SE150A4

Hardware User Guide

1VV0301698 Rev. 1 – 2021-05-17

Telit Technical Documentation

APPLICABILITY TABLE

PART NUMBER
SE150A4-NA
SE150A4-EU

Contents

1. INTRODUCTION

1.1. Scope

This document describes electrical specifications, mechanical information, interfaces application and manufacturing information about Telit SE150A4 Smart module. With the help of this document and other application notes or user guides, users can understand Telit SE150A4 Smart module well and develop various products quickly.

1.2. Audience

This document is intended for Telit customers, especially system integrators, about to implement their applications using the Telit module.

1.3. Contact Information, Support

For general contact, technical support services, technical questions and report documentation errors contact Telit Technical Support at:

- *TS-EMEA@telit.com*
- *TS-AMERICAS@telit.com*
- *TS-APAC@telit.com*
- *TS-SRD@telit.com*

Alternatively, use: *http://www.telit.com/support*

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit *http://www.telit.com*

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Text

Danger: This information MUST be followed or catastrophic equipment failure or personal injury may occur.

Warning: Alerts the user on important steps about the module integration.

Note/Tip: Provides advice and suggestions that may be useful when integrating the module.

Electro-static Discharge: Notifies the user to take proper grounding precautions before handling the product.

All dates are in ISO 8601 format, that is. YYYY-MM-DD.

1.5. Related Documents

Table 1: Related documents

Module Name	Description
1VV0301694	SE150A4 Smart EVB User Guide
1VV0301695	SE150A4 SDK User Guide

2. GENERAL PRODUCT DESCRIPTION

2.1. Overview

The Telit SE150A4 Smart module is a multi-mode and multi-band wireless smart module, which is based on Qualcomm QCM2150 platform. It includes baseband, memory, RF front end and required circuitry to support rich multimedia features, global location-based service, wireless connectivity, and air interface standards including GSM, WCDMA, and LTE.

With higher integration to reduce PCB surface area, time-to-market, and BOM costs, Telit SE150A4 Smart module will help drive wireless products adoption in more industry around the world.

The operating bands are different between Telit SE150A4 Smart module variants.

2.2. Product Variants and Frequency Bands

The Telit SE150A4 Smart module is available in two variants. For details on the differences between the two variants.

- SE150A4-NA
- SE150A4-EU

SE150A4-NA	SE150A4-EU

Table 2: Product Variants and Frequency Bands

Configuration		SE150A4-NA	SE150A4-EU
CPU		1.3GHz	1.3GHz
Memory	RAM	1GB	1GB
	Flash	8GB	8GB
Standards & bands			
GSM	900MHz		✓
	1800M Hz		✓
WCDMA	B1		✓
	B2	✓	
	B4	✓	
	B5	✓	✓
	B8		✓
FDD-LTE	B1		✓
	B2	✓	
	B3		✓
	B4	✓	
	B5	✓	✓
	B7	✓	✓
	B8		✓
	B12	✓	
	B13	✓	
	B14	✓	
	B17	✓	
	B20		✓
	B25	✓	
	B26	✓	
	B28A		✓
	B28B		✓
	B66	✓	
	B71	✓	
	B38		✓
	B40		✓
	B41	✓	✓
WLAN	2.4G/5GHz; 802.11a/b/g/n	✓	✓
BT	BT 4.x + BR/EDR + BLE	✓	✓
GNSS	GPS	✓	✓
	GLONASS	✓	✓
	Galileo	✓	✓
	BEIDOU	✓	✓

2.3. Target market

The Telit SE150A4 Smart module provides tamper-resistance, confidential, secure, and authentic end-to-end connectivity for telematics applications. The Telit SE150A4 Smart module is one of the key component among the M2M applications, such as:

- CPE (Customer Premises-based Equipment)
- POS machine
- Smart metering
- Router
- Data card
- Digital signage
- Alarm panel
- Security
- Industrial PDA.

2.4. Main Features

Table 3: Main Features

Function	Features
Application processor	Quad ARM Cortex-A53 cores up to 1.3 GHz, 64-bit Arm Cortex
Memory RAM	1 GB, 32bit BUS, up to 672MHz, LPDDR3 SRAM
Memory Flash	8 GB (default) SE150A4-NA / SE150A4-EU External memory via SDC2 Support SD3.0 flash devices, up to128 GB
Graphics	Adreno 308; up to 485 MHz
Operating system	Support Android P and above
Software upgrade	Upgrade via USB interface; support forced download
Power supply	Voltage range: 3.4V ~ 4.4V, support single-cell lithium battery power supply
Charge management	Integrated 1.44 A linear charger for single-cell lithium-ion batteries
Display support	4-lane MIPI_DSI, 1.5Gbps each; HD+(1440*720), 60fps
Camera interfaces	Dual ISP, 13 MP max, MIPI_CSI, 2.1Gbps each Primary camera: 4-lane MIPI_CSI, 13MP Secondary camera: 2-lane MIPI_CSI, 8MP
Video applications performance	Encode: 1080p 30 fps: H264 480p 30 fps: MP4/H263 Decode: 1080p 30 fps: HEVC, H.264, VP8 Encode + Decode: 1080p 30 fps + 720p 30 fps
Audio supply	Three analog inputs that support single-ended configurations OR two data input Three outputs: earpiece, stereo headphones, and mono class-D speaker driver
Audio codec support	MP3; AAC; He-AAC v1, v2; WMA 9/Pro; Dolby AC-3, eAC-3, DTS-HD M6 and DTS-HD M8
Voice codec support	EVRC, -B, -WB; G.711; G.729A,-AB; GSM-FR,-EFR,-HR; ARM-NB,-WB; eAMR; BeAMR
USB	One USB 2.0 high-speed port
UART	Supports up to 3*UART, up to 4 MHz
I2C	Supports up to 6*I2C, used to cameras, sensors, TP, and so forth
SPI	Supports up to 5*SPI, up to 50MHz. (master only)
ADC	Supports up to 2*ADC, typical input range: 0.3~4.5V
UIM card	Dual cards dual standby; 1.8V/2.95V dual voltage adaptation
LTE features	Support 3GPP R10 CAT4 FDD and TDD Support 1.4 to 20 MHz RF bandwidth Support DL 2 x 2 MIMO FDD: Max 150Mbps (DL)/Max 50Mbps (UL) TDD: Max 100Mbps (DL)/ Max 35Mbps (UL)

UMTS features	Support 3GPP R9 DC-HSDPA/HSPA+/HSDPA/HSUPA/WCDMA Support 16-QAM, QPSK DC-HSDPA: Max 42Mbps (DL) HSUPA: Max 5.76Mbps (UL) WCDMA: Max 384Kbps (DL)/ Max 384Kbps (UL)
GSM features	R99: CSD: 9.6kbps, 14.4kbps GPRS: Support GPRS multi-slot level 33 (default 33) coding schemes: CS-1, CS-2, CS-3 ,CS-4 Max 85.6Kbps (UL) / Max 107Kbps (DL) EDGE: Support EDGE multi-slot level 33 (default 33) Support GMSK and 8-PSK Modulation coding DL coding schemes: CS 1-4 and MCS 1-9 UP coding schemes: CS 1-4 and MCS 1-9 Max 236.8Kbps (UL) / Max 296Kbps (DL)
WLAN features	Support SoftAP Function, 802.11 a/b/g/n Encryption: WFA WPA/WPA2 Qos: WFA WMM, WMM PS RF performance: 11b power 17 dBm, EVM≤35% 11g power 15dBm, EVM<-25dB 11n power 11dBm, EVM<-27dB Wi-Fi bands: 2.4GHz/5GHz
BT Features	Bluetooth 4.x and earlier Specification: V2.1+EDR, 3.0+HS, V4.1 BLE Tx power levels: Class 1 & 2

2.5. TX Output Power

Table 4: TX Output Power

Band	Power class
EGSM 900 MHz	Class 4
DCS 1800	Class 1
WCDMA/HSPA+	Class 3
LTE All Bands	Class 3

2.6. Mechanical specifications

2.6.1. Dimensions

The overall dimensions of the Telit SE150A4 Smart module family are:

- Length: 40.5 mm, +/- 0.15 mm tolerance
- Width: 40.5 mm, +/- 0.15 mm tolerance

- Thickness: 2.8 mm, +/- 0.15 mm tolerance

2.7. Temperature Range

Table 5: Temperature Range

Status	Range	Note
Operating	-35℃ ~ +75℃	The module is fully functional(*) in the complete temperature range, and it fully meets the 3GPP specifications.
Storage and non-operating	–40°C ~ +90°C	

(*) Functional: the module is able to make and receive voice calls, data calls, SMS and make data traffic.

2.8. Block Diagram

The following is the architecture block diagram

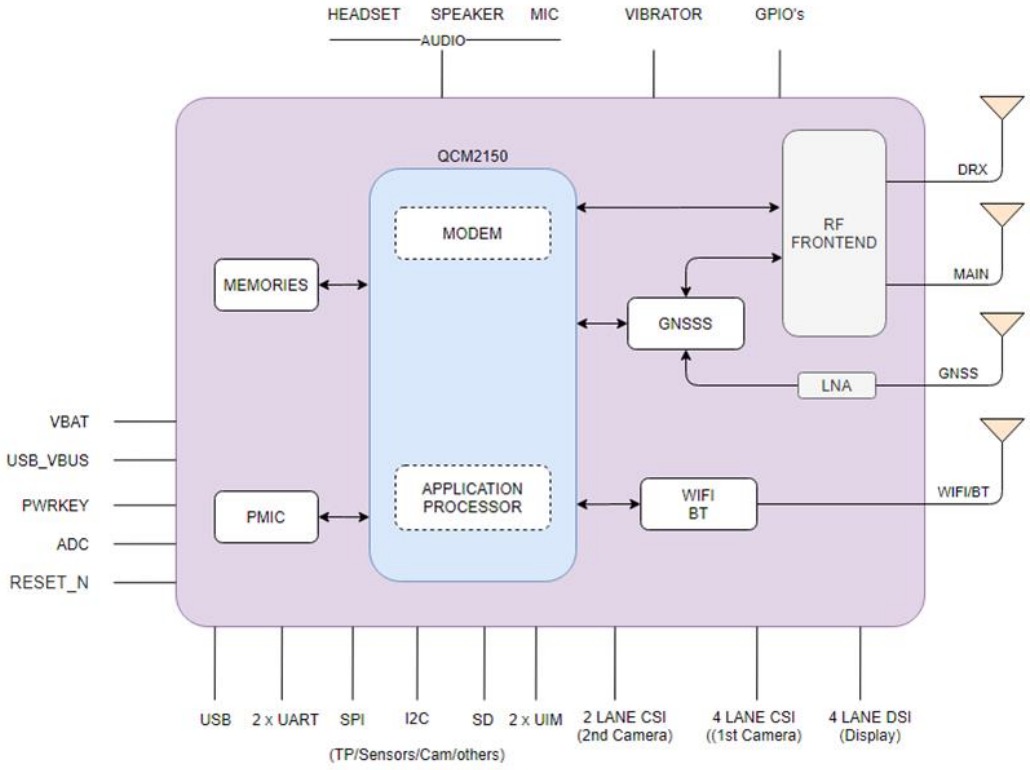


Figure 1:Telit SE150A4 Smart module block diagram

3. PINS ALLOCATION

3.1. LGA pad layout

The following is the top view diagram

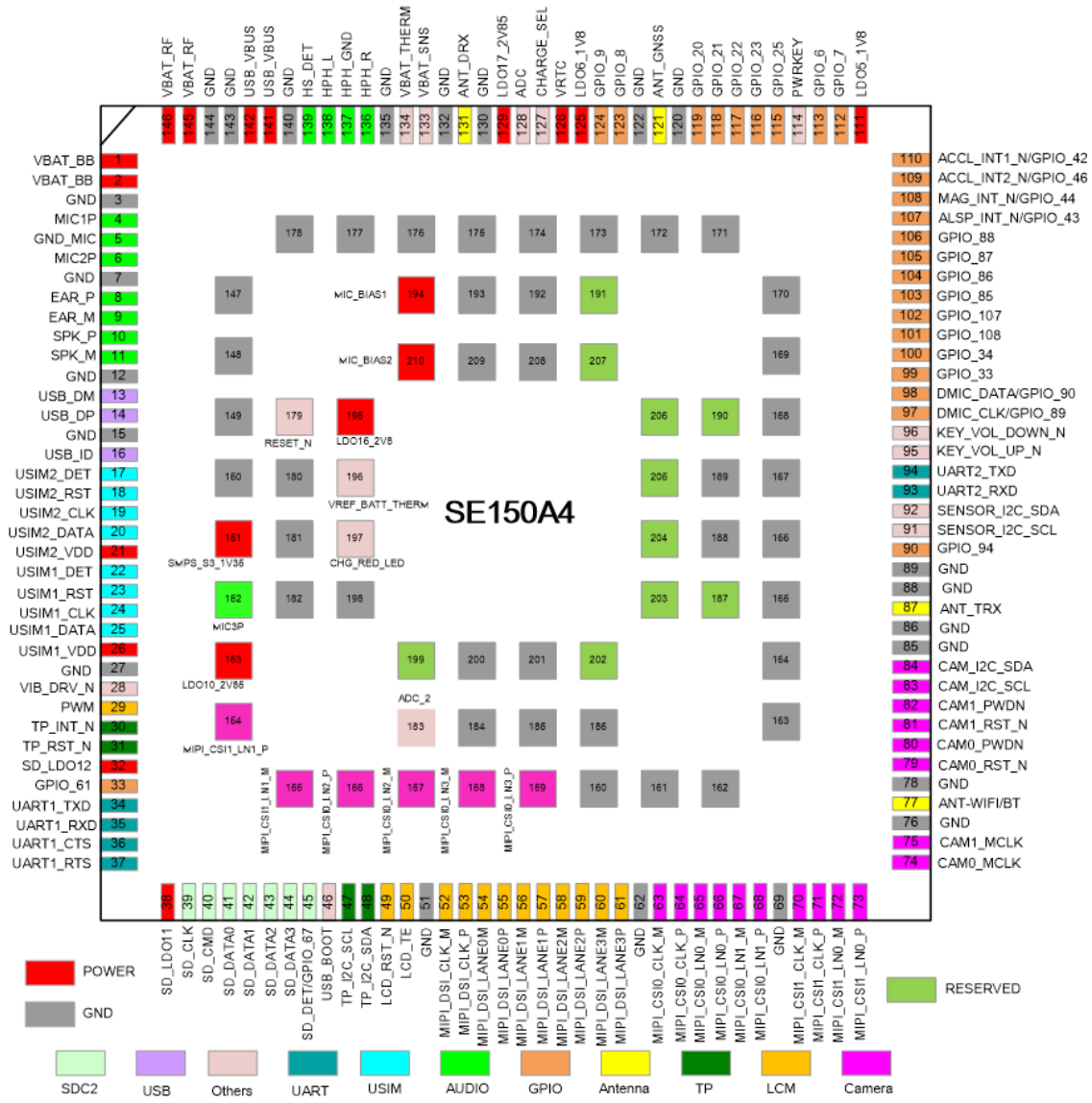


Figure 2:Telit SE150A4 Smart module block diagram

3.2. PIN-out

Table 6: PIN-out Description

USB interface

PIN	Signal	I/O	Function	Type	Comment
141	USB_ VBUS	I	Input power from USB source	PI	Current up to 1.44A. TVS is recommended for surge protection

142	USB_ VBUS	I	Input power from USB source	PI	
13	USB_DM	I/O	USB HS data (-)	DI/DO	Requires differential impedance of 90 Ohm +-10%
14	USB_DP	I/O	USB HS data (+)	DI/DO	
16	USB _ID	I	USB HS ID	DI	Default high level
46	USB_BOOT	I	Force boot from USB interface	DI	

Asynchronous Serial Port 1 (UART1)

PIN	Signal	I/O	Function	Type	Comment
34	UART1_TXD	O	UART1 data TX	DO	
35	UART1_RXD	I	UART1 data RX	DI	
36	UART1_CTS	I	UART1 Clear To Send	DI	
37	UART1_RTS	O	UART1 Require To Send	DO	

Asynchronous Serial Port 2 (UART2)

PIN	Signal	I/O	Function	Type	Comment
93	UART2_RXD	I	Debug UART2 data RX	DI	
94	UART2_TXD	O	Debug UART2 data TX	DO	

USIM Interface

PIN	Signal	I/O	Function	Type	Comment
22	USIM1_DET	I	USIM2 presence detection	DI	1.8V power domain. External pull-up resistor is required. If unused, keep it open.
23	USIM1_RST	O	USIM2 reset	DO	It can't be used as GPIO
24	USIM1_CLK	O	USIM2 clock	DO	It can't be used as GPIO
25	USIM1_DATA	I/O	USIM2 data	DI/DO	It can't be used as GPIO
26	USIM1_VDD	O	LDO 14 output for USIM1, 1.8V/2.95V	PO	A parallel 100nf capacitance is required.
17	USIM2_DET	I	USIM1 presence detection	DI	1.8V power domain. External pull-up resistor is required. If unused, keep it open.
18	USIM2_RST	O	USIM1 reset	DO	It can't be used as GPIO
19	USIM2_CLK	O	USIM1 clock	DO	It can't be used as GPIO
20	USIM2_DATA	I/O	USIM1 data	DI/DO	It can't be used as GPIO
21	USIM2_VDD	O	LDO 15 output for USIM2, 1.8V/2.95V	PO	A parallel 100nf capacitance is required.

SDIO/SDcard interface

PIN	Signal	I/O	Function	Type	Comment
32	SD_LDO12	O	1.8V/2.95V LDO output, for SD pull-up only.	PO	Only for SD pull-up only.
38	SD_LDO11	O	LDO 11 output for SD card	PO	If support SD3.0 Current up to 800m, A parallel 2.2uf capacitance is required.
39	SD_CLK	O	Secure digital card clock	DO	
40	SD_CMD	I/O	Secure digital card command	DI/DO	
41	SD_DATA0	I/O	Secure digital card data	DI/DO	
42	SD_DATA1	I/O	Secure digital card data bit 1	DI/DO	
43	SD_DATA2	I/O	Secure digital card data bit 2	DI/DO	
44	SD_DATA3	I/O	Secure digital card data bit 3	DI/DO	
45	SD_DET/ GPIO_67	I	Secure digital card detection	DI	

Display interface

PIN	Signal	I/O	Function	Type	Comment
29	PWM	O	PWM control for external WLED driver	DO	
49	LCD_RST_N	O	LCD reset	DO	
50	LCD_TE	I	LCD reset	DI	
52	MIPI_DSI_CLK_M	O	Display MIPI Clock M	DO	
53	MIPI_DSI_CLK_P	O	Display MIPI Clock P	DO	
54	MIPI_DSI_LANE0M	O	Display MIPI Lane0 M	DO	
55	MIPI_DSI_LANE0P	O	Display MIPI Lane0 P	DO	
56	MIPI_DSI_LANE1M	O	Display MIPI Lane1 M	DO	
57	MIPI_DSI_LANE1P	O	Display MIPI Lane1 P	DO	
58	MIPI_DSI_LANE2M	O	Display MIPI Lane2 M	DO	
59	MIPI_DSI_LANE2P	O	Display MIPI Lane2 P	DO	
60	MIPI_DSI_LANE3M	O	Display MIPI Lane3 M	DO	
61	MIPI_DSI_LANE3P	O	Display MIPI Lane3 P	DO	

TP interface

PIN	Signal	I/O	Function	Type	Comment
48	TP_I2C_SDA	I/O	Touch screen I2C (Data)	DI/DO	1.8V power domain. External pull-up resistors 2.2k are required
47	TP_I2C_SCL	O	Touch screen I2C (Clock)	DO	
30	TP_INT_N	I	Touch screen interrupt	DI	

31	TP_RST_N	O	Touch screen reset	DO	

Camera interface

PIN	Signal	I/O	Function	Type	Comment
63	MIPI_CSI0_CLK_M	O	Primary camera serial interface (Clock M)	DO	Requires differential impedance of 85 Ohm +-15% Ohm.
64	MIPI_CSI0_CLK_P	O	Primary camera serial interface (Clock P)	DO	
65	MIPI_CSI0_LN0_M	I	Primary camera serial interface (Lane0 M)	DI	
66	MIPI_CSI0_LN0_P	I	Primary camera serial interface (Lane0 P)	DI	
67	MIPI_CSI0_LN1_M	I	Primary camera serial interface (Lane1 M)	DI	
68	MIPI_CSI0_LN1_P	I	Primary camera serial interface (Lane1 P)	DI	
157	MIPI_CSI0_LN2_M	I	Primary camera serial interface (Lane2 M)	DI	
156	MIPI_CSI0_LN2_P	I	Primary camera serial interface (Lane2 P)	DI	
158	MIPI_CSI0_LN3_M	I	Primary camera serial interface (Lane3 M)	DI	
159	MIPI_CSI0_LN3_P	I	Primary camera serial interface (Lane3 P)	DI	
74	CAM0_MCLK	O	Primary Camera master clock	DO	
79	CAM0_RST_N	O	Primary Camera reset	DO	
80	CAM0_PWDN	O	Primary Camera power down	DO	
70	MIPI_CSI1_CLK_M	O	Secondary camera serial interface (Clock M)	DO	
71	MIPI_CSI1_CLK_P	O	Secondary camera serial interface (Clock P)	DO	
72	MIPI_CSI1_LN0_M	I	Secondary camera serial interface (Lane0 M)	DI	
73	MIPI_CSI1_LN0_P	I	Secondary camera serial interface (Lane0 P)	DI	
155	MIPI_CSI1_LN1_M	I	Secondary camera serial interface (Lane1 M)	DI	
154	MIPI_CSI1_LN1_P	I	Secondary camera serial interface (Lane1 P)	DI	
75	CAM1_MCLK	O	Secondary Camera master clock	DO	
81	CAM1_RST_N	O	Secondary Camera reset	DO	
82	CAM1_PWDN	O	Secondary Camera power down	DO	
83	CAM_I2C_SCL	O	Camera I2C (Data)	DO	1.8V power domain.
84	CAM_I2C_SDA	I/O	Camera I2C (Clock)	DI/DO	

					External pull-up resistors 2.2k are required

Keypad interface

PIN	Signal	I/O	Function	Type	Comment
95	KEY_VOL_UP_N	I	Volume up keypad	DI	Pull-up resistors can't be added externally, If unused, keep it open.
96	KEY_VOL_DOWN_N	I	Volume down keypad	DI	If unused, keep it open.
114	PWRKEY	I	Power on keypad	DI	
179	RESET_N	I	Hardware Reset keypad	DI	If unused, keep it open.
95	KEY_VOL_UP_N	I	Volume up keypad	DI	Pull-up resistors can't be added externally, If unused, keep it open.

