

Getting started with the X-NUCLEO-IHM09M2 motor control connector expansion board for STM32 Nucleo

Introduction

The X-NUCLEO-IHM09M2 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 connecting the STM32 Nucleo development board to an external ST motor control power board, thanks to the ST morpho and motor control connector.

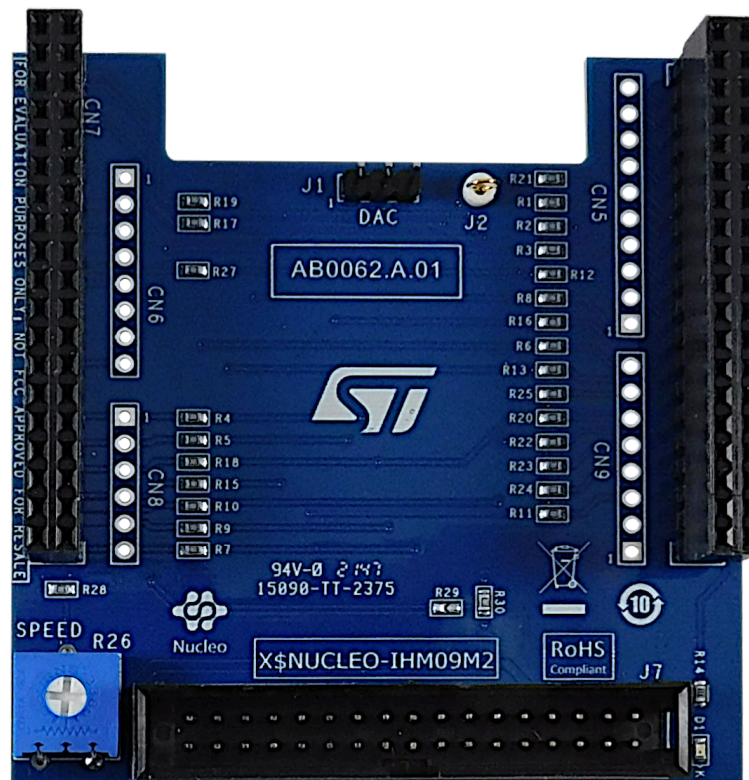
The 34-pin motor control connector is compatible with all major ST motor control power boards, which requires an external digital section (MCU) to drive a three-phase motor.

The DAC connector supports the user code development and testing with easy access to the MCU peripherals.

An LED is available for fault condition signaling or status indication.

The X-NUCLEO-IHM09M2 is fully compatible with the ST six-step and field-oriented control (FOC) firmware library.

Figure 1. X-NUCLEO-IHM09M2 motor control connector expansion board



1 System overview

1.1 Main characteristics

The X-NUCLEO-IHM09M2 expansion board is designed for three-phase motor driver applications. It features:

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

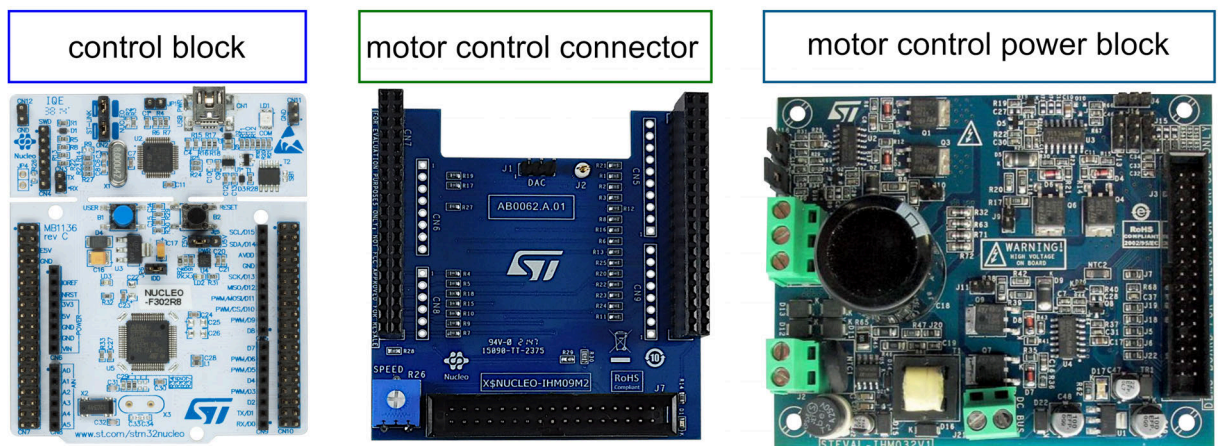
2 Getting started

2.1 System architecture

A generic motor control system consists of the following major blocks:

