

## Getting started with the X-STM32MP-IOT01A and X-STM32MP-IOT01E expansion boards for the STM32MP157F-DK2 discovery kit

### Introduction

The X-STM32MP-IOT01A and X-STM32MP-IOT01E are a 40-pin connector expansion boards for the STM32MP157F-DK2 discovery kit. The X-STM32MP-IOT01A features the SPIRIT1 SPSGRF-915 whereas the X-STM32MP-IOT01E features the SPSGRF-868 RF module for Sub-1 GHz RF communication.

Both boards embed the LSM6DSOX iNEMO inertial module for IoT applications. They interface with the STM32MP157F-DK2 microprocessor via GPIO connector pins and use SPI, I<sup>2</sup>C, GPIO connections for the SPSGRF, iNEMO inertial module, switches, and LED.

The expansion boards are compatible with the STM32MP157F-DK2 and Raspberry Pi GPIO connector layout.

Figure 1. X-STM32MP-IOT01A expansion board

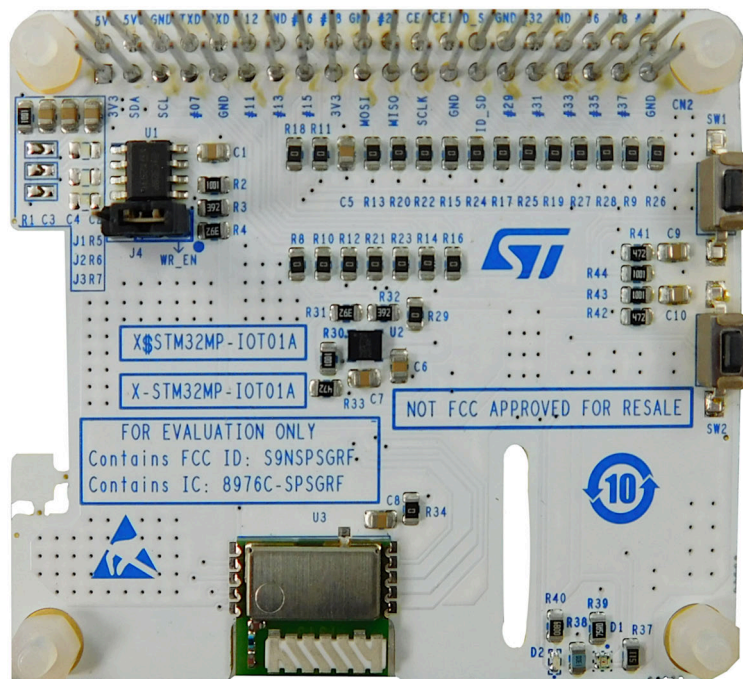
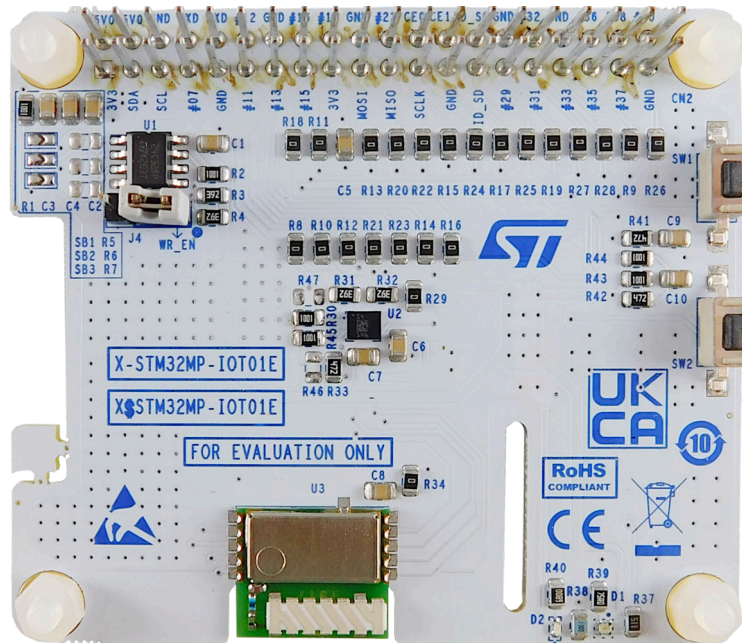


Figure 2. X-STM32MP-IOT01E expansion board



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## 1 Safety precautions

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The X-STM32MP-IOT01A and X-STM32MP-IOT01E expansion boards are powered via a standard 3.3 V supply through the GPIO connector of the STM32MP157F-DK2.

*Important:* Ensure that the DC supply used is compliant with the safety standards required in the region of operation.

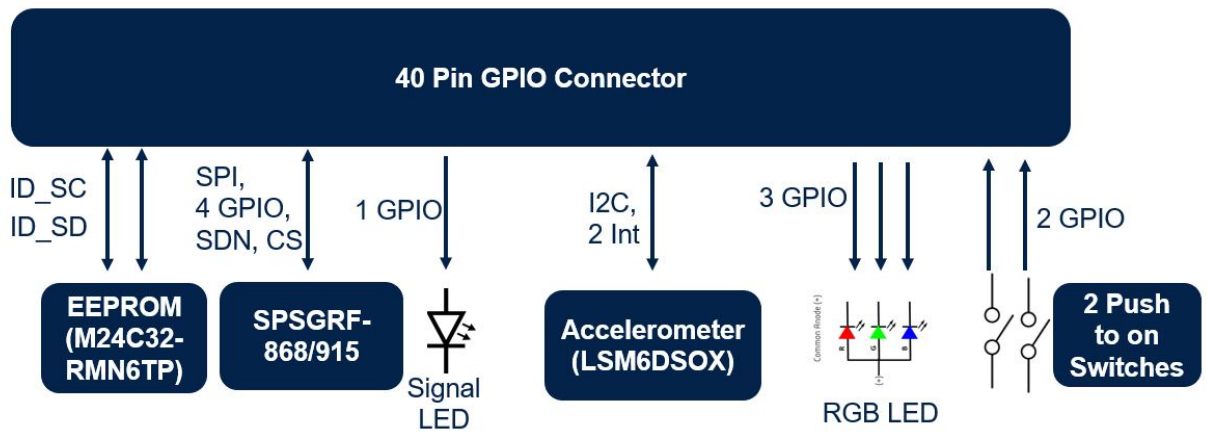
## 2 Overview

The X-STM32MP-IOT01A and X-STM32MP-IOT01E operate in the 915 MHz and 868 MHz ISM band, respectively.

The LSM6DSOX iNEMO inertial module is used for the motion detection.

The expansion board interface with the STM32MP157F-DK2 via the 40-pin GPIO connector pins. They uses SPI, I<sup>2</sup>C, and GPIO connections for the SPSGRF, LSM6DSOX, keys, and LED.

**Figure 3. System block diagram**



The on-board devices are controlled through the STM32MP157F-DK2 using various peripheral pins available on the GPIO connector.

The SPSGRF interfaces with the STM32MP157F-DK2 using the SPI.

The I<sup>2</sup>C interface is used to interact with the LSM6DSOX.

The RGB LED and switches control through GPIOs is used for the user interface. Table 6 shows the configuration of the GPIO connector pins to connect the various devices.

The expansion boards embed the following key devices:

- **SPSGRF**: based on the SPIRIT1 device, which is a low data rate, low-power sub-GHz transceiver. The SPIRIT1 operates both in the license-free ISM and SRD frequency bands at 169, 433,868 MHz, and 915 MHz. The SPSGRF module is an FCC and IC certified module (FCC ID: S9NSPSGRF and IC: 8976C-SPSGRF). It interfaces with the STM32 Nucleo development boards through an SPI interface and some GPIOs. The SPSGRF module also integrates the BALF-SPI-01D3 balun and a chip antenna.

**Table 1. SPSGRF details**

Order code	Package	Operating voltage
SPSGRF-915 (for X-STM32MP-IOT01A) SPSGRF-868(for X-STM32MP-IOT01E)	SMD 11 pin	1.8 to 3.6 V

- **M24C32-RMN6TP**: a 32-Kbit I<sup>2</sup>C-compatible EEPROM organized as 4 K x 8 bits. The following table shows the various features of this EEPROM package.

**Table 2. M24C32-R package details**

Order code	Operating voltage	Ambient temperature
M24C32-W	2.5 to 5.5 V	-
-M24C32-R	1.8 to 5.5 V	-
M24C32-F	1.7 to 5.5 V	40°C/+85°C
M24C32-DF	1.7 to 5.5 V	40°C/+85°C
M24C32-X	1.6 to 5.5 V	-20°C/+85°C

**Table 3. M24C32-RMN6TP details**

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

- **LSM6DSOX**: features a 3-axis digital accelerometer and a 3-axis digital gyroscope with a 0.55 mA boost performance in high-performance mode. It enables always-on low-power features for an optimal motion experience for the consumer. The **LSM6DSOX** has a full-scale acceleration range of  $\pm 2/\pm 4/\pm 8/\pm 16$  g and an angular rate range of  $\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000$  dps. It fully supports EIS and OIS applications as the module includes a dedicated configurable signal processing path for OIS and the auxiliary SPI, configurable for both the gyroscope and accelerometer.

**Table 4. LSM6DSOX details**

Order code	Package	Operating voltage
LSM6DSOX	LGA-14L	1.71 to 3.6 V

- **RGB LED (SML-LX0404SIUPGUSB)**: used as an output to detect any error from the devices.
- **Two push-button switches**: used for the user's inputs.

