LM940
HW Design Guide

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TECHNICAL
DOCUMENTATION

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Applicability Table

PRODUCTS

- LM940

Contents

1. INTRODUCTION

1.1. Scope

This document introduces the Telit LM940 module and presents possible and recommended hardware solutions for developing a product based on the LM940 module. All the features and solutions detailed in this document are applicable to all LM940 variants, where “LM940” 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.

Information – LM940 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. 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 LM940 module.

Information – The integration of the WCDMA/HSPA+/LTE LM940 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 LM940 module.

1.3. Contact Information, Support

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

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

Alternatively, use:

http://www.telit.com/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 of our information.

1.4. Text Conventions

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.

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

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.5. Related Documents

- LM940 SW User Guide, 1VV0301343
- LM940 AT Commands Reference Guide, 80545ST10791A
- Generic EVB HW User Guide, 1VV0301249
- LM940 Interface Board HW User Guide, 1VV0301384
- SIM Integration Design Guide Application Note Rev10, 80000NT10001A
- Antenna Detection Application Note, 80000NT10002A

2. GENERAL PRODUCT DESCRIPTION

2.1. Overview

The aim of this document is to present possible and recommended hardware solutions useful for developing a product with the Telit LM940 Mini PCIe module.

LM940 is Telit's platform for Mini PCIe module for applications, such as M2M applications, industrial mobile router and table PC, based on the following technologies:

- LTE / WCDMA networks for data communication
- Designed for industrial grade quality

In its most basic use case, LM940 can be applied as a wireless communication front-end for mobile router products, offering mobile communication features to an external host CPU through its rich interfaces.

LM940 can further support customer software applications and security features. LM940 provides a software application development environment with sufficient system resources for creating rich on-board applications. Thanks to a dedicated application processor and embedded security resources, product developers and manufacturers can create products that guarantee fraud prevention and tamper evidence without extra effort for additional security precautions.

LM940 is available in hardware variants as listed in Applicability Table
The designated RF band sets per each variant are detailed in Section 2.2, Product Variants and Frequency Bands.

2.2. Product Variants and Frequency Bands

The operating frequencies in LTE & WCDMA modes conform to the 3GPP specifications.

2.2.1. RF Bands per Regional Variant

This table summarizes the LM940, showing the supported band sets and the supported band pairs and triple for carrier aggregation.

RF Bands and Carrier Aggregation

	LTE FDD	LTE TDD	HSPA+
Bands	1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 20, 25, 26, 28, 29, 30, 66	38, 40, 41	1, 2, 4, 5, 8
GNSS	GPS, GLONASS, BeiDou, Galileo		
LTE 2DL carrier aggregation combinations			
North America	B2+B2, B2+B4, B2+B5, B2+B12, B2+B13, B2+B17, B2+B29, B2+B30, B4+B4, B4+B5, B4+B7, B4+B12, B4+B13, B4+B17, B4+B29, B4+B30, B5+B30, B12+B12, B12+B30, B25+B25, B25+B26, B25+B41, B26+B41, B29+B30, B41+B41		
Europe	B1+B20, B3+B3, B3+B7, B3+B20, B3+B38, B7+B7, B7+B8, B7+B20, B38+B38		

Australia	B1+B3, B1+B7, B1+B28, B3+B8, B3+B28, B5+B7, B5+B40, B7+B8, B7+B20
LTE 3DL carrier aggregation combinations	
North America	B2+B2+B12/17, B2+B2+B13, B2+B2+B4, B2+B4+B5, B2+B4+B12, B2+B4+B13, B2+B4+B29, B2+B5+B30, B2+B12+B12, B2+B12+B30, B2+B29+B30, B4+B4+B5, B4+B4+B7, B4+B4+B12, B4+B4+B13, B4+B5+B30, B4+B12+B12, B4+B12+B30, B4+B29+B30, B25+B26+B41, B25+B41+B41, B26+B41+B41, B41+B41+B41
Europe	B1+B3+B20, B1+B7+B20, B3+B3+B7, B3+B3+B20, B3+B7+B20, B3+B7+B7, B3+B20+B38, B3+B38+B38
Australia	B3+B3+B5, B3+B3+B8, B3+B7+B7, B3+B7+B28, B7+B7+B28, B28+B40+B40, B40+B40+B40

Refer to Chapter 13 for details information about frequencies and bands.

2.3. Target market

LM940 can be used for telematics applications where tamper-resistance, confidentiality, integrity, and authenticity of end-user information are required, for example:

- Mobile router
- Industrial equipment
- Home network
- Internet connectivity

2.4. Main features

The LM940 family of industrial grade cellular modules features LTE and multi-RAT module together with an on-chip powerful application processor and a rich set of interfaces.

The major functions and features are listed below.

Main Features

Function	Features
Module	• Multi-RAT cellular module for data communication o LTE FDD/TDD Cat11(600/75 Mbps DL/UL) o WCDMA up to DC HSPA+, Rel.9 • Support for GPS, GLONASS, BeiDou, Galileo
Audio subsystem	• Support digital audio interface (optional)

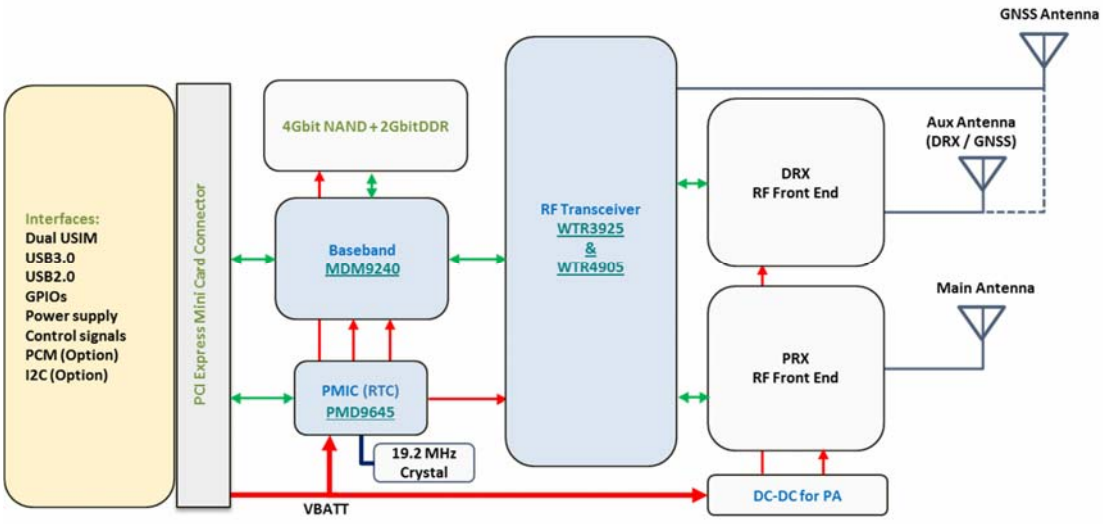
Function	Features
Two USIM ports – dual voltage	• Support for dual SIM • Class B and Class C support • Clock rates up to 4 MHz
Application processor	Application processor to run customer application code • 32 bit ARM Cortex-A7 up to 1.19 GHz running the Linux operating system • 4Gbit NAND Flash + 2Gbit LPDDR2 MCP is supported to allow for customer's own software applications
Interfaces	Rich set of interfaces, including: • USB2.0 / USB3.0 – 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 • Peripheral Ports – GPIOs
Major software features	• Advanced security features o Boot integrity of firmware up to customer applications o Disable/secure re-enable of debug o Embedded security • FOTA (optional) • Telit Unified AT command set
Form factor	Mini PCIe Form factor (50.95x30x2.7mm), accommodating the multiple RF bands

Function	Features
Environment and quality requirements	The entire module is designed and qualified by Telit for satisfying the environment and quality requirements for use in applications[1].
Single supply module	The module generates all its internal supply voltages.
RTC	The real-time clock is supported.
Operating temperature	Range -40 °C to +85 °C (conditions as defined in Section 2.9.1, Temperature Range)

2.5. Block Diagram

Below figure shows an overview of the internal architecture of the LM940 module.

LM940 Block Diagram



It includes the following sub-functions:

- Application processor, Module subsystem and Location processing with their external interfaces. These three functions are contained in a single SOC.
- RF front end

[1] In accordance with Telit's Robustness Validation, using AEC-Q100-defined qualification tests

- Rich IO interfaces. Depending on which LM940 software features are enabled, some of its interfaces that are exported through multiplexing may be used internally and thus may not be usable by the application.
- PMIC with the RTC function inside

2.6. TX Output Power

Band	Power class
3G WCDMA	Class 3 (0.2W)
LTE All Bands	Class 3 (0.2W)

2.7. RX Sensitivity

Below the 3GPP measurement conditions used to define the RX sensitivity:

Technology	3GPP Compliance
4G LTE	Throughput >95% 10MHz Dual Receiver
3G WCDMA	BER <0.1% 12.2 Kbps Dual Receiver

Product	Band	Typical Rx Sensitivity (dBm) * / ** (LTE BW = 10 MHz)
LM940	LTE FDD B1	-101.5
	LTE FDD B2	-101.0
	LTE FDD B3	-101.5
	LTE FDD B4	-101.0
	LTE FDD B5	-102.5
	LTE FDD B7	-99.5
	LTE FDD B8	-102.5
	LTE FDD B12	-102.0
	LTE FDD B13	-102.0
	LTE FDD B17	-102.0
	LTE FDD B20	-102.0

	LTE FDD B25	-101.0
	LTE FDD B26	-102.0
	LTE FDD B28	-102.0
	LTE FDD B30	-100.5
	LTE FDD B66	-101.0
	LTE TDD B38	-100.0
	LTE TDD B40	-100.0
	LTE TDD B41	-99.5
LM940	WCDMA FDD B1	-108.5
	WCDMA FDD B2	-108.5
	WCDMA FDD B4	-108.5
	WCDMA FDD B5	-109.5
	WCDMA FDD B8	-109.5

* LTE Rx Sensitivity shall be verified by using both (all) antenna ports simultaneously.

