Getting started with the X-NUCLEO-IKS02A1 industrial motion MEMS sensor expansion board for STM32 Nucleo

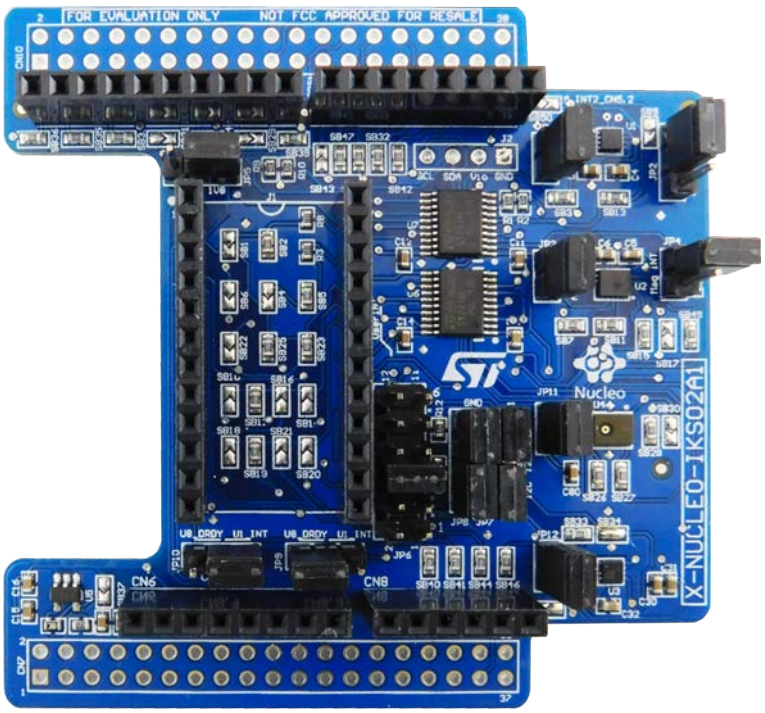
Introduction

The X-NUCLEO-IKS02A1 industrial motion MEMS sensor expansion board is compatible with the Arduino UNO R3 connector layout.

It embeds the ISM330DHCX 3-axis accelerometer and 3-axis gyroscope, the IIS2MDC 3-axis magnetometer, the IIS2DLPC 3-axis accelerometer, the IMP34DT05 digital microphone.

The X-NUCLEO-IKS02A1 interfaces with the STM32 microcontroller via I²C pin, with the possibility of changing the default I²C port.

Figure 1. X-NUCLEO-IKS02A1 expansion board



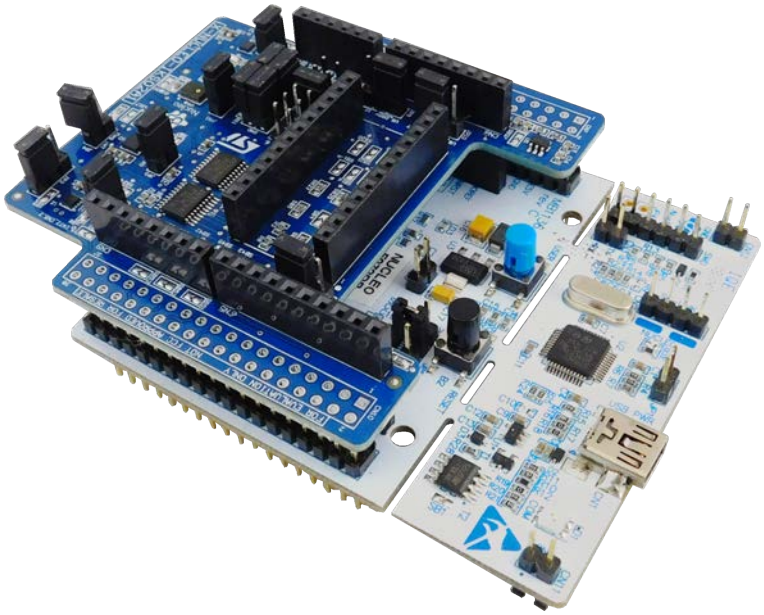
1 Getting started

1.1 Hardware requirements

The X-NUCLEO-IKS02A1 expansion board has been designed to be used with any STM32 Nucleo development board equipped with an Arduino UNO R3 connector.