## 2.1 EEPROM (M24C32-RMN6TP)

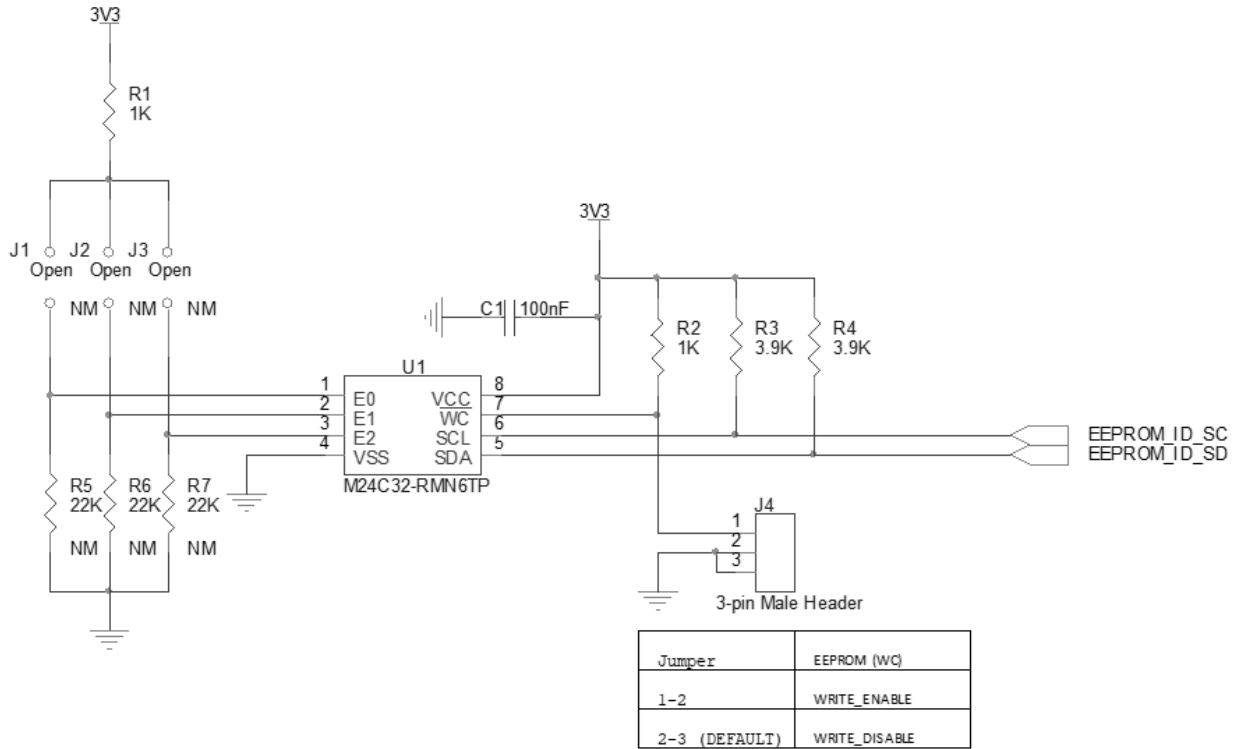
The EEPROM communicates with the **X-STM32MP-IOT01A** and **X-STM32MP-IOT01E** through I<sup>2</sup>C signals. The J4 jumper J4 makes the device write-enabled.

The device can perform the read and write operations by setting the jumpers as detailed in the following table.

**Table 5. Jumper settings**

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

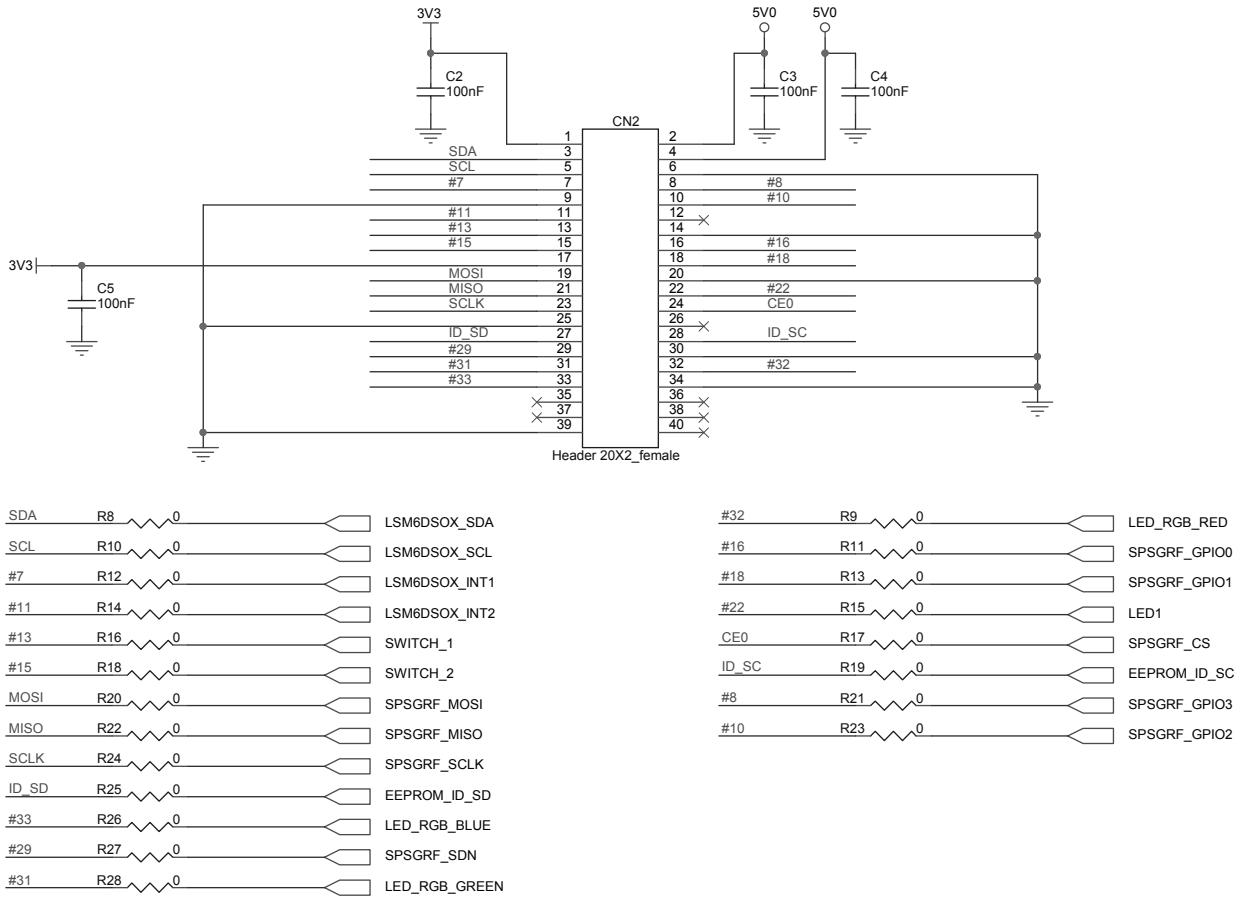
Figure 4. EEPROM section



## 2.2 GPIO connector

The X-STM32MP-IOT01A and X-STM32MP-IOT01E on-board devices are controlled through the STM32MP157F-DK2 using various peripheral pins available on the GPIO connector.

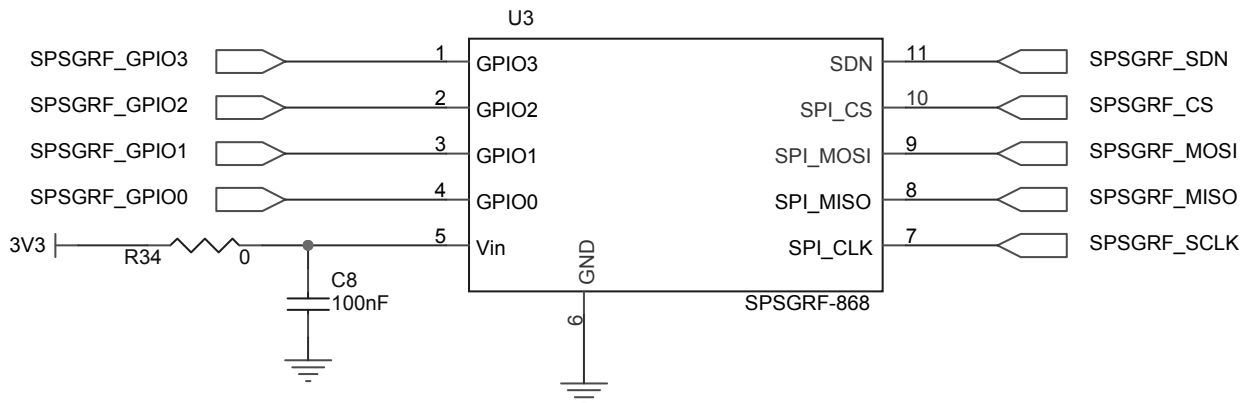
The series resistors are used to isolate the GPIO connector pins.

**Figure 5. GPIO connector section**

**Table 6. Configuration of the GPIO connector pins**

Pin no.	Name	STM32MP157F-DK2	Pin no.	Name	STM32MP157F-DK2
1	3V3		2	5V0	
3	LSM6DSOX_SDA	PA12/I2C5_SDA	4	5V0	
5	LSM6DSOX_SCL	PA11/I2C5_SCL	6	GND	
7	LSM6DSOX_INT1	PA8/MCO1	8	SPSGRF_GPIO3	PB10/USART3_TX
9	GND	GND	10	SPSGRF_GPIO2	PB12/USART3_RX
11	LSM6DSOX_INT2	PG8/USART3_RTS	12	#12	PI5/SAI2_SCKA
13	SWITCH_1	PD7/SDMMC3_D3	14	GND	
15	SWITCH_2	PG15/SDMMC3_CK	16	SPSGRF_GPIO0	PF1/SDMMC3_CMD
17	3V3		18	SPSGRF_GPIO1	PF0/SDMMC3_D0
19	SPSGRF_MOSI	PF9/SPI5_MOSI	20	GND	
21	SPSGRF_MISO	PF8/SPI5_MISO	22	LED1	PF4/SDMMC3_D1
23	SPSGRF_SCLK	PF7/SPI5_SCK	24	SPSGRF_CS	PF6/SPI5_NSS
25	GND		26	CE1	PF3/GPIO7
27	EEPROM_ID_SD	PF15/I2C1_SDA	28	EEPROM_ID_SC	PD12/I2C1_SCL
29	SPSGRF_SDN	PG2/MCO2	30	GND	
31	LED_RGB_GREEN	PH11/TIM5_CH2	32	LED_RGB_RED	PD13/TIM4_CH2
33	LED_RGB_BLUE	PC7/TIM3_CH2	34	GND	

