Getting started with the X-NUCLEO-IKS5A1 motion MEMS and environmental sensor expansion board for STM32 Nucleo

Introduction

X-NUCLEO-IKS5A1 is a motion MEMS and environmental sensor evaluation board kit consisting of the main board X-NUCLEO-IND5A1, which hosts the motion MEMS and environmental sensors, and the detachable add-on board STEVAL-MKIGI07A, which hosts 2 x 2 x 6 pin connectors for the DIL24 adapter.

It is compatible with the Arduino® UNO R3 connector layout and features the ISM330IS and ISM6HG256X MEMS IMUs, the IIS2MDC 3-axis magnetometer, the IIS2DULPX 3-axis accelerometer, and the ILPS22QS MEMS pressure sensor.

X-NUCLEO-IKS5A1 interfaces with the STM32 microcontroller via the I²C pin or, for external sensors mounted on DIL24 adaptor, via the SPI pins.

Figure 1. Photo of the board (top)

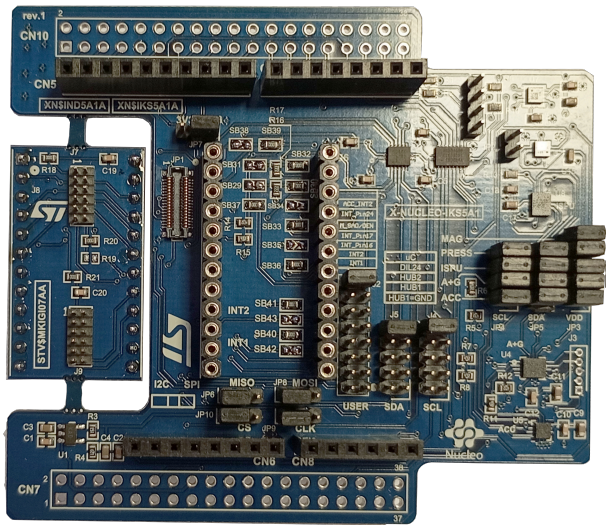
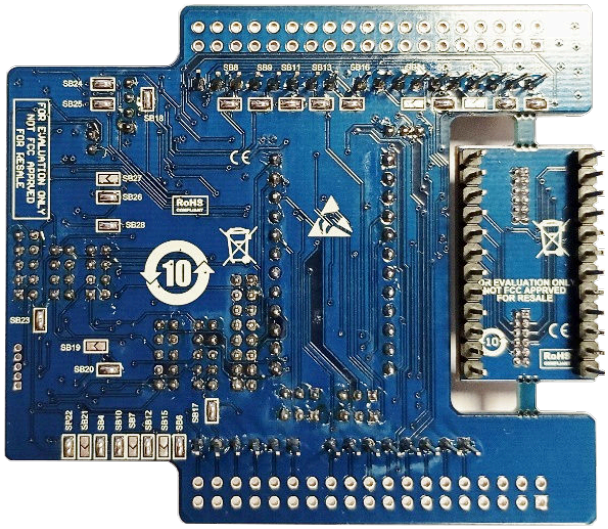


Figure 2. Photo of the board (bottom)



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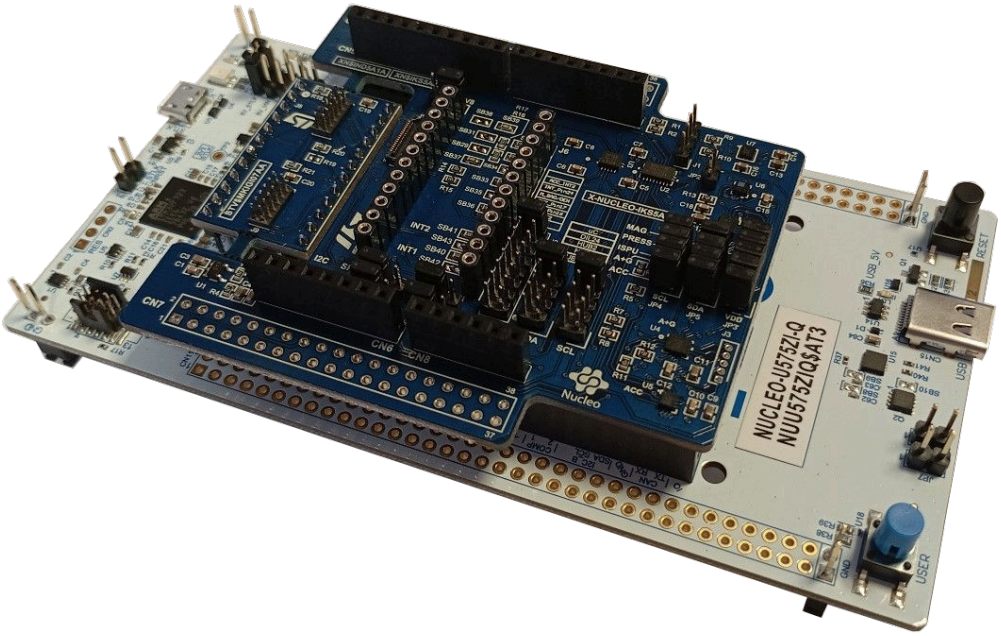
1 Getting started

1.1 Hardware requirements

X-NUCLEO-IKS5A1 is designed to be used with STM32 Nucleo boards.

Figure 3. X-NUCLEO-IKS5A1 plugged on STM32 Nucleo board



X-NUCLEO-IKS5A1 must be connected on the matching pins of any STM32 Nucleo board with the Arduino® R3 connector.

Note: X-NUCLEO-IKS5A1 components are ESD sensitive and, as the board has male/female pass-through connectors, it is important to handle it with care to avoid bending or damaging the pins.

2 System requirements

To complete the system setup, you need:

- Windows® (7, 8, 10, 11) PC.
- USB type-A to micro-B USB cable to connect the STM32 Nucleo to the PC. The type of USB connector is dependent on the Nucleo board.
- Board firmware and software package (X-CUBE-MEMS1) installed on the user PC.