1. **Control block**, which accepts the user commands and provides motor control signals to drive a motor. The X-NUCLEO-IHM09M2 adapter connects an STM32 Nucleo development board to a power board that requires an external digital section.
2. **Power block**, which is normally in a three-phase inverter topology. It contains all the necessary active power and analog components to control a low voltage PMSM/BLDC motor.
3. **Motor**, which is a three-phase brushless motor.

Figure 2. System architecture

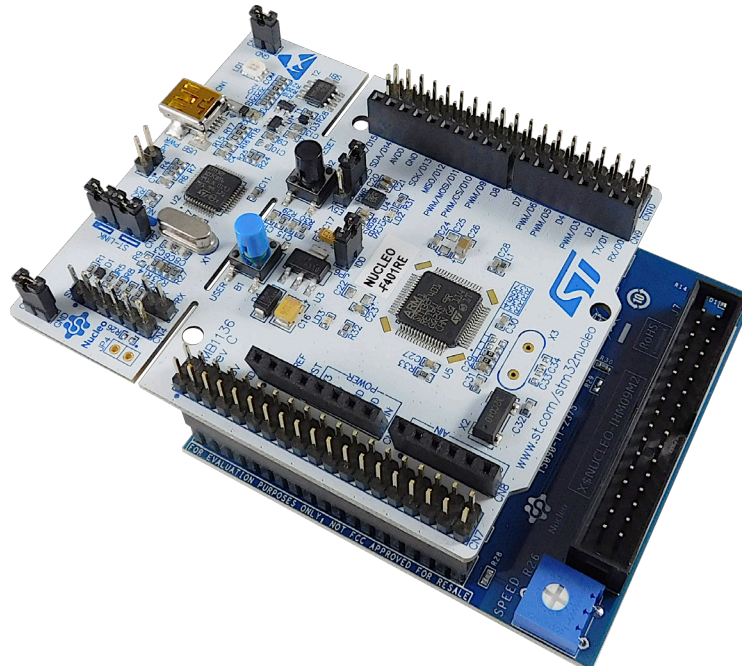


2.2 Building the system

The X-NUCLEO-IHM09M2 expansion board adapts the STM32 Nucleo development board to the ST motor control power boards, which require an external digital section to control a three-phase PMSM/BLDC motor.

For the regular board operation, plug the expansion board onto the top of the development board (control block) via the ST morpho connector, as shown below.

Figure 3. X-NUCLEO-IHM09M2 plugged onto the STM32 Nucleo



The interconnection between the two boards is fully compatible with a wide range of STM32 Nucleo development boards. No solder bridge modification is required.

The stacked solution is ready to operate with a compatible power board via a standard 34-pin flat cable.