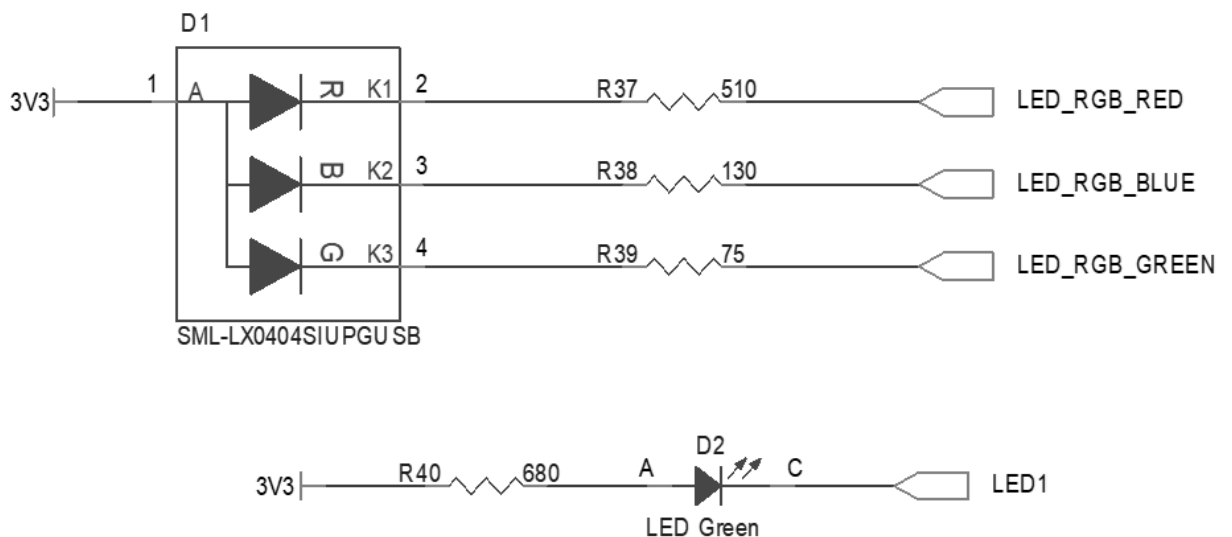




**Figure 8. SPSGRF-868 circuit**


## 2.5 RGB LED

The X-STM32MP-IOT01A and X-STM32MP-IOT01E include an RGB LED (SML-LX0404SIUPGUSB).

**Figure 9. LED section**


## 2.6 RF specifications

The RF specifications for the X-STM32MP-IOT01E are:

- Integrated radio module/chipset: radio module
- RF power: RF output power up to +11.6 dBm
- Operating band: 779 MHz to 956 MHz
- Channel spacing: 12.5 kHz min

## 3 Getting started

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### 3.1 System requirements

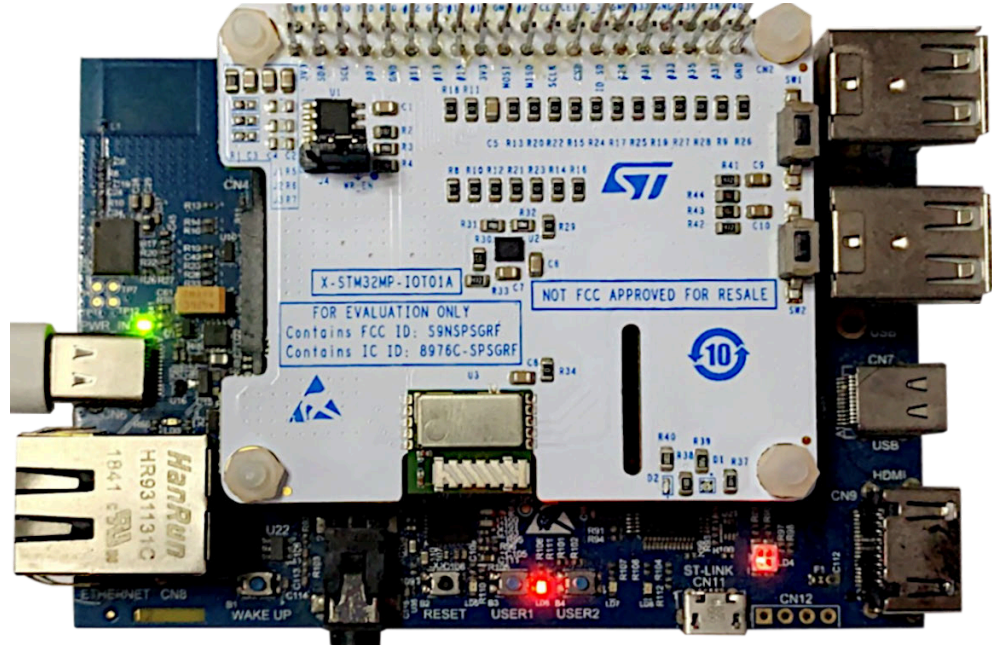
- An X-STM32MP-IOT01A or X-STM32MP-IOT01E expansion board
- An STM32MP157F-DK2 discovery kit
- A NUCLEO-F401RE development board
- An X-NUCLEO-IDS01A5 expansion board for X-STM32MP-IOT01A or X-NUCLEO-IDS01A4 for X-STM32MP-IOT01E
- A 3.3 V DC power supply
- A USB Type-C™ cable
- Two mini-USB ports
- A programming cable (compatible with ST-LINK)
- A LAN cable to connect with the internet router, to keep the STM32MP157F-DK2 and the Linux PC on the same network
- A Linux PC with a USB port

### 3.2 System setup

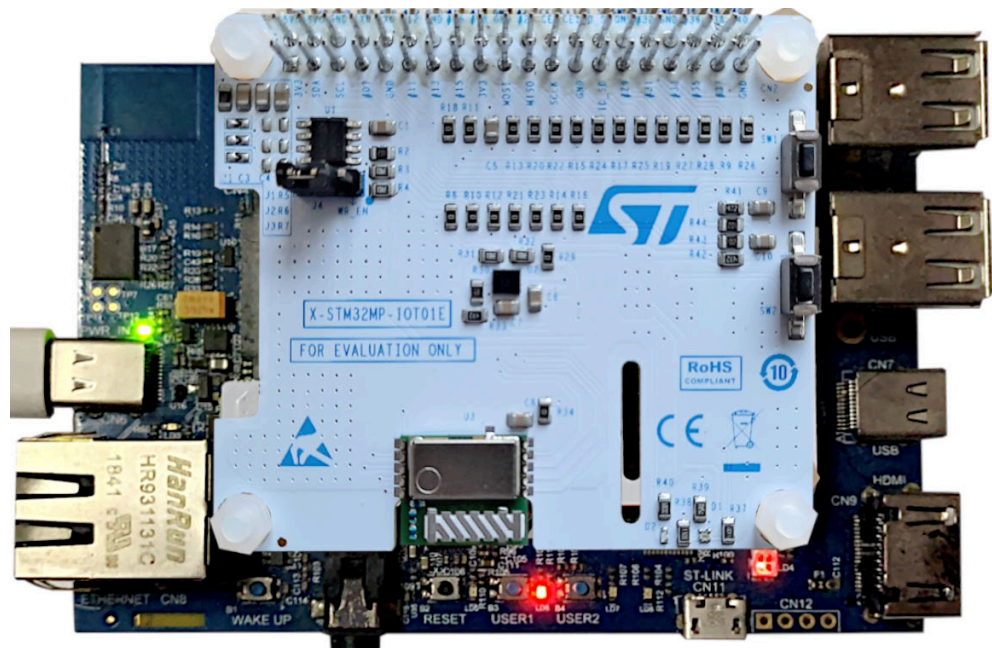
- Step 1.** Check that the jumper on the X-STM32MP-IOT01A/X-STM32MP-IOT01E J4 connector is connected. This jumper enables the write operation for the EEPROM.

**Step 2.** Connect the X-STM32MP-IOT01A/X-STM32MP-IOT01E to the STM32MP157F-DK2 from the top.

**Figure 10.** X-STM32MP-IOT01A expansion board on top of the STM32MP157F-DK2



**Figure 11.** X-STM32MP-IOT01E expansion board on top of the STM32MP157F-DK2



**Step 3.** Power the STM32MP157F-DK2 via the USB Type-C™ cable.

**Step 4.** Program the supported firmware in the STM32MP157F-DK2.  
The system is ready for use.

# 4 X-STM32MP-IOT01A schematic diagrams

Figure 12. X-STM32MP-IOT01A schematic diagram (1 of 6)

