# UM1925
# User manual

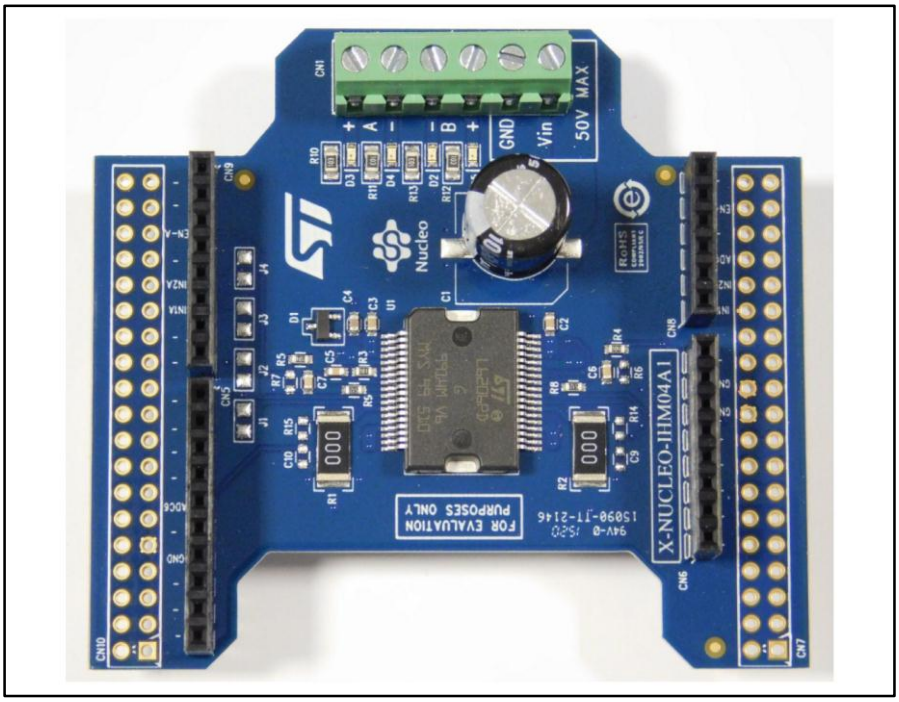
## Getting started with the X-NUCLEO-IHM04A1 dual brush DC motor driver expansion board for STM32 Nucleo

## Introduction

The X-NUCLEO-IHM04A1 is a dual brush DC motor drive expansion board based on L6206 (DMOS dual full bridge driver) to drive dual bipolar DC or quad unipolar DC motors. It provides a low cost, robust and easy-to-use solution for driving DC motors in your STM32 Nucleo project. A flexible solution for driving 1 to 4 DC motors is implemented via jumpers.

The X-NUCLEO-IHM04A1 is compatible with the Arduino UNO R3 connector, and supports the addition of other expansion boards with a single STM32 Nucleo board. The user can also mount the ST Morpho connector.

**Figure 1: X-NUCLEO-IHM04A1: Dual brush DC motor driver expansion board based on L6206**



# Contents

# 1 Getting started

The X-NUCLEO-IHM04A1 expansion board is a dual brush DC motor driver covering a wide range of applications. The maximum ratings of the board are the following:

- Power stage supply voltage (VS) from 8 V to 50 V
- Motor phase current up to 2.8 A r.m.s.

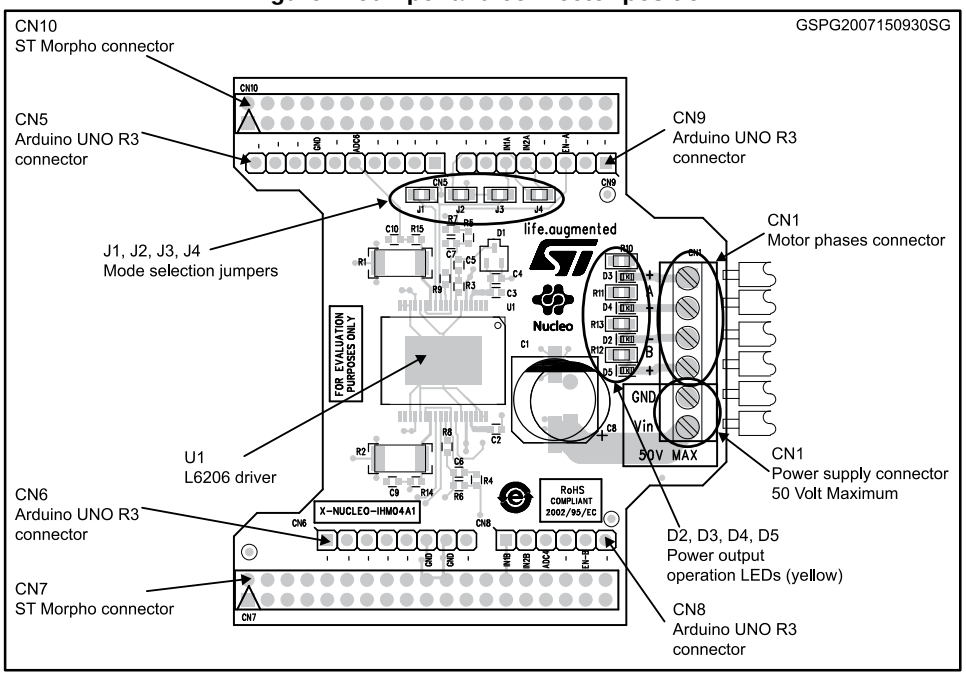
Follow this sequence to start your project with the board:

