UM2121
User manual

Getting started with the X-NUCLEO-IKS01A2 motion MEMS and environmental sensor expansion board for STM32 Nucleo

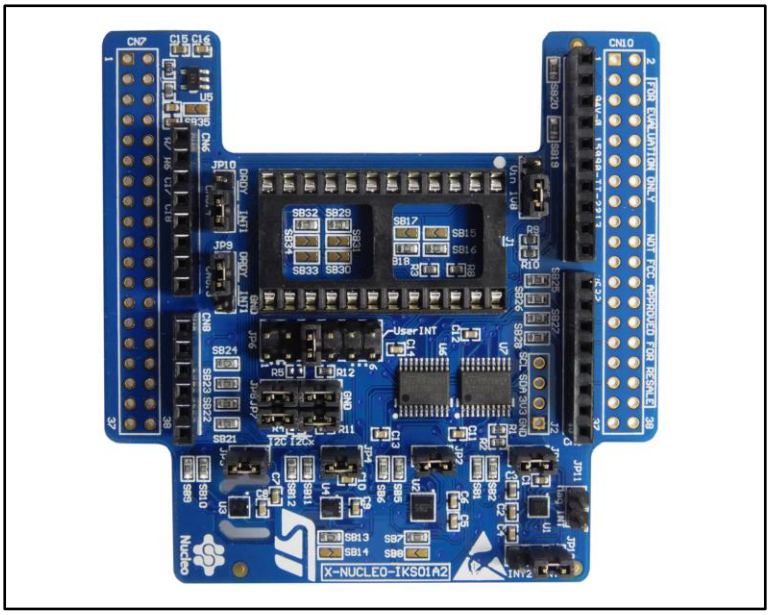
Introduction

The X-NUCLEO-IKS01A2 is a motion MEMS and environmental sensor expansion board for the STM32 Nucleo.

It is equipped with Arduino UNO R3 connector layout, and is designed around the LSM6DSL 3D accelerometer and 3D gyroscope, the LSM303AGR 3D accelerometer and 3D magnetometer, the HTS221 humidity and temperature sensor and the LPS22HB pressure sensor.

The X-NUCLEO-IKS01A2 interfaces with the STM32 microcontroller via the I²C pin, and it is possible to change the default I²C port.

Figure 1: X-NUCLEO-IKS01A2 expansion board



Contents

List of tables

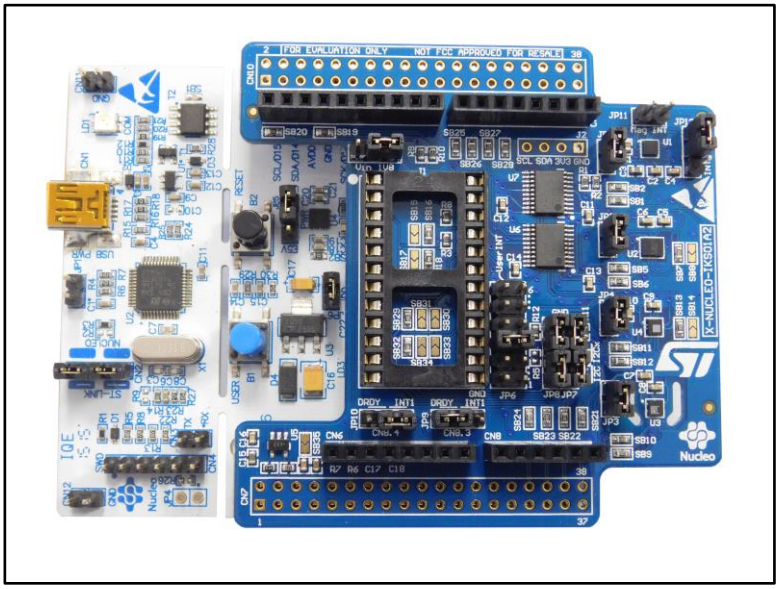
List of figures

1 Getting started

1.1 Hardware requirements

The X-NUCLEO-IKS01A2 is designed to be used with STM32 Nucleo boards (visit *www.st.com* for further information).

Figure 2: X-NUCLEO-IKS01A2 plugged on an STM32 Nucleo board



The X-NUCLEO-IKS01A2 must be plugged on the matching pins of the STM32 Nucleo board connector.

The interconnection between the STM32 Nucleo and the X-NUCLEO-IKS01A2 allows the use of any STM32 Nucleo board equipped with an Arduino UNO R3 connector.