2.2.1

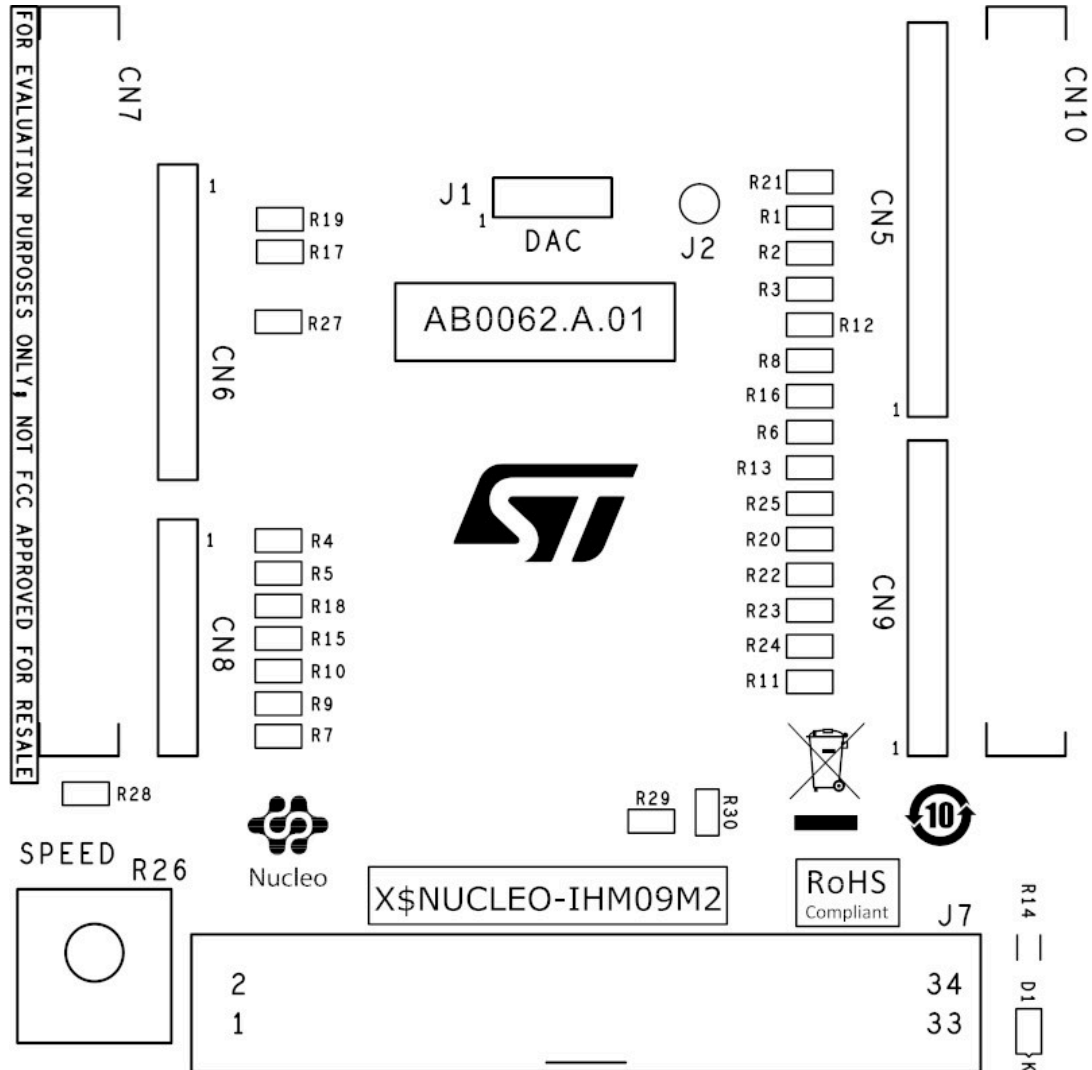
Hardware settings

Set the X-NUCLEO-IHM09M2 J1 jumper off.

Table 1. Jumper, connectors, and LED

Jumper/connector	Description
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 for fault or status indication

Figure 4. X-NUCLEO-IHM09M2 - top layer with silk-screen



The X-NUCLEO-IHM09M2 is equipped with ST morpho connectors. The male pin headers are CN7 and CN10. These connectors are used to connect the expansion board to the STM32 Nucleo.

The MCU signals and power pins are available on the morpho connector. For further details, refer to UM1724, section 5.12.

