LE910Cx

Hardware User Guide

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Making machines talk.

Applicability Table

This documentation applies to the following products:

Table 1: Applicability Table

Module Name	Description
LE910C1-NA	North America – AT&T with global roaming
LE910C1-NS	North America - Sprint variant
LE910C1-AP	APAC variant

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1. Introduction

1.1. Scope

This document introduces the Telit LE910Cx module and presents possible and recommended hardware solutions for developing a product based on the LE910Cx module. All the features and solutions detailed in this document are applicable to all LE910Cx variants, where “LE910Cx” refers to the variants listed in the applicability table.

If a specific feature is applicable to a specific product only, it will be clearly marked.

NOTE:

LE910Cx refers to all modules listed in the Applicability Table.

This document takes into account all the basic functions of a wireless module; a valid hardware solution is suggested for each function, and incorrect solutions and common errors to be avoided are pointed out.

Obviously, this document cannot embrace every hardware solution or every product that can be designed. Obviously, avoiding invalid solutions must be considered mandatory. Where the suggested hardware configurations need not be considered mandatory, the information given should be used as a guide and a starting point for properly developing your product with the Telit LE910Cx module.

NOTE:

The integration of the GSM/GPRS/EGPRS/WCDMA/HSPA+/LTE LE910Cx cellular module within a user application must be done according to the design rules described in this manual.

1.2. Audience

This document is intended for Telit customers, especially system integrators, about to implement their applications using the Telit LE910Cx module.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit’s Technical Support Center (TTSC) at:

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

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components, visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit’s Technical Support Center (TTSC).

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 about the information provided.

1.4. Text Conventions

The following conventions are used to emphasize specific types of information:

Danger:

This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning:

Alerts the user to important points about integrating the module. If these points are not followed, the module and end user equipment may fail or malfunction.

NOTE:

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

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

1.5. Related Documents

Table 2: Related Documents

Document Title	Document Number
Ref 1: LE9x0 AT Command User Guide	80407ST10116A
Ref 2: Telit EVB HW User Guide	1VV0301249
Ref 3: LE910Cx Interface Board HW User Guide	1VV0301323
Ref 4: LE910/LE920 Digital Voice Interface Application Note	80000NT11246A
Ref 5: SIM Integration Design Guide Application Note Rev10	80000NT10001A
Ref 6: Telit_LE920A4_LE910Cx_Wi-Fi_Interface_Application_Note_r1	80490NT11511A
Ref 7: Antenna Detection Application Note	80000NT10002A
Ref 8: High-Speed Inter-Chip USB Electrical Specification, version 1.0 (a supplement to the USB 2.0 specification, Section 3.8.2)	

1.6. Abbreviations

Term	Definition
ADC	Analog-to-digital converter
AE	Application-enabled
DAC	Digital-to-analog converter
DTE	Data Terminal Equipment
FDD	Frequency division duplex
GLONASS	Global orbiting navigation satellite system
GNSS	Global navigation satellite system
GPIO	General-purpose input/output
GPRS	General packet radio services
GPS	Global positioning system
GSM	Global system for mobile communications
HSIC	High-speed inter-chip
I2C	Inter-integrated circuit
LTE	Long term evolution
SD	Secure digital
SGMII	Serial Gigabit media-independent interface
SIM	Subscriber identity module
SOC	System-on-Chip
SPI	Serial peripheral interface
UART	Universal asynchronous receiver transmitter
UMTS	Universal mobile telecommunications system
USB	Universal serial bus
WCI	Wireless Coexistence Interface
WCDMA	Wideband code division multiple access

2. General Product Description

2.1. Overview

LE910Cx is Telit's new LTE series for IoT applications.

In its most basic use case, LE910Cx can be applied as a wireless communication front-end for telematics products, offering GNSS and mobile communication features to an external host CPU through its rich interfaces.

LE910Cx is available in hardware variants as listed in Table 1: Applicability Table. For differences in the designated RF band sets – refer to Section 2.6.1, RF Bands per Regional Variant.

2.2. Applications

LE910Cx can be used for telematics applications where tamper-resistance, confidentiality, integrity, and authenticity of end-user information are required, for example:

- Emergency call
- Telematics services
- Road pricing
- Pay-as-you-drive insurance
- Stolen vehicles tracking
- Internet connectivity

2.3. General Functionality and Main Features

The LE910Cx series of cellular modules features LTE and multi-RAT modem together with an on-chip powerful application processor and a rich set of interfaces.

The major functions and features are listed below:

Function	Features
Modem	• Multi-RAT cellular modem for voice and data communication ○ LTE FDD Cat1 (Other variants) (10/5Mbps DL/UL). ○ Carrier aggregation is not supported ○ GSM/GPRS/EDGE ○ WCDMA up to DC HSPA+, Rel.9 • Support for European eCall , US E911, and ERA Glonass • Support for SIM profile switching • Regional variants with optimal choice of RF bands for worldwide coverage of countries and MNOs • State-of-the-art GNSS solution with GPS/GLONASS/BeiDou/Galileo/QZSS receiver
Digital audio subsystem	• PCM/I2S digital audio interface • Up to 48 kHz sample rate, 16 bit words
Two USIM ports – dual voltage	• Class B and Class C support • Hot swap support • Clock rates up to 4 MHz
Application processor	Application processor to run customer application code • 32 bit ARM Cortex-A7 up to 1.3 GHz running the Linux operating system • Flash + DDR are large enough to allow for customer’s own software applications

Function	Features
Interfaces	Rich set of interfaces, including: • SD/MMC Card Interface supporting SD3.0 standard • SDIO for external WiFi transceiver supporting SDIO3.0 standard • SGMII for external Ethernet transceiver (optional) o Compliant with IEEE802.3 o Full duplex operation at 1 Gbps o Half/full duplex operation at 10/100 Mbps o Support for VLAN tagging o Support for IEEE1588, PTP (Precision Time Protocol) • USB2.0 – USB port is typically used for: o Flashing of firmware and module configuration o Production testing o Accessing the Application Processor’s file system o AT command access o High-speed WWAN access to external host o Diagnostic monitoring and debugging o Communication between Java application environment and an external host CPU o NMEA data to an external host CPU • HSIC o High-speed 480 Mbps (240 MHz DDR) USB transfers are 100% host driver compatible with traditional USB cable connected topologies o Bidirectional data strobe signal (STROBE) o Bidirectional data signal (DATA) o No power consumption unless a transfer is in progress o Maximum trace length 10 cm o Signals driven at 1.2V standard LVCMOS levels • Peripheral Ports – SPI, I2C, UART • GPIOs • Antenna ports

Function	Features
Form factor	Form factor (28x28mm), accommodating the multiple RF bands in each region variant
Environment and quality requirements	The entire module is designed and qualified by Telit for satisfying the environment and quality requirements.
Single supply module	The module generates all its internal supply voltages.
RTC	No dedicated RTC supply, RTC is supplied by VBATT
Operating temperature	Range -40 °C to +85 °C (conditions as defined in Section 2.5.1, Temperature Range).

NOTE:

The following interfaces are unique for the LE910Cx and may not be supported on other (former or future) xE910 family. Special care must be taken when designing the application board if future compatibility is required:

- SGMII for Ethernet connectivity
- SDIO for WIFI connectivity
- SD/MMC for SD Card connectivity

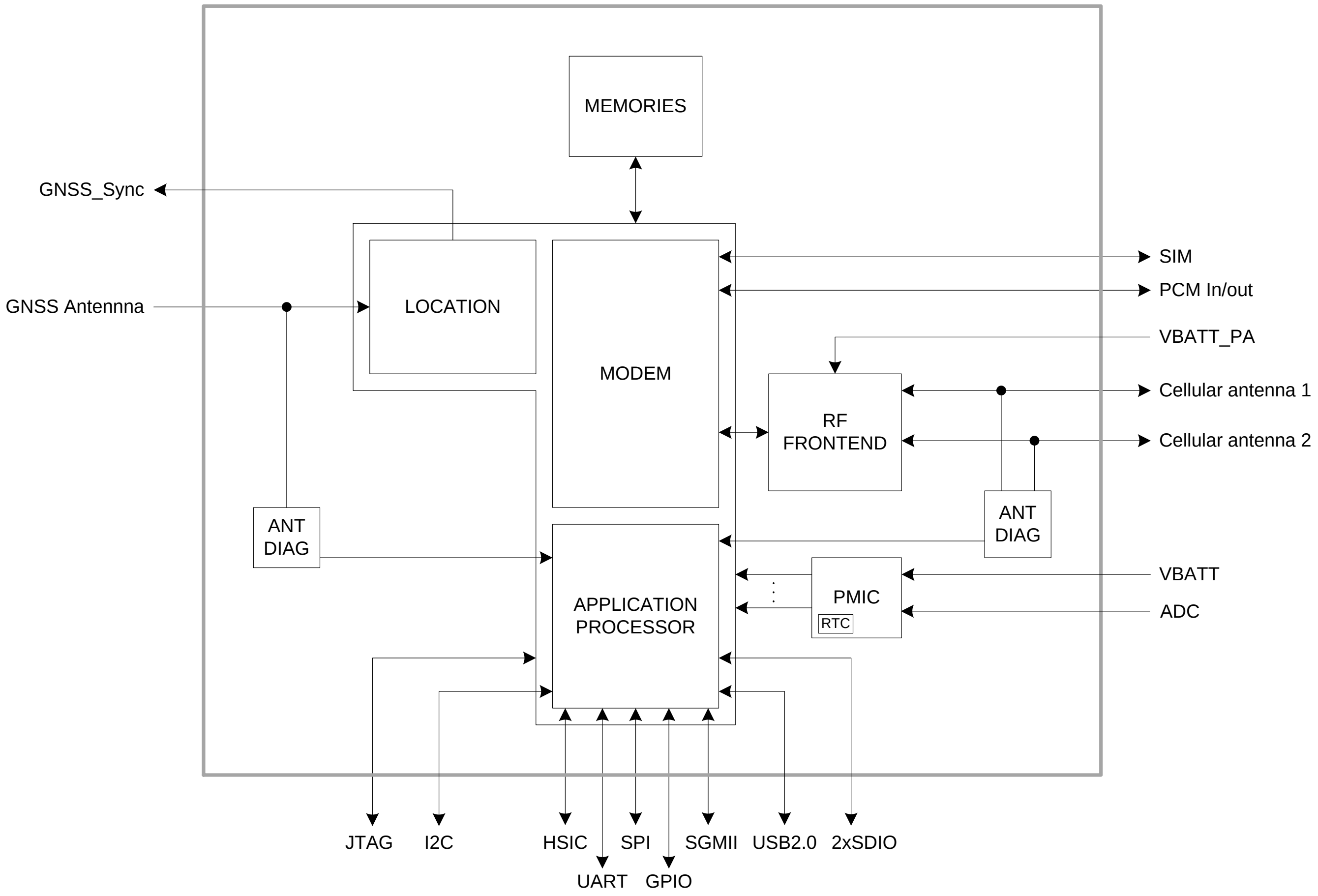
2.4. Block Diagram

Figure 1 shows an overview of the internal architecture of the LE910Cx module.

It includes the following sub-functions:

- Application processor, Modem subsystem and Location processing with their external interfaces. These three functions are contained in a single SOC.
- RF front end, including antenna diagnosis circuitry
- Analog Audio codec for attaching external speaker amplifier and microphone
- Rich IO interfaces. Depending on which LE910Cx software features are enabled, some of its interfaces that are exported due to multiplexing may be used internally and thus may not be usable by the application.
- PMIC with the RTC function inside

Figure 1: LE910Cx Block Diagram



2.5. Environmental Requirements

2.5.1. Temperature Range

Operating temperature range	-20 ~ +55°C. This range is defined by 3GPP (the global standard for wireless mobile communication). Telit guarantees its modules to comply with all the 3GPP requirements and to have full functionality of the module with in this range.
	-40 ~ +85°C. Telit guarantees full functionality within this range as well. However, there may possibly be some performance deviations in this extended range relative to 3GPP requirements, which means that some RF parameters may deviate from the 3GPP specification in the order of a few dB. For example: receiver sensitivity or maximum output power may be slightly degraded. Even so, all the functionalities, such as call connection, SMS, USB communication, UART activation etc., will be maintained, and the effect of such degradations will not lead to malfunction.
Storage and non-operating temperature range	–40°C ~ +85°C

2.5.2. RoHS Compliance

As a part of the Telit corporate policy of environmental protection, the LE910Cx complies with the RoHS (Restriction of Hazardous Substances) directive of the European Union (EU directive 2011/65/EU).

2.6. Frequency Bands

The operating frequencies in GSM850, EGSM900, DCS1800, PCS1900, WCDMA & LTE modes conform to the 3GPP specifications.

2.6.1. RF Bands per Regional Variant

Table 3 summarizes all region variants within the LE910Cx family, showing the supported band sets in each variant.

Table 3: RF Bands per Regional Variant

Region Variant	LTE FDD	LTE TDD	HSPA+	TD-SCDMA	2G
LE910C1-NA	2, 4, 12	-	1, 2, 4, 5, 8	-	2, 3, 5, 8
LE910C1-NS	2, 4, 5, 12, 25, 26	-	-	-	-
LE910C1-AP	1, 3, 5, 8, 28	-	1, 5, 8	-	-

2.6.2. Reference Table of RF Bands Characteristics

Table 4: RF Bands Characteristics

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
PCS 1900	1850.2 ~ 1909.8	1930.2 ~ 1989.8	512 ~ 810	80 MHz
DCS 1800	1710 ~ 1785	1805 ~ 1880	512 ~ 885	95 MHz
GSM 850	824.2 ~ 848.8	869.2 ~ 893.8	128 ~ 251	45 MHz
EGSM 900	890 ~ 915	935 ~ 960	0 ~ 124	45 MHz
	880 ~ 890	925 ~ 935	975 ~ 1023	45 MHz
WCDMA 2100 – B1	1920 ~ 1980	2110 ~ 2170	Tx: 9612 ~ 9888 Rx: 10562 ~ 10838	190 MHz
WCDMA 1900 – B2	1850 ~ 1910	1930 ~ 1990	Tx: 9262 ~ 9538 Rx: 9662 ~ 9938	80 MHz
WCDMA 1800 – B3	1710 ~ 1785	1805 ~ 1880	Tx: 937 ~ 1288 Rx: 1162 ~ 1513	95 MHz
WCDMA AWS – B4	1710 ~ 1755	2110 ~ 2155	Tx: 1312 ~ 1513 Rx: 1537 ~ 1738	400 MHz
WCDMA 850 – B5	824 ~ 849	869 ~ 894	Tx: 4132 ~ 4233 Rx: 4357 ~ 4458	45 MHz
WCDMA 900 – B8	880 ~ 915	925 ~ 960	Tx: 2712 ~ 2863 Rx: 2937 ~ 3088	45 MHz
WCDMA 1800 – B9	1750 ~ 1784.8	1845 ~ 1879.8	Tx: 8762 ~ 8912 Rx: 9237 ~ 9387	95 MHz
WCDMA 800 – B19	830 ~ 845	875 ~ 890	Tx: 312 ~ 363 Rx: 712 ~ 763	45 MHz
TDSCDMA 2000 – B34	2010 ~ 2025	2010 ~ 2025	Tx: 10054 ~ 10121 Rx: 10054 ~ 10121	0 MHz

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
TDSCDMA 1900 – B39	1880 ~ 1920	1880 ~ 1920	Tx: 9404 ~ 9596 Rx: 9404 ~ 9596	0 MHz
LTE 2100 – B1	1920 ~ 1980	2110 ~ 2170	Tx: 18000 ~ 18599 Rx: 0 ~ 599	190 MHz
LTE 1900 – B2	1850 ~ 1910	1930 ~ 1990	Tx: 18600 ~ 19199 Rx: 600 ~ 1199	80 MHz
LTE 1800 – B3	1710 ~ 1785	1805 ~ 1880	Tx: 19200 ~ 19949 Rx: 1200 ~ 1949	95 MHz
LTE AWS – B4	1710 ~ 1755	2110 ~ 2155	Tx: 19950 ~ 20399 Rx: 1950 ~ 2399	400 MHz
LTE 850 – B5	824 ~ 849	869 ~ 894	Tx: 20400 ~ 20649 Rx: 2400 ~ 2649	45 MHz
LTE 2600 – B7	2500 ~ 2570	2620 ~ 2690	Tx: 20750 ~ 21449 Rx: 2750 ~ 3449	120 MHz
LTE 900 – B8	880 ~ 915	925 ~ 960	Tx: 21450 ~ 21799 Rx: 3450 ~ 3799	45 MHz
LTE 1800 – B9	1749.9 ~ 1784.9	1844.9 ~ 1879.9	Tx: 21800 ~ 2149 Rx: 3800 ~ 4149	95 MHz
LTE AWS+ – B10	1710 ~ 1770	2110 ~ 2170	Tx: 22150 ~ 22749 Rx: 4150 ~ 4749	400 MHz
LTE 700a – B12	699 ~ 716	729 ~ 746	Tx : 23010 ~ 23179 Rx : 5010 ~ 5179	30 MHz
LTE 700c – B13	777 ~ 787	746 ~ 756	Tx : 27210 ~ 27659 Rx : 9210 ~ 9659	-31 MHz
LTE 700b – B17	704 ~ 716	734 ~ 746	Tx: 23730 ~ 23849 Rx: 5730 ~ 5849	30 MHz

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
LTE 800 – B19	830 ~ 845	875 ~ 890	Tx: 24000 ~ 24149 Rx: 6000 ~ 6149	45 MHz
LTE 800 – B20	832 ~ 862	791 ~ 821	Tx: 24150 ~ 24449 Rx: 6150 ~ 6449	-41 MHz
LTE 1500 – B21	1447.9 ~ 1462.9	1495.9 ~ 1510.9	Tx: 24450 ~ 24599 Rx: 6450 ~ 6599	48 MHz
LTE 850+ – B26	814 ~ 849	859 ~ 894	Tx: 26690 ~ 27039 Rx: 8690 ~ 9039	45 MHz
LTE 700 – B28	703 ~ 748	758 ~ 803	Tx : 27210 ~ 27659 Rx : 9210 ~ 9659	45 MHz
LTE TDD 2600 – B38	2570 ~ 2620	2570 ~ 2620	Tx: 37750 ~ 38250 Rx: 37750 ~ 38250	0 MHz
LTE TDD 1900 – B39	1880 ~ 1920	1880 ~ 1920	Tx: 38250 ~ 38650 Rx: 38250 ~ 38650	0 MHz
LTE TDD 2300 – B40	2300 ~ 2400	2300 ~ 2400	Tx: 38650 ~ 39650 Rx: 38650 ~ 39650	0 MHz
LTE TDD 2500 – B41	2496 ~ 2690	2496 ~ 2690	Tx: 39650 ~ 41590 Rx: 39650 ~ 41590	0 MHz

2.7. Sensitivity

LE910Cx maximum sensitivity levels are as follow:

- -108 dBm (TBD) @ 2G
- -111 dBm (TBD) @ 3G
- -102 dBm (TBD) @ 4G FDD (BW=5 MHz)

2.8. LE910Cx Mechanical Specifications

2.8.1. Dimensions

The LE910Cx module's overall dimensions are:

- Length: 28.2 mm, +/- 0.15 mm Tolerance
- Width: 28.2 mm, +/- 0.15 mm Tolerance
- Thickness: 2.2 mm, +/- 0.22 mm Tolerance

2.8.2. Weight

The nominal weight of the LE910Cx module is 9.0 gram.