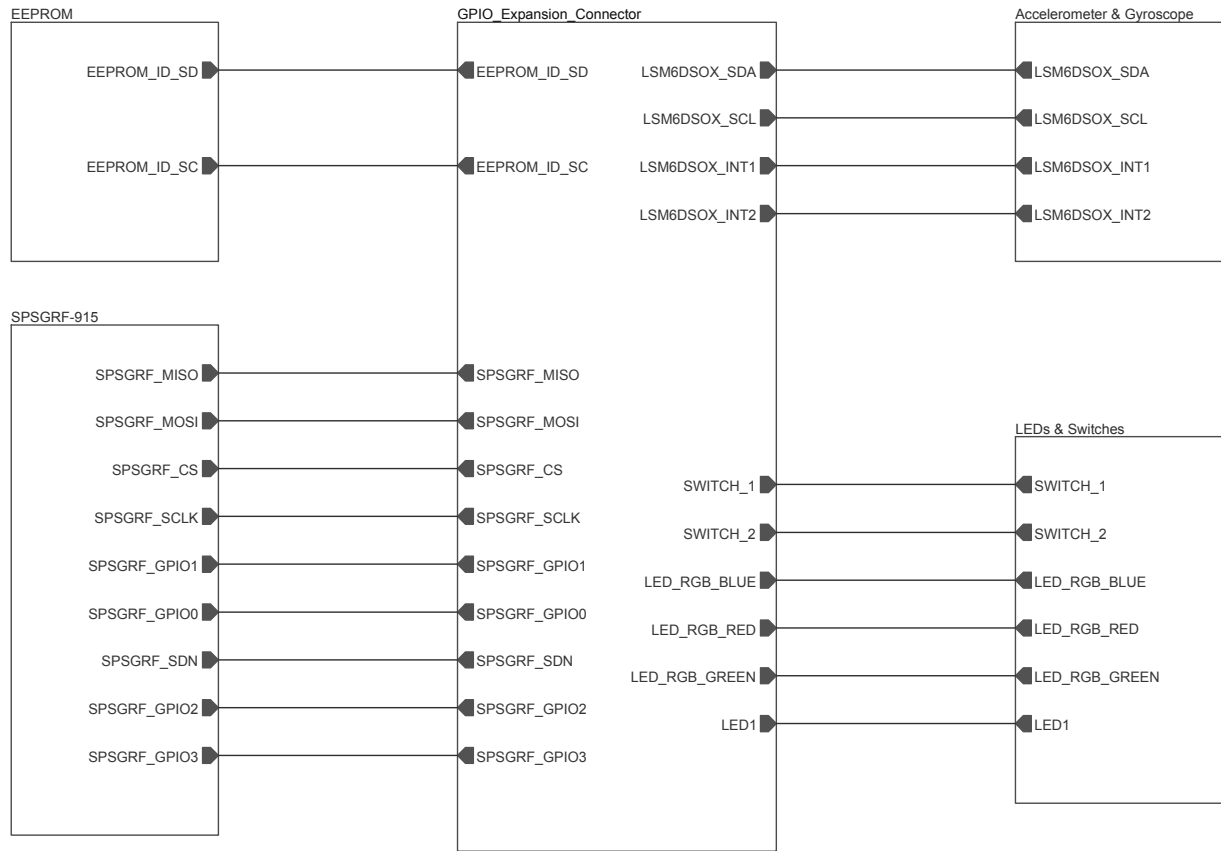


Figure 13. X-STM32MP-IOT01A schematic diagram (2 of 6)

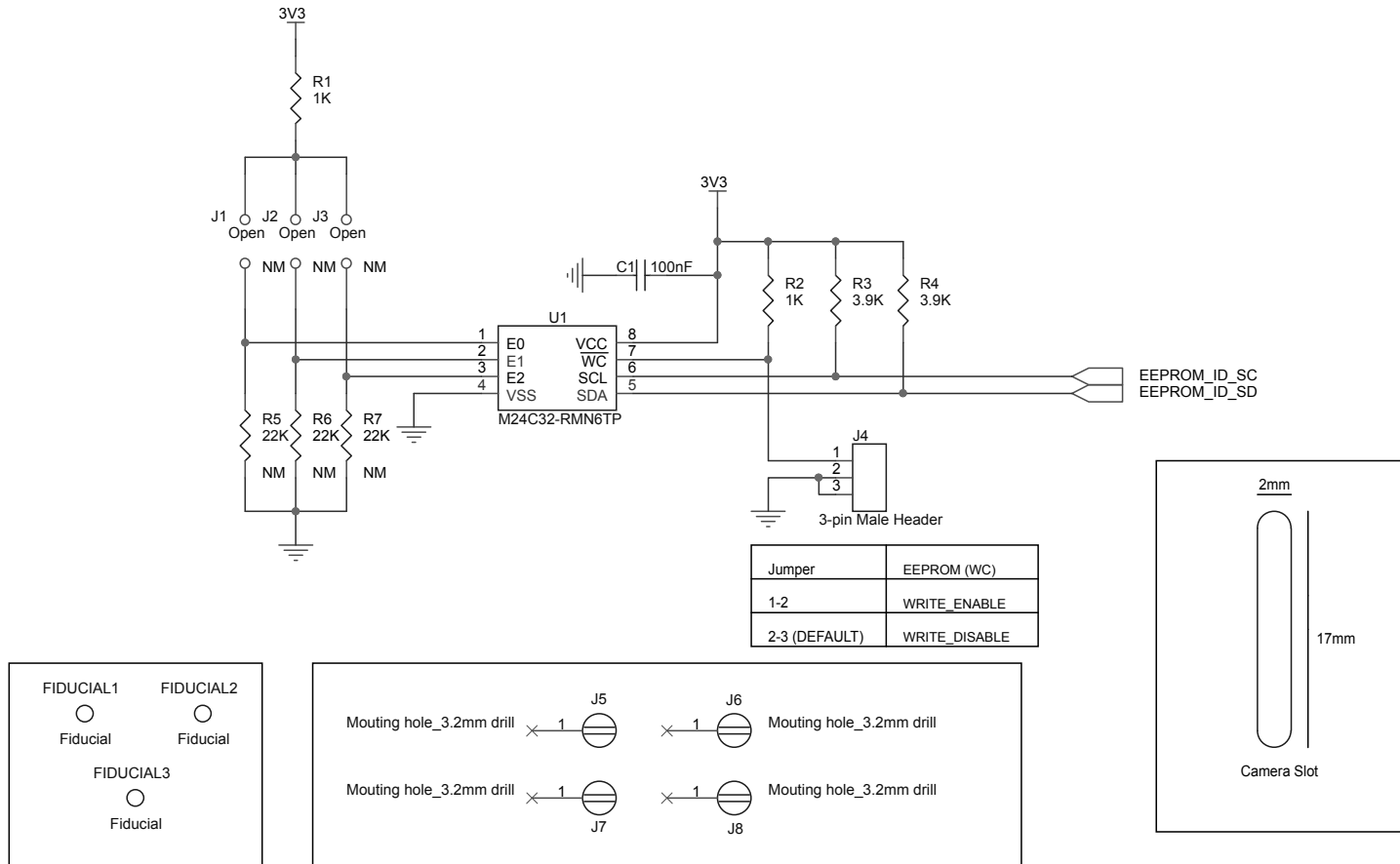


Figure 14. X-STM32MP-IOT01A schematic diagram (3 of 6)

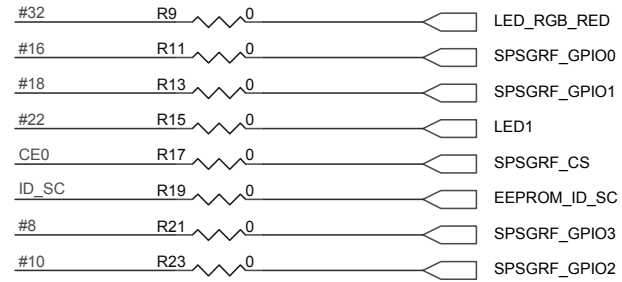
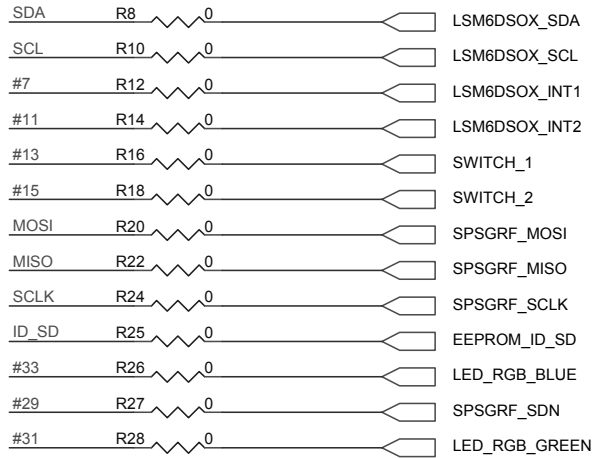
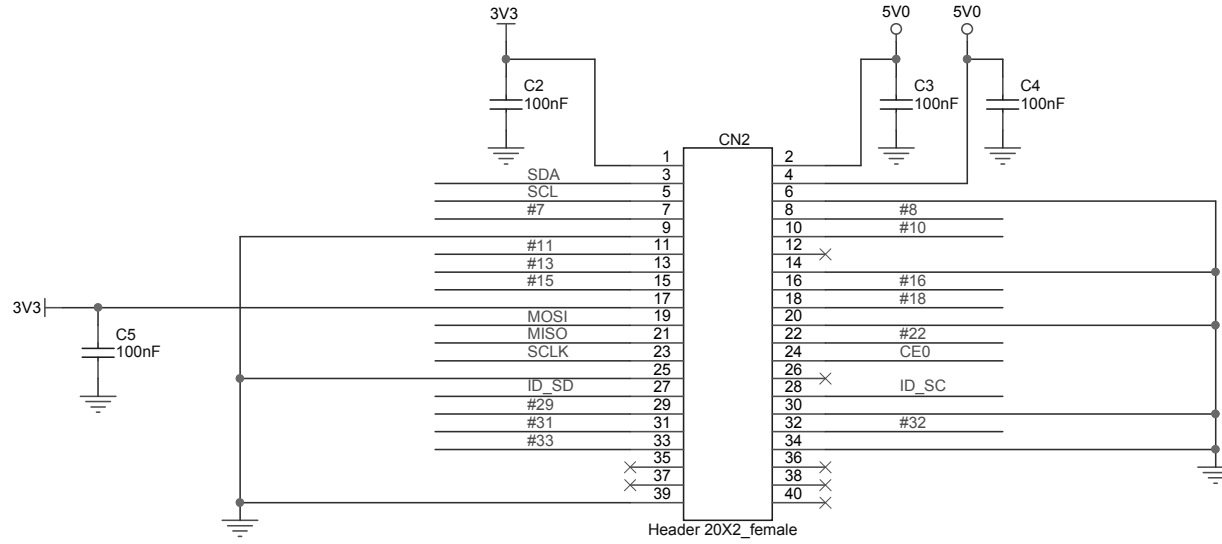


Figure 15. X-STM32MP-IOT01A schematic diagram (4 of 6)