1. Check the jumper position based on your configuration (see *Section 2: "Hardware description and configuration"*)
2. Connect the board with the STM32 Nucleo board through Arduino UNO R3 for the X-NUCLEO-IHM04A1
3. Supply the board through the input 6 (VS) and 5 (ground) of the connector CN1
4. Develop your application using the examples provided with the firmware library, X-CUBE-SPN4

Further support material is available on the L6206 and the STM32 Nucleo web pages on www.st.com

# 2 Hardware description and configuration

**Figure 2: Jumper and connector position**




The following table provides the detailed pinout of the Arduino UNO R3 and ST Morpho connectors.

**Table 1: Arduino UNO R3 connector table**

| Connector | Pin (1) | Signal | Remarks |
|---|---|---|---|
| CN5 | 5 | ADC-6 | |
| | 7 | Ground | |
| CN9 | 3 | EN-A | |
| | 5 | IN2A | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 6 | IN1A | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| CN6 | 6 | Ground | |
| | 7 | Ground | |
| CN8 | 1 | IN1B | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 2 | IN2B | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 3 | ADC-4 | |
| | 5 | | |

**Notes:**

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

**Table 2: ST Morpho connector table**

| Connector | Pin (1) | Signal | Remarks |
|---|---|---|---|
| CN10 | 9 | Ground | |
| | 13 | ADC-6 | |
| | 27 | IN1A | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 29 | IN2A | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 33 | EN-A | |
| CN7 | 20 | Ground | |
| | 22 | Ground | |
| | 28 | IN1B | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 30 | IN2B | See *Section 2.1: "overcurrent (OCD) threshold setting"* |
| | 32 | ADC-4 | |
| | 36 | EN-B | |

**Notes:**

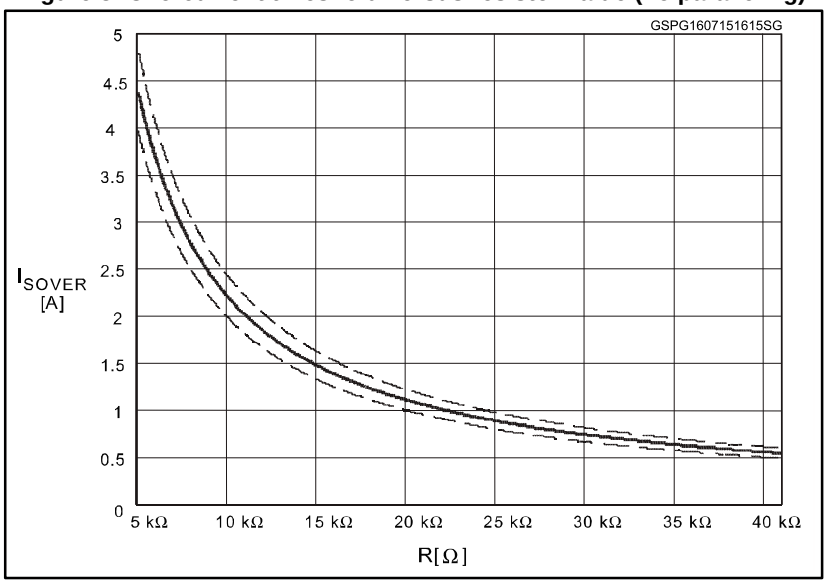
(1)All the non-listed pins are not connected.

## 2.1 overcurrent (OCD) threshold setting

The device integrates two overcurrent protection circuits with adjustable threshold, one for each full bridge.

The overcurrent threshold is set through the R9 (bridge A) and R8 (bridge B) resistors, as indicated in *Figure 3: "Overcurrent threshold versus resistor value (no paralleling)"*.

**Figure 3: Overcurrent threshold versus resistor value (no paralleling)**




When one of the paralleling modes is used (see *Section 2.2: "Selecting the mode"*), the actual OCD threshold value may be scaled as indicated in *Table 1: "Arduino UNO R3 connector table"*.

## 2.2 Selecting the mode

This board can drive 1 to 4 DC motors with several configurations.

The selection is done by Jumper J1 - J2 - J3 and J4, by default: all jumpers are not populated.