The expansion board must be plugged on the matching pins of the development board connector.

Figure 2. X-NUCLEO-IKS02A1 plugged on an STM32 Nucleo board



Note: X-NUCLEO-IKS02A1 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.

1.2 System requirements

To complete the system setup, you need:

- Windows (version 7 or above) 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.

2 Hardware description

The X-NUCLEO-IKS02A1 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 ISM330DHCX sensor hub function testing.

The board features:

- ISM330DHCX MEMS 3D accelerometer (±2/±4/±8/±16 g) plus 3D gyroscope (±125/±250/±500/±1000/±2000 dps)
- IIS2MDC MEMS 3D magnetometer (±50 gauss)
- IIS2DLPC MEMS 3D accelerometer low power (±2/±4/±8/±16 g)
- IMP34DT05 MEMS digital omnidirectional microphone (-26 dBFS, ±3 dB sensitivity)
- DIL 24-pin socket available for additional MEMS adapters and other sensors
- Free comprehensive development firmware library and samples for all sensors compatible with STM32Cube firmware
- Available I²C sensor hub features on ISM330DHCX
- Compatible with STM32 Nucleo boards
- Equipped with Arduino UNO R3 connector
- RoHS and WEEE compliant

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

All MEMS sensors use a 1.8 V domain.

The expansion board is power supply compatible with STM32 Nucleo boards. It contains LDOs to generate 1.8 V.

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

RELATED LINKS

2.2 I²C bus connection modes on page 4

2.1 Default solder bridge configuration

The X-NUCLEO-IKS02A1 solder bridges can be opened (not mounted) or closed (mounted) to have the different hardware configurations.

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

Device	BUS name	Solder bridge (default)	Solder bridge (not mounted)
IIS2DLPC	I²C2	SB3, SB13	
ISM330DHCX	I²C2	SB7, SB11	
IIS2DMC	I²C1	SB33, SB34	
STM32 Nucleo	I²C2	SB35, SB36	
DIL 24 adapter	I²C1	SB12, SB19	SB1, SB4, SB6, SB10, SB14, SB16, SB18, SB20, SB21, SB22
DIL 24 adapter	I²C2	SB16, SB21	SB1, SB4, SB6, SB10, SB14, SB12, SB18, SB20, SB19, SB22
DIL 24 adapter	I²Cx	SB14, SB20	SB1, SB4, SB6, SB10, SB12, SB16, SB18, SB19, SB21, SB22

Table 2. **Device I²C address**

Device	Solder bridge (non default)	I²C address default
IIS2DLPC	SB8	32h
IIS2DLPC	SB9(1)	30h
ISM330DHCX	SB15	D6h
ISM330DHCX	SB17(1)	D4h
IIS2DMC	--	3Ch

1. *Not mounted by default.*

Other default solder bridges are: SB40 to SB48 (STM32 Nucleo GPIO INT), SB23, SB25, SB39, SB32.
Other not mounted by default solder bridges are: SB37, SB50, SB51, SB52, SB53, SB54.

2.2 I²C bus connection modes

The ISM330DHCX I²C sensor hub can be used as I²C master of other devices (slaves) connected to an I²Caux bus.

The sensors on the X-NUCLEO-IKS02A1 expansion board can thus be connected in five different I²C bus modes (with or without the ISM330DHCX sensor hub).