3. LE910Cx Module Connections

3.1. Pin-out

Table 5: LE910Cx Pin-out

PAD	Signal	I/O	Function	Type	Comment
USB HS 2.0 Communication Port					
B15	USB_D+	I/O	USB differential Data(+)		
C15	USB_D-	I/O	USB differential Data(-)		
A13	USB_VBUS	AI	Power sense for the internal USB transceiver	Power	2.5V – 5.5V
A14	USB_ID	AI	USB ID		See note below
Asynchronous UART					
N15	C103/TXD	I	Serial data input (TXD) from DTE	1.8V	
M15	C104/RXD	O	Serial data output to DTE	1.8V	
L14	C105/RTS	I	Input for Request to send signal (RTS) from DTE	1.8V	
P15	C106/CTS	O	Output for Clear to send signal (CTS) to DTE	1.8V	
P14	C107/DSR	O	Output for Data Set Ready (DSR) to DTE	1.8V	Alternate Fn GPIO_32
M14	C108/DTR	I	Input for Data Terminal Ready (DTR) from DTE	1.8V	Alternate Fn GPIO_34
N14	C109/DCD	O	Output for Data Carrier Detect (DCD) to DTE	1.8V	Alternate Fn GPIO_33
R14	C125/RING	O	Output for Ring Indication (RI) to DTE	1.8V	Alternate Fn GPIO_31

SPI – Serial Peripheral Interface / AUX UART					
F15	SPI_CLK	O	SPI Clock output	1.8V	
E15	SPI_MISO/ RX_AUX	I	SPI data Master Input Slave output / RX_AUX	1.8V	
D15	SPI_MOSI/TX_AUX	O	SPI data Master Output Slave input/ TX_AUX	1.8V	
H14	SPI_CS/GPIO11	O	SPI Chip select output / GPIO11	1.8V	See note below
SD/MMC Card Digital I/O					
J12	SD/MMC_CMD	O	SD Command	1.8/2.95V	
F12	SD/MMC_CLK	O	SD Card Clock	1.8/2.95V	
E12	SD/MMC_DATA0	I/O	SD Serial Data 0	1.8/2.95V	
G12	SD/MMC_DATA1	I/O	SD Serial Data 1	1.8/2.95V	
K12	SD/MMC_DATA2	I/O	SD Serial Data 2	1.8/2.95V	
H12	SD/MMC_DATA3	I/O	SD Serial Data 3	1.8/2.95V	
G13	SD/MMC_CD	I	SD card detect input	1.8V	Active Low
F13	VMMC	-	Power supply for MMC card pull-up resistors	1.8/2.95V	

WiFi (SDIO) Interface					
N13	WiFi_SD_CMD	O	Wi-Fi SD Command	1.8V	
L13	WiFi_SD_CLK	O	Wi-Fi SD Clock	1.8V	
J13	WiFi_SD_DATA0	I/O	Wi-Fi SD Serial Data 0	1.8V	
M13	WiFi_SD_DATA1	I/O	Wi-Fi SD Serial Data 1	1.8V	
K13	WiFi_SD_DATA2	I/O	Wi-Fi SD Serial Data 2	1.8V	
H13	WiFi_SD_DATA3	I/O	Wi-Fi SD Serial Data 3	1.8V	
L12	WiFi_SDRST	O	Wi-Fi Reset / Power enable control	1.8V	Active Low
M11	WLAN_SLEEP_CLK	O	Wi-Fi Sleep clock output	1.8V	
M10	RFCLK2_QCA	O	Wi-Fi low noise RF clock output	1.8V	
LTE-WiFi Coexistence					
M8	WCI_TX	O	Wireless coexistence interface TXD	1.8V	
M9	WCI_RX	I	Wireless coexistence interface RXD	1.8V	
SIM Card Interface 1					
A6	SIMCLK1	O	External SIM 1 signal – Clock	1.8/2.85V	
A7	SIMRST1	O	External SIM 1 signal – Reset	1.8/2.85V	
A5	SIMIO1	I/O	External SIM 1 signal - Data I/O	1.8/2.85V	Internally PU 20 kΩ to SIMVCC1
A4	SIMIN1	I	External SIM 1 signal - Presence	1.8V	Active low
A3	SIMVCC1	-	External SIM 1 signal – Power supply for SIM 1	1.8/2.85V	

SIM Card Interface 2					
C1	SIMCLK2	O	External SIM 2 signal – Clock	1.8/2.85V	
D1	SIMRST2	O	External SIM 2 signal – Reset	1.8/2.85V	
C2	SIMIO2	I/O	External SIM 2 signal – Data I/O	1.8/2.85V	Internally PU 20kΩ to SIMVCC2
G4	SIMIN2	I	External SIM 2 signal – Presence	1.8V	Active low
D2	SIMVCC2	-	External SIM 2 signal – Power supply for SIM 2	1.8/2.85V	
Digital Voice Interface (DVI)					
B9	DVI_WAO	O	Digital Voice interface (WAO master output)	1.8V	
B6	DVI_RX	I	Digital Voice interface (Rx)	1.8V	
B7	DVI_TX	O	Digital Voice interface (Tx)	1.8V	
B8	DVI_CLK	O	Digital Voice interface (CLK master output)	1.8V	
B12	REF_CLK	O	Reference clock for external Codec	1.8V	See Note below
General Purpose Digital I/O					
C8	GPIO_01	I/O	GPIO_01 / STAT_LED	1.8V	Alternate Fn I2C
C9	GPIO_02	I/O	GPIO_02	1.8V	Alternate Fn I2C
C10	GPIO_03	I/O	GPIO_03	1.8V	Alternate Fn I2C
C11	GPIO_04	I/O	GPIO_04	1.8V	Alternate Fn I2C
B14	GPIO_05	I/O	GPIO_05	1.8V	Alternate Fn I2C
C12	GPIO_06	I/O	GPIO_06	1.8V	Alternate Fn I2C
C13	GPIO_07	I/O	GPIO_07	1.8V	Alternate Fn I2C
K15	GPIO_08	I/O	GPIO_08 / SW_RDY	1.8V	Alternate Fn I2C
L15	GPIO_09	I/O	GPIO_09	1.8V	Alternate Fn I2C
G15	GPIO_10	I/O	GPIO_10	1.8V	Alternate Fn I2C

RF Section					
K1	Antenna	I/O	GSM/EDGE/UMTS/LTE Main antenna (50 Ohm)	RF	
F1	ANT_DIV	I	UMTS/LTE antenna diversity input (50 Ohm)	RF	
GPS Section					
R9	ANT_GPS	I	GPS antenna (50 Ohm)	RF	
R7	GPS_LNA_EN	O	Enables the external regulator for GPS LNA	1.8V	
N9	GPS_SYNC	O	GPS sync signal for Dead Reckoning	1.8V	
Miscellaneous Functions					
R12	ON_OFF_N	I	Power ON / Power OFF input		Active low
R13	HW_SHUTDOWN_N	I	Unconditional Shutdown input		Active low
R11	VAUX/PWRMON	O	Supply output for external accessories / Power ON monitor	1.8V	
B1	ADC_IN1	AI	Analog/Digital Converter Input 1	Analog	
H4	ADC_IN2	AI	Analog/Digital Converter Input 2	Analog	
D7	ADC_IN3	AI	Analog/Digital Converter Input 3	Analog	
SGMII Interface					
E4	SGMII_RX_P	AI	SGMII receive – plus	PHY	
F4	SGMII_RX_M	AI	SGMII receive – minus	PHY	
D5	SGMII_TX_P	AO	SGMII transmit – plus	PHY	
D6	SGMII_TX_M	AO	SGMII transmit - minus	PHY	
HSIC Interface					
A12	HSIC_DATA	I/O	High-speed inter-chip interface - data	1.2V	
A11	HSIC_STB	I/O	High-speed inter-chip interface - strobe	1.2V	

I2C Interface					
B11	I2C_SCL	I/O	I2C clock	1.8V	Internally PU 2.2kΩ to 1.8V
B10	I2C_SDA	I/O	I2C Data	1.8V	Internally PU 2.2kΩ to 1.8V
Power Supply					
M1	VBATT	-	Main Power Supply (Digital Section)	Power	
M2	VBATT	-	Main Power Supply (Digital Section)	Power	
N1	VBATT_PA	-	Main Power Supply (RF Section)	Power	
N2	VBATT_PA	-	Main Power Supply (RF Section)	Power	
P1	VBATT_PA	-	Main Power Supply (RF Section)	Power	
P2	VBATT_PA	-	Main Power Supply (RF Section)	Power	
A2	GND	-	Ground		
B13	GND		Ground		
D4	GND	-	Ground		
E1	GND	-	Ground		
E2	GND	-	Ground		
E14	GND	-	Ground		
F2	GND	-	Ground		
G1	GND	-	Ground		
G2	GND	-	Ground		
G7	GND	-	Ground		
G8	GND	-	Ground		
G9	GND	-	Ground		
H1	GND	-	Ground		

H2	GND	-	Ground		
H7	GND	-	Ground		
H8	GND	-	Ground		
H9	GND	-	Ground		
J1	GND	-	Ground		
J2	GND	-	Ground		
J7	GND	-	Ground		
J8	GND	-	Ground		
J9	GND	-	Ground		
K2	GND	-	Ground		
L1	GND	-	Ground		
L2	GND	-	Ground		
M3	GND	-	Ground		
M4	GND	-	Ground		
M12	GND	-	Ground		
N3	GND	-	Ground		
N4	GND	-	Ground		
N5	GND	-	Ground		
N6	GND	-	Ground		
P3	GND	-	Ground		
P4	GND	-	Ground		
P5	GND	-	Ground		
P6	GND	-	Ground		
P8	GND	-	Ground		

P9	GND	-	Ground		
P10	GND	-	Ground		
P13	GND	-	Ground		
R2	GND	-	Ground		
R3	GND	-	Ground		
R5	GND	-	Ground		
R6	GND	-	Ground		
R8	GND	-	Ground		
R10	GND	-	Ground		
Reserved					
A8	Reserved	-	Reserved		
A9	Reserved	-	Reserved		
A10	Reserved	-	Reserved		
B2	Reserved	-	Reserved		
B3	Reserved	-	Reserved		
B4	Reserved	-	Reserved		
B5	Reserved	-	Reserved		
C3	Reserved	-	Reserved		
C4	Reserved	-	Reserved		
C5	Reserved	-	Reserved		
C6	Reserved	-	Reserved		
C7	Reserved	-	Reserved		
C14	Reserved	-	Reserved		
D3	Reserved	-	Reserved		

D8	Reserved	-	Reserved		
D9	Reserved	-	Reserved		
D10	Reserved	-	Reserved		
D11	Reserved	-	Reserved		
D12	Reserved	-	Reserved		
D13	Reserved	-	Reserved		
D14	Reserved	-	Reserved		
E3	Reserved	-	Reserved		
E13	Reserved	-	Reserved		
F3	Reserved	-	Reserved		
F14	Reserved	-	Reserved		
G3	Reserved	-	Reserved		
G14	Reserved	-	Reserved		
H3	Reserved	-	Reserved		
H15	Reserved	-	Reserved		
J3	Reserved	-	Reserved		
J4	Reserved	-	Reserved		
J14	Reserved	-	Reserved		
J15	Reserved	-	Reserved		
K3	Reserved	-	Reserved		
K4	Reserved	-	Reserved		
K14	Reserved	-	Reserved		
L3	Reserved	-	Reserved		
L4	Reserved	-	Reserved		

M5	Reserved	-	Reserved		
M6	Reserved	-	Reserved		
M7	Reserved	-	Reserved		
N7	Reserved	-	Reserved		
N8	Reserved	-	Reserved		
N10	Reserved	-	Reserved		
N11	Reserved	-	Reserved		
N12	Reserved	-	Reserved		
P7	Reserved	-	Reserved		
P11	Reserved	-	Reserved		
P12	Reserved	-	Reserved		
Reserved for future use					
R4	RFU	-	Reserved for future use. Not connected internally		Can be tied to GND

Caution:

GPIO_09 and WCI_RX are used as special HW flags during boot.

If they are used as GPIOs, they must be connected via a 3-state buffer to avoid any undesirable effect during the boot.

NOTE:

When the UART signals are used as the communication port between the Host and the Modem, RTS must be connected to GND (on the module side) if flow control is not used.

If the UART port is not used, UART signals can be left floating.

NOTE:

Unless otherwise specified, RESERVED pins must be left unconnected (Floating).

NOTE:

The following pins are unique for the LE910Cx and may not be supported on other (former or future) xE910 family. Special care must be taken when designing the application board if future compatibility is required

REF_CLK

SPI_CS

USB_ID

I2C_SCL

I2C_SDA

ADC_IN2

ADC_IN3

3.2. LE910Cx - Signals That Must Be Connected

Table 6 specifies the LE910Cx signals that must be connected even if not used by end application:

Table 6: Mandatory Signals

PAD	Signal	Notes
M1, M2, N1, N2, P1, P2	VBATT & VBATT_PA	
A2, B13, D4, E1, E2, E14, F2, G1, G2, G7, G8, G9, H1, H2, H7, H8, H9, J1, J2, J7, J8, J9, K2, L1, L2, M3, M4, M12, N3, N4, N5, N6, P3, P4, P5, P6, P8, P9, P10, P13, R2, R3, R5, R6, R8, R10	GND	
R12	ON/OFF	Main power on off signal
R13	HW_SHUTDOWN_N	Emergency power off
B15	USB_D+	If not used, connect to a Test Point or an USB connector
C15	USB_D-	If not used, connect to a Test Point or an USB connector
A13	USB_VBUS	If not used, connect to a Test Point or an USB connector
N15	C103/TXD	If not used, connect to a Test Point
M15	C104/RXD	If not used, connect to a Test Point
L14	C105/RTS	If flow control is not used, connect to GND
P15	C106/CTS	If not used, connect to a Test Point
D15	TX_AUX	If not used, connect to a Test Point
E15	RX_AUX	If not used, connect to a Test Point
K1	Antenna	MAIN antenna
F1	ANT_DIV	DIV antenna

PAD	Signal	Notes
R9	ANT_GPS	GPS antenna
C4, C5, C6, C7, D3, E3, G3, K4, L4, P11	Reserved	Connect to a Test Point for Telit internal use
L15	GPIO_09	If not used, connect to a Test Point
M9	WCI_RX	If not used, connect to a Test Point

3.3. LGA Pads Layout

Figure 2: LGA Pads Layout

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
1		ADC_IN1	SIMCLK2	SIMRST2	GND	ANT_DIV	GND	GND	GND	ANT_MAIN	GND	VBATT	VBATT_PA	VBATT_PA	
2	GND	RES	SIMIO2	SIMVCC2	GND	GND	GND	GND	GND	GND	GND	VBATT	VBATT_PA	VBATT_PA	GND
3	SIMVCC	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	GND	GND	GND	GND
4	SIMIN	RES	RES	GND	SGMII_RX_P	SGMII_RX_M	SIMIN2	ADC_IN2	RES	RES	RES	GND	GND	GND	RFU
5	SIMIO	RES	RES	SGMII_TX_P								RES	GND	GND	GND
6	SIMCLK	DVI_RX	RES	SGMII_TX_M								RES	GND	GND	GND
7	SIMRST	DVI_TX	RES	ADC_IN3			GND	GND	GND			RES	RES	RES	GPS_LNA_EN
8	RES	DVI_CLK	GPIO_01	RES			GND	GND	GND			WCI_TXD_TGPIO24	RES	GND	GND
9	RES	DVI_WA0	GPIO_02	RES			GND	GND	GND			WCI_RXD_TGPIO25	GPS_SYNC	GND	ANT_GPS
10	RES	I2C_SDA	GPIO_03	RES								RFCLK2_QCA	RES	GND	GND
11	HSIC_STB	I2C_SCL	GPIO_04	RES								WLAN_SLEEP_CLK	RES	RES	VAUX/PWRMON
12	HSIC_DATA	REF_CLK	GPIO_06	RES	MMC_DAT0	MMC_CLK	MMC_DAT1	MMC_DAT3	MMC_CMD	MMC_DAT2	WIFI_SDRST	GND	RES	RES	ON_OFF*
13	VUSB	GND	GPIO_07	RES	RES	VMMC	MMC_CD	WIFI_SD3	WIFI_SD0	WIFI_SD2	WIFI_SDCLK	WIFI_SD1	WIFI_SDCMD	GND	HW_SHUTDOWN*
14	USB_ID	GPIO_05	RES	RES	GND	RES	RES	SPI_CS / GPIO_11	RES	RES	C105/RTS	C108/DTR	C109/DCD	C107/DSR	C125/RING
15		USB_D+	USB_D-	SPI_MOSI / TX_AUX	SPI_MISO /RX_AUX	SPI_CLK	GPIO_10	RES	RES	GPIO_8	GPIO_9	C104/RXD	C103/TXD	C106/CTS	

3.4. Backward Compatibility to xE910 Family

The LE910Cx is a new series in the xE910 form factor

The LE910Cx is fully backward compatible to the previous xE910 in terms of:

- Mechanical dimensions
- Package and pin-map

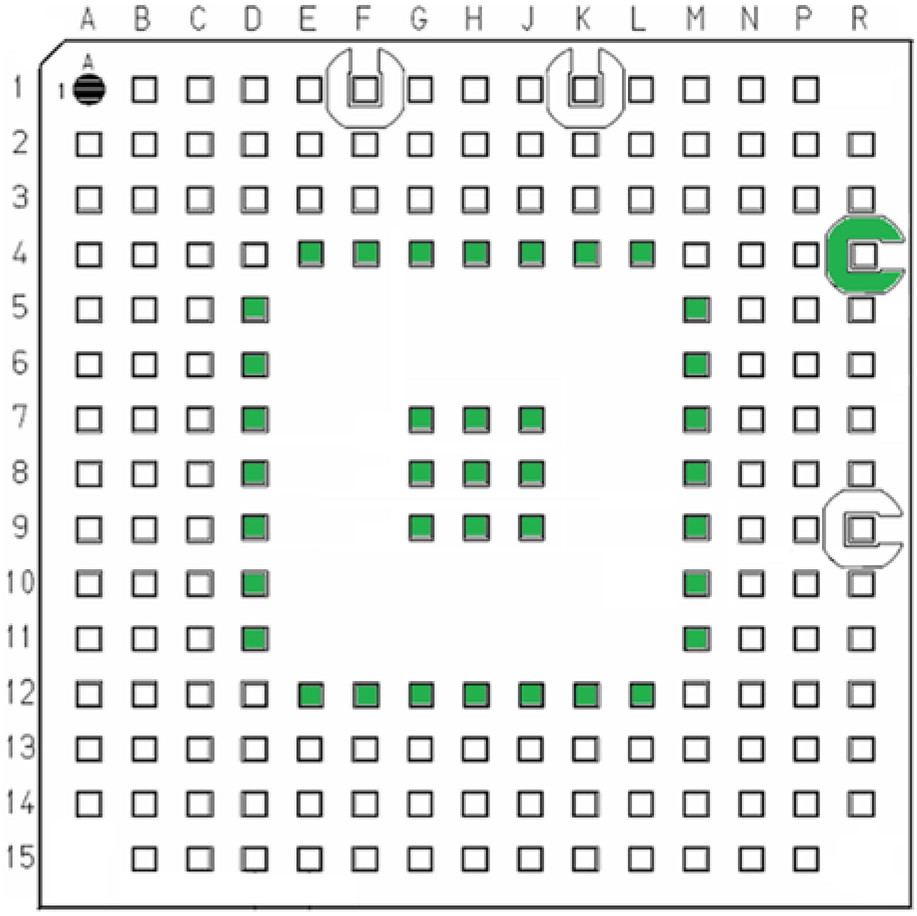
To support the extra features and additional interfaces, the LE910Cx introduces more pins compared to the xE910.

The extra pins of the LE910Cx can be considered as optional if not needed and can be left unconnected (floating) if not used.

In this case, the new LE910Cx can be safely mounted on existing carrier boards designed for the previous xE910.

The additional pins of the LE910Cx are shown in Figure 3 (marked as Green)

Figure 3: LE910Cx vs. LE910 Pin-out Comparison (top view)



4. Electrical Specifications

4.1. Absolute Maximum Ratings – Not Operational

A deviation from the value ranges listed below may harm the LE910Cx module.

Table 7: Absolute Maximum Ratings – Not Operational

Symbol	Parameter	Min	Max	Unit
VBATT	Battery supply voltage on pin VBATT	-0.5	+6.0	[V]
VBATT TRANSIENT	Transient voltage on pin VBATT (< 10 ms)	-0.5	+7.0	[V]
VBATT_PA	Battery supply voltage on pin VBATT_PA	-0.3	+6.0	[V]

4.2. Recommended Operating Conditions

Table 8: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
T_{amb}	Ambient temperature	-40	+25	+85	[°C]
VBATT	Battery supply voltage on pin VBATT	3.4	3.8	4.2	[V]
VBATT_PA	Battery supply voltage on pin VBATT_PA	3.4	3.8	4.2	[V]
$I_{BATT\_PA} + I_{BATT}$	Peak current to be used to dimension decoupling capacitors on pin VBATT_PA	-	80	2000	[mA]

4.3. Logic Level Specifications

Unless otherwise specified, all the interface circuits of the LE910Cx are 1.8V CMOS logic.

Only few specific interfaces (such as USIM and SD Card) are capable of dual voltage I/O.

The following tables show the logic level specifications used in the LE910Cx interface circuits. The data specified in the tables below is valid throughout all drive strengths and the entire temperature ranges.

NOTE:

Do not connect LE910Cx's digital logic signal directly to OEM's digital logic signal with a level higher than 2.7V for 1.8V CMOS signals.

