Getting started with the industrial smart sensor kit based on L6364W dual IO-Link device transceiver

Introduction

The STEVAL-IOD04KT1 is a reference design kit that exploits the features of the L6364W IO-Link dual-channel device transceiver.

The kit consists of the STEVAL-IOD004V1 main board (not available for sale), the STLINK-V3MINI programmer and debugger tool, a 14-pin flat cable, and an M8 to M12 standard industrial connector adapter.

The kit acts as a modern smart industrial sensor to be connected to a master IO-Link hub (or a suitable PLC interface).

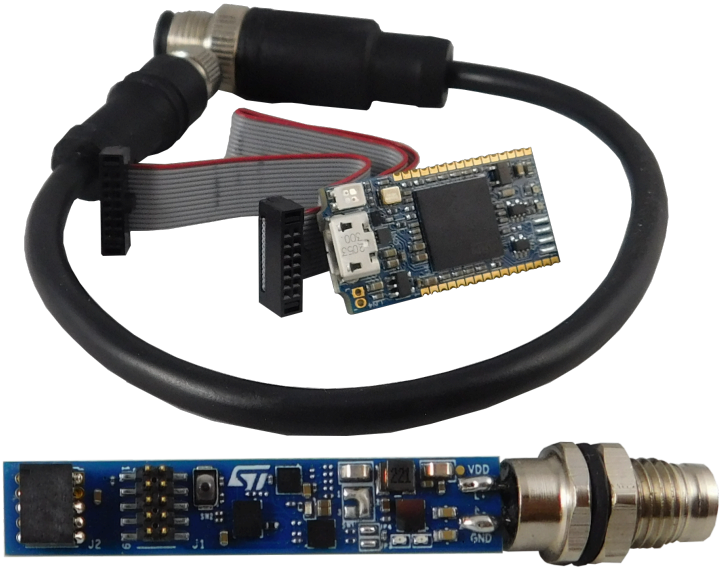
The power supply for the MCU, sensors, and other logic devices derives from the DC-DC converter controller embedded in the L6364W.

The on-board STM32G071EB microcontroller runs an IO-Link demo stack v.1.1, which controls the IO-Link communication, and the software code that manages the L6364W transceiver and the MEMS industrial sensors.

The tiny dimensions of the main board have been achieved thanks to the small sizes of the CSP package options of L6364W and STM32G071EB.

Connect the main board to an IO-Link master via the adapter and the M8 connector included in the kit for normal operation. Connect the same board to the STLINK-V3MINI through the flat cable only if you want to program the STM32G071EB with a new firmware.