3 Hardware description

The board lets you test the functionality of the motion MEMS accelerometer, gyroscope and magnetometer, as well as the environmental humidity, temperature and pressure sensors via the I²C communication bus.

It also allows complete testing of all ISM330IS and ISM6HG256X functionalities. There is also the possibility to attach two STHS34PF80 IR sensors (or other sensors) using connectors J7 and J9 on STEVAL-MKIGI07A add-on board.

The board features:

- Wide range of industrial motion and environmental sensors:
  - ISM6HG256X: intelligent IMU with simultaneous low-g and high-g acceleration detection
  - ISM330IS: 6-axis IMU, always-on 3-axis accelerometer and 3-axis gyroscope with ISPU
  - IIS2DULPX: intelligent ultralow power accelerometer for industrial applications
  - ILPS22QS: dual full-scale, 1260 hPa and 4060 hPa, absolute digital output barometer
  - IIS2MDC: high accuracy, ultralow power, 3-axis digital output magnetometer
- DIL24 socket and industrial connectors for external sensors
- Compatible with X-CUBE-MEMS1, an expansion software package for STM32Cube
- I²C sensor hub features on ISM330IS and ISM6HG256X available
- Supported by MEMS-Studio, a software solution for MEMS sensors with graphical no-code design of algorithms and development of embedded AI features
- Compatible with STM32 Nucleo boards
- Equipped with Arduino® UNO R3 connector
- RoHS compliant and WEEE compliant

Each device has a separate power supply to allow power consumption measurement of every sensor.

The expansion board is power supply compatible with STM32 Nucleo boards: it mounts an LDO to generate 1.8 V for all the MEMS sensors, except for the external sensor mounted on DIL24 adapter, which can be powered at both 1.8 V and 3.3 V (main supply from Nucleo board).

All signals between the sensors and the main board are translated by a level shifter (except for the SPI lines on DIL24).

3.1 Default jumper and solder bridge configuration

The user can configure several aspects of the X-NUCLEO-IKS5A1 through several solder bridges and two-pin jumpers, which can be left open (not mounted) or closed (mounted) to configure different hardware settings.

Here is the list of the jumpers and solder bridges (that are replaced with 0 Ω resistors in the production line).

Table 1. Solder bridges configuration

Name	Default	Description
SB1	Closed	SDA on CN5.9
SB2	Closed	SCL on CN5.10
SB3	Open	SPI_CK on CN5.6
SB4	Closed	MAG_DRDY / ACC_INT on CN8.3
SB5	Closed	SPI_CK on CN9.4
SB6	Closed	MAG_DRDY / ACC_INT1 on CN8.4
SB7	Open	MAG_DRDY on SB4
SB8	Closed	USER INTERRUP on CN9.3
SB9	Closed	ISM6HG256X_INT2 on CN9.5
SB10	Closed	ACC_INT1 on SB4
SB11	Closed	ISM6HG256X_INT1 on CN9.6
SB12	Closed	MAG_DRDY on SB6

Name	Default	Description
SB13	Closed	DIL24_INT1 on CN9.7
SB14	Open	ACC_INT2 on CN5.2
SB15	Open	ACC_INT1 on SB6
SB16	Closed	ISM6HG256X_INT2 on CN9.8
SB17	Closed	DIL24_INT2 on CN8.5
SB18	Closed	ISM330IS on CN8.6
SB19	Open	ISM6HG256X I^2C address SA0 to VDD
SB20	Closed	ISM6HG256X I^2C address SA0 to GND
SB21	Open	IIS2DULPX I^2C address SA0 to GND
SB22	Closed	IIS2DULPX I^2C address SA0 to VDD
SB23	Closed	Select ISM6HG256X INT2
SB24	Closed	IIS2MDC SCL pin
SB25	Closed	IIS2MDC SDA pin
SB26	Closed	ISM330IS I^2C address SA0 to VDD
SB27	Open	ISM330IS I^2C address SA0 to GND
SB28	Closed	Select ISM6HG256X INT2
SB29	Open	DIL24_pin22 to 1V8
SB30	Closed	DIL24_pin22 to GND
SB31	Open	DIL24_pin23 to 1.8 V
SB32	Closed	DIL24_pin23 to GND
SB33	Closed	DIL24_pin21 to SDA
SB34	Open	DIL24_pin21 to HUB2_SDA
SB35	Open	DIL24_pin20 to HUB2_SCL
SB36	Closed	DIL24_pin20 to SCL
SB37	Closed	DIL24_pin18 to GND
SB38	Open	Select VDDIO at VDD level
SB39	Closed	Select VDDIO at 1.8 V
SB40	Closed	DIL24_INT1 enter in level shift
SB41	Closed	DIL24_INT2 enter in level shift
SB42	Open	DIL24_INT1 bypass level shift
SB43	Open	DIL24_INT2 bypass level shift

Table 2. Jumper configuration

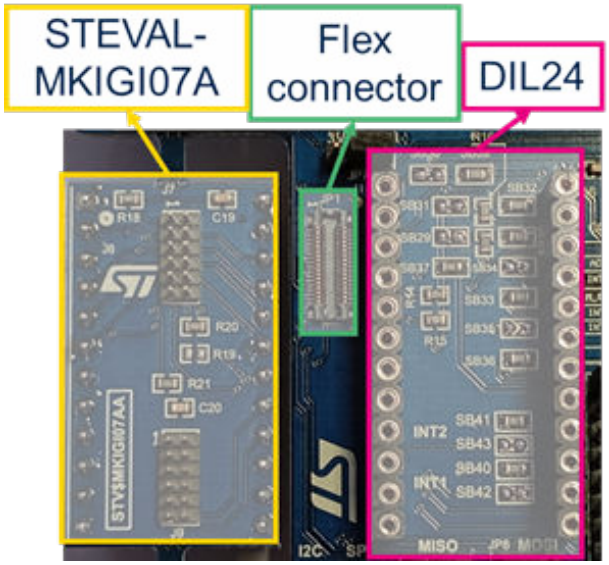
Name	Default	Description
JP2	Open	Connection MAG_DRDY with ISM6H256X INT2
JP3	Closed	VDD on sensors (5x)
JP4	Closed	SCL on sensors except IIS2MDC (4x)
JP5	Closed	SDA on sensors except IIS2MDC (4x)
JP6	Closed 1-2	I^2C SA0(default) – SPI MISO
JP7	Closed 1-2	VDD selection (default 1.8 V)

Name	Default	Description
JP8	Closed 1-2	I²C SDA (default) – SPI MOSI
JP9	Closed 1-2	I²C SCL (default) – SPI CLK
JP10	Closed 1-2	I²C (default) – SPI CS
J2	Closed 1-2	User INT selection
J4	Closed 9-10	SCL routing
J5	Closed 9-10	SDA routing

3.2 Block diagram

ISM330IS and ISM6HG256X have an I²C sensor hub that allows them to behave as the I²C master for other slave devices connected via an I²C aux bus. Various bus configurations are possible to select the I²C master of the environmental / DIL24 sensors.

