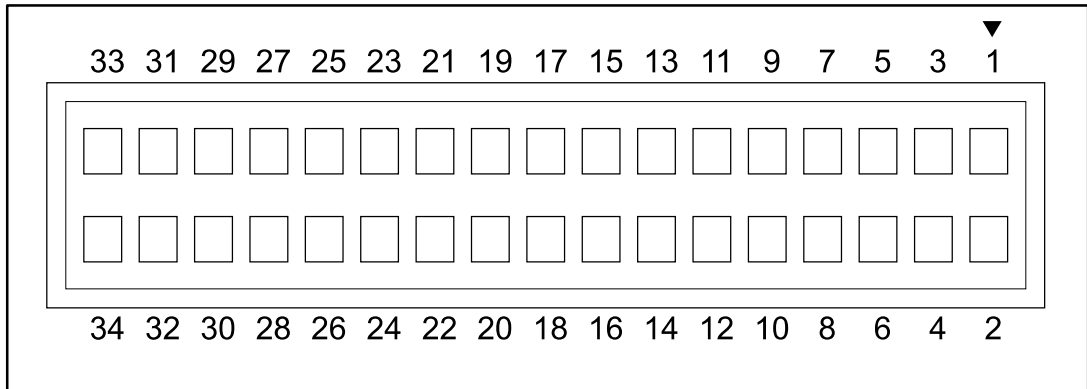
The X-NUCLEO-IHM09M1 expansion board supports motor control via the J7 34-pin connector, which provides all the required control and feedback signals to and from an ST motor power-drive board. The signals available on this connector include emergency stop, speed or position feedback, three-phase motor current, bus voltage sensor and heatsink temperature sensor from the motor.

Table 4: ST motor control connector J7 pin assignments

Pin	Default	Function
1	PA6/PA11	DIAG/ENABLE/BKIN1
2	GND	Dissipative brake/OCP disable
3	PA8	UH_PWM
4	GND	
5	PA7/PB15	UL_PWM
6	GND	
7	PA9	VH_PWM
8	GND	
9	PB0	VL_PWM
10	GND	
11	PA10	WH_PWM
12	GND	
13	PB1	WL_PWM
14	PA1	VBUS_sensing
15	PA0	Curr_fdbk_PhA
16	N.C.	
17	PC1	Curr_fdbk_PhB
18	N.C.	
19	PC0	Curr_fdbk_PhC
20	N.C.	
21	PC10	NTC bypass
22	N.C.	
23	PC11	Dissipative brake/OCP disable
24	N.C.	
25	E5V	
26	PC2	Temperature feedback
27	N.C.	
28	3V3	
29	N.C.	
30	N.C.	
31	PA15	Encoder A/ Hall H1
32	N.C.	
33	PB3	Encoder B/ Hall H2
34	PB10	Encoder Z/ Hall H3

2.2.3 DAC settings for debug

For debugging purposes, it is possible to use the DAC peripheral and configure the motor control library in order to drive the signal. For instance, the PA4 pin is accessible through the ST morpho connector or J1 connector and it is typically connected to DAC_CH1. Other pins are available at the J1 connector according to the STM32 Nucleo board used.

2.2.4 User LED

The X-NUCLEO-IHM09M1 provides a programmable LED (D1) connected on pin PB2. It can be used to signal motor status, faults, etc. This pin must be configured at the user level and driven by the application code written by the user.

3 MC FOC SDK – Configuration guide for X-NUCLEO-IHM09M1

The X-NUCLEO-IHM09M1 expansion board for the STM32 Nucleo is compatible with the motor control (MC) FOC SDK (firmware library and Workbench software graphical user interface), and no hardware modification is needed to run the motor with this control algorithm. During MC FOC SDK pin configuration, please adhere to the indications in Table 2: ST morpho connector – CN7 and Table 3: ST morpho connector – CN10.

Connection of the STM32 Nucleo board with the MC Workbench software graphical user interface (GUI) is possible through a virtual COM embedded in the STM32 Nucleo board that allows the use of the USART2 on PA2 and PA3 pins directly from the same USB type A to Mini-B USB cable used for STM32 Nucleo programming.

For further information regarding MC FOC SDK, please consult the STSW-STM32100 documents on the ST website: *www.st.com*.