The table below briefly summarizes the possible configurations:

**Table 3: Board configuration summary**

| Mode | Max output current | Output $R_{DS(on)}$ | OCD threshold scaling | J1 | J2 | J3 | J4 |
|---|---|---|---|---|---|---|---|
| Two bidirectional DC motors | 2.8 A rms | 0.3 Ω | × 1 | Disconnected | Disconnected | Disconnected | Disconnected |
| Four unidirectional DC motors | 2.8 A rms (1) | 0.3 Ω | × 1 (1) | Disconnected | Disconnected | Disconnected | Disconnected |
| High current parallel one bidirectional DC motor | 5.6 A rms | 0.15 Ω | × 2 | Disconnected | Disconnected | Connected | Connected |
| High current parallel two unidirectional DC motors | 5.6 A rms | 0.15 Ω | × 2 | Disconnected | Disconnected | Connected | Connected |
| Low current parallel one DC motors bidirectional | 2.8 A rms | 0.15 Ω | × 1 | Connected | Connected | Disconnected | Disconnected |
| Low current parallel two unidirectional DC motors | 2.8 A rms | 0.15 Ω | × 1 | Connected | Connected | Disconnected | Disconnected |

| Mode | Max output current | Output $R_{DS(on)}$ | OCD threshold scaling | J1 | J2 | J3 | J4 |
|---|---|---|---|---|---|---|---|
| Parallel all bridges one unidirectional DC motor | 11.2 A rms | 0.075 Ω | × 4 | Connected | Connected | Connected | Connected |

**Notes:**

(1)The current limit is shared between the two motors connected on the same full-bridge (A or B).

### 2.2.1 Mode no. 1: two bidirectional DC motors

Two independent DC motors are driven by the board.

The supply voltage of both motors is connected to J1 pin 5 and 6 with a maximum voltage at 50 V DC.

Maximum current is 2.8 A rms and the output $R_{DS(on)}$ is equal to 0.3 W ($T_J$ = 25 °C).

The maximum overcurrent detection threshold is set to 5.6 A.

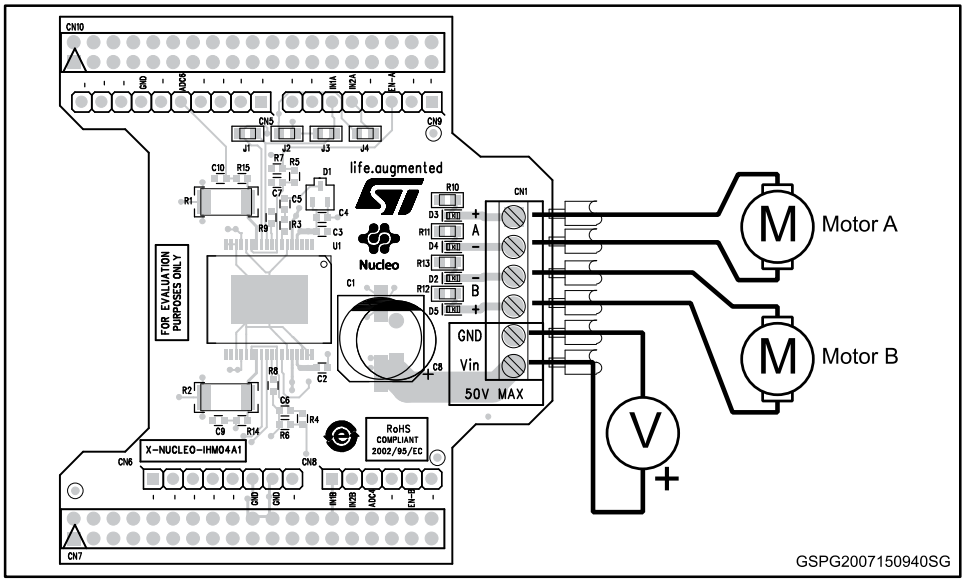
Motor A connected between A+ (CN1 pin1) and A- (CN1 pin2)

Motor B connected between B+ (CN1 pin4) and B- (CN1 pin3)

**Table 4: Jumper selection**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Disconnected | Disconnected | Disconnected | Disconnected |

**Figure 4: two bidirectional DC motors**




### 2.2.2 Mode no. 2: four DC motors unidirectional

Four independent DC motors are driven by the board.

The supply voltage of both motors is connected to J1 pin 5 and 6 with a maximum voltage of 50 V DC.

Maximum current is 2.8 A rms and the output $R_{DS(on)}$ is equal to 0.3 W ($T_J$ = 25 °C).

The maximum overcurrent detection threshold is set to 5.6 A.

The total rms current flowing in A+ and A- DC motor must be below the 2.8 A rms limit. The OCD threshold is also triggered when the sum of the two output currents exceeds the programmed threshold.

The same for the B+ and B- outputs.