Figure 1. STEVAL-IOD04KT1 evaluation kit



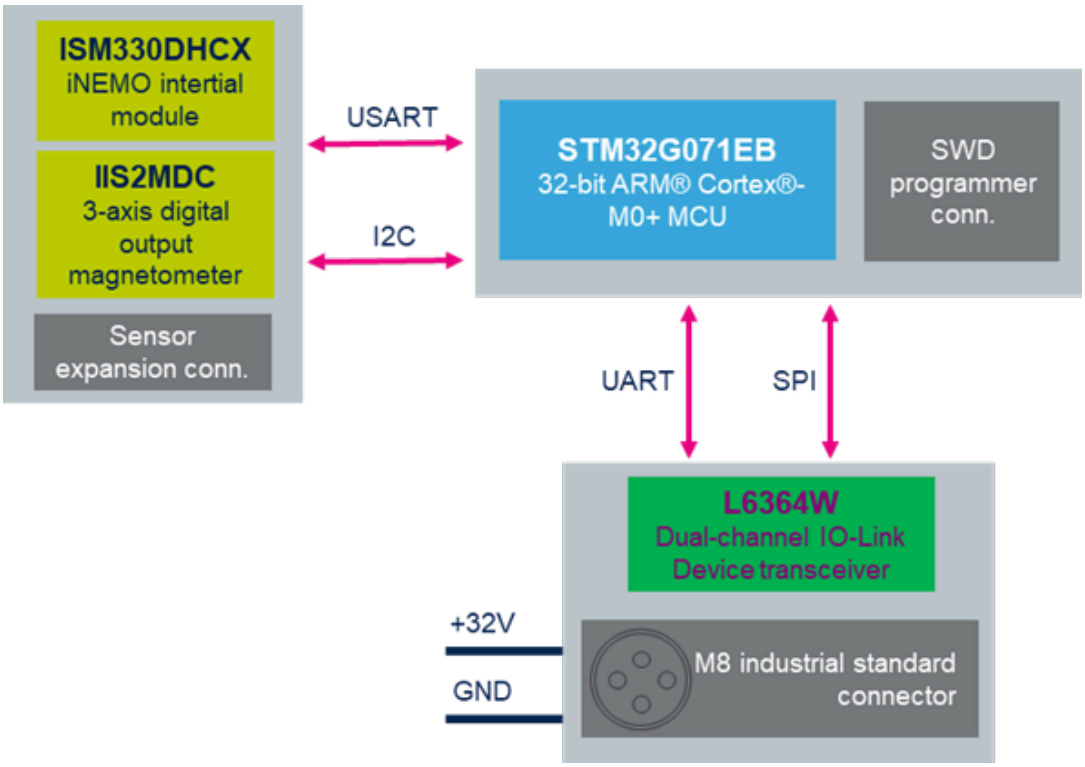
1 Getting started

1.1 Features

- Kit content:
  - STEVAL-IOD004V1 (45.8 x 8.3 mm) main board with shape easy to be integrated in industrial sensors housing (not available for separate sale)
  - STLINK-V3MINI programmer and debugger tool
  - M8-M12 industrial connector adapter including a 20 cm cable
  - 14-pin flat cable
- Main board features:
  - Industrial sensor node based on STM32G071EB (mainstream Arm® Cortex®-M0+ RISC core MCU operating at up to 64 MHz frequency), L6364W (dual channel transceiver IC for SIO and IO-Link sensor applications), IIS2MDC (high accuracy, ultra-low-power, 3-axis digital output magnetometer) and ISM330DHCX (iNEMO inertial module with machine learning core, and finite state machine with digital output for industrial applications)
  - Runs an IO-Link v.1.1 demo-stack and MEMS control software, included in the companion package STSW-IOD04K together with the IODD file
  - Operating voltage range 7 to 32 V
  - Four-pole M8 industrial standard connector
  - L6364W embedded DC-DC converter provides 3.3 V supply for all on-board ICs
  - General-purpose LEDs for transmission, programming/debugging, warning, and status
  - Jumpers for CQ and DIO selection in independent or joint mode
  - Switch for transmission mode selection (transparent, single, or multioctet)
  - Reset button
  - 10-pin connector for sensor expansion options
  - SWD connector for debugging and programming capability
  - Protections against surge pulse (up to ± 3APK with 500 Ω coupling) and reverse polarity
  - EMC and EMI tested according to standard requirements
  - RoHS compliant

1.2 Main board hardware architecture

Figure 2. Main board functional block diagram



The figure above shows the functional block of the main board.

The connection of the blocks results in a robust architecture implementing a smart industrial sensor node connected as IO-Link device.

The design is centered on the STM32G071EB microcontroller, which manages the IO-Link protocol mini-stack code embedded to drive the L6364W device transceiver.

The M8 4-way plug connector is strictly related to the L6364W transceiver. This connector allows establishing half duplex IO-Link communication with an IO-Link master and with a power supply rail (≤ 32 V).

The blocks on the left hand identify the sensors: the ISM330DHCX 6-axis inertial module device with machine learning core and the IIS2MDC 3-axis digital magnetometer.

1.3 Main board components

1.3.1 STM32G071EB

The STM32G071x8/xB mainstream microcontrollers are based on high-performance Arm® Cortex®-M0+ 32-bit RISC core operating at up to 64 MHz frequency. Offering a high level of integration, they are suitable for a wide range of applications in consumer, industrial and appliance domains, as well as Internet of Things (IoT) solutions.

These microcontrollers incorporate a memory protection unit (MPU), high-speed embedded memories (36 kbytes of SRAM and up to 128 kbytes of Flash program memory with read protection, write protection, proprietary code protection, and secure area), DMA, an extensive range of system functions, enhanced I/Os, and peripherals.

Optimized dynamic consumption, together with a comprehensive set of power-saving modes, low-power timers and low-power UART, allows the design of low-power applications.