** 3.3 Voltage / Room temperature

2.8. Mechanical specifications

2.8.1. Dimensions

The LM940 module's overall dimensions are:

- Length: 50.95 mm, +/- 0.15 mm tolerance
- Width: 30.00 mm, +/- 0.15 mm tolerance
- Thickness: 2.70 mm, +/- 0.15 mm tolerance

2.8.2. Weight

The nominal weight of the LM940 module is 9.6 gram.

2.9. Environmental Requirements

2.9.1. Temperature Range

		Note
Operating Temperature Range	–20°C ~ +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.

		Note
	–40°C ~ +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	

2.9.2. RoHS Compliance

As a part of the Telit corporate policy of environmental protection, the LM940 complies with the RoHS (Restriction of Hazardous Substances) directive of the European Union (EU directive 2011/65/EU).

3. PINS ALLOCATION

3.1. Pin-out

LM940 Pin-out

Pin	Signal	I/O	Function	Type	Comment
USB HS 2.0 Communication Port					
38	USB_D+	I/O	USB 2.0 Data Plus	Analog	
36	USB_D-	I/O	USB 2.0 Data Minus	Analog	
USB SS 3.0 Communication Port					
25	USB_SS_TX_P	O	USB 3.0 super-speed transmit – plus	Analog	
23	USB_SS_TX_M	O	USB 3.0 super-speed transmit – minus	Analog	
33	USB_SS_RX_P	I	USB 3.0 super-speed receive – plus	Analog	
31	USB_SS_RX_M	I	USB 3.0 super-speed receive – minus	Analog	
SIM Card Interface 1					
8	SIMVCC1	O	Supply output for an external UIM1 card	1.8V / 2.85V	Power
10	SIMIO1	I/O	Data connection with an external UIM1 card	1.8V / 2.85V	
12	SIMCLK1	O	Clock output to an external UIM1 card	1.8V / 2.85V	
14	SIMRST1	O	Reset output to an external UIM1 card	1.8V / 2.85V	

SIM Card Interface 2					
13	SIMVCC2	O	Supply output for an external UIM2 card	1.8 / 2.85V	Power
19	SIMIO2	I/O	Data connection with an external UIM2 card	1.8 / 2.85V	
17	SIMCLK2	O	Clock output to an external UIM2 card	1.8 / 2.85V	
7	SIMRST2	O	Reset output to an external UIM2 card	1.8 / 2.85V	
Digital I/O (GPIOs)					
3	GPIO_01	I/O	General purpose I/O, SIMIN1 depending on product	1.8V	
5	GPIO_02	I/O	General purpose I/O, SIMIN2 depending on product	1.8V	
44	GPIO_03	I/O	General purpose I/O	1.8V	
46	GPIO_04	I/O	General purpose I/O	1.8V	
Control Signal					
1	WAKE_N	O	Host wake-up	1.8V	
20	W_DISABLE_N	I	RF disable	1.8V	
42	WAN_LED_N	O	LED control	1.8V	
Miscellaneous Functions					
11	VREG_L6_1P8	O	Reference Voltage	1.8V	Power

22	SYSTEM_RESET_N	I	Reset Input	1.8V
Digital Audio Interface				
45	DVI _CLK	O	PCM Clock	1.8V
47	DVI _TX	O	PCM Data Out	1.8V
49	DVI _RX	I	PCM Data In	1.8V
51	DVI _WAO	O	PCM Frame Sync	1.8V
I2C Interface				
30	I2C_SCL	O	I2C Clock	1.8V
32	I2C_SDA	I/O	I2C Data	1.8V
Power Supply				
2	VBATT	I	Power supply	Power
24	VBATT	I	Power supply	Power
39	VBATT	I	Power supply	Power
41	VBATT	I	Power supply	Power
52	VBATT	I	Power supply	Power
GROUND				
4	GND	-	Ground	Ground
9	GND	-	Ground	Ground
15	GND	-	Ground	Ground
18	GND	-	Ground	Ground

21	GND	-	Ground	Ground
26	GND	-	Ground	Ground
27	GND	-	Ground	Ground
29	GND	-	Ground	Ground
34	GND	-	Ground	Ground
35	GND	-	Ground	Ground
37	GND	-	Ground	Ground
40	GND	-	Ground	Ground
43	GND	-	Ground	Ground
50	GND	-	Ground	Ground
Reserved				
6	Reserved	-	Reserved (NC)	
16	Reserved	-	Reserved (NC)	
28	Reserved	-	Reserved (NC)	
48	Reserved	-	Reserved (NC)	

Information – If the DVI and I2C interface are not used, the signals can be left floating.

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

3.2. LM940 Signals That Must Be Connected

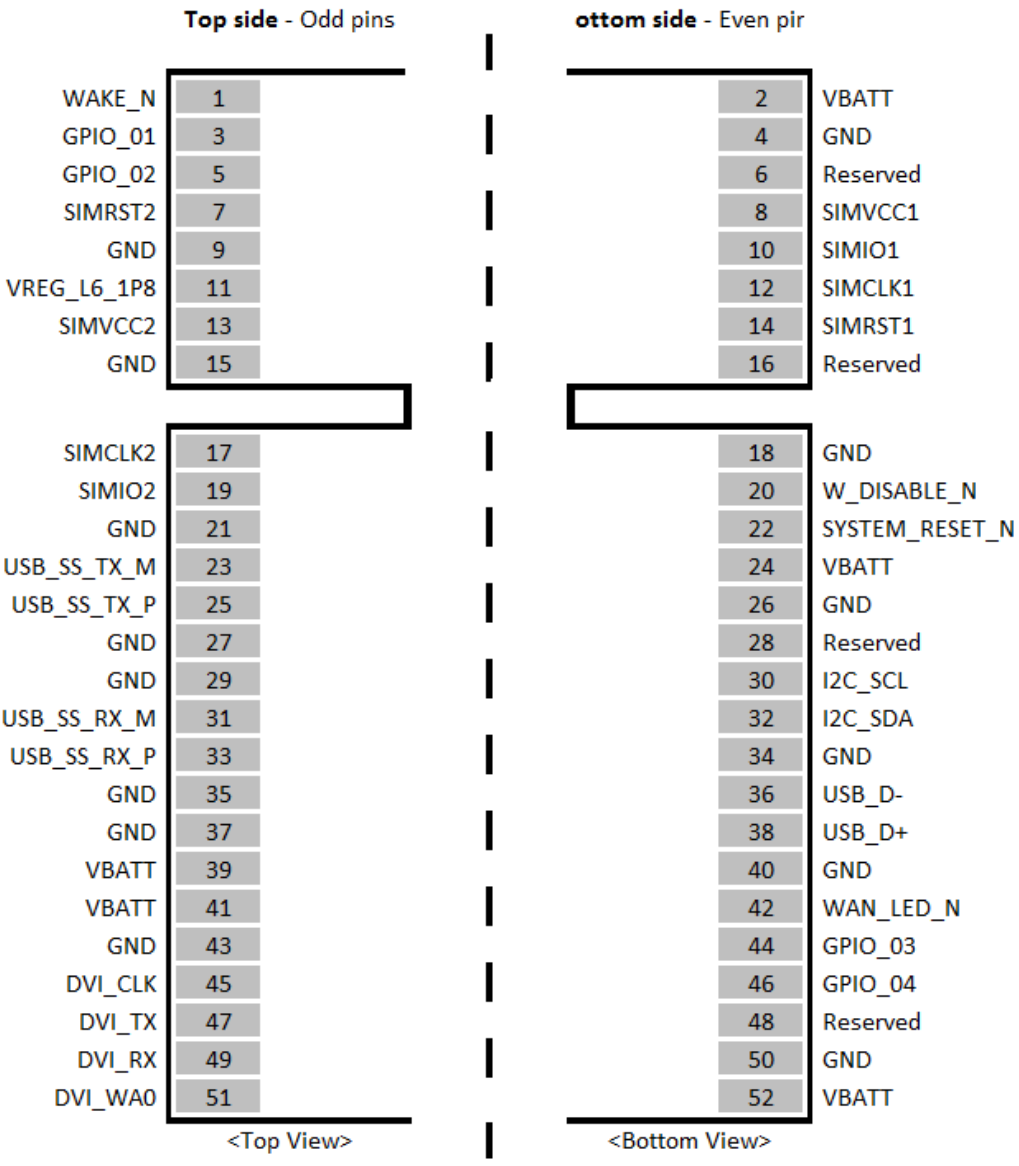
Below table specifies the LM940 signals that must be connected for a debugging purpose even if not used by the end application:

Mandatory Signals

Pin	Signal	Notes
2, 24, 39, 41, 52	VBATT	
4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50	GND	
38	USB_D+	If not used, connect to a test point or an USB connector
36	USB_D-	If not used, connect to a test point or an USB connector

3.3. Pin Layout

LM940 Pin Layout



4. 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.