X-NUCLEO-IKS01A2 components are ESD sensitive. Since 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:

- a Windows® (7, 8) PC
- a USB type A to mini-B USB cable to connect the STM32 Nucleo to the PC
- board firmware and software package (X-CUBE-MEMS1) installed on the user PC

The X-CUBE-MEMS1 firmware and related documentation is available on www.st.com.

3 Hardware description

The board allows functionality testing of the motion MEMS accelerometer, gyroscope, magnetometer and environmental sensors for humidity, temperature and pressure through I²C communication bus.

It also allows all the LSM6DSL sensor hub function testing.

The board features:

- LSM6DSL MEMS 3D accelerometer (±2/±4/±8/±16 g) and 3D gyroscope (±125/±245/±500/±1000/±2000 dps)
- LSM303AGR MEMS 3D accelerometer (±2/±4/±8/±16 g) and MEMS3D magnetometer (±50 gauss)
- LPS22HB MEMS pressure sensor, 260-1260 hPa absolute digital output barometer
- HTS221: capacitive digital relative humidity and temperature
- DIL24 socket for additional MEMS adapters and other sensors
- Free comprehensive development firmware library and example for all sensors compatible with STM32Cube firmware
- I²C sensor hub features on LSM6DSL available
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- RoHS compliant

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

The expansion board is power supply compatible with STM32 Nucleo boards.

It contains a LDO to generate 1.8 V. All MEMS sensors use a 1.8 V domain.

All signals between the sensors and the main board are translated by a level shifter.

3.1 Default solder bridge configuration

On the expansion board there are some solder bridges, which can be opened (not mounted) or closed (mounted) to have the different hardware configurations.

The following table shows the X-NUCLEO-IKS01A2 default solder bridge configuration.

Table 1: Solder bridge default configuration (device to I²C bus connection)

Device	I²C bus	Solder bridge (default)	Solder bridge (not mounted)
LSM303AGR	I²C1	SB1, SB2	
LSM6DSL	I²C2	SB5, SB6	
HT221	I²C1	SB9, SB10	
LPS22HB	I²C1	SB11, SB12	
STM32 Nucleo	I²C2	SB19, SB20	
DIL24 adapter	I²C1	SB29, SB32	SB30, SB31, SB33, SB34
DIL24 adapter(1)	I²C2	SB31, SB34	SB29, SB30, SB32, SB33
DIL24 adapter(1)	I²Cx	SB30, SB33	SB30, SB31, SB33, SB34

Notes:

(1)not mounted by default

Table 2: Device I²C address

Device	Solder bridge	I²C address default
LSM303AGR	--	Acc= 32h Mag= 3Ch
LSM6DSL	SB7	D6h
LSM6DSL	SB8(1)	D4h(1)
LPS22HB	SB13	BAh
LPS22HB	SB14(1)	B8h(1)
HTS221	--	BEh

Notes:

(1)not mounted by default

Other default SBs are: SB21 to SB28 (STM32 Nucleo GPIO INT), SB16, SB18.
Other not mounted by default SBs are: SB15, SB17, SB35

3.2 Board block diagram

The LSM6DSL has an I²C sensor hub through which it can be an I²C master of other devices (slaves) connected to an I²Caux bus.

The following paragraphs shows X-NUCLEO-IKS01A2 expansion board block diagram in five different I²C bus connection (with or without the LSM6DSL sensor hub).

Mode 1: standard I²C bus connection (all sensors)

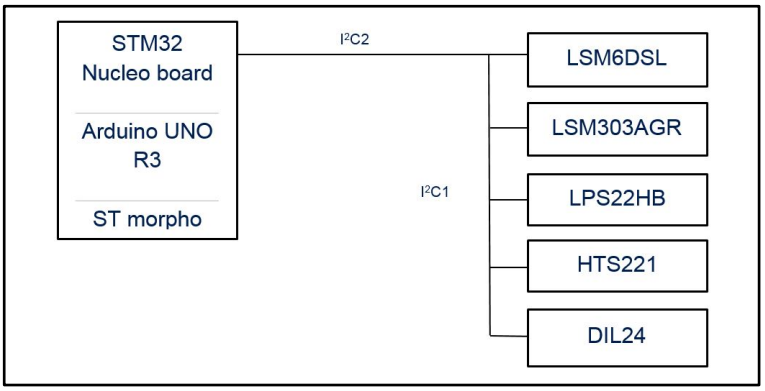
In standard I²C mode, all devices are connected to an external main board via the same I²C bus.

