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UM2095
User manual

Getting started with the X-NUCLEO-IHM11M1 low voltage 3-phase brushless DC motor driver expansion board based on STSPIN230

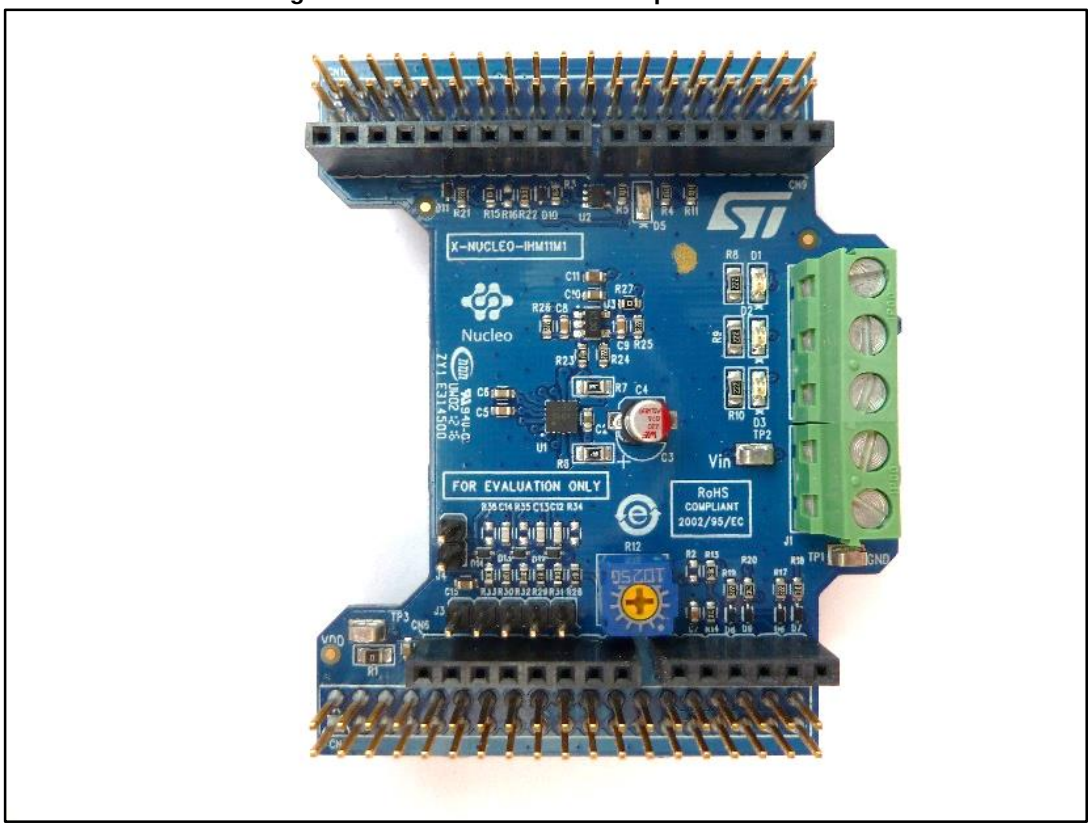
Introduction

The X-NUCLEO-IHM11M1 is a low voltage three-phase brushless DC motor driver expansion board based on STSPIN230 for STM32 Nucleo. It is an affordable and easy-to-use solution with motor driver operation in low voltage battery scenarios, allowing zero consumption state (such as in thermal printers, robotics, toys, etc..).

The X-NUCLEO-IHM11M1 is compatible with the Arduino UNO R3 and the ST morpho connectors and supports the addition of other boards to a single STM32 Nucleo board.

Furthermore, the board is designed for six-step and FOC algorithms.

Figure 1: X-NUCLEO-IHM11M1 expansion board



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1 Hardware and software requirements

To use the STM32 Nucleo development boards with the X-NUCLEO-IHM11M1 expansion board, the following software and hardware specifications are required:

- a Windows PC (XP, Vista 7 , Win 8, Win 10) to install the software package
- an X-NUCLEO-IHM11M1 expansion board
- an STM32 Nucleo development board (NUCLEO-F401RE, NUCLEO-F334R8, NUCLEO-F030R8 or NUCLEO-L053R8)
- a type A USB to mini-B USB cable to connect the STM32 Nucleo board to the PC
- the X-CUBE-SPN7 software package (available on *www.st.com*)
- an IDE chosen among IAR Embedded Workbench for ARM (EWARM), Keil microcontroller development kit (MDK-ARM) and system workbench for STM32 Nucleo project
- three-phase brushless DC motor with compatible voltage and current for STSPIN230 driver
- an external power supply or battery able to provide the voltage required by the stepper motor used

2 Getting started

The X-NUCLEO-IHM11M1 expansion board is a three-phase brushless DC motor driver covering a wide range of applications.