4.3.1. 1.8V Pads - Absolute Maximum Ratings

Table 9: Absolute Maximum Ratings - Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-0.3V	+2.16V
Input voltage on analog pins when on	-0.3V	+2.16 V

4.3.2. 1.8V Standard GPIOs

Table 10: Operating Range – Interface Levels (1.8V CMOS)

Pad	Parameter	Min	Max	Unit	Comment
V_{IH}	Input high level	1.25V	--	[V]	
V_{IL}	Input low level	--	0.6V	[V]	
V_{OH}	Output high level	1.4V	--	[V]	
V_{OL}	Output low level	--	0.45V	[V]	
I_{IL}	Low-level input leakage current	-1	--	[uA]	No pull-up
I_{IH}	High-level input leakage current	--	+1	[uA]	No pull-down
R_{PU}	Pull-up resistance	30	390	[kΩ]	

Pad	Parameter	Min	Max	Unit	Comment
R_{PD}	Pull-down resistance	30	390	[kΩ]	
C_i	Input capacitance	--	5	[pF]	

NOTE:

Pull-Up and Pull-Down resistance of GPIO3, GPIO7 and GPIO8 is different than above mentioned

GPIO3 pull resistance is specified as 10KΩ to 50KΩ

4.3.3. 1.8V SD Card Pads

Table 11: Operating Range – SD Card Pads Working at 1.8V

Pad	Parameter	Min	Max	Unit	Comment
V_{IH}	Input high level	1.27V	2V	[V]	
V_{IL}	Input low level	-0.3V	0.58V	[V]	
V_{OH}	Output high level	1.4V	--	[V]	
V_{OL}	Output low level	0	0.45V	[V]	
I_{IL}	Low-level input leakage current	-2	-	[uA]	No pull-up
I_{IH}	High-level input leakage current	-	2	[uA]	No pull-down
R_{PU}	Pull-up resistance	10	100	[kΩ]	
R_{PD}	Pull-down resistance	10	100	[kΩ]	
C_i	Input capacitance		5	[pF]	

4.3.4. 1.8V SIM Card Pads

Table 12: Operating Range – SIM Pads Working at 1.8V

Pad	Parameter	Min	Max	Unit	Comment
V_{IH}	Input high level	1.35V	2V	[V]	
V_{IL}	Input low level	-0.3V	0.43V	[V]	
V_{OH}	Output high level	1.35V	1.875V	[V]	

Pad	Parameter	Min	Max	Unit	Comment
V_{OL}	Output low level	0V	0.4V	[V]	
I_{IL}	Low-level input leakage current	-2	-	[uA]	No pull-up
I_{IH}	High-level input leakage current	-	2	[uA]	No pull-down
R_{PU}	Pull-up resistance	10	100	[kΩ]	
R_{PD}	Pull-down resistance	10	100	[kΩ]	
C_i	Input capacitance		5	[pF]	

4.3.5. Dual Voltage Pads - Absolute Maximum Ratings

Table 13: Absolute Maximum Ratings - Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-0.3V	+3.6V
Input voltage on analog pins when on	-0.3V	+3.6 V

4.3.6. SD Card Pads @ 2.95V

Table 14: Operating Range – For SD Card Pads Operating at 2.95V

Pad	Parameter	Min	Max	Unit	Comments
V_{IH}	Input high level	1.9V	3.1V	[V]	
V_{IL}	Input low level	-0.3V	0.7V	[V]	
V_{OH}	Output high level	2.1V	3.05V	[V]	
V_{OL}	Output low level	0V	0.4V	[V]	
I_{IL}	Low-level input leakage current	-10		[uA]	No pull-up
I_{IH}	High-level input leakage current		10	[uA]	No pull-down
R_{PU}	Pull-up resistance	10	100	[kΩ]	

Pad	Parameter	Min	Max	Unit	Comments
R_{PD}	Pull-down resistance	10	100	[kΩ]	
C_i	Input capacitance		5	[pF]	

4.3.7. SIM Card Pads @2.95V

Table 15: Operating Range – For SIM Pads Operating at 2.95V

Pad	Parameter	Min	Max	Unit	Comment
V_{IH}	Input high level	2.1V	3.1V	[V]	
V_{IL}	Input low level	-0.3V	0.55V	[V]	
V_{OH}	Output high level	2.25V	3.1V	[V]	
V_{OL}	Output low level	0V	0.4V	[V]	
I_{IL}	Low-level input leakage current	-10		[uA]	No pull-up
I_{IH}	High-level input leakage current		10	[uA]	No pull-down
R_{PU}	Pull-up resistance	10	100	[kΩ]	
R_{PD}	Pull-down resistance	10	100	[kΩ]	
C_i	Input capacitance		5	[pF]	

5. Hardware Commands

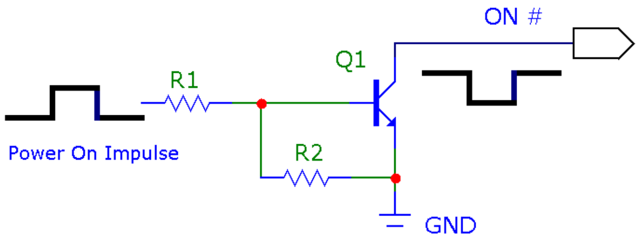
5.1. Turning on the LE910Cx Module

To turn on the LE910Cx module, the ON/OFF# pad must be asserted low for at least 1 second and then released.

The maximum current that can be drained from the ON/OFF # pad is 0.1 mA. This pin is internally pulled up; customers should expect to see ~ 800 mV on the output.

Figure 4 illustrates a simple circuit to power on the module using an inverted buffer output.

Figure 4: Power-on Circuit



NOTE:

Recommended values R2 = 47kΩ, R1 = 10kΩ.

5.2. Initialization and Activation State

After turning on the LE910Cx module, the LE910Cx is not yet activated because the SW initialization process of the LE910Cx module is still in process internally. It takes some time to fully complete the HW and SW initialization of the module.

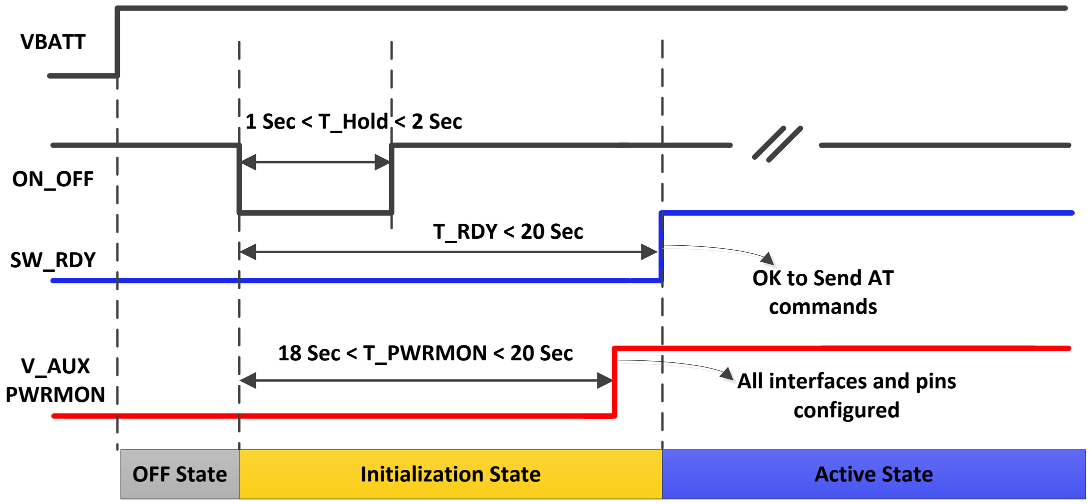
For this reason, it is impossible to access LE910Cx during the Initialization state.

As shown in Figure 5, the LE910Cx becomes operational (in the Activation state) at least 20 seconds after the assertion of ON_OFF.

NOTE:

During the Initialization state, AT commands are not available. The DTE host must wait for the Activation state prior to communicating with the LE910Cx.

Figure 5: LE910Cx Initialization and Activation



NOTE:

SW_RDY signal is available on GPIO_08 (by default GPIO_08 functions as SW_RDY)

NOTE:

To check if the LE910Cx has completely powered on, monitor the SW_RDY signal. When SW_RDY goes high, the module has completely powered on and is ready to accept AT commands.

NOTE:

During SW initialization of the LE910Cx, the SW configures all pads and interfaces to their desired mode. When PWRMON goes high, this indicates that the initialization of all I/O pads is completed.

NOTE:

Do not use any pull-up resistor on the ON/OFF# line as it is internally pulled up. Using a pull-up resistor may cause latch-up problems on the LE910Cx power regulator and improper powering on/off of the module. The ON/OFF# line must be connected only in an open-collector configuration.

NOTE:

Active low signals are labeled with a name that ends with "#" or with “_N”

NOTE:

To avoid a back-powering effect, it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when it is powered OFF or during an ON/OFF transition.

5.3. Turning OFF the LE910Cx Module

Turning OFF the device can be done in four different ways:

- AT#SHDN software command
- Hardware shutdown using ON/OFF# pad
- Hardware Unconditional Shutdown using the HW_SHUTDOWN_N

When the device is shut down by a software command or a hardware shutdown, it issues a detach request to the network, informing the network that the device will not be reachable any more.

NOTE:

To check if the device has powered off, monitor the PWRMON hardware line. When PWRMON goes low, this indicates that the device has powered off.

NOTE:

To avoid a back-powering effect, it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when it is powered OFF or during an ON/OFF transition.

5.3.1. Shutdown by Software Command

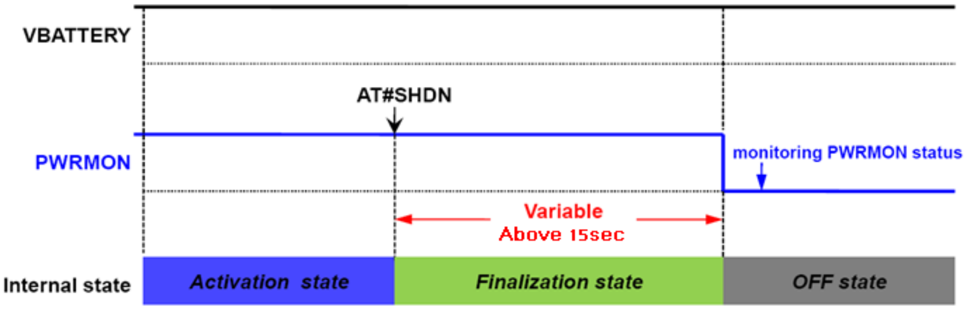
The LE910Cx module can be shut down by a software command.

When a shutdown command is sent, LE910Cx goes into the Finalization state and at the end of the finalization process shuts down PWRMON.

The duration of the finalization state can differ according to the current situation of the module, so a value cannot be defined.

Usually, it will take more than 15 seconds from sending a shutdown command until reaching a complete shutdown. The DTE should monitor the status of PWRMON to observe the actual power-off.

Figure 6: Shutdown by Software Command



NOTE:

To check whether the device has powered OFF, monitor the PWRMON hardware line. When PWRMON goes low, the device has powered OFF.

5.3.2. Hardware Shutdown

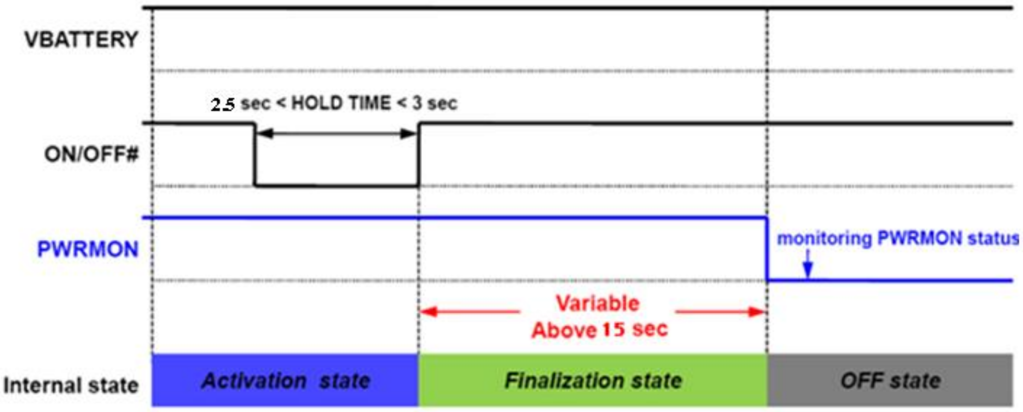
To turn off LE910Cx module, the ON/OFF# pad must be asserted low for at least 2.5 seconds and then released. Use the same circuitry and timing for power-on.

When the hold time of ON/OFF# is above 2.5 seconds, LE910Cx goes into the Finalization state and in the end shuts down PWRMON.

The duration of the Finalization state can differ according to the current situation of the module, so a value cannot be defined.

Usually, it will take more than 15 seconds from sending a shutdown command until reaching a complete shutdown. DTE should monitor the status of PWRMON to observe the actual power-off.

Figure 7: Hardware Shutdown



NOTE:

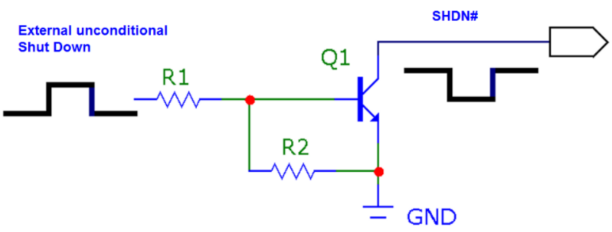
To check whether the device has powered off, monitor the PWRMON hardware line. When PWRMON goes low, the device has powered off.

5.3.4. Unconditional Hardware Shutdown

To unconditionally shut down the LE910Cx module, the HW_SHUTDOWN_N pad must be tied low for at least 200 milliseconds and then released.

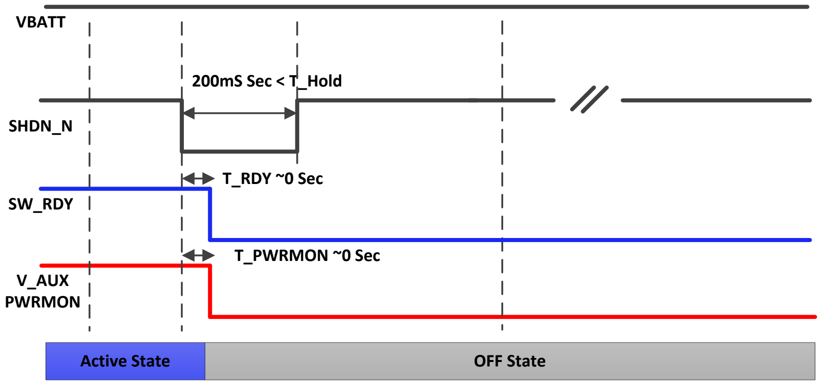
A simple circuit for applying unconditional shutdown is shown below:

Figure 8: Circuit for Unconditional Hardware Shutdown



The system power down timing for using HW_SHUTDOWN_N is shown below

Figure 9 Power down timing using HW_SHUTDOWN_N



NOTE:

Recommended values R2 = 47kΩ, R1 = 10kΩ.

NOTE:

Do not use any pull-up resistor on the HW_SHUTDOWN_N line or any totem pole digital output. Using a pull-up resistor may cause latch-up problems on the LE910Cx power regulator and improper functioning of the module. The HW_SHUTDOWN_N line must be connected only in an open-collector configuration.

NOTE:

The Unconditional Hardware Shutdown must always be implemented on the boards, but the software must use it only as an emergency exit procedure, and not as a normal power-off operation.

6. Power Supply

The power supply circuitry and board layout are very important parts of the full product design, with critical impact on the overall product performance. Read the following requirements and guidelines carefully to ensure a good and proper design.

6.1. Power Supply Requirements

The LE910Cx power requirements are as follows:

Table 16: Power Supply Requirements

Nominal supply voltage	3.8V
Supply voltage range	3.4V – 4.2V
Max ripple on module input supply	30mV

Table 17 provides typical current consumption values of LE910Cx for various operation modes.

Table 17: LE910Cx Current Consumption

Mode		**Average [Typical]**	**Mode Description**
1) Switched Off			
Switched off		25µA	Module is powered but switched Off (RTC On)
2) IDLE Mode (Standby Mode; No Call in Progress)			
AT+CFUN=4		1.0mA	Tx and Rx are disabled ; module is not registered on the network (Flight mode)
DRX	GSM	2.0mA	DRx2
		1.4mA	DRx5
	WCDMA	1.4mA	DRx7
		1.2mA	DRx8
	LTE	1.8mA	Paging cycle #128 frames (1.28 sec DRx cycle)
		1.4mA	Paging cycle #256 frames (2.56 sec DRx cycle)

Mode	Average [Typical]	Mode Description
3) Operative Mode (LTE)		
LTE (0 dBm)	190mA	LTE CAT 4 channel BW 20 MHz, RB=1, Tx = 0 dBm (Test case: BAND 1, Channel 300)
LTE (22 dBm)	500mA	LTE CAT 4 channel BW 20 MHz, RB=1, Tx = 22 dBm (Test case: BAND 1, Channel 300)
4) Operative Mode (WCDMA)		
WCDMA Voice	200mA	WCDMA voice call (Tx = 10 dBm)
WCDMA HSDPA (0 dBm)	150mA	WCDMA data call (Cat 14, Tx = 0 dBm, Max throughput)
WCDMA HSDPA (22 dBm)	310mA	WCDMA data call (Cat 14, Tx = 22 dBm, Max throughput)
5) Operative Mode (GSM)		
GSM Tx and Rx mode		
GSM900 PL5	250mA	GSM voice call
DCS1800 PL0	170mA	
GPRS 4 Tx + 1 Rx		
GSM900 PL5	430mA	GPRS Sending Data mode (CS-4)
DCS1800 PL0	340mA	

* Worst/best case current values depend on network configuration - not under module control.

NOTE:

The electrical design for the power supply must ensure a peak current output of at least 2A.

NOTE:

In GSM/GPRS mode, RF transmission is not continuous, but is packed into bursts at a base frequency of about 216 Hz with relative current peaks as high as about 2A. Therefore, the power supply must be designed to withstand these current peaks without big voltage drops. This means that both the electrical design and the board layout must be designed for this current flow.

If the layout of the PCB is not well designed, a strong noise floor is generated on the ground. This will reflect on all the audio paths producing an audible annoying noise at 216 Hz.

If the voltage drops during the peaks, current absorption is too high. The device may even shut down as a consequence of the supply voltage drop.

6.2. General Design Rules

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

- Electrical design
- Thermal design
- PCB layout

6.2.1. Electrical Design Guidelines

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

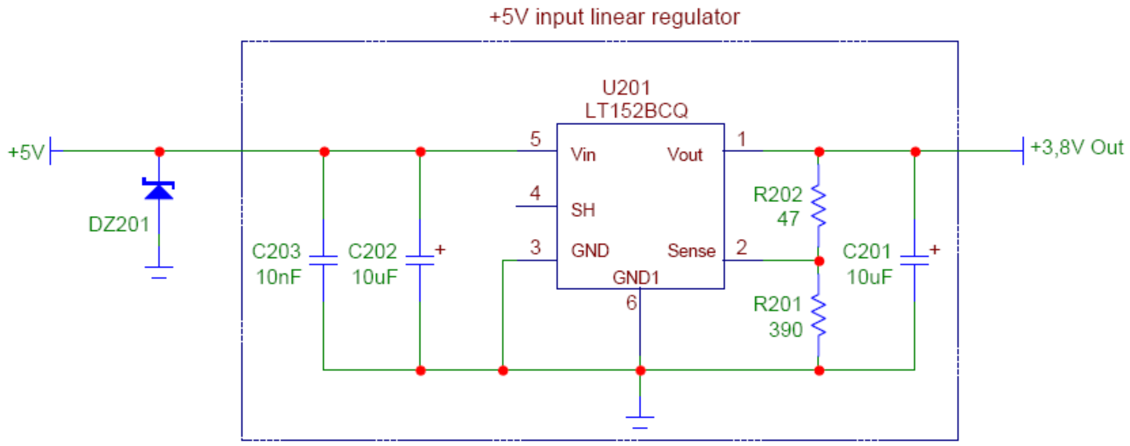
- +5V input (typically PC internal regulator output)
- +12V input
- Battery

6.2.1.1. + 5V Input Source Power Supply – Design Guidelines

- The desired output for the power supply is 3.8V. So, the difference between the input source and the desired output is not big, and therefore a linear regulator can be used. A switching power supply is preferred to reduce power consumption.
- When using a linear regulator, a proper heat sink must be provided to dissipate the power generated.
- A bypass low ESR capacitor of adequate capacity must be provided to cut the current absorption peaks close to the LE910Cx module. A 100 µF tantalum capacitor is usually suitable (on both VBATT and VBATT_PA together).
- Make sure that the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- A protection diode must be inserted close to the power input to protect the LE910Cx module from power polarity inversion.

Figure 10 shows an example of linear regulator with 5V input.

Figure 10: Example of Linear Regulator with 5V Input



6.2.1.2. + 12V Input Source Power Supply – Design Guidelines

- The desired output for the power supply is 3.8V. Due to the big difference between the input source and the desired output, a linear regulator is unsuitable and must not be used. A switching power supply is preferable because of its better efficiency, especially with the 2A peak current load which is expected during GSM Tx.
- When using a switching regulator, a 500-kHz or higher switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- In any case, the selection of the frequency and switching design is related to the application to be developed due to the fact that the switching frequency can also generate EMC interference.
- For car batteries (lead-acid accumulators) the input voltage can rise up to 15.8V. This must be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A bypass low ESR capacitor of adequate capacity must be provided to cut the current absorption peaks. A 100µF tantalum capacitor is usually suitable (on both VBATT and VBATT_PA together).
- Make sure that the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- For automotive applications, a spike protection diode must be inserted close to the power input to clean the supply of spikes.
- A protection diode must be inserted close to the power input to protect the LE910Cx module from power polarity inversion. This can be the same diode as for spike protection.

Figure 11 and Figure 12 show an example of switching regulator with 12V input.

Figure 11: Example of Switching Regulator with 12V Input – Part 1

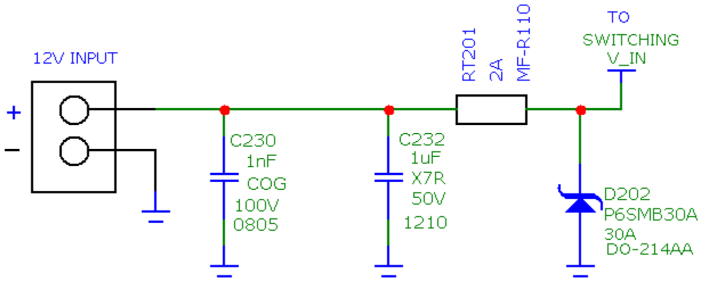
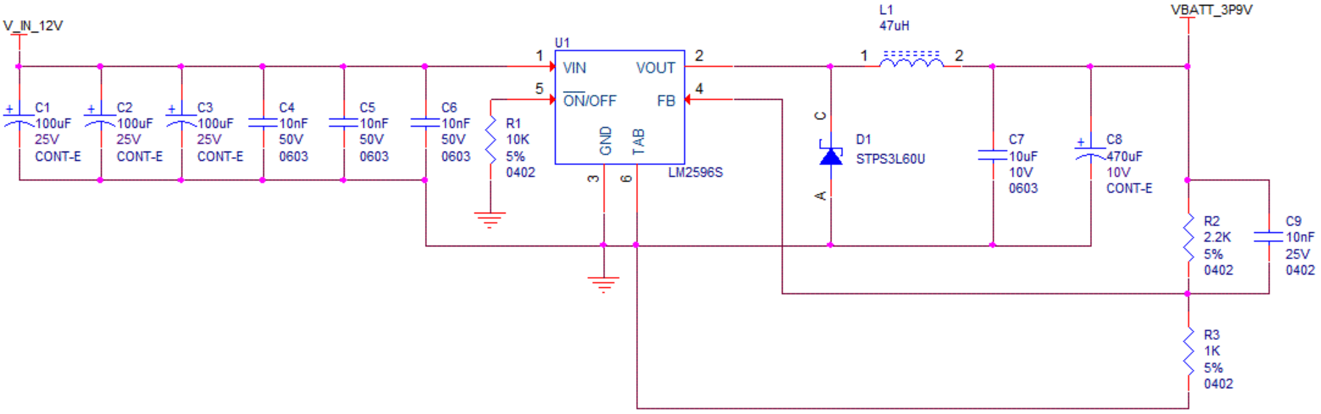


Figure 12: Example of Switching Regulator with 12V Input – Part 2



6.2.1.3. Battery Source Power Supply – Design Guidelines

- The desired nominal output for the power supply is 3.8V, and the maximum allowed voltage is 4.2V. Hence, a single 3.7V Li-Ion cell battery type is suitable for supplying the power to the LE910Cx module.