Sensor interface

PIN	Signal	I/O	Function	Type	Comment
91	SENSOR_I2C_SCL	O	Sensors I2C (Clock)	DO	Sensors I2C
92	SENSOR_I2C_SDA	I/O	Sensors I2C (Data)	DI/DO	1.8V power domain. External pull-up resistors 2.2K are required.
107	ALSP_INT_N/GPIO_43	I	Ambient light and proximity sensor interrupt	DI	
108	MAG_INT_N/GPIO_44	I	Magnetic sensor interrupt	DI	
109	ACCL_INT2_N/GPIO_46	I	Accelerate sensor interrupt 2	DI	
110	ACCL_INT1_N/GPIO_42	I	Accelerate sensor interrupt 1	DI	

ADC

PIN	Signal	I/O	Function	Type	Comment
133	VBAT_SNS	I	Battery voltage sense	AI	Must be used Maximum input voltage is 4.75V.

128	ADC	I	Analog to digital converter	AI	Maximum input voltage is 5.1V. If unused, keep it open.
134	VBAT_THERM	I	Battery thermistor	AI	

RF Interface

PIN	Signal	I/O	Function	Type	Comment
87	ANT_TRX	I/O	2G/3G/4G main antenna port	AI/AO	
131	ANT_DRX	I	4G diversity antenna port	AI	
121	ANT_GNSS	I	GNSS antenna port	AI	
77	ANT-WIFI/BT	I/O	WIFI/BT antenna port	AI/AO	

Audio interface

PIN	Signal	I/O	Function	Type	Comment
8	EAR_P	O	Earpiece output +	AO	
9	EAR_M	O	Earpiece output -	AO	
136	HPH_R	O	Headphone output, right channel	AO	
137	HPH_GND	I	Headphone ground reference	PI	
138	HPH_L	O	Headphone output, left channel	AO	
139	HS_DET	I	Headset detection	DI	
5	GND_MIC	I	Microphone input 2 ground reference	PI	
4	MIC1P	I	Microphone input 1 +	AI	
6	MIC2P	I	Microphone input 2 -	AI	
152	MIC3P	I	Microphone input 3, positive	AI	
10	SPK_P	O	Speaker driver output, positive	AO	
11	SPK_M	O	Speaker driver output, negative	AO	
194	MIC_BIAS1	O	Microphone bias 1	PO	Bias for external MEMS Microphone. ECM: keep MIC_BIAS1/2 open
210	MIC_BIAS2	O	Microphone bias 2	PO	
97	DMIC_CLK/ GPIO_89	O	Digital MIC clock	DO	
98	DMIC_DATA/ GPIO_90	I/O	Digital MIC data	DI/DO	

Battery Charger

PIN	Signal	I/O	Function	Type	Comment
127	CHARGE_SEL	O	Charger Selection	DO	Option config. control bit1: Hi-Z → internal charger GND → external charger
196	VREF_BATT_THERM	I/O	Power for Battery Thermal up level	DI/DO	
197	CHG_RED_LED	I	Charging indicator	DI	

Vibrator

PIN	Signal	I/O	Function	Type	Comment
28	VIB_DRV_N	O	Vibration output	PO	

GPIO

PIN	Signal	I/O	Function	Type	Comment
113	GPIO_6	I/O	GPIO	DI/DO	
112	GPIO_7	I/O	GPIO	DI/DO	
123	GPIO_8	I/O	GPIO	DI/DO	
124	GPIO_9	I/O	GPIO	DI/DO	Do not add external Pull-up resistors.
119	GPIO_20	I/O	GPIO	DI/DO	
118	GPIO_21	I/O	GPIO	DI/DO	
117	GPIO_22	I/O	GPIO	DI/DO	
116	GPIO_23	I/O	GPIO	DI/DO	
115	GPIO_25	I/O	GPIO	DI/DO	CAM_DVDD_EN
99	GPIO_33	I/O	GPIO	DI/DO	CAMERA_ENM
100	GPIO_34	I/O	GPIO	DI/DO	CAMERA_ENF
33	GPIO_61	I/O	GPIO	DI/DO	
103	GPIO_85	I/O	GPIO	DI/DO	
104	GPIO_86	I/O	GPIO	DI/DO	
105	GPIO_87	I/O	GPIO	DI/DO	
106	GPIO_88	I/O	GPIO	DI/DO	Do not add external Pull-up resistors.
90	GPIO_94	I/O	GPIO	DI/DO	
102	GPIO_107	I/O	GPIO (only for RF Ant tuner switch)	DI/DO	Do not add external Pull-up resistors.
101	GPIO_108	I/O	GPIO (only for RF Ant tuner switch)	DI/DO	Do not add external Pull-up resistors.

Power

PIN	Signal	I/O	Function	Type	Comment
1	VBAT_BB	I/O	Main power supply for the Baseband, and linear charger output	PI/PO	It must be able to provide sufficient current up to 3A. TVS is recommended for surge protection.
2	VBAT_BB	I/O	Main power supply for the Baseband, and linear charger output	PI/PO	It must be able to provide sufficient current up to 3A. TVS is recommended for surge protection.
145	VBAT_RF	I	Main power supply for the RF	PI	
146	VBAT_RF	O	Main power supply for the RF	PI	
126	VRTC	I/O	Coin cell or backup-battery charger	PI/PO	If unused, keep it open.
125	LDO6_1V8	O	1.8V LDO output	PO	Power supply for external circuit. A parallel 2.2uF~4.7uf capacitance is required. If unused, keep it open.
129	LDO17_2V85	O	2.85V LDO output	PO	Power supply for external circuit. A parallel 2.2Uf~4.7uf capacitance is required. If unused, keep it open.
111	LDO5_1V8	O	1.8V LDO output for GPIO pull-up	PO	Power supply for external GPIO's pull up and level shift circuits. If unused, keep it open.
153	LDO10_2V85	O	Power supply for camera AFVDD	PO	Power supply for external circuit. A parallel 2.2Uf~4.7uf capacitance is required. If unused, keep it open.
195	LDO16_2V8	O	Power supply for camera AVDD	PO	Power supply for external circuit. A parallel 2.2Uf~4.7uf capacitance is required. If unused, keep it open.
151	SMPS_S3 _1V35	O	Power supply for camera DVDD LDO	PO	Power supply for external circuit. A parallel 2.2uF~4.7uf capacitance is required. If unused, keep it open.
26	USIM1_VDD	I/O	LDO 14 output for USIM1, 1.8V/2.95V	PO	A parallel 100nf capacitance is required.
21	USIM2_VDD	I	LDO 15 output for USIM2, 1.8V/2.95V	PI/PO	A parallel 100nf capacitance is required.

GND

PIN	Signal	Function
3, 7, 12, 15, 27, 51, 62, 69, 76, 78, 85, 86, 88, 89, 120, 122, 130, 132, 135, 140, 143, 144, 147, 148, 149, 150, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 180, 181, 182, 184, 185, 186, 188, 189, 192, 193, 198, 200, 201, 208, 209	GND	Ground

Reserved

PIN	Signal	Function
187, 190, 191, 199, 202, 203, 204, 205, 206, 207	RESERVED	Reserved

Note/Tip: Reserved Pin's must not be connected.

3.3. PIN Description

Table 7: PIN Description

Symbol	Description
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output
DI	Digital input

3.4. Logic Levels

Table 8: Logic Levels

Number	PIN name	Voltage	QCM2150 platform PIN name	Reset Status	Wakeup Interrupt	Note
1	VBAT_BB	3.4~4.4V				
2	VBAT_BB	3.4~4.4V				
3	GND					
4	MIC1P					
5	GND_MIC					
6	MIC2P					
7	GND					
8	EAR_P					
9	EAR_M					
10	SPK_P					

11	SPK_M					
12	GND					
13	USB_DM					
14	USB_DP					
15	GND					
16	USB_ID					
17	USIM2_DET	1.8V	GPIO_58	PD	X	
18	USIM2_RST	1.8/2.95V	GPIO_57	PD		
19	USIM2_CLK	1.8/2.95V	GPIO_56	PD		
20	USIM2_DATA	1.8/2.95V	GPIO_55	PD		
21	USIM2_VDD	1.8/2.95V				
22	USIM1_DET	1.8V	GPIO_54	PD	X	
23	USIM1_RST	1.8/2.95V	GPIO_53	PD		
24	USIM1_CLK	1.8/2.95V	GPIO_52	PD		
25	USIM1_DATA	1.8/2.95V	GPIO_51	PD		
26	USIM1_VDD	1.8/2.95V				
27	GND					
28	VIB_DRV_N	1.2-3.1V				
29	PWM		PM_MPP_4			
30	TP_INT_N	1.8V	GPIO_65	PD	X	
31	TP_RST_N	1.8V	GPIO_64	PD		
32	SD_LDO12	1.8/2.95V				
33	GPIO_61	1.8V	GPIO_61	PD	X	
34	UART1_TXD	1.8V	GPIO_16	PD		
35	UART1_RXD	1.8V	GPIO_17	PD	X	
36	UART1_CTS	1.8V	GPIO_18	PD		
37	UART1_RTS	1.8V	GPIO_19	PD		
38	SD_LDO11	2.95V				
39	SD_CLK	1.8/2.95V		NP		
40	SD_CMD	1.8/2.95V		PD		
41	SD_DATA0	1.8/2.95V		PD		
42	SD_DATA1	1.8/2.95V		PD		
43	SD_DATA2	1.8/2.95V		PD		
44	SD_DATA3	1.8/2.95V		PD		
45	SD_DET/GPIO_67	1.8V	GPIO_67	PD	X	
46	USB_BOOT	1.8V	GPIO_37	PD	X	
47	TP_I2C_SCL	1.8V	GPIO_11	PD		
48	TP_I2C_SDA	1.8V	GPIO_10	PD		
49	LCD_RST_N	1.8V	GPIO_60	PD		
50	LCD_TE	1.8V	GPIO_24	PD		
51	GND					
52	MIPI_DSI_CLK_M					
53	MIPI_DSI_CLK_P					

54	MIPI_DSI_LANE0M					
55	MIPI_DSI_LANE0P					
56	MIPI_DSI_LANE1M					
57	MIPI_DSI_LANE1P					
58	MIPI_DSI_LANE2M					
59	MIPI_DSI_LANE2P					
60	MIPI_DSI_LANE3M					
61	MIPI_DSI_LANE3P					
62	GND					
63	MIPI_CSI0_CLK_M					
64	MIPI_CSI0_CLK_P					
65	MIPI_CSI0_LN0_M					
66	MIPI_CSI0_LN0_P					
67	MIPI_CSI0_LN1_M					
68	MIPI_CSI0_LN1_P					
69	GND					
70	MIPI_CSI1_CLK_M					
71	MIPI_CSI1_CLK_P					
72	MIPI_CSI1_LN0_M					
73	MIPI_CSI1_LN0_P					
74	CAM0_MCLK	1.8V	GPIO_26	PD		
75	CAM1_MCLK	1.8V	GPIO_28	PD	X	
76	GND					
77	ANT-WIFI/BT					
78	GND					
79	CAM0_RST_N	1.8V	GPIO_36	PD	X	
80	CAM0_PWDN	1.8V	GPIO_35	PD	X	
81	CAM1_RST_N	1.8V	GPIO_40	PD		
82	CAM1_PWDN	1.8V	GPIO_39	PD		
83	CAM_I2C_SCL	1.8V	GPIO_30	PD		
84	CAM_I2C_SDA	1.8V	GPIO_29	PD		
85	GND					
86	GND					
87	ANT_TRX					
88	GND					
89	GND					
90	GPIO_94	1.8V	GPIO_94	PD		
91	SENSOR_I2C_SCL	1.8V	GPIO_15	PD		
92	SENSOR_I2C_SDA	1.8V	GPIO_14	PD		
93	UART2_RXD	1.8V	GPIO_5	PD	X	
94	UART2_TXD	1.8V	GPIO_4	PD		
95	KEY_VOL_UP_N	1.8V	GPIO_91	PD	X	
96	KEY_VOL_DOWN_N	1.8V	GPIO_93	PD	X	

97	DMIC_CLK/GPIO_89	1.8V	GPIO_89	PD		
98	DMIC_DATAK/GPIO_90	1.8V	GPIO_90	PD	X	
99	GPIO_33	1.8V	GPIO_33	PD		
100	GPIO_34	1.8V	GPIO_34	PD		
101	GPIO_106	1.8V	GPIO_106	PD		
102	GPIO_104	1.8V	GPIO_104	PD		
103	GPIO_85	1.8V	GPIO_85	PD		
104	GPIO_86	1.8V	GPIO_86	PD	X	
105	GPIO_87	1.8V	GPIO_87	PD		
106	GPIO_88	1.8V	GPIO_88	PD		
107	ALSP_INT_N/GPIO_43	1.8V	GPIO_43	PD	X	
108	MAG_INT_N/GPIO_44	1.8V	GPIO_44	PD	X	
109	ACCL_INT2_N/GPIO_46	1.8V	GPIO_46	PD	X	
110	ACCL_INT1_N/GPIO_42	1.8V	GPIO_42	PD	X	
111	LDO5_1V8	1.8V				
112	GPIO_7	1.8V	GPIO_7	PD		
113	GPIO_6	1.8V	GPIO_6	PD		
114	PWRKEY	1.8V				
115	GPIO_25	1.8V	GPIO_25	PD	X	
116	GPIO_23	1.8V	GPIO_23	PD		
117	GPIO_22	1.8V	GPIO_22	PD		
118	GPIO_21	1.8V	GPIO_21	PD	X	
119	GPIO_20	1.8V	GPIO_20	PD		
120	GND					
121	ANT_GNSS					
122	GND					
123	GPIO_8	1.8V	GPIO_8	PD		
124	GPIO_9	1.8V	GPIO_9	PD	X	
125	LDO6_1V8	1.8V				
126	VRTC					
127	CHARGE_SEL	1.8V	PM_OPT_1			
128	ADC	1.8V	PM_MPP_2			
129	LDO17_2V85	2.85V				
130	GND					
131	ANT_DRX					
132	GND					
133	VBAT_SNS					
134	VBAT_THERM					
135	GND					
136	HPH_R					
137	HPH_GND					
138	HPH_L					
139	HS_DET					

140	GND					
141	USB_VBUS	5V				
142	USB_VBUS	5V				
143	GND					
144	GND					
145	VBAT_RF	3.4~4.4V				
146	VBAT_RF	3.4~4.4V				
147	GND					
148	GND					
149	GND					
150	GND					
151	SMPS_S3_1V35	1.35V				
152	MIC3P					
153	LDO10_2V85	2.85V				
154	MIPI_CSI1_LN1_P					
155	MIPI_CSI1_LN1_M					
180	MIPI_CSI0_LN2_P					
157	MIPI_CSI0_LN2_M					
158	MIPI_CSI0_LN3_M					
159	MIPI_CSI0_LN3_P					
160	GND					
161	GND					
162	GND					
163	GND					
164	GND					
165	GND					
166	GND					
167	GND					
168	GND					
169	GND					
170	GND					
171	GND					
172	GND					
173	GND					
174	GND					
175	GND					
176	GND					
177	GND					
178	GND					
179	RESIN_N					
180	GND					
181	GND					
182	GND					

183	RESERVED					
184	GND					
185	GND					
186	GND					
187	RESERVED					
188	GND					
189	GND					
190	RESERVED					
191	RESERVED					
192	GND					
193	GND					
194	MIC_BIAS1					1.6-2.85
195	LDO16_2V8	2.8V				
196	VREF_BATT_THERM					
197	CHG_RED_LED					
198	GND					
199	RESERVED					
200	GND					
201	GND					
202	RESERVED					
203	RESERVED					
204	RESERVED					
205	RESERVED					
206	RESERVED					
207	RESERVED					
208	GND					
209	GND					
210	MIC_BIAS2	1.8V				1.6-2.85

Note/Tip: In the QCM2150 Platform PIN Name column, except for the UIM card signal line, the other GPIO_XX can be used as GPIO. (GPIO_8\GPIO_9\GPIO_88\GPIO_91\GPIO_107\GPIO_108 cannot be pulled up externally).

4. POWER SUPPLY

The power supply circuitry and board layout are a very important part in the full product design and they strongly reflect on the product overall performances, hence read carefully the requirements and the guidelines that will follow for a proper design.

To ensure high power transmission, we recommend to use a power supply that supports up to 3A.

4.1. Power Supply Requirements

Table 9: Power Supply Requirements

Power Supply	Value
Nominal Supply Voltage	3.8 V
Operating Voltage Range	3.40 V ÷ 4.40 V
Extreme Voltage Range	3.00 V ÷ 4.75 V

Note/Tip: The Extreme Operating Voltage Range MUST never be exceeded.

If the power supply is not properly designed, it can cause a large voltage drop.

The hardware shutdown voltage of the module is 3.0V. If the voltage drops below 3.0V, the module hardware will be shut down.

4.2. Power Consumption

Table 10: Power Consumption

Parameter	Conditions	Min	Typical	Max	Unit
Leakage current	Off mode	-	-	80	uA
Flight mode	Flight mode	2.2	2.2	3.2	mA
Standby GSM/GPRS	BS-PA-MFRMS=9	-	2.7	-	mA
	BS-PA-MFRMS=5	-	3.2	-	mA
	BS-PA-MFRMS=2	-	3.7	-	mA
Standby WCDMA	2.56sec, DRX=8	2.5	-	3.6	
Standby LTE FDD	2.56sec, DRX=8	14.2	-	16.2	mA
Standby LTE TDD	1.28s, DRX=7	17.2	-	19.2	mA
Voice Call 2G	EGSM900 PCL= 5@ 31.97dB Channel=62	-	294	300	mA
	EGSM1800 PCL= 0@ 28.95dB	-	190	250	mA

	Cannel=698				
Voice Call 3G	B1 power@ 21dB Channel=10700	-	-	540	mA
	B8 power@ 21dB, Channel=3012	-	-	540	mA
Data Call LTE	FDD B1 power@ 22dB BW=10MHZ Ch=18300	-	640	700	mA
	FDD B3 power@ 22dB BW=10MHZ Ch=19575	-	620	700	mA
	FDD B5 power@ 22dB BW=10MHZ Ch=20525	-	590	600	mA
	FDD B8 power@ 22dB BW=10MHZ Ch=21625	-	650	600	mA
	TDD B38 power@ 23dB BW=10MHZ Ch=37800	-	690	700	mA
	TDD B40 power@ 23dB BW=10MHZ Ch=38700	-	690	700	mA
	TDD B41 power@ 23dB BW=10MHZ Ch=40740	-	580	700	mA
Peak Current	-	-	-	3	A

Note/Tip:

- Leakage current: The current supplied by VBAT during shutdown.
- Flight mode: The Flight mode powers off the backlight and display.

4.3. General Design Rules

The principal guidelines for the Power Supply Design embrace three different design steps:

- Electrical design
- Thermal design
- PCB layout

4.3.1. Electrical Design Guidelines

The electrical design of the power supply depends on the power source. Power sources can be distinguished by three categories:

- +5V input (typically PC internal regulator output)
- +12V input
- Battery

4.3.1.1.LDO Power Supply Guidelines

The Telit SE150A4 Smart module supports single-cell Li-Ion battery (4.2V or 4.35V cells)/ Other battery types may be used, but the maximum allowed voltage limit of the module must not be exceeded. If exceeded, the module may be damaged.

For non-battery applications, if the DC input voltage is +5V then power efficiency optimization is not required. A high-current low-dropout regulator is recommended.

The following is the circuit diagram:

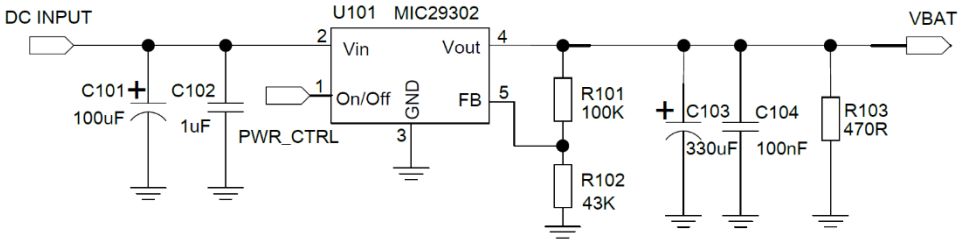


Figure 3: LDO power supply reference circuit

Note/Tip: To ensure proper behavior of the regulator under minimal load, an extra minimum load is required. The Telit SE150A4 Smart module consumes miniscule power in sleep mode and power off mode. For more details about minimum load, please refer to MIC29302 specifications.

4.3.1.2.DC To DC Power Supply Guidelines

To increase power efficiency, it is recommended to use a switch mode DC-DC converter, specifically when the DC input voltage high.