4 Schematic diagram

Figure 6: X-NUCLEO-IHM09M1 schematic: PWM
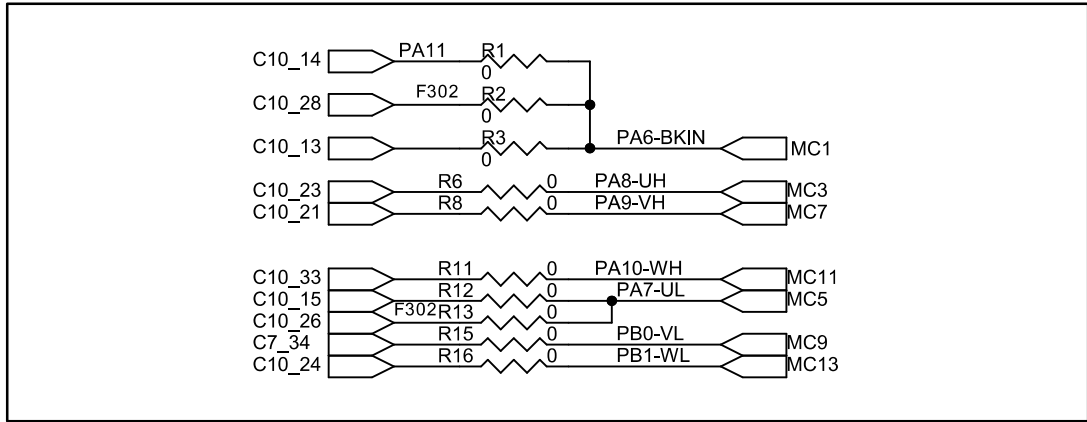
Figure 7: X-NUCLEO-IHM09M1 schematic: Hall/encoder sensor
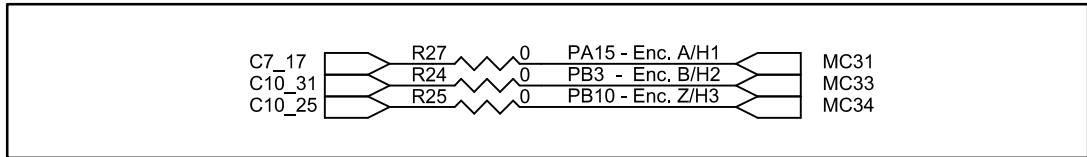

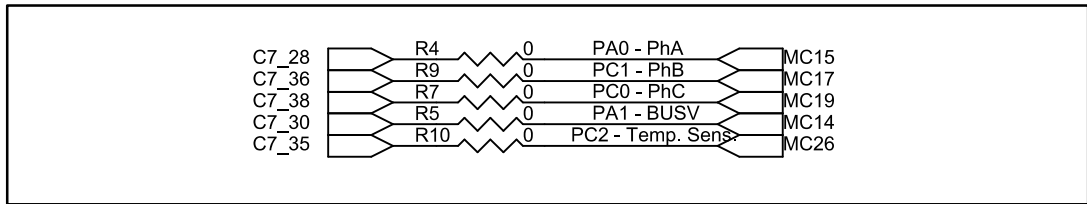
Figure 8: X-NUCLEO-IHM09M1 schematic: currents

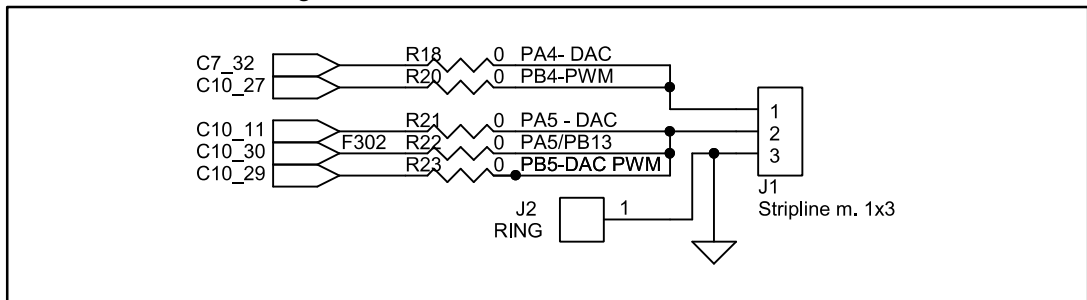**Figure 9: X-NUCLEO-IHM09M1 schematic: DAC**

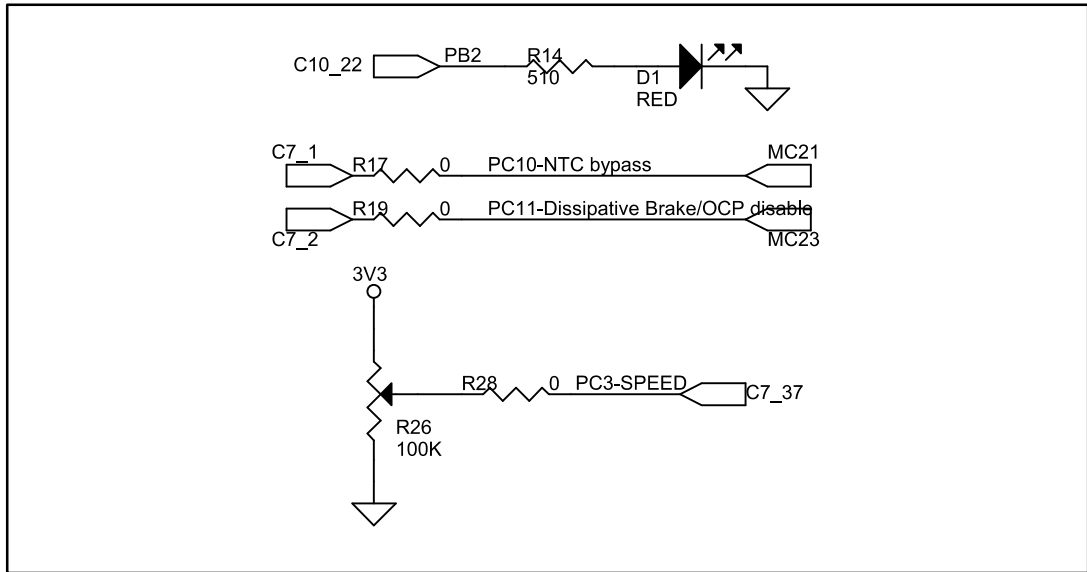**Figure 10: X-NUCLEO-IHM09M1 schematic: user interface**