NOTE:

Do not use any Ni-Cd, Ni-MH, and Pb battery types directly connected to the LE910Cx module. Their use can lead to overvoltage on the LE910Cx and damage it. Use only Li-Ion battery types.

- A bypass low ESR capacitor of adequate capacity must be provided to cut the current absorption peaks; a 100μF tantalum capacitor is usually suitable (on both VBATT and VBATT_PA together).
- Make sure that the low ESR capacitor (usually a tantalum one) is rated at least 10V.
- A protection diode must be inserted close to the power input to protect the LE910Cx module from power polarity inversion. Otherwise, the battery connector must be done in a way to avoid polarity inversions when connecting the battery.
- The battery capacity must be at least 900 mAh to withstand the current peaks of 2A.

6.2.2. Thermal Design Guidelines

The thermal design for the power supply heat sink must be done with the following specifications:

- Average current consumption during RF transmission @PWR level max in LE910Cx as shown in Table 17
- Average current consumption during Class12 GPRS transmission @PWR level max as shown in Table 17
- Average GPS current during GPS ON (Power Saving disabled) : mA (TBD)

NOTE:

The average consumption during transmission depends on the power level at which the device is requested to transmit via the network. Therefore, the average current consumption varies significantly.

NOTE:

The thermal design for the power supply must be made keeping an average consumption at the max transmitting level during calls of (LTE/HSPA)/GPRS plus average consumption in GPS Tracking mode.

Considering the very low current during Idle, especially if the Power Saving function is enabled, it is possible to consider from the thermal point of view that the device absorbs significant current only during an Active Call or Data session.

For the heat generated by the LE910Cx module, consider it to be 2W max during transmission at Class12 GPRS upload. The generated heat is mostly conducted to the ground plane under the LE910Cx module. Ensure that your application can dissipate heat.

In LTE/WCDMA/HSPA mode, the LE910Cx emits RF signals continuously during transmission. Therefore, you must pay special attention how to dissipate the heat generated.

Application board design needs to make sure the area under the LE910Cx module is as large as possible. Make sure that the LE910Cx is mounted on the large ground area of application board and provide many ground vias to dissipate the heat.

Even though peak current consumption in GSM mode is higher than in LTE/WCDMA/HSPA, considerations for the heat sink are more important in the case of WCDMA due to the continuous transmission conditions.

6.2.3. Power Supply PCB Layout Guidelines

As seen in the electrical design guidelines, the power supply must have a low ESR capacitor on the output to cut the current peaks and a protection diode on the input to protect the supply from spikes and polarity inversion. The placement of these components is crucial for the correct operation of the circuitry. A misplaced component can be useless or can even decrease the power supply performances.

- The bypass low ESR capacitor must be placed close to the LE910Cx power input pads, or if the power supply is of a switching type, it can be placed close to the inductor to cut the ripple, as long as the PCB trace from the capacitor to LE910Cx is wide enough to ensure a drop-less connection even during the 2A current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure that no voltage drops occur during the 2A current peaks.

Note that this is not done to save power loss but especially to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz that will reflect on all the components connected to that supply (also introducing the noise floor at the burst base frequency.)

For this reason while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application does not have an audio interface but only uses the data feature of the LE910Cx, this noise is not so disturbing, and the power supply layout design can be more forgiving.

- The PCB traces to LE910Cx and the bypass capacitor must be wide enough to ensure that no significant voltage drops occur when the 2A current peaks are absorbed. This is needed for the same above-mentioned reasons. Try to keep these traces as short as possible.
- The PCB traces connecting the switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for the switching power supply). This is done to reduce the radiated field (noise) at the switching frequency (usually 100-500 kHz).
- Use a good common ground plane.
- Place the power supply on the board in a way to guarantee that the high current return paths in the ground plane do not overlap any noise sensitive circuitry, such as the microphone amplifier/buffer or earphone amplifier.
- The power supply input cables must be kept separate from noise sensitive lines, such as microphone/earphone cables.

7. Antenna(s)

Antenna connection and board layout design are the most important parts in the full product design, and they have a strong influence on the product's overall performance. Read carefully and follow the requirements and guidelines for a good and proper design.

7.1. GSM/WCDMA/LTE Antenna Requirements

The antenna for the LE910Cx device must meet the following requirements:

Table 18: GSM / WCDMA/ LTE Antenna Requirements

Frequency range	The customer must use the most suitable antenna band width for covering the frequency bands provided by the network operator and also supported by the car OEM while using the Telit module. The bands supported by each variant of the LE910Cx module family are provided in Section 2.6.1, RF Bands per Regional Variant.
Gain	Gain < 3 dBi
Impedance	50 Ohm
Input power	> 33 dBm(2 W) peak power in GSM > 24 dBm average power in WCDMA & LTE
VSWR absolute max	<= 10:1
VSWR recommended	<= 2:1

Since there is no antenna connector on the LE910Cx module, the antenna must be connected to the LE910Cx antenna pad (K1) by a transmission line implemented on the PCB.

If the antenna is not directly connected to the antenna pad of the LE910Cx, a PCB line is required to connect to it or to its connector.

This transmission line must meet the following requirements:

Table 19: Antenna Line on PCB Requirements

Characteristic impedance	50 Ohm
Max attenuation	0.3 dB
Avoid coupling with other signals.	
Cold End (Ground Plane) of the antenna must be equipotential to the LE910Cx ground pads.	

Furthermore, if the device is developed for the US and/or Canada market, it must comply with the FCC and/or IC approval requirements.

NOTE:

This device is to be used only for mobile and fixed application. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance. OEM integrators must ensure that the end user has no manual instructions to remove or install the LE910Cx module. Antennas used for this OEM module must not exceed 3dBi gain for mobile and fixed operating configurations.

7.2. GSM/WCDMA/LTE Antenna – PCB Line Guidelines

- Make sure that the transmission line’s characteristic impedance is 50 Ohm.
- Keep the line on the PCB as short as possible since the antenna line loss should be less than around 0.3 dB.
- Line geometry should have uniform characteristics, constant cross sections, and avoid meanders and abrupt curves.
- Any suitable geometry/structure can be used for implementing the printed transmission line affecting the antenna.
- If a ground plane is required in the line geometry, this plane must be continuous and sufficiently extended so the geometry can be as similar as possible to the related canonical model.
- Keep, if possible, at least one layer of the PCB used only for the ground plane. If possible, use this layer as reference ground plane for the transmission line.
- Surround the PCB transmission line with ground (on both sides). Avoid having other signal tracks facing the antenna line track directly.
- Avoid crossing any un-shielded transmission line footprint with other tracks on different layers.
- The ground surrounding the antenna line on the PCB must be strictly connected to the main Ground plane by means of via-holes (once per 2 mm at least) placed close to the ground edges facing the line track.
- Place EM-noisy devices as far as possible from LE910Cx antenna line.
- Keep the antenna line far away from the LE910Cx power supply lines.
- If EM-noisy devices are present on the PCB hosting the LE910Cx, such as fast switching ICs, take care to shield them with a metal frame cover.

- If EM-noisy devices are not present around the line, geometries like Micro strip or Grounded Coplanar Waveguide are preferred because they typically ensure less attenuation compared to a Strip line having the same length.

7.3. GSM/WCDMA/LTE Antenna – Installation Guidelines

- Install the antenna in a location with access to the network radio signal.
- The antenna must be installed such that it provides a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.
- The antenna must not be installed inside metal cases.
- The antenna must be installed according to the antenna manufacturer's instructions.

7.4. Antenna Diversity Requirements

This product includes an input for a second Rx antenna to improve radio sensitivity. The function is called Antenna Diversity.

Table 20: Antenna Diversity Requirements

Frequency range	The customer must use the most suitable antenna band width for covering the frequency bands provided by the network operator and also supported by the car OEM while using the Telit module. The bands supported by each variant of the LE910Cx module family are provided in Section 2.6.1, RF Bands per Regional Variant
Impedance	50Ω
VSWR recommended	≤ 2:1

Since there is no antenna connector on the LE910Cx module, the antenna must be connected to the LE910Cx diversity antenna pad (F1) by means of a transmission line implemented on the PCB.

If the antenna is not directly connected at the antenna pad of the LE910Cx, a PCB line is required to connect to it or to its connector.

The second Rx antenna must not be located in close vicinity of the main antenna. To improve diversity gain and isolation and to reduce mutual interaction, the two antennas should be located at the maximum reciprocal distance possible, taking into consideration the available space within the application.

NOTE:

If Rx Diversity is not used/connected, disable the Diversity functionality using the AT#RXDIV command (refer to the AT User guide) and leave the Diversity pad F1 unconnected.

7.5. GNSS Antenna Requirements

LE910Cx supports an active antenna.

It is recommended to use antennas as follow:

- An external active antenna (GPS only)
- An external active antenna plus GNSS pre-filter

NOTE:

The external GNSS pre-filter is required for the GLONASS application.

The GNSS pre-filter must meet the following requirements:

Source and load impedance = 50 Ohm

- Insertion loss (1575.42–1576.42 MHz) = 1.4 dB (Max)
- Insertion loss (1565.42–1585.42 MHz) = 2.0 dB (Max)
- Insertion loss (1597.5515–1605.886 MHz) = 2.0 dB (Max)

NOTE:

It is recommended to add a DC block to the customer’s GPS application to prevent damage to the LE910Cx module due to unwanted DC voltage.

7.5.1. Combined GNSS Antenna

The use of a combined RF/GNSS antenna is NOT recommended. This solution can generate an extremely poor GNSS reception. In addition, the combination of antennas requires an additional diplexer, which adds significant power loss in the RF path.

7.5.2. Linear and Patch GNSS Antenna

Using this type of antenna introduces at least 3 dB of loss compared to a circularly polarized (CP) antenna. Having a spherical gain response instead of a hemispherical gain response can aggravate the multipath behavior and create poor position accuracy.

7.5.3. Front End Design Considerations

Since there is no antenna connector on the LE910Cx module, the antenna must be connected to the LE910Cx through the PCB to the antenna pad.

If the antenna is not directly connected at the antenna pad of the LE910Cx, a PCB line is required.

This line of transmission must meet the following requirements:

Table 21: Antenna Line on PCB Requirements

Characteristic impedance	50 Ohm
Max attenuation	0.3 dB
Avoid coupling with other signals.	
Cold End (Ground Plane) of the antenna must be equipotential to the LE910Cx ground pads.	

Furthermore, if the device is developed for the US and/or Canada market, it must comply with the FCC and/or IC requirements.

This device is to be used only for mobile and fixed application.

7.5.4. GNSS Antenna – PCB Line Guidelines

- Ensure that the antenna line impedance is 50 Ohm.
- Keep the line on the PCB as short as possible to reduce the loss.
- The antenna line must have uniform characteristics, constant cross section, avoiding meanders and abrupt curves.
- Keep one layer of the PCB used only for the Ground plane; if possible.
- Surround (on the sides, over and under) the antenna line on the PCB with Ground. Avoid having other signal tracks directly facing the antenna line track.
- The Ground around the antenna line on the PCB must be strictly connected to the main Ground plane by placing vias at least once per 2mm.
- Place EM-noisy devices as far as possible from LE910Cx antenna line.
- Keep the antenna line far away from the LE910Cx power supply lines.
- If EM-noisy devices are around the PCB hosting the LE910Cx, such as fast switching ICs, ensure shielding the antenna line by burying it inside the layers of PCB and surrounding it with Ground planes; or shield it with a metal frame cover.
- If you do not have EM-noisy devices around the PCB of LE910Cx, use a Micro strip line on the surface copper layer for the antenna line. The line attenuation will be lower than a buried one.

7.5.5. GNSS Antenna – Installation Guidelines

- The LE910Cx, due to its sensitivity characteristics, is capable of performing a fix inside buildings. (In any case, the sensitivity could be affected by the building characteristics i.e. shielding.)
- The antenna must not be co-located or operating in conjunction with any other antenna or transmitter.
- The antenna must not be installed inside metal cases.
- The antenna must be installed according to the antenna manufacturer’s instructions.

8. Hardware Interfaces

Table 22 summarizes all the hardware interfaces of the LE910Cx module.

Table 22: LE910Cx Hardware Interfaces

Interface	LE910Cx
SGMII	For Ethernet support
HSIC	x1
SD/MMC	x1 dual voltage interface for supporting SD/MMC card
SDIO	For WIFI support (1.8V only)
USB	USB2.0, OTG support
SPI	Master only, up to 50 MHz
I2C	For sensors, audio control
UART	2 HS-UART (up to 4 Mbps)
Audio I/F	I2S/PCM, Analog I/O
GPIO	10 ~ 27 (10 dedicated + 17 multiplexed with other signals)
USIM	x2, dual voltage each (1.8V/2.85V)
ADC	Up to x3
Antenna ports	2 for Cellular, 1 for GNSS

8.1. USB Port

The LE910Cx module includes a Universal Serial Bus (USB) transceiver, which operates at USB high-speed (480 Mbits/sec). It can also operate with USB full-speed hosts (12 Mbits/sec).

It is compliant with the USB 2.0 specification and can be used for control and data transfers as well as for diagnostic monitoring and firmware update.

The USB port is typically the main interface between the LE910Cx module and OEM hardware.

NOTE:

The USB_D+ and USB_D- signals have a clock rate of 480 MHz. The signal traces must be routed carefully. Minimize trace lengths, number of vias, and capacitive loading. The impedance value should be as close as possible to 90 Ohms differential.

Table 23 lists the USB interface signals.

Table 23: USB Interface Signals

Signal	Pad No	Usage
USB_VBUS	A13	Power and cable detection for the internal USB transceiver. Acceptable input voltage range 2.5V – 5.5V @ max 5 mA consumption
USB_D-	C15	Minus (-) line of the differential, bi-directional USB signal to/from the peripheral device
USB_D+	B15	Plus (+) line of the differential, bi-directional USB signal to/from the peripheral device
USB_ID	A14	Used for USB OTG in order to determine host or client mode

NOTE:

USB_VBUS input power is internally used to detect the USB port and start the enumeration process. It is not used for supplying power to the internal LE910Cx USB HW block. Therefore, only a maximum of 5 mA is required.

NOTE:

Even if USB communication is not used, it is still highly recommended to place an optional USB connector on the application board.

At least test points of the USB signals are required since the USB physical communication is needed in the case of SW update.

NOTE

An external 5V power supply is required on the application board for supporting USB OTG

8.2. HSIC Interface

The application processor exposes a High-Speed Inter-Chip (HSIC). HSIC eliminates the analog transceiver from a USB interface for lower voltage operation and reduced power dissipation.

- High-speed 480 Mbps (240 MHz DDR) USB transfers are 100% host driver compatible with traditional USB cable connected topologies
- Bidirectional data strobe signal (STROBE)
- Bidirectional data signal (DATA)
- No power consumption unless a transfer is in progress

Further details will be provided in a future release of this document.

8.3. SGMII Interface (optional)

The SOC optionally includes an integrated Ethernet MAC with an SGMII interface, having the following key features:

- The SGMII interface can be used connect to an external Ethernet PHY, or an external switch.
- When enabled, an additional network interface will be available to the Linux kernel’s router.

Further details will be provided in a future release of this document.

8.4. Serial Ports

The serial port is typically a secondary interface between the LE910Cx module and OEM hardware. Two serial ports are available on the module:

- MODEM SERIAL PORT 1(Main)
- MODEM SERIAL PORT 2 (Auxiliary)

Several configurations can be designed for the serial port on the OEM hardware. The most common are:

- RS232 PC com port
- Microcontroller UART @ 1.8V (Universal Asynchronous Receive Transmit)
- Microcontroller UART @ 3.3V/5V or other voltages different from 1.8V

Depending on the type of serial port on the OEM hardware, a level translator circuit may be needed to make the system operate. The only configuration that does not need level translation is the 1.8V UART.

The levels for LE910Cx UART are the CMOS levels as described in Section 4.3, Logic Level Specifications.

8.4.1. Modem Serial Port 1 Signals

Serial Port 1 on LE910Cx is a +1.8V UART with 7 RS232 signals. It differs from the PC-RS232 in signal polarity (RS232 is reversed) and levels.

Table 24 lists the signals of LE910Cx Serial Port 1.

Table 24: Modem Serial Port 1 Signals

RS232 Pin No.	Signal	LE910Cx Pad No.	Name	Usage
1	DCD - DCD_UART	N14	Data Carrier Detect	Output from the LE910Cx that indicates carrier presence
2	RXD - TX_UART	M15	Transmit line *see Note	Output transmit line of the LE910Cx UART
3	TXD - RX_UART	N15	Receive line *see Note	Input receive line of the LE910Cx UART
4	DTR - DTR_UART	M14	Data Terminal Ready	Input to LE910Cx that controls the DTE READY condition
5	GND	A2, B13, D4…	Ground	Ground
6	DSR - DSR_UART	P14	Data Set Ready	Output from the LE910Cx that indicates that the module is ready
7	RTS - RTS_UART	L14	Request to Send	Input to LE910Cx controlling the Hardware flow control
8	CTS - CTS_UART	P15	Clear to Send	Output from LE910Cx controlling the Hardware flow control
9	RI - RI_UART	R14	Ring Indicator	Output from LE910Cx indicating the Incoming call condition

NOTE:

DCD, DTR, DSR, RI signals that are not used for UART functions can be configured as GPIO using AT commands.

NOTE:

To avoid a back-powering effect, it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when it is powered OFF or during an ON/OFF transition.

NOTE:

For minimum implementations, only the TXD and RXD lines need be connected. The other lines can be left open provided a software flow control is implemented.

NOTE:

According to V.24, Rx/Tx signal names refer to the application side; therefore, on the LE910Cx side, these signal are in the opposite direction: TXD on the application side will be connected to the receive line (here named TXD/ RX_UART) of the LE910Cx serial port and vice versa for Rx.

8.4.2. Modem Serial Port 2

Serial Port 2 on the LE910Cx is a +1.8V UART with RX and TX signals only.

The UART functionality is shared with SPI thus simultaneous of SPI and UART is not supported.

The below table lists the signals of LE910Cx Serial Port 2.

Table 25 Modem Serial Port 2 Signals

PAD	Signal	I/O	Function	Type	COMMENT
D15	TX_AUX	O	Auxiliary UART (Tx Data to DTE)	1.8V	Shared with SPI_MOSI
E15	RX_AUX	I	Auxiliary UART (Rx Data to DTE)	1.8V	Shared with SPI_MISO

NOTE:

To avoid a back-powering effect, it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when it is powered OFF or during an ON/OFF transition.

NOTE:

The Auxiliary UART is used as the SW main debug console. It is required to place test points on this interface even if not used.

8.4.3. RS232 Level Translation

To interface the LE910Cx with a PC com port or a RS232 (EIA/TIA-232) application, a level translator is required. This level translator must:

- Invert the electrical signal in both directions
- Change the level from 0/1.8V to +15/-15V

The RS232 UART 16450, 16550, 16650 & 16750 chipsets accept signals with lower levels on the RS232 side (EIA/TIA-562), allowing a lower voltage-multiplying ratio on the level translator. Note that the negative signal voltage must be less than 0V and hence some sort of level translation is always required.

The simplest way to translate the levels and invert the signal is by using a single chip-level translator. There are a multitude of them, differing in the number of drivers and receivers and in the levels (be sure to get a true RS232 level translator, not a RS485 or other standards).

By convention, the driver is the level translator from the 0-1.8V UART to the RS232 level. The receiver is the translator from the RS232 level to 0-1.8V UART.

To translate the whole set of control lines of the UART, the following is required:

- 2 drivers
- 2 receivers

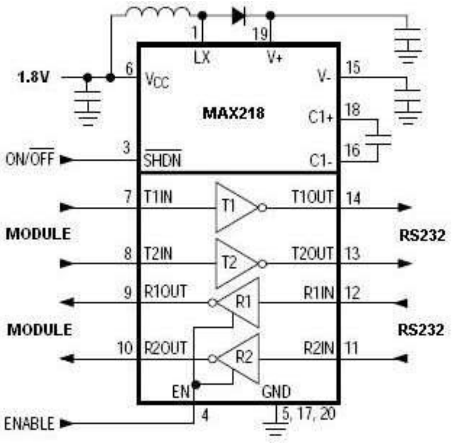
NOTE:

The digital input lines operating at 1.8V CMOS have an absolute maximum input voltage of 2.7V. Therefore, the level translator IC must not be powered by the +3.8V supply of the module. Instead, it must be powered from a dedicated +1.8V power supply.

An example of RS232 level adaption circuitry could use a MAXIM transceiver (MAX218).