Table 2. ST morpho connector - CN7

Pin	Default	Signal	Solder bridge
1	PC10	NTC bypass	R17
2	PC11	Dissipative brake/OCP disable	R19
3	PC12		
4	PD2		
5	VDD		
6	E5V		
7	BOOT0		
8	GND		
9	NC/PF6		

Pin	Default	Signal	Solder bridge
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 (not mounted)
33	VLCD/VBAT		
34	PB0	VL_PWM	R15
35	PC2	Temperature feedback	R10
36	PC1 or PB9	Curr_fdbk_PhB	R9 ⁽¹⁾
37	PC3	Potentiometer	R28
38	PC0 or PB8	Curr_fdbk_PhC	R7 ⁽¹⁾

1. For further details, refer to [UM1724](#), table 9.

Table 3. ST morpho connector - CN10

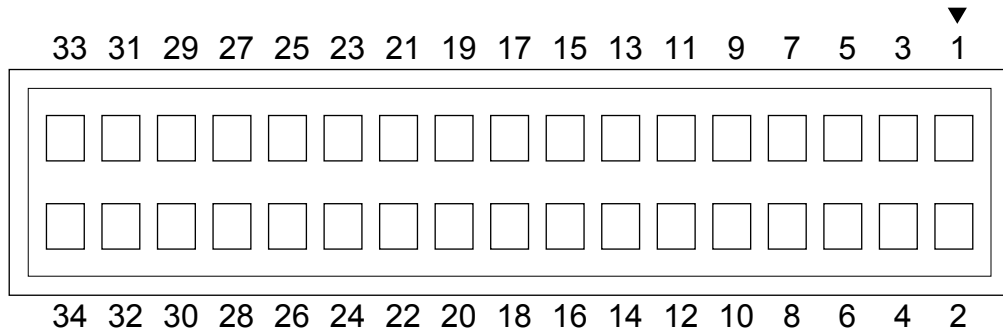
Pin	Default	Signal	Solder bridge
1	PC9		
2	PC8		
3	PB8		
4	PC6		
5	PB9		
6	PC5		
7	AVDD		
8	U5V ⁽¹⁾		

Pin	Default	Signal	Solder bridge
9	GND		
10	NC		
11	PA5 ⁽²⁾	GPIO/DAC/PWM	R21
12	PA12		
13	PA6 ⁽³⁾	DIAG/ENABLE/BKIN1	R3
14	PA11	DIAG/ENABLE/BKIN2	R1
15	PA7 ⁽⁴⁾	UL_PWM	R12
16	PB12		
17	PB6		
18	PB11/NC		
19	PC7		
20	GND		
21	PA9	VH_PWM	R8
22	PB2	Red LED	R14
23	PA8	UH_PWM	R6
24	PB1	WL_PWM	R16
25	PB10	Encoder Z/Hall H3	R25
26	PB15 ⁽⁴⁾		
27	PB4	PWM/DEBUG	R20
28	PB14 ⁽³⁾	DIAG/ENABLE/BKIN1	R2
29	PB5	GPIO/DAC/PWM	R23
30	PB13 ⁽²⁾	GPIO/DAC/PWM	R22
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		

1. U5V is the 5 V power from the ST-LINK/V2-1 USB connector and it rises above +5 V.
2. For NUCLEO-F302R8 only: pin PA5 is on CN10/pin 30 and PB13 is on CN10/pin 11.
3. For NUCLEO-F302R8 only: pin PA6 is on CN10/pin 28 and PB14 is on CN10/pin 13.
4. For NUCLEO-F302R8 only: pin PA7 is on CN10/pin 26 and PB15 is on CN10/pin 13.

2.2.2 Pinout of the motor control connector

Figure 5. J7 motor control connector (top view)



The X-NUCLEO-IHM09M2 expansion board supports motor control via the J7 34-pin connector. This connector provides all the required control and feedback signals to and from an ST motor power-drive board.

The available signals include the emergency stop, speed or position feedback, three-phase motor current, bus voltage, and heatsink temperature.

Table 4. 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	Not connected	
17	PC1	Curr_fdbk_PhB
18	Not connected	
19	PC0	Curr_fdbk_PhC
20	Not connected	
21	PC10	NTC bypass
22	Not connected	
23	PC11	Dissipative brake/OCP disable

Pin	Default	Function
24	Not connected	
25	E5V	
26	PC2	Temperature feedback
27	Not connected	
28	Not connected	
29	Not connected	
30	Not connected	
31	PA15	Encoder A/Hall H1
32	Not connected	
33	PB3	Encoder B/Hall H2
34	PB10	Encoder Z/Hall H3

2.2.3 DAC settings for debug

For debugging purposes, you can use the DAC peripheral and configure the motor control library to drive the signal.