The devices operate within ambient temperatures from -40 to 125°C and with supply voltages from 1.7 to 3.6 V. V_{BAT} direct battery input allows keeping RTC and backup registers powered.

For further information, see the STM32G071EB relevant web page.

1.3.2 L6364

The L6364 is a dual-channel transceiver for industrial sensor applications. It has been designed to support the IO-Link standard and acts as a bridge between a microcontroller with a sensor or actuator function, a supply (up to 32 V), and a signaling cable.

In normal operation, the microcontroller configures the L6364 via the SPI interface at start-up. Thus, the L6364 operates as a single input/output IO-Link device driving the output lines as configured by the microcontroller. If the device is connected to an IO-Link master, then the master can initiate communication and exchange data with the microcontroller while the L6364 acts as a physical layer for the communication.

The main features are:

- supply voltage from 5 to 35 V
- low dissipative (5 Ω) CQ and DIO output stages configurable in high-side, low-side, push/pull
- configurable (0.11 to 0.25 A) current limitation threshold of CQ and DIO lines
- configurable (0.22 to 0.5 A) current limitation threshold of CQ/DIO line (join mode)
- full protections:
  - embedded reverse polarization diode (D_{OUT} pin)
  - full zero current reverse polarity between V_{plus}, CQ, DIO, and PGND pins
  - configurable (up to 216°C) thermal shutdown threshold
  - 7-bit, calibrated, temperature measurement
  - configurable (6.0 to 15 V) V_{plus} undervoltage detection
  - CQ and DIO short-circuit current limit and reporting
- -40 to +150°C operating temperature
- suitable to drive L, C, and R loads
- integrated UART peripheral with M-sequence handling (including checksum) for all IO-Link sequences according to specification v1.1
- single octet UART mode for unlimited M-sequence size and continuous data transfer
- designed to meet the following application requirements:
  - ESD IEC 61000-4-2 protection to 4 kV
  - EMC surge protection 2A/50 µs (coupling 500 Ω)
- QFN-20L 4x4 mm and CSP 2.5x2.5 mm (used for the design of STEVAL-IOD004V1) packages available
- internal DC-DC buck converter controller with two internal MOS switches. A configurable switching frequency buck converter can be obtained with an external capacitor and an inductor. The device also includes linear regulators, which can optionally be used.

1.3.3 ISM330DHCX

The ISM330DHCX is a system-in-package featuring a high-performance 3D digital accelerometer and 3D digital gyroscope tailored for Industry 4.0 applications.

The various sensing elements have been manufactured using specialized micro-machining processes, while the IC interfaces have been developed using CMOS technology that allows the design of a dedicated circuit trimmed to match better the characteristics of the sensing element.

In the ISM330DHCX, the sensing elements of the accelerometer and of the gyroscope are implemented on the same silicon die, thus guaranteeing superior stability and robustness.

The ISM330DHCX has a full-scale acceleration range of ±2/±4/±8/±16 g and a wide angular rate range of ±125/±250/±500/±1000/±2000/±4000 dps, permitting its usage in a broad range of applications.

All the design aspects and the calibration of the ISM330DHCX have been optimized to reach superior accuracy, stability, extremely low noise and full data synchronization.

An unmatched set of embedded features (machine learning core, programmable FSM, FIFO, sensor hub, event decoding and interrupts) enables the implementation of smart and complex sensor nodes for high performance at very low power.

1.3.4 IIS2MDC

The IIS2MDC is a high-accuracy, ultra-low-power 3-axis digital magnetic sensor, with a magnetic field dynamic range of up to ±50 gauss.

The IIS2MDC includes an I²C serial bus interface that supports standard mode, fast mode, fast mode plus, and high-speed (100 kHz, 400 kHz, 1 MHz, and 3.4 MHz) as well as an SPI serial standard interface.

The device can be configured to generate an interrupt signal for magnetic field detection.

The IIS2MDC is available in a plastic land grid array package (LGA) and is guaranteed to operate over an extended temperature range (from -40°C to +85°C).

2 How to run the STEVAL-IOD004V1 smart industrial sensor

To run the STEVAL-IOD004V1 main board with the STSW-IOD04K preloaded firmware, follow the procedure below.

Step 1. Connect the board to an IO-Link master embedding a standard M8 4-way socket side connector.