In this case, the chipset is capable of translating directly from 1.8V to the RS232 levels (Example on 4 signals only).

Figure 13: RS232 Level Adaption Circuitry Example

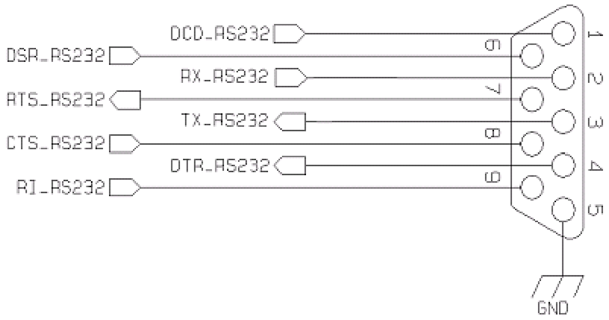


NOTE:

In this case, the length of the lines on the application must be taken into account to avoid problems in the case of High-speed rates on RS232.

The RS232 serial port lines are usually connected to a DB9 connector as shown in Figure 14. Signal names and directions are named and defined from the DTE point of view.

Figure 14: RS232 Serial Port Lines Connection Layout



8.5. Peripheral Ports

In addition to the LE910Cx serial ports, the LE910Cx supports the following peripheral ports:

- SPI – Serial Peripheral Interface
- I2C - Inter-integrated circuit
- SD/MMC Card Interface
- SDIO Interface

8.5.1. SPI – Serial Peripheral Interface

The LE910Cx SPI supports the following:

- Master Mode only
- 1.8V CMOS level
- Up to 50 MHz clock rate

NOTE:

SPI is supported only on the Linux side.

The LE910Cx module supports Master mode only and cannot be configured as Slave mode.

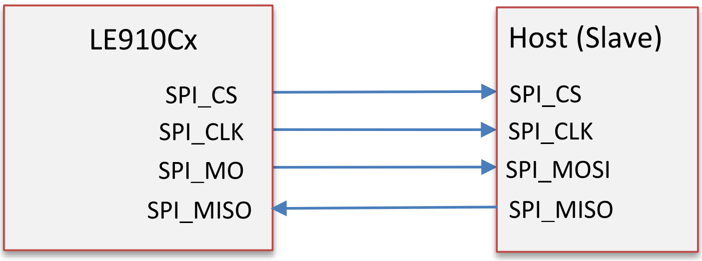
NOTE:

Simultaneous / Concurrent usage of AUX UART and SPI is not supported.

Table 26: SPI Signals

PAD	Signal	I/O	Function	Type	Comment
F15	SPI_CLK	O	SPI clock output	1.8V	
E15	SPI_MISO	I	SPI data Master input Slave output	1.8V	Shared with RX_AUX
D15	SPI_MOSI	O	SPI data Master output Slave input	1.8V	Shared with TX_AUX
H14	SPI_CS/GPIO11	O	SPI chip-select output	1.8V	

Figure 15: SPI Signal Connectivity



8.5.2. I2C - Inter-integrated Circuit

The LE910Cx supports an I2C interface on the following pins:

- B11 - I2C_SCL
- B10 - I2C_SDA

The I2C can also be used externally by the end customer application.

In addition, SW emulated I2C functionality can be used on GPIO 1-10 pins.

Any GPIO (among GPIO 1-10) can be configured as SCL or SDA.

LE910Cx supports I2C Master Mode only.

NOTE:

SW emulated I2C on GPIO lines is supported only from the Modem side.

For more information, refer to the LE910Cx AT SW manual for command settings.

8.5.3. SD/MMC Card Interface

The LE910Cx provides an SD port supporting the SD3.0 specification, which can be used to support standard SD/MMC memory cards with the following features:

- Interface with SD/MMC memory cards up to 2 TB
- Max clock @ 2.95V - 50 MHz SDR
- Max Data: 25 MB/s
- SD standard: HS-SDR25 at 2.95V
- Max clock @ 1.8V - 200 MHz SDR
- Max Data: 100 MB/s
- SD standard: UHS-SDR104 at 1.8 V
- Max clock @ 1.8V - 50 MHz DDR
- Max Data: 50 MB/s
- SD standard: UHS-DDR50 at 1.8 V

Table 27 lists the LE910Cx SD card signals.

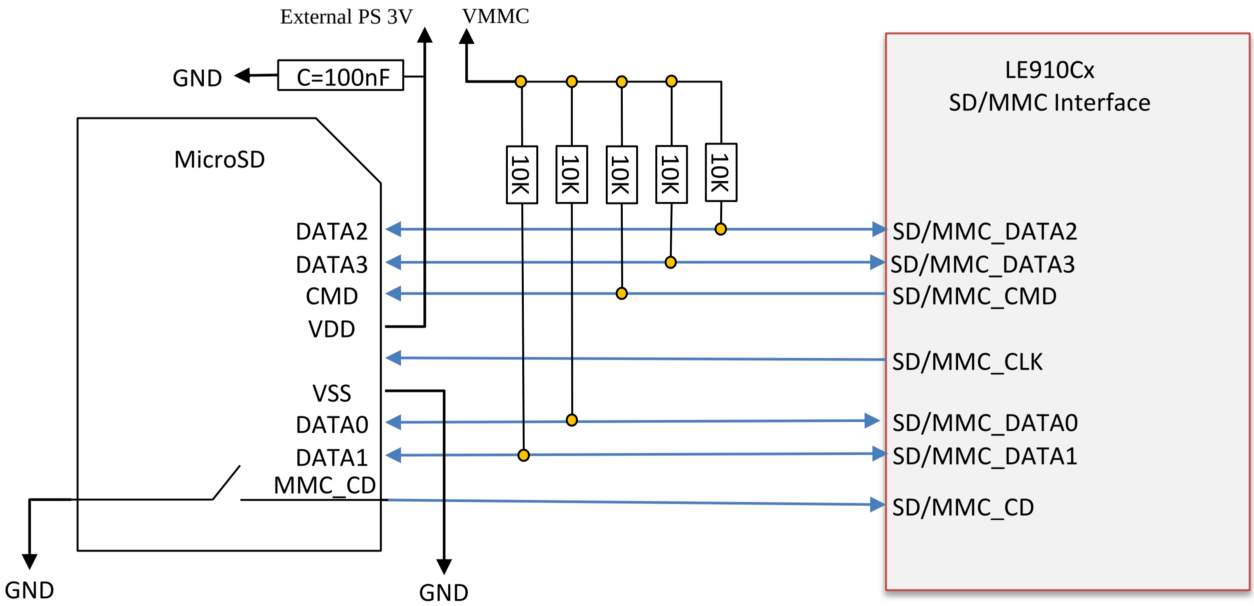
Table 27: SD Card Signals

PAD	Signal	I/O	Function	Type	Comments
J12	SD/MMC_CMD	O	SD command	1.8/2.95V	
F12	SD/MMC_CLK	O	SD card clock	1.8/2.95V	

PAD	Signal	I/O	Function	Type	Comments
E12	SD/MMC_DATA0	I/O	SD Serial Data 0	1.8/2.95V	
G12	SD/MMC_DATA1	I/O	SD Serial Data 1	1.8/2.95V	
K12	SD/MMC_DATA2	I/O	SD Serial Data 2	1.8/2.95V	
H12	SD/MMC_DATA3	I/O	SD Serial Data 3	1.8/2.95V	
G13	SD/MMC_CD	I	SD card detect input	1.8V	Active Low
F13	VMMC	-	Power supply for MMC card pull-up resistors	1.8/2.95V	Max Current is 50mA

Figure 16 shows the recommended connection diagram of the SD interface.

Figure 16: SD/MMC Interface Connectivity



NOTE:

SD/MMC is supported only on the Linux side.

The power supply to the SD/MMC card is to be provided by the Host application board. The LE910Cx does not provide a dedicated power supply for the SD/MMC card.

VMMC Supply is limited to 50mA thus can only supply the MMC card external pull-up resistors.

Pull-up resistors must be placed on the host application board.

The card detection input has an internal pull-up resistor.

VMMC can be used for enabling of the external power supply (LDO Enable signal)

8.5.4. WiFi SDIO Interface

The LE910Cx provides an SDIO port supporting the SDIO3.0 specification, which can be used to interface with a WiFi chipset (Qualcomm QCA6574 chipset or other WiFi solutions)

The LE910Cx module includes an integrated SW driver for supporting the Qualcomm QCA6574 chipset

The LE910Cx SDIO port supports the SDIO 3.0 specification at 1.8V CMOS only, thus cannot be used as an external SD/MMC card connection.

The LE910Cx module supports an LTE/WiFi coexistence mechanism via the WCI (Wireless Coexistence Interface) port, which connects between the module and the external WiFi IC.

For a detailed explanation, refer to Ref 6:

Table 28: WiFi SDIO Interface Signals

PAD	Signal	I/O	Function	Type	Comments
N13	WIFI_SD_CMD	O	WiFi SD Command	1.8V	
L13	WIFI_SD_CLK	O	WiFi SD Clock	1.8V	200 MHz max.
J13	WIFI_SD_DATA0	I/O	WiFi SD Serial Data 0	1.8V	
M13	WIFI_SD_DATA1	I/O	WiFi SD Serial Data 1	1.8V	
K13	WIFI_SD_DATA2	I/O	WiFi SD Serial Data 2	1.8V	
H13	WIFI_SD_DATA3	I/O	WiFi SD Serial Data 3	1.8V	
L12	WIFI_SDRST	O	WiFi Reset / Power enable control	1.8V	Active Low
M8	WCI_TX	O	Wireless coexistence interface TXD	1.8V	
M9	WCI_RX	I	Wireless coexistence interface RXD	1.8V	

NOTE:

It is recommended that WiFi_SDRST be equipped with a pull-up resistor to 1.8V on the host application to disable WiFi reset function if needed.

8.6. Audio Interface

The LE910Cx module support digital audio interface.

8.6.1. Digital Audio

The LE910Cx module can be connected to an external codec through the digital interface.

The product provides a single Digital Audio Interface (DVI) on the following pins:

Table 29: Digital Audio Interface (DVI) Signals

PAD	Signal	I/O	Function	Type	COMMENT
B9	DVI_WAO	O	Digital Audio Interface (WAO)	B-PD 1.8V	PCM_SYNC
B6	DVI_RX	I	Digital Audio Interface (RX)	B-PD 1.8V	PCM_DIN
B7	DVI_TX	O	Digital Audio Interface (TX)	B-PD 1.8V	PCM_DOUT
B8	DVI_CLK	O	Digital Audio Interface (CLK)	B-PD 1.8V	PCM_CLK
B12	REF_CLK	O	Audio Master Clock	B-PD 1.8V	I2S_MCLK

LE910Cx DVI has the following characteristics:

- PCM Master mode using short or long frame sync modes
- 16 bit linear PCM format
- PCM clock rates of 256 kHz, 512 kHz, 1024 kHz and 2048 kHz (Default)
- Frame size of 8, 16, 32, 64, 128 & 256 bits per frame
- Sample rates of 8 kHz and 16 kHz

In addition to the DVI port, the LE910Cx module provides a master clock signal (REF_CLK on Pin B12) which can either provide a reference clock to an external codec or form an I2S interface together with the DVI port where the REF_CLK acts as the I2S_MCLK.

The REF_CLK default frequency is 12.288 MHz.

When using the DVI with REF_CLK as an I2S interface, 12.288 MHz is 256 x fs (where fs = 48 kHz)

8.6.1.1. Short Frame Timing Diagrams

Figure 17: Primary PCM Timing

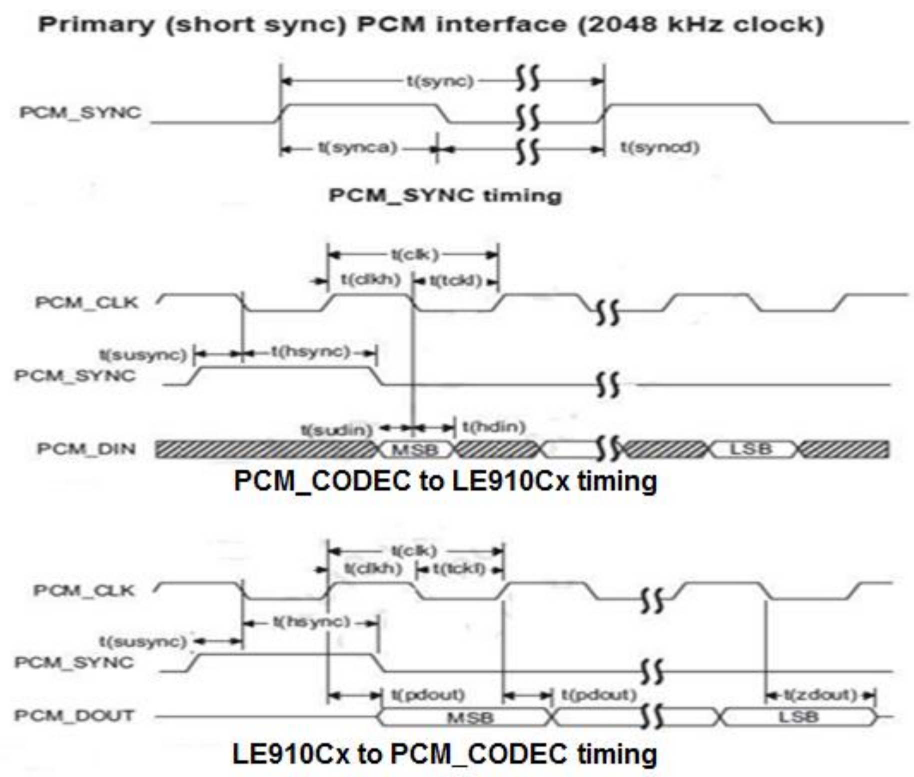
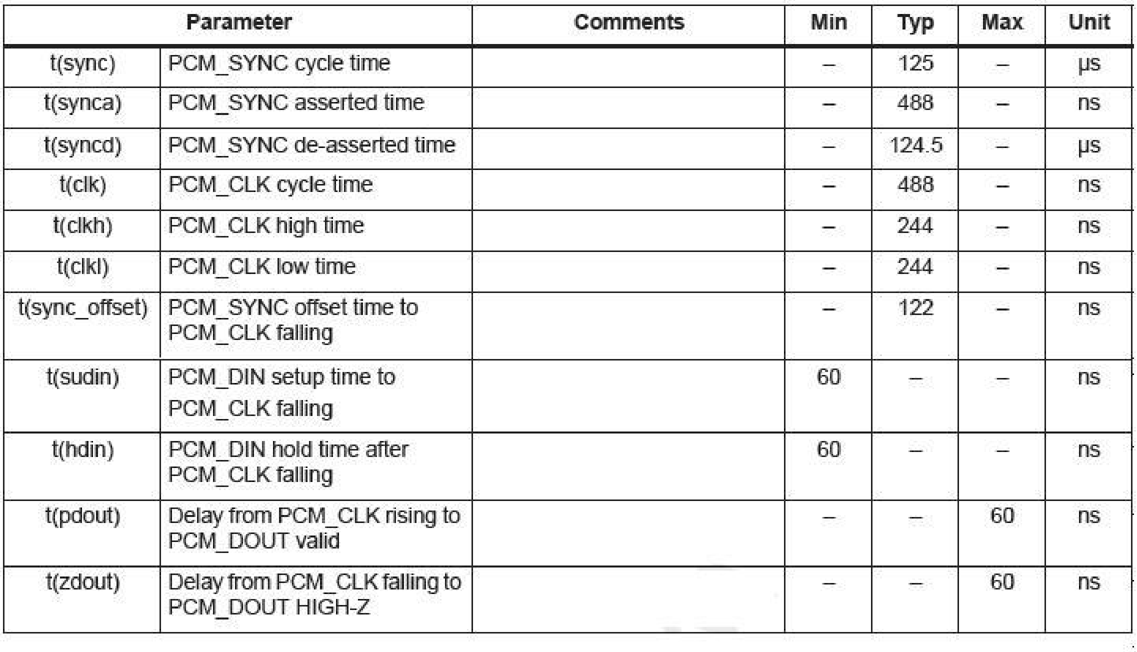


Table 30: PCM_CODEC Timing Parameters



Parameter		Comments	Min	Typ	Max	Unit
t(sync)	PCM_SYNC cycle time		–	125	–	µs
t(synca)	PCM_SYNC asserted time		–	488	–	ns
t(syncd)	PCM_SYNC de-asserted time		–	124.5	–	µs
t(clk)	PCM_CLK cycle time		–	488	–	ns
t(clkh)	PCM_CLK high time		–	244	–	ns
t(clkl)	PCM_CLK low time		–	244	–	ns
t(sync_offset)	PCM_SYNC offset time to PCM_CLK falling		–	122	–	ns
t(sudin)	PCM_DIN setup time to PCM_CLK falling		60	–	–	ns
t(hdin)	PCM_DIN hold time after PCM_CLK falling		60	–	–	ns
t(pdout)	Delay from PCM_CLK rising to PCM_DOUT valid		–	–	60	ns
t(zdout)	Delay from PCM_CLK falling to PCM_DOUT HIGH-Z		–	–	60	ns

8.6.1.2. Long Frame Timing Diagrams

Figure 18: Auxiliary PCM Timing

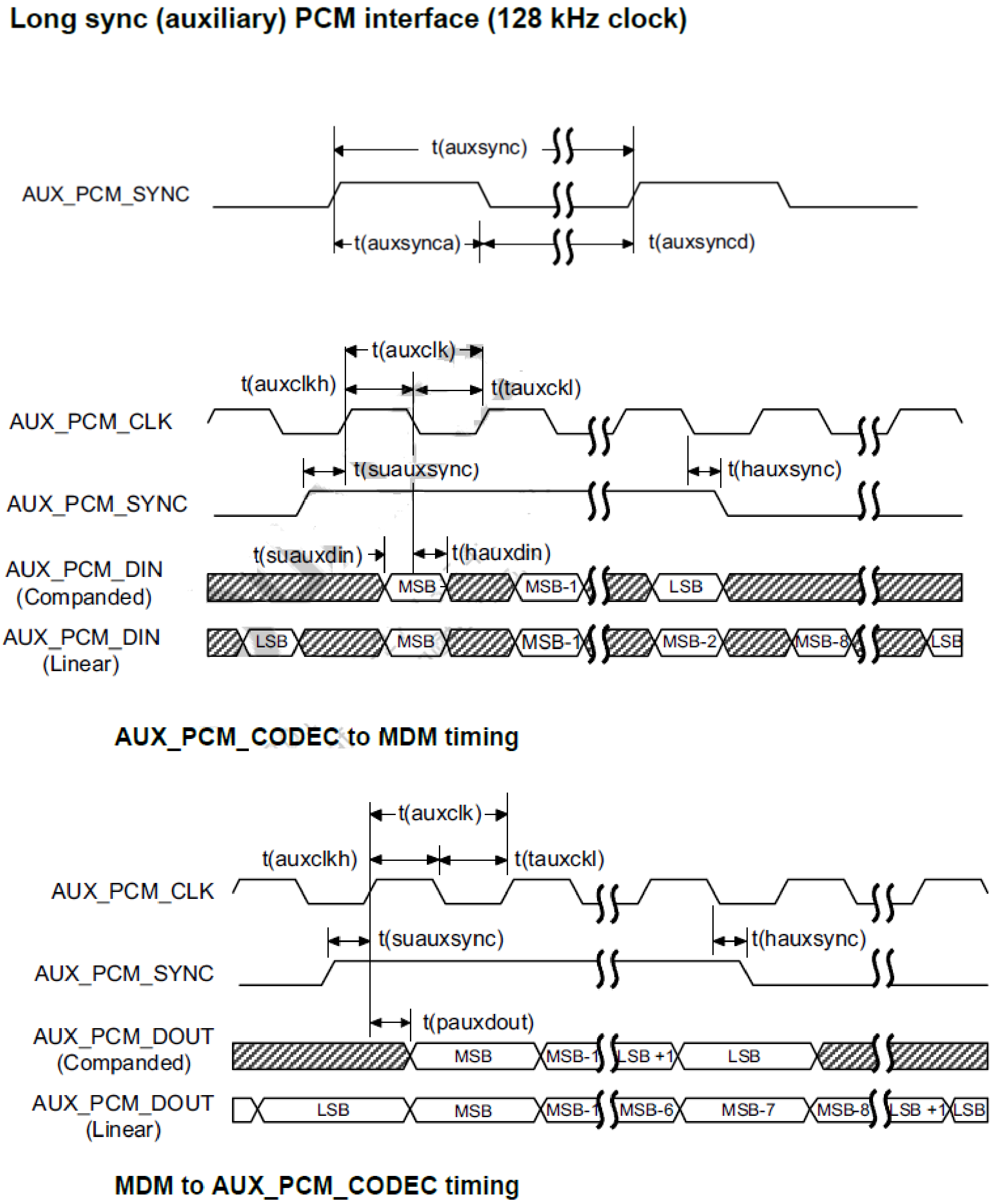
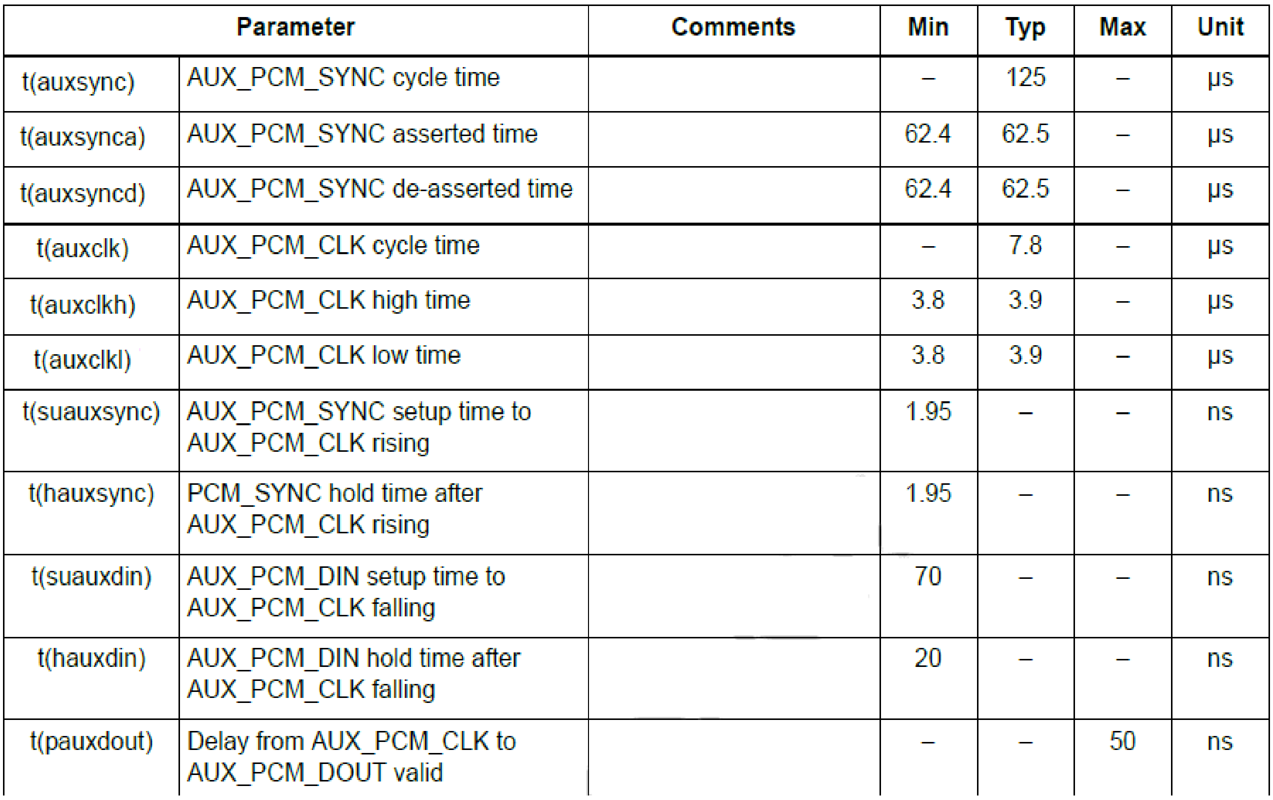


