Getting started with X-STM32MP-GNSS2 expansion board for the STM32MP157F-DK2 discovery kit

Introduction

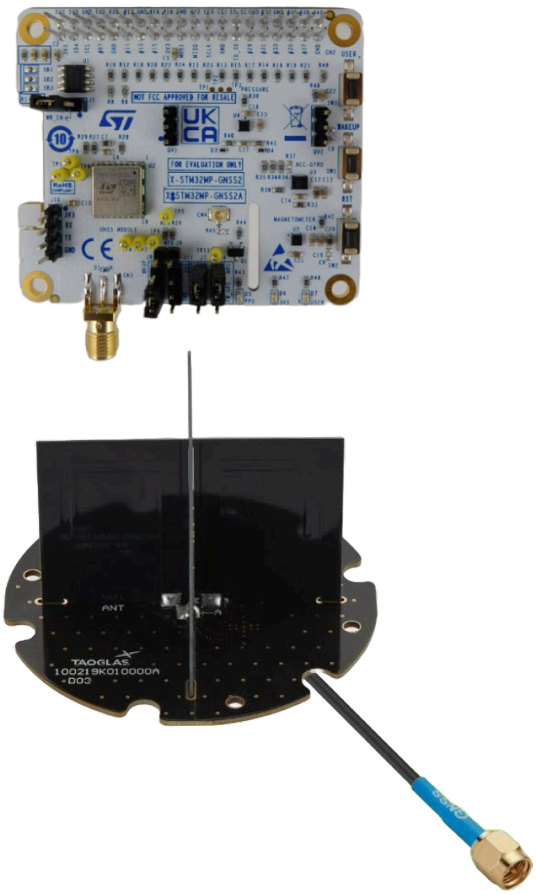
The X-STM32MP-GNSS2 multisensor expansion board embeds the following devices:

- The Teseo-LIV4F module for Low power GNSS communication along with sensor for position accuracy.
- The ISM330DHCX iNEMO 3-axis accelerometer and 3-axis gyroscope
- The IIS2MDC 3-axis magnetometer
- The ILPS22QS pressure sensor
- Switches and LEDs are present

The X-STM32MP-GNSS2 interfaces with the STM32MP157F-DK2 microprocessor via a 40-pin GPIO connector, using I²C, SPI, and GPIO peripherals.

The X-STM32MP-GNSS2 expansion board is compatible with both the STM32MP157F-DK2 and Raspberry Pi GPIO expansion connector layout.

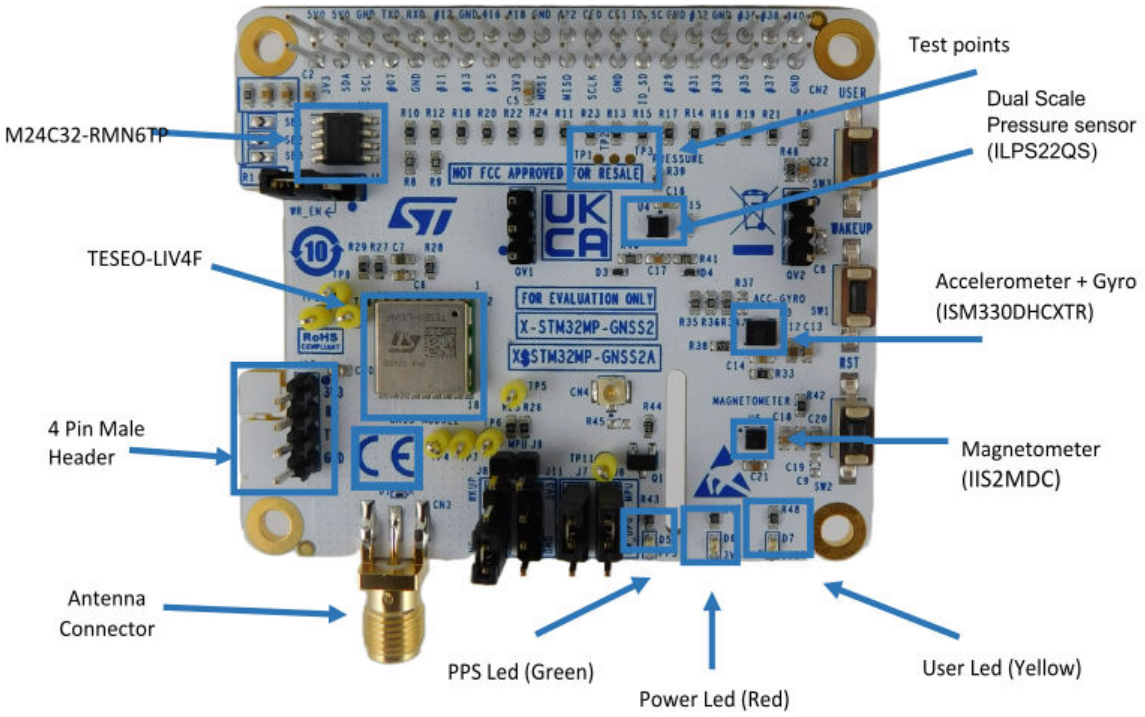
Figure 1. X-STM32MP-GNSS2 expansion board



1 Overview

The X-STM32MP-GNSS2 is powered via a standard 3.3 V supply through the STM32MP157F-DK2 GPIO connector. The figure below shows the component placement on the board.

Figure 2. X-STM32MP-GNSS2 component placement details



X-STM32MP-GNSS2 is a 40-pin connector expansion board for STM32MP157F-DK2 discovery kit with Teseo-LIV4F module for GNSS communication along with sensors for data and positioning accuracy.

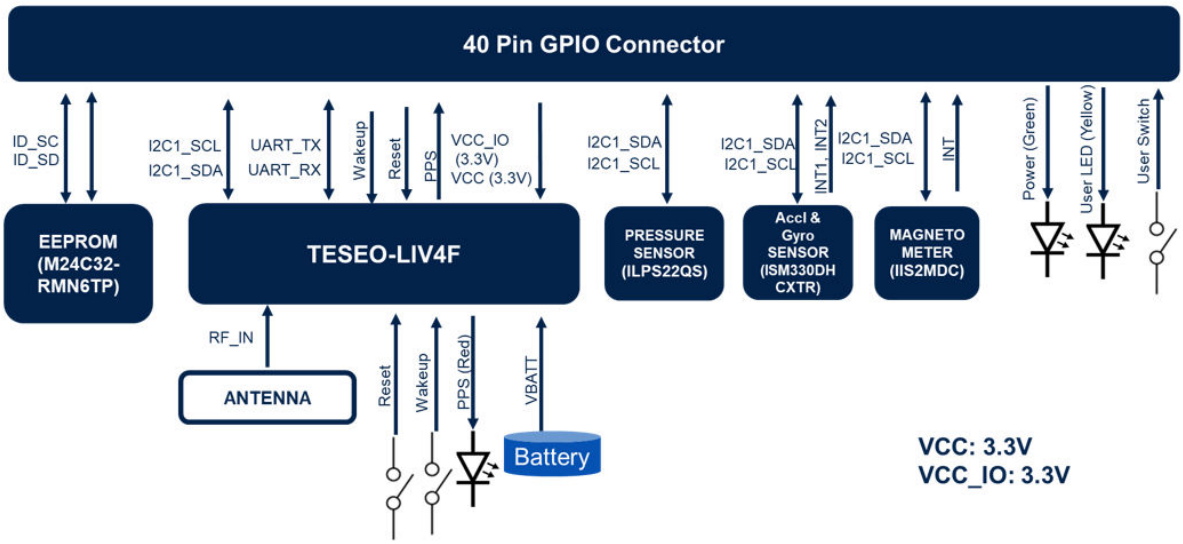
For motion detection, the iNEMO inertial module ISM330DHCX is used which is a 3D digital accelerometer and a 3D digital gyroscope with full-scale acceleration range of ±2/±4/±8/±16 g and an angular rate range of ±125/±250/±500/±1000/±2000/±4000 dps.