The following is the circuit diagram:

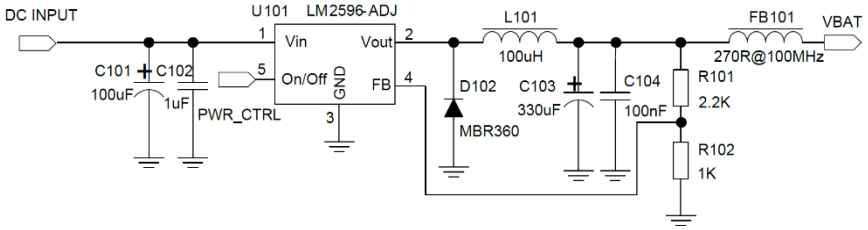


Figure 4: DC to DC power supply reference circuit

For battery-powered application, a 3.7V lithium battery may be connected to Telit SE150A4 Smart module VBAT pins. Other types of battery may be used, but the maximum voltage must be lower than the absolute maximum voltage of the module. When the battery is in use, the total impedance between battery and VBAT pins must be less than 150mΩ.

4.3.1.3.Battery Source Power Supply Design Guidelines

The Telit SE150A4 Smart module supports single-cell Li-Ion battery (4.2V or 4.35V cells). Other battery types may be used, but the maximum allowed voltage limit of the module must not be exceeded. If exceeded, the module may be damaged.

4.3.2. Thermal Design Guidelines

The thermal design for the power supply heat sink must performed taking into account the following specifications:

- Average current consumption during RF transmission at maximum power level as shown in Telit SE150A4 Smart module current consumption.
- Average current consumption during Class10 GPRS transmission at maximum power level as shown in Telit SE150A4 Smart module current consumption.
- Average GPS current consumption during GPS tracking (LTE @ idle): mA (TBD mA).

4.3.3. Enhanced Power Stability

To enhance power stability, it is recommended to add some bypass capacitors and TVS diode closed to VBAT pins. C101 and C102 are two 100uF tantalum capacitors with low ESR, C103 could be a 1~10uF ceramic capacitor, 33pF and 10pF capacitors are used for eliminating the high frequency interference, 5V/1600W transient Voltage Suppressor diode can protect the module against voltage surge.

The following is the circuit diagram:

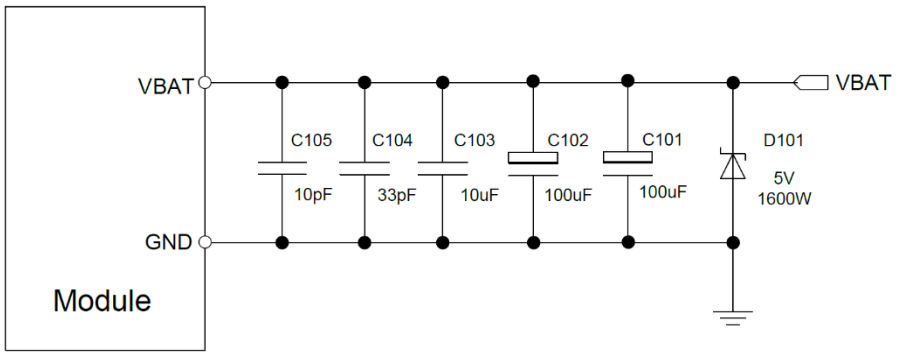


Figure 5: VBAT input reference circuit

Table 11: Enhanced Power Stability

Vendor	Part number	Power(watts)	Packages
Prisemi	PTVSHC3N4V8U	3200W	DFN2×2-3L
Prisemi	PTVSHC2EN5VU	1600W	DFN1610-2L

4.4. RTC Bypass Out

VRTC is the power supply for RTC circuit and charger output for coin cell or backup battery. If RTC support is needed when the battery is removed, a qualified coin cell or keep-alive capacitor is required on the VRTC PIN. When VBAT is present and valid, coin cell charging is enabled through software control and powered from VBAT.

- If the RTC fails, the module can synchronize the RTC clock through data connection after power on.
- Refer to VRTC characteristics for VRTC hardware parameters.
- Input voltage range of VRTC power supply is 2.0-3.25V, typical value is 3.0V, and the average current consumption is 5ua when VBATis disconnected and VRTCis connectedonly.
- RTC error is 50ppm when the module is powered by VBAT; RTC error is 200 ppm when the module is powered by VRTC.
- When the rechargeable button battery is connected externally, the ESR of button battery is required to be less than 2K. It is recommended to use Seiko's ms621fe fl11e.
- If the VRTCPIN is connected with large capacitance externally, the recommended capacitance value is 100uF with low ESR, which can keep the real-time clock for about 45 seconds.

The following is the circuit diagram:

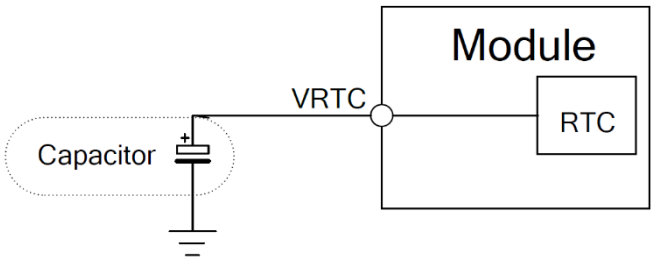


Figure 6: Keep-alive capacitor

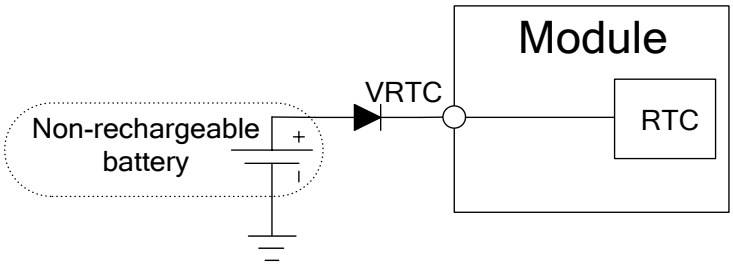


Figure 7: Non-rechargeable battery

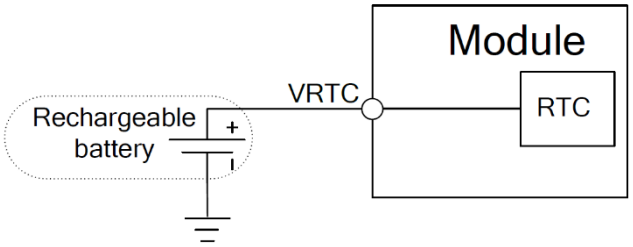


Figure 8: Rechargeable battery:

VRTC typical voltage is 3.0V, and the current consumption is about 7.5uA when VBAT is not present.

Table 12: RTC Bypass Out

Parameter	Description	Min	Type	Max	Unit
VRTC-IN	VRTC input voltage	2.0	3.0	3.25	V
IRTC-IN	VRTC current consumption	-	7.5	-	uA
VRTC-OUT	VRTC output voltage	2.5	3.1	3.2	V
IRTC-OUT	VRTC output current	-		2	mA

Table 13: VRTC Absolute Maximum

Parameter	Description	Min	Max	Unit
VRTC-MAX	VRTC Absolute Maximum Input Value	2.0	3.5	V

Note/Tip: If the battery connected to the module is never removed, the VRTC PIN can be left floating. The software needs to modify the code to turn off the VRTC charge and discharge function.

4.5. Output Power Management

The Telit SE150A4 Smart module provides one High-speed USB 2.0 interface, used for software upgrading, debugging, charging, etc.

Table 14: Output Power Management

PIN name	PIN	Specified range (V)	Rated current (mA)	Sleep state	Expected use
LDO5_1V8	111	1.8	50	On	GPIO pull up power
LDO6_1V8	125	1.8	150	On	Output power for TP/LCD/SENSOR IOVDD
LDO17_2V85	129	2.85	450	Off	Output power for TP/LCD/SENSOR VDD
SD_LDO12	32	1.8/2.95	50	On	Output power for SD card Pull-up
LDO10_2V85	153	2.85	150	Off	Output power for camera AFVDD
LDO16_2V8	195	2.8	55	Off	Output power for camera AVDD
SMPS_S3_1V35	151	1.35	400	On	Output power for camera DVDD LDO
USIM1_VDD	26	1.8/2.95	55	Off	LDO L15A output for SIM1 1.8/2.95V dual voltage
USIM2_VDD	21	1.8/2.95	55	Off	LDO L17A output for SIM2 1.8/2.95V dual voltage
SD_LDO11	38	2.95	600	On	Output power for SD VDD
MIC_BIAS1	194	1.8	3	On	Microphone bias 1voltage
MIC_BIAS2	210	1.8	3	On	Headphones Microphone bias voltage

4.6. Battery Charge

The Telit SE150A4 Smart module integrates a 1.44A linear battery charger for single-cell lithium-ion batteries

4.6.1. Charging Control

Battery charging is controlled by a PMIC state-machine. The first step in the automated charging process determines if trickle charging is needed. Charging of a severely depleted battery must begin with trickle charging to limit the current, avoid pulling VDD down, and protect the battery from more charging current than it can handle. Once a minimum battery voltage is established using trickle charging, constant-current charging is enabled to charge the battery quickly – this mode is sometimes called fast charging. Once the battery approaches its target voltage, the charge is completed using constant-voltage charging.

The following is the charge control diagram:

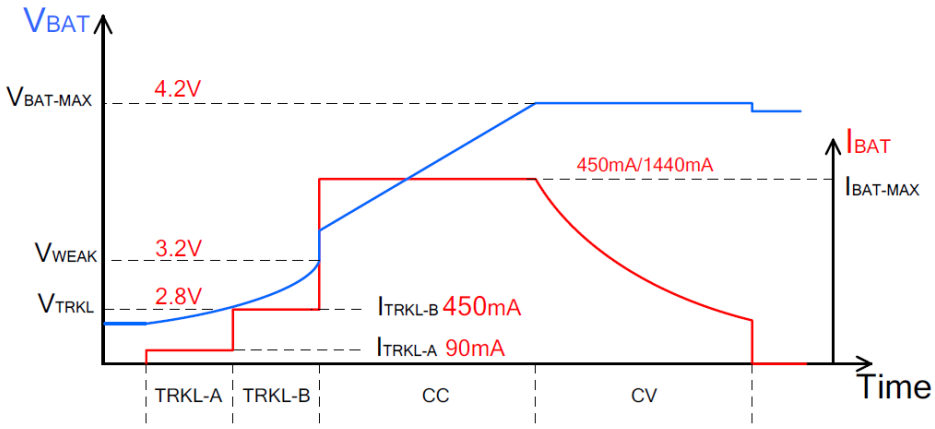


Figure 9: Charging control diagram

Table 15: Chargin Control

Parameter	Comments	Min	Type	Max	Units
ITRKL-A	Trickle-A Charging current	81	90	99	mA
ITRKL-B	Trickle-B Charging current	405	450	495	mA
VTRKL	Trickle-B threshold voltage range Programmable, 15.62 mV steps	2.5	2.796	2.984	V
VWEAK	Weak battery threshold range Programmable, 18.75 mV steps	3.0	3.206	3.581	V
VBAT_MAX	Maximum battery voltage Programmable, 25 mV steps	4	4.2	4.775	V
IBAT_MAX	Fast charging current range Programmable, 90mA steps	90		1440	mA

4.6.1.1.VBAT_SNS

VBAT_SNS is used for battery voltage sensing, the typical input range is 3.0V~4.75V.

VBAT_SNS PIN cannot be unused. It is connected to the battery positive PIN when the lithium battery is used for module power supply. It is connected to the module VBAT_BB, which is powered by LDO or DCDC.

4.6.1.2.VBAT_THERM

VBAT_THERM is used for battery-temperature monitoring (BTM) and battery-presence detection (BPD).

If BAT_THERM is not used, it must be grounded, and the software battery temperature feature must be disabled. If an external charger is used, then BAT_THERM pin must be grounded.

A 10K (B-Constant = 3380K± 1%) or 47 K(B-Constant = 4050 K) NTC resistor should be integrated inside the battery, and the cold / hot comparator threshold setting should be 70% / 35%. The allowable charging temperature range is -2 ° C to 52 ° C, with an accuracy of ± 2 ° C. If there is no NTC resistor inside the battery, choose R_S3 and R_S1 with the same value to keep the battery-temperature monitoring 25 ° C all the time.

The following is the circuit diagram:

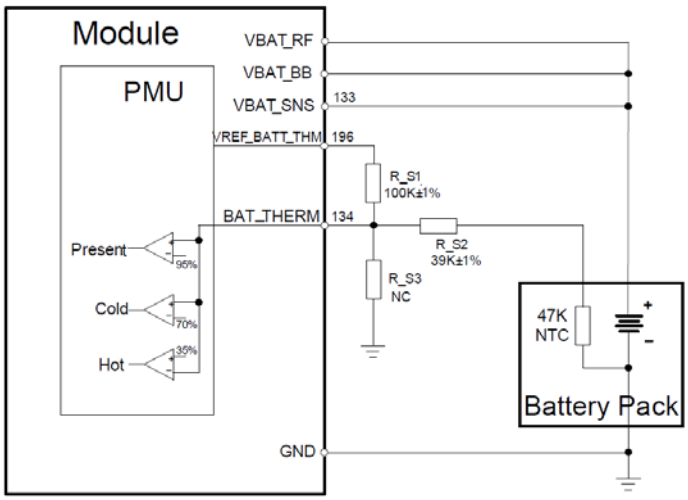


Figure 10: BPD and BTM functional block diagram

Table 16: VBAT_THERM

Battery inside NTC value	R_S1	R_S2	R_S3
10K (B-Constant = 3380K±1%)	15K, 1%	3.3K, 1%	NC
47K (B-Constant = 4050K)	100K, 1%	39K, 1%	NC
None	100K, 1%	NC	100K, 1%

4.6.1.3.Charging LED

The Telit SE150A4 Smart module supports a charging LED indicator.

Table 17: Charging LED

PIN name	PIN number	I/O	Description
CHG_RED_LED	197	PO	charging indicator

The following is the circuit diagram:

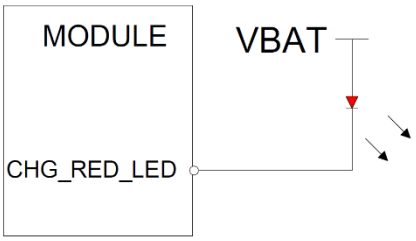


Figure 11: LED reference circuit

Note/Tip: While charging, the CHG_LED_SINK pin controls the LED indicator. If the LBC is not active, then the CHG_LED_SINK pin cannot control the LED indicator.

(CHARGE_SEL is grounded).

5. DIGITAL SECTION

5.1. Digital-logic Characteristics

Unless specifically stated, the standard logic level for Telit SE150A4 Smart module is 1.8V.

Table 18: Digital-logic Charactrastics

Parameter	Description	Min	Type	Max	Unit
VIH	High-level input voltage	1.17	-	2.1	V
VIL	Low-level input voltage	-0.3	-	0.63	V
VOH	High-level output voltage	1.3	-	1.8	V
VOL	Low-level output voltage	-	-	0.45	V

5.2. Power On

You may power on the Telit SE150A4 Smart module by holding down the PWRKEY PIN for more than 2 seconds then release it. This PIN is already pulled up to 1.8V internally, so external pull up is not necessary.

Table 19: Power On

Parameters	Description	Min	Type	Max	Unit
VIH	High-level input voltage	1.4	-	-	V
VIL	Low-level input voltage	-	-	0.6	V

The following is the circuit diagram:

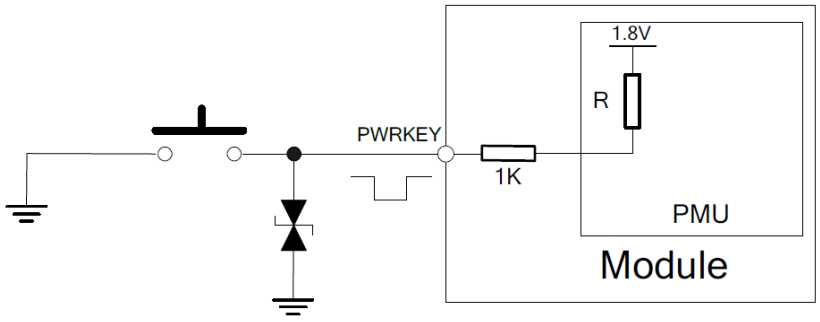


Figure 12: Power On/ Off using the power button

The following is the circuit diagram:

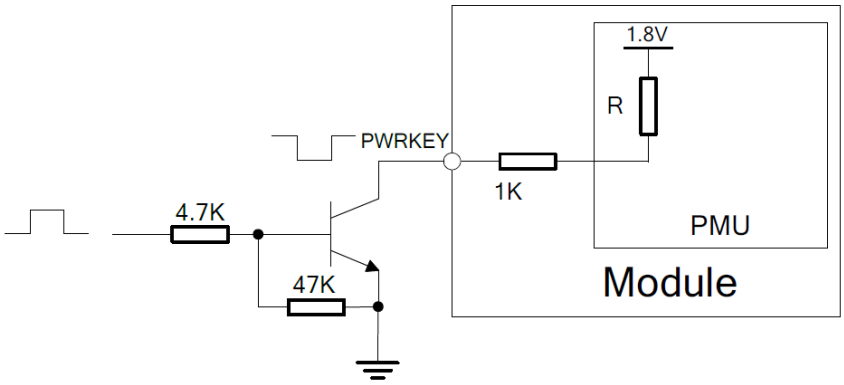


Figure 13: Power On/ Off using the transistor

5.2.1. Power-On Sequence

The following is the power on sequence diagram:

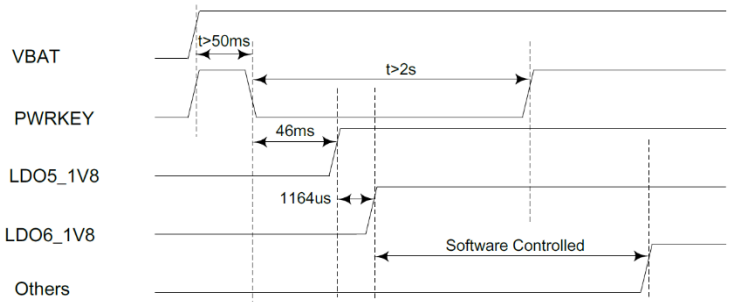


Figure 14: Power-on sequence

Note/Tip:

1. Make sure that VBAT is stable before pulling down PWRKEY PIN. Before removing the pin, ensure to wait for atleast 50ms.
2. PWRKEY PIN cannot be pulled down all the time..

5.3. Power Off

Users can turn off Telit SE150A4 Smart module by pulling down the PWRKEY PIN for more than 1 second. After the module detects that the PWRKEY is low level, a prompt window will pop up on the screen to confirm whether to execute the shutdown action.

Module can also be forced to shut down by pulling down PWRKEY for more than 8 seconds.

Note/Tip:

•The VBAT power supply circuit of the module can be cut off in the customer's hardware design.

•It is recommended to add a low-cost MCU, which can control the PWRKEY

to power on and power off the module, as wellas the hardware watchdog to protect the normal operation.

•Do not directly cut off the power supply VBAT of the module while it is in operation, otherwise the internal flash of the module may be damaged. It is strongly recommended to shut down the module through PWRKEY or AT command before disconnecting the power supply VBAT of the module.

5.4. Unconditional Restart

Users can turn off Telit SE150A4 Smart module by pulling down the RESET_N PIN for more than 200ms. After the module detects that the RESET_N is low level, the device will perform an unconditional restart.

Note/Tip: The RESET_N line should be used only in emergency recovery situations.

It is always suggested to follow the standard Power Off procedure to properly power off the device.

5.5. Communication Ports

5.5.1. USB Interface

The Telit SE150A4 Smart module provides one High-speed USB 2.0 interface, used for software upgrading, debugging, charging, etc.

5.5.1.1.USB Interface Operating Voltage

The interface is following the USB 2.0 specifications

Table 20: USB Interface electrical characteristics for VBUS line

Parameter	Description	Min	Typical	Max	Unit
VBUS	USB VBUS Operating voltage	4.35	5	6.2	V

5.5.1.2.USB Interface Connections Diagram

The Telit SE150A4 Smart module provides one High-speed USB 2.0 interface, used for software upgrading, debugging, charging, etc.

The following is the circuit diagram:

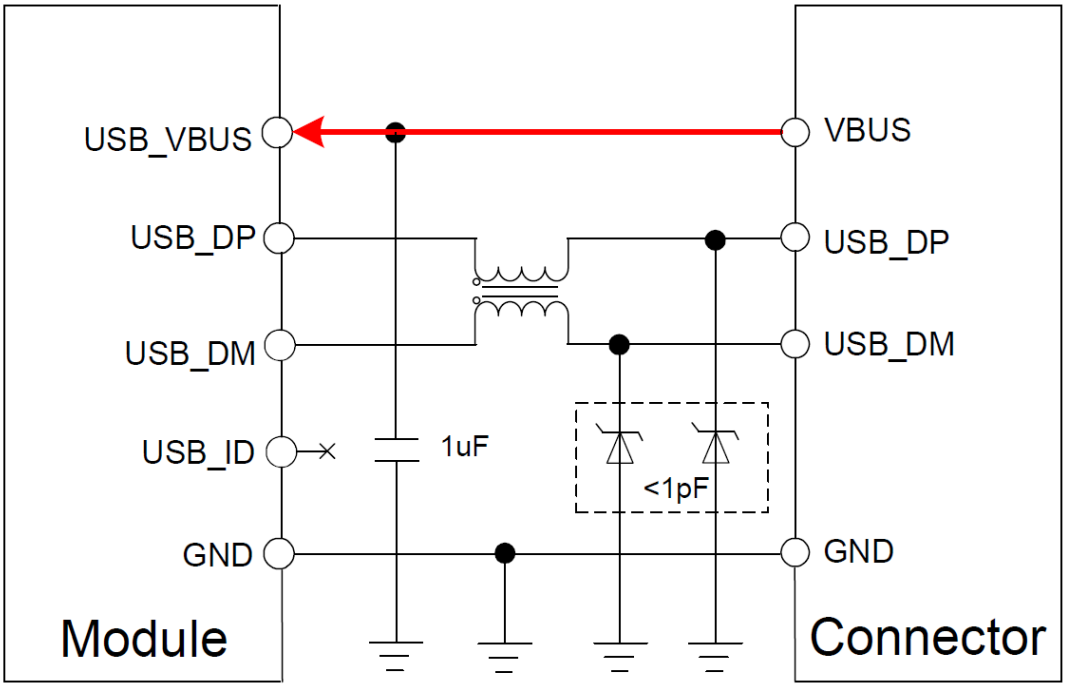


Figure 15: USB reference circuit

In addition, Telit SE150A4 Smart module supports OTG function, but external 5V power supply is required.