4.1. Power Supply Requirements

The LM940 power requirements are as follows:

Power Supply Requirements

Nominal supply voltage	3.3V
Supply voltage range	3.10V – 3.6V
Maximum ripple on module input supply	30 mV

4.2. Power Consumption

Below table provides typical current consumption values of LM940 for various operation modes.

LM940 Current Consumption

Mode	Average [Typ.]	Mode Description
IDLE Mode		
IDLE Mode	60.0 mA	No call connection USB3.0 is connected to a host
Operative Mode (LTE)		
LTE (22 dBm)	750 mA	LTE data call (Non-CA BW 5MHz, RB=1)
	1250 mA	LTE data call (CA_3A+7A+20A, 20MHz+20MHz+20MHz, Full RB, 256QAM DL / 64QAM UL, FDD 600Mbps DL / 75Mbps UL)
Operative Mode (WCDMA)		
WCDMA Voice	650 mA	WCDMA voice call (Tx = 23 dBm)
WCDMA HSPA (22 dBm)	650 mA	WCDMA data call (DC-HSDPA up to 42 Mbps, Max Throughput)

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

** Applied MPR –2dB 16-QAM full RB

*** 3.3 voltage / room temperature

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

4.3. General Design Rules

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

- Electrical design
- Thermal design
- PCB layout

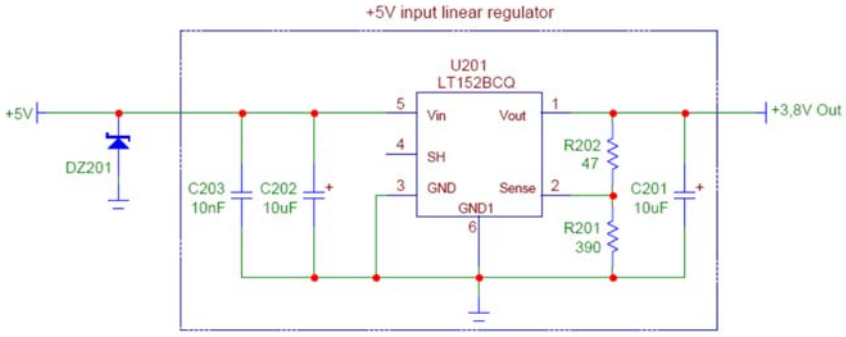
4.3.1. Electrical Design Guidelines

The electrical design of the power supply depends strongly on the power source where this power is drained.

4.3.1.1. + 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 LE925A4 module. A 100 µF tantalum capacitor is usually suitable (on both VPH_PWR and VPH_PWR_RF 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 LE925A4 module from power polarity inversion.

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



4.3.2. 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 LM940 as shown in Section 4.2, Power Consumption table.

Information – 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.

Information – The thermal design for the power supply must be made keeping an average consumption at the maximum transmitting level during calls of LTE/HSPA.

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 Data session.

In LTE/WCDMA/HSPA mode, the LM940 emits RF signals continuously during transmission. Therefore, you must pay special attention how to dissipate the heat generated.

While designing the application board, the designer must make sure that the LM940 module is located on a large ground area of the application board for effective heat dissipation.

Information – The LM940 must be connected to the ground and metal chassis of the host board for best RF performance and thermal dispersion as well as to have module fixed.

- The two holes at the top of the module and the main ground of the host board must be fastened together.
- The shield cover of the module and the main board of the host board or the metal chassis of the host device should be connected with conductive materials.

4.3.3. 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 LM940 power input pins, 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 LM940 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.
- The PCB traces to LM940 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.

4.4. RTC

The RTC within the LM940 module does not have a dedicated RTC supply pin. The RTC block is supplied by the VBATT supply.

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

4.5. Reference Voltage

1.8V regulated power supply output is provided as the reference voltage to a host board. This output is active when the module is ON and goes OFF when the module is shut down.

This table lists the VREG_L6_IP8 signal of LM940.

LM940 Reference Voltage

PIN	Signal	I/O	Function	Type	Comment
11	VREG_L6_1P8	O	Reference Voltage	power	1.8V

4.6. Internal LDO for GNSS bias

The LDO for GNSS bias is applied inside the LM940 model.

The voltage supply come from LM940's LDO to GNSS active antenna.

This table lists the LDO for GNSS bias of LM940.

LM940 Reference Voltage

Symbol	Parameter	Min	Typ	Max	Unit
$V_{GNSS\ DC\ bias}$	Voltage of Internal LDO for GNSS bias	2.9	3.1	3.3	[V]
$I_{GNSS\ DC\ bias}$	Current of Internal LDO for GNSS bias	-	-	50	[mA]

5. ELECTRICAL SPECIFICATIONS

5.1. Absolute Maximum Ratings – Not Operational

Caution – A deviation from the value ranges listed below may harm the LM940 module.

Absolute Maximum Ratings – Not Operational

Symbol	Parameter	Min	Max	Unit
VBATT	Battery supply voltage on pin VBATT	-0.5	+4.0	[V]

5.2. Recommended Operating Conditions

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
T_{amb}	Ambient temperature	-40	+25	+85	[°C]
VBATT	Battery supply voltage on pin VBATT	3.1	3.3	3.6	[V]
I_{VBATT} + I_{VBATT_PA}	Peak current to be used to dimension decoupling capacitors on pin VBATT	-	80	2500	[mA]

6. DIGITAL SECTION

6.1. Logic Levels

Unless otherwise specified, all the interface circuits of the LM940 are 1.8V CMOS logic.

Only USIM interfaces are capable of dual voltage I/O.

The following tables show the logic level specifications used in the LM940 interface circuits. The data specified in the tables below is valid throughout all drive strengths and the entire temperature ranges.

Caution – Do not connect LM940's digital logic signal directly to OEM's digital logic signal with a level higher than 2.3V for 1.8V CMOS signals.

6.1.1. 1.8V Pins – Absolute Maximum Ratings

Absolute Maximum Ratings – Not Functional

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

6.1.2. 1.8V Standard GPIOs

Operating Range – Interface Levels (1.8V CMOS)

Parameter		Min	Max	Unit	Comment
VIH	Input high level	1.17V	2.1V	[V]	
VIL	Input low level	-0.3V	0.63V	[V]	
VOH	Output high level	1.35V	1.8V	[V]	
VOL	Output low level	0V	0.45V	[V]	
IIL	Low-level input leakage current	-1	--	[uA]	No pull-up
IIH	High-level input leakage current	--	1	[uA]	No pull-down
IILPU	Low-level input leakage current	-97.5	-27.5	[uA]	With pull-up

Parameter		Min	Max	Unit	Comment
IIHPD	High-level input leakage current	27.5	97.5	[uA]	With pull-down
CI/o	I/O capacitance	--	5	[pF]	

6.1.3. 1.8V SIM Card Pins

Operating Range – SIM Pins Working at 1.8V

Parameter		Min	Max	Unit	Comment
VIH	Input high level	1.26V	2.1V	[V]	
VIL	Input low level	-0.3V	0.36V	[V]	
VOH	Output high level	1.44V	1.8V	[V]	
VOL	Output low level	0V	0.4V	[V]	
IIL	Low-level input leakage current	--	1000	[uA]	No pull-up
IIH	High-level input leakage current	-20	20	[uA]	No pull-down

6.1.4. 2.85V Pins – Absolute Maximum Ratings

Absolute Maximum Ratings – Not Functional

Parameter	Min	Max
Input level on any digital pin when on	--	+3.42V
Input voltage on analog pins when on	--	+3.42 V

6.1.5. SIM Card Pins @2.85V

Operating Range – For SIM Pins Operating at 2.85V

Parameter		Min	Max	Unit	Comment
VIH	Input high level	1.995V	3.15V	[V]	
VIL	Input low level	-0.3V	0.57V	[V]	
VOH	Output high level	2.28V	2.85V	[V]	
VOL	Output low level	0V	0.4V	[V]	

Parameter		Min	Max	Unit	Comment
IIL	Low-level input leakage current	--	1000	[uA]	No pull-up
IIH	High-level input leakage current	-20	20	[uA]	No pull-down

6.2. Power On

The LM940 is automatically turning on when the VBATT is supplied.

Information – To turn on the LM940 module, the W_DISABLE_N pin must not be asserted low.

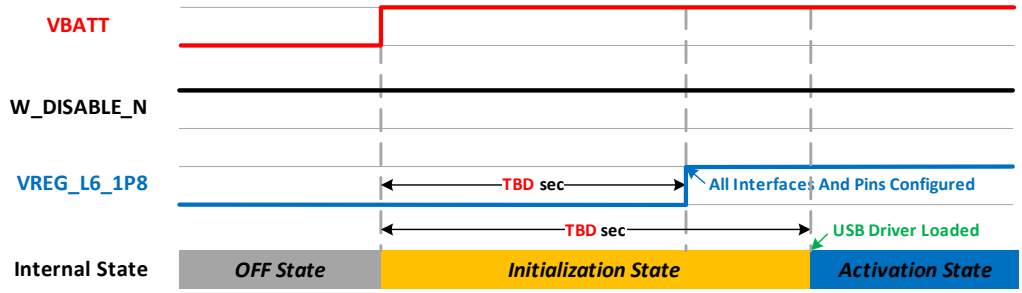
6.2.1. Initialization and Activation State

After turning on the LM940 module, the LM940 is not yet activated because the SW initialization process of the LM940 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 LM940 during the Initialization state.