It also has a dual full-scale, 1260 hPa and 4060 hPa, absolute digital output barometer with embedded Qvar electrostatic pressure sensor, namely ILPS22QS.

A 3D digital magnetometer with dynamic range up to ±50 gausses for position accuracy is also present. Additionally, an LNA (Low noise amplifier) along with SAW filter on the RF path for amplification of any weak signals received through the antenna.

The X-STM32MP-GNSS2 interfaces with microprocessor mother board via 40 pin GPIO connector pins using I²C, UART, GPIO connections for Teseo-LIV4F, iNEMO inertial module, sensors, Keys & LEDs. This board is compatible with both STM32MP157F-DK2 and Raspberry Pi's GPIO connector layout.

Figure 3. **System Block diagram**



1.1 System requirements

To test the X-STM32MP-GNSS2, you need:

- an X-STM32MP-GNSS2 expansion board
- an STM32MP157F-DK2 discovery kit
- a laptop/desktop (with Windows 10 or above)
- a USB Type-A to micro-B USB cable (for connection as a virtual serial device, if required)
- a USB PD compliant 5 V 3 A power supply with a USB Type-C® to Type-C® cable

1.2 Board setup

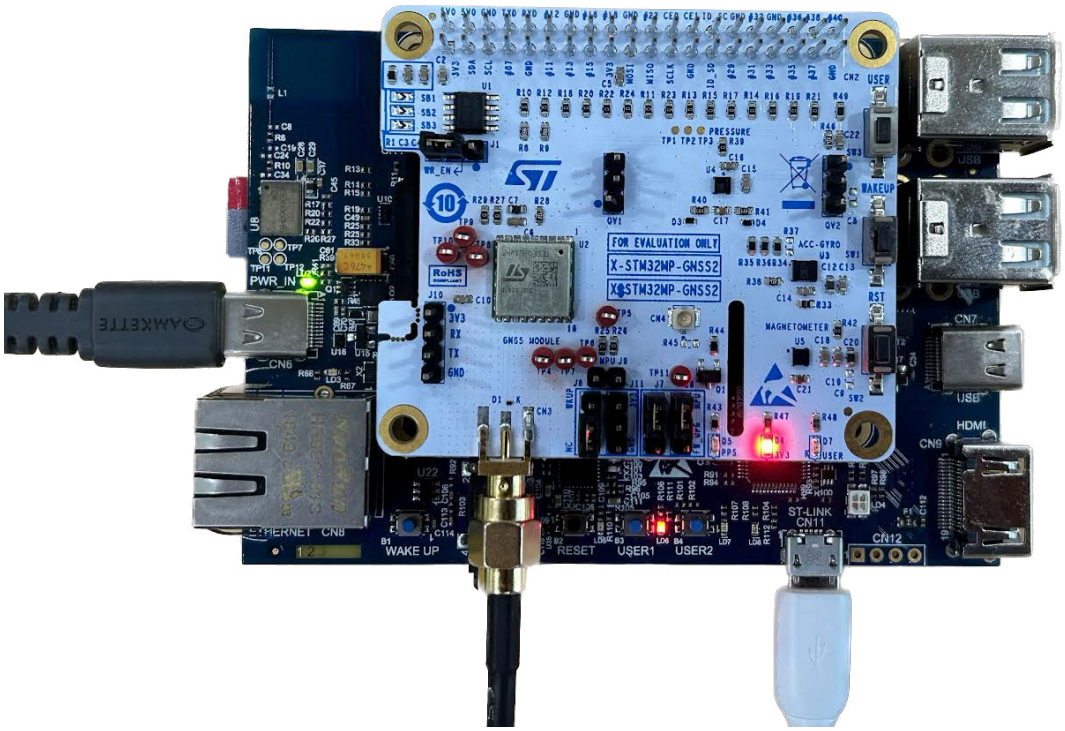
To set up the board, follow the steps below.

Step 1. Check the position of the jumper on the J4 connector. This jumper enables the write operation for the EEPROM, if required.

Step 2. Connect the X-STM32MP-GNSS2 to the STM32MP157F-DK2 from the top, as shown below. Ensure that pin 1 of the X-STM32MP-GNSS2 board matches with pin 1 of the STM32MP157F-DK2 board. Pin 1 can be identified as a rectangular footprint pad on both boards.

Note: Boards can damage if not connected properly.

Figure 4. X-STM32MP-GNSS2 connected to STM32MP157F-DK2



Step 3. Power the STM32MP157F-DK2 using the USB Type-C® cable.

Step 4. Program the supported firmware in the microSD™ card of the STM32MP157F-DK2 board. The X-STM32MP-GNSS2 board is ready for use.

1.3 Jumper settings for Programming Teseo-LIV4F

Table 1. Jumper settings for Programming Teseo-LIV4F

S.No.	Jumper	Configuration	Comments
1.	J6	2-3 (FW_UPG)	Firmware Upgrade
2.	J7	2-3 (FW_UPG)	Firmware Upgrade
3.	J8	Not Connected	Not used
4.	J9	1-2 (closed)	Closed
5.	J11	Not Connected	Not used

2 Component description

The board comprises the following key devices:

2.1 EEPROM section

M24C32 is a 32-Kbit I²C-compatible EEPROM (electrically erasable programmable memory) organized as 4 K × 8 bits.

Table 2. M24C32-R package details

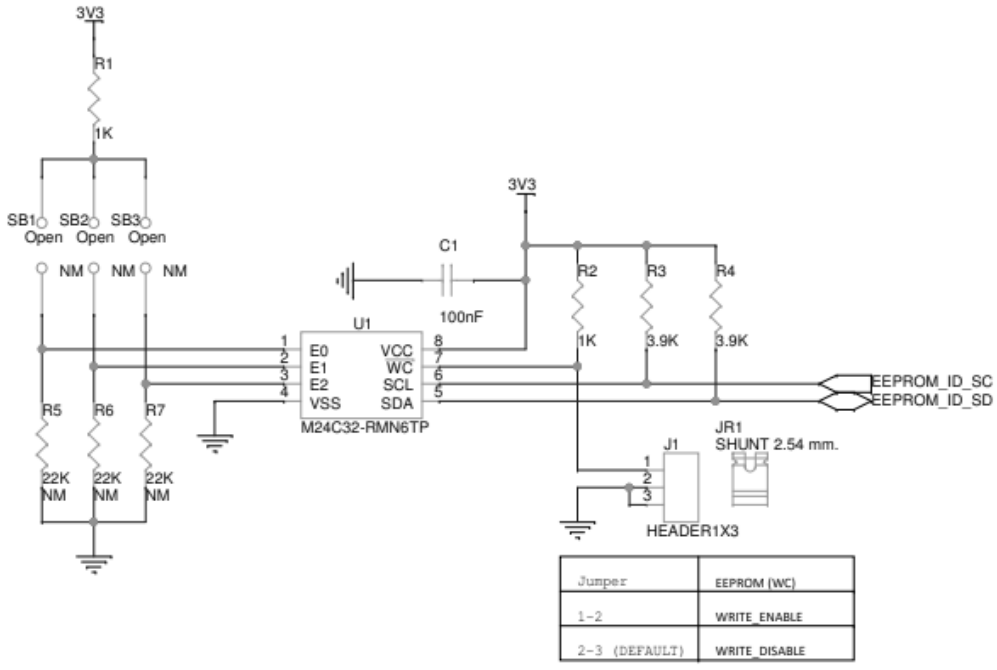
Features	Description
Order code	M24C32-RMN6TP
Package	SO-8
Operating voltage	1.8 V to 5.5 V

Onboard jumper J1 can be used to enable or disable the write operation on the EEPROM to prevent unauthorized write operations. This jumper setting details are shown in Table 2.