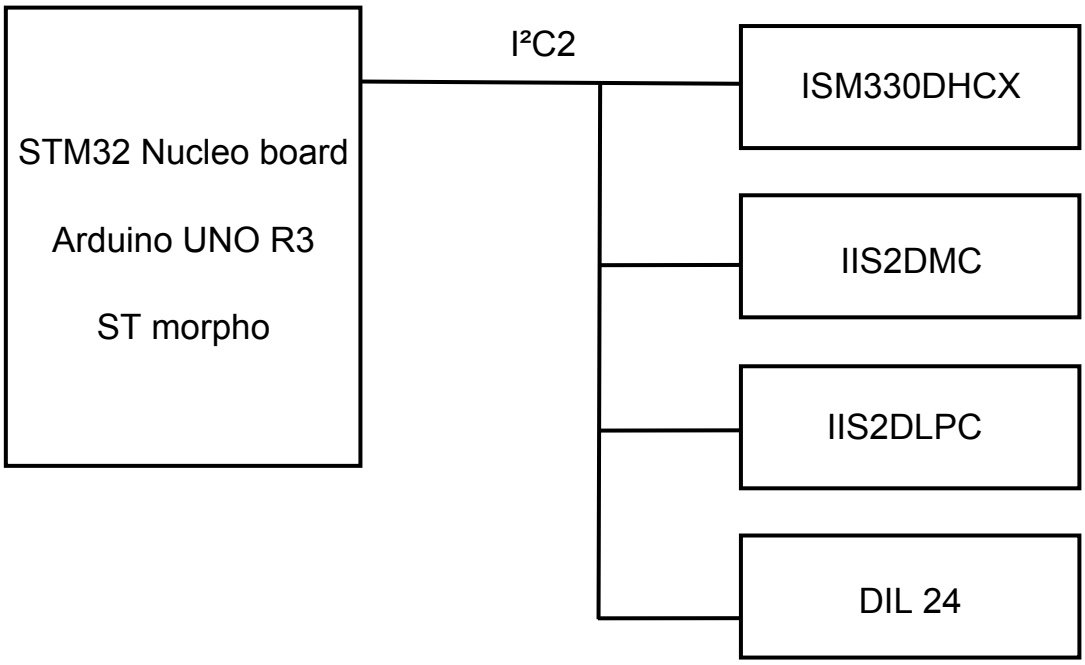
Mode 1: standard I²C bus connection (all sensors)

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-IKS02A1 standard I²C**



Mode 2: ISM330DHCX I²C sensor hub (all sensors)

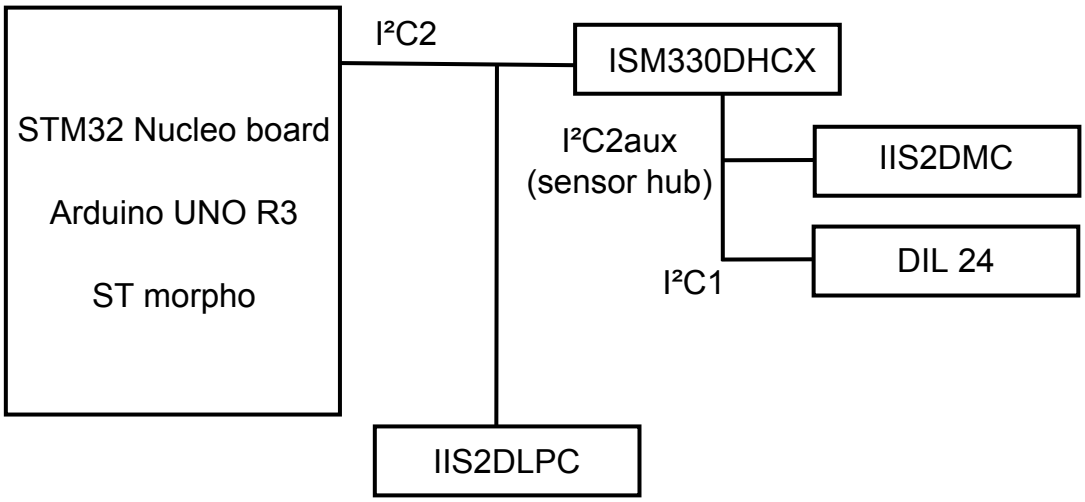
In sensor hub I²C mode, the ISM330DHCX is connected to an external main board by an I²C bus; all other devices are slaves connected to ISM330DHCX via I²Caux, except IIS2DLPC.

The board configuration is:

- JP7: 2-3 (I²C1 = I²Cx)

- JP8: 2-3 (I²C1 = I²Cx)