Figure 4. X-NUCLEO-IKS5A1 connectors

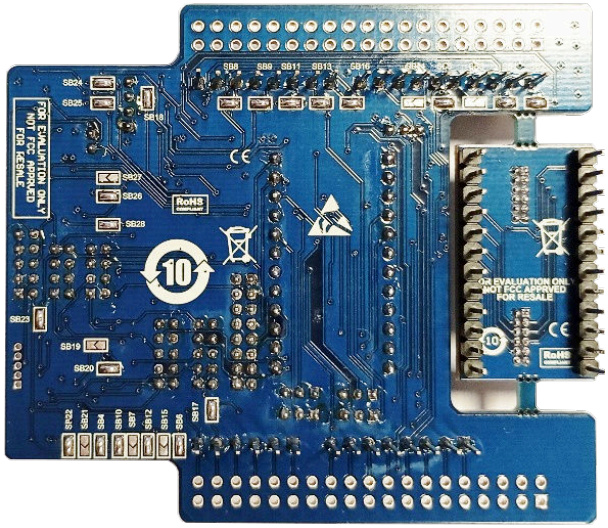


3.2.1 Mode 1: standard I²C bus connection

In standard I²C mode, all devices are connected to an external main board via the same I²C bus.
All devices are powered at 1.8 V, both VDD and VDDIO. The board configuration is:

- J4: 1-2, 9-10 (HUB2_SCx = GND, STM_SCL = SENS_SCL).
- J5: 1-2, 9-10 (HUB2_SDx = GND, STM_SDA = SENS_SDA).
- JP6, JP8, JP9, JP10 closed in I²C.

Figure 5. **X-NUCLEO-IKS5A1 standard I²C**

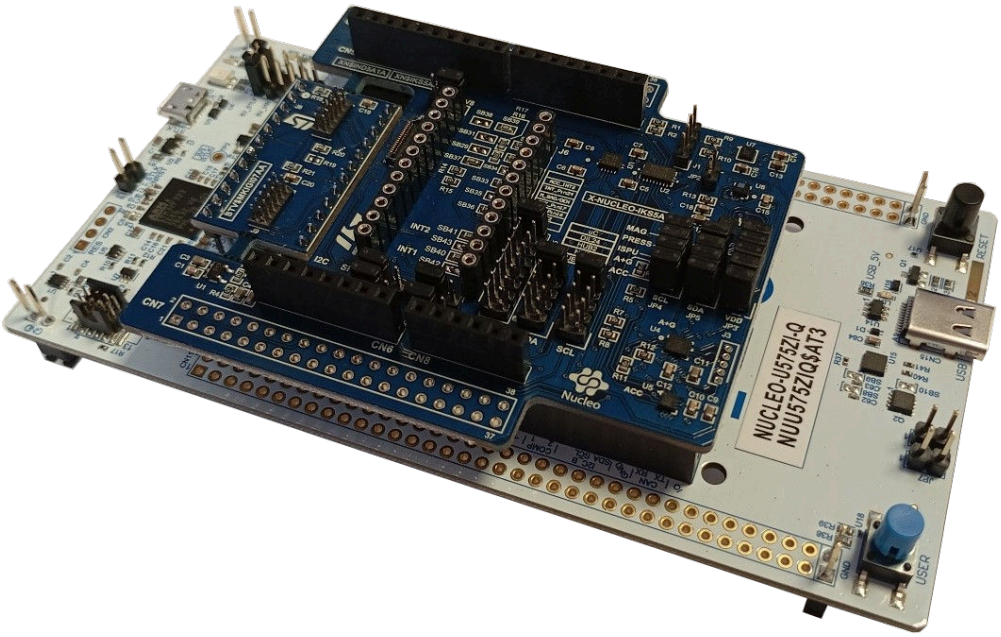


3.2.2 Mode 2: ISM330IS I²C sensor hub (all sensors)

In this sensor hub I²C mode, it is possible to power up the 6-axes inertial measurement unit (IMU) functionalities by collecting external data through a direct control of the on-board environmental sensors (magnetometer, sensor) and external sensor (DIL24) through the auxiliary I²C bus “SENS_I²C”. ISM6HG256X and IIS2DULPX remain connected to the main bus “uC_I²C” coming from the external boards. The main configuration is:

- J4: 3 - 4 (HUB1_SCx = SENS_SCL).
- J5: 3 - 4 (HUB1_SDx = SENS_SDA).