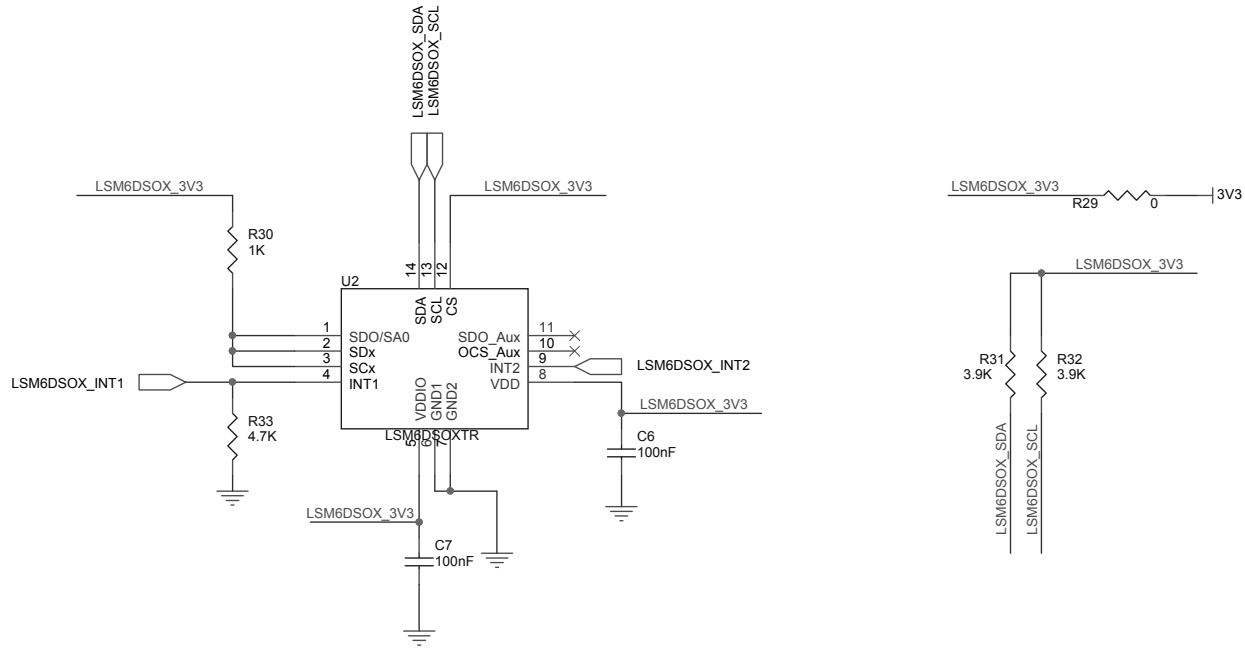


Figure 16. X-STM32MP-IOT01A schematic diagram (5 of 6)

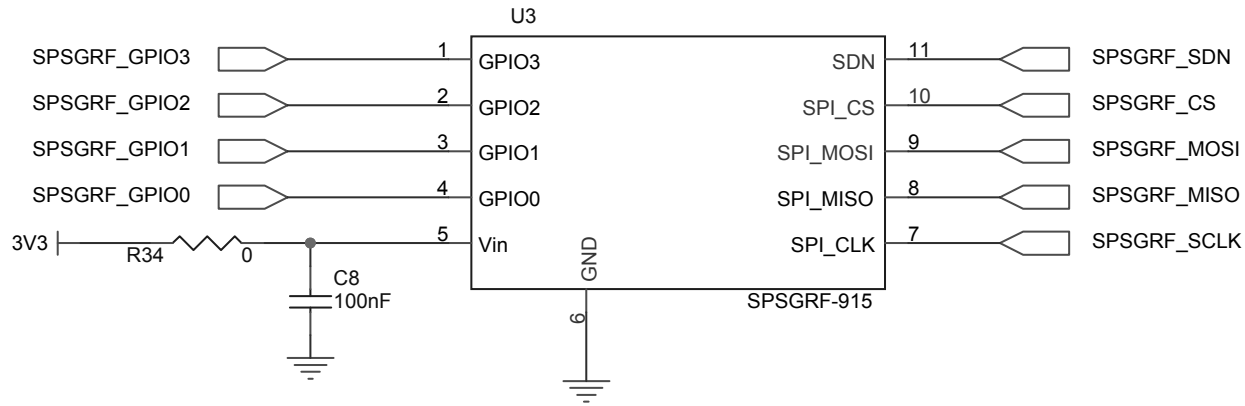
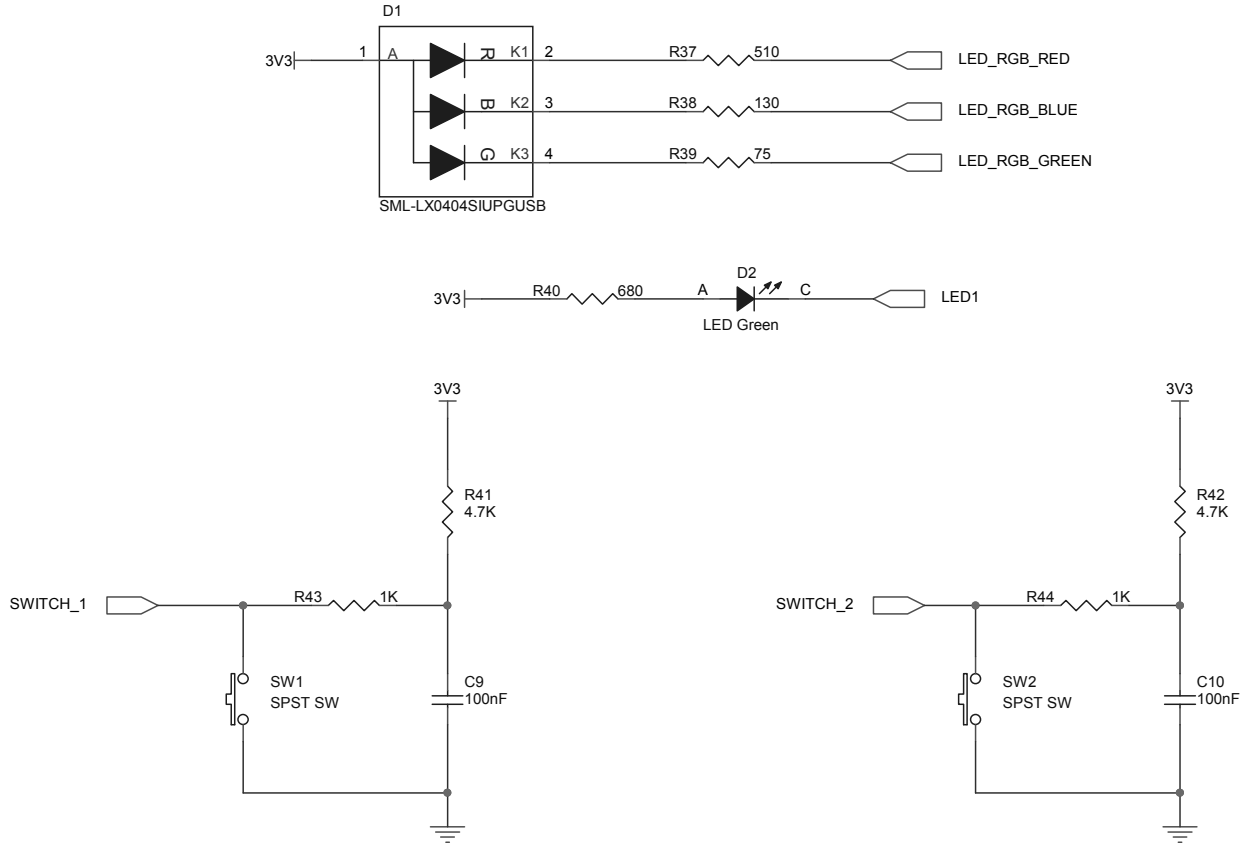


Figure 17. X-STM32MP-IOT01A schematic diagram (6 of 6)





# 5 X-STM32MP-IOT01E schematic diagrams

Figure 18. X-STM32MP-IOT01E schematic diagram (1 of 6)