Figure 4. **X-NUCLEO-IKS02A1 ISM330DHCX I²C sensor hub**



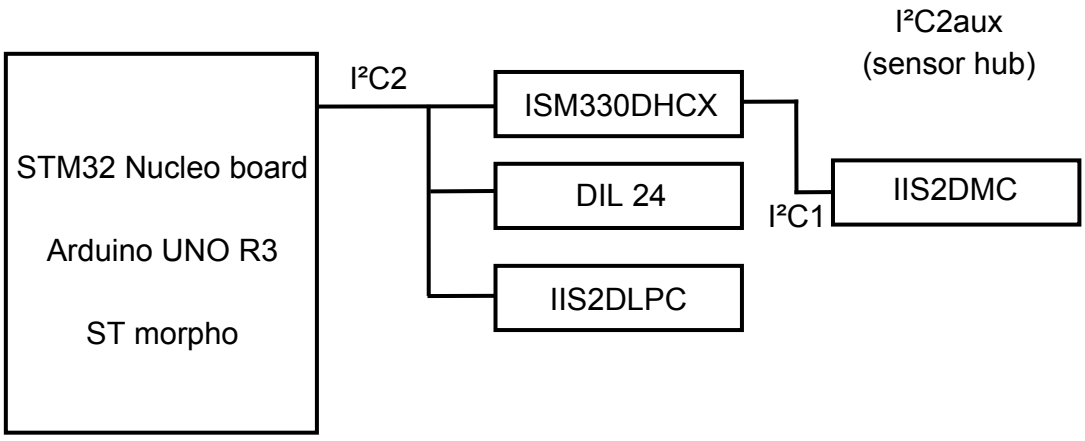
Mode 3: DIL 24 plus ISM330DHCX I²C sensor hub (all sensors, not DIL 24)

In sensor hub I²C mode, the ISM330DHCX and the DIL 24 adapter are connected to an external main board by an I²C bus; all other devices are slaves of the ISM330DHCX via I²Caux.

The board configuration is:

- JP7: 2-3 (I²C1 = I²Cx)
- JP8: 2-3 (I²C1 = I²Cx)
- DIL24 adapter (to I²C2): SB16, SB21
- Not mounted: SB6, SB10, SB12, SB14, SB18, SB19, SB20, SB22

Figure 5. **X-NUCLEO-IKS02A1 DIL 24, ISM330DHCX I²C sensor hub (all sensors)**



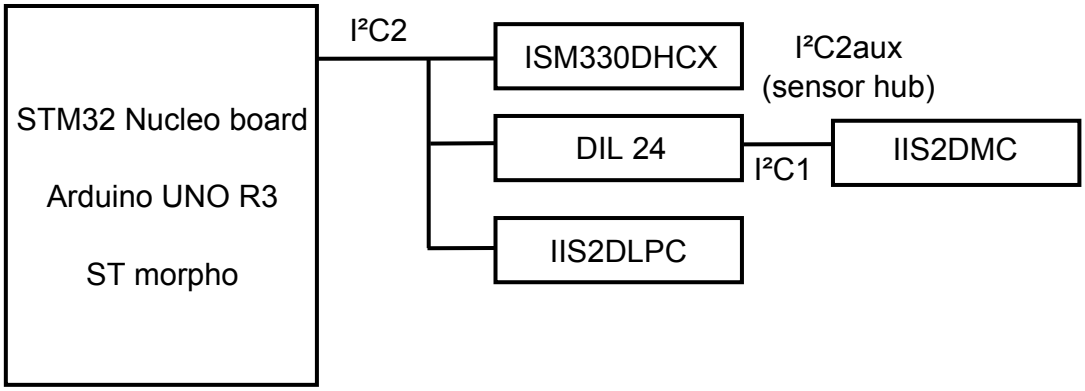
Mode 4: ISM330DHCX plus DIL 24 I²C sensor hub (all sensors)

In sensor hub I²C mode, the ISM330DHCX and the DIL 24 adapter are connected to an external main board by an I²C bus; all other devices are slaves of the DIL 24 adapter via I²Caux, except IIS2DLPC.

The board configuration is:

- JP7: 2-3 (I²C1 = I²Cx)
- JP8: 2-3 (I²C1 = I²Cx)
- DIL24 adapter (to I²C2): SB12, SB19
- Not mounted: SB6, SB10, SB14, SB16, SB18, SB20, SB21, SB22