The board configuration is:

JP7: 1-2 3-4 (I²C1 = I²C2, I²Cx=GND)

JP8: 1-2 3-4 (I²C1 = I²C2, I²Cx=GND)

Figure 3: X-NUCLEO-IKS01A2 standard I²C



Mode 2: LSM6DSL I²C sensor hub (all sensors)

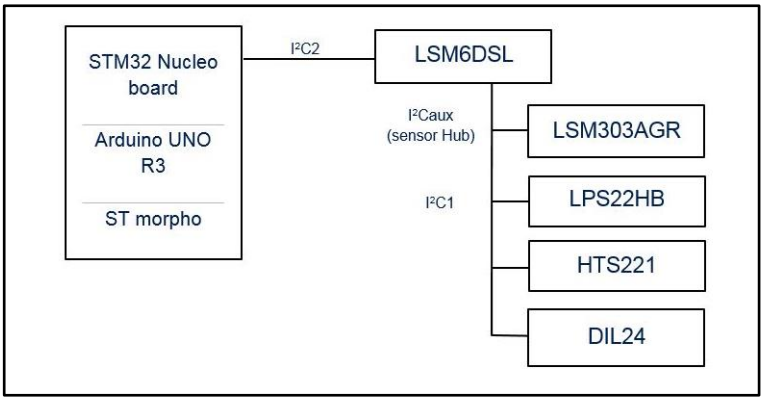
In sensor hub I²C mode, the LSM6DSL is connected to an external main board by an I²C bus; all other devices are slaves connected to LSM6DSL via I²Caux.

The board configuration is:

JP7: 2-3 (I²C1 = I²Cx)

JP8: 2-3 (I²C1 = I²Cx)

Figure 4: X-NUCLEO-IKS01A2 LSM6DSL I²C sensor hub



Mode 3: DIL24 plus LSM6DSL I²C sensor hub (all sensors)

In sensor hub I²C mode, the LSM6DSL and the DIL24 adapter are connected to an external main board by an I²C bus; all other devices are slaves of the LSM6DSL via I²Caux.

The board configuration is:

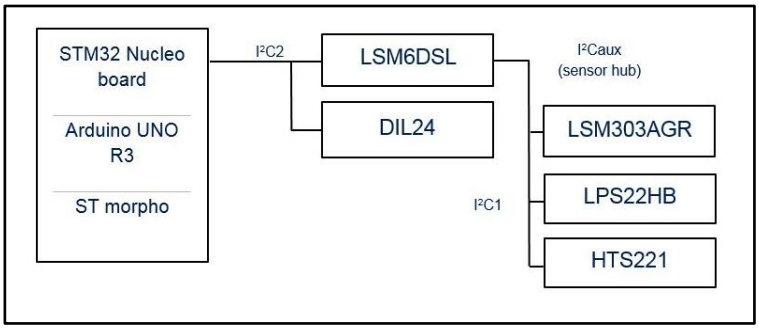
JP7: 2-3 (I²C1 = I²Cx)

JP8: 2-3 (I²C1 = I²Cx)

DIL24 adapter (to I²C2): SB31, SB34

Not mounted: SB29, SB30, SB32 and SB33.

Figure 5: X-NUCLEO-IKS01A2 DIL24, LSM6DSL I²C sensor hub (all sensors)



Mode 4: LSM6DSL plus DIL24 I²C sensor hub (all sensors)

In sensor hub I²C mode, the LSM6DSL and the DIL24 adapter are connected to an external main board by an I²C bus; all other devices are slaves of the DIL24 adapter via I²Caux.

The board configuration is:

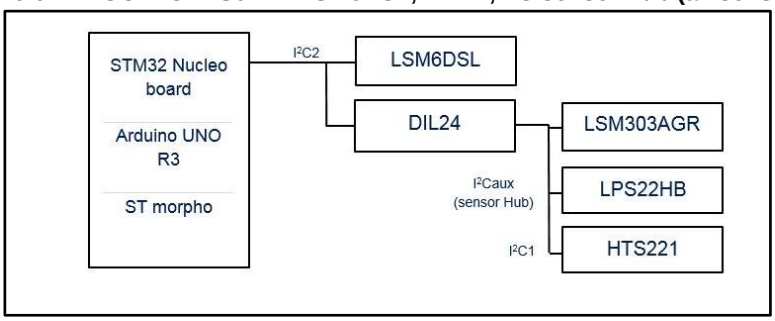
JP7: 2-3 (I²C1 = I²Cx)

JP8: 2-3 (I²C1 = I²Cx)

DIL24 adapter (to I²C2): SB31, SB34

Not mounted: SB29, SB30, SB32 and SB33.