If the IO-Link master and the available cabling are M12, you can use the M8 to M12 connector adapter provided in the STEVAL-IOD04KT1 reference design kit.

Once the STEVAL-IOD004V1 is connected to a master, it should recognize the sensor node thanks to the IODD file preloaded in the STSW-IOD04K, assuming that the cable is correctly powering the smart industrial sensor node at 24 V and below 32 V.

Step 2. Use the STLINK-V3MINI compact in-circuit debugger and programmer for STM32 included in the kit to debug code for firmware analysis or for code modification.

3 Firmware overview

The STSW-IOD04K is the firmware associated to the STEVAL-IOD04KT1 reference design kit.

This firmware package is available for download at www.st.com.

The package includes freely customizable C-code written examples to speed up the development time.

Note: This IO-Link protocol mini-stack has some limitations regarding event management and ISDU, which are not included.

4 Schematic diagrams

Figure 3. **STEVAL-IOD004V1 (main board) circuit schematic (1 of 4)**

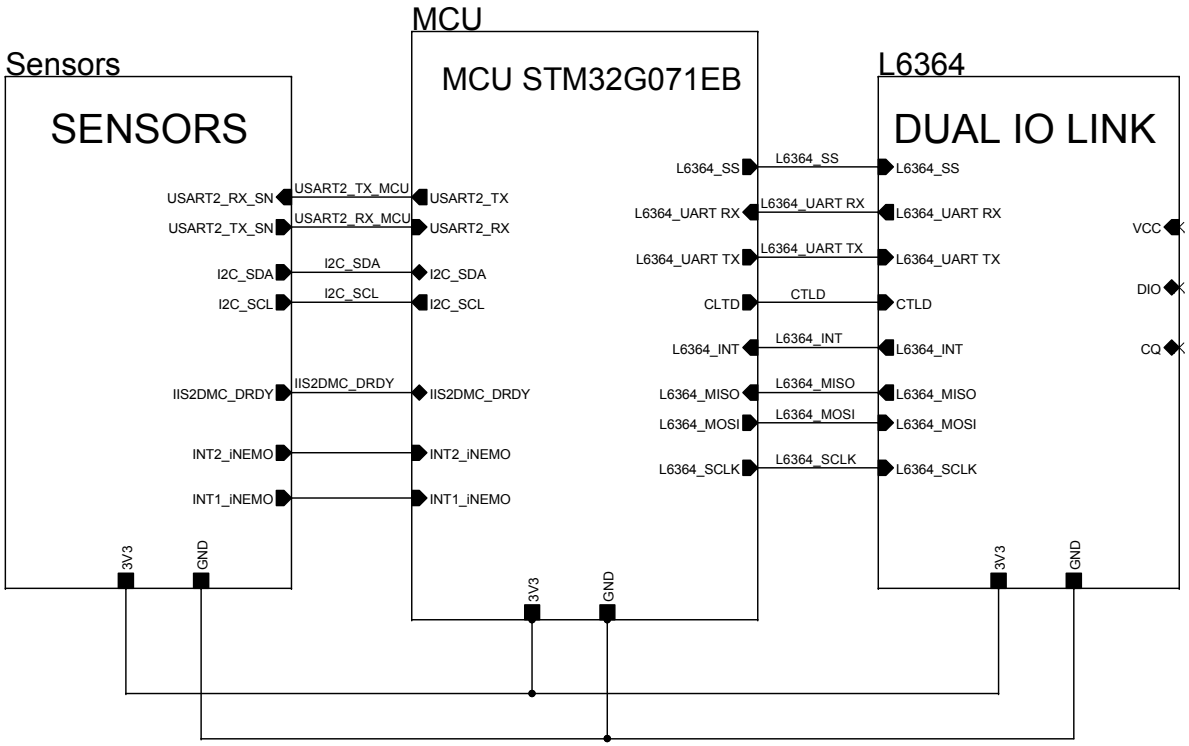


Figure 4. **STEVAL-IOD004V1 (main board) circuit schematic (2 of 4)**

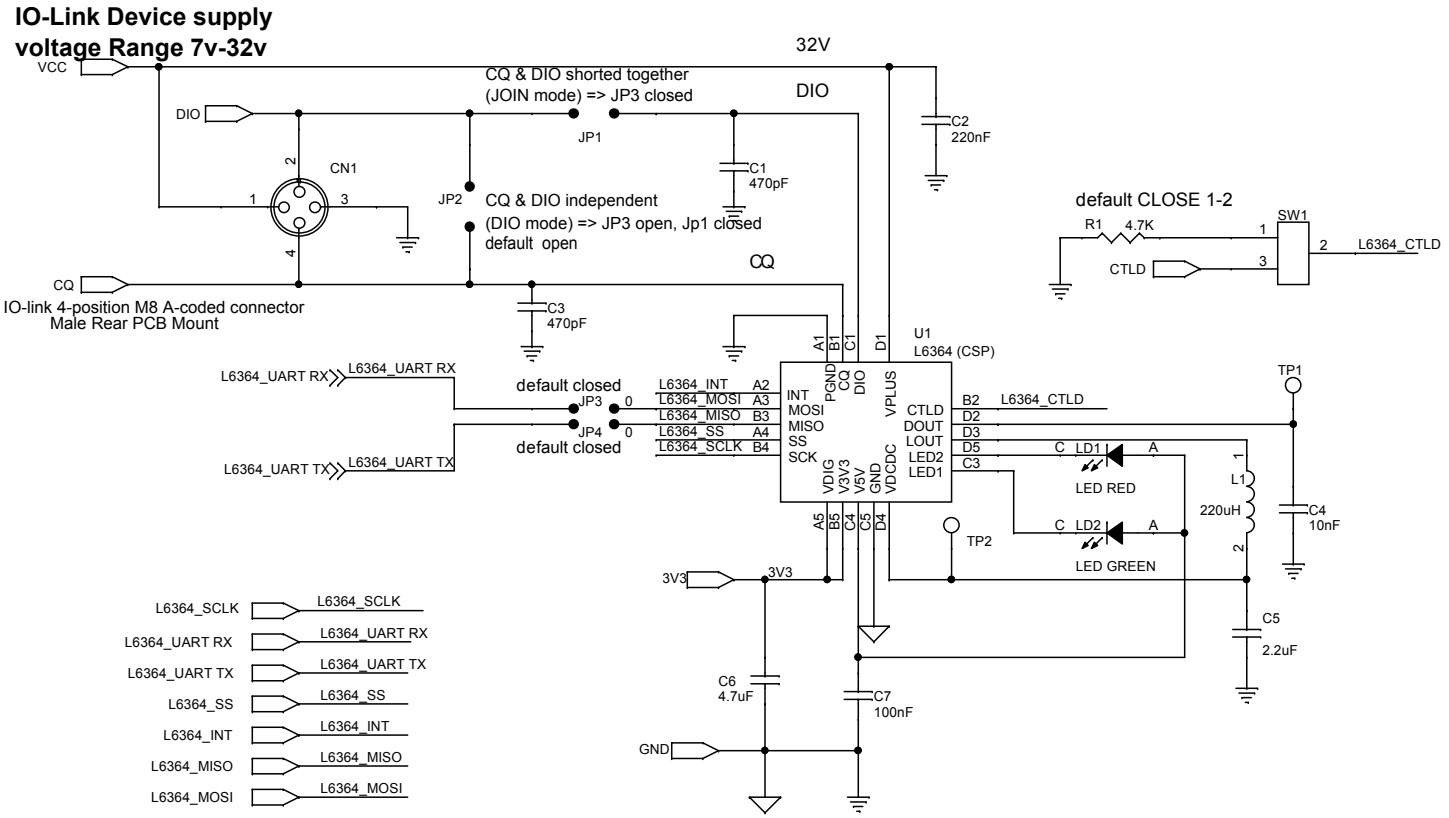


Figure 5. STEVAL-IOD004V1 (main board) circuit schematic (3 of 4)