The following is the circuit diagram:

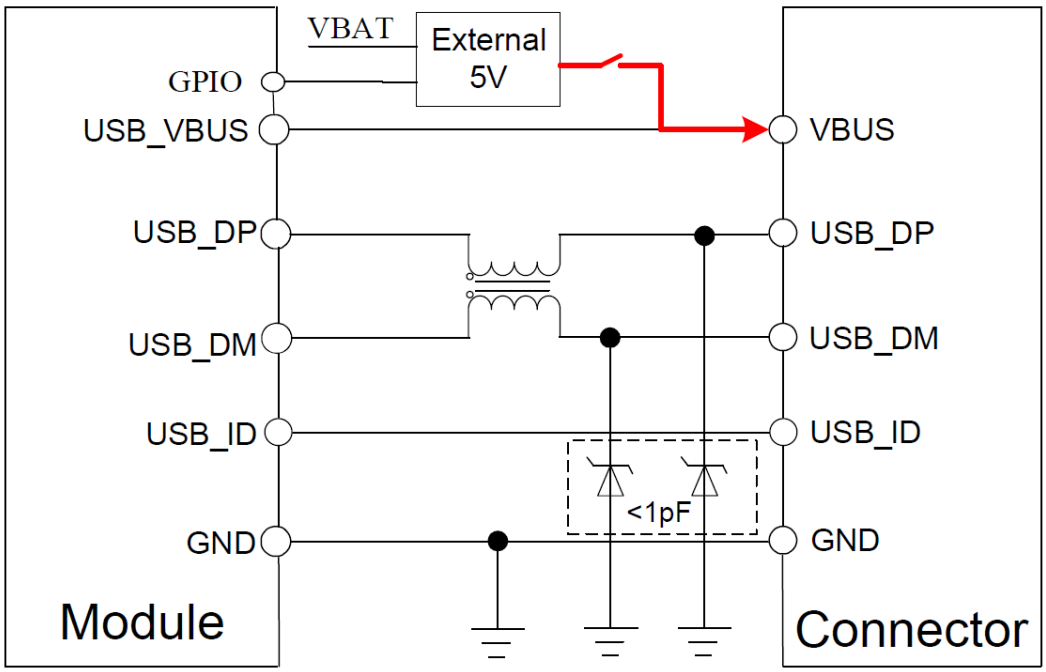


Figure 16: USB_OTG reference circuit

Note/Tip: Please refer to Chapter 5 for detailed layout design rules.

5.5.1.3.Forced USB BOOT

FORCED_USB_BOOT is the emergency download interface. If FORCED_USB_BOOT is pulled up to LDO5_1V8, the module enters emergency download mode. Used when the product does not start properly. To facilitate the subsequent software upgrades and debugging, you must reserve the test points

The following is the circuit diagram:

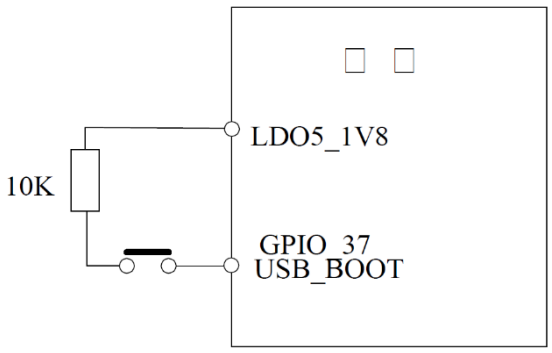


Figure 17: Forced download circuit

Table 21:Forced USB Boot

PIN name	PIN	I/O	Description	Note
USB_BOOT	46	I	USB forced download signal, short-circuit to LDO5_1V8 at power-on to enter forced download mode.	Reserved test point
LDO5_1V8	111	PO	1.8V LDO output	

5.5.1.4.PCB Layout Guidelines For USB Lines

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- 90 Ω differential, ± 10% trace impedance
- Differential data pair matching < 0.7 mm
- External components should be located near the USB connector.
- Should be routed away from sensitive circuits and signals.
- If there are test points, place them on the trace to keep branches as short as possible
- If USB connector is used as the charger input, USB_VBUS node must be routed to the module using extremely wide traces or sub planes.

5.5.2. UART/SPI/I2C/I2S

The Telit SE150A4 Smart module provides several sets of GPIOs which are available as BLSP (BAM-enabled low-speed peripheral) interfaces that can be configured to support various interface combinations. The operation voltage is 1.8V

UART: Support 3*UART; up to 4 Mbps

SPI: Supports 5*SPI; master-only mode; up to 50 MHz.

I2C: Support 6*I2C; master-only mode; up to 3.4 MHz, 2.2Kohm pull-up resistors are needed externally.

5.5.2.1.UART/SPI/I2C Functional Assignments

Table 22: UART/SPI/I2C Functional Assignments

PIN name	PIN	Expected or Default Function	Alternate function 1	Alternate function 2	Alternate function 3
UART2_TXD	94	BLSP2_UART_TX	BLSP2_UART_TX	BLSP2_SPI_MOSI	GPIO_4

UART2_RXD	93	BLSP2_UART_RX	BLSP2_UART_RX	BLSP2_SPI_MISO	GPIO_5
GPIO_6	113	GPIO_6	BLSP2_UART_CTS_N	BLSP2_SPI_CS_N	BLSP2_I2C_SDA
GPIO_7	112	GPIO_7	BLSP2_UART_RFR_N	BLSP2_SPI_CLK	BLSP2_I2C_SCL
GPIO_8	123	GPIO_8		BLSP3_SPI_MOSI	
GPIO_9	124	GPIO_9		BLSP3_SPI_MISO	
TP_I2C_SDA	48	BLSP3_I2C_SDA	GPIO_10	BLSP3_SPI_CS_N	GP_CLK_2B
TP_I2C_SCL	47	BLSP3_I2C_SCL	GPIO_11	BLSP3_SPI_CLK	GP_CLK_3B
SENSOR_I2C_SDA	92	BLSP4_I2C_SDA	GPIO_14		
SENSOR_I2C_SCL	91	BLSP4_I2C_SCL	GPIO_15		
UART1_TX	34	BLSP5_UART_TX		BLSP5_SPI_MOSI	GPIO_16
UART1_RX	35	BLSP5_UART_RX		BLSP5_SPI_MISO	GPIO_17
UART1_CTS	36	BLSP5_UART_CTS	BLSP5_I2C_SDA	BLSP5_SPI_CS_N	GPIO_18
UART1_CTS	37	BLSP5_UART_RFR	BLSP5_I2C_SCL	BLSP5_SPI_CLK	GPIO_19
GPIO_20	119	GPIO_20	BLSP6_UART_TX	BLSP6_SPI_MOSI	
GPIO_21	118	GPIO_21	BLSP6_UART_RX	BLSP6_SPI_MISO	
GPIO_22	117	GPIO_22	BLSP6_UART_CTS_N	BLSP6_SPI_CS_N	BLSP6_I2C_SDA
GPIO_23	116	GPIO_23	BLSP6_UART_RFR_N	BLSP6_SPI_CLK	BLSP6_I2C_SCL
GPIO_25	115	GPIO_25	CAM_DVDD_EN		MI2S_1_MCLK_
CAM_I2C_SDA	84	CAM_I2C_SDA	GPIO_29		
CAM_I2C_SCL	83	CAM_I2C_SCL	GPIO_30		
GPIO_85	103	GPIO_85		BLSP7_SPI_MOSI	MI2S_1_SCK

GPIO_86	104	GPIO_86		BLSP7_SPI_MISO	MI2S_1_D1
GPIO_87	105	GPIO_87		BLSP7_SPI_CS_N	MI2S_1_WS
GPIO_88	106	GPIO_88		BLSP7_SPI_CLK	MI2S_1_D0

5.5.2.2.UART Level Conversion Circuit

The serial port level of the Telit SE150A4 Smart module UART port is 1.8V. To communicate with the 3.3V serial port level, a level conversion chip must be added between the conversion chip and the module. It is recommended to use TI's TXS0104EPWR

The following is the circuit diagram:

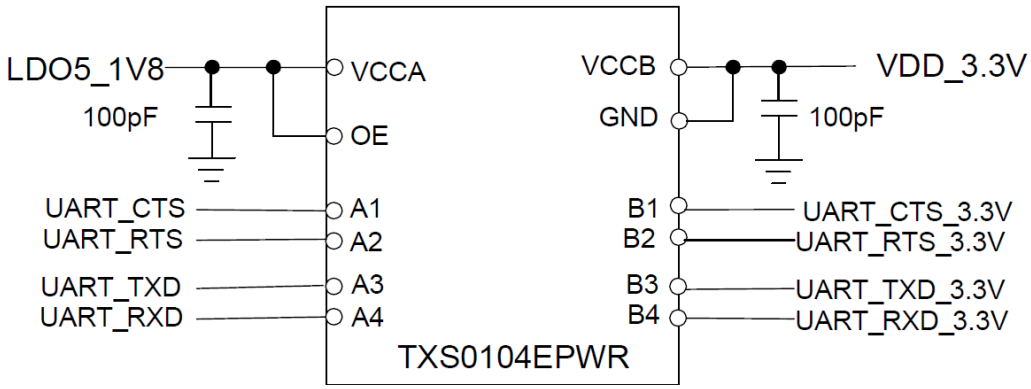


Figure 18: UART level conversion circuit

The following is the circuit diagram:

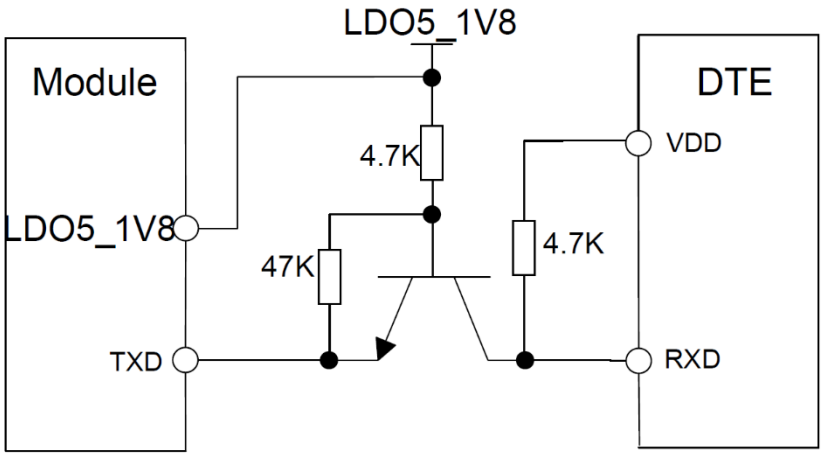


Figure 19: UART TX level conversion circuit

The following is the circuit diagram:

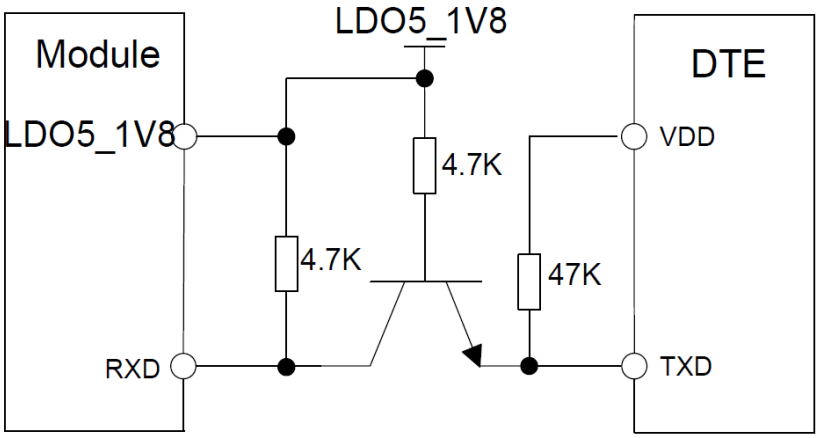


Figure 20: UART RX level conversion circuit

5.6. General Purpose I/O

Table 23: General Purpose I/O

PIN	Signal	I/O	Reset Status	Wakeup Interrupt	Comment
113	GPIO_6	I/O	PD		
112	GPIO_7	I/O	PD		
123	GPIO_8	I/O	PD		
124	GPIO_9	I/O	PD	X	Do not add external Pull-up resistors.
119	GPIO_20	I/O	PD		
118	GPIO_21	I/O	PD	X	
117	GPIO_22	I/O	PD		
116	GPIO_23	I/O	PD		
115	GPIO_25	I/O	PD	X	CAM_DVDD_EN
99	GPIO_33	I/O	PD		CAMERA_ENM
100	GPIO_34	I/O	PD		CAMERA_ENF
33	GPIO_61	I/O	PD		
103	GPIO_85	I/O	PD		
104	GPIO_86	I/O	PD	X	
105	GPIO_87	I/O	PD		
106	GPIO_88	I/O	PD		Do not add external Pull-up resistors.

90	GPIO_94	I/O	PD		
102	GPIO_107	I/O	-		Do not add external Pull-up resistors. Usable only for RF Ant tuner switch
101	GPIO_108	I/O	-		Do not add external Pull-up resistors. Usable only for RF Ant tuner switch

Table 24: Legend

Symbol	Description
NP	No internal pull
PU	Internal pull up
PD	Internal pull down

5.7. UIM Interface

The Telit SE150A4 Smart module provides one 4-bit secure digital interface, which supports SD 3.0 specifications.

Table 25: UIM Interface

PIN	Signal	I/O	Function	Type	Comment
22	USIM1_DET	I	USIM1 presence detection	DI	1.8V power domain. External pull-up resistor is required. If unused, keep it open.
23	USIM1_RST	O	USIM1 reset	DO	It can't be used as GPIO
24	USIM1_CLK	O	USIM1 clock	DO	It can't be used as GPIO
25	USIM1_DATA	I/O	USIM1 data	DI/DO	It can't be used as GPIO
26	USIM1_VDD	O	LDO 14 output for USIM1, 1.8V/2.95V	PO	A parallel 100nf capacitance is required.
17	USIM2_DET	I	USIM2 presence detection	DI	1.8V power domain. External pull-up resistor is required. If unused, keep it open.
18	USIM2_RST	O	USIM2 reset	DO	It can't be used as GPIO
19	USIM2_CLK	O	USIM2 clock	DO	It can't be used as GPIO
20	USIM2_DATA	I/O	USIM2 data	DI/DO	It can't be used as GPIO
21	USIM2_VDD	O	LDO 15 output for USIM2, 1.8V/2.95V	PO	A parallel 100nf capacitance is required.

Table 26: UIM Interface Description

Parameter	Description	Min	Typical	Max	Unit
VIH	High level input voltage	0.7* USIM_VDD	-	USIM_VDD +0.3	V
VIL	Low level input voltage	-0.3	-	0.2* USIM_VDD	V
VOH	High level output voltage	0.8* USIM_VDD	-	USIM_VDD	V
VOL	Low level output voltage	0	-	0.4	V

The following is the circuit diagram:

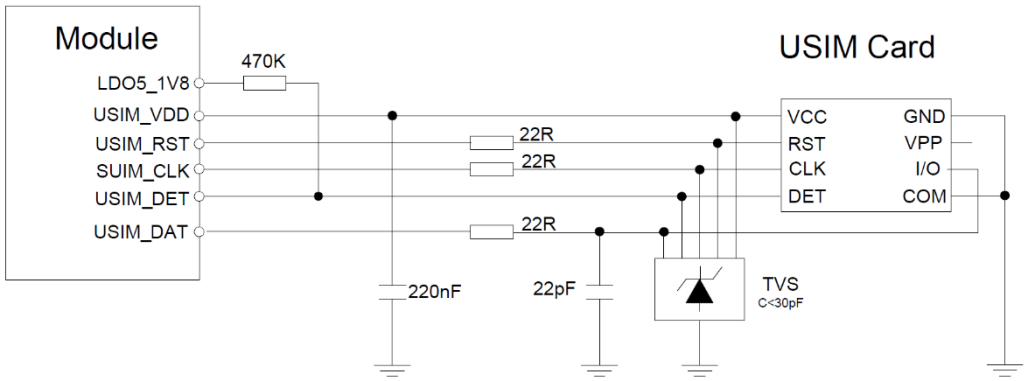


Figure 21: SD card reference circuit

Note/Tip: USIM_DAT has been pulled up with a 10Kohm resistor to USIM_VDD in module.

A 220nF shut capacitor on USIM_VDD is used to reduce interference.

5.7.1. UART/SPI/I2C/I2S

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- Ensure UIM card holder is far away from antenna or RF signal
- ESD component and bypass caps should be placed closed to UIM Ca
- UIM card signals should be far away from other high-speed signal
- Digital devices and traces should not be placed near sensitive signals like RF and clock.

5.8. ADC Converter

The Telit SE150A4 Smart module includes two 15bits ADC.

Table 27: ADC Converter Performace Parameters

PIN name	PIN	I/O	Description	Note
ADC	128	AI	Analog to digital converter	Maximum input voltage is 4.5V. If unused, keep it open.
ADC2	183	AI	Analog to digital converter	

Table 28: ADC performance

Parameter	Comments	Min	Type	Max	Unit
Input voltage range	Programmable	0.1	-	1.7	V
		0.3	-	4.5	
Resolution		-	15	-	bits
Analog input bandwidth		-	100	-	kHz
Sample rate	XO/8	-	2.4	-	MHz
INL	15-bit output	-8	-	8	LSB
DNL	15-bit output	-4	-	4	LSB
Offset error	Relative to full-scale	-1	-	1	%
Gain error	Relative to full-scale	-1	-	1	%

Note/Tip: Ensure to use a resistor divider before connecting to the ADC. This prevents the ADC from damaging the module due to high power supply.

5.9. Vibrator

The Telit SE150A4 Smart module supports silent incoming-call alarms with a vibration motor driver. The vibration driver is a programmable voltage output that is referenced to VBAT; when off, its output voltage is VBAT. The motor is connected between VBAT and the VIB_DRV_N PIN. The programmable motor voltage ranges from 1.2 to 3.1 V in 100 mV steps.

Table 29: Vibrator

PIN name	PIN	I/O	Description	Note
VIB_DRV_N	28	PO	Vibration motor driver output control	

The following is the circuit diagram:

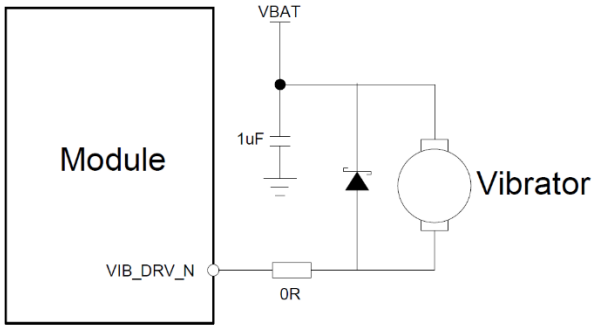


Figure 22: Vibrator reference circuit

5.10. Secure Digital Interface

The Telit SE150A4 Smart module provides one 4-bit secure digital interface, which is compliant to SD 3.0 specifications.

Table 30: Secure Digital Interface Available Signals

PIN	Signal	I/O	Function	Type
38	SD_LDO11	O	LDO11 output for SD card	PO
32	SD_LDO12	O	LDO12 output for SD IO pull up	PO
39	SD_CLK	O	Secure digital controller clock	DO
40	SD_CMD	I/O	Secure digital controller command	DI/DO
41	SD_DATA0	I/O	Secure digital controller data bit 0	DI/DO
42	SD_DATA1	I/O	Secure digital controller data bit 1	DI/DO
43	SD_DATA2	I/O	Secure digital controller data bit 2	DI/DO
44	SD_DATA3	I/O	Secure digital controller data bit 3	DI/DO
45	SD_DET/GPIO_67	I/O	Secure digital card detection	DI

Table 31: Electrical characteristics (1.8V)

Parameter	Comment	Min	Typical	Max	Unit
VIH	High level input voltage	1.27	-	2	V
VIL	Low level input voltage	-0.3	-	0.58	V
VOH	High level output voltage	1.4	-	-	V
VOL	Low level output voltage	0	-	0.45	V

Table 32: SD Interface electrical characteristics

Parameter	Comment	Min	Typical	Max	Unit
VIH	High level input voltage	1.84	-	3.25	V
VIL	Low level input voltage	-0.3	-	0.74	V
VOH	High level output voltage	2.21	-	2.95	V
VOL	Low level output voltage	0	-	0.37	V

The following is the circuit diagram:

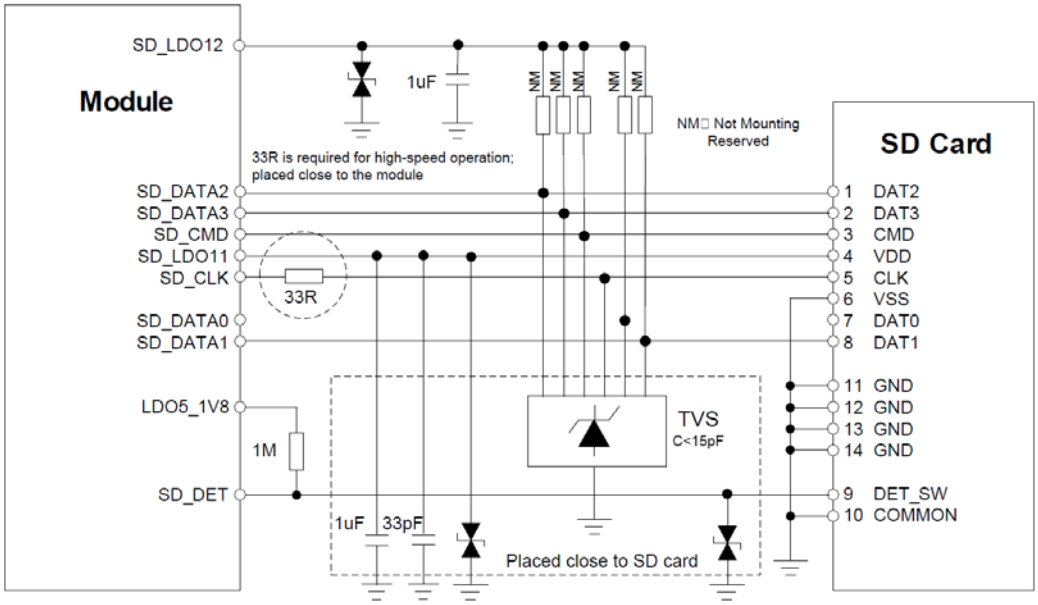


Figure 23: SD card reference circuit

Note/Tip: SDC signals cannot be pulled up to SD_LDO11.