For instance, the PA4 pin is accessible through the ST morpho connector or J1 connector. This pin is usually connected to DAC_CH1.

Different pins are available on the J1 connector, according to the [STM32 Nucleo](#) development board used.

2.2.4 User LED

The [X-NUCLEO-IHM09M2](#) provides a programmable LED (D1) connected on the PB2 pin. It can be used to signal motor status, faults, etc.

You have to configure this pin and drive it through the application code you have developed.

3 MC FOC SDK: configuration guide for X-NUCLEO-IHM09M2

The [X-NUCLEO-IHM09M2](#) expansion board is compatible with the motor control (MC) FOC SDK, which is a firmware library and workbench GUI.

No hardware modification is needed to run the motor through this control algorithm.

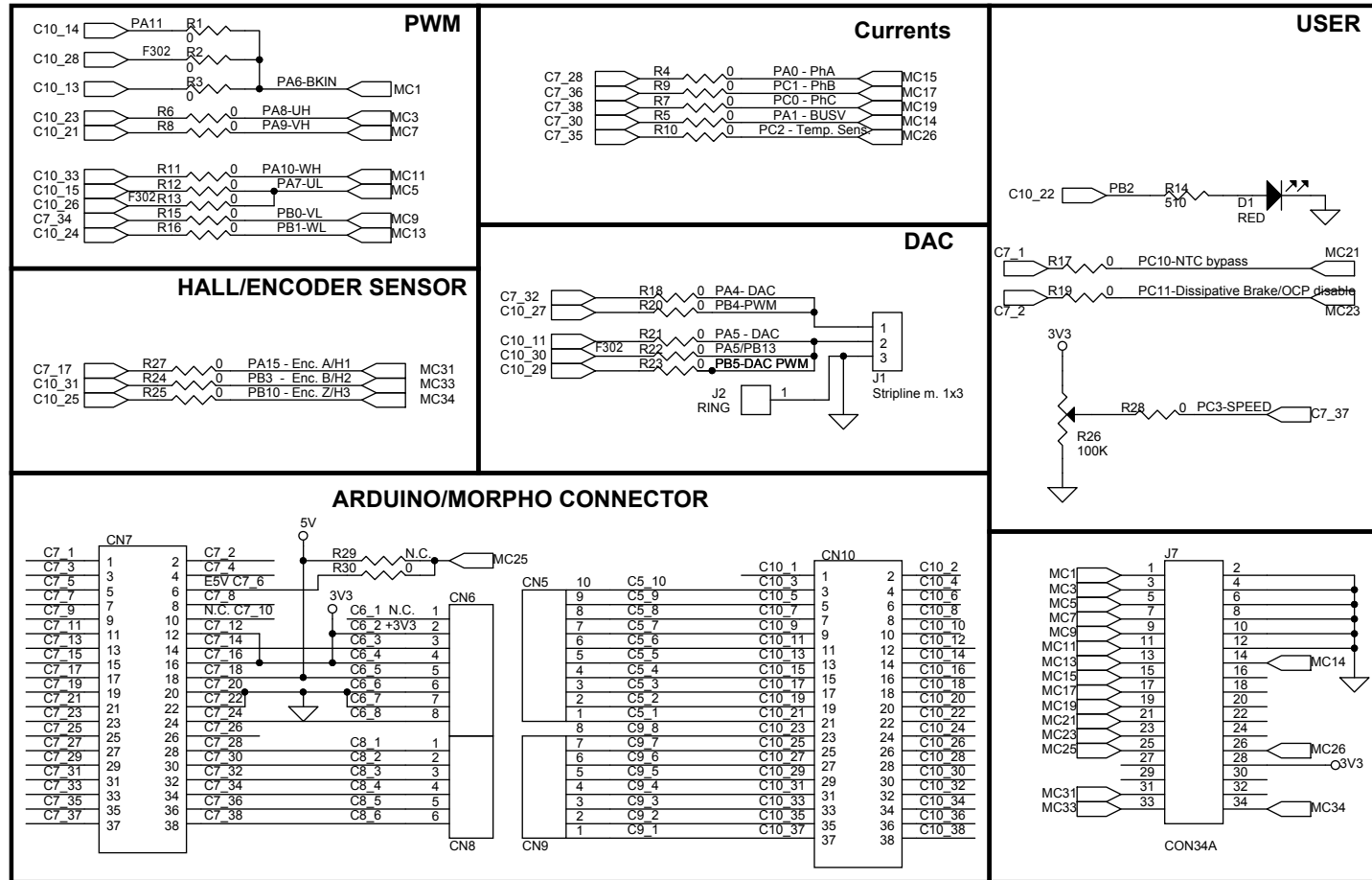
For the pin configuration, see [Table 2](#) and [Table 3](#).