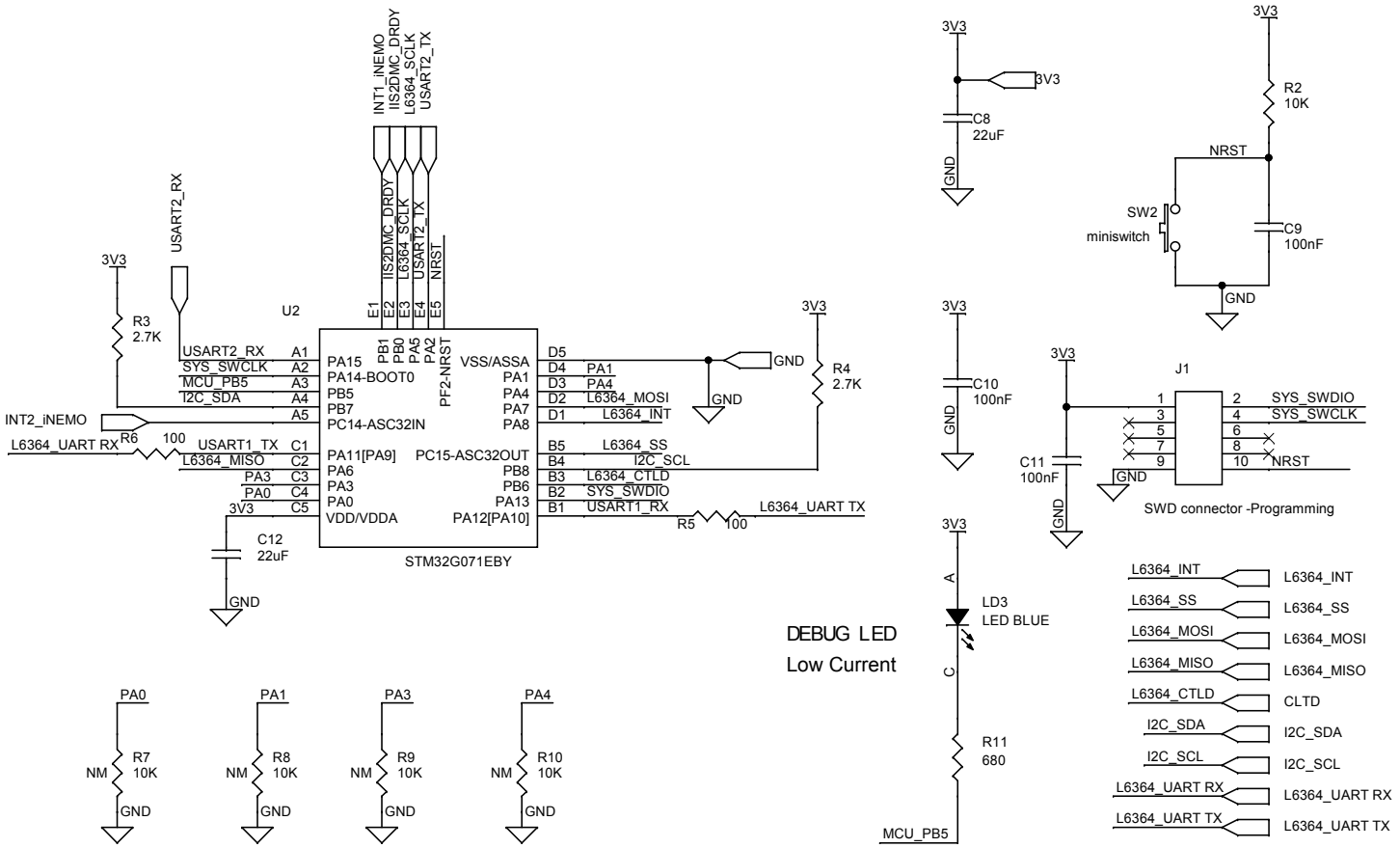