Figure 6: X-NUCLEO-IKS01A2 LSM6DSL, DIL24, I²C sensor hub (all sensors)



Mode 5: LSM6DSL plus I²C sensor hub DIL24

In sensor hub I²C mode, the LSM6DSL and other sensors are connected to an external main board via an I²C bus; the DIL24 adapter is a slave of the LSM6DSL via I²Caux.

The board configuration is:

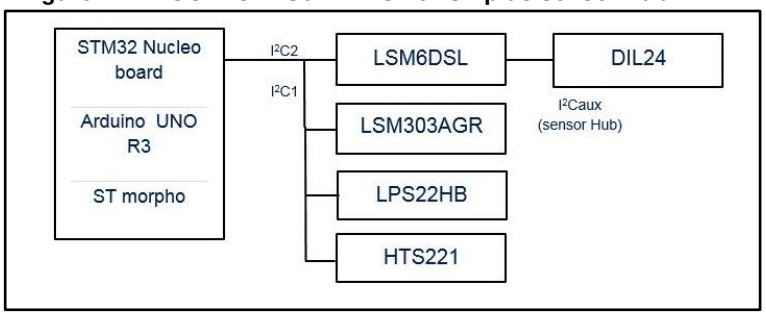
JP7: 1-2 (I²C1 = I²Cx)

JP8: 1-2 (I²C1 = I²Cx)

DIL24 adapter (to I²Cx): SB30, SB33

Not mounted: SB29, SB31, SB32 and SB34.

Figure 7: X-NUCLEO-IKS01A2 LSM6DSL plus sensor hub DIL24



3.3 Sensor I²C address selection

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

Table 3: Solder bridges for SDO level control and I²C address

Sensor	SDO high	SDO low
LSM303AGR (U1)	Mag = 3Ch Acc = 38h	
LSM6DSL (U2)	SB7 ADD = D6h	SB8 ADD = D4h
LPS22HB (U4)	SB13 AD = BAh	SB14 ADD = B8h
HTS221 (U3)	ADD = BEh	
DIL24 adapter (J1)	SB15/SB17	SB16/SB18

3.4 Sensor current consumption measurement

The X-NUCLEO-IKS01A2 expansion board is equipped with jumpers which allow separate current consumption measurement of each sensor.

To measure current consumption, connect an ammeter to the appropriate jumper.

As the sensors have very low current consumption, you should set a suitable range and use an ammeter with low burden voltage.

Table 4: Jumpers for current consumption measurement

Sensor	Jumper
LSM303AGR (U1)	JP1
LSM6DSL (U2)	JP2
HTS221 (U3)	JP3
LPS22HB (U4)	JP4
DIL24 Adapter (J1)	JP5

3.5 Sensor disconnection

To disconnect a sensor, you should disconnect the I²C bus as well as the power supply. See the table below for the relevant jumpers and solder bridges.

Table 5: Link between sensors, jumpers and I²C solder bridges

Sensor	Power	SDA	SCL
LSM303AGR (U1)	JP1	SB2	SB1
LSM6DSL (U2)	JP2	SB6	SB5
HTS221 (U3)	JP3	SB9	SB10
LPS22HB (U4)	JP4	SB12	SB11
DIL24 adapter	JP5	SB29,30,31	SB32,33,34

3.6 Adapter board for DIL24 socket

An additional sensor can be connected as an adapter board to J1 DIL24 socket.

Please visit *www.st.com* to find other available sensors.

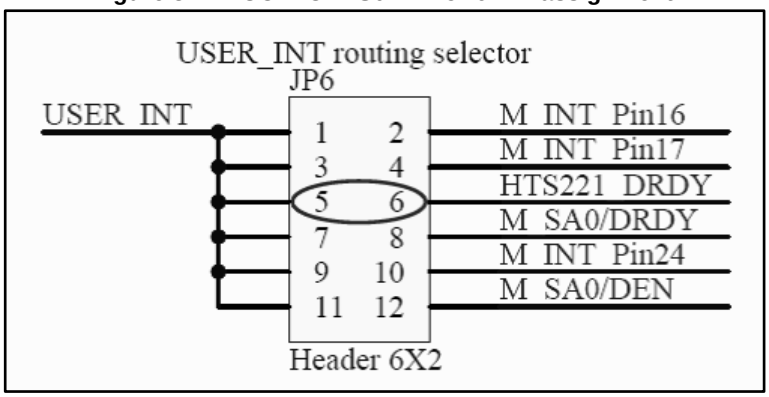
As there are a few different interrupt signal assignments for DIL24 pins, the appropriate pin can be selected using the JP6 header.