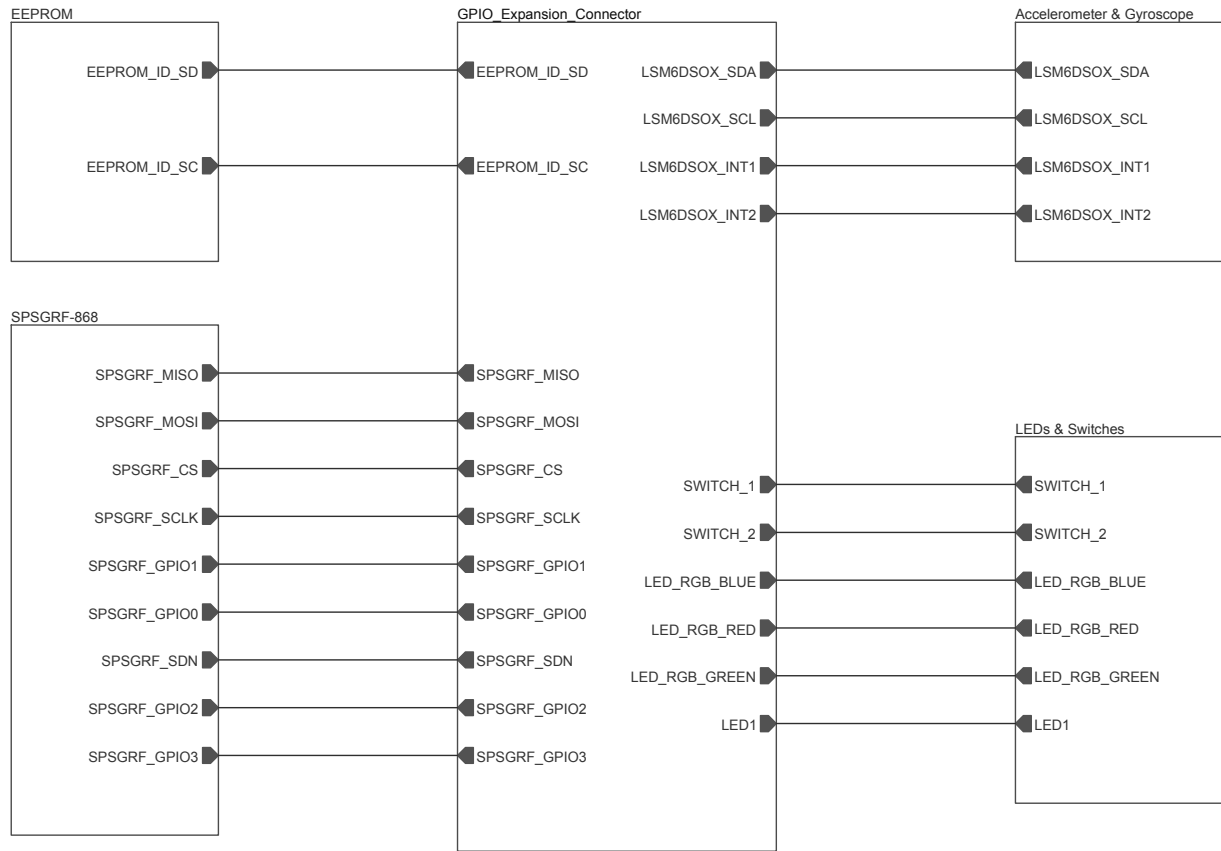


Figure 19. X-STM32MP-IOT01E schematic diagram (2 of 6)

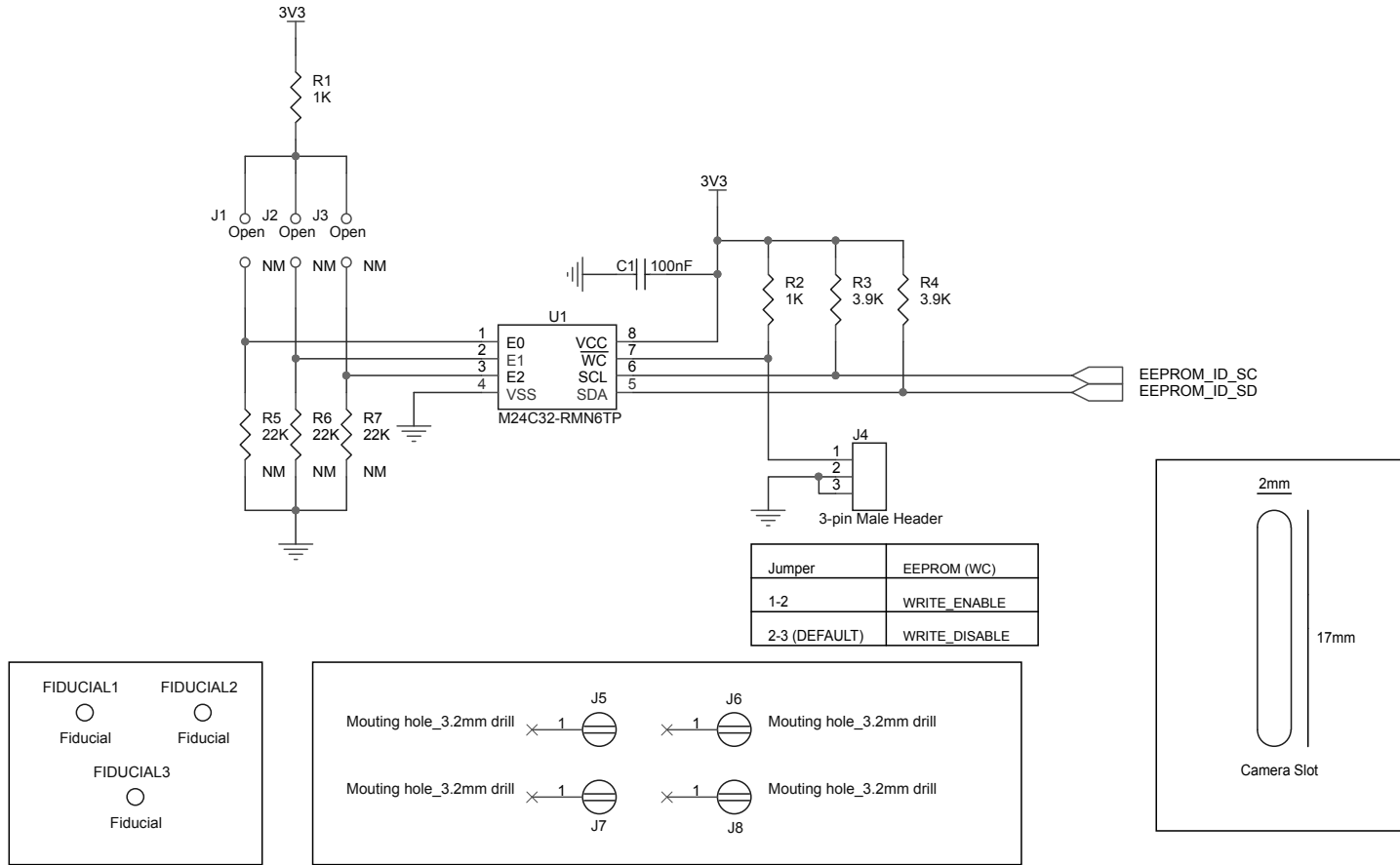


Figure 20. X-STM32MP-IOT01E schematic diagram (3 of 6)

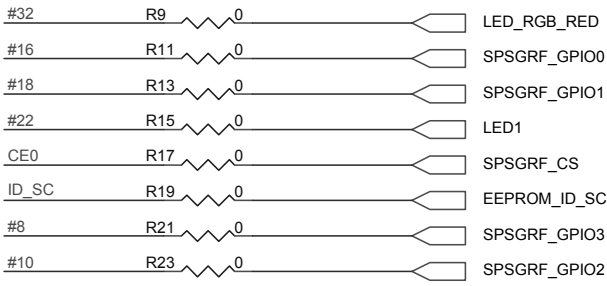
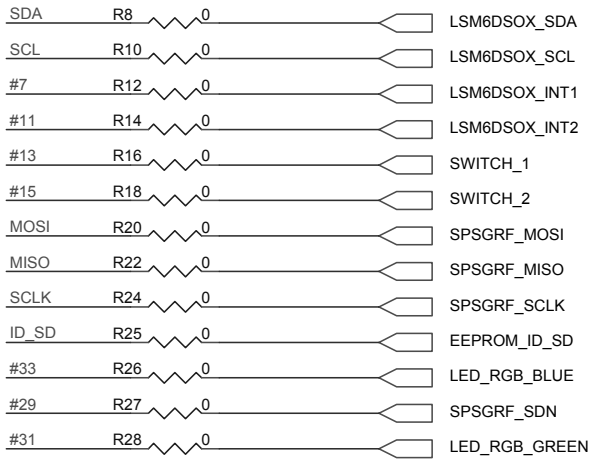
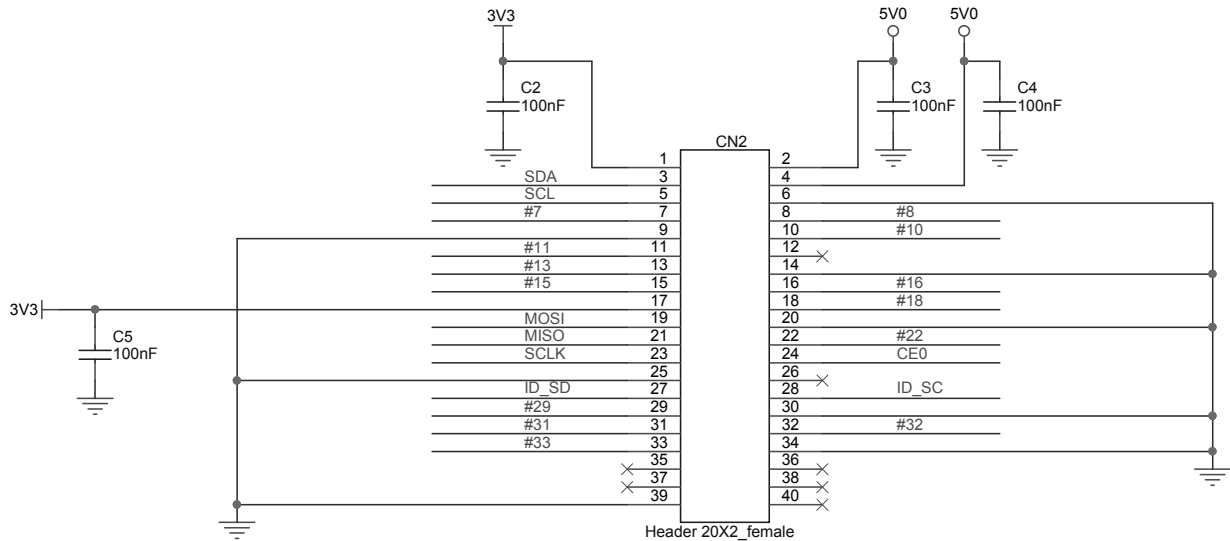


Figure 21. X-STM32MP-IOT01E schematic diagram (4 of 6)