The board maximum ratings are:

- Power stage supply voltage (Vsub) from 1.8 to 10 V
- Motor phase current up to 1.3 A_{rms}

To start your project with the board:

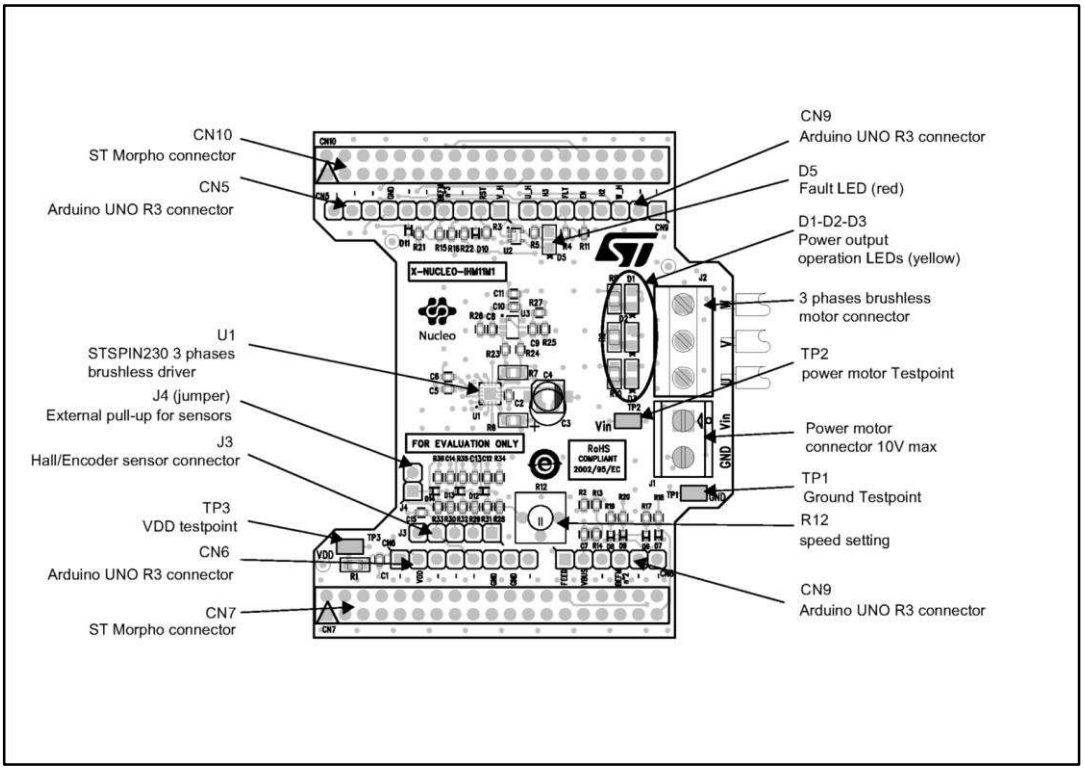
1. Check the jumper position of your configuration (see *Section 2: "Introduction"*).
2. Connect the X-NUCLEO-IHM11M1 with the STM32 Nucleo development board through ST morpho connectors (CN7, CN10).
3. Supply the board through input 5 (Vin) and 6 (GND) of the J1 connector: the D5 (red) LED turns on.
4. Develop your application using the examples provided with the firmware library.

Further support material is available on the STSPIN230 (www.st.com) and STM32 Nucleo web pages (*www.st.com/stm32nucleo*)

3 Hardware description and configuration

The figure below shows the board connector and jumper positions.

Figure 2: X-NUCLEO-IHM11M1 jumper and connector positions



The table below shows ST morpho connector detailed pinout.