Table 3. EEPROM jumper details

Jumper	EEPROM
1-2	WRITE_ENABLE
2-3 (default)	WRITE_DISABLE

Figure 5. EEPROM circuit



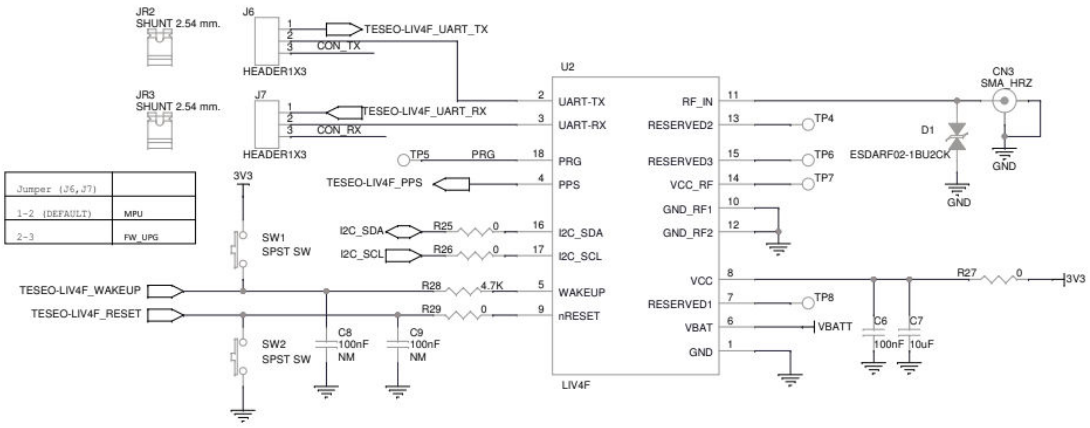
2.2 Teseo-LIV4F module section:

The Teseo-LIV4F module is based on the TESEO IV single die GNSS receiver IC working simultaneously on multiple constellations GPS/Galileo/Glonass/BeiDou/QZSS/IRNSS) able to provide positioning data. It is a low-power tiny GNSS receiver. Within its 9.7 x 10.1 mm tiny size, the Teseo-LIV4F offers superior accuracy as it has a temperature compensated Crystal oscillator (TCXO) and a reduced time to first fix (TTFF) relying to its dedicated real-time clock (RTC) oscillator. Teseo-LIV4F provides also the real-time assisted GNSS able to predict satellite data based on previous observation of the satellite.

Table 4. Teseo-LIV4F details

Features	Description
Order code	Teseo-LIV4FTR
Package	LCC-18
Operating voltage	3.0 to 3.63 V

Figure 6. Teseo-LIV4F circuit



2.3 Accelerometer and gyroscope: 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. 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 that enable 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) are enablers for implementing smart and complex sensor nodes, which deliver high performance at very low power.

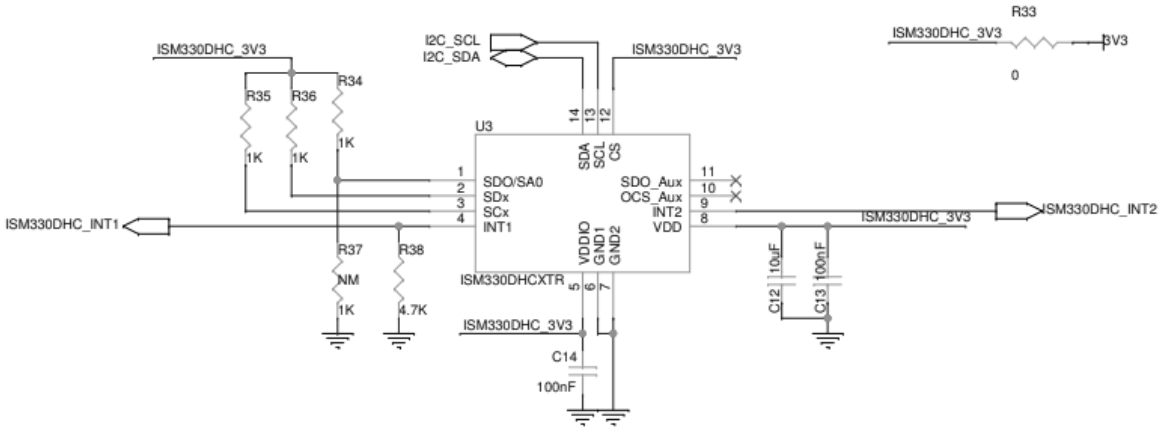
The ISM330DHCX is available in a 14-lead plastic land grid array (LGA) package.

Table 5. ISM330DHCXTR details

Features	Description
Order code	ISM330DHCX, ISM330DHCXTR

Features	Description
Package	LGA-14L
Operating voltage	1.71 V to 3.6 V

Figure 7. ISM330DHCXTR circuit



2.4 Pressure sensor ILPS22QS

The ILPS22QS is an ultracompact piezoresistive absolute pressure sensor, which functions as a digital output barometer, supporting dual full-scale up to user-selectable 4060 hPa. An embedded Qvar (electric charge variation detection) channel can be enabled for sensing in applications such as tap, double tap, long press, and L/R - R/L swipe.

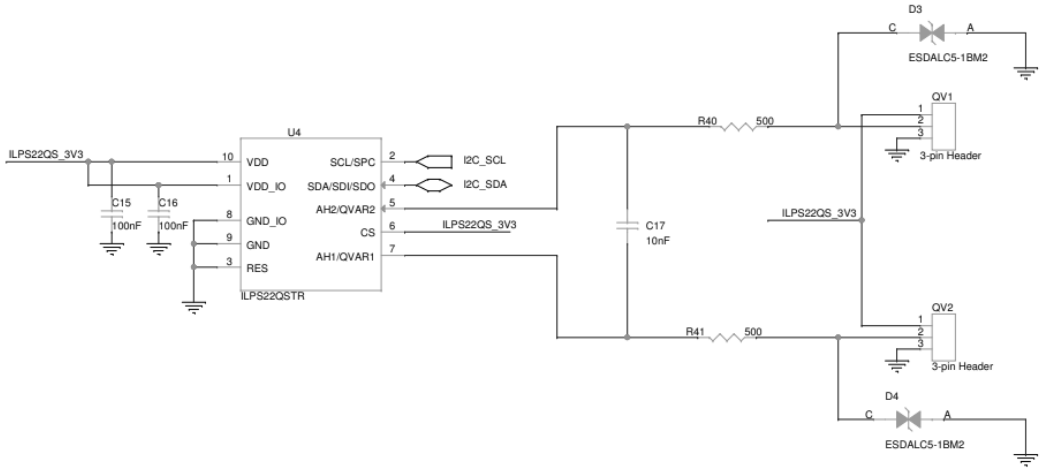
The ILPS22QS comprises a sensing element and an IC interface, which communicates over I²C, MIPI I3CSM or SPI interfaces from the sensing element to the application and supports 1.2 V digital interface as well.

The ILPS22QS is available in a full-mold, holed LGA package (HLGA). The package is holed to allow external Pressure to reach the sensing element.

Table 6. ILPS22QSTR details

Features	Description
Order code	ILPS22QSTR
Package	HLGA-10L
Operating voltage	1.71 V to 3.6 V

Figure 8. **ILPS22QSTR circuit**



2.5 Magnetometer IIS2MDC

The IIS2MDC is a high-accuracy, ultra-low-power 3-axis digital magnetometer. The IIS2MDC has a magnetic field dynamic range up to ±50 gausses.

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

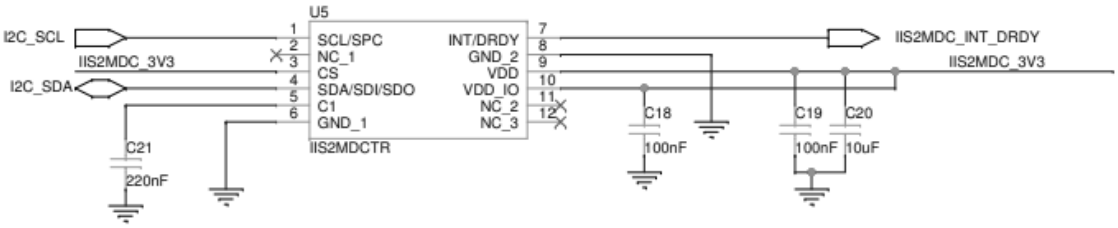
The device can be configured to generate an interrupt signal for magnetic field detection.