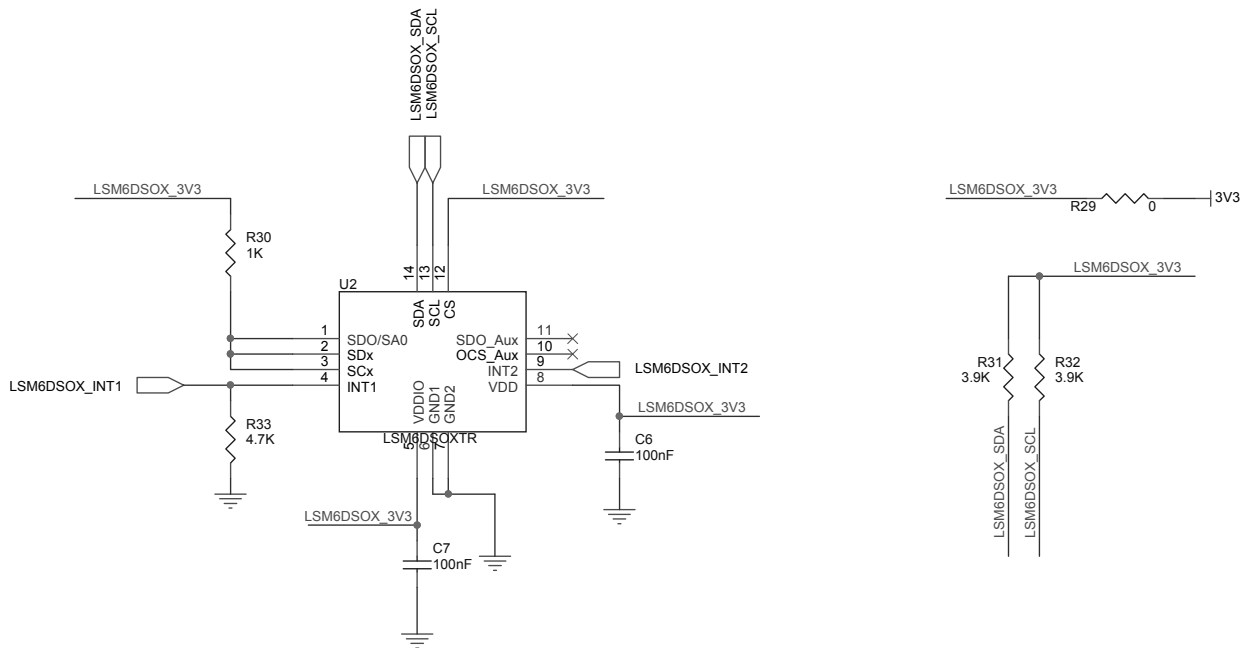


Figure 22. X-STM32MP-IOT01E schematic diagram (5 of 6)

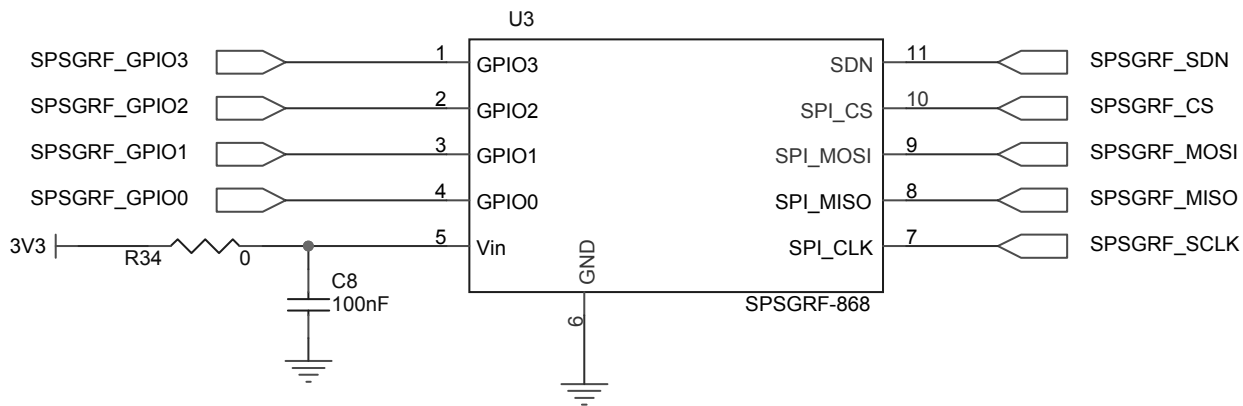
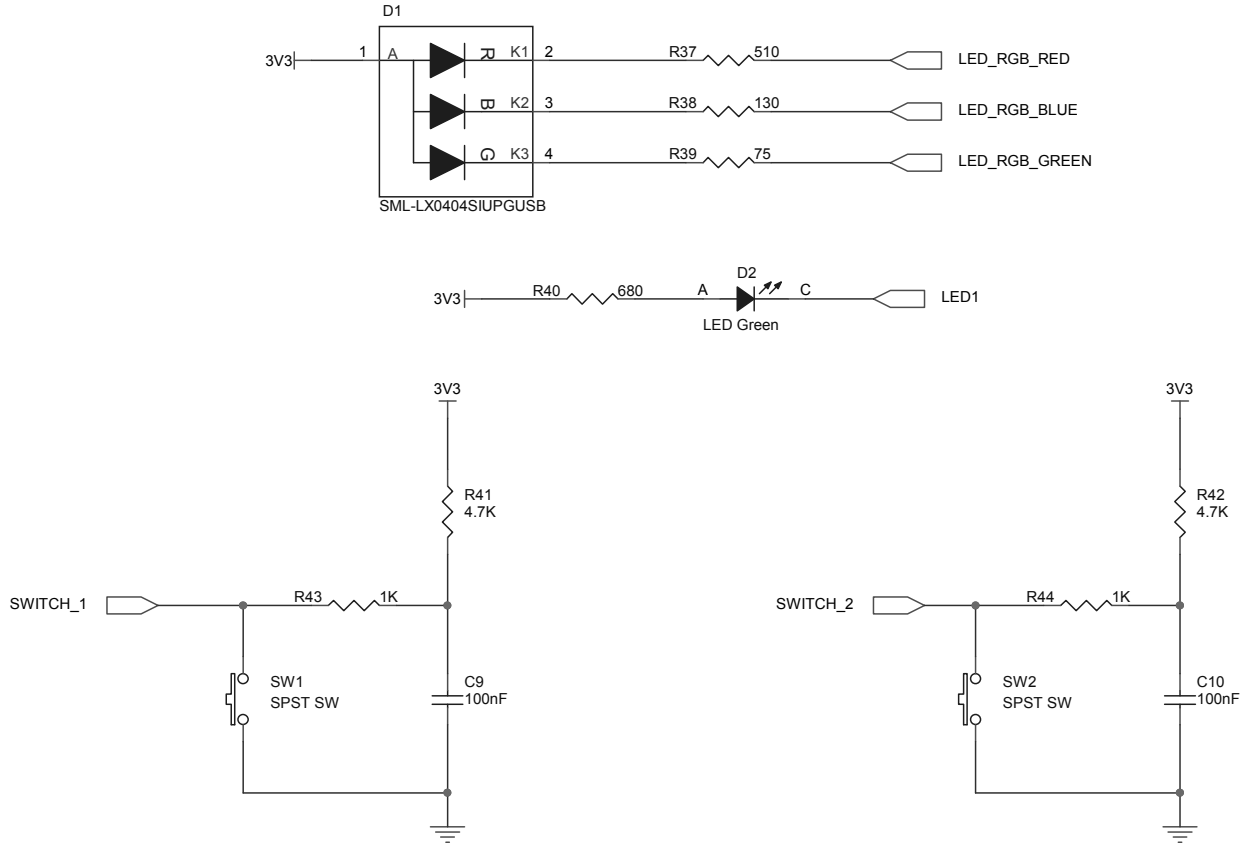


Figure 23. X-STM32MP-IOT01E schematic diagram (6 of 6)



## 6 X-STM32MP-IOT01A bill of materials

**Table 7. X-STM32MP-IOT01A bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	10	C1 C2 C3 C4 C5 C6 C7 C8 C9 C10	100 nF 0805 (2012 metric) 10 V ±5% SMD	Ceramic capacitors	Vishay Vitramon	VJ0805Y104JXQCW1BC
2	1	CN2	Header 20X2_female Header 20X2_female_2. 54mm pitch	Double Row_Vertical_1 00" _Extended Tail Connector	Samtec	SSQ-120-03-T-D
3	1	D1	SML- LX0404SIUPGU SB 0404 (1010 Metric) 2mA Red, 2mA Green, 2mA Blue SMD	RGB LED	Lumex Opto/ Components Inc.	SML-LX0404SIUPGUSB
4	1	D2	LED Green 0402 (1005 Metric) 5mA	Green LED	OSRAM Opto Semiconductors	LT QH9G-Q200-25-2Z4Y
5	3	J1 J2 J3	Open 0603	Tin drop jumpers 0603 (not mounted)	Samsung Electro- Mechanics	RC2012J000CS
6	1	J4	3-pin Male Header 3-pin Male Header_2.54m m pitch	Connector header	Samtec Inc.	TSW-103-07-F-S
7	5	R1 R2 R30 R43 R44	1K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Stackpole Electronics Inc	RMCF0805JT1K00
8	2	R3 R4	3.9K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-073K9RL
9	3	R5 R6 R7	22K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors (not mounted)	Stackpole Electronics Inc	RMCF0805JT22K0
10	23	R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28 R29 R34	0 0805 (2012 Metric) 0.125W, 1/8W 1%	Chip resistors	Samsung Electro- Mechanics	RC2012J000CS
11	2	R31 R32	3.9K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-073K9RL
12	3	R33 R41 R42	4.7K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-074K7L
13	1	R37	510 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Panasonic Electronic Components	ERJ-6ENF5100V

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
14	1	R38	130 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Panasonic Electronic Components	ERJ-6ENF1300V
15	1	R39	75 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Yageo	RC0805FR-0775RL
16	1	R40	680 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Yageo	RC0805FR-07680RL
17	2	SW1 SW2	SPST SW 6.00mm x 3.50mm	Tactile switch	TE Connectivity ALCOSWITCH Switches	1437566-3
18	1	U1	M24C32- RMN6TP, SO8	32 Kbit serial I <sup>2</sup> C bus EEPROM	ST	<a href="#">M24C32-RMN6TP</a>
19	1	U2	LSM6DSOX TR, VFLGA2.5X3X. 86 14L P.5 L.475X.25	iNEMO inertial module with machine learning core, finite state machine, and advanced digital functions. Ultra-low power for battery-operated IoT, gaming, wearable, and personal electronics	ST	<a href="#">LSM6DSOXTR</a>
20	1	U3	SPSGRF-915, RF module	Sub-GHz (915 MHz) low-power programmable RF transceiver module	ST	<a href="#">SPSGRF-915</a>
21	4	-	M3x0.5 Hex Nut 0.217" (5.50mm) Nylon	Plastic hexagonal nuts	Würth Elektronik	709940300
22	4	-	Hex Standoff Threaded M3x0.5 Nylon 0.472" (12.00mm) Natural	Spacers	Essentra	36M30MF012
23	1	-	2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) Gold	Shunt connector	Samtec Inc.	SNT-100-BK-G