3.7 Interrupt assignment

There are a few different interrupt assignments between the external main board and the devices on the expansion board.

Through JP6 jumper it is possible to select some interrupt signals of the DIL24 adapter and HTS221_DRDY to USER_INT signal (CN 9.3 of the external main board) as shown in the following figure.

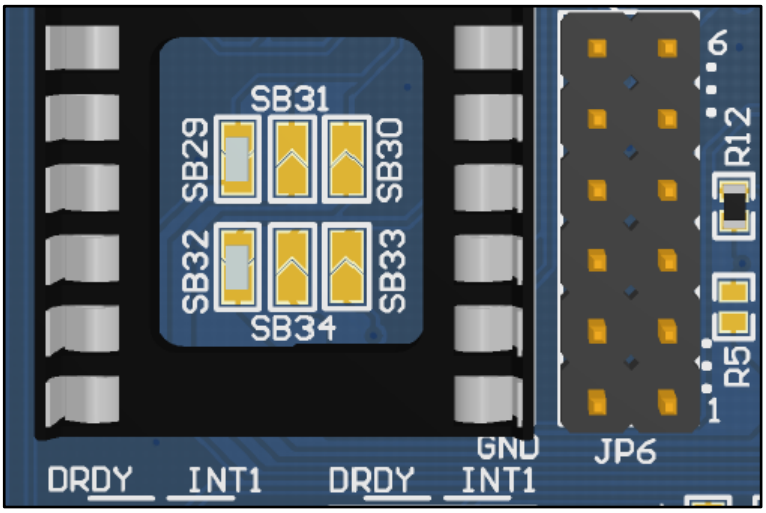
Figure 8: X-NUCLEO-IKS01A2: JP6 INT assignment



The default configuration is on the HTS221 data ready signal.

It is possible to connect only one INT signal to USER_INT through JP6.

Figure 9: X-NUCLEO-IKS01A2: JP6 zoom



The JP9 and JP10 jumpers (see *Figure 10: "X-NUCLEO-IKS01A2: JP9/JP10 INT assignment"*) can be used to switch the assignment of LSM303AGR_INT and LSM303AGR_DRDY to CN8.3 and CN8.4 (see *Figure 11: "X-NUCLEO-IKS01A2: JP9/JP10 zoom"*). This feature avoids hardware conflicts in other expansion boards.

Figure 10: X-NUCLEO-IKS01A2: JP9/JP10 INT assignment

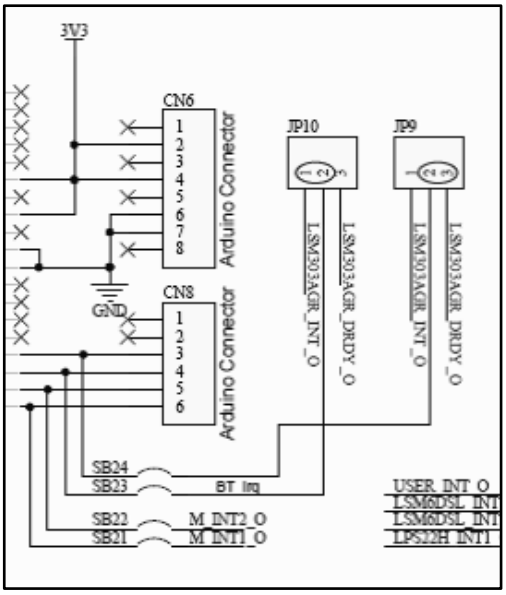
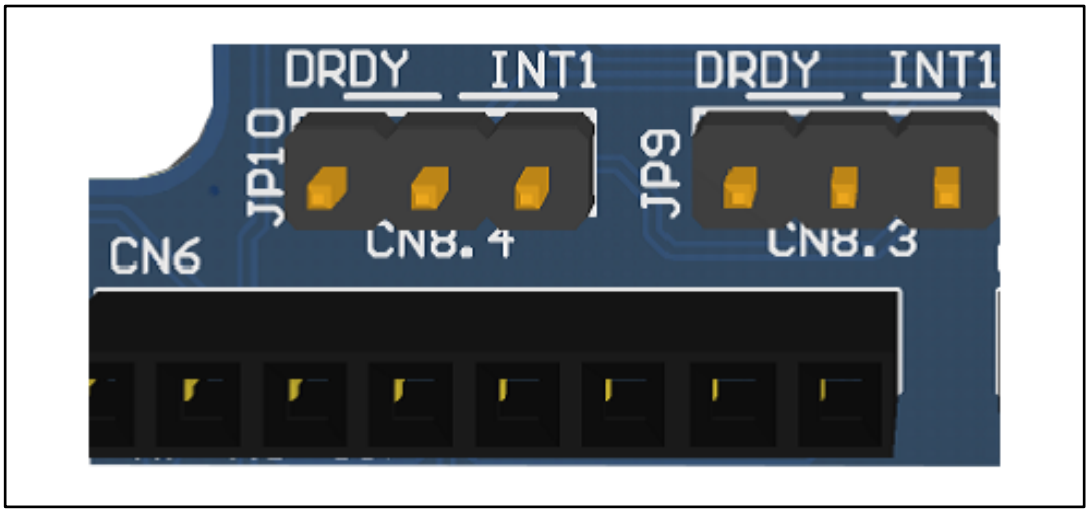