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.

Table 7. **IIS2MDCTR details**

Features	Description
Order code	IIS2MDCTR
Package	12-WFLGA
Operating voltage	1.71 V to 3.6 V

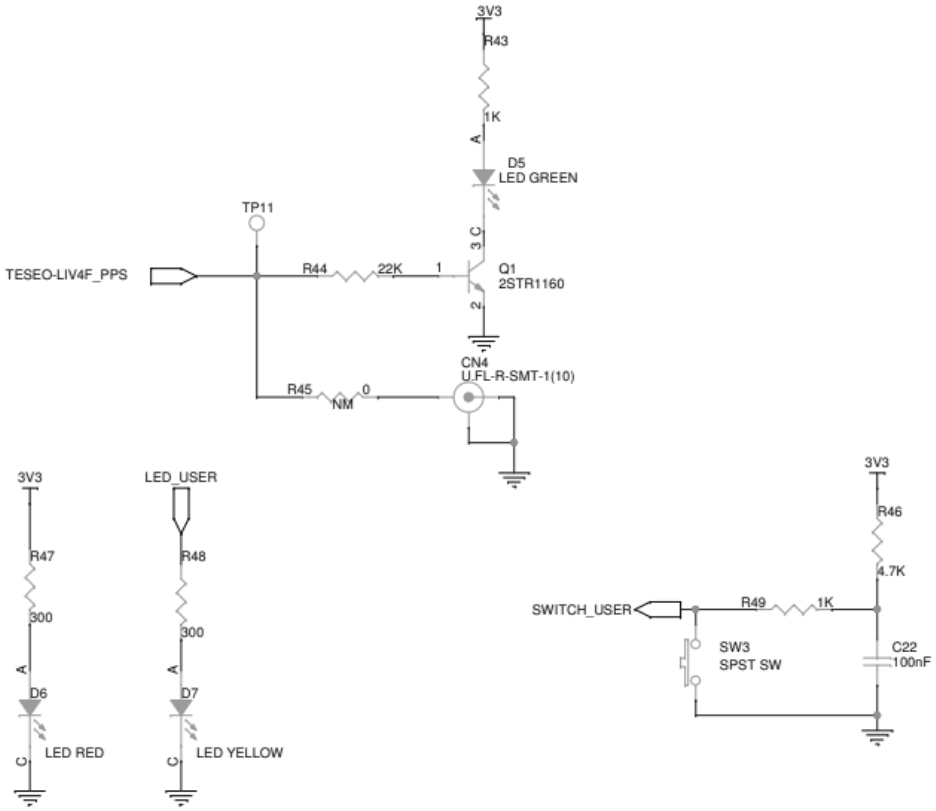
Figure 9. **IIS2MDC circuit**



2.6 LEDs and switches

Three LEDs are used as an output to indicate to the user the functioning of the module. A red LED glows constantly indicating an adequate power supply is available to the board. A green LED blinks continuously to indicate the functioning of PPS (pulse per second). All user-indicated functions are denoted by the yellow LED when the USER switch (SW3) is pressed. The other two push button switches (SW1, SW2) are used to take input such as RESET or WAKE UP from the user.

Figure 10. LEDS and switches circuit



2.7 40 PIN GPIO CONNECTOR

The on-board devices are controlled through the main board using various peripheral pins available on the GPIO connector. The series resistors are used to isolate the pins of the GPIO connector.

Figure 11. **GPIO Connector**

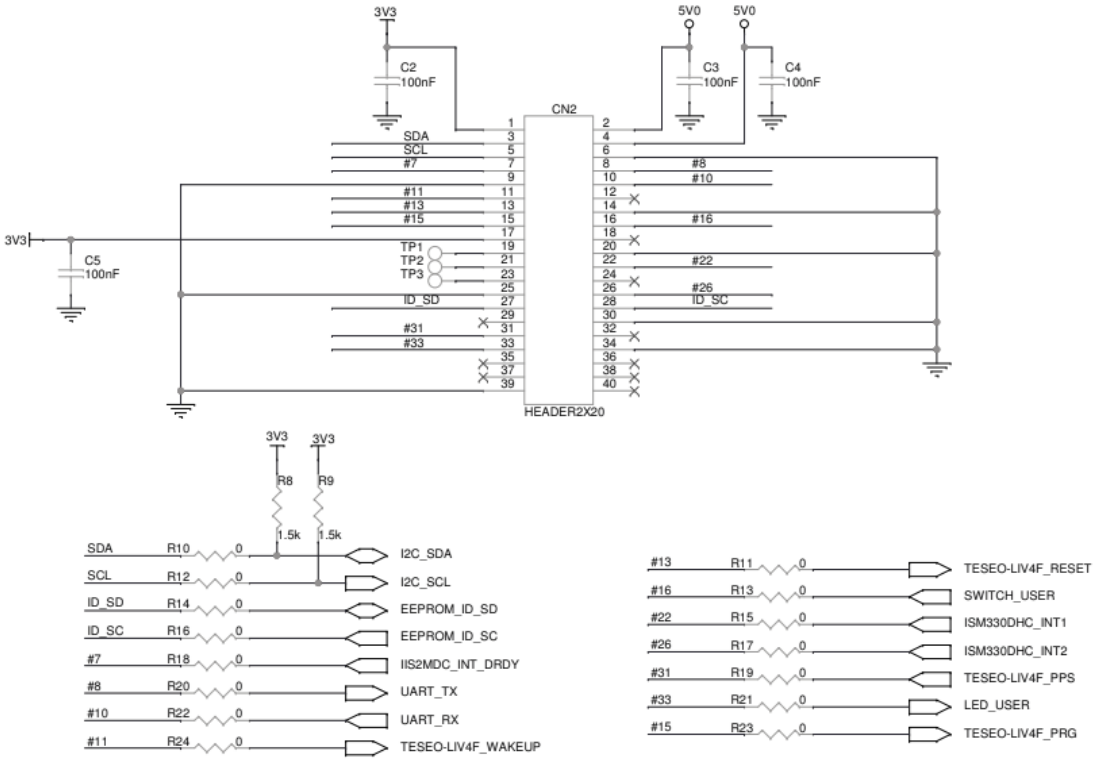


Table 8. **GPIO connector pin configuration**

Pin No	Name	STM32MP157F-DK2	Pin No	Name	STM32MP157F-DK2
1	3V3		2	5V0	
3	I2C_SDA	PA12 / I2C5_SDA	4	5V0	
5	I2C_SCL	PA11 / I2C5_SCL	6	GND	
7	IIS2MDC_INT_DRDY	PA8/ MCO1	8	TESEO-LIV4F_UART_RX	PB10 / USART3_TX
9	GND	GND	10	TESEO-LIV4F_UART_TX	PB12 / USART3_RX
11	TESEO-LIV4F_WAKEUP	PG8 / USART3_RTS	12		PI5 / SAI2_SCKA
13	TESEO-LIV4F_RESET	PD7 / SDMMC3_D3	14	GND	
15	TESEO-LIV4F_PRG	PG15 / SDMMC3_CK	16	SWITCH_USER	PF1 /SDMMC3_CMD
17	3V3		18	#18	PF0 / SDMMC3_D0
19	#19	PF9/ SPI5_MOSI	20	GND	
21	#21	PF8 / SPI5_MISO	22	ISM330DHC_INT1	PF4 / SDMMC3_D1
23	#23	PF7 / SPI5_SCK	24	#24	PF6 / SPI5_NSS
25	GND		26	ISM330DHC_INT2	PF3 / GPIO7
27	EEPROM_ID_SD	PF15/I2C1_SDA	28	EEPROM_ID_SC	PD12 / I2C1_SCL
29		PG2/ MCO2	30	GND	
31	TESEO-LIV4F_PPS	PH11 / TIM5_CH2	32	#32	PD13 / TIM4_CH2
33	LED_USER (YELLOW)	PC7/TIM3_CH2	34	GND	
35	#35	PI7 / SAI2_FSA	36	#36	PB13 /USART3_CTS