## 7 X-STM32MP-IOT01E bill of materials

**Table 8. X-STM32MP-IOT01E bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	10	C1 C2 C3 C4 C5 C6 C7 C8 C9 C10	100 nF 0805 (2012 metric) 10 V ±5% SMD	Ceramic capacitors	Vishay Vitramon	VJ0805Y104JXQCW1BC
2	1	CN2	Header 20X2_female Header 20X2_female_2. 54mm pitch	Double Row_Vertical_1 00" _Extended Tail Connector	Samtec	SSQ-120-03-T-D
3	1	D1	SML- LX0404SIUPGU SB 0404 (1010 Metric) 2mA Red, 2mA Green, 2mA Blue SMD	RGB LED	Lumex Opto/ Components Inc.	SML-LX0404SIUPGUSB
4	1	D2	LED Green 0402 (1005 Metric) 5mA	Green LED	OSRAM Opto Semiconductors	LT QH9G-Q200-25-2Z4Y
5	3	J1 J2 J3	Open 0603	Tin drop jumpers 0603 (not mounted)	Samsung Electro- Mechanics	RC2012J000CS
6	1	J4	3-pin Male Header 3-pin Male Header_2.54m m pitch	Connector header	Samtec Inc.	TSW-103-07-F-S
7	5	R1 R2 R30 R43 R44	1K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Stackpole Electronics Inc	RMCF0805JT1K00
8	2	R3 R4	3.9K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-073K9RL
9	3	R5 R6 R7	22K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors (not mounted)	Stackpole Electronics Inc	RMCF0805JT22K0
10	23	R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28 R29 R34	0 0805 (2012 Metric) 0.125W, 1/8W 1%	Chip resistors	Samsung Electro- Mechanics	RC2012J000CS
11	2	R31 R32	3.9K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-073K9RL
12	3	R33 R41 R42	4.7K 0805 (2012 Metric) 0.125W, 1/8W ±5%	Chip resistors	Yageo	RC0805JR-074K7L
13	1	R37	510 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Panasonic Electronic Components	ERJ-6ENF5100V



Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
14	1	R38	130 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Panasonic Electronic Components	ERJ-6ENF1300V
15	1	R39	75 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Yageo	RC0805FR-0775RL
16	1	R40	680 0805 (2012 Metric) 0.125W, 1/8W ±1%	Chip resistor	Yageo	RC0805FR-07680RL
17	2	SW1 SW2	SPST SW 6.00mm x 3.50mm	Tactile switch	TE Connectivity ALCOSWITCH Switches	1437566-3
18	1	U1	M24C32- RMN6TP, SO8	32 Kbit serial I <sup>2</sup> C bus EEPROM	ST	<a href="#">M24C32-RMN6TP</a>
19	1	U2	LSM6DSOX TR, VFLGA2.5X3X. 86 14L P.5 L.475X.25	iNEMO inertial module with machine learning core, finite state machine, and advanced digital functions. Ultra-low power for battery-operated IoT, gaming, wearable, and personal electronics	ST	<a href="#">LSM6DSOXTR</a>
20	1	U3	SPSGRF-868, RF module	Sub-GHz (868 MHz) low-power programmable RF transceiver module	ST	<a href="#">SPSGRF-868</a>
21	4	-	M3x0.5 Hex Nut 0.217" (5.50mm) Nylon	Plastic hexagonal nuts	Würth Elektronik	709940300
22	4	-	Hex Standoff Threaded M3x0.5 Nylon 0.472" (12.00mm) Natural	Spacers	Essentra	36M30MF012
23	1	-	2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) Gold	Shunt connector	Samtec Inc.	SNT-100-BK-G

## 8 X-STM32MP-IOT01A versions

Table 9. X-STM32MP-IOT01A versions

PCB version	Schematic diagrams	Bill of materials
X\$STM32MP-IOT01A <sup>(1)</sup>	X\$STM32MP-IOT01A schematic diagrams	X\$STM32MP-IOT01A bill of materials

1. This code identifies the X-STM32MP-IOT01A evaluation board first version. It is printed on the board PCB.

## 9 X-STM32MP-IOT01E versions

Table 10. X-STM32MP-IOT01E versions

PCB version	Schematic diagrams	Bill of materials
X\$STM32MP-IOT01E <sup>(1)</sup>	X\$STM32MP-IOT01E schematic diagrams	X\$STM32MP-IOT01E bill of materials

1. This code identifies the X-STM32MP-IOT01E evaluation board first version. It is printed on the board PCB.

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## 10 Regulatory compliance information for the X-STM32MP-IOT01A

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### **Formal Notices Required by the U.S. Federal Communications 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.

### **Formal Product Notice Required by Industry Canada**

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).

## 11 Regulatory compliance information for the X-STM32MP-IOT01E

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### **Notice for the European Union**

The X-STM32MP-IOT01E is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Harmonized standards applied are listed in the EU Declaration of Conformity.

### **Notice for the United Kingdom**

The X-STM32MP-IOT01E 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

## Revision history

**Table 11. Document revision history**

Date	Revision	Changes
15-Jun-2022	1	Initial release.
11-Oct-2022	2	Updated title. Updated all document to add X-STM32MP-IOT01E compatibility information.

## Contents

<b>1</b>	<b>Safety precautions</b> .....	<b>3</b>
<b>2</b>	<b>Overview</b> .....	<b>4</b>
<b>2.1</b>	EEPROM (M24C32-RMN6TP) .....	5
<b>2.2</b>	GPIO connector.....	6
<b>2.3</b>	iNEMO inertial module (LSM6DSOX).....	8
<b>2.4</b>	SPSGRF module.....	8
<b>2.5</b>	RGB LED .....	9
<b>2.6</b>	RF specifications.....	9
<b>3</b>	<b>Getting started</b> .....	<b>10</b>
<b>3.1</b>	System requirements .....	10
<b>3.2</b>	System setup.....	10
<b>4</b>	<b>X-STM32MP-IOT01A schematic diagrams</b> .....	<b>12</b>
<b>5</b>	<b>X-STM32MP-IOT01E schematic diagrams</b> .....	<b>17</b>
<b>6</b>	<b>X-STM32MP-IOT01A bill of materials</b> .....	<b>22</b>
<b>7</b>	<b>X-STM32MP-IOT01E bill of materials</b> .....	<b>24</b>
<b>8</b>	<b>X-STM32MP-IOT01A versions</b> .....	<b>26</b>
<b>9</b>	<b>X-STM32MP-IOT01E versions</b> .....	<b>27</b>
<b>10</b>	<b>Regulatory compliance information for the X-STM32MP-IOT01A</b> .....	<b>28</b>
<b>11</b>	<b>Regulatory compliance information for the X-STM32MP-IOT01E</b> .....	<b>29</b>
	<b>Revision history</b> .....	<b>30</b>
	<b>List of tables</b> .....	<b>32</b>
	<b>List of figures</b> .....	<b>33</b>

## List of tables

<b>Table 1.</b>	SPSGRF details . . . . .	4
<b>Table 2.</b>	M24C32-R package details . . . . .	5
<b>Table 3.</b>	M24C32-RMN6TP details . . . . .	5
<b>Table 4.</b>	LSM6DSOX details . . . . .	5
<b>Table 5.</b>	Jumper settings . . . . .	5
<b>Table 6.</b>	Configuration of the GPIO connector pins . . . . .	7
<b>Table 7.</b>	X-STM32MP-IOT01A bill of materials . . . . .	22
<b>Table 8.</b>	X-STM32MP-IOT01E bill of materials . . . . .	24
<b>Table 9.</b>	X-STM32MP-IOT01A versions . . . . .	26
<b>Table 10.</b>	X-STM32MP-IOT01E versions . . . . .	27
<b>Table 11.</b>	Document revision history . . . . .	30



## List of figures

Figure 1.	X-STM32MP-IOT01A expansion board	1
Figure 2.	X-STM32MP-IOT01E expansion board	2
Figure 3.	System block diagram	4
Figure 4.	EEPROM section	6
Figure 5.	GPIO connector section	7
Figure 6.	LSM6DSOX section	8
Figure 7.	SPSGRF-915 circuit	8
Figure 8.	SPSGRF-868 circuit	9
Figure 9.	LED section	9
Figure 10.	X-STM32MP-IOT01A expansion board on top of the STM32MP157F-DK2	11
Figure 11.	X-STM32MP-IOT01E expansion board on top of the STM32MP157F-DK2	11
Figure 12.	X-STM32MP-IOT01A schematic diagram (1 of 6)	12
Figure 13.	X-STM32MP-IOT01A schematic diagram (2 of 6)	13
Figure 14.	X-STM32MP-IOT01A schematic diagram (3 of 6)	14
Figure 15.	X-STM32MP-IOT01A schematic diagram (4 of 6)	15
Figure 16.	X-STM32MP-IOT01A schematic diagram (5 of 6)	15
Figure 17.	X-STM32MP-IOT01A schematic diagram (6 of 6)	16
Figure 18.	X-STM32MP-IOT01E schematic diagram (1 of 6)	17
Figure 19.	X-STM32MP-IOT01E schematic diagram (2 of 6)	18
Figure 20.	X-STM32MP-IOT01E schematic diagram (3 of 6)	19
Figure 21.	X-STM32MP-IOT01E schematic diagram (4 of 6)	20
Figure 22.	X-STM32MP-IOT01E schematic diagram (5 of 6)	20
Figure 23.	X-STM32MP-IOT01E schematic diagram (6 of 6)	21

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