5.10.1. PCB Design For SD Card Lines

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- Protect other sensitive signals/circuits from SDC corruption.
- Protect SDC signals from noisy signals (clocks, SMPS, etc.).
- Up to 200 MHz clock rate
- 50 Ω nominal, ±20% trace impedance
- CLK to DATA/CMD length matching < 1 mm
- 30–35 Ω termination resistor on clock lines near the module
- Total routing length < 50 mm recommended
- Spacing to all other signals = 2x line width
- Bus capacitance < 15 pF

5.11. LCD Interface

The Telit SE150A4 Smart module provides a 4-lane MIPI_DSI, with 1.5 Gbps per lane high-speed mode bandwidth, to support HD+(1440*720), 60fps

PWM pin is used as PWM control for external WLED driver.

Table 33: LCD Interface Available Signals

PIN	Signal	I/O	Description	Type
29	PWM	O	PWM control for external WLED driver	DO
49	LCD_RST_N	O	LCD reset	DO
50	LCD_TE	I	LCD tear effect	DI
52	MIPI_DSI_CLK_M	O	MIPI display serial interface Differential 85 Ohm impedance line control Tolerance +-15%	DO
53	MIPI_DSI_CLK_P	O		DO
54	MIPI_DSI_LANE0M	O		DO
55	MIPI_DSI_LANE0P	O		DO
56	MIPI_DSI_LANE1M	O		DO
57	MIPI_DSI_LANE1P	O		DO
58	MIPI_DSI_LANE2M	O		DO
59	MIPI_DSI_LANE2P	O		DO
60	MIPI_DSI_LANE3M	O		DO
61	MIPI_DSI_LANE3P	O		DO

If only 2-lane MIPI_DSI is needed, just leave LANE2 and LANE3 floating. Common mode filters is recommended for EMI issue, and it may be omitted if best EMI practices are followed.

5.11.1. PCB Design For LCD Lines

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- Protect MIPI_DSI signals from noisy signals (clocks, SMPS, etc.)
- Differential pairs, 85 Ω nominal, ±15%
- Total routing length < 305 mm
- Intra-pair length matching < 5 ps (0.67 mm)
- Inter-pair length matching < 10 ps (1.3 mm)
- Lane-to-lane trace spacing = 3x line width
- Spacing to all other signals = 4x line width
- Maintain a solid ground reference for clocks to provide a low-impedance path for return currents
- Each trace needs to be next to a ground plane
- Minimize the number of via on the trace

Table 34: MIPI traces inside the module

PIN	Signal	Length (mm)
52	MIPI_DSI_CLK_M	13.62
53	MIPI_DSI_CLK_P	13.52
54	MIPI_DSI_LANE0M	13.14
55	MIPI_DSI_LANE0P	13.24

56	MIPI_DSI_LANE1M	13.51
57	MIPI_DSI_LANE1P	13.17
58	MIPI_DSI_LANE2M	13.36
59	MIPI_DSI_LANE2P	13.28
60	MIPI_DSI_LANE3M	13.65
61	MIPI_DSI_LANE3P	13.74

The following is the circuit diagram:

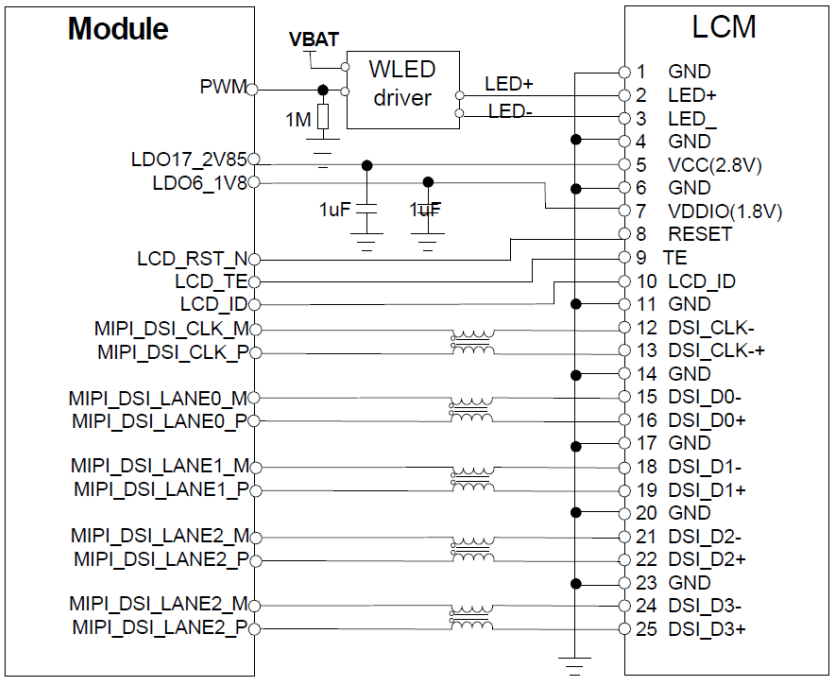


Figure 24: LCD reference cicuit

5.12. Touch Screen Interface

Table 35: Touch Screen Interface Available Signals

PIN	PIN name	Type	Description
48	TP_I2C_SDA	DI/DO	Touch screen I2C, pull-up resistors are needed externally
47	TP_I2C_SCL	DO	
30	TP_INT_N	DI	Touch screen interrupt
31	TP_RST_N	DO	Touch screen reset
129	LDO17_2V85	PO	Power for touch screen VDD
111	LDO5_1V8	PO	Power for touch screen pull up level

Note/Tip: TP_I2C: supports master-only mode; 2.2Kohm pull-up resistors are needed externally.

The following is the circuit diagram:

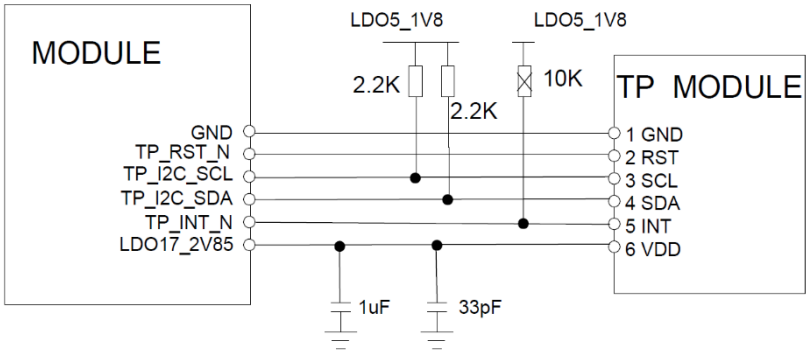


Figure 25: TP reference circuit

5.13. Camera interface

The Telit SE150A4 Smart module supports two cameras: 4-lane MIPI_CSI primary camera up to 13MP resolution and 2-lane MIPI_CSI secondary camera up to 8MP resolution.

Table 36: Camera Interface Available Signals

PIN	Signal	I/O	Description	Note	Type
63	MIPI_CSI0_CLK_M	I	Primary camera MIPI interface	Differential 85 Ohm impedance line control Tolerance +-15%	DI
64	MIPI_CSI0_CLK_P	I			DI
65	MIPI_CSI0_LN0_M	I			DI
66	MIPI_CSI0_LN0_P	I			DI
67	MIPI_CSI0_LN1_M	I			DI
68	MIPI_CSI0_LN1_P	I			DI
157	MIPI_CSI0_LN2_M	I			DI
156	MIPI_CSI0_LN2_P	I			DI
158	MIPI_CSI0_LN3_M	I			DI
159	MIPI_CSI0_LN3_P	I			DI
70	MIPI_CSI1_CLK_M	I	Secondary Camera MIPI interface	Differential 85 Ohm impedance line control Tolerance +-15%	DI
71	MIPI_CSI1_CLK_P	I			DI
72	MIPI_CSI1_LN0_M	I			DI
73	MIPI_CSI1_LN0_P	I			DI
155	MIPI_CSI1_LN1_M	I			DI
154	MIPI_CSI1_LN1_P	I			DI
74	CAM0_MCLK	O	Primary Camera master clock		DO
75	CAM1_MCLK	O	Secondary Camera master clock		DO
79	CAM0_RST_N	O	Primary Camera reset		DO

80	CAM0_PWDN	O	Primary Camera power down		DO
81	CAM1_RST_N	O	Secondary Camera reset		DO
82	CAM1_PWDN	O	Secondary Camera power down		DO
83	CAM_I2C_SCL	O	Camera I2C data	Pull-up resistor 2.2Kohm	DO
84	CAM_I2C_SDA	I/O	Camera I2C clock	Pull-up resistor 2.2Kohm	DI/DO
125	LDO6_1V8	O	power supply for camera IOVDD		PO
153	LDO10_2V85	O	power supply for camera AFVDD		PO
195	LDO16_2V8	O	power supply for camera AVDD		PO
151	SMPS_S3_1V35	O	power supply for camera DVDD LDO		PO

5.13.1. PCB Design For LCD Lines

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- Protect MIPI_CSI signals from noisy signals (clocks, SMPS, etc.)
- Differential pairs, 85 Ω nominal, ±15%
- Total routing length < 305 mm
- Intra-pair length matching < 5 ps (0.67 mm)
- Inter-pair length matching < 10 ps (1.3 mm)
- Lane-to-lane trace spacing = 3x line width
- Spacing to all other signals = 4x line width
- Maintain a solid ground reference for clocks to provide a low-impedance path for return currents
- Each trace needs to be next to a ground plane
- Minimize the number of via on the trace

Table 37: MIPI traces inside the module

PIN	Signal	Length (mm)
63	MIPI_CSI0_CLK_M	14.35
64	MIPI_CSI0_CLK_P	14.32
65	MIPI_CSI0_LN0_M	14.23
66	MIPI_CSI0_LN0_P	14.22
67	MIPI_CSI0_LN1_M	14.27

68	MIPI_CSI0_LN1_P	14.30
157	MIPI_CSI0_LN2_M	14.66
156	MIPI_CSI0_LN2_P	14.65
158	MIPI_CSI0_LN3_M	14.55
159	MIPI_CSI0_LN3_P	14.48
70	MIPI_CSI1_CLK_M	26.21
71	MIPI_CSI1_CLK_P	26.02
72	MIPI_CSI1_LN0_M	26.29
73	MIPI_CSI1_LN0_P	26.26
154	MIPI_CSI1_LN1_M	26.67
155	MIPI_CSI1_LN1_P	26.81

5.14. Sensor Interface

The Telit SE150A4 Smart module communicates with sensors using I2C or SPI. The Telit SE150A4 Smart module supports various sensors such as Hall, acceleration, Magnetic, light and pressure sensors

Table 38: Sensor Interface Available Signals

PIN	Signal	I/O	Description	Type
91	SENSOR_I2C_SCL	O	Sensors I2C Clock, pull-up 2.2K resistors are needed externally	DO
92	SENSOR_I2C_SDA	I/O	Sensors I2C Data, pull-up 2.2K resistors are needed externally	DI/DO
107	ALSP_INT_N/GPIO_43	I	Ambient light and proximity sensor interrupt	DI
108	MAG_INT_N/GPIO_44	I	Magnetic sensor interrupt	DI
109	ACCL_INT2_N/GPIO_46	I	Accelerate sensor interrupt 2	DI
110	ACCL_INT1_N/GPIO_42	I	Accelerate sensor interrupt 1	DI
125	LDO6_1V8	O	LDO output power for VDD1.8V and I2C pull-up level	PO
129	LDO17_2V85	O	LDO output power for VDD2.85	PO

6. CELLULAR RF CONNECTIONS

6.1. Antenna Requirements

The Telit SE150A4 Smart module provides two antenna interfaces for the Cellular part: TRX antenna and DRX antenna.

Table 39: Cellular RF Connections

Item	Value
Frequency range	According to the product's supported bands
Gain	1dBi
Impedance	50 Ohm
Input power	> 2 W
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)
Polarization	Vertical
Cable Insertion Loss:	< 1dB (GSM850/EGSM900, WCDMA B5/B8, LTE B5/B8/B12/B17/ B20) < 1.5dB (DCS1800/PCS1900, WCDMA B1/B2/B3/B4, LTE B1, B2 ,B3, B4) < 2dB (LTE B7/B38/B40/B41)

6.1.1. TRX Antenna Reference Circuit

The following is the circuit diagram:

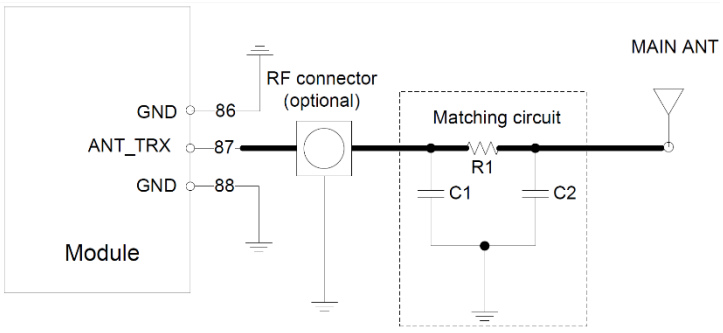


Figure 26: MAIN antenna recommended circuit

R1, C1 and C2 are antenna matching components, the value of these components are determined according to the antenna tuning results. By default, R1 is 0Ω, C1 and C2 are reserved. The RF connector is used to ensure the accuracy and convenience of the conduction testing, so TELIT suggest keeping it. If a Low-Cost BOM is required, you may discard the connector.

6.1.2. DRX Antenna Reference Circuit

The following is the circuit diagram:

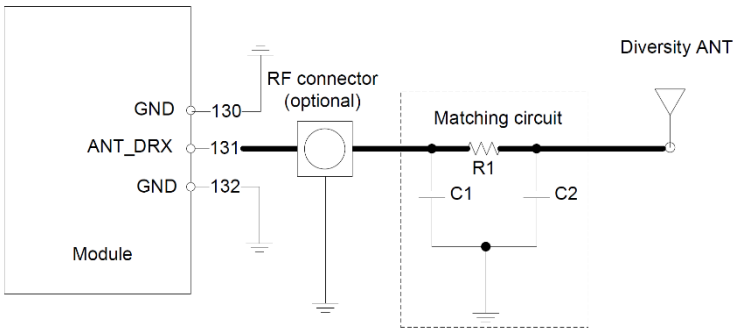


Figure 27: DRX antenna recommended circuit

R1, C1 and C2 are antenna matching components, the value of these components are determined according to the antenna tuning results. By default, R1 is 0Ω, C1 and C2 are reserved. accurate and convenient conducted RF tests and Telit recommends to mount it. If a Low-Cost BOM is required, you may discard the connector.

6.1.3. PCB Design Guidelines

To ensure good RF performance, users should meet the following requirements:

- At least, 4-layer through-hole PCB should be chosen for good impedance control and signal shielding.
- Keep the RF traces at 50Ω.
- Maintain a complete and continuous reference ground plane from antenna PIN to the RF connector.
- The RF traces should be away from any other noisy traces.
- Keep the RF traces as short as possible.
- Locate Telit SE150A4 Smart module in the center of PCB, rather than in the corner.
- Digital devices and traces should not be placed near sensitive signals like RF and clock.
- Keep SPKR and MIC away from sensitive RF lines.
- RF connectors should be placed close to the module's antenna PIN.
- Antenna matching circuit should be placed close to the antenna.
- Keep the RF traces at 50Ω.
- Maintain a complete and continuous reference ground plane from antenna PIN to the RF connector.
- The RF traces should be far away from any other noisy traces.
- Keep the RF traces as short as possible.

- If using a coaxial RF cable to connect the antenna, please avoid spanning on UIM cards, power circuits and high-speed digital circuits to minimize the impact of each other.

The characteristic impedance of RF signals should be controlled at 50 Ohm. In general, the impedance of RF signal is determined by the Permittivity (ER) of PCB material, line width (W), ground clearance (S), height of reference ground plane (H) and other factors.

Microstrip line and coplanar waveguide are usually used to control the characteristic impedance of RF wiring. The following illustrations show the structure design of microstrip line and coplanar waveguide.

The following is the structure diagram:

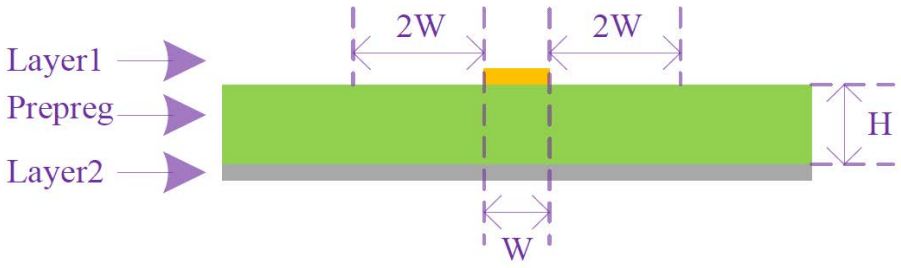


Figure 28: Two layer PCB microstrip structure

Table 40: Impedance control of microstrip line structure

Item	Value	
PCB thickness	1mm	1.6mm
Permittivity (ER)	4.2	4.2
Line thickness	0.035mm	0.035mm
Layer	Layer1	Layer1
Reference plane	Layer2	Layer2
Target impedance	50 ohm	50 ohm
Expected linewidth W	1.7mm (67 mil)	3mm (118 mil)

The following is the structure diagram:

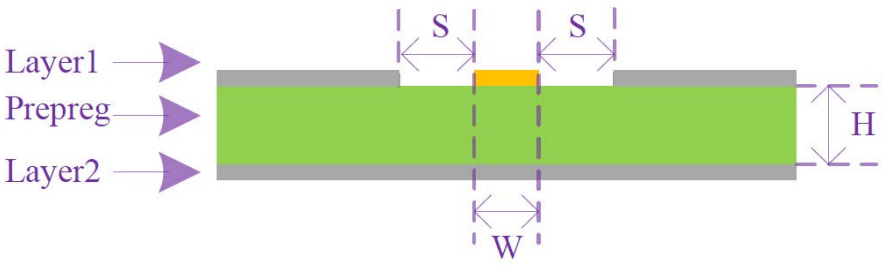


Figure 29: Two layer PCB coplanar waveguide structure

Table 41: Impedance control of coplanar waveguide structure

Item	Value	
PCB thickness	1mm	1.6mm
Permittivity (ER)	4.2	4.2
Line thickness	0.035mm	0.035mm
Layer	Layer 1	Layer 1
Reference plane	Layer2	Layer2
Target impedance	50 ohm	50 ohm
Expected gap to ground S	0.65mm (25.6 mil)	0.65mm (25.6 mil)
Expected linewidth W	0.2mm (7.8 mil)	0.15mm (5.9 mil)

The following is the structure diagram:

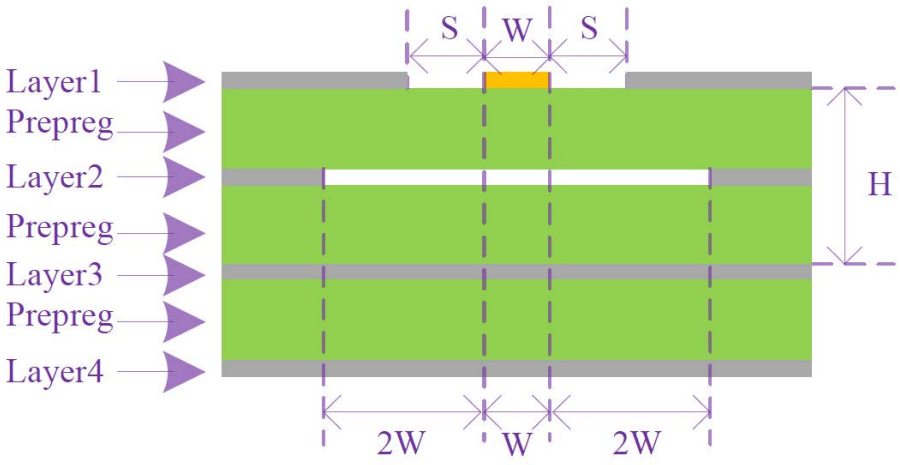


Figure 30: Four layer PCB coplanar waveguide structure 1#

Four layer PCB coplanar waveguide structure 2# is shown in following figure. The fourth layer is reference layer.