Pin No	Name	STM32MP157F-DK2	Pin No	Name	STM32MP157F-DK2
37	#37	PF5/ SDMMC3_D2	38	#38	PI6 / SAI2_SDA
39	GND		40	#40	PF11 / SAI2_SDB

3 Schematic diagrams

Figure 12. X-STM32MP-GNSS2 schematic diagram (1 of 8)

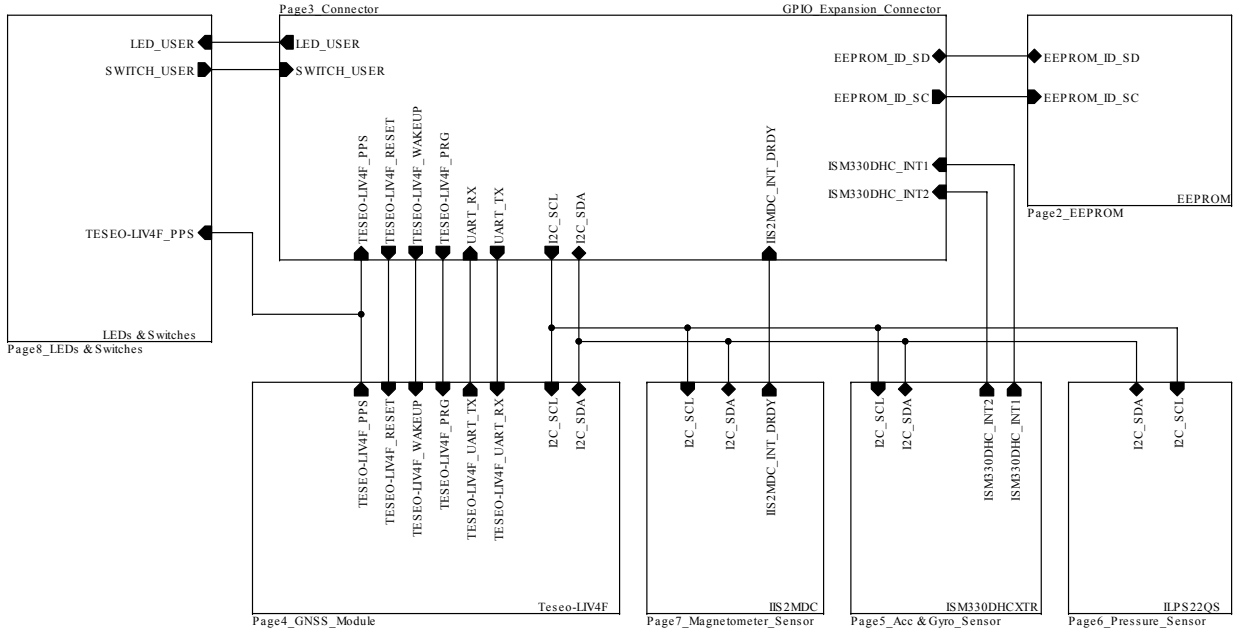


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Figure 13. X-STM32MP-GNSS2 schematic diagram (2 of 8)

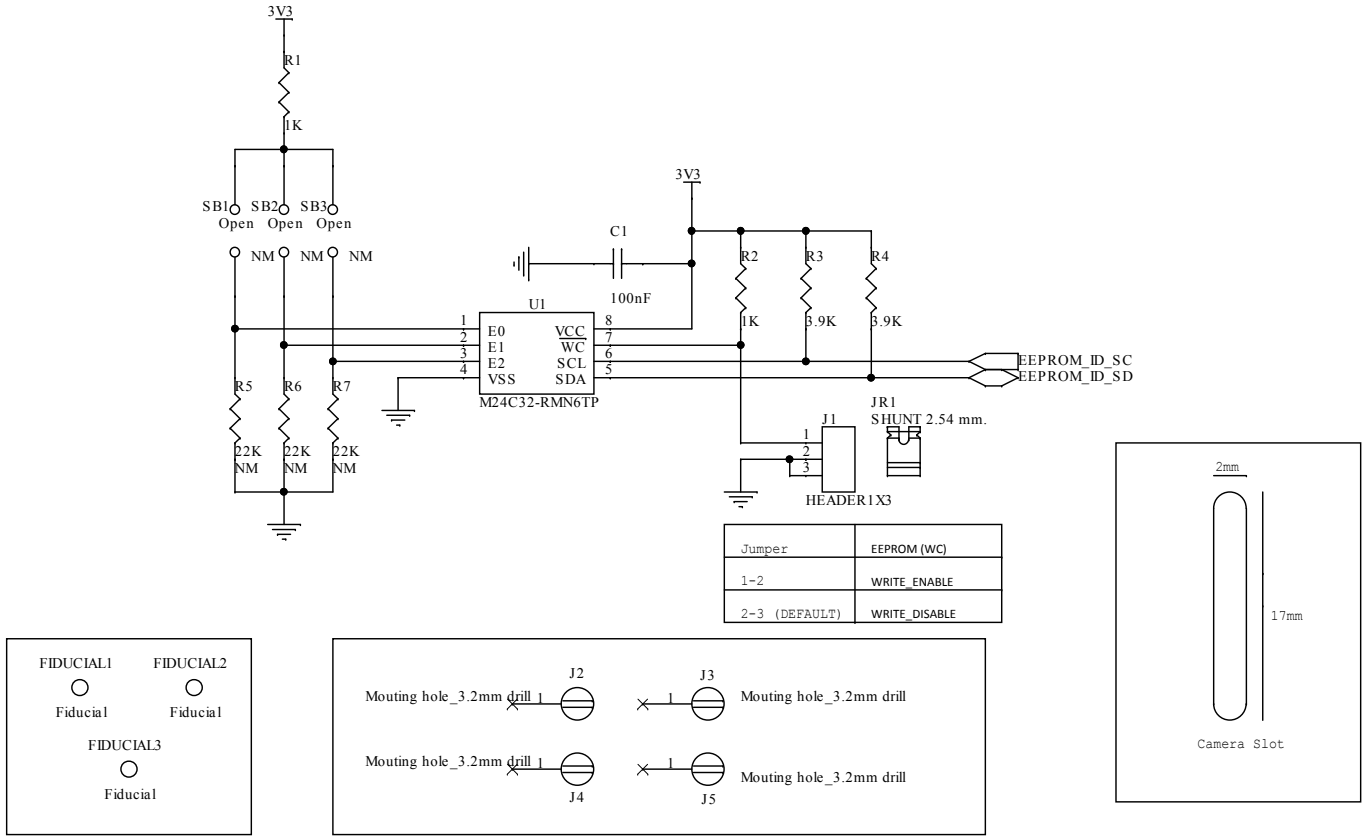

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Figure 14. X-STM32MP-GNSS2 schematic diagram (3 of 9)