Figure 6. **X-NUCLEO-IKS02A1 ISM330DHCX, DIL 24, I²C sensor hub (all sensors)**



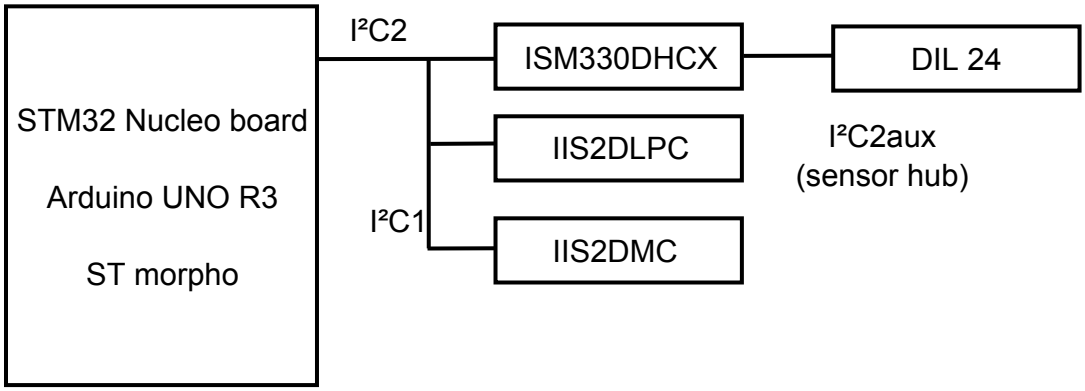
Mode 5: ISM330DHCX plus I²C sensor hub DIL24

In sensor hub I²C mode, the ISM330DHCX and other sensors are connected to an external main board via an I²C bus; the DIL 24 adapter is a slave of the ISM330DHCX via I²Caux.

The board configuration is:

- JP7: 1-2 (I²C1 = I²Cx)
- JP8: 1-2 (I²C1 = I²Cx)
- DIL24 adapter (to I²Cx): SB14, SB20
- Not mounted: SB6, SB10, SB12, SB16, SB18, SB19, SB21, SB22

Figure 7. **X-NUCLEO-IKS02A1 ISM330DHCX plus sensor hub DIL 24**



2.3 Sensor I²C address selection

Most of the sensors allow selecting LSB of the I²C address by pulling SD0 pin low or high.

The X-NUCLEO-IKS02A1 expansion board contains solder bridges to control SD0 level.

Table 3. **Solder bridges for SD0 level control and I²C address**

Sensor	SD0 High	SD0 Low
IIS2DLPC(U1)	SB8 ADD=32h	SB9 ADD=30h
ISM330DHCX (U2)	SB15 ADD=D6h	SB17 ADD=D4h
IIS2DMC (U3)	ADD =3Ch	ADD =3Ch
DIL24 Adapter (J1)	SB1/SB2	SB4/SB5

2.4 Sensor current consumption measurement

The X-NUCLEO-IKS02A1 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
IIS2DMC (U3)	JP12
ISM330DHCX (U2)	JP3
IMP34DT05 (U4)	JP11
IIS2DLPC (U1)	JP1
DIL24 Adapter (J1)	JP5

2.5 Sensor disconnection

To disconnect a sensor, you should disconnect the I²C bus as well as the power supply.

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

Sensor	Power	SDA	SCL
IIS2DMC (U3)	JP12	SB34	SB33
ISM330DHCX (U2)	JP3	SB11	SB7
IIS2DLPC (U1)	JP1	SB3	SB13
IMP34DT05 (U4)	JP11	SB26	SB27
DIL24 adapter	JP5	SB12,14,16	SB19,20,21

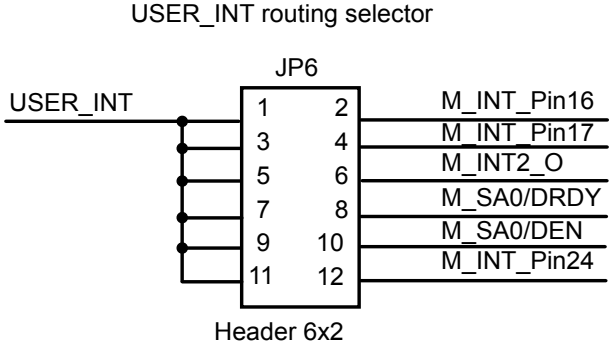
2.6 Adapter board for DIL 24 socket

An additional sensor can be connected as an adapter board to J1 DIL 24 socket.

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

As there are a few different interrupt signal assignments for DIL 24 pins, the appropriate pin can be selected using the JP6 header.