Table 31: AUX_PCM_CODEC Timing Parameters



Parameter		Comments	Min	Typ	Max	Unit
t(auxsync)	AUX_PCM_SYNC cycle time		–	125	–	µs
t(auxsynca)	AUX_PCM_SYNC asserted time		62.4	62.5	–	µs
t(auxsyncd)	AUX_PCM_SYNC de-asserted time		62.4	62.5	–	µs
t(auxclk)	AUX_PCM_CLK cycle time		–	7.8	–	µs
t(auxclkh)	AUX_PCM_CLK high time		3.8	3.9	–	µs
t(auxclkl)	AUX_PCM_CLK low time		3.8	3.9	–	µs
t(suauxsync)	AUX_PCM_SYNC setup time to AUX_PCM_CLK rising		1.95	–	–	ns
t(hauxsync)	PCM_SYNC hold time after AUX_PCM_CLK rising		1.95	–	–	ns
t(suauxdin)	AUX_PCM_DIN setup time to AUX_PCM_CLK falling		70	–	–	ns
t(hauxdin)	AUX_PCM_DIN hold time after AUX_PCM_CLK falling		20	–	–	ns
t(pauxdout)	Delay from AUX_PCM_CLK to AUX_PCM_DOUT valid		–	–	50	ns

8.7. General Purpose I/O

The general-purpose I/O pads can be configured to act in three different ways:

- Input
- Output
- Alternate function (internally controlled)

Input pads can only be read and report digital values (high or low) present on the pad at the read time. Output pads can only be written or queried and set the value of the pad output. An alternate function pad is internally controlled by LE910Cx firmware and acts depending on the implemented function.

The following GPIOs are always available as a primary function on the LE910Cx.

Table 32: Primary GPIOs

PAD	Signal	I/O	Function	Type	Drive Strength
C8	GPIO_01	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
C9	GPIO_02	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
C10	GPIO_03	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
C11	GPIO_04	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
B14	GPIO_05	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
C12	GPIO_06	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
C13	GPIO_07	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
K15	GPIO_08	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
L15	GPIO_09	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
G15	GPIO_10	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA

The additional GPIOs below can be used in case their initial functionality is not used:

PAD	Signal	I/O	Initial Function	Alternate Function	Type	Drive Strength
L12	GPIO_13	I/O	WIFI_SDRST	Configurable GPIO	CMOS 1.8V	2-16 mA
N13	GPIO_14	I/O	WIFI_SDIO_CMD	Configurable GPIO	CMOS 1.8V	2-16 mA
J13	GPIO_15	I/O	WIFI_SDIO_D0	Configurable GPIO	CMOS 1.8V	2-16 mA
M13	GPIO_16	I/O	WIFI_SDIO_D1	Configurable GPIO	CMOS 1.8V	2-16 mA
K13	GPIO_17	I/O	WIFI_SDIO_D2	Configurable GPIO	CMOS 1.8V	2-16 mA
H13	GPIO_18	I/O	WIFI_SDIO_D3	Configurable GPIO	CMOS 1.8V	2-16 mA
L13	GPIO_19	I/O	WIFI_SDIO_CLK	Configurable GPIO	CMOS 1.8V	2-16 mA
M8	GPIO_24	I/O	WCI_TXD	Configurable GPIO	CMOS 1.8V	2-16 mA
M9	GPIO_25	I/O	WCI_RXD	Configurable GPIO	CMOS 1.8V	2-16 mA
R14	GPIO_31	I/O	UART_RI	Configurable GPIO	CMOS 1.8V	2-16 mA
P14	GPIO_32	I/O	UART_DSR	Configurable GPIO	CMOS 1.8V	2-16 mA
N14	GPIO_33	I/O	UART_DCD	Configurable GPIO	CMOS 1.8V	2-16 mA
M14	GPIO_34	I/O	UART_DTR	Configurable GPIO	CMOS 1.8V	2-16 mA
F15	GPIO_35	I/O	SPI_CLK	Configurable GPIO	CMOS 1.8V	2-16 mA
E15	GPIO_36	I/O	SPI_MISO	Configurable GPIO	CMOS 1.8V	2-16 mA
D15	GPIO_37	I/O	SPI_MOSI	Configurable GPIO	CMOS 1.8V	2-16 mA
H14	GPIO_11	I/O	SPI_CS	Configurable GPIO	CMOS 1.8V	2-16 mA

NOTE:

To avoid a back-powering effect, it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the module when it is powered OFF or during an ON/OFF transition.

NOTE:

LE910Cx GPIO 1~10 can also be used as alternate I2C function.

Refer to Section 0,

I2C - Inter-integrated Circuit.

8.7.1. Using a GPIO Pad as Input

GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 1.8V CMOS levels of the GPIO.

If the digital output of the device is connected with the GPIO input, the pad has interface levels different from the 1.8V CMOS. It can be buffered with an open collector transistor with a 47 kΩ pull-up resistor to 1.8V.

8.7.2. Using a GPIO Pad as an interrupt / Wakeup source

GPIO pads which are used as input can also be used as an interrupt source for the software.

In general all GPIO pads can be also used as interrupts.

However, not all GPIO’s can be used as a wakeup source of the module (wakeup from sleep)

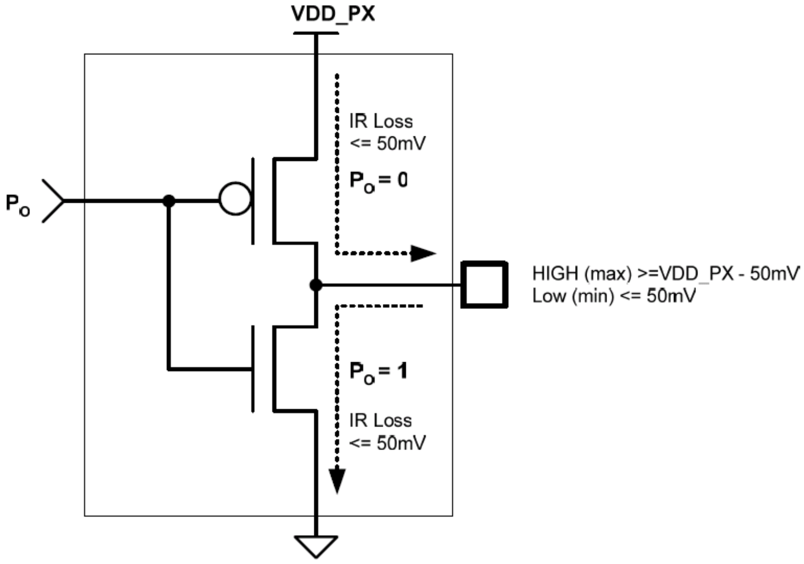
Only the following GPIO’s can be used for waking up the system from sleep

- GPIO1
- GPIO4
- GPIO5
- GPIO8

8.7.3. Using a GPIO Pad as Output

GPIO pads, when used as outputs, can drive 1.8V CMOS digital devices or compatible hardware. When set as outputs, the pads have a push-pull output, and therefore the pull-up resistor can be omitted.

Figure 19: GPIO Output Pad Equivalent Circuit



9. Miscellaneous Functions

9.1. Indication of Network Service Availability

The STAT_LED signal shows information on the network service availability and call status. In the LE910Cx modules, the STAT_LED usually needs an external transistor to drive an external LED.

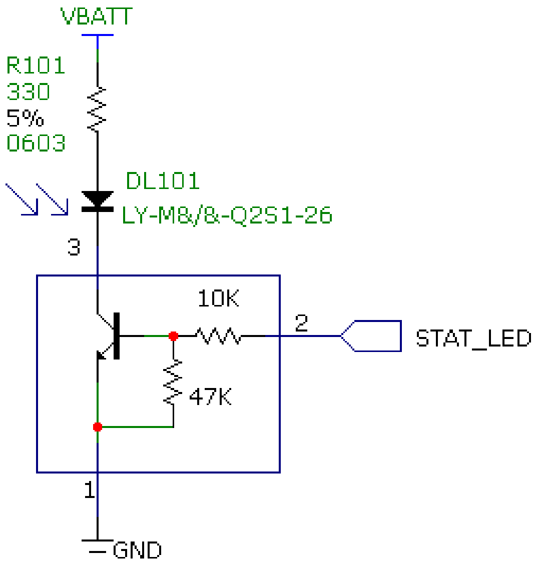
The STAT_LED does not have a dedicated pin. The STAT_LED functionality is available on GPIO_01 pin (by default GPIO_01 functions as STAT_LED)

The table below shows the device status corresponding to the pin status:

Table 33: Network Service Availability Indication

LED Status	Device Status
Permanently off	Device off
Fast blinking (Period 1s, T_{on} 0,5s)	Net search / Not registered / Turning off
Slow blinking (Period 3s, T_{on} 0,3s)	Registered full service
Permanently on	A call is active

Figure 20: Status LED Reference Circuit



9.2. Indication of Software Ready

The SW_RDY signal provides indication about the ability of the module to receive commands

As long as the SW_RDY is asserted low it indicates that the LE910Cx has not yet finished booting

Once the SW_RDY is asserted high, it indicates that the LE910Cx is ready to receive commands

The SW_RDY does not have a dedicated pin

The SW_RDY functionality is available on GPIO_08 pin (by default GPIO_08 functions as SW_RDY

9.3. RTC – Real Time Clock

The RTC within the LE910Cx module does not have a dedicated RTC supply pin.

The RTC block is supplied by the VBATT supply.

If the battery is removed, RTC is not maintained so if maintaining an internal RTC is needed, VBATT must be supplied continuously.

In Power OFF mode, the average current consumption is ~25uA.

9.4. VAUX Power Output

A regulated power supply output is provided to supply small devices from the module. This output is active when the module is ON and goes OFF when the module is shut down. The operating range characteristics of the supply are as follows:

Table 34: Operating Range – VAUX Power Supply

	Min	Typical	Max
Output voltage	1.75V	1.80V	1.85V
Output current			100 mA
Output bypass capacitor (inside the module)			1 µF

9.5. ADC Converter

9.5.1. Description

The LE910Cx module provides three 8-bit Analog to Digital converters. Each ADC reads the voltage level applied on the relevant pin, converts it, and stores it into an 8-bit word.

Table 35 shows the ADC characteristics.

Table 35: ADC Parameters

	Min	Max	Units
Input voltage range	0.1	1.7	Volt
AD conversion	-	8	bits
Resolution	-	< 6.6	mV

9.5.2. Using the ADC Converter

An AT command is available to use the ADC function.

The command is AT#ADC=1,2. The read value is expressed in mV.

Refer to LE9x0 AT Command User Guide 0 for the full description of this function.

9.6. Using the Temperature Monitor Function

The Temperature Monitor permits to control the module’s internal temperature and, if properly set (see the #TEMPMON command in LE9x0 AT Command User Guide(, raises a GPIO to High Logic level when the maximum temperature is reached.

9.7. GNSS Characteristics

The table below specifies the GNSS characteristics and expected performance

The values are related to typical environment and conditions Table 36 GNSS Characteristics

Parameters		**Typical Measurement**	**Notes**
Sensitivity	Standalone or MS Based Tracking Sensitivity	-162.3 dBm	
	Acquisition	-162.3 dBm	
	Cold Start Sensitivity	-157.5 dBm	
TTFF	Hot	1.1s	GPS+GLONASS Simulator test
	Warm	22.1s	GPS+GLONASS Simulator test
	Cold	29.94s	GPS+GLONASS Simulator test
Accuracy		0.8 m	GPS+GLONASS Simulator test
Min Navigation update rate		1Hz	
Dynamics		2g	
A-GPS		Supported	

10. Mounting the Module on your Board

10.1. General

The LE910Cx module was designed to be compliant with a standard lead-free SMT process.

10.2. Finishing & Dimensions

Figure 21 shows the mechanical dimensions of the LE910Cx module.

Figure 21: LE910Cx Mechanical Dimensions (bottom view)

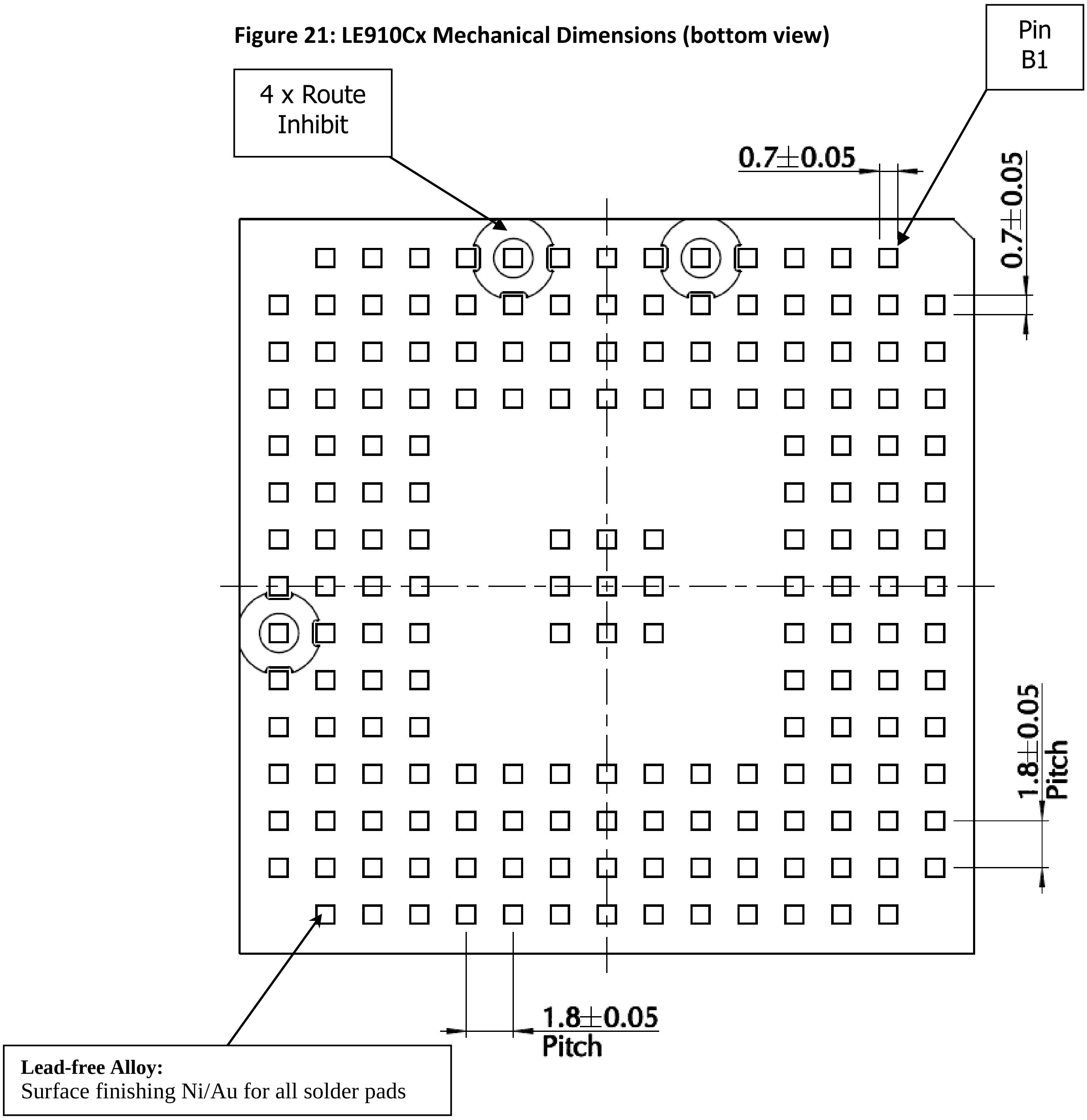


Figure 22: LE910Cx Mechanical Dimensions (Top view)

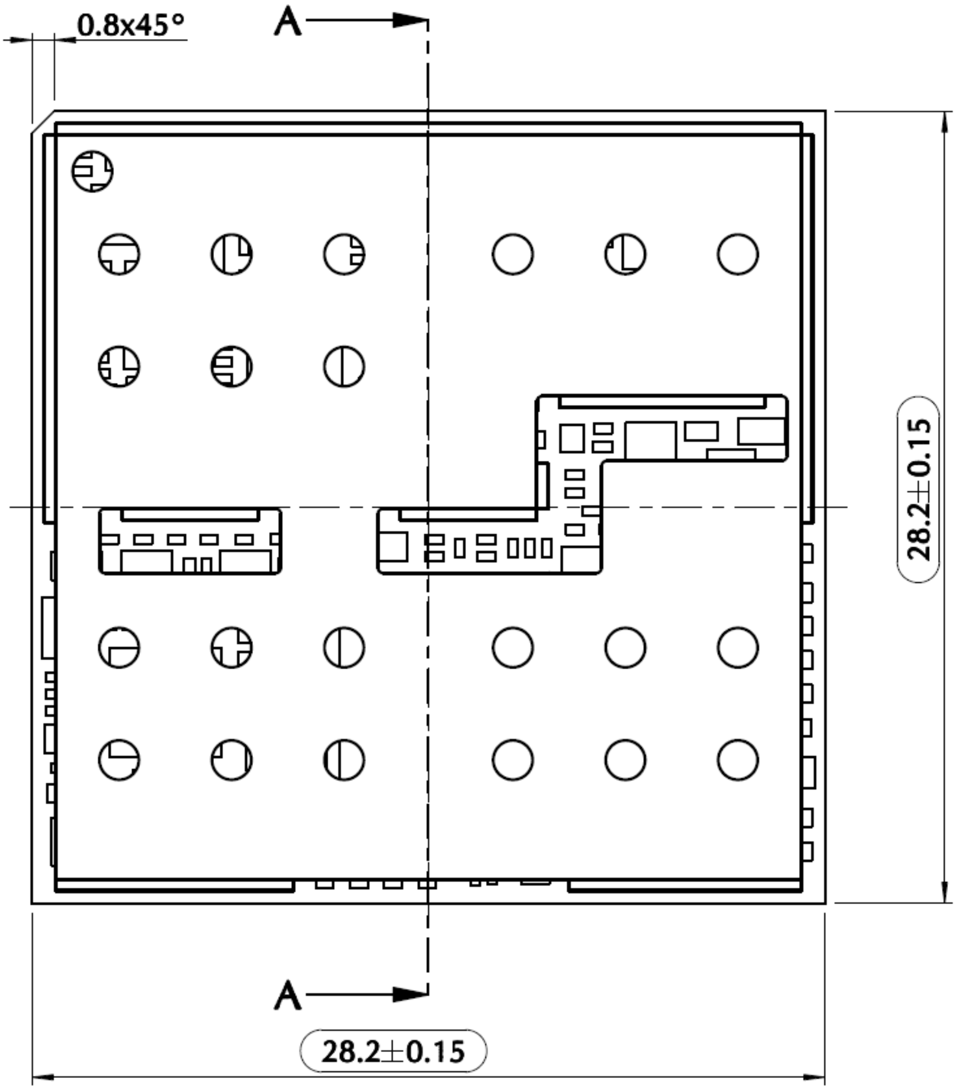
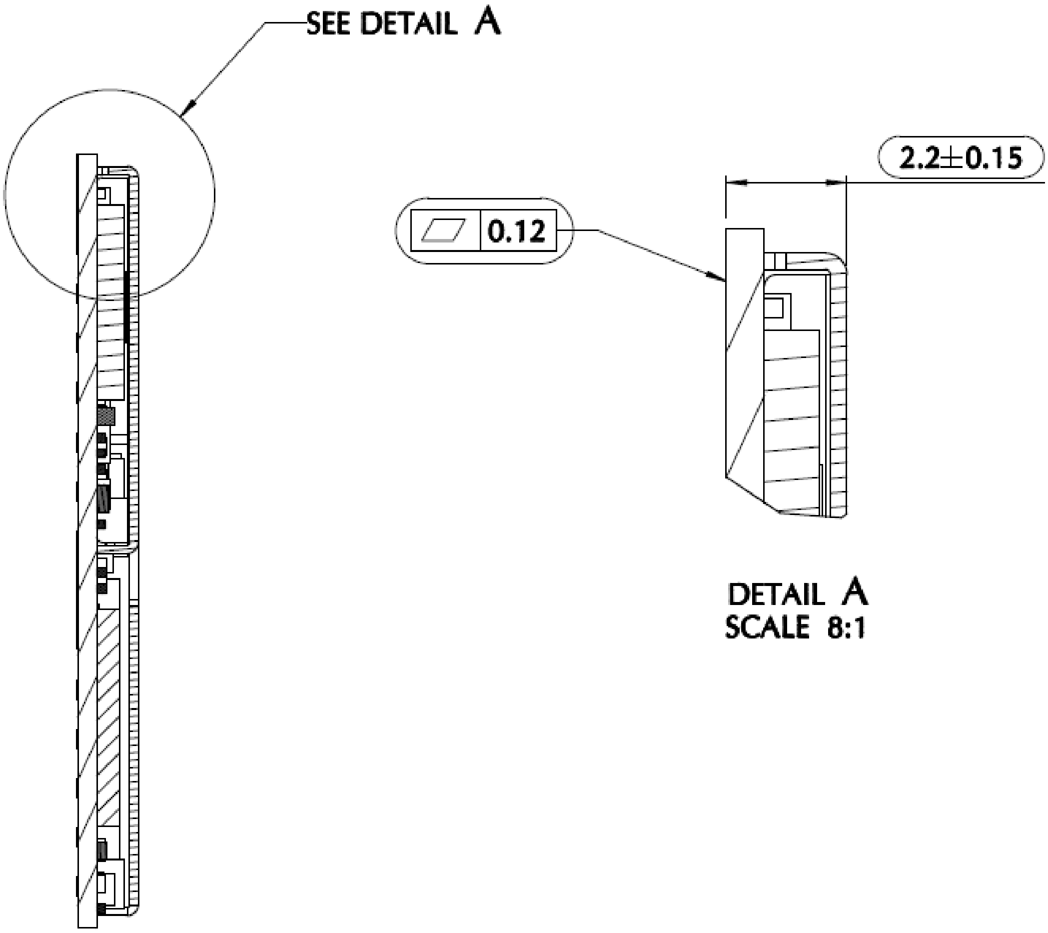


Figure 23: LE910Cx Mechanical Dimensions (Side view)



10.3. Recommended Footprint for the Application

Figure 24 shows the recommended footprint for the application board (dimensions are in mm).