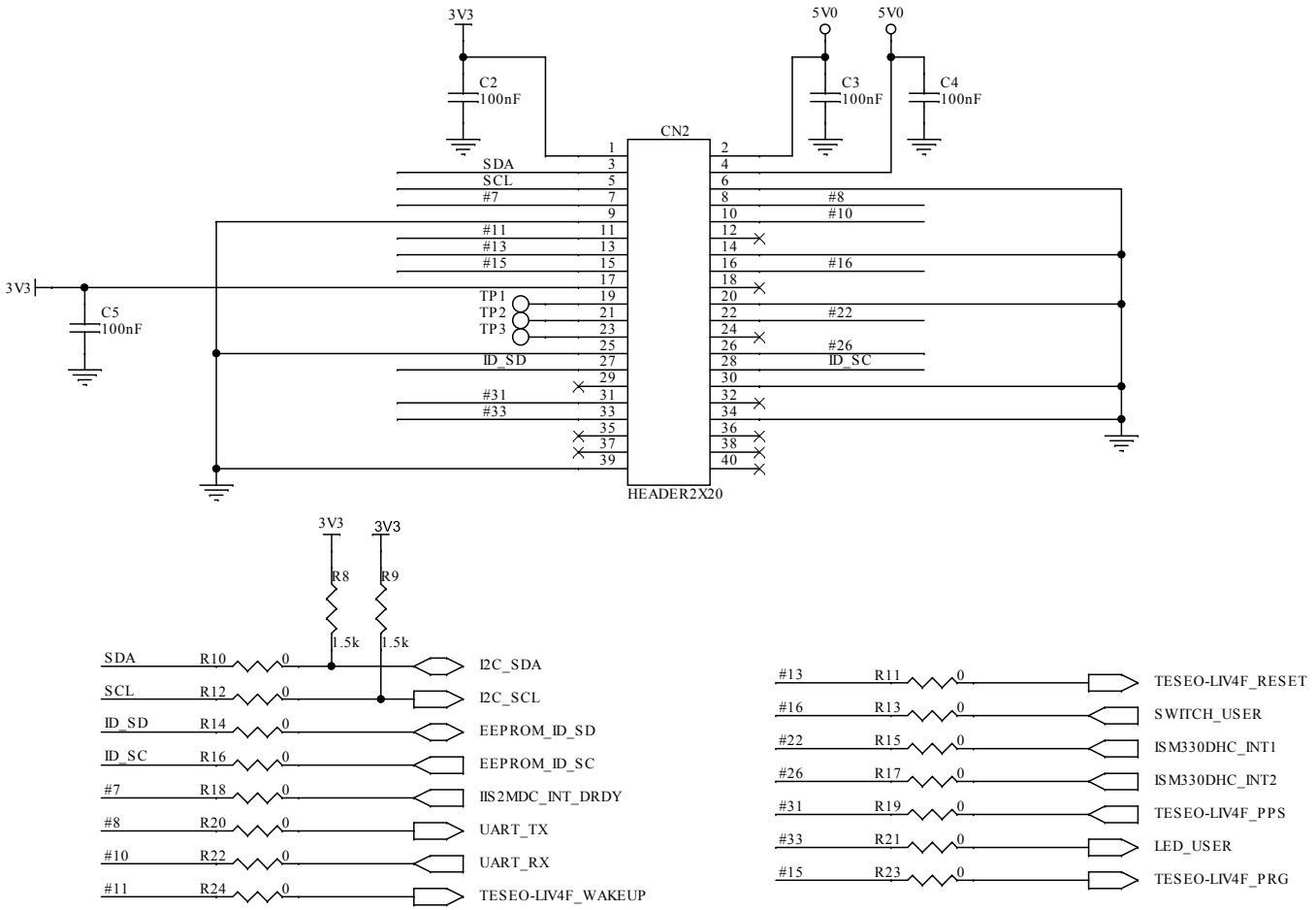

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Figure 15. X-STM32MP-GNSS2 schematic diagram (4 of 8)

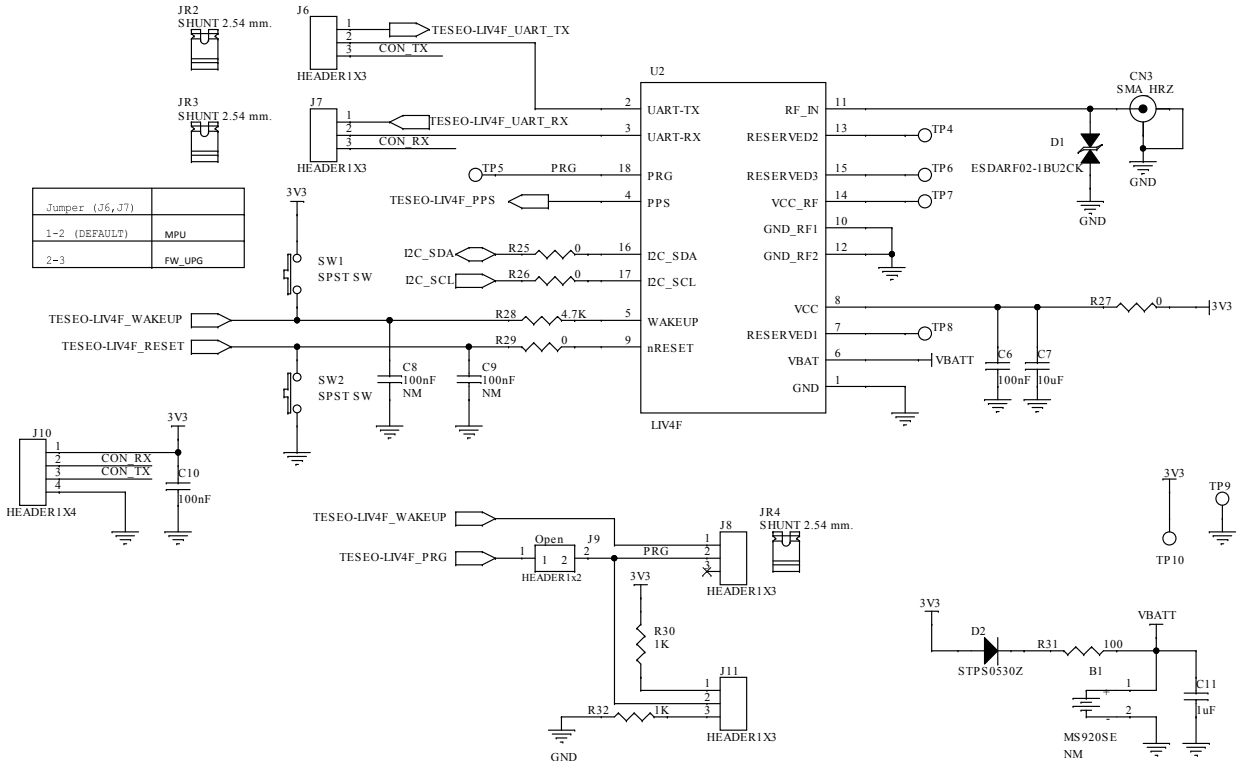
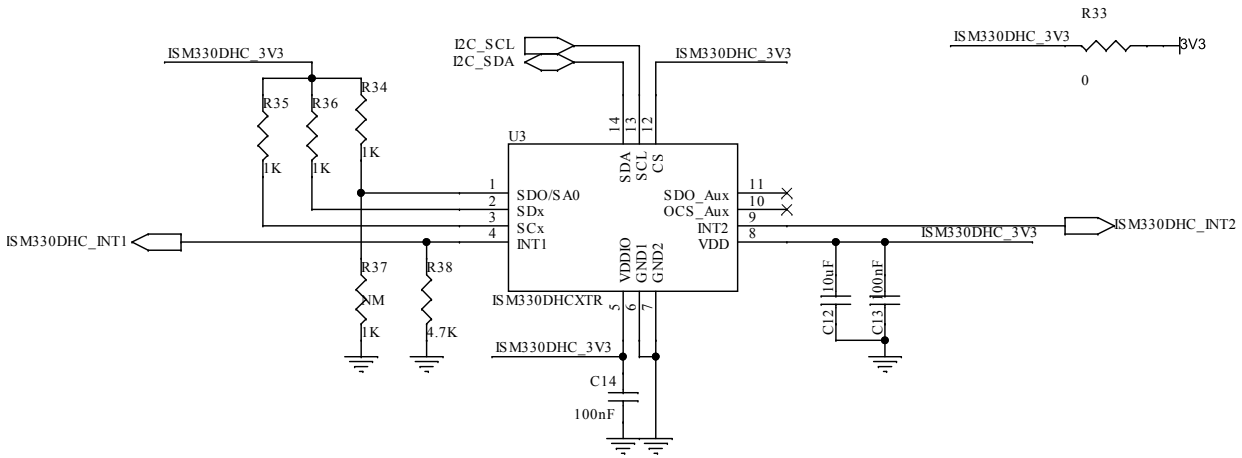