Motor A connected between A+ (CN1 pin1) and GND

Motor B connected between A- (CN1 pin2) and GND

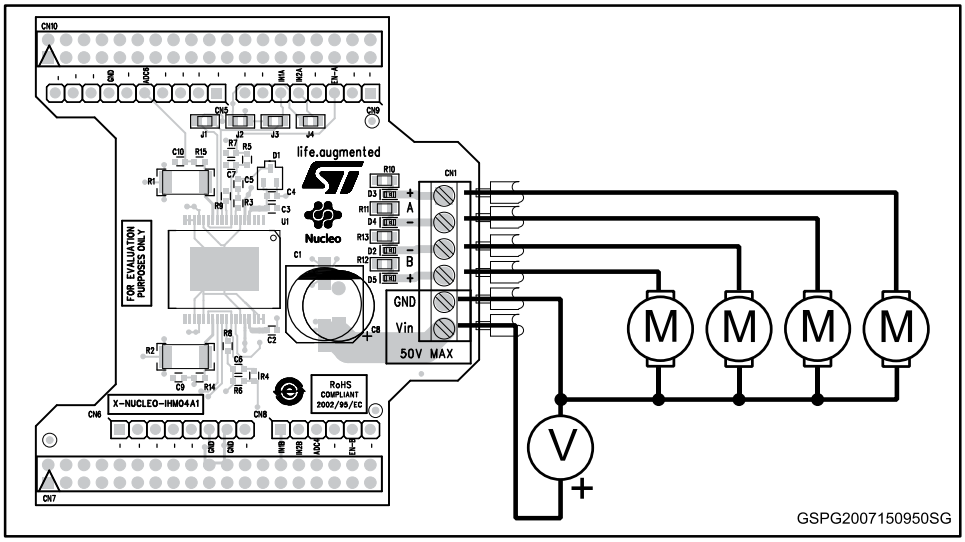
Motor C connected between B+ (CN1 pin4) and GND

Motor D connected between B- (CN1 pin3) and GND

**Table 5: Jumper selection**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Disconnected | Disconnected | Disconnected | Disconnected |

**Figure 5: Four unidirectional DC motors**




## 2.2.3 Mode no. 3: parallel connection for higher current - one DC motor bidirectional

This mode, with output power in parallel, increases the output current capability.

The motor supply voltage is connected to J1 pin 5 and 6 with a maximum voltage of 50 V DC.

Maximum current is 5.6 A rms and the output $R_{DS(on)}$ is equal to 0.15 W ($T_J$ = 25 °C).

The maximum overcurrent detection threshold is set to 11.2 A.

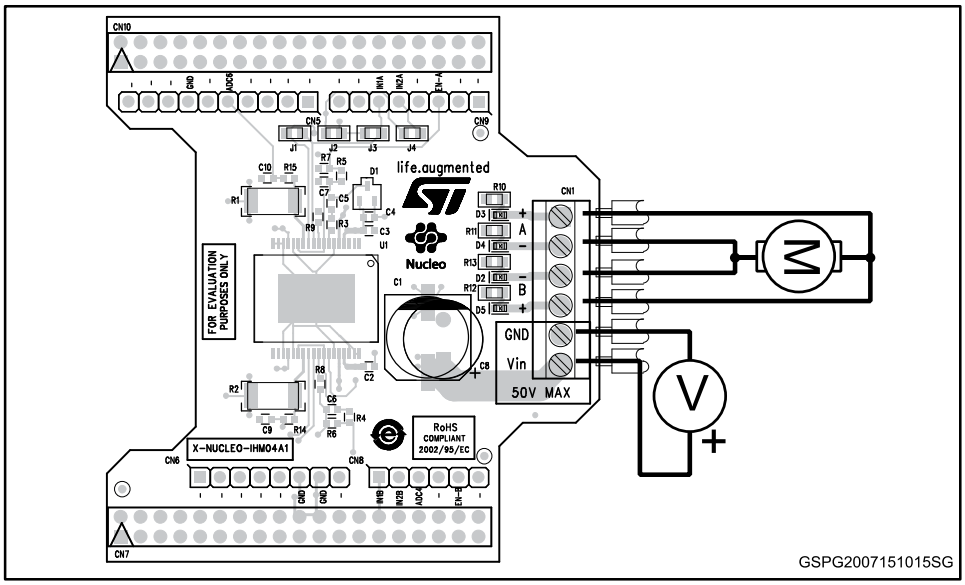
Motor A connected between

- Both A+ (CN1 pin1) B+ (CN1 pin4)
- Both A- (CN1 pin2) B- (CN1 pin3)

**Table 6: Jumper selection**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Disconnected | Disconnected | Connected | Connected |

**Figure 6: One DC motor bidirectional - higher current**




## 2.2.4 Mode n °4: parallel connection for higher current - two unidirectional DC motors

This mode is similar to mode 3 - the bidirectional DC motor is replaced by two unidirectional DC motors