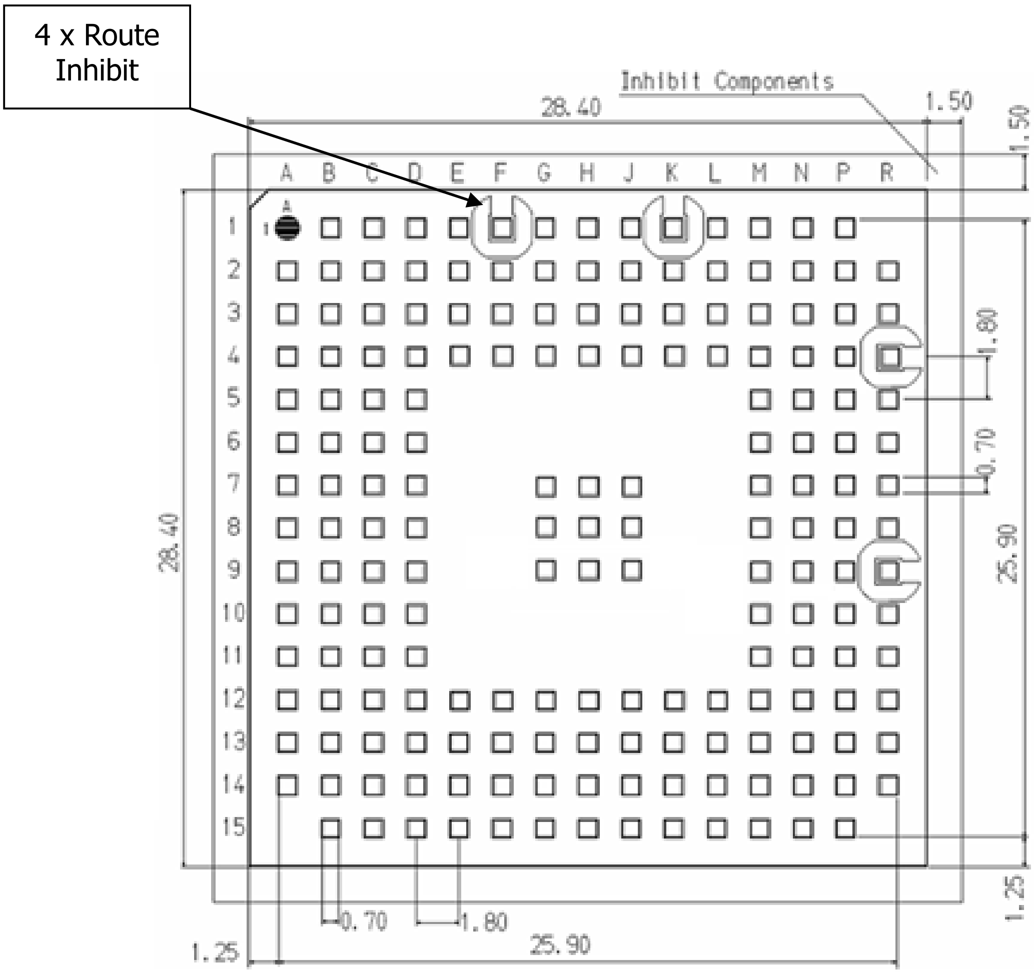
To facilitate replacing the LE910Cx module if necessary, it is suggested to design the application with a 1.5 mm placement inhibit area around the module.

It is also suggested, as a common rule for an SMT component, to avoid having a mechanical part of the application in direct contact with the module.

NOTE:

In the customer application, the region marked as INHIBIT in Figure 24 must be clear of any signal wiring or ground polygons.

Figure 24: Recommended Footprint - Top View, 181 pads (dimensions are in mm, top view).



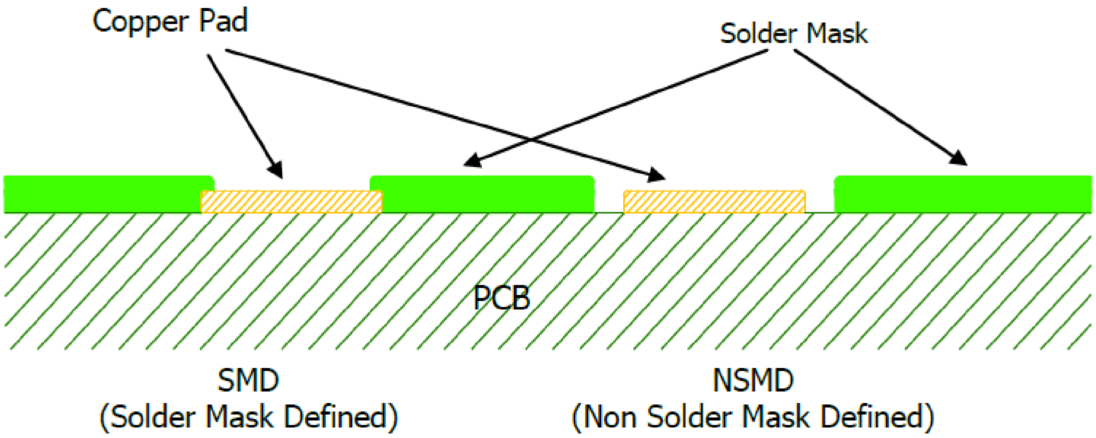
10.4. Stencil

Stencil’s apertures layout can be the same as the recommended footprint (1:1). The suggested thickness of stencil foil is greater than 120 µm.

10.5. PCB Pad Design

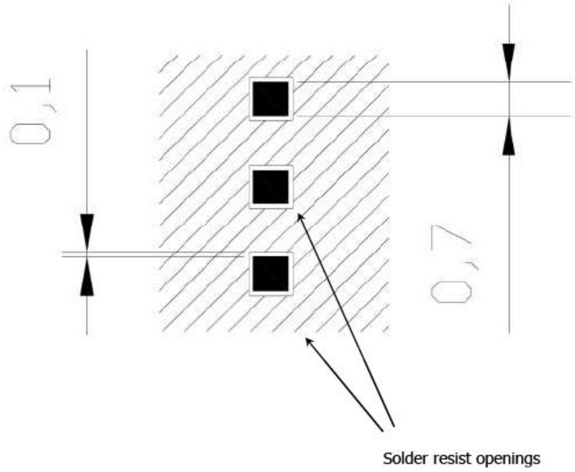
The solder pads on the PCB are recommended to be of the Non Solder Mask Defined (NSMD) type.

Figure 25: PCB Pad Design



10.6. Recommendations for PCB Pad Dimensions (mm)

Figure 26: PCB Pad Dimensions



It is not recommended to place around the pads a via or micro-via that is not covered by solder resist in an area of 0.15 mm unless it carries the same signal as the pad itself. Micro via inside the pads are allowed.

Holes in pad are allowed only for blind holes and not for through holes.

Table 37: Recommendations for PCB Pad Surfaces

Finish	Layer Thickness (um)	Properties
Electro-less Ni / Immersion Au	3-7 / 0.05-0.15	Good solder ability protection, high shear force values

The PCB must be able to resist the higher temperatures, which occur during the lead-free process. This issue should be discussed with the PCB-supplier. Generally, the wettability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

10.7. Solder Paste

We recommend using only “no clean” solder paste to avoid the cleaning of the modules after assembly.

10.7.1. Solder Reflow

Figure 27 shows the recommended solder reflow profile.

Figure 27: Solder Reflow Profile

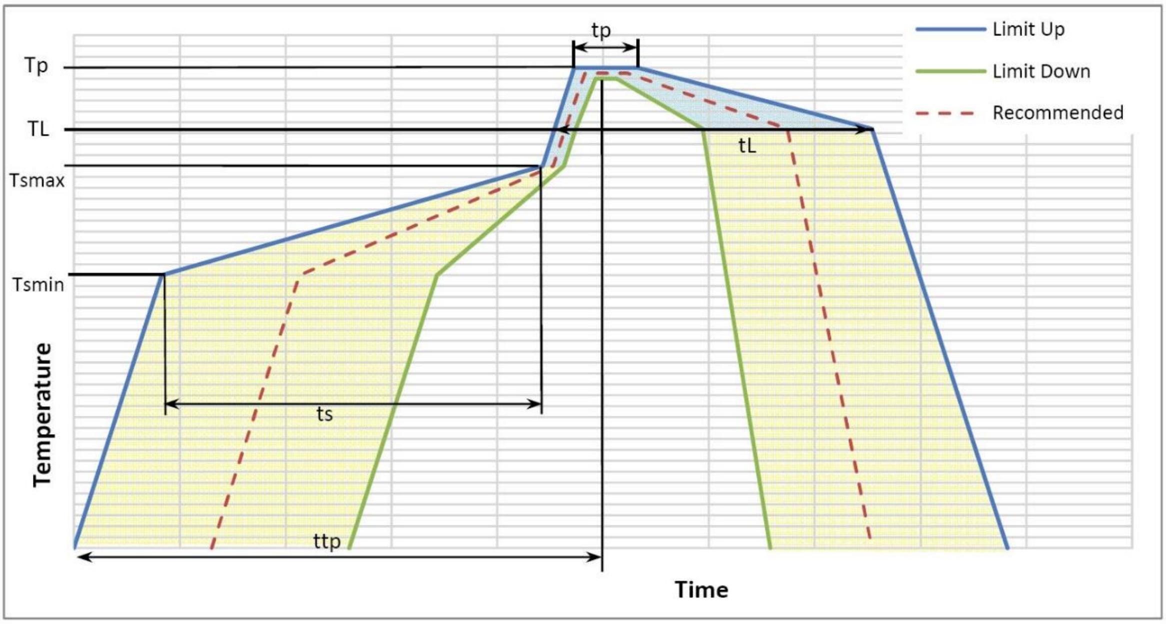


Table 38: Solder Profile Characteristics

Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat – Temperature min (Tsmin) – Temperature max (Tsmax) – Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Tsmax to TL – Ramp-up rate	 3°C/second max
Time maintained above: – Temperature (TL) – Time (tL)	 217°C 60-150 seconds
Peak temperature (Tp)	245 +0/-5°C
Time within 5°C of actual peak Temperature (tp)	10-30 seconds
Ramp-down rate	6°C/second max
Time 25°C to peak temperature	8 minutes max

NOTE:

All temperatures refer to topside of the package, measured on the package body surface.

Warning:

The LE910Cx module withstands one reflow process only.

11. Application Guide

11.1. Debug of the LE910Cx Module in Production

To test and debug the mounting of the LE910Cx module, we strongly recommend to add several test pads on the host PCB for the following purposes:

- Checking the connection between the LE910Cx itself and the application
- Testing the performance of the module by connecting it with an external computer

Depending on the customer application, these test pads include, but are not limited to the following signals:

- TXD
- RXD
- ON/OFF
- HW_SHUTDOWN_N
- GND
- VBATT
- TX_AUX
- RX_AUX
- USB_VBUS
- USB_D+
- USB_D-
- GPIO_09
- WCI_RX

In addition, the following signals are also recommended (but not mandatory):

- PWRMON
- GPIO_01 (STAT_LED)
- GPIO_08 (SW_RDY)

11.2. Bypass Capacitor on Power Supplies

When a sudden voltage step is asserted to or a cut from the power supplies, the steep transition causes some reactions such as overshoot and undershoot. This abrupt voltage transition can affect the device causing it to not operate or to malfunction.

Bypass capacitors are needed to alleviate this behavior. The behavior can appear differently depending on the various applications. Customers must pay special attention to this issue when they design their application board.

The length and width of the power lines must be considered carefully and the capacitance of the capacitors must be selected accordingly.

The capacitor will also prevent ripple of the power supplies and the switching noise caused in TDMA systems such as GSM.

Especially, a suitable bypass capacitor must be mounted on the following lines on the application board:

- VBATT & VBATT_PA (M1, M2, N1, N2, P1, P2)
- USB_VBUS (Pad A13)

Recommended values are:

- 100uF for both VBATT and VBATT_PA together
- 4.7uF for USB_VBUS (including the 1uF capacitor inside the module)

Customers must still consider that the capacitance mainly depends on the conditions of their application board.

Generally, more capacitance is required when the power line is longer.

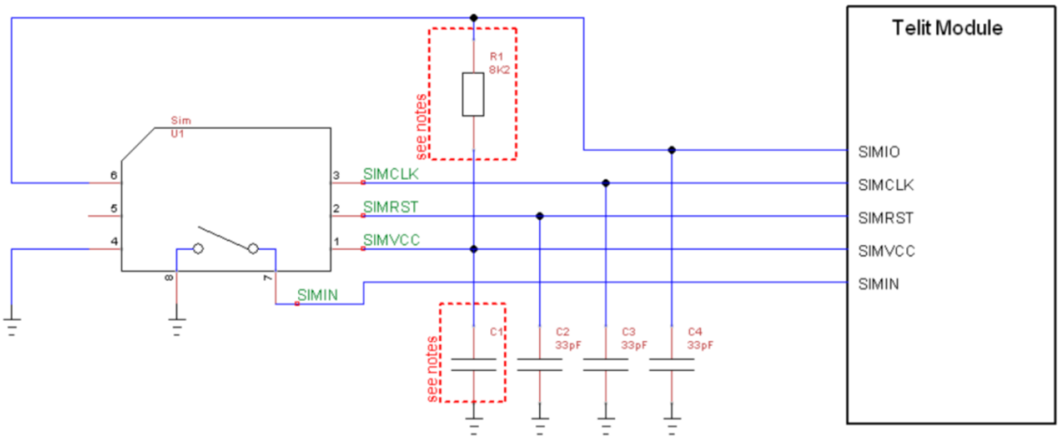
11.3. SIM Interface

This section presents the recommended schematics for the design of SIM interfaces on the application boards. The LE910Cx supports two external SIM interfaces.

11.3.1. SIM Schematic Example

Figure 28 illustrates in particular how the application side should be designed, and what values the components should have.

Figure 28: SIM Schematics



NOTE:

The resistor value on SIMIO pulled up to SIMVCC must be defined to be compliant with the 3GPP specification for USIM electrical testing.

The LE910Cx module contains an internal pull-up resistor of 20K Ω on SIMIO.

However, the un-mounted option in the application design can be recommended to tune R1 if necessary.

Table 39 lists the values of C1 to be adopted with the LE910Cx product:

Table 39: SIM Interface – C1 Range

Product P/N	C1 Range (nF)
LE910Cx	100 nF

Refer to the following document for details:

- Ref 5: SIM Integration Design Guide Application Note Rev10

11.4. EMC Recommendations

All LE910Cx signals are provided with some EMC protection. Nevertheless, the accepted level differs according to the specific pin. Table 40 lists the characteristics.

Table 40: EMC Recommendations

Pad	Signal	I/O	Function	Contact	Air
All Pins					
	All			± TBD	± TBD
Antenna					
F1,K1,R9	Antenna pads	Analog I/O	Antenna pad	± TBD	± TBD

Appropriate series resistors must be considered to protect the input lines from overvoltage.

11.5. Download and Debug Port

Chose one of the following options in the design of host system to download or upgrade the Telit software and debug the LE910Cx module when it is already mounted on a host system.

- UART and USB interfaces

  Users who use both UART and USB interfaces to communicate with the LE910Cx module must implement a USB download method in the host system to upgrade the LE910Cx when it is mounted.

- USB interface only

  Users who use a USB interface only to communicate with the LE910Cx module must arrange for a USB port in the host system to debug or upgrade the LE910Cx when it is mounted.

- UART interface only

  Users who use a UART interface only to communicate with the LE910Cx module must arrange for a UART port in the host system to debug or upgrade the LE910Cx when it is mounted.

11.5.1. Fast Boot mode

Fast boot mode is normally used by Telit SW to enter SW download mode

Fastboot is triggered by GPIO_09 (PAD L15). Asserting this signal high (1.8V) during boot will force the system into Fastboot

11.5.2. Recovery Boot Mode

Emergency boot download mode is used in case of corrupted boot image was flashed into the device or in case all other recovery modes failed to work

Emergency download mode is triggered by WCI_RX signal (PAD M9). Asserting this signal high (1.8V) during boot will force the system into Emergency download.

NOTE:

Application board must support accessible test pads on GPIO_09 and WCI_RX signal in order to enable download recovery modes mentioned above

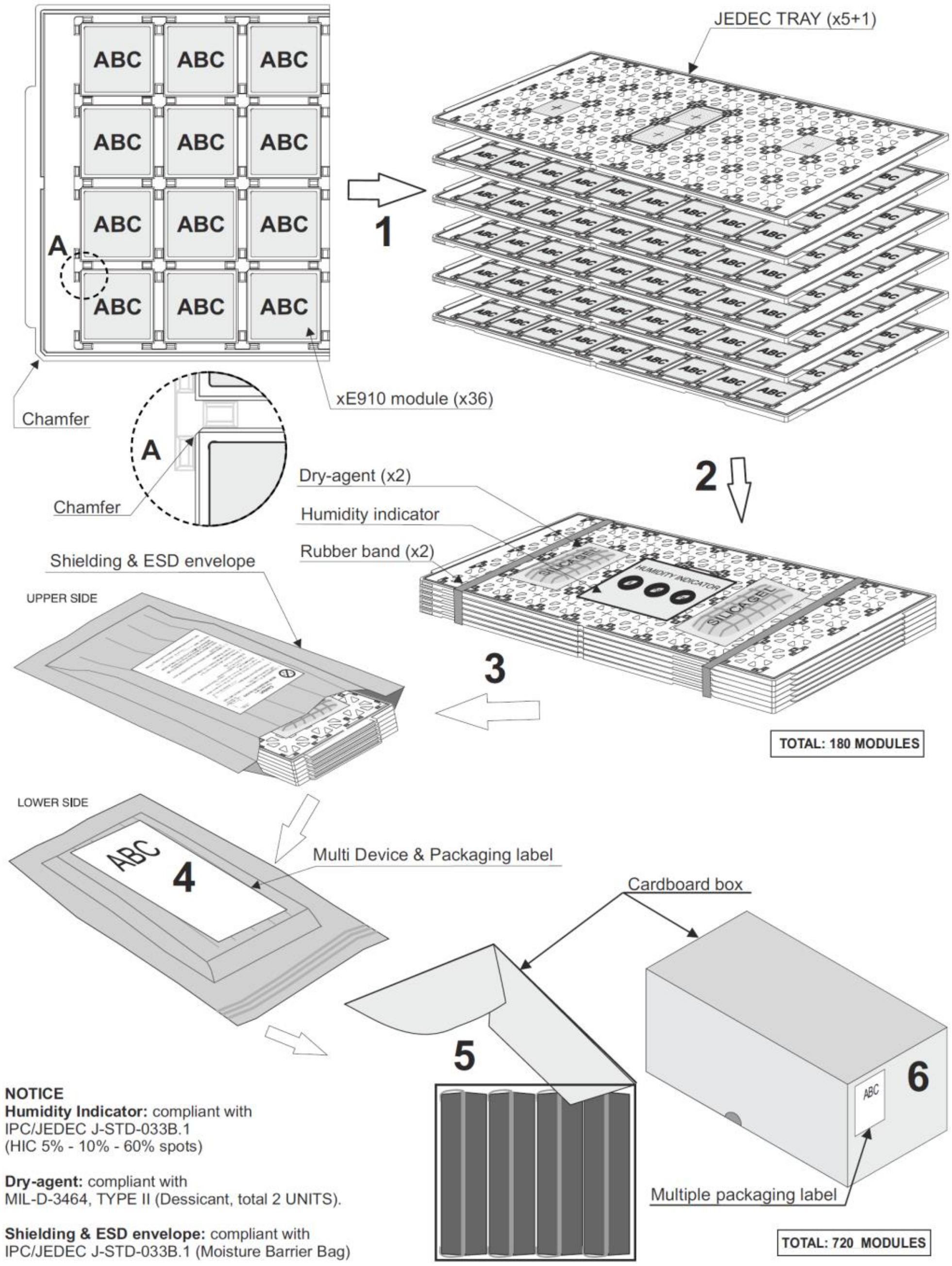
12. Packing System

12.1. Packing system – Tray

The LE910Cx modules are packaged on trays of 36 pieces each as shown in Figure 29.