Figure 11: X-NUCLEO-IKS01A2: JP9/JP10 zoom



3.8 Connectors

Table 6: X-NUCLEO-IKS01A2

Connector	Pin(1)	Signal
CN5	7	GND
	9	I²C SDA
	10	I²C SCL
CN6	2	3.3 V
	4	3.3 V
	6	GND
	7	GND

Connector	Pin(1)	Signal
	8	not connected
CN8	3	LSM303AGR INT / DRDY
	4	LSM303AGR INT / DRDY
	5	INT2 (DIL24)
	6	INT1 (DIL24)
CN9	3	USER INT
	5	LSM6DSL INT1
	6	LSM6DSL INT2
	7	LPS22H INT1

Notes:

(1)Unlisted pins are not connected.

Table 7: ST morpho connectors

Connector	Pin(1)	Signal
CN7	12	3.3 V
	16	3.3 V
	20	GND
	22	GND
	32	LSM303AGR INT / DRDY
	34	LSM303AGR INT / DRDY
	36	INT2 (DIL24)
	38	INT2 (DIL24)
CN10	3	I²C SCL
	5	I²C SDA
	25	LPS22HB INT1
	27	LSM6DSL INT2
	29	LSM6DSL INT1
	33	USER INT

Notes:

(1)Unlisted pins are not connected.

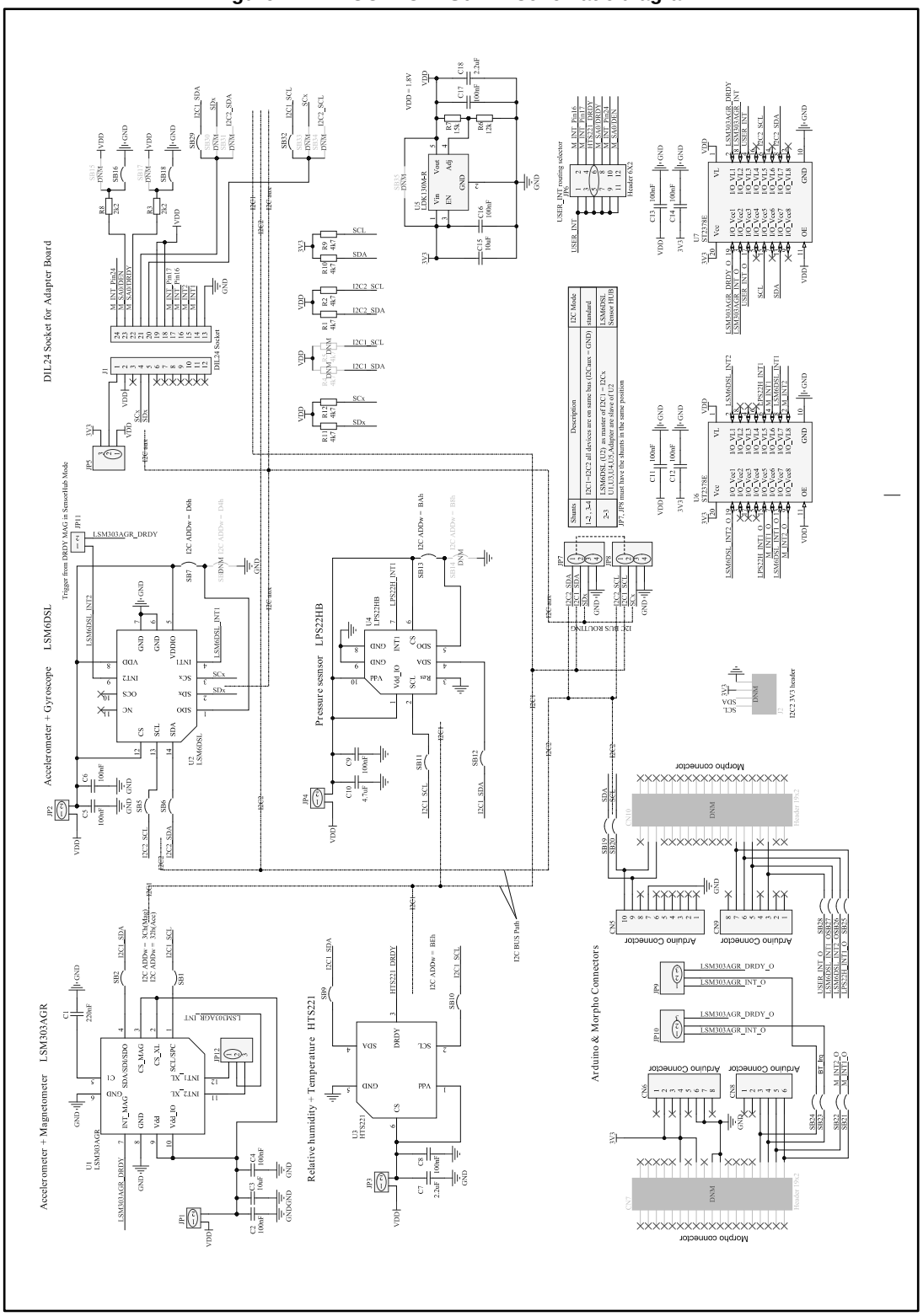
4 Schematic diagram and bill of materials