Figure 6. **X-NUCLEO-IKS5A1 - ISM330IS I²C sensor hub**

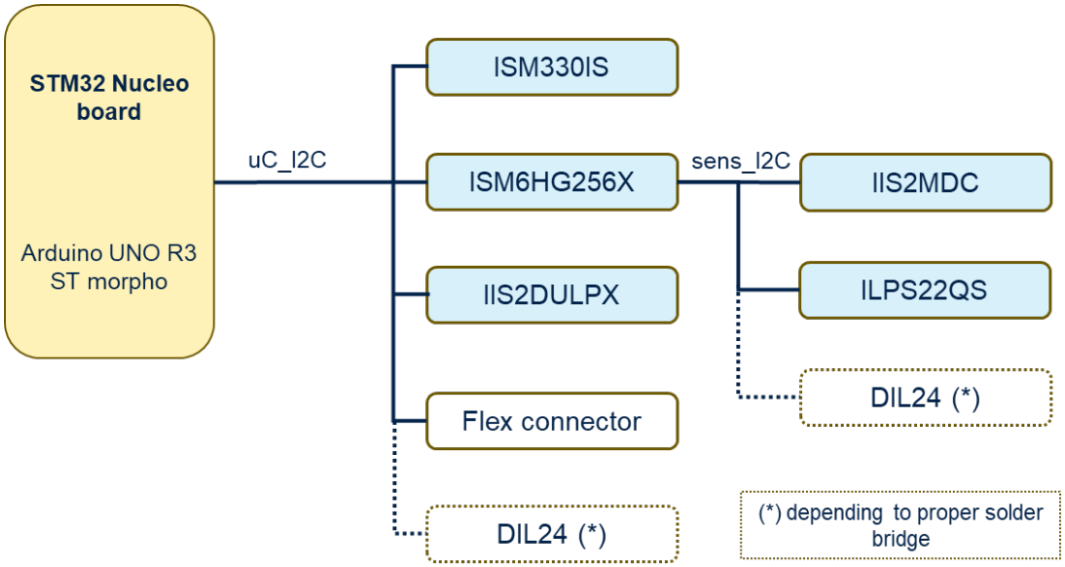


3.2.3 Mode 3: ISM6HG256X I²C sensor hub

In this sensor hub I²C mode, it is possible to power up the 6-axes IMU functionalities by collecting external data through a direct control of the on-board environmental sensors (magnetometer, sensor) and external sensor (DIL24) through the auxiliary I²C bus “SENS_I²C”. ISM330IS and IIS2DULPX remain connected to the main bus “uC_I²C” coming from the external boards. The main configuration is:

- J4: 5 - 6 (HUB_SCx = SENS_SCL).
- J5: 5 - 6 (HUB_SDx = SENS_SDA).

Figure 7. X-NUCLEO-IKS5A1 - ISM6HG256X I²C sensor hub



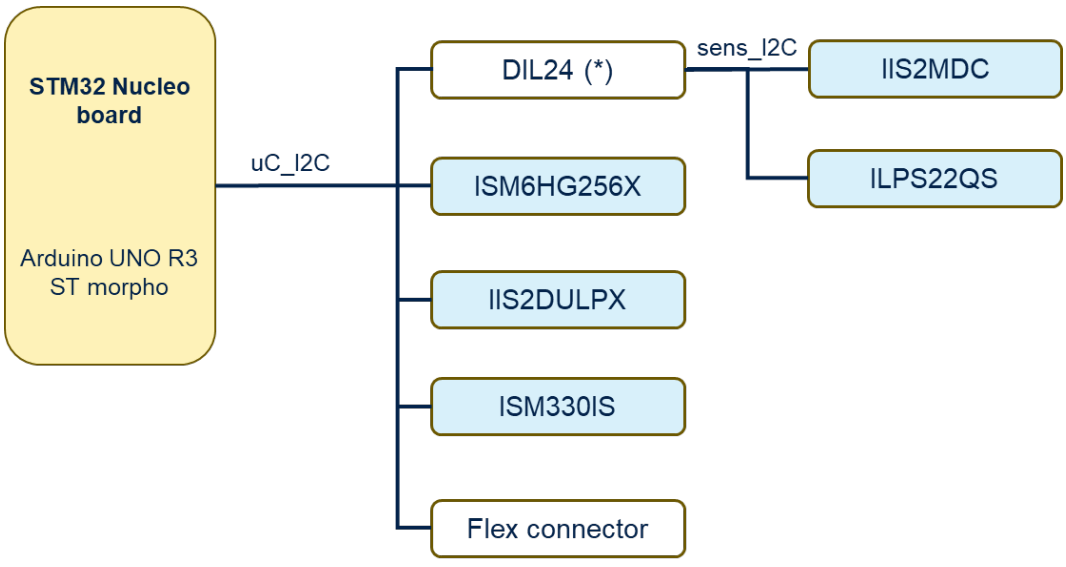
3.2.4 Mode 4: DIL24 I²C sensor hub (all sensors)

In this case, a sensor with embedded sensor hub functionality is mounted to the X-NUCLEO-IKS5A1 through the DIL24 adapter to exploit this functionality, as for ISM330IS and ISM6HG256X.

The board configuration is:

- J4: 7 - 8 (DIL_SCx = SENS_SCL).
- J5: 7 - 8 (DIL_SDx = SENS_SDA).

Figure 8. X-NUCLEO-IKS5A1 - DIL24 I²C sensor hub



3.2.5 Mode 5: DIL24 SPI communication

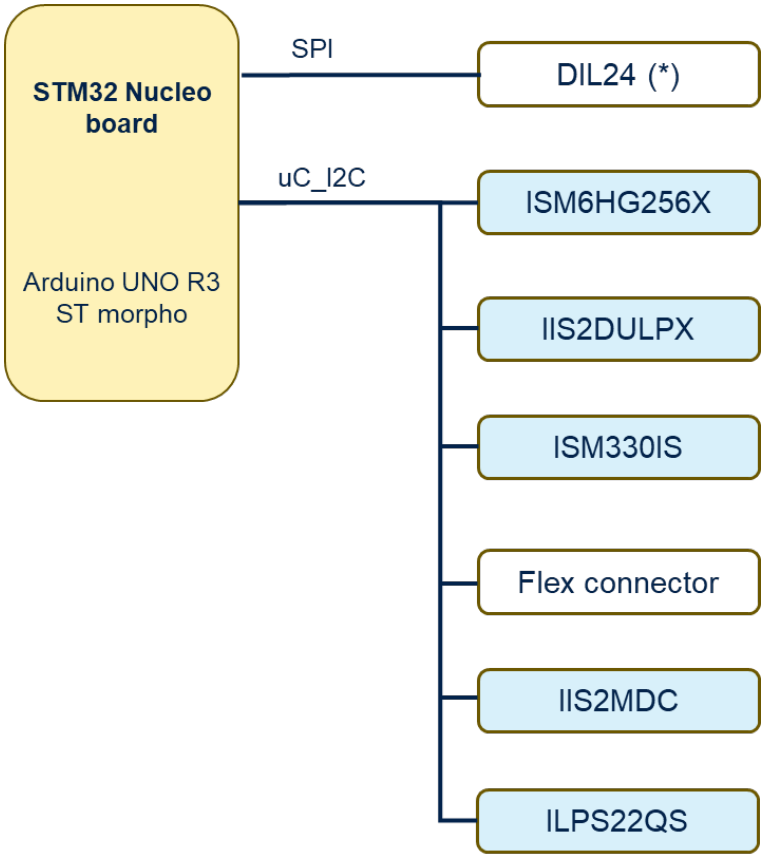
In X-NUCLEO-IKS5A1, there is the possibility to use SPI instead of I²C using the DIL24 adapter. In this configuration, all lines bypass the level shifter. For this reason, the signal must be 3.3 V instead of 1.8 V (default).