The following is the structure diagram:

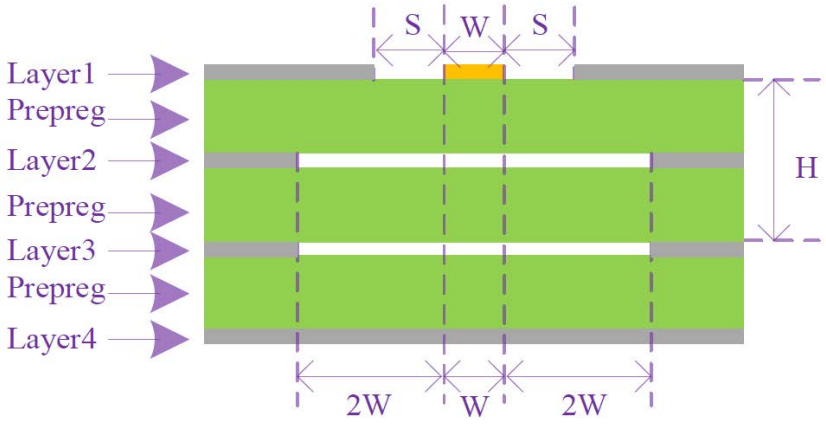


Figure 31: Four layer PCB coplanar waveguide structure 2#

7. GNSS RF SECTION

7.1. Antenna Requirements

The Telit SE150A4 Smart module includes a GNSS receiver. The Antenna requirements are the following:

Table 42: GNSS RF Antenna Requirements

Item	Value
Frequency range	1565 - 1607MHz
Polarization	RHCP or linear VSWR: < 2 (Typical)
Passive antenna gain	> 0dBi
Active antenna gain	> -2dBi
Active antenna noise figure	< 1.5dB
Active antenna embedded LNA gain	20dB (Typical)
Active antenna total gain	> 18dBi (Typical)

7.2. GNSS Antenna Reference Circuit

The following is the circuit diagram:

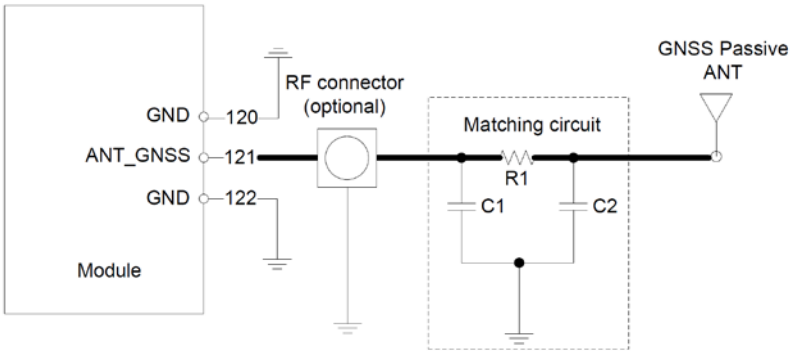


Figure 32: GNSS antenna recommended circuit

R1, C1 and C2 are antenna matching components; the value of these components are determined according to the antenna tuning results. By default, R1 is 0Ω, C1 and C2 are not mounted. The RF connector is used to allow accurate and convenient RF measurements in conducted mode.

If a Low-Cost BOM is required, you may discard the connector.

The module has an internal LNA, so there is no need for an external active antenna. If the antenna is away from the module, you may use an extention cable to connect the antenna. You may also use an external active antenna,

The following is the circuit diagram:

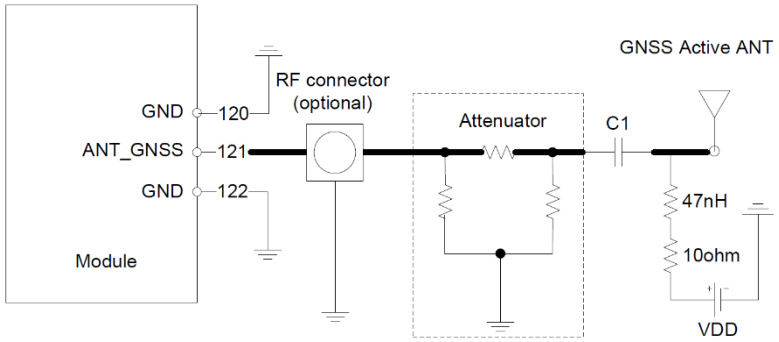


Figure 33: GNSS active antenna circuit

The attenuator must be added as required and attenuation value is determined according to the active antenna gain. Normally, the relationship between the attenuation value and the gain satisfies the following formula:

Antenna gain = Attenuation value + Cable Losses

VDD is used to provide voltage to the external active antenna and its value should be taken according to antenna characteristic; C1 is used for DC blocking and its value is 33pF by default. The RF connector is used to ensure the accuracy and easy test in conducted.

If a Low-Cost BOM is required, you may discard the connector.

8. WIFI/BT RF SECTION

8.1. Antenna Requirements

The Telit SE150A4 Smart module supports both WIFi and Bluetooth transceivers that have a common antenna pad. Antenna requirements are mentioned below:

Table 43: WIFI/BT RF Antenna Requirements

Item	Value
Frequency range	1565 - 1607MHz
Polarization	RHCP or linear VSWR: < 2 (Typical)
Passive antenna gain	> 0dBi
Active antenna gain	> -2dBi
Active antenna noise figure	< 1.5dB
Active antenna embedded LNA gain	20dB (Typical)
Active antenna total gain	> 18dBi (Typical)

8.2. WIFI/BT Antenna Reference Circuit

The following is the circuit diagram:

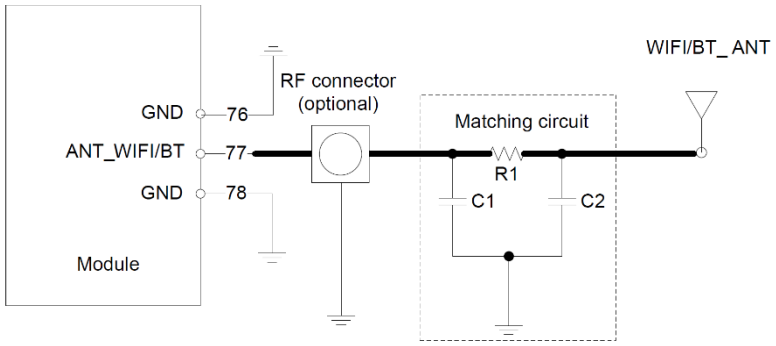


Figure 34: WIFI/BT Antenna Reference Circuit

R1, C1 and C2 are antenna matching components; the value of these components are determined according to the antenna tuning results. By default, R1 is 0Ω, C1 and C2 are not mounted. The RF connector is used to allow accurate and convenient RF measurements in conducted mode.

If a Low-Cost BOM is required, you may discard the connector.

The recommended RF connector is HIROSE UF.L-R-SMT.

8.2.1. PCB Design Guidelines

- RF connector should be placed close to the module's antenna PIN.
- Antenna matching circuit should be placed as close as possible to the antenna.
- Keep the RF traces at 50Ω.

- Maintain a complete and continuous reference ground plane from antenna PIN to the RF connector.
- The RF traces should be far away from any other noisy traces.
- Keep the RF traces as short as possible.

If using a coaxial RF cable to connect the antenna, please avoid spanning on UIM cards, power circuits and high-speed digital circuits to minimize the impact of each other.

8.3. 2.4G WIFI Main RF Characteristics

Table 44: 2.4G WIFI Main RF Characteristics

Item	802.11B (11M)	802.11G (54M)	802.11N(MCS7)	Unit
TX Output power	17	15	12.5	dBm
EVM	<20%	<-25dB	<-27dB	
RX sensitivity	-88	-73.5	-71	dBm

8.4. 5G WIFI Main RF Characteristic

Table 45: 5G WIFI Main RF Characteristic

Item	802.11G (54M)	802.11N(MCS7)	Unit
TX Output power	15	11	dBm
EVM	<-25	<-27	dB
RX sensitivity	-73.5	-71	dBm

8.5. Bluetooth Main RF Characteristic

Table 46: Bluetooth Main RF Characteristic

Item	DH5	2DH5	3DH5	Unit
TX Output power	9	7	7	dBm
RX sensitivity	-90	-80	-80	dBm

9. AUDIO INTERFACE

The Telit SE150A4 Smart module provides four microphone inputs and three outputs including earpiece, stereo headphones, and mono class-D speaker driver.

Table 47: Audio Interface Available Signals

PIN	Signal	I/O	Function	Type	Comment
Audio interface					
8	EAR_P	O	Earpiece output +	AO	
9	EAR_M	O	Earpiece output -	AO	
136	HPH_R	O	Headphone output, right channel	AO	
137	HPH_GND	I	Headphone ground reference	PI	
138	HPH_L	O	Headphone output, left channel	AO	
139	HS_DET	I	Headset detection	DI	
5	GND_MIC	I	Microphone input 2 ground reference	PI	
4	MIC1P	I	Microphone input 1 +	AI	
6	MIC2P	I	Microphone input 2 -	AI	
152	MIC3P	I	Microphone input 3, positive	AI	
10	SPK_P	O	Speaker driver output, positive	AO	
11	SPK_M	O	Speaker driver output, negative	AO	
194	MIC_BIAS1	O	Microphone bias 1	PO	Bias for external MEMS Microphone ECM: keep MIC_BIAS1/2 open
210	MIC_BIAS2	O	Microphone bias 2	PO	
97	DMIC_CLK/ GPIO_89	O	Digital MIC clock	DO	
98	DMIC_DATA/ GPIO_90	I/O	Digital MIC data	DI/DO	

9.1. Electrical Charactrestics

9.1.1. Analog Microphone

Internal MIC_BIAS pull-up is used to reduce BOM cost and PCB routing.

Single-ended capless input is the only supported configuration, but differential routing is recommended.

The following is the circuit diagram:

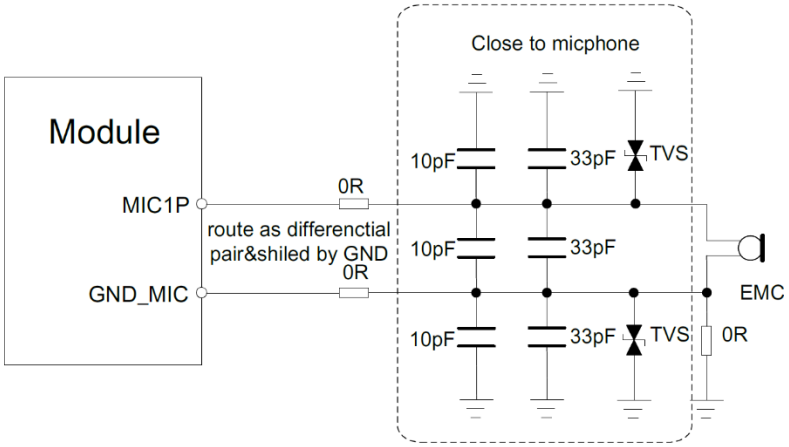


Figure 35: EMC microphone reference circuit

The following is the circuit diagram:

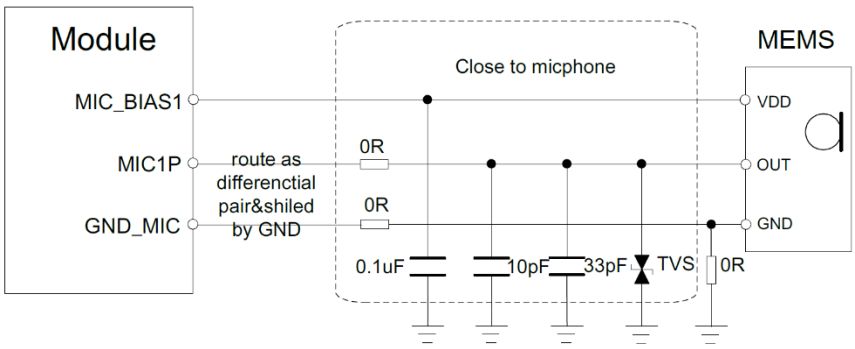


Figure 36: MEMS microphone reference circuit

Note/Tip: The Telit SE150A4 Smart module cannot support in parallel the analog MIC and digital MIC.

9.1.2. Analog Microphone Input Performance

Table 48: Microphone amplifier gain = 0 dB (minimum gain)

Parameter	Test conditions	Min	Typical	Max	Units
Input referred noise	Single-ended, A-weighted, capless	-	18.5	25.1	µVrms
Signal-to-noise ratio	Single-ended, A-weighted, capless	92	94	-	dB
THD+N ratio, Analog input = -1 dBV	f = 1.02 kHz; single-ended input; 200 Hz to 20 kHz bandwidth; capless	-	-83	-70	dB

Table 49: Microphone amplifier gain = 6 dB

Parameter	Test conditions	Min	Typical	Max	Units
Input referred noise	Single-ended, A-weighted, capless	-	10	13	µVrms
Signal-to-noise ratio	Single-ended, A-weighted, capless	91	94	-	dB
THD+N ratio Analog input = -1 dBV	f = 1.02 kHz; single-ended input; 200 Hz to 20 kHz bandwidth; capless	-	-82.5	-70	dB

Table 50: Microphone amplifier gain = 24 dB (maximum gain)

Parameter	Test conditions	Min	Typical	Max	Units
Input referred noise	Single-ended, A-weighted, capless	-	2.6	4.2	µVrms
Signal-to-noise ratio	Single-ended, A-weighted, capless	84	87.5	-	dB
THD+N ratio Analog input = -1 dBV	f = 1.02 kHz; single-ended input; 200 Hz to 20 kHz bandwidth; capless	-	-82	-60	dB

Table 51: General Requirement

Parameter	Test conditions	Min	Typical	Max	Units
Full-scale input voltage	Single-ended 1 kHz input. Input signal level required to get 0 dBFS digital output	-0.5	0	0.5	dBV
Input impedance	Capless input Input disabled	1	-	-	MΩ
		3	-	-	MΩ
Input capacitance	Capless input	-	-	15	pF

9.1.3. Microphone Bias

The Telit SE150A4 Smart module provides two microphone bias outputs: MIC_BIAS1 and MIC_BIAS2.

The microphone bias cannot be used for ECM-type microphone.

MIC_BIAS1 and MIC_BIAS2 could be used for External MEMS microphone as power supply.

9.1.4. Microphone Bias Output Performance Specifications

Table 52: Microphone Bias Output Performance Specifications

Parameter	Test conditions	Min	Typical	Max	Units
Output voltage	No load	1.60	-	2.85	V
Output voltage accuracy	No load	-3.00	0.00	3.00	%
Output current	2 microphone loads of 1.0 to 1.5 mA each	2.0	3.0	-	mA
Output switch to ground	On resistance	-	-	20	Ω
	Sink current	2.0	-	-	mA
Output noise	0.1 µF bypass	0.0	2.0	4.0	µVrms
PSRR - Power supply rejection ratio 100 mVpp applied to PMIC Vbatt input	at 20 Hz	90	-	-	dB
	at 200 Hz to 1 kHz	90	-	-	dB
	at 5 kHz	90	-	-	dB
	at 10 kHz	90	-	-	dB
	at 20 kHz	85	-	-	dB
Output capacitor value	External bypass mode	0.1	0.1	0.5	µF
	No external bypass mode	-	-	270	pF

9.1.5. PCB Guidelines For Audio

9.1.5.1. Analog Input

- 4 to 5 mil trace widths; 4 to 5 mil spacing between traces.
- Differential route for MIC1P\ MIC2P\ MIC3P with GND_MIC.
- Isolate from noise sources, such as antenna, RF signals, SMPS, clocks, and other digital signals with fast transients.

9.1.5.2.Analog Output

- Coplanar ground fill on both sides (of traces or pair as appropriate); in between ground planes – grounds above and below
- Isolate from noise sources such as antenna, RF signals, SMPS, clocks, and other digital signals with fast transients.
- EAR output signal – route as differential pair with 10 mil trace widths.
- SPKR output signals – route as differential pair with 20 mil trace widths with 8 Ω load and 25 mil trace widths with 4 Ω load
- HPH output signals – not a differential pair; 10 mil trace widths for HPH_L and HPH_R; 15 mil trace widths for HPH_REF

- Connect HPH_REF to the ground PIN of the jack connector and route HPH_REF in between HPH_L and HPH_R for best crosstalk minimization.

9.1.6. Analog Microphone

The following is the circuit diagram:

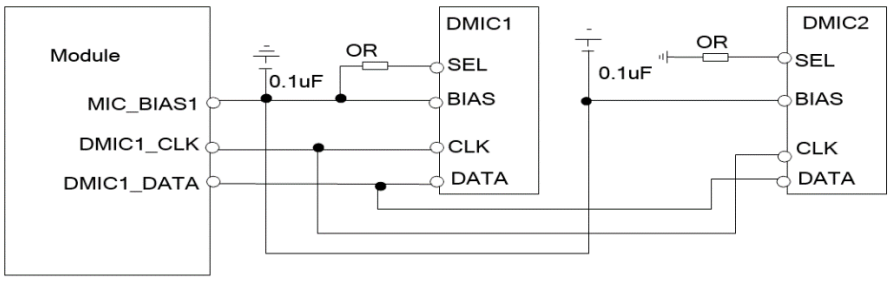


Figure 37: Microphone reference circuit

9.1.7. Digital Microphone Input Performance

Table 53: Digital Microphone Input Performance

Parameter	Test conditions	Min	Typical	Max	Units
Sensitivity	@1kHz (0dB=1V/Pa)	-27	-26	-25	dBFS
Signal-to-noise ratio	94dBSPL@1kHz, A-weighted Bandwidth 20KHz	-	65	-	dB FS(A)
Maximum Acoustic Input	THD<10% @1kH		122		dB SPL
Current consumption	VDD=1.8V, fclock =2.4MHz	390	560	730	uA
Power supply rejection ratio	200 mVPP sinewave @ 1kHz		64		dB FS/V

9.1.8. Headset

The Telit SE150A4 Smart module supports Stereo class-AB headphone with 16 Ω, 32 Ω impedance and up to 50 KΩ loads.

Its typical output power at 1.02 KHz and THD + N ≤ 1% is:

- 21.5 Mw with 16 Ω loads, 0 dBFS and -4.5 dB gain
- 30.8 Mw with 32 Ω loads, 0 dBFS and 0 dB gain

A 100KΩ pull-down resistor is integrated at HPH_L PIN, which could be used for mechanical insertion or removal detection through HS_DET PIN.

The following is the circuit diagram:

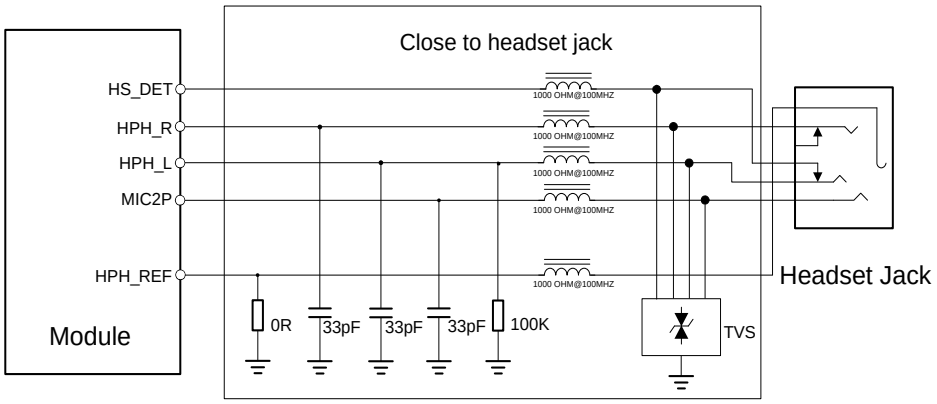


Figure 38: Headset reference circuit

Note/Tip:

- Telit SE150A4 Smart module also supports NO/NC type headset jack with detect PIN on HPH_L or GND.
- HPH has a negative swing and requires a bi-directional TVS diode.

9.1.9. Headset Output Performance

Table 54: Headset Output Performance

Parameter	Test conditions	Min	Typical	Max	Units
Output power	16 Ω load f = 1.02 kHz, 0 dB FS; VDD_CP* = 1.9 V	15.6	21.5	25.5	mW
	32 Ω load f = 1.02 kHz, 0 dB FS; VDD_CP* = 1.9 V	27.0	30.8	32.0	mW
Full-scale output Voltage	16 Ω load f = 1.02 kHz, 0 dB FS; VDD_CP* = 1.9V	0.50	0.59	0.64	Vrms
	32 Ω load f = 1.02 kHz, 0 dB FS; VDD_CP* = 1.9V	0.96	0.99	1.00	Vrms
Ouput Load	0 dBV maximum output	26	32	50000	Ω
	-4.5 dBV maximum output	13	16	50000	Ω
Disabled Output	Measured externally, with amplifier disabled	1.0	-	-	MΩ

Note/Tip: The VDD_CP is internal Voltage of module

9.1.10. Earpiece

The Telit SE150A4 Smart module supports one Earpiece Output.

The following is the circuit diagram:

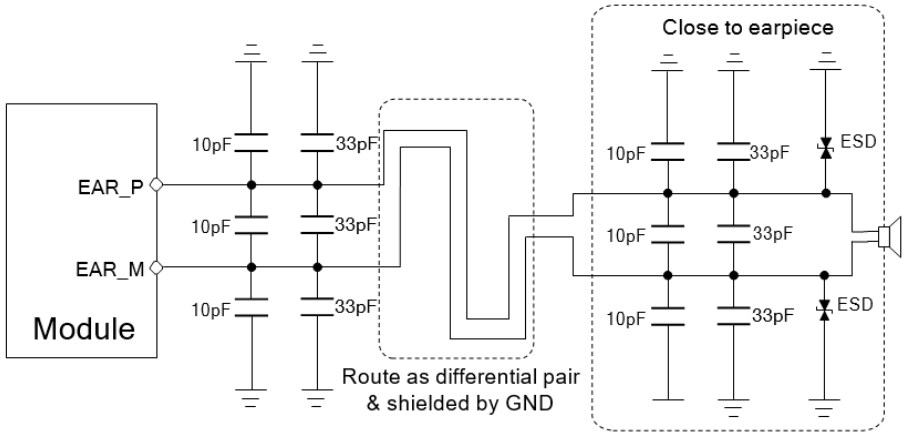


Figure 39: Earpience reference circuit

9.1.11. Earpiece Output Performance

Table 55: Earpiece Output Performance

Parameter	Test conditions	Min	Typical	Max	Units
Output power	32 Ω load f = 1.02 kHz, 6 dB gain THD+N < 1%	120	124.5	-	mW
	16 Ω load f = 1.02 kHz, 6 dB gain THD+N < 1%	235	243	-	mW
	10.67 Ω load f = 1.02 kHz, 6 dB gain THD+N < 1%	310	320		mW
Full-scale output	6 dB gain mode f = 1.02 kHz	1.8	2	2.1	Vrms
Voltage	1.5 dB gain mode f = 1.02 kHz	1	1.2	1.3	Vrms
Output load		10.7	32	50000	Ω
Disabled output impedance	Measured externally, amplifier disabled	1	-	-	MΩ

9.1.12. Speaker

The Telit SE150A4 Smart module includes one Class-D mono differential loud speaker driver that supports 4 Ω and 8 Ω loads. Integrated boost circuit (max output voltage 5.5V is inside the module.