Figure 8. JP6 header



2.7 Connectors

Table 6. **X-NUCLEO-IKS02A1 connectors**

Connector	Pin[1]	Signal
CN5	7	GND
	9	I²C SDA
	10	I²C SCL
	2	IIS2DLPS_INT2
	4	MIC_DAT
	6	MIC_CLK
CN6	2	Vio
	4	3.3 V
	6	GND
	7	GND
CN8	3	IIS2DMC DRDY / IIS2DLPC INT
	4	IIS2DMC DRDY / IIS2DLPC INT
	5	IIS2DLPC INT2
	6	INT1 (DIL24)
CN9	3	USER INT
	4	MIC_CLK
	5	MIC_DATA
	6	ISM330DHCX INT2
	7	ISM330DHCX INT1

1. *The non-listed pins are not connected.*

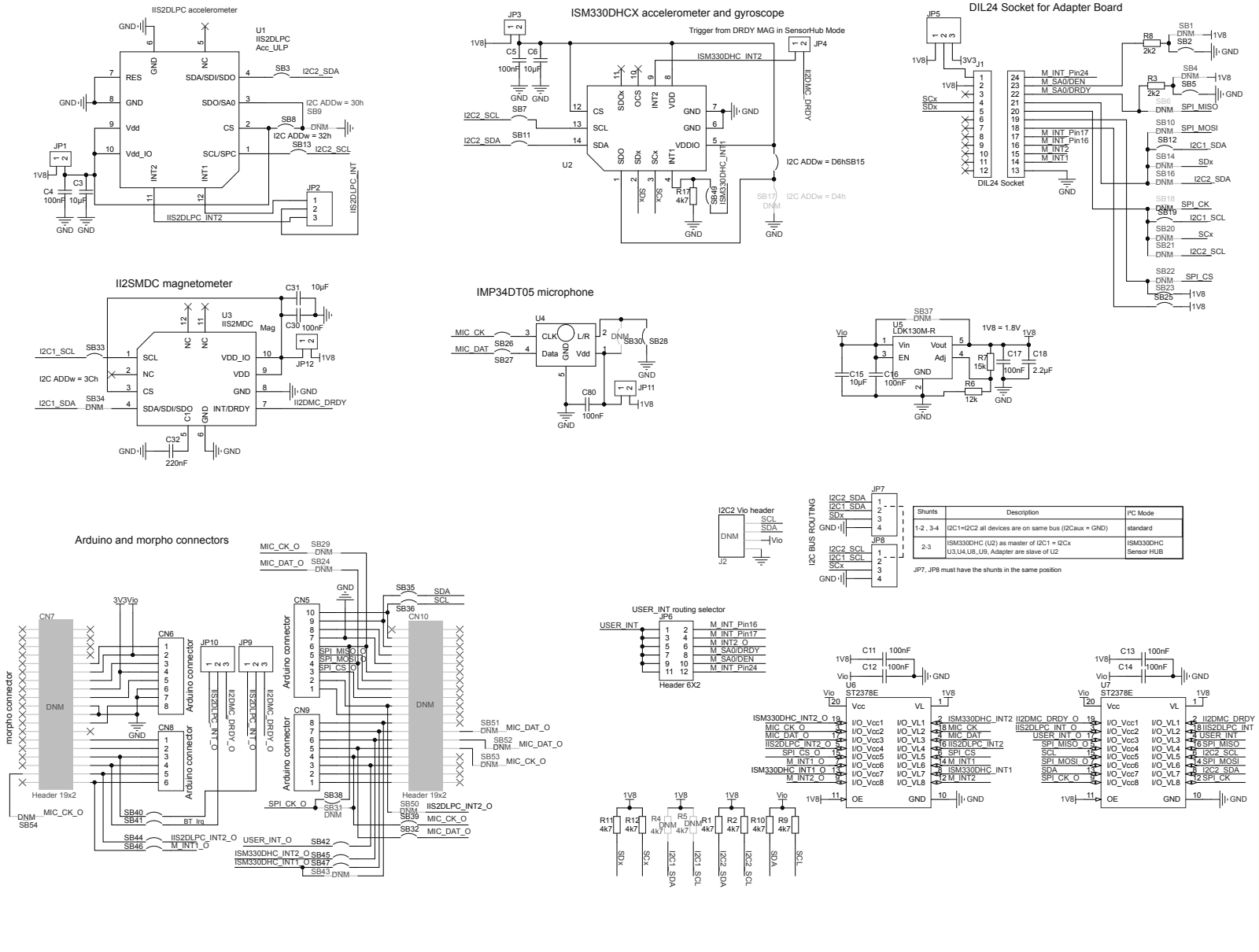
Table 7. ST morpho connectors

Connector	Pin[1]	Signal
CN7	12	3.3 V
	16	3.3 V
	20	GND
	22	GND
	32	IIS2DMC DRDY/ IIS2DLPC_INT
	34	IIS2DMC DRDY/ IIS2DLPC_INT
	35	MIC_CLK
	36	IIS2DLPC_INT2
	38	INT1 (DIL24)
CN10	3	I²C SCL
	5	I²C SDA
	9	GND
	11	MIC_CLK
	15	MIC_DATA
	19	IIS2DLPC_INT2
	25	ISM330DHCX INT1
	26	MIC_DATA
	27	ISM330DHCX INT2
	28	MIC_DATA
	29	MIC_DATA
	30	MIC_CLK
	31	MIC_CLK
	33	USER INT

1. *The non-listed pins are not connected.*

3 Schematic diagram

Figure 9. X-NUCLEO-IKS02A1 circuit schematic



4 Bill of materials

Table 8. **X-NUCLEO-IKS02A1 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	4	C3, C6, C15, C31	10 µF C0603	Capacitors	Multicomp	MC0603X106M6R3CT
2	10	C4, C5, C11, C12, C13, C14, C16, C17, C30, C80	100 nF C0603	Capacitors	Multicomp	MC0603B104K250CT
3	1	C18	2.2 µF C0603	Capacitor	Multicomp	MC0603X225K100CT
4	1	C32	220 nF C0603	Capacitor	Kemet	C0603X224K4RACTU
5	1	CN5	Header 10x1 HDR1X10 - Shield	Header	Any	Any
6	2	CN6, CN9	Header 8x1 HDR1X8 - Shield	Headers	Any	Any
7	1	CN8	Header 6x1 HDR1X6 - Shield	Header	Any	Any
8	1	J1	2.54 mm	DIL24 socket	Multicomp	2212S-12SG-85
9	5	JP1, JP3, JP4, JP11, JP12	Header 2x1 + Shunt HDR1X2	Jumpers	Harwin	M20-9990246