The main configuration is:

- Close jumper JP7 to select 3.3 V instead of 1.8 V.
- Desolder SB39 and solder SB38 to select VDDIO as VDD.
- Close JP6, JP8, JP9, and JP10 to 2-3 to select SPI communication.
- Remove SB40 and SB4 and solder SB42 and SB43 (INT1 and INT2).

Note: Selecting JP7 to 3.3 V and VDDIOI = VD, all signals coming from DIL24 go at 3.3 V instead of 1.8 V. Verify that DIL24_SDx and DIL24_SCx are not connected with other I²C (J4 and J5).

Figure 9. X-NUCLEO-IKS5A1 - DIL24 with SPI communication



3.3 Sensor I²C address selection

Most sensors allow I²C address LSB selection by pulling the SA0 pin to low or high. The board has solder bridges to control SA0 level.

Table 3. Shunts for I²C address

Sensor	SA0 low	SA0 high
IIS2DULPX (U5)	SB21 ADDR: 0x30	SB22 ADDR: 0x32 (default)
ISM6HG256X (U4)	SB20 ADDR: 0xD4 (default)	SB19 ADDR: 0xD6
ILPS22QS (U6)	ADDR 0xB8	Selection not available
IIS2MDC (U7)	ADDR 0x3C	Selection not available
ISM330IS (U8)	SB27 ADDR 0xD4	SB26 ADDR 0xD6 (default)

3.4 Sensor current consumption measurement and disconnection

Power consumption: the X-NUCLEO-IKS5A1 expansion board is equipped with jumpers that allow separate current consumption measurements for each sensor.

To measure current consumption, connect an amperemeter instead of a proper shunt.

To disconnect a sensor, you should disconnect the I^2C bus, as well as the power supply.

The shunts for VDD, SDA, and SCL are shown in Figure 10.

To disconnect IISMDC, desoldering SDA (SB25) and SCL (SB24) solder bridges is mandatory.

Figure 10. Shunts on VDD and I^2C signals

3.5 Adapter board for DIL24 socket

An additional sensor can be connected as an adapter board to the J6 DIL24 socket.

As there are a few different interrupt signal assignments for the DIL24 pins, the appropriate pin can be selected using the J2 header.

3.6 Connectors

Table 4. Arduino® R3 UNO default connectors

Connector	Pin (*)	Signal
CN5	7	GND
	9	I^2C SDA
	10	I^2C SCL
CN6	2	3.3 V
	4	3.3 V
	5	5 V
	6	GND
	7	GND
CN8	3	IIS2MDC DRDY
	4	IIS2DULPX INT1
	5	DIL24 INT2
	6	ISM330IS INT1
CN9	3	User interrupt
	4	SPI CLK
	5	ISM6HG256X INT2
	6	ISM6HG256X INT1
	7	DIL24 INT1
	8	ISM330IS INT2