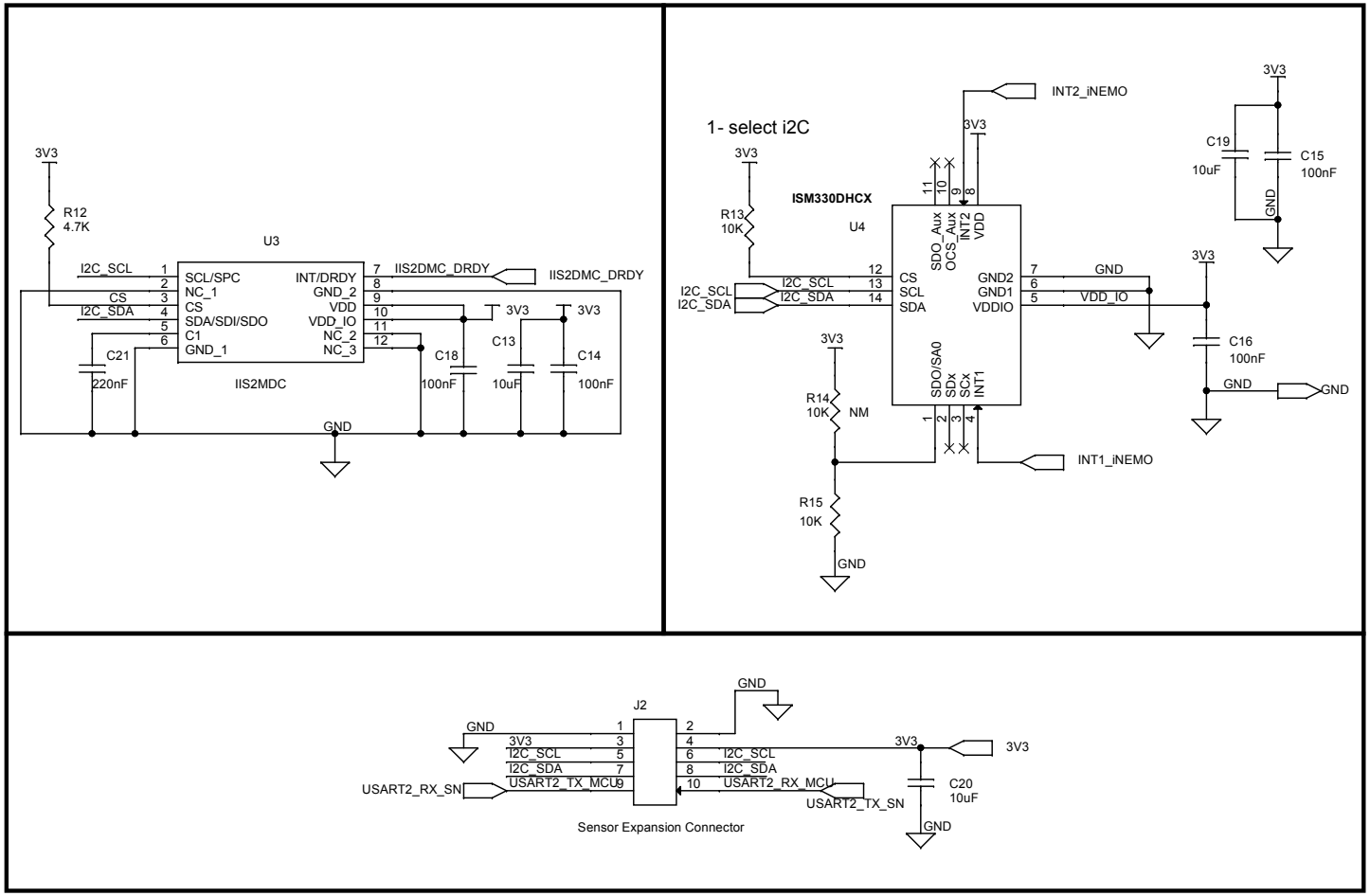