10	1	JP2	Header + Shunt HDR1X3	Jumper	Generic Components	2211S-03G
11	3	JP5, JP9, JP10	Header + Shunt HDR1X3	Jumpers	Generic Components	2211S-03G
12	1	JP6	Header + Shunt HDR2X6	Jumper	Generic Components	2211S-06G
13	2	JP7, JP8	Header + 2 shunts HDR1X4	Jumpers	Generic Components	2211S-04G
14	7	R1, R2, R9, R10, R11, R12, R17	4k7 R0603	Resistors	Multicomp	MC0063W060314K7
15	2	R3, R8	2k2 R0603	Resistors	Multicomp	MC0063W060312K2
16	1	R6	12 K R0603	Resistor	Multicomp	MC0063W0603512K
17	1	R7	15 K R0603	Resistor	Multicomp	MC0063W0603515K
18	29	SB2, SB3, SB5, SB7, SB8, SB11, SB12, SB13, SB15, SB19, SB23, SB25, SB26, SB27, SB28, SB32, SB33, SB35, SB36, SB38, SB39, SB40, SB41, SB42, SB44, SB45, SB46, SB47, SB49	0603	Solder bridges	Any	Any

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
19	1	U1	IIS2DLPC LGA 2x2 12L 05P	MEMS digital output motion sensor: high-performance ultra-low-power 3-axis accelerometer for industrial applications	ST	IIS2DLPC
20	1	U2	ISM330DHCX LGA 2.5x3.0 14L	iNEMO inertial module: always-on 3D accelerometer and 3D gyroscope with digital output for industrial applications	ST	ISM330DHCX
21	1	U3	II2DMC LGA 2x2 12L	High accuracy, ultra-low-power, 3-axis digital output magnetometer	ST	IIS2MDC
22	1	U4	IMP34DT05 MP34DT	MEMS audio sensor omnidirectional digital microphone for industrial applications	ST	IMP34DT05
23	1	U5	LDK130M-R SOT23-5	300 mA low quiescent current very low noise LDO	ST	LDK130M-R
24	2	U6, U7	ST2378E SMD_TSSOP20_ REFLOW	8-bit level translator with 15 kV ESD protection	ST	ST2378E

Revision history

Table 9. **Document revision history**

Date	Version	Changes
11-Nov-2019	1	Initial release.