4 Schematic diagrams

Figure 11. **X-NUCLEO-IKS5A1 circuit schematic (1 of 4)**

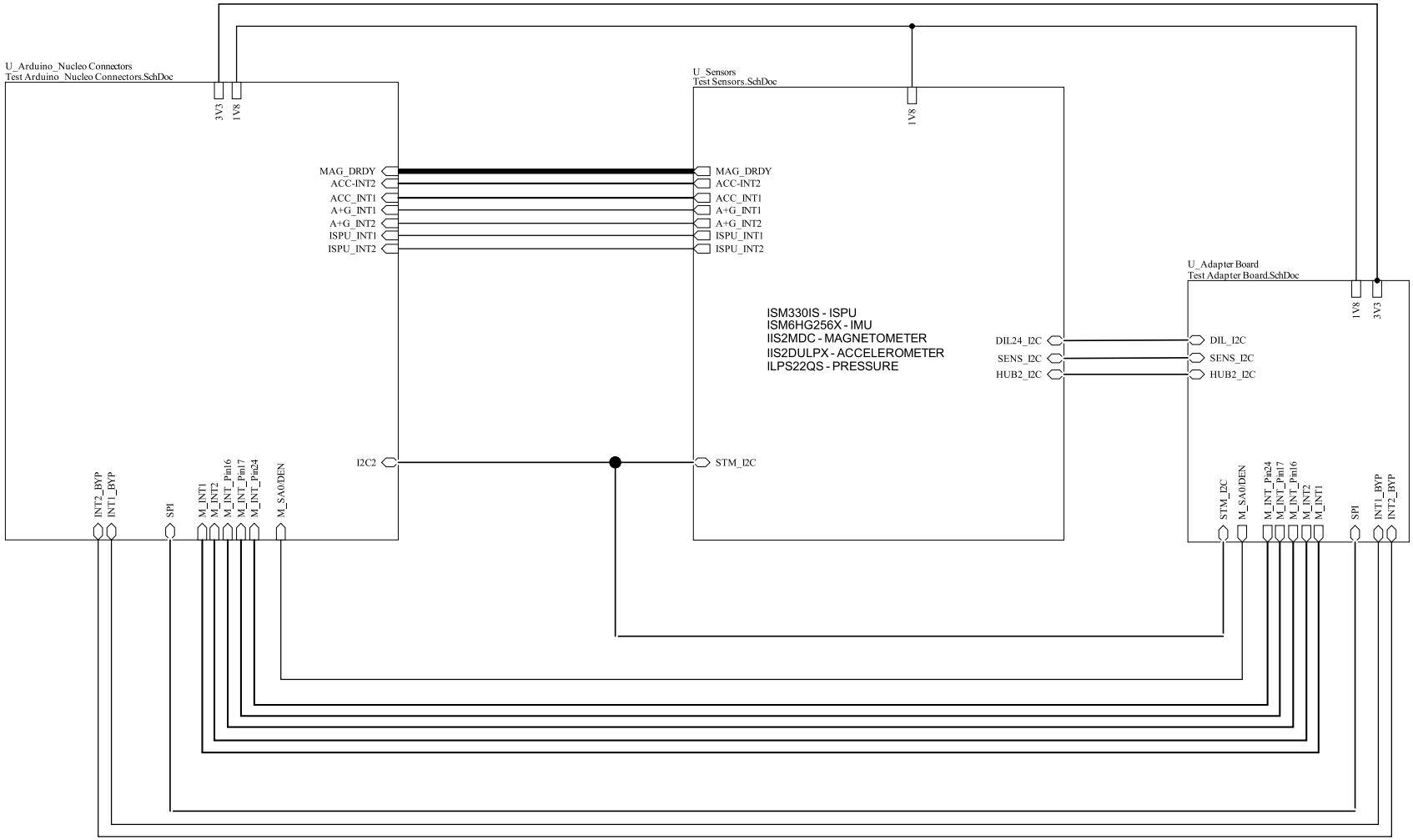


Figure 12. X-NUCLEO-IKS5A1 circuit schematic (2 of 4)

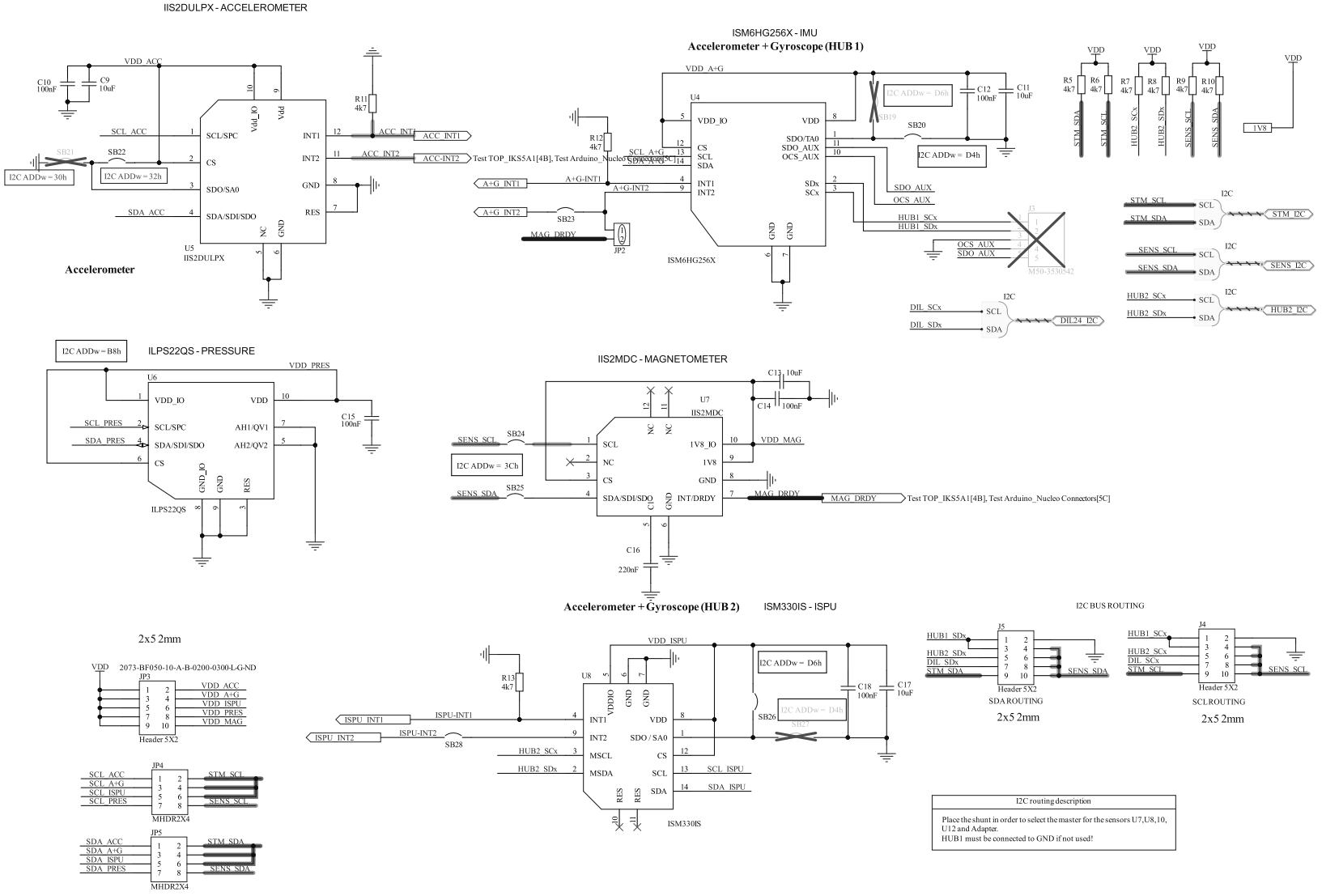


Figure 13. X-NUCLEO-IKS5A1 circuit schematic (3 of 4)