Motor A connected between

- Both A+ (CN1 pin1) B+ (CN1 pin4)
- GND

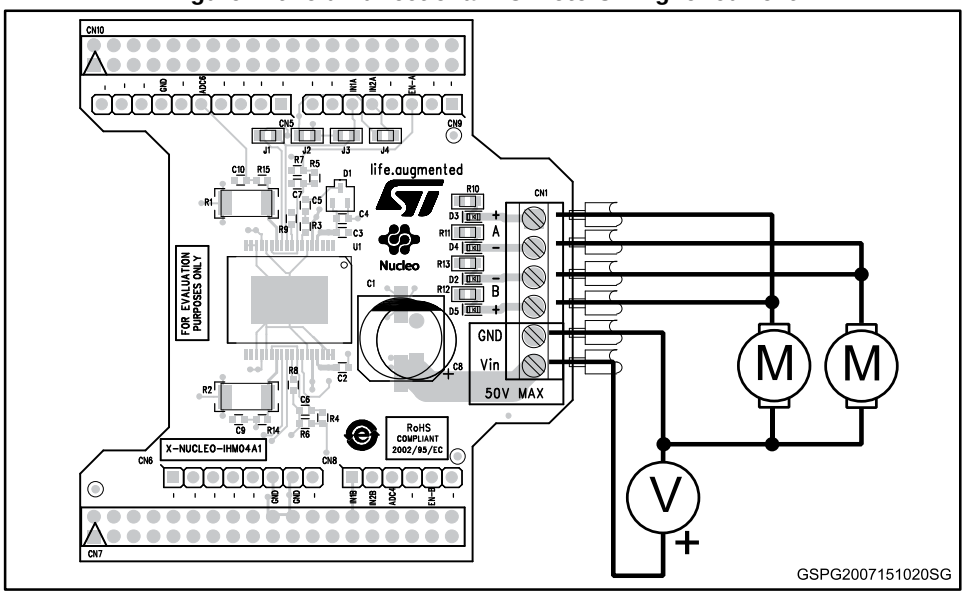
Motor B connected between

- Both A- (CN1 pin2) B- (CN1 pin3)
- GND

**Table 7: Jumper selection**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Disconnected | Disconnected | Connected | Connected |

**Figure 7: two unidirectional DC motors - higher current**




### 2.2.5 Mode no. 5: parallel connection for lower overcurrent - one DC motor bidirectional

This mode, with output power in parallel, maintains a lower operating current compared to the solution in mode 3, but power dissipation is reduced.

The motor supply voltage is connected to J1 pin 5 and 6 with a maximum voltage of 50 V DC.

Maximum current is 2.8 A RMS and the output $R_{DS(on)}$ is equal to 0.15 W (Th = 25 °C).

The maximum overcurrent detection threshold is set to 5.6 A.

Motor A connected between

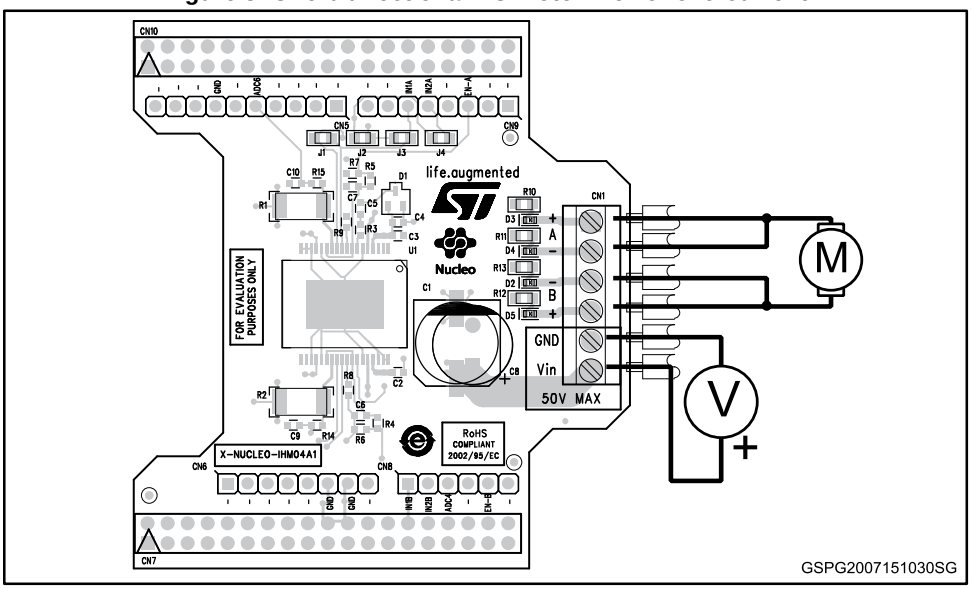
Both A+ (CN1 pin1) A- (CN1 pin2)

Both B+ (CN1 pin4) B- (CN1 pin3)

**Table 8: Jumper selection**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Connected | Connected | Disconnected | Disconnected |

**Figure 8: One bidirectional DC motor - lower overcurrent**




## 2.2.6 Mode n °6: parallel connection for lower overcurrent - two unidirectional DC motors

This mode is similar to the mode 5 - the bidirectional DC motor is replaced by two unidirectional DC motors.