The following is the circuit diagram:

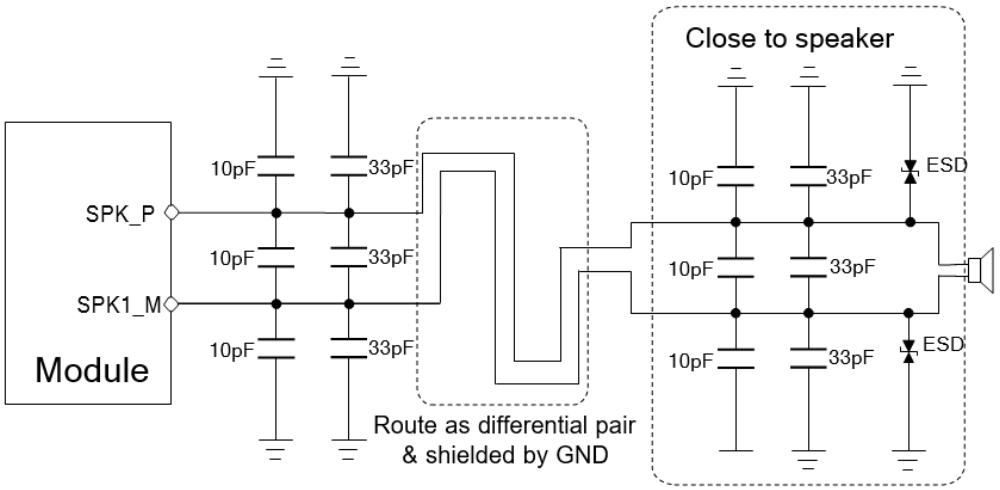


Figure 40: Speaker reference circuit

9.1.13. Speaker Output Performance

Table 56: Speaker Output Performance

Parameter	Test conditions	Min	Typical	Max	Units
Output power (Pout) (f = 1 kHz, gain = 12 dB, THD+N ≤ 1%)	15 µH + 8 Ω + 15 µH Vdd = 5 V	1200	1500	-	mW
	15 µH + 4 Ω + 15 µH Vdd = 5 V	1500	2000	-	mW
THD+N (1 kHz)	1.5 W Pout VDD_SPKR = 5.5 V	-	-86.5	-80	dB
	1.2 W Pout VDD_SPKR = 5 V	-	-86	-80	dB
Efficiency Vdd = 5V)	Pout = 1 W 115 µH + 8 + 15 µH	73	81	-	%
	Pout = 2 W 15 µH + 4 + 15 µH	61	72	-	%
Output impedance	Disabled	25	-	-	kΩ
Shutdown current		-	0.1	1	µA
Turn on time		-	0.2	10	ms

10. RECOMMENDED PERIPHERALS LIST

Warning: The components listed in the recommended peripherals list are for information purpose only. For more information, see Terms of Use.

10.1. Camera

Table 57: Camera Peripheral List

Item	Part Number	Vendor	Resolution
1	OV12A10	OmniVision	2M
2	OV5670	OmniVision	5M
3	OV5695	OmniVision	5M
4	GC8034	GalaxyCore	8M
5	OV8856	OmniVision	8M
6	OV8858	OmniVision	8M
7	OV8865	OmniVision	8M
8	S5K2L7SA03	SAMSUNG	12M
9	IMX362	SONY	12M
10	IMX378	SONY	12M
11	OV13850	OmniVision	13M
12	OV13855	OmniVision	13M
13	OV13880	OmniVision	13M
14	S5K3L8	SAMSUNG	13M
15	IMX214	SONY	13M
16	IMX258(PDAF)	SONY	13M

10.2. LCD Driver

Table 58: LCD Driver Peripheral List

Item	Part Number	Vendor	Resolution
1	OTM9605A	Orise	QHD
2	OTM1289A	Orise	HD
3	FT8606	FocalTech	HD
4	HX8389B	Himax	QHD
5	HX8394	Himax	HD
6	ILI9881	Ilitek	HD
7	NT35517	Novatek	QHD
8	NT35597	Novatek	HD
9	R61350	Renesas	HD

10.3. Accelerometer & Gyroscope

Table 59: Accelerometer & Gyroscope Peripheral List

Item	Part Number	Vendor	Accelerometer	Gyroscope
1	BMA255	Bosch	√	√
2	BMA250	Bosch	√	
3	BMA222E	Bosch	√	√
4	BMA223	Bosch	√	
5	BMH160	Bosch	√	√
6	BMA253	Bosch	√	√
7	BMA254	Bosch	√	
8	BMA421	Bosch	√	
9	BMI120	Bosch	√	√
10	BMI160	Bosch	√	√
11	BMI260	Bosch	√	√
12	BMI270	Bosch	√	√
13	BMX160	Bosch	√	√
14	ICM-20600	InvenSense	√	√
15	ICM-20602	InvenSense	√	√
16	ICM-20607	InvenSense	√	√
17	ICM-20608-D	InvenSense	√	√
18	ICM-20609	InvenSense	√	√
19	ICM-20621	InvenSense	√	√
20	ICM-20622	InvenSense	√	√
21	ICM-20626	InvenSense	√	√
22	ICM-20690	InvenSense	√	√
23	ICM-40602	InvenSense	√	√
24	ICM-40604	InvenSense	√	√
25	ICM-40605	InvenSense	√	√
26	ICM-42602	InvenSense	√	√
27	ICM-42605	InvenSense	√	√
28	ICM-42605-M	InvenSense	√	√
29	ICM-42608	InvenSense	√	√
30	LSM6DS3TR	ST	√	√
31	LSM6DS3TR-C	ST	√	√
32	LSM6DSLTR	ST	√	√
33	LSM6DSM	ST	√	√
34	LSM6DSMTR	ST	√	√

10.4. E-Compass

Table 60: E-Compass Peripheral List

Item	Part Number	Vendor
1	AK09911C	AKM
2	AK09915C	AKM
3	AK09915D	AKM
4	AK09916C	AKM
5	AK09918C	AKM
6	HSCDTD008A	Alps
7	BMM150	Bosch
8	BMX160	Bosch
9	GMC306	Globalmems
10	IST8305	iSentek
11	IST8306	iSentek
12	IST8307	iSentek
13	IST8310	iSentek
14	MXG4300	MagnaChip
15	MMC3530	MEMSIC
16	MMC3630	MEMSIC
17	MMC3630KJ	MEMSIC
18	MMC5603NJ	MEMSIC
19	STM350MC	Senodia
20	STM480MW	Senodia
21	LIS2MDL	ST
22	AF6133	Voltafield
23	AF6133E	Voltafield
24	AF8133J	Voltafield
25	AF9133	Voltafield
26	YAS539	Yamaha

10.5. Proximity & Ambient Light

Table 61: Proximity & Ambient Light Peripheral List

Number	Part Number	Vendor	Proximity	Ambient Light
1	TMD27723	ams	√	√
2	TMG39933	ams	√	√
2	CM36686	Capella	√	√
3	AP3426	Dyna Image	√	√
4	EPL2590KTWJP	Elan	√	√
5	MN66213	Elan	√	√
6	LTR-578ALS	Lite-On	√	√
7	RPR-0521RS	ROHM	√	√

8	RPR-0531	ROHM	√	√
9	RPR-0531RS	ROHM	√	√
10	STK2232	Sensortek	√	√
11	STK3311	Sensortek	√	√
12	STK3321	Sensortek	√	√
13	STK3327	Sensortek	√	√
14	STK3328	Sensortek	√	√
15	STK3332	Sensortek	√	√
16	STK3335	Sensortek	√	√
17	STK3338	Sensortek	√	√
18	V2000	Sensortek	√	√
19	PA22401001	TXC	√	
20	PA22A00001	TXC	√	√

10.6. Pressure

Table 62: Pressure Peripheral List

Number	Part Number	Vendor
1	BME680	Bosch
2	BMP280	Bosch
3	BMP285	Bosch
4	BMP380	Bosch
5	ICP-10100	InvenSense
6	ICP-10101	InvenSense
7	ICP-10110	InvenSense
8	ICP-10111	InvenSense
9	2SMPB-02B	omron
10	2SMPB-02E	omron
11	BM1383AGLV	ROHM
12	LPS22HB	ROHM
13	LPS22HBTR	ROHM
14	LPS22HH	ROHM

11. MECHANICAL DESIGN

The following is the Top and bottom view of Telit SE150A4 Smart module

11.1. Drawing

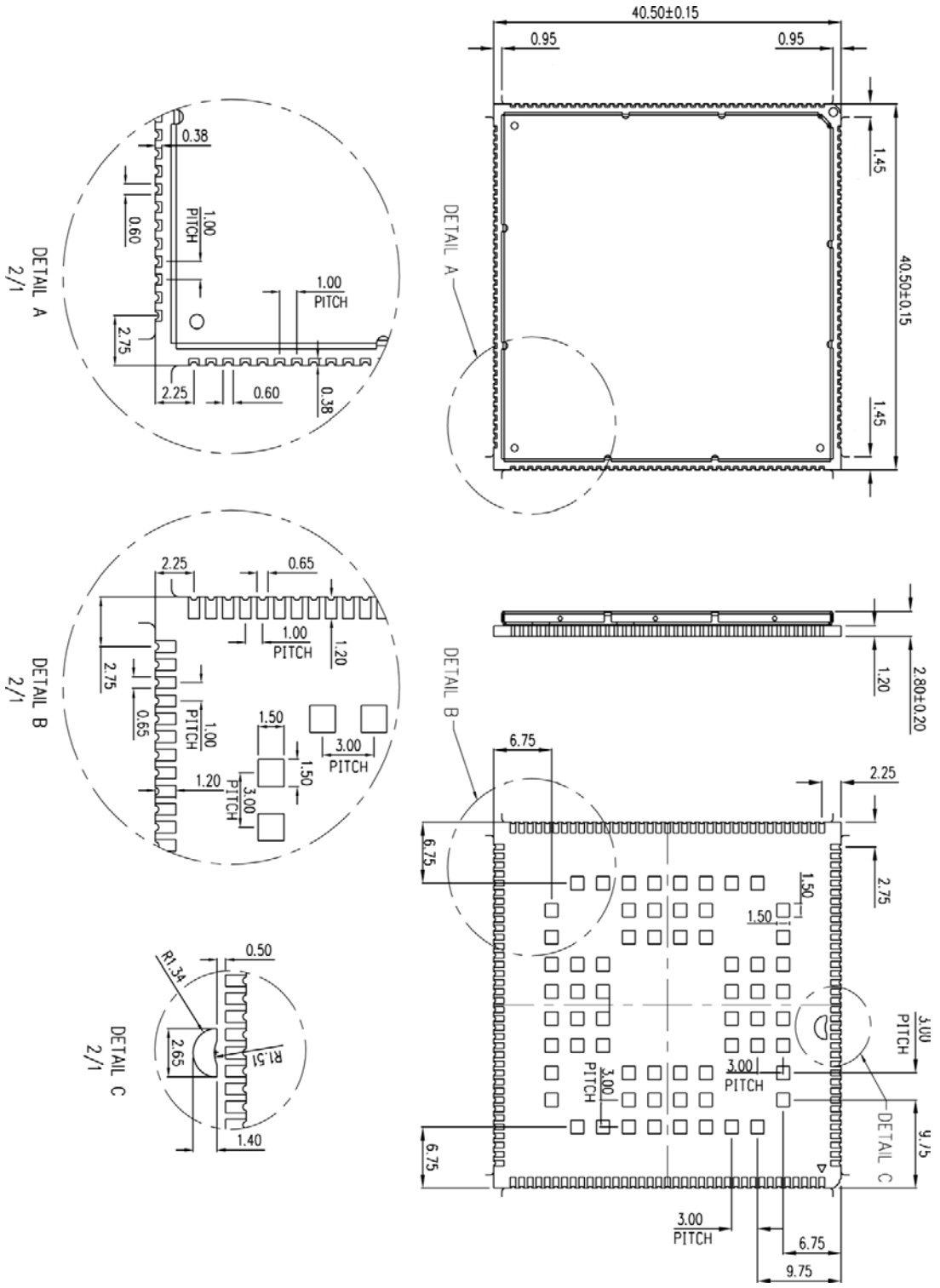


Figure 41: Drawing of the Telit SE150A4 Smart module

12. APPLICATION PCB DESIGN

12.1. Footprint

The following is the footprint diagram:

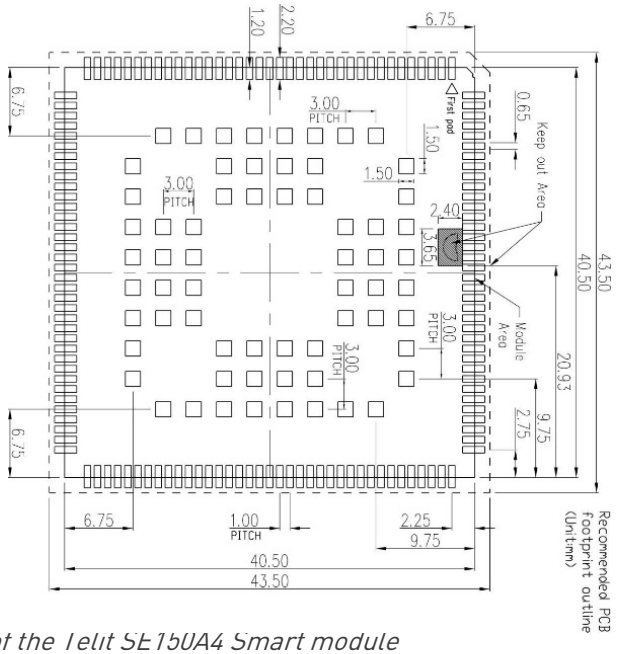


Figure 42: Footprint of the Telit SE150A4 Smart module

12.2. Stencil

PIN stencil thickness requires stepped window opening

The outer ring PIN stencil should be increased to 0.18mm.

The inner ring function PIN and the middle GND PIN should be reduced in thickness (0.15mm) or reduce the opening area of the stencil.

The following is the stencil of the Telit SE150A4 Smart module:

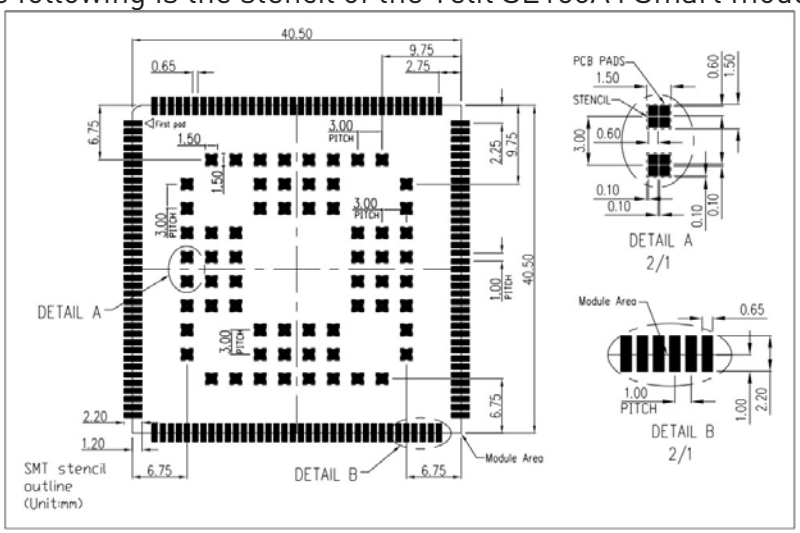


Figure 43: Stencil of the Telit SE150A4 Smart module

12.3. Solder reflow

The following is the SMT reflow of the Telit SE150A4 Smart module

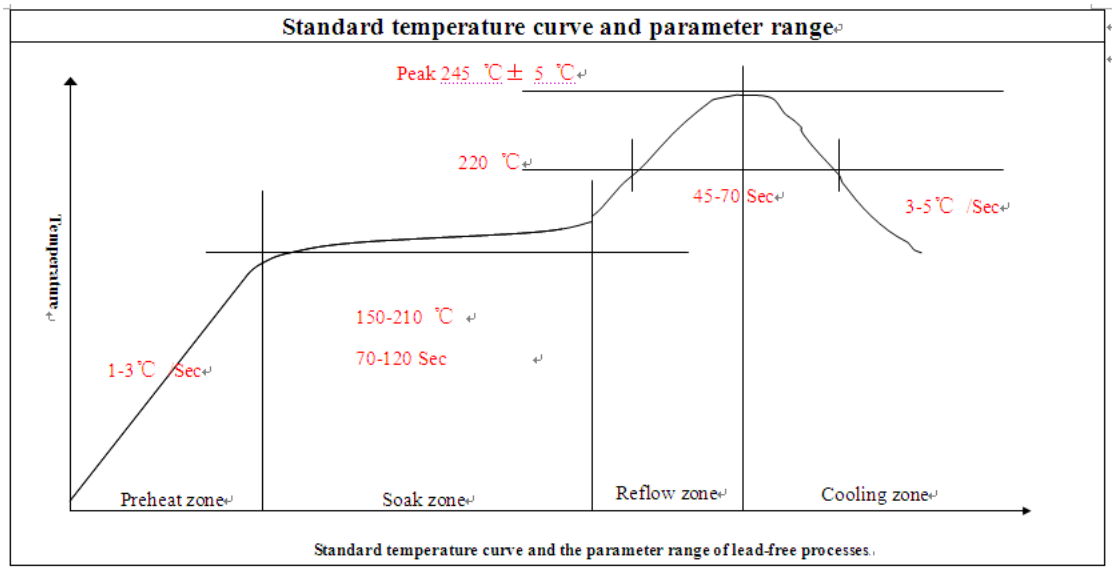


Figure 44: SMT reflow of the Telit SE150A4 Smart module

13. PACKAGING

13.1. Tray

Telit SE150A4 Smart module supports tray packaging.