Table 8: X-NUCLEO-IKS01A2 bill of materials

Item	Quantity	Reference	Part / Value	Description	Manufacturer	Part Number
1	1	C1	220 nF	CAP CER 0603 220 nF 25 V X7R 10%	KEMET	C0603X224K4RACTU
2	12	C2, C4, C5, C6, C8, C9, C11, C12, C13, C14, C16, C17	100 nF	CAP CER 0603 100 nF 25 V X7R 10%	MULTICOMP	MC0603B104K250CT
3	2	C3, C15	10 µF	CAP CER 0603 10 µF 6.3 V X5R 20%	MULTICOMP	MC0603X106M6R3CT
4	2	C7, C18	2.2 µF	CAP CER 0603 2.2 µF 25 V X5R 10%	MULTICOMP	MC0603X225K100CT
5	1	C10	4.7 µF	CAP CER 0805 4.7µF 16 V X7R 10%	TDK	C2012X7R1C475K125AB
6	1	CN5	Header 10x1	Extra-long 10 pins female-male strip		
7	2	CN6, CN9	Header 8x1	Extra-long 8 pins female-male strip		
8	1	CN8	Header 6x1	Extra-long 6 pins female-male strip		
9	1	J1	DIL24 Socket	DIL24 Socket	MULTICOMP	SPC15503
10	5	JP1, JP2, JP3, JP4, JP11	Header 2x1 + Shunt	Header 1x2 pins, 2.54 mm, straight	HARWIN	M20-9990246
11	3	JP5, JP9, JP10	Header 3x1 + Shunt	Header Male 2.54 mm	Generic Components	2211S-03G
12	1	JP6	Header 6x2 + Shunt	Header Male 2.54 mm	Generic Components	90131-0126
13	2	JP7, JP8	Header 4x1 + 2 Shunts	Header Male 2.54 mm	Generic Components	2211S-04G
14	1	JP12	Header 3x1 + Shunt	Header Male 2.54 mm	Generic Components	2211S-03G
15	6	R1, R2, R9, R10, R11, R12	4k7 Ω	RES 0603 4k7 1% 1/16 W	MULTICOMP	MC0063W060314K7
16	2	R3, R8	2k2 Ω	RES 0603 2k2 1% 1/16 W	MULTICOMP	MC0063W060312K2
17	1	R6	12k Ω	RES 0603 12k 1% 1/16 W	MULTICOMP	MC0063W0603512K