Figure 6. STEVAL-IOD004V1 (main board) circuit schematic (4 of 4)



5 Bill of materials

Table 1. STEVAL-IOD04KT1 bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	Table 2. STEVAL-IOD004V1	-	Main board	ST	Not available for separate sale
2	1	STLINK-V3MINI	-	In-circuit debugger and programmer for STM32	ST	STLINK-V3MINI
3	1	Cable adapter	-	M8 to M12 adapter including a 20 cm cable	Katlax	CDF08S-M12S5-0.2BPVC

Table 2. STEVAL-IOD004V1 (main board) bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	2	C1, C3	470 pF, 0603, 50 V	Ceramic capacitors	Any	Any
2	1	C2	220 nF, 0402, 25 V	Ceramic capacitor	Any	Any
3	1	C4	10 nF, 0402, 25 V	Ceramic capacitor	Any	Any
4	1	C5	2.2 µF, 0402, X5R, 25 V ±10%	Ceramic capacitor	Any	Any
5	1	C6	4.7 µF, X5R, 0201, 6.3 V ±20%	Ceramic capacitor	Any	Any
6	8	C7, C9, C10, C11, C14, C15, C16, C18	100 nF X5R, 0201, 10 V ±10%	Ceramic capacitors	Any	Any
7	2	C8, C12	22 µF X5R, 0402, 6.3 V, ±20%	Ceramic capacitors	Any	Any
8	3	C13, C19, C20	10 µF X5R, 0402, 6.3 V ±20%	Ceramic capacitors	Any	Any
9	1	C21	220 nF X5R, 0402, 6.3 V ±10%	Ceramic capacitor	Any	Any
10	1	CN1	IO LINK M8, PTH 4-pin male rear PCB mount	IO-Link 4-position M8 A-coded connector	Katlax	CPM08-RM8BR4-S0
11	1	J1	SWD connector - programming, SMD	Connector header	Samtec Inc.	FTSH-105-01-L-DV-K-TR
12	1	J2	Sensor expansion connector, PTH 10-pin	Sensor expansion connector	Harwin	M50-3200545
13	4	JP1, JP2, JP3, JP4	0 Ohm Jumper, drop 0402	Jumpers	Any	Any
14	1	L1	220 µH, ±10%, SMD	Fixed inductor	Würth	744032221
15	1	LD1	LED, 20 mA, 0402	Red LED	Würth	150040RS73240
16	1	LD3	LED, 20 mA, 2.5 V, 0402	Blue LED	Kingbright	APHHS1005LQBC/D-V
17	1	LD2	LED, 20 mA, 0402	Green LED	Würth	150040VS73240
18	1	R1	4.7 K Ohm, 1/20 W ±1%, 0201	Resistor	Any	Any
19	2	R2, R15	10 K Ohm, 1/20 W ±1%, 0201	Resistors	Any	Any
20	2	R3, R4	2.7 K Ohm, 1/20 W ±1%, 0201	Resistors (not mounted)	Any	Any
21	2	R5, R6	100 Ohm, 1/20 W ±1%, 0201	Resistors	Any	Any

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
22	5	R7, R8, R9, R10, R14	10 K Ohm, 1/20 W ±1%, 0201	Resistors (not mounted)	Any	Any
23	1	R11	680 Ohm, 1/20 W ±1%, 0201	Resistor	Any	Any
24	1	R12	4.7 K Ohm, 1/20 W ±1%, 0201	Resistor (not mounted)	Any	Any
25	1	R13	10 K Ohm, 1/16 W ±1%, 0402	Resistor	Any	Any
26	1	SW1	3-pin, drop SMD	Switch	Any	Any
27	1	SW2	Mini switch, SMD	Switch	E-Switch	TL3780AF240QG
28	2	TP1, TP2	Test point, SMD	Test points	Keystone	5015
29	1	U1	L6364 (CSP), CSP-19	Dual channel transceiver IC for SIO and IO-Link sensor applications	ST	L6364W
30	1	U2	STM32G071EBY, WLCSP-25	Mainstream Arm Cortex-M0+ MCU	ST	STM32G071EBY6TR
31	1	U3	IIS2MDC, LGA-12	High accuracy, ultra-low-power, 3-axis digital output magnetometer	ST	IIS2MDCTR
32	1	U4	ISM330DHCX, LGA-14	IMUs - Inertial Measurement Units iNEMO inertial module: 3D accelerometer and 3D gyroscope	ST	ISM330DHCXTR
33	1	Cable Adapter	Cable adapter M8-M12 20 cm	Cable	Katlax	CDF08S4-M12S5-02BPVC

6 Board versions

Table 3. **STEVAL-IOD04KT1 versions**

Finished good	Schematic diagrams	Bill of materials
STEVAL$IOD04KT1A (1)	STEVAL$IOD04KT1A schematic diagrams	STEVAL$IOD04KT1A bill of materials

1. *This code identifies the STEVAL-IOD04KT1 evaluation board first version.*

7 Regulatory compliance

Formal Notice Required by the U.S. Federal Communications Commission

FCC NOTICE:

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.

Formal Product Notice Required by Industry Canada Innovation, Science and Economic Development

Canada compliance:

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Formal product notice required by EU

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Revision history

Table 4. **Document revision history**

Date	Revision	Changes
27-Oct-2021	1	Initial release.

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