Motor A connected between

- Both A+ (CN1 pin1) A- (CN1 pin2)
- GND

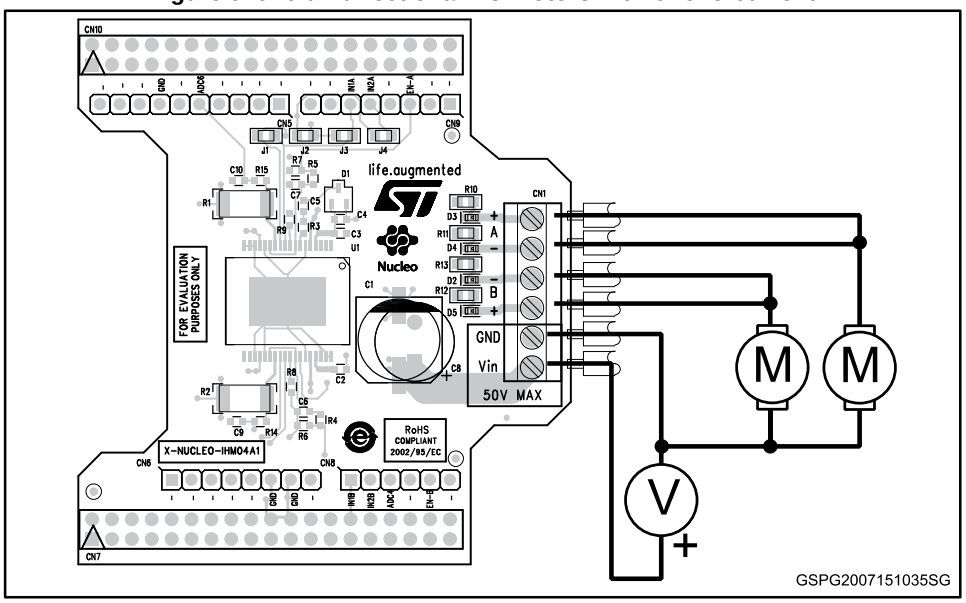
Motor B connected between

- Both B+ (CN1 pin4) B- (CN1 pin3)
- GND

**Table 9: Jumper selection change**

| J1 | J2 | J3 | J4 |
|---|---|---|---|
| Connected | Connected | Disconnected | Disconnected |

**Figure 9: two unidirectional DC motors - lower overcurrent**




## 2.2.7 Mode no. 7: parallel all bridges - one unidirectional DC motor

This mode, with all output power in parallel, allows driving a single-brush unidirectional DC motor.

The motor supply voltage is connected to J1 pin 5 and 6 with a maximum voltage of 50 V DC.

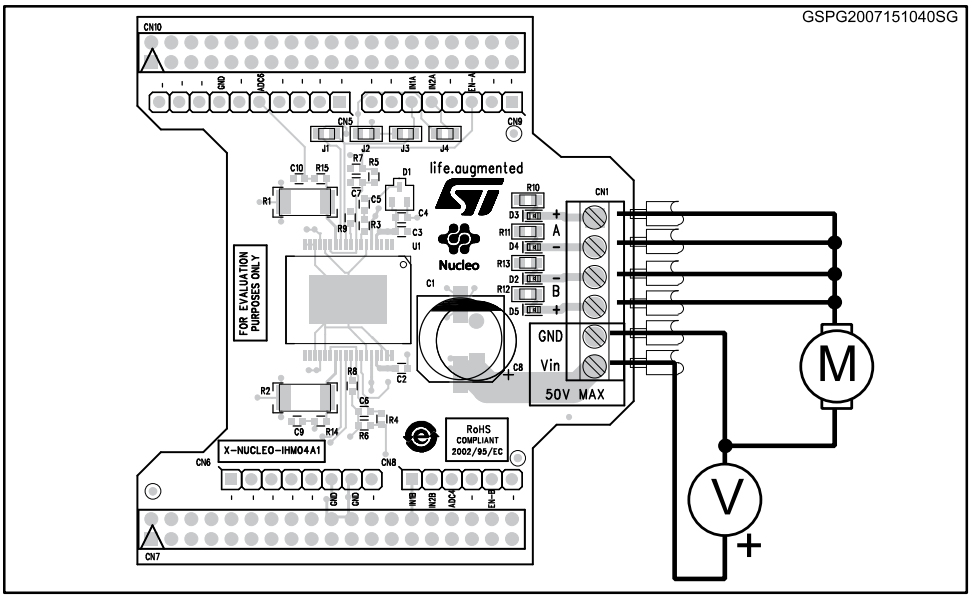
Maximum current is 11.2 A rms and the output $R_{DS(on)}$ is equal to 0.075 Ω ($T_J$ = 25 °C).