Item	Quantity	Reference	Part / Value	Description	Manufacturer	Part Number
18	1	R7	15k Ω	RES 0603 15W 1% 1/16 W	MULTICOMP	MC0063W0603515K
19	24	SB1, SB2, SB5, SB6, SB7, SB9, SB10, SB11, SB12, SB13, SB16, SB18, SB19, SB20, SB21, SB22, SB23, SB24, SB25, SB26, SB27, SB28, SB29, SB32	Solder bridge	RES 0603 0R 1% 1/16 W		
20	1	U1	LSM303AGR	LSM303AGR	STM	LSM303AGR
21	1	U2	LSM6DSL	LSM6DSL	STM	LSM6DSL
22	1	U3	HTS221	HTS221	STM	HTS221
23	1	U4	LPS22HB	LPS22HB	STM	LPS22HB
24	1	U5	LDK130M-R	LDO adj, 0.3A	STM	LDK130M18R
25	2	U6, U7	ST2378E	ST2378E	STM	ST2378E

Figure 12: X-NUCLEO-IKS01A2 schematic diagram



5 Layout

Figure 13: X-NUCLEO-IKS01A2 top side layout

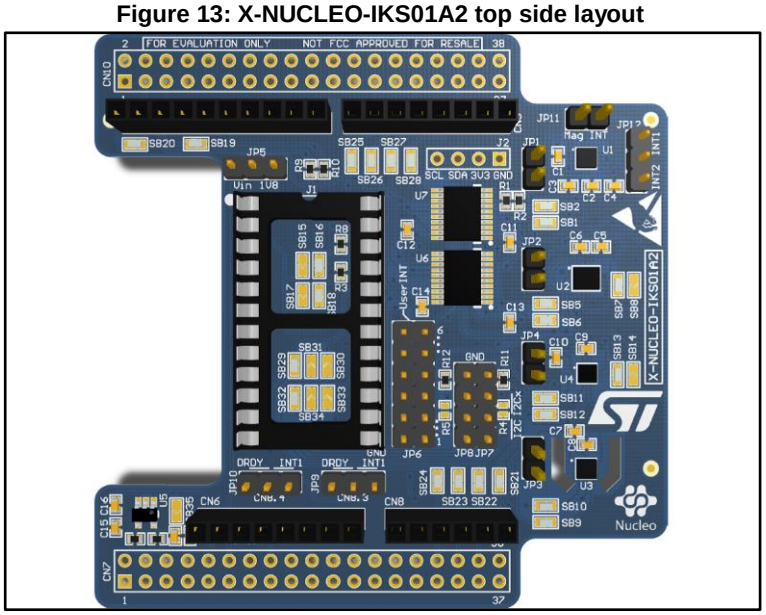
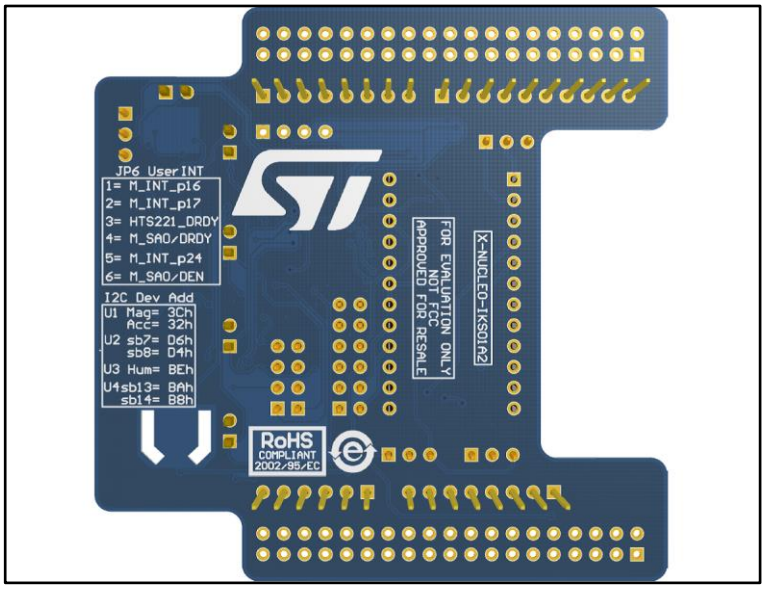


Figure 14: X-NUCLEO-IKS01A2 bottom side layout



6 Revision history

Table 9: Document revision history

Date	Version	Changes
02-Nov-2016	1	Initial release.
12-Jan-2017	2	Minor text changes In *Section 3.2: "Board block diagram"*: - updated Mode 3 board configuration - updated Mode 5 board configuration

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.