As shown in below figure, the LM940 becomes operational (in the Activation state) at least 15 seconds after the VBATT is supplied.

LM940 Initialization and Activation



Information – To check if the LM940 has completely powered on, LM940 and the host must be connected via USB. When USB driver completely loaded, the module has completely powered on and is ready to accept AT commands.

Information – During SW initialization of the LM940, the SW configures all pins and interfaces to their desired mode. When VREG_L6_1P8 goes high, this indicates that the initialization of all I/O pins is completed.

Information – Active low signals are labeled with a name that ends with "_N"

Information – 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.

6.3. Power Off

The LM940 module can be shut down by a software command.

When a shutdown command is sent, LM940 goes into the Finalization state and at the end of the finalization process shuts down VREG_L6_1P8. The duration of the finalization state can differ according to the current situation of the module, so a value cannot be defined.

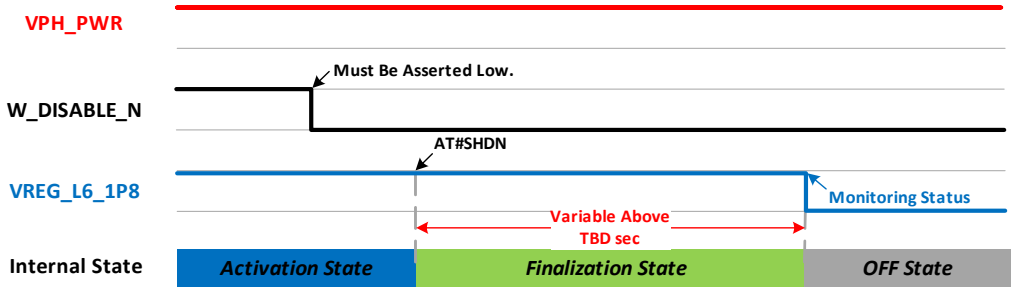
Usually, it will take more than 12 seconds from sending a shutdown command until reaching a complete shutdown. The DTE should monitor the status of VREG_L6_1P8 to observe the actual power-off.

Information – To completely shut down the LM940 module, the W_DISABLE_N pin must be asserted low.

Otherwise, the LM940 will turn on again after shut down.

Information – 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.

Shutdown by Software Commnad

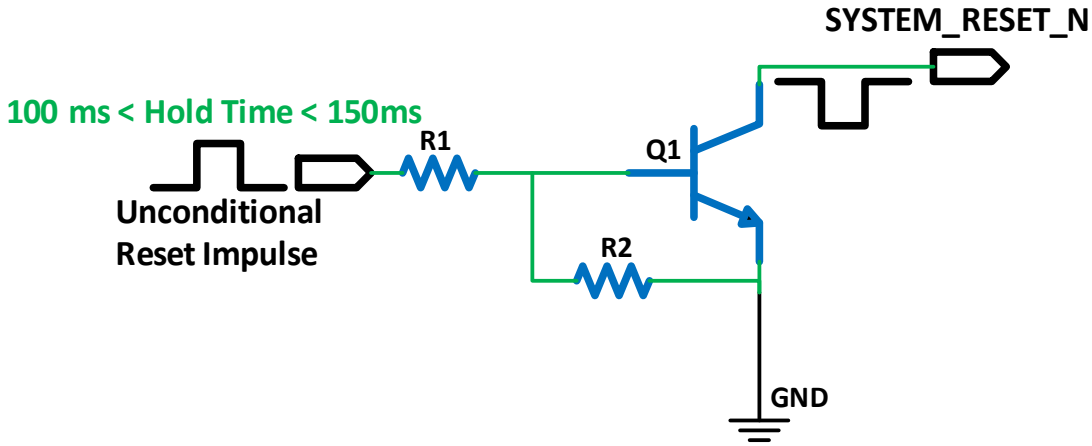


6.4. Unconditional Hardware Reset

To unconditionally restart the LM940 module, the SYSTEM_RESET_N pin must be asserted low for a between 100 milliseconds and 150milliseconds then released.

Below figure shows a simple circuit for this action.

Circuit for Unconditional Hardware Reset



Information – The Unconditional Hardware Reset must be used only as an emergency exit procedure, and not as a normal power-off operation.

Information – Do not use any pull-up resistor on the RESET_N line or any totem pole digital output. Using a pull-up resistor may cause latch-up problems on the LM940 power regulator and improper functioning of the module. The RESET_N line must be connected only in an open-collector configuration.

6.5. Communication ports

Below table summarizes all the hardware interfaces of the LM940 module.

LM940 Hardware Interfaces

Interface	LM940
USB	Super-speed USB3.0 with high-speed USB2.0
USIM	x2, dual voltage each (1.8V/2.85V)
Control Signals	W_DISABLE_N, WAKE_N, WAN_LED_N
GPIO	X4, GPIO
I2C	I2C (optional)
Audio I/F	PCM (optional)
Antenna ports	2 for Cellular, 1 for GNSS

6.5.1. USB Interface

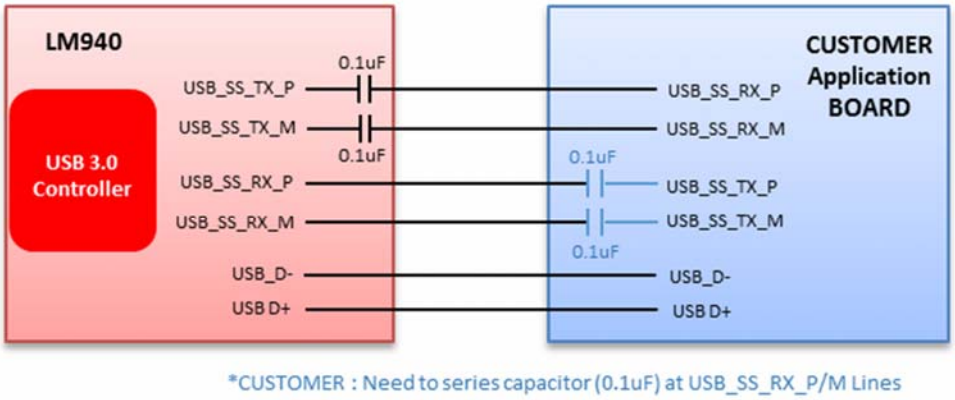
The LM940 module includes super-speed USB3.0 with high-speed USB2.0 backward compatibility. It is compliant with Universal Serial Bus Specification, Revision 3.0 and can be used for control and data transfers as well as for diagnostic monitoring and firmware update.

The USB port is typically the main interface between the LM940 module and OEM hardware.

USB 3.0 needs series capacitors on the TX lines in both directions for AC coupling. In order to interface USB3.0 with an application board of customer, 0.1uF capacitors should be installed on USB_SS_RX_P/M lines of the LM940. There are already series capacitors on USB_SS_TX_P/M lines inside LM940 module.

The USB interface suggested connection is the following:

Connection for USB Interface



Information – The USB 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.

Below table lists the USB interface signals.

USB Interface Signals

PIN	Signal	I/O	Function	Type	Comment
38	USB_D+	I/O	USB 2.0 Data Plus	Analog	
36	USB_D-	I/O	USB 2.0 Data Minus	Analog	
33	USB_SS_RX_P	I	USB 3.0 super-speed receive – plus	Analog	
31	USB_SS_RX_M	I	USB 3.0 super-speed receive – minus	Analog	
25	USB_SS_TX_P	O	USB 3.0 super-speed transmit – plus	Analog	
23	USB_SS_TX_M	O	USB 3.0 super-speed transmit – minus	Analog	

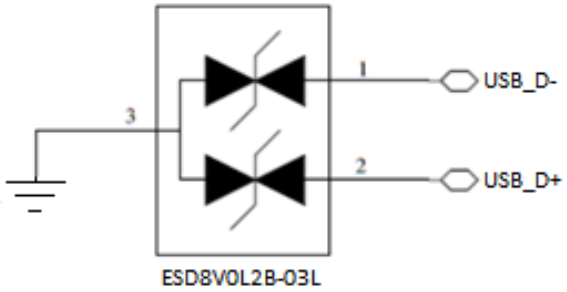
Information – Even if USB communication is not used, it is still highly recommended to place an optional USB connector on the application board.

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

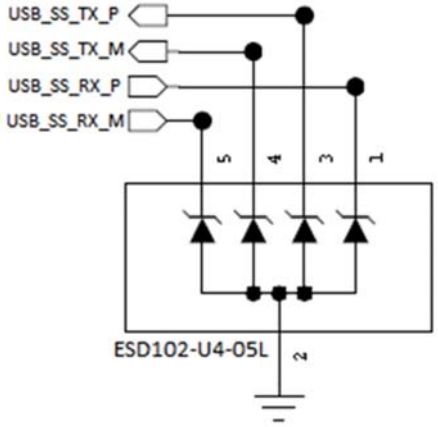
Information – Consider placing a low-capacitance ESD protection component to protect LM940 against ESD strikes

If an ESD protection should be added, the suggested connectivity is as follows:

ESD Protection for USB2.0



ESD Protection for USB3.0



6.5.2. SIM Interface

The LM940 supports two external SIM interfaces (1.8V or 2.85V).