Figure 16. **X-STM32MP-GNSS2 schematic diagram (5 of 8)**



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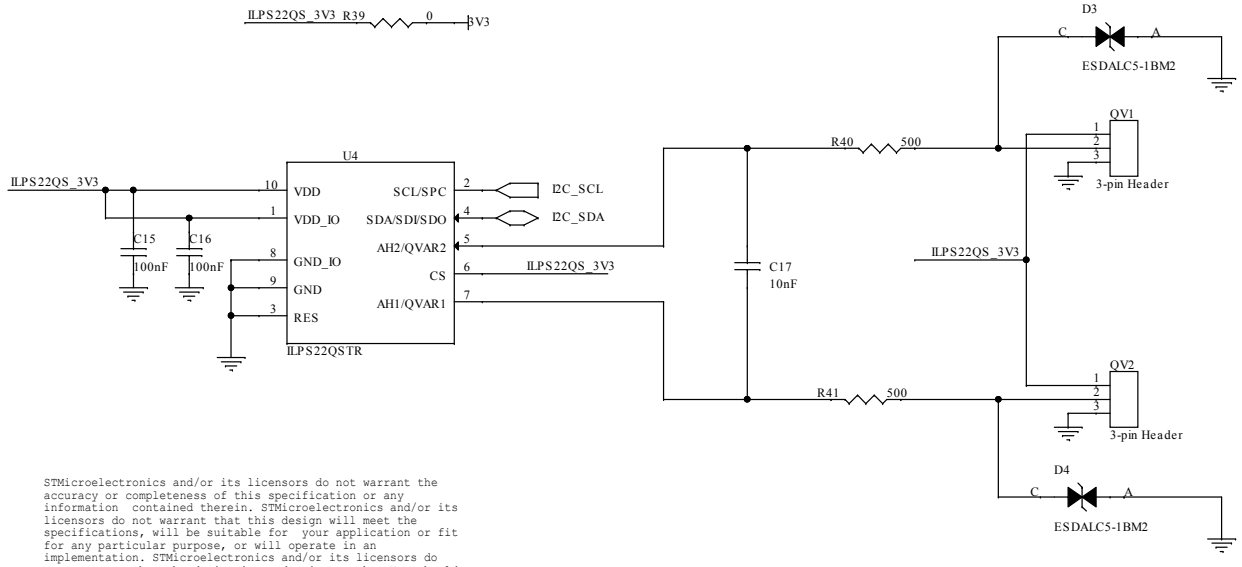
Accelerometer and Gyroscope

Figure 17. **X-STM32MP-GNSS2 schematic diagram (6 of 8)**



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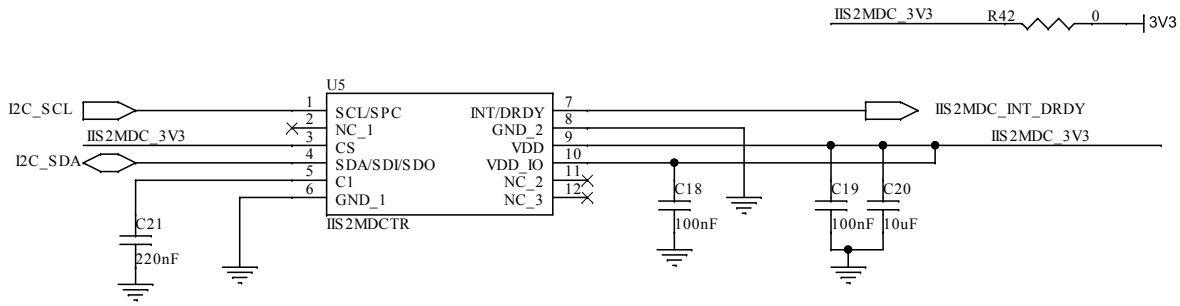
Pressure Sensor

Figure 18. **X-STM32MP-GNSS2 schematic diagram (7 of 8)**



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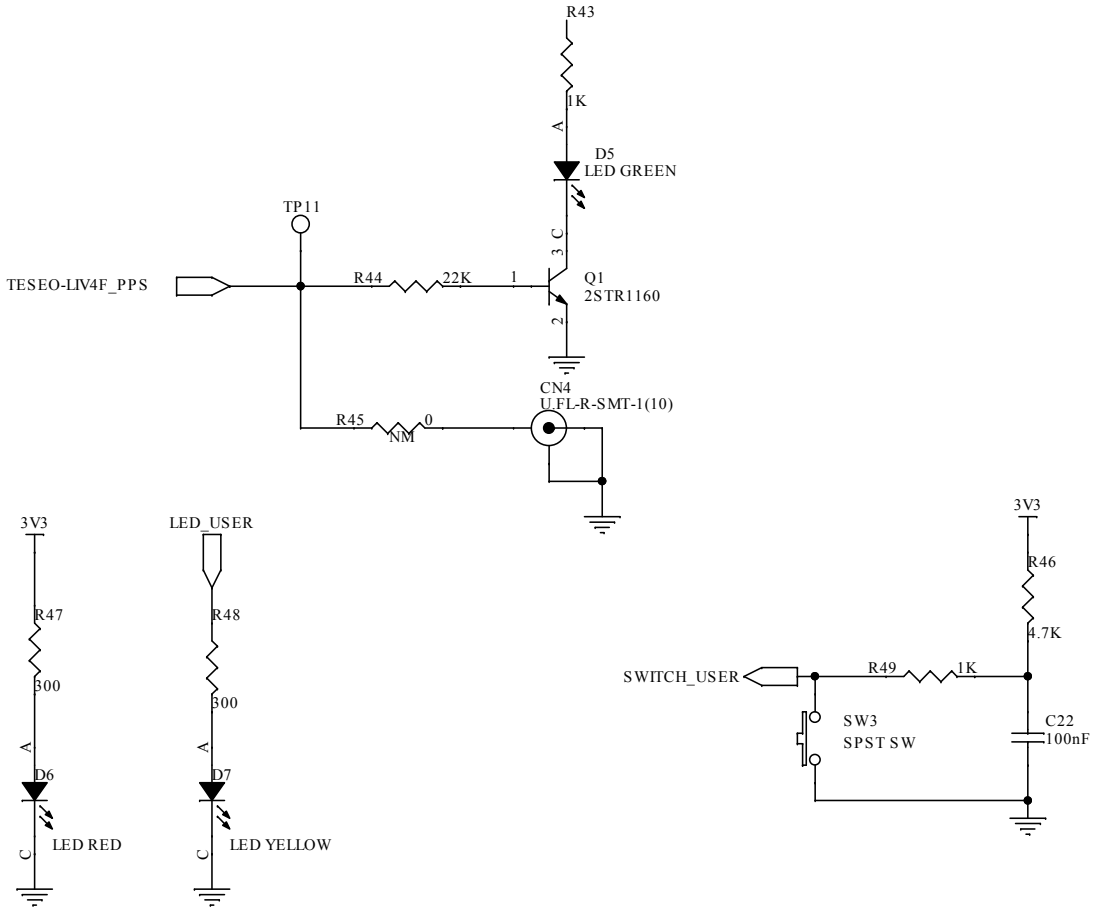
Magnetometer

Figure 19. X-STM32MP-GNSS2 schematic diagram (8 of 8)