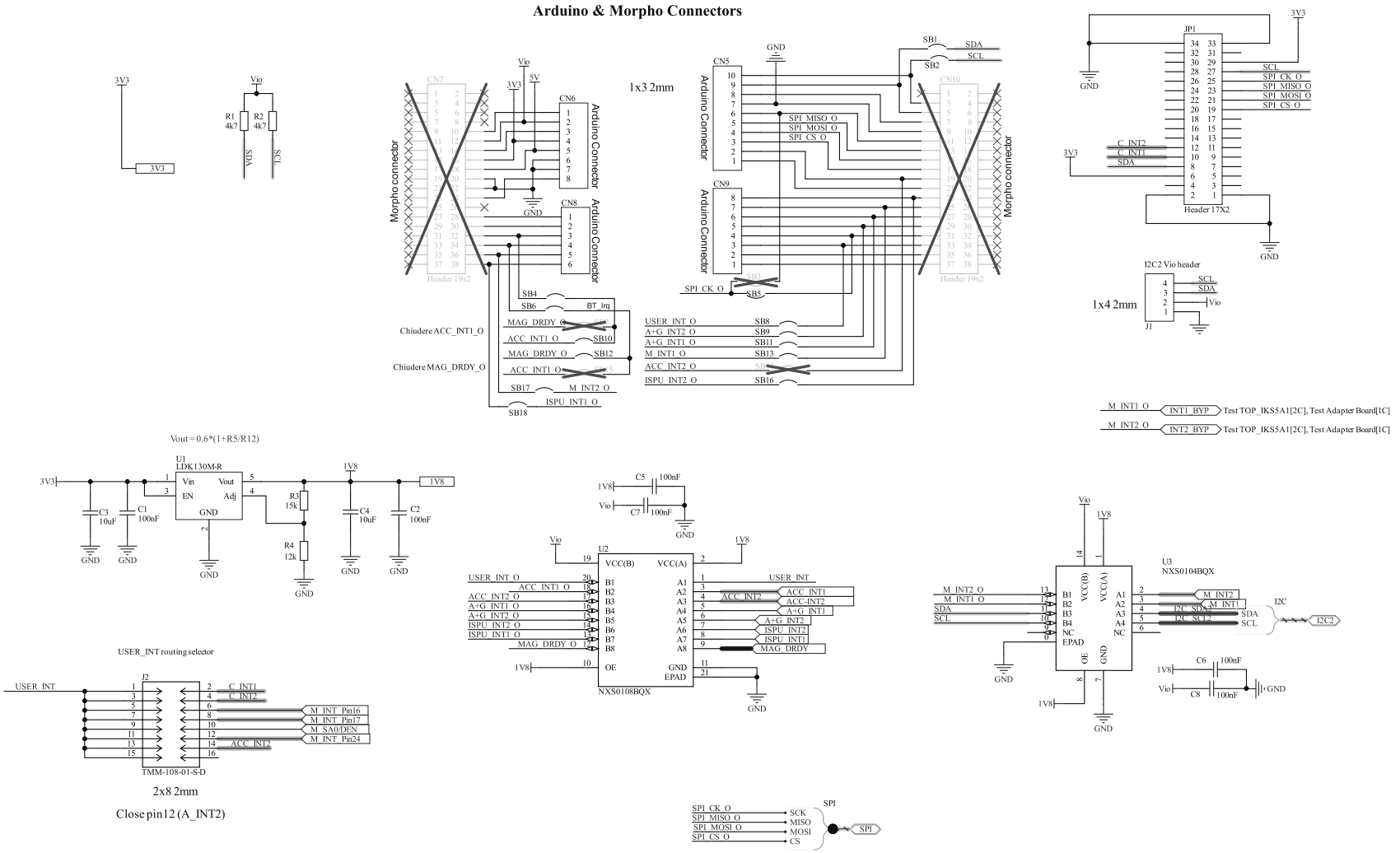
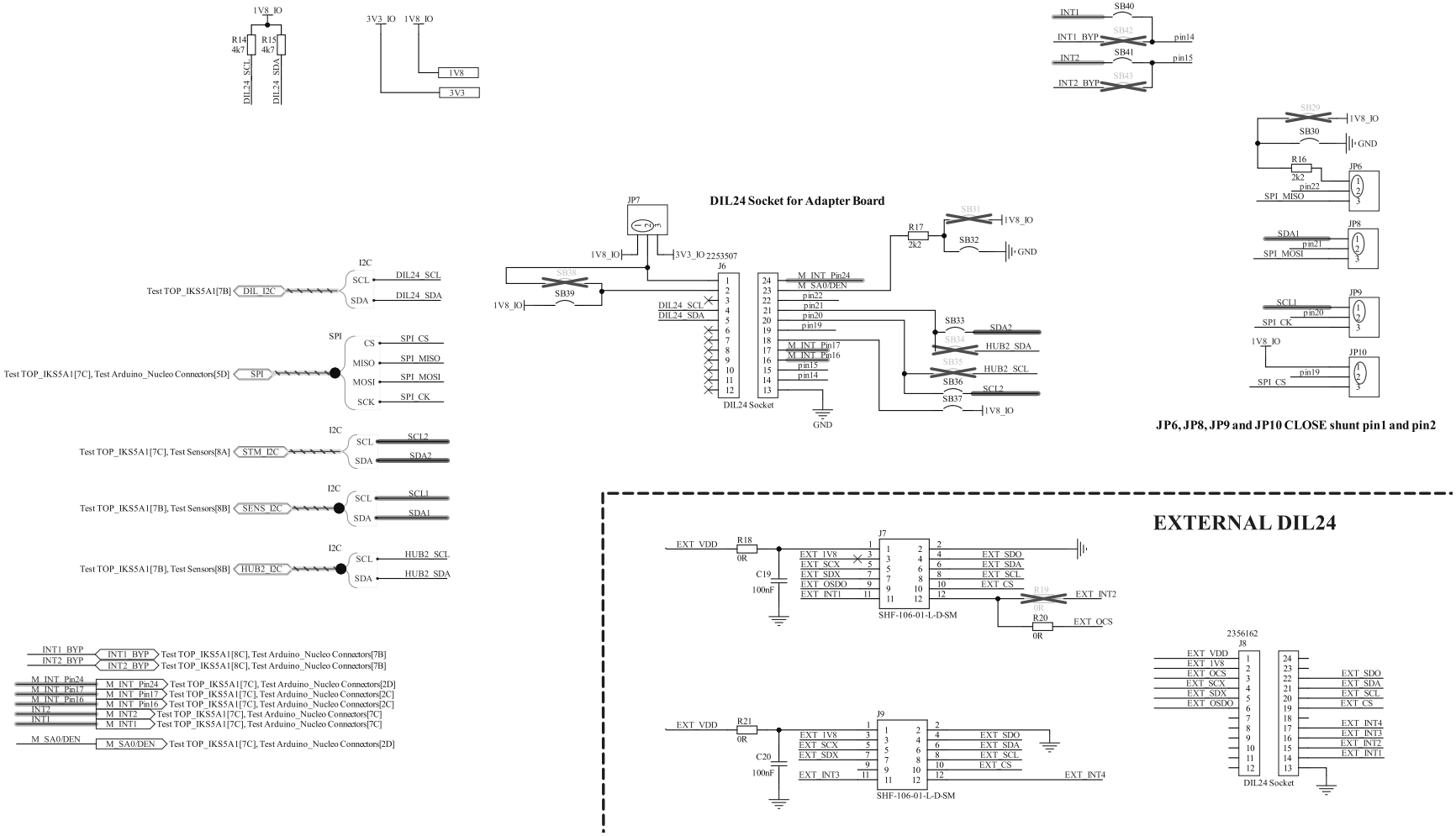