Below table lists the SIM interface signals.

SIM Interface Signals

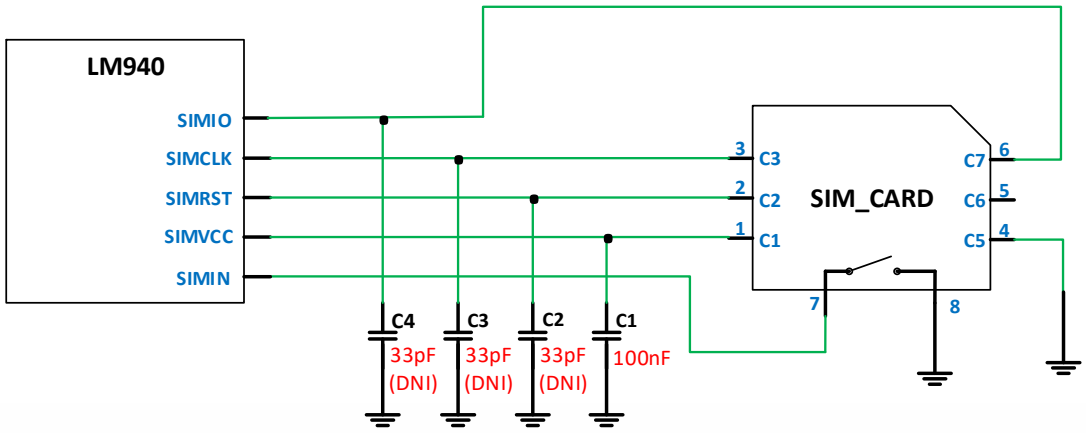
PIN	Signal	I/O	Function	Type	Comment
SIM Card Interface 1					

8	SIMVCC1	O	Supply output for an external UIM1 card	1.8V / 2.85V	Power
10	SIMIO1	I/O	Data connection with an external UIM1 card	1.8V / 2.85V	
12	SIMCLK1	O	Clock output to an external UIM1 card	1.8V / 2.85V	
14	SIMRST1	O	Reset output to an external UIM1 card	1.8V / 2.85V	
SIM Card Interface 2					
13	SIMVCC2	O	Supply output for an external UIM2 card	1.8 / 2.85V	Power
19	SIMIO2	I/O	Data connection with an external UIM2 card	1.8 / 2.85V	
17	SIMCLK2	O	Clock output to an external UIM2 card	1.8 / 2.85V	
7	SIMRST2	O	Reset output to an external UIM2 card	1.8 / 2.85V	
Digital I/O (GPIOs)					
3	GPIO_01	I	UIM1 Card Present Detect	1.8V	GPIO_01 can be used as SIMIN1
5	GPIO_02	I	UIM2 Card Present Detect	1.8V	GPIO_02 can be used as SIMIN2

6.5.2.1. SIM Schematic Example

The following Figures illustrate in particular how the application side should be designed.

SIM Schematics



Information – LM940 contains an internal pull-up resistor on SIMIO. It is not necessary to install external pull – up resistor.

6.5.3. Control Signals

The LM940 supports the following control signals:

- W_DISABLE_N
- WAKE_N
- WAN_LED_N

Below table lists the control signals of LM940.

Module Control Signal

PIN	Signal	I/O	Function	Type	Comment
20	W_DISABLE_N	I	RF disable (airplane mode)	1.8V	
1	WAKE_N	O	Host wake-up	1.8V	
42	WAN_LED_N	O	LED control	1.8V	

6.5.3.1. W_DISABLE_N

The W_DISABLE_N signal is provided to make the LM940 goes into the airplane mode:

- Enter into the airplane mode: Low
- Normal operating mode: High or Leave the W_DISABLE_N not connected

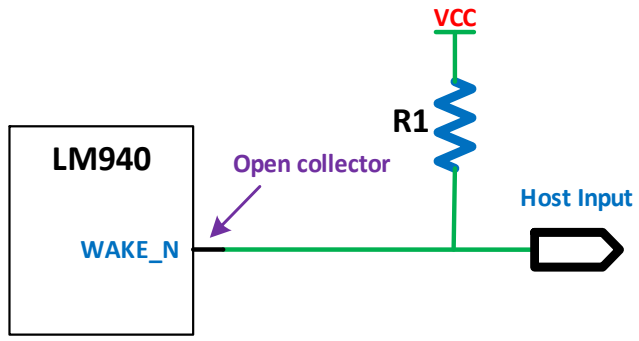
The W_DISABLE_N should be controlled when the LM940 to either turn on or off.

6.5.3.2. WAKE_N

The WAKE_N signal wakes the host when specific events occur.

Recommended WAKE_N connection is the following:

Recommended WAKE_N connection

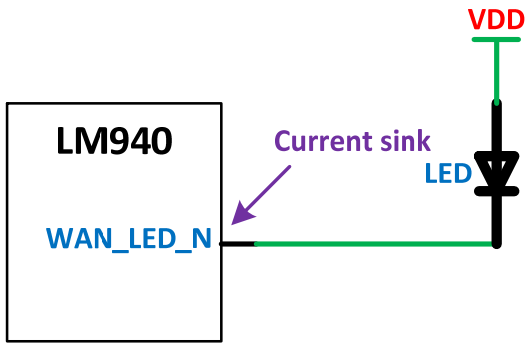


6.5.3.3. WAN_LED_N

The WAN_LED_N signal drives the LED output.

The recommended WAN_LED_N connection is the following:

Recommended WAN_LED_N connection



6.5.4. General Purpose I/O

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

- Input
- Output
- Dedicate Function (Customer Requirement)

Input pins can only be read and report digital values (high or low) present on the pin at the read time. Output pins can only be written or queried and set the value of the pin output.

The following GPIOs are always available as a primary function on the LM940.

Below table lists the GPIO signals of LM940.

GPIOs

Pin no.	Signal	I/O	Function	Type	Drive Strength
3	GPIO_01	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
5	GPIO_02	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
44	GPIO_03	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA
46	GPIO_04	I/O	Configurable GPIO	CMOS 1.8V	2-16 mA

6.5.4.1. Using a GPIO Pin as Input

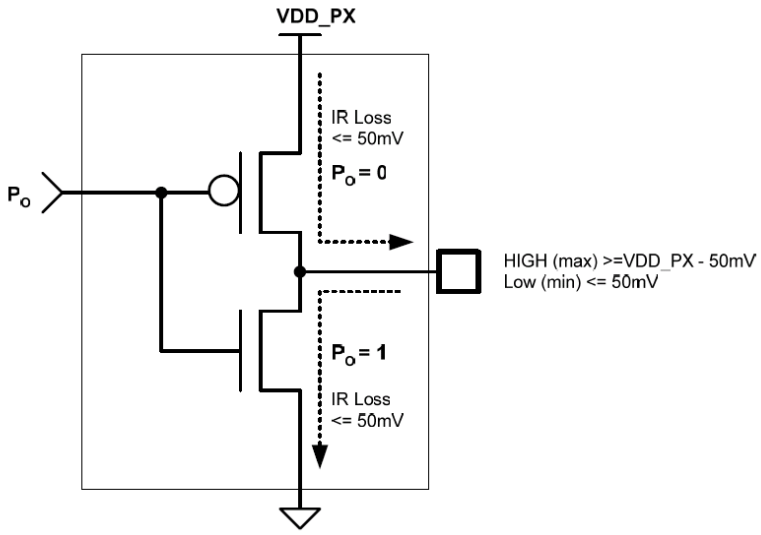
GPIO pins, when used as inputs, can be tied to a digital output of another device and report its status, provided the device interface levels are compatible with the GPIO 1.8V CMOS levels.

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

6.5.4.2. Using a GPIO Pin as Output

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

GPIO Output Pin Equivalent Circuit



6.5.5. I2C – Inter-integrated circuit

The LM940 supports an I2C interface on the following pins:

Below table lists the I2C signals of LM940.

Module I2C Signal

PIN	Signal	I/O	Function	Type	Comment
30	I2C_SCL	O	I2C Clock	CMOS 1.8V	
32	I2C_SDA	I/O	I2C Data	CMOS 1.8V	

The I2C interface is used for controlling peripherals inside the module (such as codec, etc.).

Information – I2C is supported only on from Modem side as SW emulation of I2C on GPIO lines.

Please contact us if you use it.

Information – If the I2C interface is not used, the signals can be left floating.

6.6. Using the Temperature Monitor Function

The Temperature Monitor permits to monitor the module's internal temperature and, if properly set (see the #TEMPSENS command in LM940 AT Commands Reference Guide), raises a GPIO to High Logic level when the maximum temperature is reached.

7. RF SECTION

7.1. Antenna requirements

The antenna connection is one of the most important aspect in the full product design as it strongly affects the product overall performance. Hence read carefully and follow the requirements and the guidelines for a proper design.

The LM940 is provided with three RF connectors.