You can connect the [STM32 Nucleo](#) to the MC workbench GUI through a virtual COM embedded in the [STM32 Nucleo](#), which allows using the USART2 on PA2 and PA3 pins from the same USB type A to Mini-B USB cable used to program the [STM32 Nucleo](#).

For further information on the MC FOC SDK, see [X-CUBE-MCSDK](#).

4 Schematic diagrams

Figure 6. X-NUCLEO-IHM09M2 circuit schematic



5 Bill of materials

Table 5. X-NUCLEO-IHM09M2 bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	D1	RED, SMD 0603,	LED standard - SMD	Lite-on	LTST-C193KRKT-5A
2	1	J1	Stripline m. 1x3, TH 2.54 mm pitch	3-way strip line	Stelvio Kontek	613040167028
3	1	J2	RING, TH, 1 mm	Test point	Vero Technologies	20-2137
4	2	CN7, CN10, male on top, female on bottom	CONN 38, TH 2.54 mm pitch	38-pin elevated socket morpho connector	Samtec	ESQ-119-24-T-D
					4UCONN	08413
5	0	CN6, CN9, female on top, male on bottom	CONN8, TH 2.54 mm pitch	8-pin elevated socket morpho connector (not mounted)	Samtec	ESQ-108-24-T-S
					4UCONN	15284
6	0	CN5, female on top, male on bottom	CONN10, TH 2.54 mm pitch	10-pin elevated socket (not mounted)	Samtec	ESQ-110-24-T-S
					4UCONN	15286
7	1	J7	Motor control connector, TH	34-way IDC straight boxed header	ASSMANN WSW	AWHW 34G-0202-T
8	0	CN8, female on top, male on bottom	CONN6, TH 2.54 mm pitch	6-pin elevated socket (not mounted)	Samtec	ESQ-106-24-T-S
					4UCONN	15282
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 Ohm, 0603, 0.1 W	SMD resistors	RS PRO	716-9743
10	1	R14	510 Ohm, 0603, 0.1 W	SMD resistor	RS PRO	804-8820
11	1	R26	100 kOhm, 1/2 W, $\pm 10\%$	Trimmer resistor	Bourns	3386G-1-104LF
12	0	R29	0, 0603, 1/2 W	Solder bridge (not mounted) - leave open	-	-
13	1	R30 closed with a drop of tin	0, 0603, 1/2 W	Solder bridge	Any	-

6 Board versions

Table 6. X-NUCLEO-IHM09M2 versions

PCB version	Schematic diagrams	Bill of materials
X\$NUCLEO-IHM09M2 ⁽¹⁾	X\$NUCLEO-IHM09M2 schematic diagrams	X\$NUCLEO-IHM09M2 bill of materials

1. This code identifies the X-NUCLEO-IHM09M2 first version. It is printed on the board PCB.

7 Regulatory compliance information

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This kit is designed to allow:

- (1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and
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Formal product notice required by EU

This device is in conformity with the essential requirements of the Directive 2015/863/EU (RoHS).

Revision history

Table 7. Document revision history

Date	Revision	Changes
18-Jul-2022	1	Initial release.

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