The following is the packaging process:

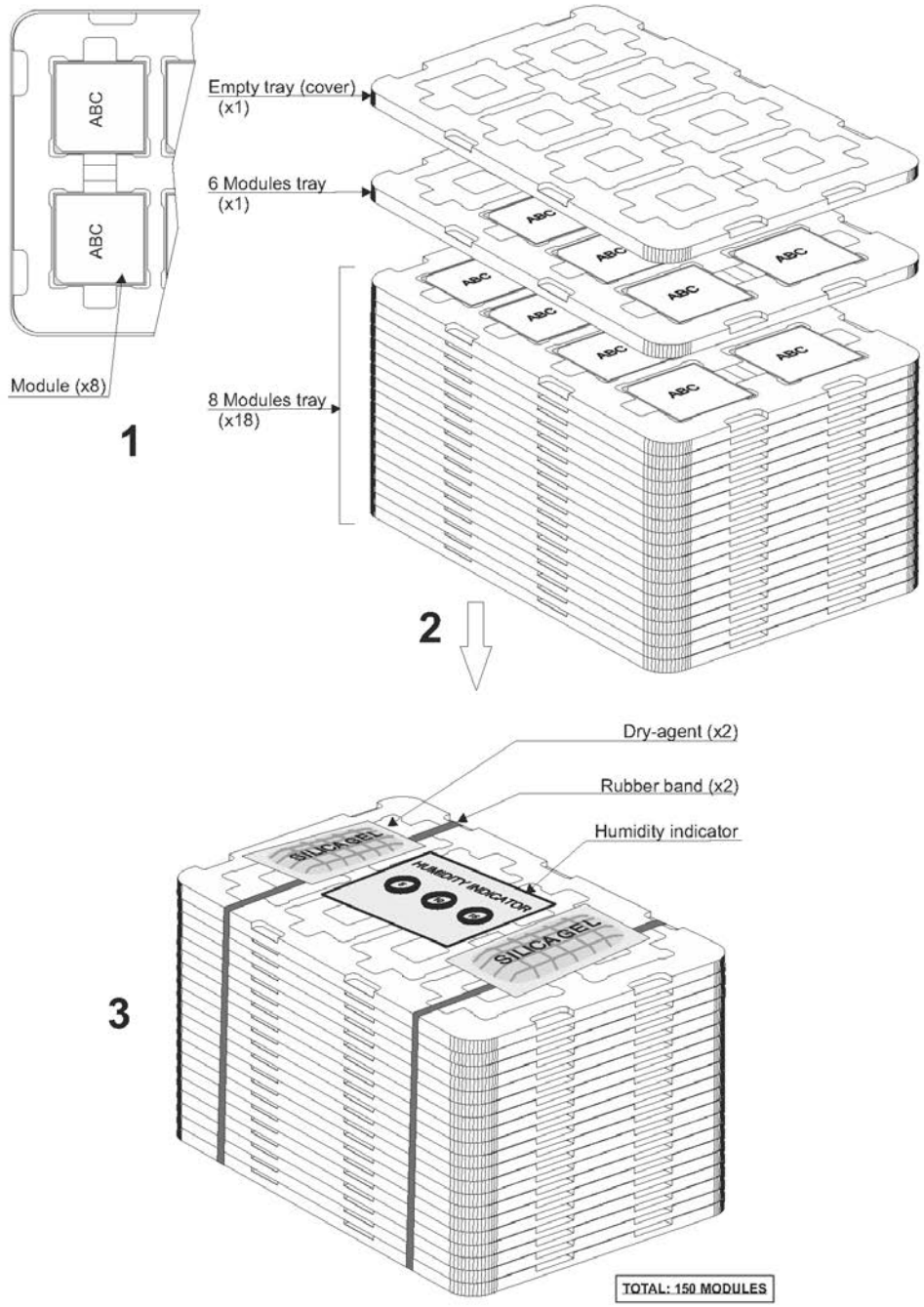
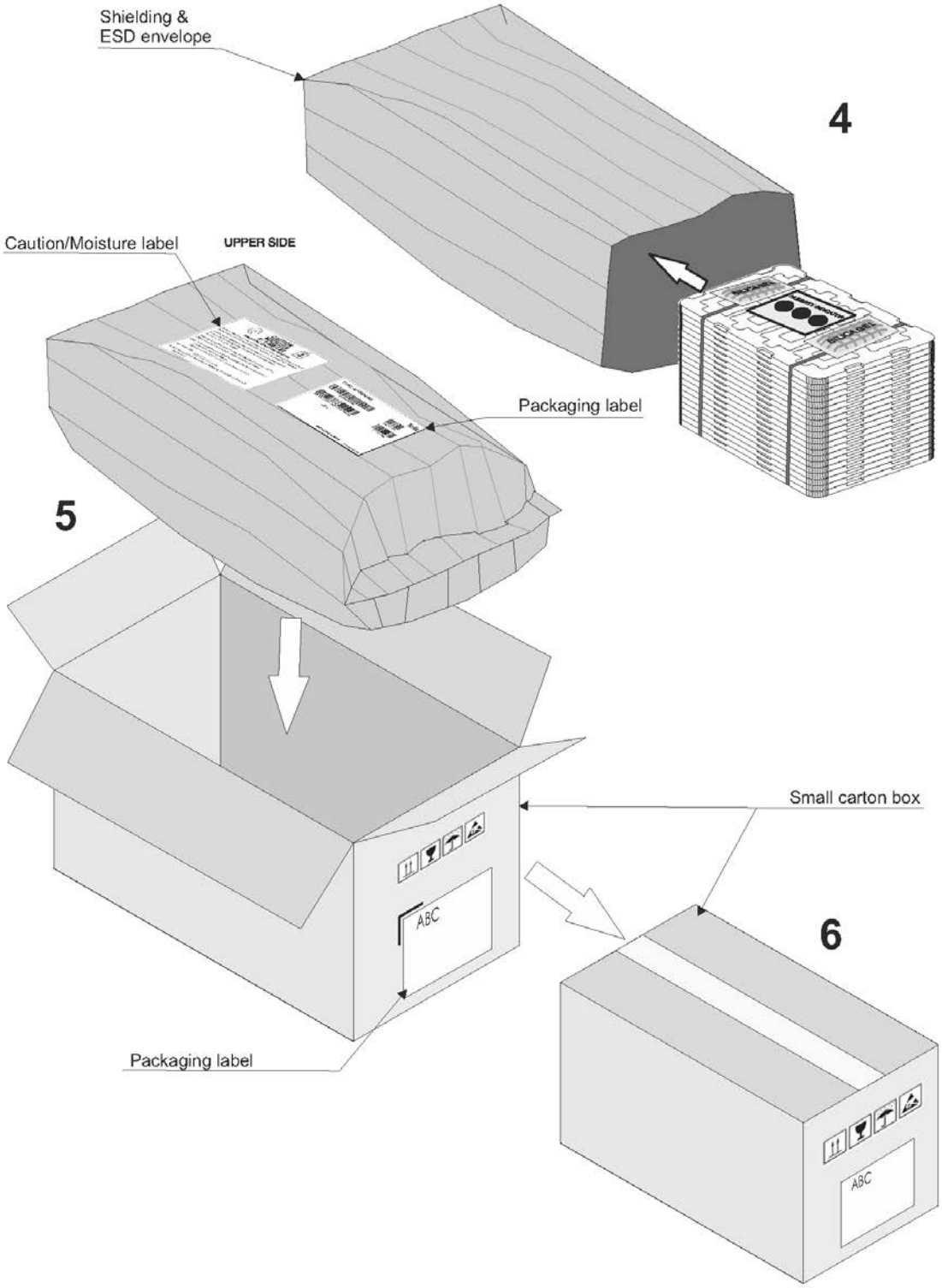


Table 63: Tray dimensions

Length	Width	Units per tray
242.0 (±3mm)	161.0 (±3mm)	8


Shielding &
ESD envelope
4
Caution/Moisture label
UPPER SIDE
Packaging label
5
Small carton box
6
ABC
Packaging label
ABC

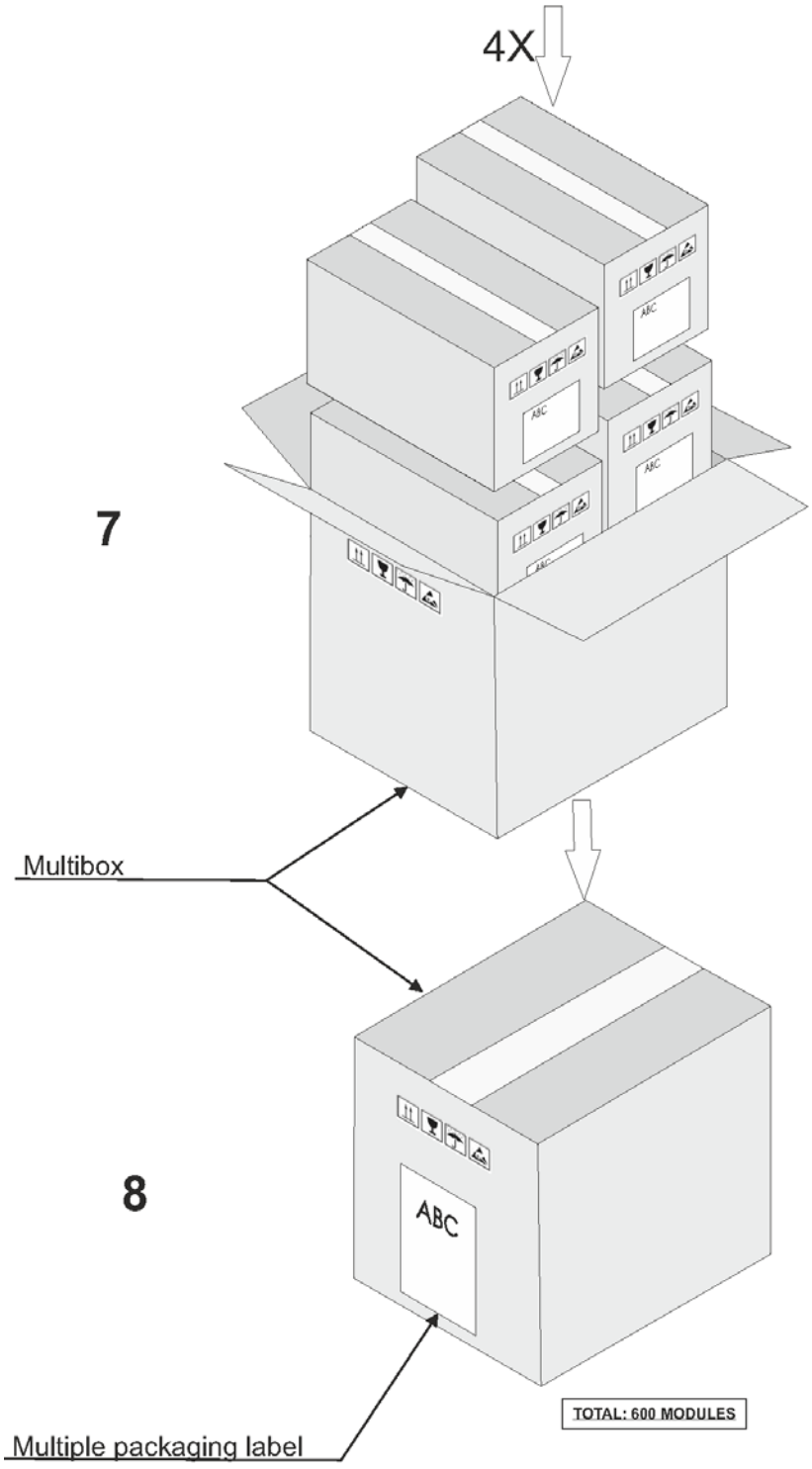


Figure 45: Packaging process

13.2. Moisture sensitivity

Telit SE150A4 Smart module is susceptible to damage induced by absorbed moisture and high temperature. A package's moisture-sensitivity level (MSL) indicates its ability to withstand exposure after it is removed from its shipment bag, while it is on the factory

floor awaiting PCB installation. A low MSL rating is better than a high rating; a low MSL device can be exposed on the factory floor longer than a high MSL device.

13.2.1. MSL rating summary

Table 64: MSL rating summary

MSL	Out-of-bag floor life	Comments
1	Unlimited	≤+30°C/85% RH
2	1 year	≤+30°C/60% RH
2a	4 weeks	≤+30°C/60% RH
3	168 hours	≤+30°C/60% RH
4	72 hours	≤+30°C/60% RH; SE150A4x rating
5	48 hours	≤+30°C/60% RH
5a	24 hours	≤+30°C/60% RH
6	Mandatory bake before use. After bake, it must be reflowed within the time limit specified on the label.	≤+30°C/60% RH

The MSM8909 device samples are currently classified as MSL4 at 255 (+5, -0)°C, following the latest IPC/JEDEC J-STD-020 standard revision for moisture-sensitivity qualification This qualification temperature (255°C) should not be confused with the peak temperature within the recommended solder reflow profile.

13.3. Baking requirements

It is necessary to bake modules if the prescribed time limit has been exceeded. The baking conditions are specified in the table mentioned below Note that if baking is required, devices must be transferred into trays that can be baked to at least 125°C.

Table 65: Banking requirements

Baking conditions options	Duration
40°C±5°C, <5% RH	192 hours
120°C±5°C, <5% RH	4 hours

14. CONFORMITY ASSESTMENT ISSUES

14.1. Approvals summary

Approvals Table 66: Approvals summary

Module	EU RED	US FCC	CA ISED	BR ANATEL	JP JRF&JTBL	CH CCC
XX123Z4-W1	Yes	Yes	Yes	-	-	Yes
XX123Z4-WW	Yes	Yes	Yes	Yes	Yes	TBD
XX123Z4-WWV	Yes	Yes	Yes	-	-	TBD

14.2. RED approval

14.2.1. RED Declaration of Conformity

Hereby, Telit Communications S.p.A declares that the XX123Z4-W1, XX123Z4-WW and XX123Z4-WWV Modules are in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: *http://www.telit.com/red*

Text of 2014/53/EU Directive (RED) can be found here:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0053

14.2.2. Antennas

This radio transmitter has been approved under RED to operate with the antenna types listed below with the maximum permissible gain indicated. The usage of a different antenna in the final hosting device may need a new assessment of host conformity to RED.

Table 67: RED Antenna Type

Model	Antenna Type
XX123Z4-W1	Omnidirectional Antenna Gain 2.14 dBi
XX123Z4-WW	
XX123Z4-WWV	

Table 68: Max Gain for RED

Max Gain for RED (dBi)			
Band	XX123Z4-W1	XX123Z4-WW	XX123Z4-WWV
GSM 900	---	---	TBD
DCS 1800	---	---	TBD
GPRS/EGPRS 900	---	5.47	5.47
GPRS/EGPRS 1800	---	9.34	9.34
FDD 1	14.84	11.84	11.84
FDD 3	14.33	11.33	11.33
FDD 8	11.45	8.45	8.45
FDD 20	11.20	8.20	8.20
FDD 28	10.47	7.47	7.47

14.3. FCC and ISED approval/*FCC et ISDE approbation*

14.3.1. FCC Certificate

The FCC Certifcate is available here:

https://www.fcc.gov/oet/ea/fccid

14.3.2. ISED approval/*ISDE approbation*

The ISED Certificate is available here /*Le certificat ISDE est disponible ici*:

https://smssgs.ic.gc.ca/equipmentSearch/searchRadioEquipments?execution=e1s1&lang=en

14.3.3. Applicable FCC and ISED rules /*Liste des règles FCC et ISDE applicables*

Table 69: Applicable FCC and ISED rules

Model *Modèle*	Applicable FCC Rules	Applicable ISED Rules *Règles ISDE applicables*
XX123Z4-W1	47 CFR Part 2, 22, 24, 27, 90	RSS: 132 Issue3, 133 Issue 6, 130 Issue 2, 139 Issue 3; RSS-Gen Issue 5
XX123Z4-WW		
XX123Z4-WWV		

14.3.4. FCC and ISED Regulatory notices/*Avis réglementaires de FCC et ISDE*

Modification statement / *Déclaration de modification*

Telit has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Telit n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement / *Déclaration d'interférence*

This device complies with Part 15 of the FCC Rules and Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Wireless notice / *Wireless avis*

This device complies with FCC/ISED radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS-102 of the ISED radio frequency (RF) Exposure rules. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body.

Le présent appareil est conforme à l'exposition aux radiations FCC / ISED définies pour un environnement non contrôlé et répond aux directives d'exposition de la fréquence de la FCC radiofréquence (RF) et RSS-102 de la fréquence radio (RF) ISED règles d'exposition. L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur. L'antenne doit être installée de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps.

FCC Class B digital device notice (FCC only)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide

reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by taking one or more of the following measures:

Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CAN ICES-3 (B) / NMB-3 (B) (ISED only) / *(ISDE seulement)*

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

14.3.5. Antennas /Antennes

FCC

This radio transmitter has been approved by FCC and ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Table 70: FCC Antenna Type

Model	Antenna Type
XX123Z4-W1	Omnidirectional Antenna Gain 2.14 dBi
XX123Z4-WW	
XX123Z4-WWV	

Table 71: Max Gain for FCC (dBi)

Max Gain for FCC (dBi)			
Band	XX123Z4-W1	XX123Z4-WW	XX123Z4-WWV
GSM 850	---	---	8.44
GSM 1900	---	---	10.04
GPRS/EGPRS 850	---	6.93	6.93
GPRS/EGPRS 1900	---	10.42	10.42
FDD 2	11.0	12.01	12.01
FDD 4	8.0	12.01	12.01
FDD 5	12.4	9.41	9.41
FDD 12	11.6	8.70	8.70
FDD 13	12.1	9.16	9.16
FDD 25	11.0	12.01	12.01
FDD 26	12.3	9.36	9.36
FDD 66	8.0	12.01	12.01
FDD 71	11.4	11.47	11.47
FDD 85	11.6	8.69	8.69

ISED / ISDE

This radio transmitter has been approved by ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio a été approuvé par ISDE pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Table 72: ISED Antenna Type

Model *Modèle*	Antenna Type *Type d'Antenne*
XX123Z4-W1	Omnidirectional Antenna Gain 2.14 dBi *Omnidirectionelle* *Gain de l'antenne 2.14 dBi*
XX123Z4-WW	
XX123Z4-WWV	

Table 73: Gain maximum for ISED (dBi)

Gain maximum pour ISED (dBi) / *Gain maximum pour ISDE (dBi)*			
Bande	XX123Z4-W1	XX123Z4-WW	XX123Z4-WWV
GSM 850			5.15
GSM 1900			10.04
GPRS/EGPRS 850	---	3.64	3.64
GPRS/EGPRS 1900	---	5.13	5.13
FDD 2	11.0	8.52	8.52
FDD 4	8.0	8.29	8.29
FDD 5	9.1	6.12	6.12
FDD 12	8.6	5.63	5.63
FDD 13	8.9	5.95	5.95
FDD 25	11.0	8.52	8.52
FDD 26	9.0	6.09	6.09
FDD 66	8.0	8.29	8.29
FDD 71	8.4	8.48	8.48
FDD 85	8.6	5.63	5.63

14.3.6. FCC Label and compliance information

The product has a FCC ID label on the device itself. Also, the OEM host end product manufacturer will be informed to display a label referring to the enclosed module The exterior label will read as follows: "Contains Transmitter Module FCC ID: RI7

XX123Z4W1" or "Contains FCC ID: RI7XX123Z4W1" for XX123Z4-W1 and : "Contains Transmitter Module FCC ID: RI7XX123Z4WW" or "Contains FCC ID: RI7XX123Z4WW" for XX123Z4-WW and XX123Z4-WWV

Below list of all the models and related FCC ID:

Table 74: FCC ID

Model	FCC ID
XX123Z4-W1	RI7XX123Z4W1
XX123Z4-WW	RI7XX123Z4WW
XX123Z4-WWV	

14.3.7. ISED Label and compliance information/*ISED Étiquette et informations de conformité*

The host product shall be properly labelled to identify the modules within the host product.

The ISED certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labelled to display the ISED certification number for the module, preceded by the word "contains" or similar wording expressing the same meaning, as follows:

Contains IC: XXXXXX-YYYYYYYYYY

In this case, XXXXXX-YYYYYYYYYY is the module's certification number.

Le produit hôte devra être correctement étiqueté, de façon à permettre l'identification des modules qui s'y trouvent.

L'étiquette d'homologation d'un module d'ISDE devra être apposée sur le produit hôte à un endroit bien en vue, en tout temps. En l'absence d'étiquette, le produit hôte doit porter une étiquette sur laquelle figure le numéro d'homologation du module d'ISDE, précédé du mot « contient », ou d'une formulation similaire allant dans le même sens et qui va comme suit :

Contient IC : XXXXXX-YYYYYYYYYY

Dans ce cas, XXXXXX-YYYYYYYYYY est le numéro d'homologation du module.

Table 75: ISED Certification Number

Model *Modèle*	ISED Certification Number *Num. de certification ISDE*
XX123Z4-W1	5131A-XX123Z4W1
XX123Z4-WW	5131A- XX123Z4WW
XX123Z4-WWV	

14.3.8. Information on test modes and additional testing requirements / *Informations sur les modes de test et les exigences de test supplémentaires*

The module has been evaluated in mobile stand-alone conditions. For different operational conditions from a stand-alone modular transmitter in a host (multiple, simultaneously transmitting modules or other transmitters in a host), additional testing may be required (collocation, retesting…)

If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093 and IC RSS-102.

Le module a été évalué dans des conditions autonomes mobiles. Pour différentes conditions de fonctionnement d'un émetteur modulaire autonome dans un hôte (plusieurs modules émettant simultanément ou d'autres émetteurs dans un hôte), des tests supplémentaires peuvent être nécessaires (colocalisation, retesting…)

Si ce module est destiné à être utilisé dans un appareil portable, vous êtes responsable de l'approbation séparée pour satisfaire aux exigences SAR de la FCC Partie 2.1093 et IC RSS-102.

14.3.9. FCC Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed. The end product with an embedded module may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

14.4. ANATEL Regulatory Notices

"Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados"

"This equipment is not entitled to protection against harmful interference and must not cause interference in duly authorized systems"

XX123Z4-WW, XX123Z4-WW, XX123Z4-WW Homologation #: 08566-20-02618

14.5. RoHS and REACH info

14.5.1. RoHS info

Any requests on information related to RoHS certifications can be addressed to *Chemical.Certifications@telit.com*.

14.5.2. REACH info

Any requests on information related to REACH certifications can be addressed to *Chemical.Certifications@telit.com*.

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15.3. Safety Recommendations

Make sure the use of this product is allowed in your country and in the environment required. The use of this product may be dangerous and has to be avoided in areas where:

- it can interfere with other electronic devices, particularly in environments such as hospitals, airports, aircrafts, etc.
- there is a risk of explosion such as gasoline stations, oil refineries, etc. It is the responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conformed to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible for the functioning of the final product. Therefore, the external components of the module, as well as any project or installation issue, have to be handled with care. Any interference may cause the risk of disturbing the GSM network or external devices or having an impact on the security system. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed carefully in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The equipment is intended to be installed in a restricted area location.

The equipment must be supplied by an external specific limited power source in compliance with the standard EN 62368-1:2014.

The European Community provides some Directives for the electronic equipment introduced on the market. All of the relevant information is available on the European Community website:

https://ec.europa.eu/growth/sectors/electrical-engineering_en

16.GLOSSARY

Table 76: Acronym List

Acronym	Definition
TTSC	Telit Technical Support Centre
USB	Universal Serial Bus
HS	High Speed
DTE	Data Terminal Equipment
UMTS	Universal Mobile Telecommunication System
WCDMA	Wideband Code Division Multiple Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
UART	Universal Asynchronous Receiver Transmitter
HSIC	High Speed Inter Chip
SIM	Subscriber Identification Module
SPI	Serial Peripheral Interface
ADC	Analog – Digital Converter
DAC	Digital – Analog Converter
I/O	Input Output
GPIO	General Purpose Input Output
CMOS	Complementary Metal – Oxide Semiconductor
MOSI	Master Output – Slave Input
MISO	Master Input – Slave Output
CLK	Clock
MRDY	Master Ready
SRDY	Slave Ready
CS	Chip Select
RTC	Real Time Clock
PCB	Printed Circuit Board
ESR	Equivalent Series Resistance
VSWR	Voltage Standing Wave Radio
VNA	Vector Network Analyzer

17. DOCUMENT HISTORY

Table 77: Acronym List

Revision	Date	Changes
1	2021-21-01	**Content updates** 2.2 Product Variants and Frequency Bands 2.8 Block Diagram **Figure updates** 4.3 General Design Rules 4.4 RTC Bypass Out 4.6 Output Power Management 5.2 Power On 5.5 Communication Ports 5.9 Vibrator 5.10 Secure Digital Interface 11.1 Drawing 12.1 Footprint 12.2 Stencil 13.1 Tray
0	2020-11-09	First issue

From Mod.0818 rev.1

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