The available connectors are:

- Main RF antenna: TX/RX path
- Auxiliary RF antenna: Combined Diversity and GNSS
- GNSS RF antenna: Dedicated GNSS

7.2. Main Antenna Requirements

The antenna for the LM940 device must meet the following requirements:

WCDMA / LTE Antenna Requirements

Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s) The bands supported by the LM940 is provided in Section 2.2, Product Variants and Frequency Bands.
Impedance	50 Ohm
Input power	> 24 dBm average power in WCDMA & LTE
VSWR absolute max	<= 10:1
VSWR recommended	<= 2:1

7.3. Antenna Diversity Requirements

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

Antenna Diversity Requirements

Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s) The bands supported by the LM940 is provided in Section 2.2, Product Variants and Frequency Bands.
Impedance	50Ω
VSWR recommended	≤ 2:1

The second Rx antenna should not be located in the close vicinity of main antenna. In order to improve Diversity Gain, Isolation and reduce mutual interaction, the two antennas should be located at the maximum reciprocal distance possible, taking into consideration the available space into the application. For the same reason, the Rx antenna should also be cross-polarized with respect to the main antenna.
Isolation between main antenna and Rx antenna must be at least 10 dB in all uplink frequency bands.

Envelope Correlation Coefficient (ECC) value should be as close as possible to zero, for best diversity performance. ECC values below 0.5 on all frequency bands are recommended.

7.4. GNSS Receiver

The LM940 integrates a GNSS receiver that could be used in Standalone mode and in A-GPS (assisted GPS), according to the different configurations.

LM940 supports an active antenna.

Frequency range	• Wide-band GNSS: 1560–1606 MHz recommended • Narrow-band GPS: 1575.42 MHz ± 2 MHz minimum • Narrow-band Galileo: 1575.42 MHz ± 2 MHz minimum • Narrow-band BeiDou: 1561.098 MHz ± 2 MHz minimum • Narrow-band GLONASS: 1601.72 MHz ± 4.2 MHz minimum.
Gain	1.5 dBi < Gain < 3 dBi
Impedance	50 Ohm
Amplification	18 dB < Gain < 21 dB
Supply Voltage	3.1 V
Current consumption	20 mA Typical

7.4.1. GNSS RF Front End Design

The LM940 contains an integrated LNA and pre-select SAW filter.
This allows the module to work well with a passive GNSS antenna. If the antenna cannot be located near the LM940, then an active antenna (that is, an antenna with a low noise amplifier built in) can be used with an external dedicated power supply circuit.

GNSS rescive path uses either the dedicated GNSS connector or the shared AUX connector.

NOTE – Please refer to the LM940 AT Commands Reference Guide, 80545ST10791A for detailed information about GNSS operating modes and GNSS Antenna selection.

7.5. Antenna connection

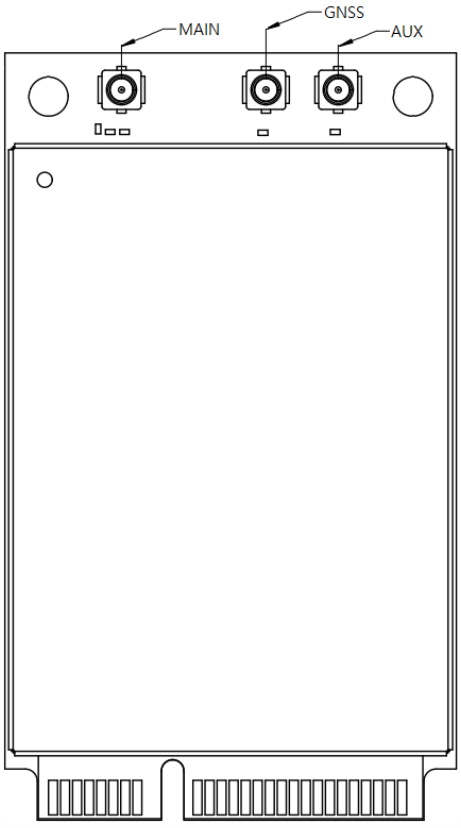
7.5.1. Antenna Connector

The LM940 is equipped with a set of 50 Ω RF U.FL. connectors from Hirose U.FL-R-SMT-1(10).

The available connectors are:

- Main RF antenna: TX/RX path
- Auxiliary RF antenna: Combined Diversity and GNSS
- GNSS RF antenna: Dedicated GNSS

See the picture on the below for their position on the interface.



For more information about mating connectors visit the website http://www.hirose-connectors.com/

7.5.2. Antenna Cable

Connecting cables between the module and the antenna must have 50 Ω impedance.
If the impedance of the module is mismatched, RF performance is reduced significantly.

If the host device is not designed to use the module's diversity or GNSS antenna, terminate the interface with a 50Ω load.

Minimize Antenna Cable Requirements

Impedance	50 Ohm
Max cable loss	0.5 dB
Avoid coupling with other signals.	

7.5.3. 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.

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

Information

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 LM940 module. Antennas used for this OEM module must not exceed gain of below table for mobile and fixed operating configurations.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

8. AUDIO SECTION

8.1. Audio Interface

The LM940 module supports digital audio interfaces.

8.2. Digital Audio

The LM940 module can be connected to an external codec through the digital interface.

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

Digital Audio Interface Signals

Pin no.	Signal	I/O	Function	Type	COMMENT
51	DVI_WAO	O	PCM Frame Sync	B-PD 1.8V	
49	DVI_RX	I	PCM Data In	B-PD 1.8V	
47	DVI _TX	O	PCM Data Out	B-PD 1.8V	
45	DVI _CLK	O	PCM Clock	B-PD 1.8V	

LM940 PCM 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

NOTE – If the Digital Audio Interface is not used, the signals can be left floating.

9. MECHANICAL DESIGN

9.1. General

The LM940 module was designed to be compliant with a standard lead-free SMT process. Moreover, it is compatible with the Mini PCIe card 52-pin card edge-type connector.

9.2. Finishing & Dimensions

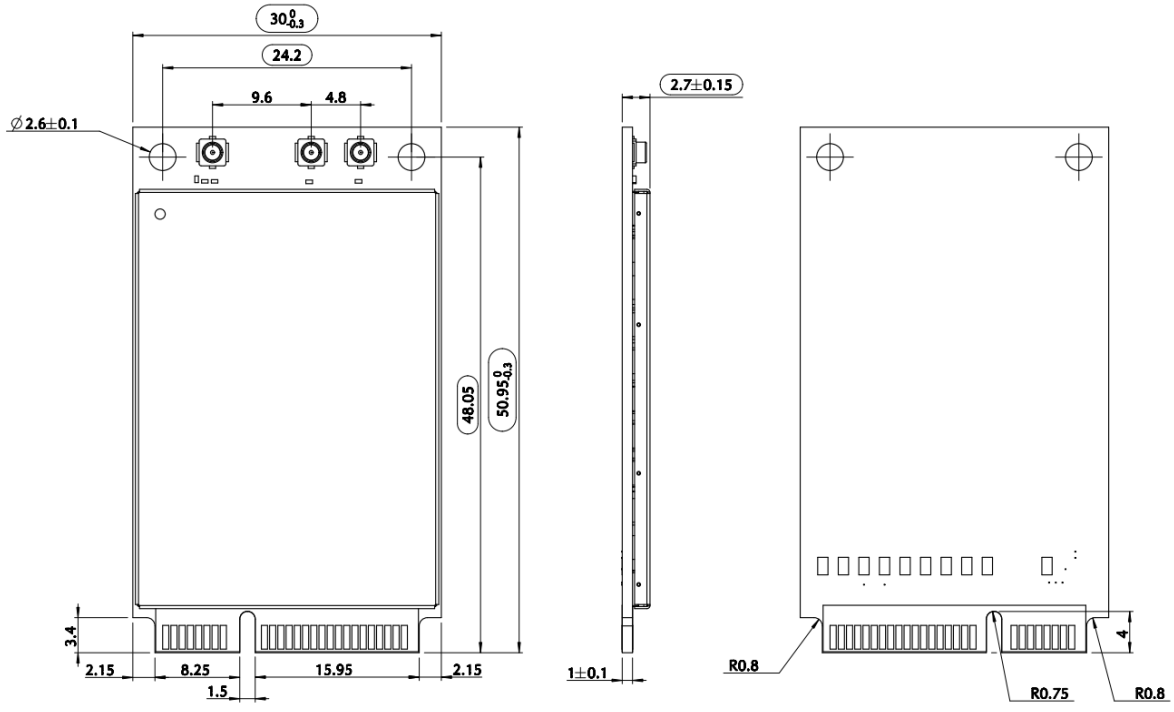
The LM940 module's overall dimensions are:

- Length: 50.95 mm
- Width: 30.00 mm
- Thickness: 2.70 mm

The module complies with the standard dimensions specified in the *PCI Express Mini Card Electromechanical Specification Revision 1.1*

9.3. Drawing

This figure shows the mechanical dimensions of the LM940 module.



10. APPLICATION GUIDE

10.1. Debug of the LM940 Module in Production

To test and debug the mounting of the LM940 module, we strongly recommend to add several test pins on the host PCB for the following purposes:

- Checking the connection between the LM940 itself and the application
- Testing the performance of the module by connecting it with an external computer

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

- SYSTEM_RESET_N, W_DISABLE_N, WAKE_N
- VBATT, GND
- VREG_L6_1P8
- USB_D-, USB_D+
- USB_SS_TX_M, USB_SS_TX_P, USB_SS_RX_M, USB_SS_RX_P

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

- WAN_LED_N
- GPIO_01, GPIO_02, GPIO_03, GPIO_04

10.2. 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

Recommended values are:

- 100uF for VBATT

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.
And if customers use the fast power down function, then more bypass capacitors should be mounted on the application board.