Figure 14. X-NUCLEO-IKS5A1 circuit schematic (4 of 4)



5 Bill of materials

Table 5. **X-NUCLEO-IKS5A1 bill of materials**

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	13	C1, C2, C5, C6, C7, C8, C10, C12, C14, C15, C18, C19, C20	100nF		Yageo	CC0603KRX7R9BB104
2	6	C3, C4, C9, C11, C13, C17	10uF	Capacitor 10uF 0603	Kyocera AVX	0603ZD106KAT2A
3	1	C16	220nF		KEMET	C0603C224K3RACTU
4	1	CN5	Header 10x1		Samtec	ESQ-110-24-T-S
5	2	CN6, CN9	Header 8x1		Samtec	ESQ-108-24-T-S
6	1	CN8	Header 6x1		Samtec	ESQ-106-24-T-S
7	1	J1		Header 4x1	Adam Equipment	2PH1-04-UA
8	1	J2		No Description Available	Samtec	TMM-108-01-S-D
9	3	J4, J5, JP3		Header, 5-Pin, Dual row	Adam Equipment	2PH2-10-UA
10	1	J6	DIL24 Socket		Wurth Electronics	61301211121
11	1	J8	Female connector		E-Tec	BL1-036-G-700-01
12	2	J7, J9		CONN HEADER VERT 12POS 1.27MM	Adam Equipment	HPH2-A-12-UA
13	1	JP1		Header, 17-Pin, Dual row	Panasonic	AXF5G3412A
14	1	JP2	Header 2x1	Jumper + Shunt	Wurth Electronics	62000211121
15	2	JP4, JP5		Header, 4-Pin, Dual row	Adam Equipment	2PH2-08-UA
16	5	JP6, JP7, JP8, JP9, JP10	Header	Header, 3-Pin, shunt	Adam Equipment	2PH1-03-UA
17	13	R1, R2, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15	4k7		Yageo	RC0603FR-074K7L
18	1	R3	15k		Multicomp	MC0063W0603515K
19	1	R4	12k		Multicomp	MC0063W0603512K
20	2	R16, R17	2k2		Vishay	CRCW06032K20FKEA
21	3	R18, R20, R21	0R	RESISTOR, 0R0, 62.5mW, 1%, 0603	Yageo	AC0603FR-070RL

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
22	27	SB1, SB2, SB4, SB5, SB6, SB8, SB9, SB10, SB11, SB12, SB13, SB16, SB17, SB18, SB22, SB23, SB24, SB25, SB28, SB30, SB32, SB33, SB36, SB37, SB39, SB40, SB41	Solder Bridge		Yageo	AC0603FR-070RL
23	1	SB20	Solder Bridge		Yageo	AC0603FR-070RL
24	1	SB26	Solder Bridge		Yageo	AC0603FR-070RL
25	1	U1	LDK130M-R, SOT23-5L	ULTRA LOW DROP LOW NOISE BICMOS VOLTAGE REGULATOR 1.8V	ST	LDK130M-R
26	1	U2	NXS0108BQX	Level Shift	Nexperia	NXS0108BQX
27	1	U3	NXS0104BQX		Nexperia	NXS0104BQX
28	1	U4	ISM6HG256X	No Description Available	ST	ISM6HG256XTR
29	1	U5	IIS2DULPX, LGA 12L 2.0x2.0x0.74 mm	2.0x2.0x0.7 12L	ST	IIS2DULPXTR
30	1	U6	ILPS22QS, HLGA 2X2X.8 10L EXP. SILIC .91SQ	No Description Available	ST	ILPS22QSTR
31	1	U7	IIS2MDC, LGA2X2X0.7 12 LEADS		ST	IIS2MDCTR
32	1	U8	ISM330IS, LGA 14L 2.5x3x0.86 mm	2.5x3.0x0.83 14L	ST	ISM330ISTR
33	21	JP3, JP4, JP5, JP6, JP8, JP9, JP10,J4,J5	2 MM SHUNT		Multicomp	MC-2205BG

6 Board versions

Table 6. **X-NUCLEO-IKS5A1 versions**

Finished good	Schematic diagrams	Bill of materials
X$NUCLEO-IKS5A1 (1)	X$NUCLEO-IKS5A1 schematic diagrams	X$NUCLEO-IKS5A1 bill of materials

1. *This code identifies the X-NUCLEO-IKS5A1 evaluation board first version.*

7 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

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 (2) Software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

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Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2011/65/EU (RoHS II), including subsequent revisions and additions, as well as amended by the Delegated Directive 2015/863/EU (RoHS III).

Notice for the United Kingdom

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2011/65/EU (RoHS II), including subsequent revisions and additions, as well as amended by the Delegated Directive 2015/863/EU (RoHS III).

Revision history

Table 7. **Document revision history**

Date	Revision	Changes
25-Aug-2025	1	Initial release.

Contents

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