Figure 11: X-NUCLEO-IHM09M1 schematic: motor control connector

Figure 12: X-NUCLEO-IHM09M1 schematic: Arduino UNO R3/ST morpho connector
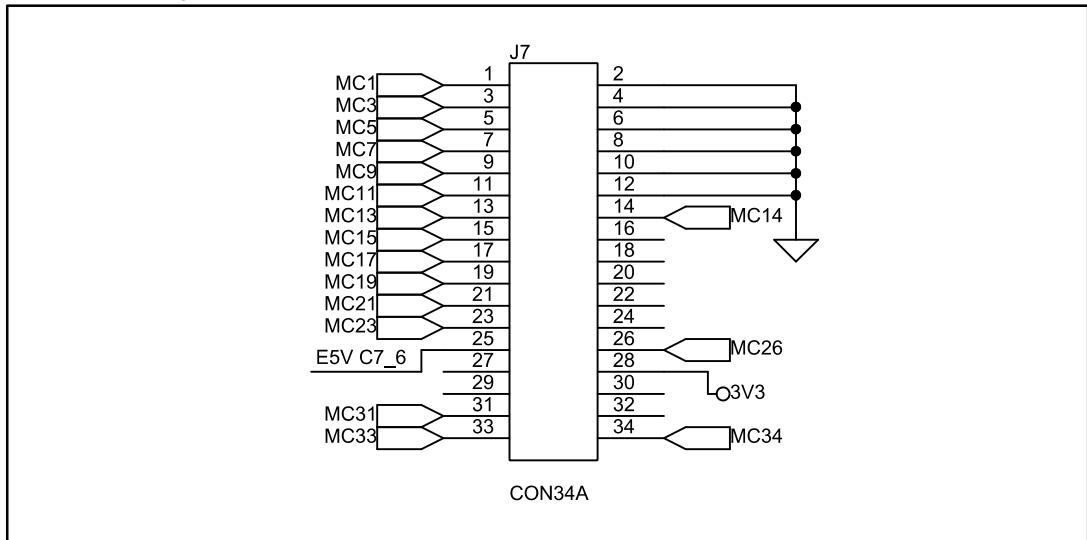
5 Bill of materials

Table 5: BOM part I

Item	Qty	Ref.	Part / value	Voltage / Watt / Ampere	Type / technology
1	1	D1	red		LED standard - SMD
2	1	J1	Stripline m. 1x3		3-way strip line-male 2.54 mm
3	1	J2	ring		test point 1 mm
4	2	CN7,CN10	CONN 38		elevated socket ST morpho connector 38 pin (19x2)
5	2	CN6,CN9	CONN8		8 pin elevated socket
6	1	CN5	CONN10		10 pin elevated socket
7	1	J7	motor control connector		34 way IDC straight boxed header
8	1	CN8	CONN6		6 pin elevated socket
9	26	R1,R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R15,R16,R17,R18,R19,R20,R21,R22,R23,R24,R25,R27,R28	0 Ω	0.1 W	SMD resistor
10	1	R14	510 Ω	0.1 W	SMD resistor
11	1	R26	100 kΩ	½ W	trimmer resistor

Table 6: BOM part II

Item	Tol.	Package	Manuf.	Manuf. order code / order p/n	Notes
1		SMD 0603	Lite-on	LTST-C193KRKT-5A	
2		TH 2.54mm pitch	any		
3		TH	Vero Technologies	20-2137	
4		TH 2.54mm pitch	Samtec	ESQ-119-24-T-D	alternative:4UCONN 08413 info: ASSEMBLY ON TOP
5		TH 2.54mm pitch	Samtec	ESQ-108-24-T-S	alternative:4UCONN 15284 Mounting info: Female on top, male on bottom -NOT MOUNTED
6		TH 2.54mm pitch	Samtec	ESQ-110-24-T-S	alternative:4UCONN 15286 Mounting info: Female on top, male on bottom -NOT MOUNTED
7		TH	any	any	
8		TH 2.54mm pitch	Samtec	ESQ-106-24-T-S	Alternative: 4UCONN 15282 Mounting info: Female on top, male on bottom -NOT MOUNTED
9		0603	ANY	ANY	
10		0603	ANY	ANY	
11	10%		Bourns	3386G-1-104LF	

6 Revision history

Table 7: Document revision history

Date	Version	Changes
28-Oct-2015	1	Initial release.

IMPORTANT NOTICE – PLEASE READ CAREFULLY