10.3. EMC Recommendations

EMC protection on the pins in the table below should be designed by application side according to the customer's requirement.

EMC Recommendations

Pin	Signal	I/O	Function	Type	Comment
USB HS 2.0 Communication Port					
38	USB_D+	I/O	USB 2.0 Data Plus	Analog	
36	USB_D-	I/O	USB 2.0 Data Minus	Analog	
USB SS 3.0 Communication Port					
33	USB_SS_RX_P	I	USB 3.0 super-speed receive – plus	Analog	
31	USB_SS_RX_M	I	USB 3.0 super-speed receive – minus	Analog	
25	USB_SS_TX_P	O	USB 3.0 super-speed transmit – plus	Analog	
23	USB_SS_TX_M	O	USB 3.0 super-speed transmit – minus	Analog	
SIM Card Interface 1					
14	SIMRST1	O	Reset output to an external UIM1 card	1.8 / 2.85V	
12	SIMCLK1	O	Clock output to an external UIM1 card	1.8 / 2.85V	
10	SIMIO1	I/O	Data connection with an external UIM1 card	1.8 / 2.85V	

8	SIMVCC1	O	Supply output for an external UIM1 card	1.8 / 2.85V	Power
SIM Card Interface 2					
7	SIMRST2	O	Reset output to an external UIM2 card	1.8 / 2.85V	
17	SIMCLK2	O	Clock output to an external UIM2 card	1.8 / 2.85V	
19	SIMIO2	I/O	Data connection with an external UIM2 card	1.8 / 2.85V	
13	SIMVCC2	O	Supply output for an external UIM2 card	1.8 / 2.85V	Power
Digital I/O (GPIOs)					
3	GPIO_01	I/O	General purpose I/O	1.8V	
5	GPIO_02	I/O	General purpose I/O	1.8V	
44	GPIO_03	I/O	General purpose I/O	1.8V	
46	GPIO_04	I/O	General purpose I/O	1.8V	
1	WAKE_N	O	Host wake-up	1.8V	Active Low
42	WAN_LED_N	O	LED control	1.8V	
Power ON/OFF Reset IN/OUT					
20	W_DISABLE_N	I	Module & RF ON/OFF Control	1.8V	Active Low
22	SYSTEM_RESET_N	I	Reset Input	1.8V	Active Low
1.8V Voltage Regulator					
11	VREG_L6_1P8	O	LDO out for 1.8V	Power	

All other pins have the following characteristics:

Human Body Model (HBM): ± 1000 V

Charged Device Model (CDM) JESD22-C101-C: ± 250 V

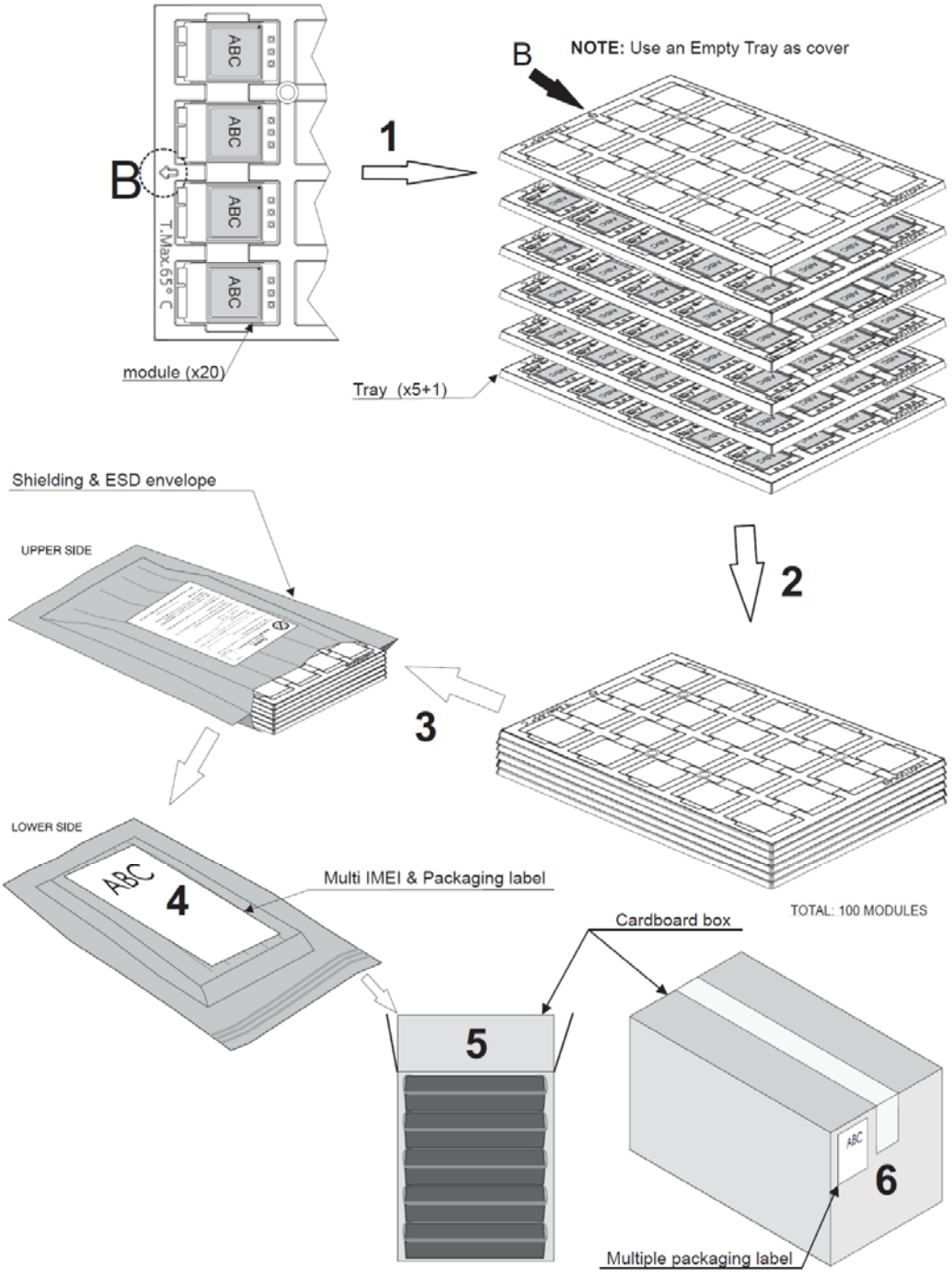
All Antenna pins up to ± 4 kV

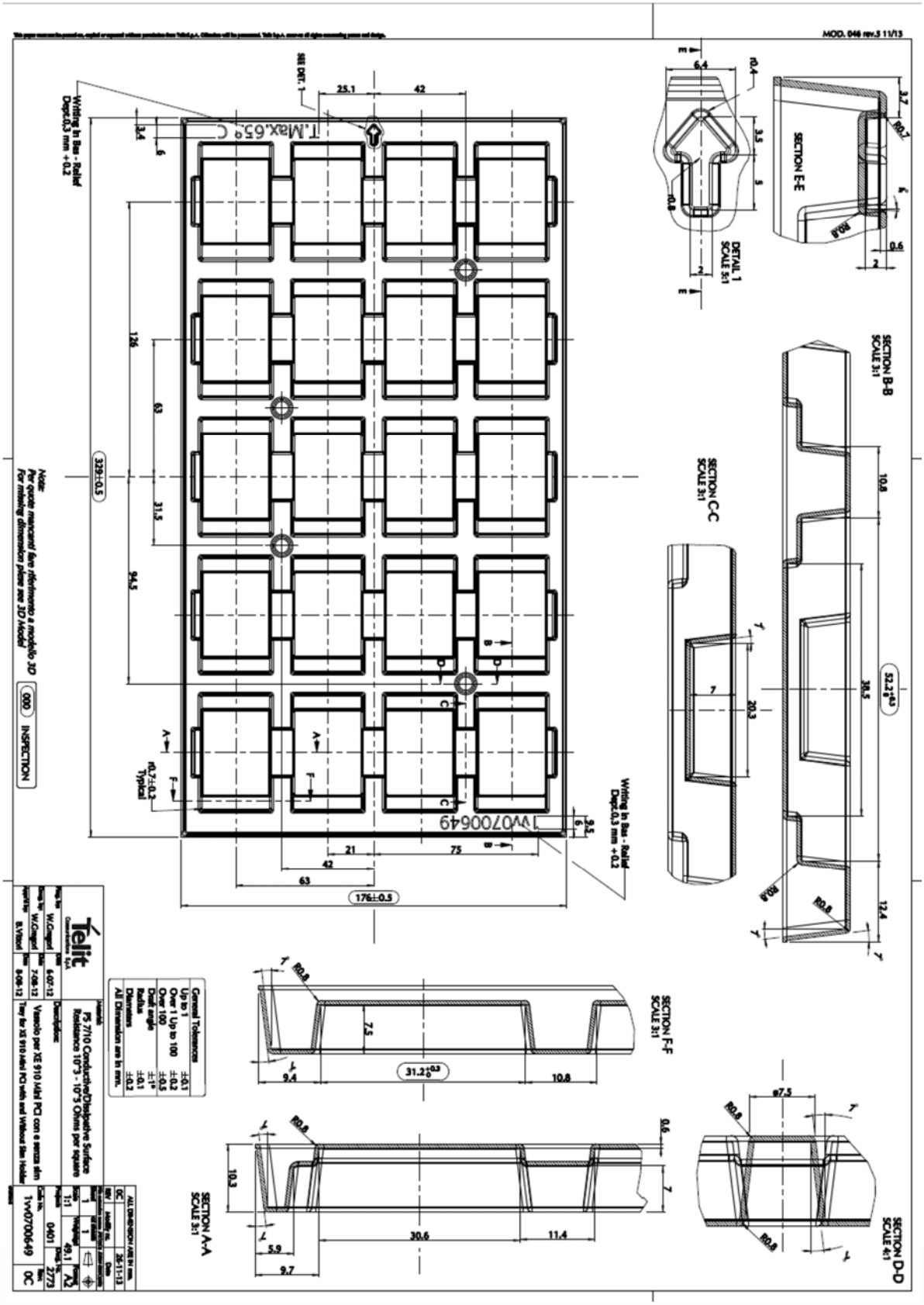
Warning – Do not touch without proper electrostatic protective equipment. The product must be handled with care, avoiding any contact with the pins because electrostatic discharge may damage the product itself.