The maximum overcurrent detection threshold is set to 22.4 A.

Motor A connected between

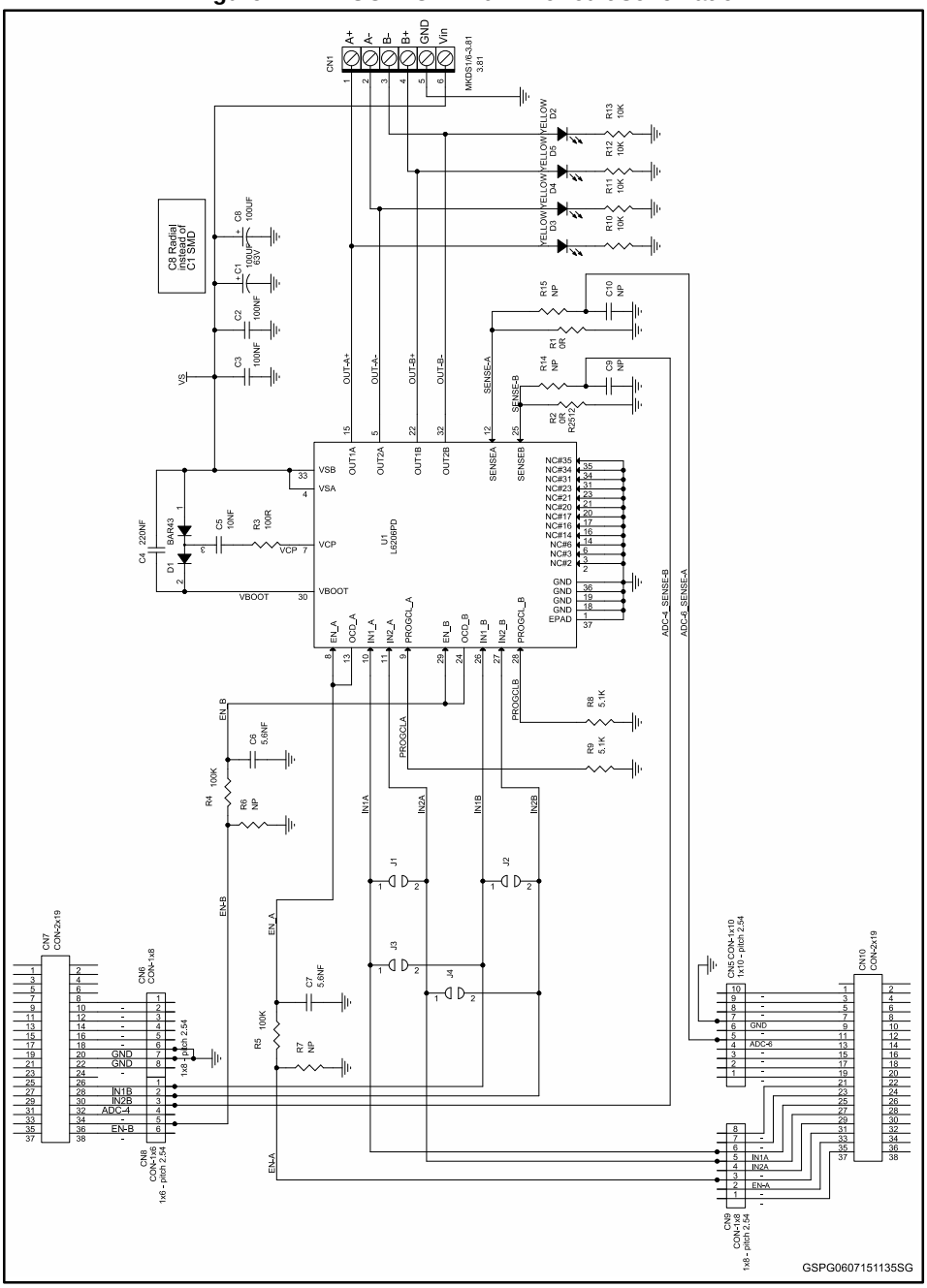
- Both A+ (CN1 pin1) A- (CN1 pin2) B+ (CN1 pin4) B- (CN1 pin3)
- GND