These trays can be used in SMT processes for pick & place handling.

Figure 29: Packing

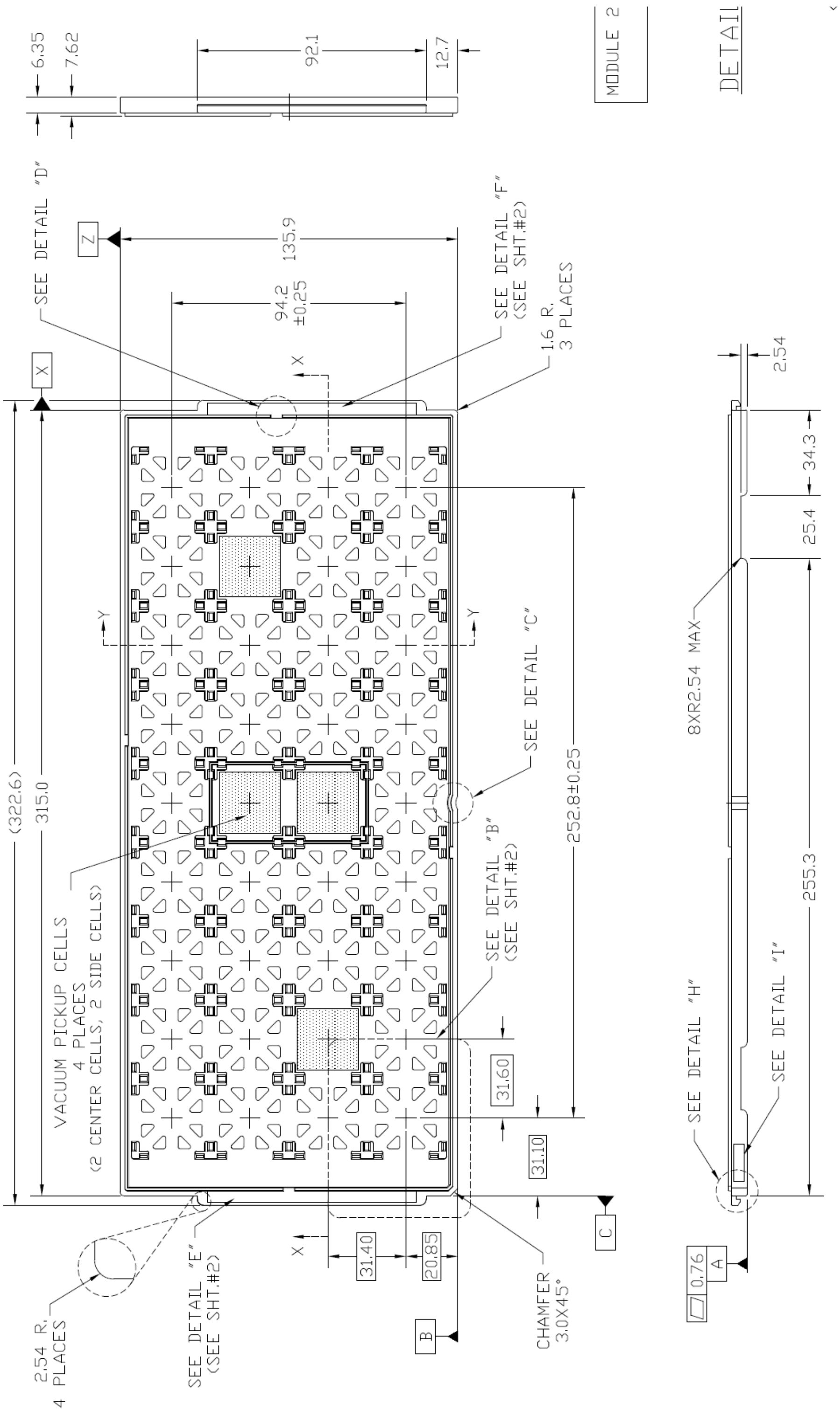


NOTICE
Humidity Indicator: compliant with
IPC/JEDEC J-STD-033B.1
(HIC 5% - 10% - 60% spots)

Dry-agent: compliant with
MIL-D-3464, TYPE II (Dessicant, total 2 UNITS).

Shielding & ESD envelope: compliant with
IPC/JEDEC J-STD-033B.1 (Moisture Barrier Bag)

Figure 30: Tray Drawing



12.2. Tape & Reel

The LE910Cx can be packaged on reels of 200 pieces each.

See figure for module positioning into the carrier.

Figure 31: Module Positioning into the Carrier

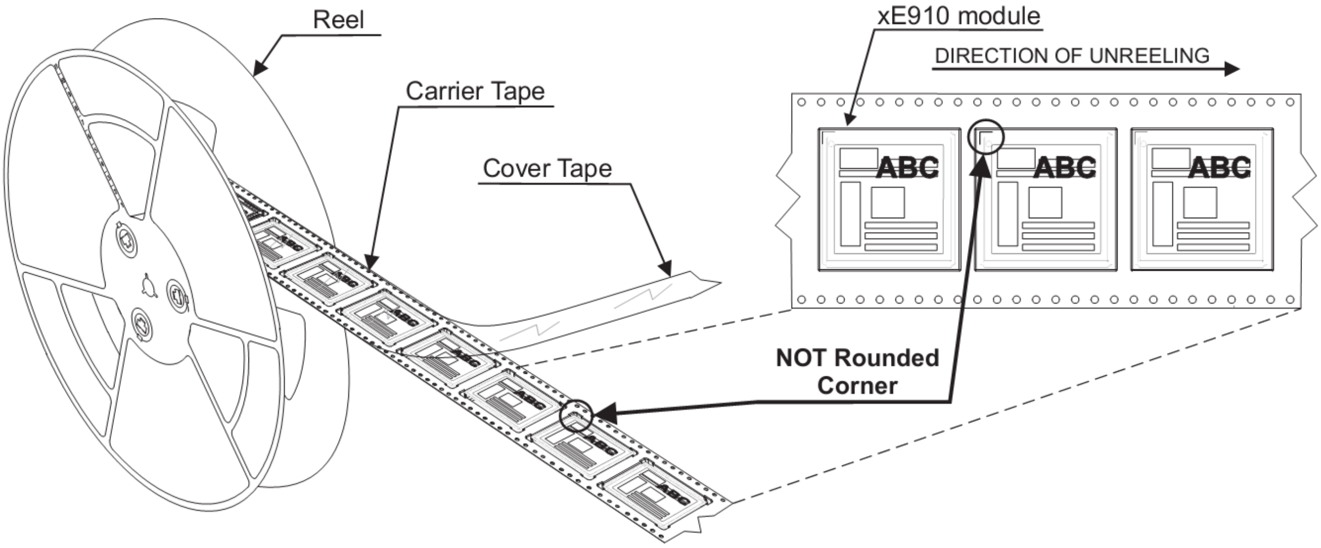
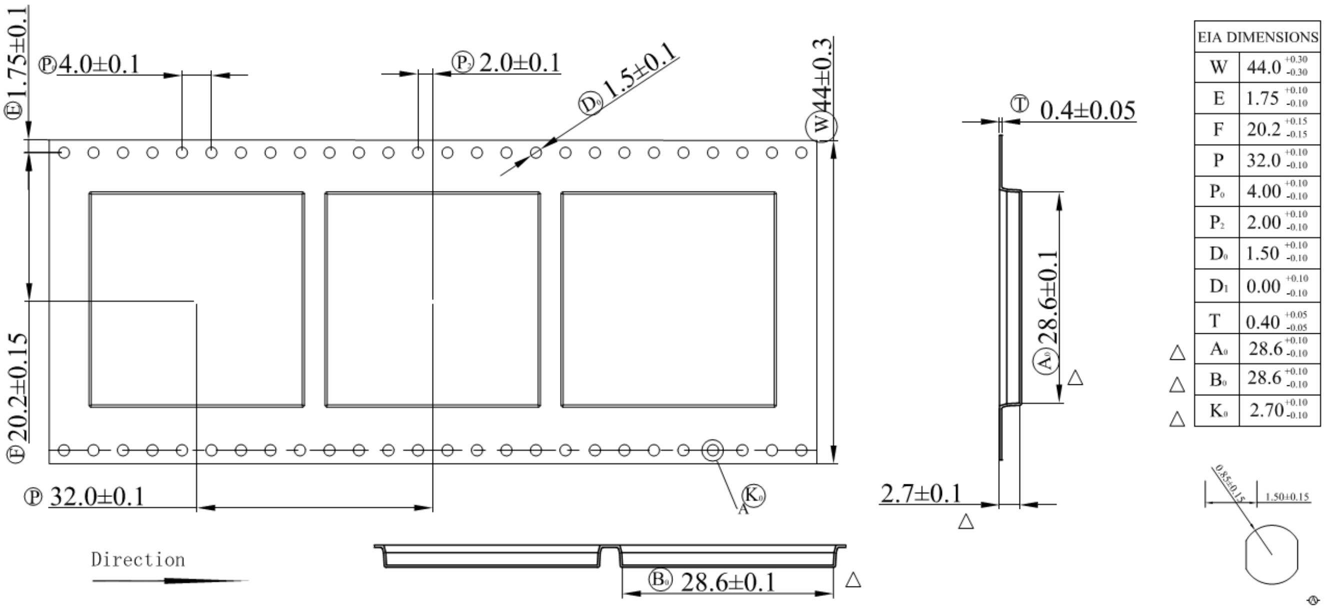
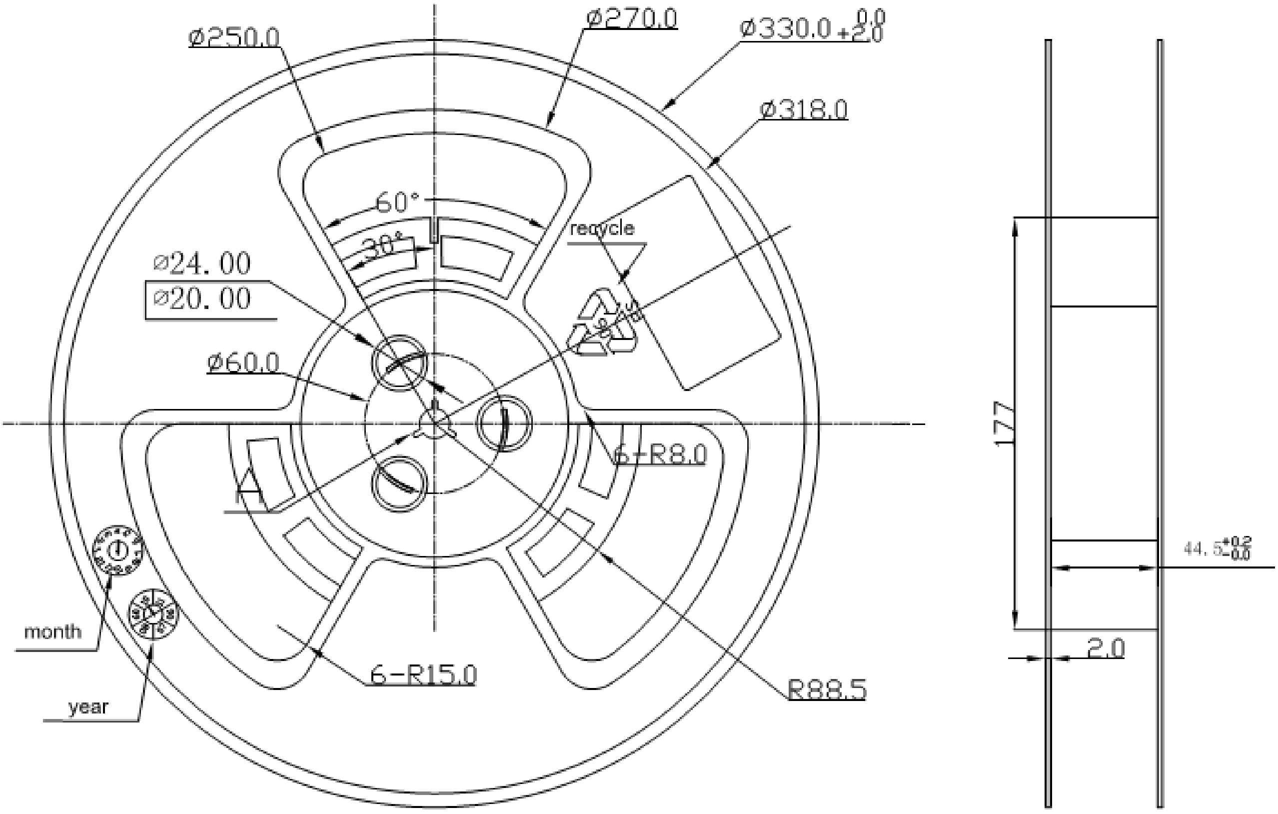


Figure 32: Carrier Tape Detail



EIA DIMENSIONS	
W	$44.0^{+0.30}_{-0.30}$
E	$1.75^{+0.10}_{-0.10}$
F	$20.2^{+0.15}_{-0.15}$
P	$32.0^{+0.10}_{-0.10}$
P_0	$4.00^{+0.10}_{-0.10}$
P_2	$2.00^{+0.10}_{-0.10}$
D_0	$1.50^{+0.10}_{-0.10}$
D_1	$0.00^{+0.10}_{-0.10}$
T	$0.40^{+0.05}_{-0.05}$
△ A_0	$28.6^{+0.10}_{-0.10}$
△ B_0	$28.6^{+0.10}_{-0.10}$
△ K_0	$2.70^{+0.10}_{-0.10}$

Figure 33: Reel Detail



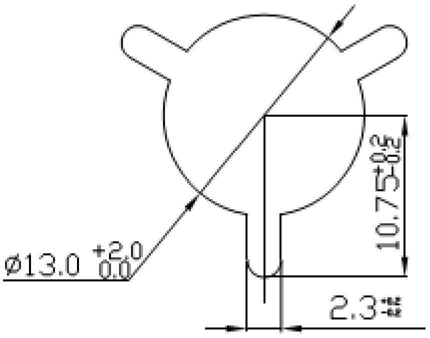
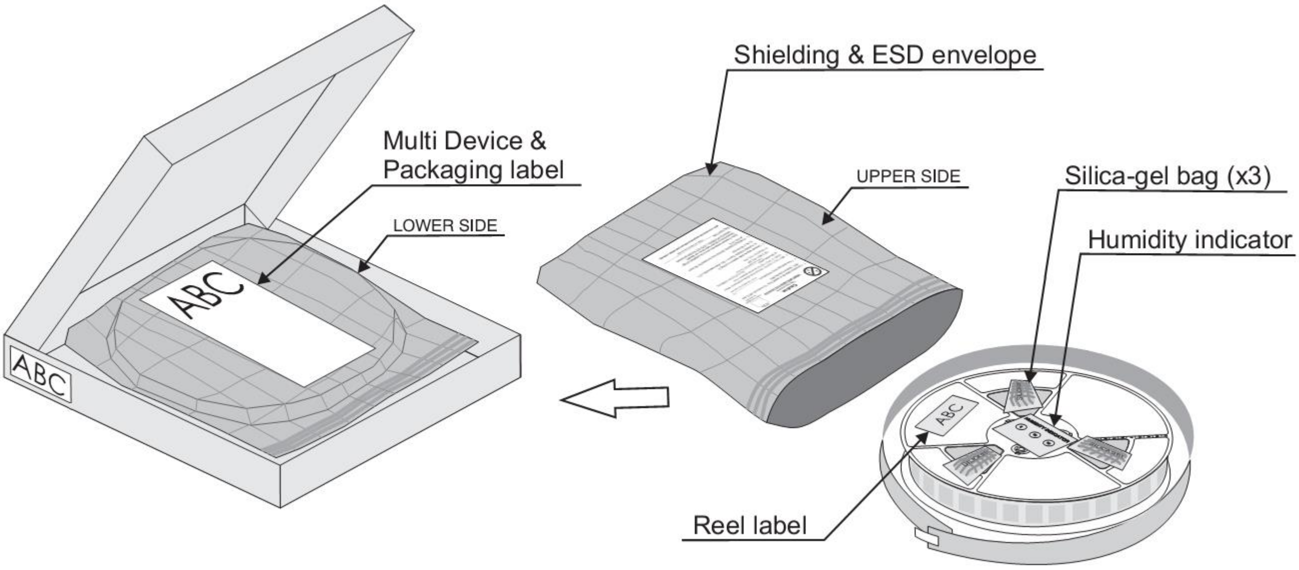


Figure 34: Reel Box Detail



12.3. Moisture Sensitivity

The LE910Cx module is a Moisture Sensitive Device Level 3, in accordance with standard IPC/JEDEC J-STD-020. Observe all of the requirements for using this kind of components.

13. Safety Recommendations

READ CAREFULLY

Be sure that the use of this product is allowed in your country and in the environment required. The use of this product may be dangerous and must be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircrafts, etc.
- Where there is risk of explosion, such as gasoline stations, oil refineries, etc.

It is the responsibility of the user to enforce the country regulations and the specific environment regulations.

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 must be supplied with a stabilized voltage source and the wiring conform to the security and fire prevention regulations.

The product must be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. The same caution must be taken for the SIM, checking carefully the instructions 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, care must be taken of the external components of the module, as well as of any project or installation issue, because of the risk of disturbing the GSM network or external devices or having any impact on safety. Should there be any doubt, refer to the technical documentation and the regulations in force.

Every module must be equipped with a proper antenna with the specified characteristics. The antenna must be installed with care to avoid any interference with other electronic devices and must be installed with the guarantee of a minimum 20 cm distance from a human body. If this requirement cannot be satisfied, the system integrator must assess the final product against the SAR regulation.

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

http://europa.eu.int/comm/enterprise/rtte/dir99-5.htm

The text of the Directive 99/05 regarding telecommunication equipment is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://europa.eu.int/comm/enterprise/rtte/dir99-5.htm

14. Conformity assessment issues

14.1. FCC/ISED Regulatory notices

Modification statement

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 (if it is not placed in the device)

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

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. Antenna gain must be below:

Frequency Band	Freq [MHz]	Gain [dBi]
850 MHz	850	0.63
1900 MHz	1900	2.51
1700 MHz	1700	5.00
700 MHz	700	5.63

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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. Gain de l'antenne doit être ci-dessous:

Frequency Band	Freq [MHz]	Gain [dBi]
850 MHz	850	0.63
1900 MHz	1900	2.51
1700 MHz	1700	5.00
700 MHz	700	5.63

L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur.

FCC Class B digital device notice

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 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.

Labelling Requirements for the Host device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID and IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: RI7LE910C1NA
Contains IC: 5131A-LE910C1NA

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. L'étiquette de certification du module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le FCC ID et le IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit :

Contains FCC ID: RI7LE910C1NA
Contains IC: 5131A-LE910C1NA

CAN ICES-3 (B) / NMB-3 (B)

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

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

15. Document History

Table 41: Document Revision History

Revision	Date	Changes
0.1	2016-08-30	First Draft
0.2	2016-09-05	Minor edits
0.3	2016-11-13	Added information for GPIO usage as Interrupt Added clarification for AUX_UART location and backward compatibility
0.4	2016-11-30	Updated band support table Updated WIFI application note doc info Added note related to future compatibility related to few pins Updated section 3.2 - Signals That Must Be Connected Updated pinout and pin description Updated pinout layout (Figure 2) Remove HW RESET description section Updated serial port 2 section Updated SPI port section Updated 1.8V pads pull info Updated AUX UART section Updated GPIO section Updated mechanical drawing (Cosmetic)
0.5	2016-12-02	Added section 9.2 to better describe SW_RDY signal Minor modifications per typos and improved description Renaming of SHDN_N pin
0.6	2016-12-07	Remove all China variant related information
1.0	2016-12-22	Section 1.5 - Updated “Related Documents” table Section 5.3.4 – Added Figure for SHDN_N power down timing Section 8.5.3 – Added clarification about VMMC Section 9.7 - Added GNSS characteristics

Revision	Date	Changes
1.01	2017-02-16	Adding Section 14: FCC/ISED Regulatory notices Changing Document History section from 14 to 15