Table 1: ST morpho connector table

Connector	Pin(1)	Signal	Remarks
CN10	1	IO_BEFM	
	9	Ground	
	15	BEFM3	*Section 3: "Hardware and software requirements"*
	19	Reset	
	21	V_High	
	23	U_High	
	24	W_Low	
	25	H3	
	26	BEFM3	*Section 3: "Hardware and software requirements"*
	27	Fault	
	28	V_Low	
	29	Enable	
	30	U_Low	
	31	H2	

Connector	Pin(1)	Signal	Remarks
	33	W_High	
CN7	12	VDD	
	17	H1	
	18	5V	
	20	Ground	
	22	Ground	
	28	CURR_FDB	
	30	VBUS	
	34	BEFM2	
	35	Speed	
	37	BEFM1	

Notes:

(1)All the non-listed pins are not connected.

The X-NUCLEO-IHM11M1 is equipped with screw connectors for motor and power supply, a jumper for enabling a Hall encoder detection circuit and a connector for Hall effect sensors (refer to the table below).

Table 2: Other connectors, jumpers and test points

Name	Pin	Label	Description
J1	1 - 2	Vin - GND	Motor power supply
J2	1 - 2 - 3	U, V, W	3-phase BLDC motor phases connection
J3	1 - 2 - 3	-	Hall/encoder sensors connector
	4 - 5	-	Sensors power supply
J4	-	J4	Selection for Hall's input lines protection (closed by default) Hall's input lines
TP1	-	GND	Ground
TP2	-	VIN	Motor power supply
TP3	-	VDD	Digital power supply (by default 3.3 V coming from STM32 Nucleo board)

3.1 Selecting the STM32 Nucleo board

This expansion board natively supports the following STM32 Nucleo development boards:

- NUCLEO-F401RE
- NUCLEO-F334R8
- NUCLEO-F030R8
- NUCLEO-L053R8

4 Circuit description

The STSPIN230 integrates a protected triple half-bridge with low $R_{DS(on)}$ for evaluating a solution for a three-phase BLDC motor in very low consumption mode.

The device is protected against overload and short-circuits: short to ground, short to motor supply voltage, short between the outputs. If one of the failure events occurs, the fault signal is set and the fault LED D5 is lit (red).

The STSPIN230 is compatible with single shunt current sense measurement. The current feedback signal conditioning is performed by hardware available on the board and sent to the STM32 Nucleo board through the CN7 ST morpho connector (pin 28).

Motor speed regulation can be performed by hardware, by acting on trimmer R12. In this way, you can change the reference used by STM32 firmware for speed regulation.

The X-NUCLEO-IHM11M1 expansion board provides two hardware solutions for motor position feedback: one based on sensors and the other one based on sensorless detection.

4.1 Hall/encoder motor speed sensor

The X-NUCLEO-IHM11M1 expansion board implements the Hall/encoder sensor detection circuit for motor speed feedback. The motor sensor feedback is connected through the J3 connector and an analog circuit to the STM32 Nucleo board in order to detect the motor rotation.

For sensors requiring external pull-up, three 10 kΩ resistors are already mounted and connected to the VDD voltage (if these are not necessary, you can remove them).

The J4 jumper (closed by default) protects the Hall's input lines connecting them to VDD voltage through a small-signal Schottky diode.

4.2 Sensorless detection

In six-step driving mode, one of the three phases is left in high impedance state: comparing this phase voltage with the center-tap voltage, we can detect the BEMF zero-crossing.

This signal is acquired through an analog circuit embedded on the expansion board and sent to the STM32 Nucleo board through the ST morpho connectors.

For each different STM32 Nucleo development board, the BEFM3 driver input can be selected through a dedicated resistor, as indicated in the table below.

Table 3: BEFM3 input selection

Nucleo board	CN10 connector	R15	R16	Remark
NUCLEO-F401RE NUCLEO-F030R8 NUCLEO-L053R8	pin15	0 Ω	Not mounted	Default
NUCLEO-F334R8	pin 26	Not mounted	0 Ω	

4.3 Bus voltage circuit

The X-NUCLEO-IHM11M1 expansion board provides the hardware bus voltage sensing. This signal is acquired with a resistor divider from the motor supply voltage (VBUS) and sent to the analog to digital converter (connector CN7 pin 30).

5 Revision history

Table 4: Document revision history

Date	Revision	Changes
19-Jul-2016	1	Initial release.

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