**Figure 10: One unidirectional DC motor - all bridges**



# 3 Schematic diagram

**Figure 11: X-NUCLEO-IHM04A1 circuit schematic**



# 4 Bill of material

**Table 10: Bill of material (Part 1)**

| Item no. | Description | Q.ty | Part reference | Value | Voltage | Part type |
|---|---|---|---|---|---|---|
| 1 | CAP ALU 100µF 63V SMD-PACK-G 10x10.2 mm | 1 | | 100UF | 63V | ALUMINIUM |
| 2 | CAP CER 100nF 50V X7R 0603 | 2 | C2 C3 | 100NF | 50V | CERAMIC |
| 3 | CAP CER 220nF 35V X7R 0603 | 1 | C4 | 220NF | 35V | CERAMIC |
| 4 | CAP CER 10nF 50V X7R 0603 | 1 | C5 | 10NF | 50V | CERAMIC |
| 5 | CAP CER 5.6nF 50V X7R 0603 | 2 | C6 C7 | 5.6NF | 50V | CERAMIC |
| 6 | CAP ALU 100µF 63V Radial 10x6-P5 | 1 | C8 | 100UF | 63V | ALUMINIUM |
| 7 | CAP NP 0603 | 2 | C9 C10 | NP | | NP |
| 8 | Screw connector 6 poles MKDS 1/6-3.81 | 1 | CN1 | MKDS1/6-3.81 | | SCREW CONNECTOR |
| 9 | THOUGH-HOLE-1x10-Pin height 14.8 - Body 8.5mn - pitch 2.54 | 1 | CN5 | CON-1x10 | | HEADER |
| 10 | THOUGH-HOLE-1x8-Pin height 14.8 - Body 8.5mn - pitch 2.54 | 2 | CN6 CN9 | CON-1x8 | | HEADER |
| 11 | THOUGH-HOLE-2x19-Pin height 14.8 - Body 8.5mn - pitch 2.54 | 2 | NOT POPULATED | CON-2x19 | | HEADER |
| 12 | THOUGH-HOLE-1x6-Pin height 14.8 - Body 8.5mn - pitch 2.54 | 1 | CN8 | CON-1x6 | | HEADER |
| 13 | Double Diode high speed switching Diode | 1 | D1 | BAR43 | | DIODE |
| 14 | LED YELLOW - 0603 | 4 | D2-D5 | YELLOW | | LED |
| 15 | TIN DROP OPEN | 4 | J1-J4 | OPEN | NOT POPULATE | CMS |
| 16 | OPTICAL_TARGET | 3 | MIRE1-MIRE3 | OPTICAL_ TARGET | | OPTICAL_ TARGET |
| 17 | RES 0 Ω 1.5W 2512 | 2 | R1 R2 | 0R | | CMS |
| 18 | RES 100 Ω 5% 1/10W | 1 | R3 | 100R | | CMS |
| 19 | RES 100 kΩ 5% 1/10W 0603 SMD | 2 | R4 R5 | 100K | | CMS |
| 20 | RES NP 0603 | 4 | R6 R7 R14 R15 | NP | | CMS |
| 21 | RES 5.1 kΩ 1% 1/10W 0603 SMD | 2 | R8 R9 | 5.1K | | CMS |
| 22 | RES 10 kΩ 5% 1/2W 0805 SMD | 4 | R10-R13 | 10K | | CMS |
| 23 | DMOS dual full bridge driver | 1 | U1 | L6206PD | | MOTOR DRIVER |

**Table 11: Bill of material (Part 2)**

| Item no. | Toler. | Package type | Manufacturer | Manufacturer Part number | Distributor | Distributor Part num. |
|---|---|---|---|---|---|---|
| 1 | 20% | EEEFK1J101P | PANASONIC | EEEFK1J101P | FARNELL | 9696040RL |
| 2 | 15% | C0603 | | | | |
| 3 | 15% | C0603 | | | | |
| 4 | 15% | C0603 | | | | |
| 5 | 15% | C0603 | | | | |
| 6 | 20% | | NICHICON | UVR1J101MPD | | |
| 7 | | C0603 | | | | |
| 8 | | MKDS1/6-3.81 | PHOENIX CONTACT | MKDS1/6-3.81 | RS | 220-4377 |
| 9 | | SSQ110-03 | SAMTEC | SSQ-110-04-F-S | | |
| 10 | | SSQ108-03 | SAMTEC | SSQ-108-04-F-S | | |
| 11 | | SSQ119-04D | SAMTEC | SSQ-119-04-L-D | | |
| 12 | | SSQ106-03 | SAMTEC | SSQ-106-04-F-S | | |
| 13 | | BAR43 | STMICROELECTRONICS | BAR43SFILM | RS | 714-0470 |
| 14 | | LEDC-0603 | | | | |
| 15 | | R0805 | | | | |
| 16 | | OPTICAL_TARGET | | | | |
| 17 | | R2512 | VISHAY DALE | CRCW25120000Z0EGHP | FARNELL | 2099593 |
| 18 | 5% | R0603 | | | | |
| 19 | 5% | R0603 | | | | |
| 20 | | R0603 | | | | |
| 21 | 1% | R0603 | | | | |
| 22 | 5% | R0805 | | | | |
| 23 | | L6206PD | STMICROELECTRONICS | L6206PD | | |

# 5 Revision history

Table 12: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 06-Aug-2015 | 1 | Initial release. |

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