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4 Bill of materials

Table 9. **X-STM32MP-GNSS2 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	B1	S8421-45R	Battery Holder (Open) Coin, 20.0mm 1 Cell SMD (SMT) Tab	Harwin Inc.	S8421-45R
2	12	C1 C2 C3 C4 C5 C13 C14 C15 C16 C18 C19 C22	100nF	CAP CER 0.1UF 16V X7R 0603	Würth Elektronik	885012206046
3	2	C6 C10	100nF	CAP CER 0.1UF 16V X7R 0603	Würth Elektronik	885012206046
4	1	C7	10uF	CAP CER 10UF 25V X5R 0603	Würth Elektronik	885012106031
5	2	C8 C9	100nF	CAP CER 0.1UF 16V X7R 0603	Würth Elektronik	885012206046
6	1	C11	1uF	CAP CER 1UF 16V X7R 0603	Würth Elektronik	885012206052
7	2	C12 C20	10uF	CAP CER 10UF 25V X5R 0603	Würth Elektronik	885012106031
8	1	C17	10nF	CAP CER 10000PF 50V X7R 0603	Würth Elektronik	885012206089
9	1	C21	220nF	CAP CER 0.22UF 16V X7R 0603	Würth Elektronik	885012206048
10	1	CN2	Header 20X2_female	Double Row_Vertical_.100"_Extended Tail Connector	Samtec	SSQ-120-03-T-D
11	1	CN3	SMA_HRZ	50 Ohm SMA Jack, Edge Mount	Samtec	SMA-J-P-H-ST-EM1
12	1	CN4	U.FL-R-SMT-1(10)	CONN U.FL RCPT STR 50 OHM SMD	Hirose Electric Co Ltd	U.FL-R-SMT-1(10)
13	1	D1	ESDARF02-1BU2CK, ST0201	TVS DIODE 3.6VWM 12VC 0201	ST	ESDARF02-1BU2CK
14	1	D2	STPS0530Z, SOD-123	Surface mount SCHOTTKY RECTIFIERS	ST	STPS0530Z
15	2	D3 D4	ESDALC5-1BM2, SOD-882	TVS DIODE 5VWM SOD882	ST	ESDALC5-1BM2
16	1	D5	LED GREEN	LED GREEN CLEAR 0603 SMD	Würth Elektronik	150060GS75000
17	1	D6	LED RED	LED RED CLEAR 0603 SMD	Würth Elektronik	150060RS75000

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
18	1	D7	LED YELLOW	LED YELLOW CLEAR 0603 SMD	Würth Elektronik	150060YS75000
19	1	J1	3-pin Male Header	CONN HEADER .100 STR 3POS	Samtec Inc.	TSW-103-07-F-S
20	4	J6 J7 J8 J11	3-pin Male Header	CONN HEADER .100 STR 3POS	Samtec Inc.	TSW-103-07-F-S
21	1	J9	HEADER1x2	2.54 PIN HEADER SINGLE ROW 2 PIN	Wurth Elektronik	61300211121
22	1	J10	HEADER1x4	CONN HEADER .100 STR 4POS	Samtec Inc.	TSW-104-07-F-S
23	4	JR1 JR2 JR3 JR4	2.54 mm	JUMPER	Wurth Elektronik	60900213421
24	1	Q1	2STR1160	TRANS NPN 60V 1A SOT-23	STMicroelectronics	2STR1160
25	2	QV1 QV2	3-pin Header	CONN HEADER .100 STR 3POS	Samtec Inc.	TSW-103-07-F-S
26	9	R1 R2 R30 R32 R34 R35 R36 R43 R49	1K	RES SMD 1K OHM 1% 1/10W 0603	Vishay Dale	CRCW06031K00FKEA
27	2	R3 R4	3.9K	RES SMD 3.9K OHM 1% 1/10W 0603	Yageo	RT0603FRE073K9L
28	3	R5 R6 R7	22K	RES SMD 22K OHM 5% 1/10W 0603	Vishay Dale	CRCW060322K0JNEA
29	2	R8 R9	1.5k	RES SMD 1.5K OHM 1% 1/10W 0603	Yageo	RC0603FR-071K5P
30	21	R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R33 R39 R42	0	RES SMD 0 OHM JUMPER 1/10W 0603	TE Connectivity Passive Product	CRG0603ZR
31	3	R28 R38 R46	4.7K	RES SMD 4.7K OHM 1% 1/10W 0603	Yageo	RC0603FR-074K7P
32	1	R29	0	RES SMD 0 OHM JUMPER 1/10W 0603	TE Connectivity Passive Product	CRG0603ZR
33	1	R31	100	RES 100 OHM 1% 1/10W 0603	Stackpole Electronics Inc	RMCF0603FT100R
34	1	R37	1K	RES SMD 1K OHM 1% 1/10W 0603	Vishay Dale	CRCW06031K00FKEA
35	2	R40 R41	500	RES 499 OHM 1% 1/10W 0603	YAGEO	RC0603FR-07499RL

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
36	1	R44	22K	RES SMD 22K OHM 5% 1/10W 0603	Vishay Dale	CRCW060322K0JNEA
37	1	R45	0	RES SMD 0 OHM JUMPER 1/10W 0603	TE Connectivity Passive Product	CRG0603ZR
38	2	R47 R48	300	RES 300 OHM 1% 1/10W 0603	Stackpole Electronics Inc.	RMCF0603FT300R
39	3	SB1 SB2 SB3	Open	RES 0 OHM JUMPER 1/10W 0603	Rohm Semiconductor	SFR03EZPJ000
40	3	SW1 SW2 SW3	Tact SW	SWITCH TACTILE SPST-NO 0.05A 24V	TE Connectivity ALCOSWITCH Switches	1437566-3
41	3	TP1 TP2 TP3	TEST POINT	PC TEST POINT	SMD Pads	SMD Pads
42	8	TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11	TEST POINT	PC TEST POINT NATURAL	Keystone Electronics	5000
43	1	U1	M24C32-RMN6TP, SO8	32 Kbit serial I2C bus EEPROM	ST	M24C32-RMN6TP
44	1	U2	LIV4F, 18LD LGA 9.7X10.1X2.55 MM PITCH	Tiny Dual-Band GNSS Low Power module	ST	TESEO-LIV4FTR
45	1	U3	ISM330DHCXTR, VFLGA2.5X3X.86 14L P.5 L.475X.25	INEMO INERTIAL MODULE: 3D digital accelerometer and 3D digital gyroscope	ST	ISM330DHCXTR
46	1	U4	ILPS22QSTR, HLGA 2X2X.8 10L EXP. SILIC .91SQ	CONSUMER MEMS	ST	ILPS22QSTR
47	1	U5	IIS2MDC, LGA2X2X0.7 12 LEADS	High accuracy, ultra-low-power ,3-axis digital output magnetometer	ST	IIS2MDCTR
				Misc		
1	4	Nut		M3x0.5 Hex Nut 0.217" (5.50mm) Nylon	Würth Elektronik	709940300
2	4	Spacer		Hex Standoff Threaded M3x0.5 Nylon 0.472" (12.00mm) Natural	Essentra	36M30MF012
3	1	Antenna			Taoglas	Taoglas EAHP.50.01.0100D

5 X-STM32MP-GNSS2 versions

Table 10. X-STM32MP-GNSS2 versions

PCB version	Schematic diagrams	Bill of materials
X$STM32MP-GNSS2A(1)	X$STM32MP-GNSS2A schematic diagrams	X$STM32MP-GNSS2A bill of materials

1. *This code identifies the X-STM32MP-GNSS2 evaluation board first version. It is printed on the board PCB.*

6 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

Notice for Innovation, Science and Economic Development Canada (ISED)

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).

Notice for the European Union

The evaluation kit is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Applied harmonized standards are listed in the EU Declaration of Conformity.

Notice for the United Kingdom

The evaluation kit is in compliance with the UK Radio Equipment Regulations 2017 (UK SI 2017 No. 1206 and amendments) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK SI 2012 No. 3032 and amendments). Applied standards are listed in the UK Declaration of Conformity.

7 Testing and certification

The Teseo-LIV4F module is CE-certified (2051-RED-222704). Refer to the device datasheet for further details.

Revision history

Table 11. **Document revision history**

Date	Revision	Changes
05-Dec-2023	1	Initial release.

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