11. PACKAGING

11.1. Tray

The LM940 modules are packaged on trays of 20 pieces each. These trays can be used in SMT processes for pick & place handling.




MOD. 046 rev.5 11/13
SEE DET. 1
25.1
42
Writing In Bas - Relief
Dept.0.3 mm +0.2
T.Max.65°C
3.4
6
126
63
31.5
94.5
329±0.5
R0.2±0.2
Typical
1VV0700649
21
75
42
63
176±0.5
9.5
6
Writing In Bas - Relief
Dept.0.3 mm +0.2
6.4
R0.4
3.5
5
10.8
DETAIL 1
SCALE 5:1
SECTION E-E
3.7
60°
4
R0.8
0.6
2
SECTION B-B
SCALE 3:1
10.8
38.5
52.2+0.3
12.4
R0.8
R0.8
SECTION C-C
SCALE 3:1
7
20.3
SECTION F-F
SCALE 3:1
R0.8
7.5
9.4
31.2+0.3
10.8
SECTION A-A
SCALE 3:1
R0.8
10.3
0.6
7
30.6
11.4
5.9
9.7
SECTION D-D
SCALE 4:1
ø7.5
R0.8
R0.8
Note:
Per quote mancanti fare riferimento a modello 3D
For missing dimension please see 3D Model
000
INSPECTION
General Tolerances
Up to 1 ±0.1
Over 1 Up to 100 ±0.2
Over 100 ±0.3
Dual angle ±1°
Radius ±0.1
Dimensions ±0.2
All Dimension are in mm.
Telit
Telit Communications S.p.A.
Drawing type: W.Cinquini
Date: 6-07-12
Approved: W.Cinquini
Date: 7-08-12
Supervisor: S.Vitali
Date: 8-08-12
Material:
FS 2710 Conductive/Dissipative Surface
Resistance 10^3 - 10^5 Ohms per square
Description:
Vassoio per XE 910 HSPA PCI con o senza slim
Tray for XE 910 HSPA PCI with and Without Slim Holder
Finish:
Scale: 1:1
Weight: 49.1
Drawing No.: 2773
Code no.: 1VV0700649
Rev.: 0C
ALL DIMENSION ARE IN mm.
0C
26-11-13

12. CONFORMITY ASSESSMENT ISSUES

12.1. Approvals

- Fully type approved confirming with R&TTE directive
- CE, GCF
- FCC, IC, PTCRB
- RoHS and REACH
- Approvals for major Mobile Network Operators

12.2. Declaration of Conformity

The DoC is available here: www.telit.com/RED/

12.3. FCC certificates

The FCC Certifcate is available here: www.fcc.gov/oet/ea/fccid

12.4. IC certificates

The IC Certifcate is available here:

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

12.5. FCC/IC 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

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.

RF exposure

This equipment complies with FCC and ISED radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body. Antenna gain must be below:

Cet appareil est conforme aux limites d'exposition aux rayonnements de l'ISED pour un environnement non contrôlé. L'antenne doit être installé de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps. Gain de l'antenne doit être ci-dessous:

WCDMA / LTE Antenna (except Band 30)

- Brand : HNS (HANKOOK Network Solution)
- Model Number : WE14-LF-07
- Type : Dipole Antenna

LTE Antenna for Band 30

- Brand : SAE HAN ANTENNA CO.,LTD
- Model Number : DH-23T-ANT
- Type : Dipole Antenna

Mode	Band	Antenna Gain (dBi)
LTE	FDD 2100 – B1	3.5
	FDD 1900 PCS – B2	3.5
	FDD 1800+ – B3	3.5
	FDD 1800 AWS-1 – B4	3.5
	FDD 850 – B5	3.0
	FDD 2600 – B7	4.0
	FDD 900 – B8	3.0
	FDD 700a – B12	3.0
	FDD 700c – B13	3.0
	FDD 700b – B17	3.0
	FDD 800 – B20	3.0

	FDD 1900+ – B25	3.5
	FDD 850+ – B26	3.0
	FDD 700 APT – B28	3.0
	FDD 700d – B29	3.0
	FDD 2300 WCS – B30	1.5
	FDD AWS-3 – B66	3.5
	TDD 2600 – B38	4.0
	TDD 2300 – B40	4.0
	TDD 2500 – B41	4.0
WCDMA	2100 – B1	3.5
	1900 PCS – B2	3.5
	1800 AWS-1 – B4	3.5
	850 – B5	3.0
	900 – B8	3.0

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

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 ISED of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

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 l'ISED du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit :

LM940
Contains FCC ID: RI7LM940
Contains IC: 5131A-LM940

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.

13. SAFETY RECOMMENDATIONS

13.1. READ CAREFULLY

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and has to 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 regulation and the specific environment regulation.

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

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

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

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. REFERENCE TABLE OF RF BANDS CHARACTERISTICS

RF Bands Characteristics

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
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 AWS – B4	1710 ~ 1755	2110 ~ 2155	Tx: 1537 ~ 1738 Rx: 1312 ~ 1513	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
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-1 – 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 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

Mode	Freq. Tx (MHz)	Freq. Rx (MHz)	Channels	Tx-Rx Offset
LTE 700b – B17	704 ~ 716	734 ~ 746	Tx: 23730 ~ 23849 Rx: 5730 ~ 5849	30 MHz
LTE 800 – B20	832 ~ 862	791 ~ 821	Tx: 24150 ~ 24449 Rx: 6150 ~ 6449	-41 MHz
LTE 1900+ – B25	1850 ~ 1915	1930 ~ 1995	Tx: 8040 ~ 8689 Rx: 26040 ~ 26689	80 MHz
LTE 850+ – B26	814 ~ 849	859 ~ 894	Tx: 8690 ~ 9039 Rx: 26690 ~ 27039	45 MHz
LTE 700 APT – B28	703 ~ 748	758 ~ 803	Tx: 9210 ~ 9659 Rx: 27210 ~ 27659	55 MHz
LTE 700 d – B29	Downlink only	717 ~ 728	Rx: 9660 ~ 9769	–
LTE 2300 WCS – B30	2305 ~ 2315	2350 ~ 2360	Tx: 9770 ~ 9869 Rx: 27660 ~ 27759	45 MHz
LTE AWS-3 – B66	1710 ~ 1780	2110 ~ 2200	Tx: 66436 ~ 67335 Rx: 131972 ~ 132671	400 MHz
LTE TDD 2600 – B38	2570 ~ 2620	2570 ~ 2620	Tx: 37750 ~ 38250 Rx: 37750 ~ 38250	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 ~ 41589 Rx: 39650 ~ 41589	0 MHz

15. ACRONYMS

TTSC	Telit Technical Support Centre
USB	Universal Serial Bus
HS	High Speed
DTE	Data Terminal Equipment
UMTS	Universal Mobile Telecommunication System
WCDMA	Wideband Code Division Multiple Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
UART	Universal Asynchronous Receiver Transmitter
HSIC	High Speed Inter Chip
SIM	Subscriber Identification Module
SPI	Serial Peripheral Interface
ADC	Analog – Digital Converter
DAC	Digital – Analog Converter
I/O	Input Output
GPIO	General Purpose Input Output
CMOS	Complementary Metal – Oxide Semiconductor
MOSI	Master Output – Slave Input
MISO	Master Input – Slave Output
CLK	Clock
MRDY	Master Ready

SRDY	Slave Ready
CS	Chip Select
RTC	Real Time Clock
PCB	Printed Circuit Board
ESR	Equivalent Series Resistance
VSWR	Voltage Standing Wave Radio
VNA	Vector Network Analyzer
FDD	Frequency division duplex
I2C	Inter-integrated circuit
LTE	Long term evolution
SOC	System-on-Chip

16. DOCUMENT HISTORY

Revision	Date	Changes
0	2017-01-17	First Draft
1	2017-06-23	Changed document form
2	2017-07-19	Updated 7. RF section Updated 12.5 RF exposure

SUPPORT INQUIRIES

Link to **www.telit.com** and contact our technical support team for any questions related to technical issues.

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