Telit Cinterion

FN990Bxx Family

Hardware Design Guide

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Technical Documentatior

Contents

1 Applicability Table

Table 1: Applicability Table

Products
FN990B40
FN990B34

Note: The applied SDX chipset varies depending on the HW version.

- FN990B40 – HW1.00: SDX72-0
- FN990B34 – HW1.10: SDX72-1

Note: The applied MCP varies depending on the Hardware version.

- HW1.00: 8G+8G MCP Memory
- HW1.10: 4G+4G MCP Memory

2 Introduction

2.1 Scope

This document introduces Telit FN990B Family module and presents possible and recommended hardware solutions for the development of a product based on this module. All the features and solutions described in this document apply to FN990B Family variant listed in the applicability table.

This document cannot include every hardware solution or every product that can be designed. Where the suggested hardware configurations are not to be considered mandatory, the information provided should be used as a guide and starting point for the proper development of the product with the Telit FN990B Family module.

2.2 Audience

This document is intended for system integrators that are using the Telit FN990B Family module in their products.

2.3 Contact Information, Support

For technical support and general questions, e-mail:

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

Alternatively, use: https://www.telit.com/contact-us/

For Product information and technical documents, visit: https://www.telit.com

2.4 Conventions

Note:	Provide advice and suggestions that may be useful when integrating the module.
Danger:	This information MUST be followed, or catastrophic equipment failure or personal injury may occur.
Warning:	Alerts the user on important steps about the module integration.

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

2.5 Terms and Conditions

Refer to https://www.telit.com/terms-conditions/

2.6 Disclaimer

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3 General Product Description

3.1 Overview

This document aims to present the possible and recommended hardware solutions useful for developing a product with the Telit FN990B Family module.

The FN990B is Telit's platform for the M.2 module for applications such as M2M applications and industrial IoT device platforms, based on the following technologies:

- 5G sub-6 / 4G / 3G networks for data communication.
- Industrial grade quality design.

It acts as a front-end for mobile products, providing mobile communication features to an external host CPU through its rich interfaces.

The FN990B Family is available in multiple hardware variants, as specified in the Applicability Table.

The designated RF band set for each variant are detailed in section Product Variants and Frequency Bands.

3.2 Product Variants and Frequency Bands

The FN990B module supports operating frequencies in 5G, LTE, and WCDMA modes, adhering to 3GPP specifications.

The table below lists the FN990B operating frequencies on 5G, LTE, and WCDMA modes.

Table 2: Product Variants

Product	WCDMA	LTE	5G	VoLTE	Region
FN990B40 FN990B34	B1, B2, B4, B5, B8	B1,B2,B3,B4,B5,B7,B8, B12,B13,B14,B17,B18, B19,B20,B25,B26,B28, B29,B30,B32,B106,B34, B38,B39,B40,B41,B42, B43,B46,B48,B53,B66, B67,B68,B70,B71	n1,n2,n3,n5,n7,n8,n12, n13,n14,n18,n20,n25, n26,n28,n29,n30,n38, n40,n41,n48,n53,n66, n67,n70,n71,n75,n76, n77,n78,n79,n91,n92, n93,n94	N	WW

For details information about frequencies and bands, refer to the "RF Section".

> **Note:** Cellular technologies and frequency bands that are enabled may vary based on the firmware version and configuration used.

3.3 Target Market

The FN990B Family can be used for industrial applications where tamper-resistance, confidentiality, integrity, and authenticity of end-user information are required, for example:

- Industrial router and gateways.
- Connected laptops and tablets.

- Network equipment requiring internet connectivity through cellular networks.

3.4 Main Features

The FN990B Family of industrial-grade cellular modules features 5G Sub-6, LTE, and multi-RAT modules together with an on-chip powerful application processor and a rich set of interfaces.

The main functions and features are listed below:

Table 3: Main Features

Function	Features
Physical	M.2 Type 3052-S3-B
Cellular technology	5G: FR1(Sub 6G), Rel 17 - FN990B40: NSA up to: 4.9 Gbps on DL, 0.55 Gbps on UL SA up to: 4.1 Gbps on DL, 0.90 Gbps on UL - FN990B34: NSA up to 3.6 Gbps on DL, 0.55 Gbps on UL SA up to 2.8 Gbps on DL, 0.9 Gbps on UL 4G: CAT. 20 (2.0Gbps) on DL, CAT. 18 (210Mbps) on UL, Rel 17 3G: HSPA+ Rel8 up to 42/11Mbps in DL/UL
Supported Bands	5G: n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29(SDL)/n30/n38/n40/n41/n48/ n53/n66/ n67(SDL) /n70/n71/n75(SDL)/n76(SDL)/n77/n78/n79/n91/n92/n93/n94 4G: B1/B2(B25)/B3/B4(B66)/B26(B5,B18,B19)/B7/B8/B12(B17)/B13/B14/B20/B28/ B29(SDL)/B30/ B32(SDL)/B106/B34/B38/B39/B40/B41/B42/B43/B46(SDL)/B48/B53/ B67(SDL) /B68/B70/B71 3G: B1/B2/B4/B5/B8
1Tx / 4Rx (4x4 DL MIMO)	4 × 4 Rx: All 4G and 5G MHB and UHB bands 2 × 2 Rx: LB and B46
2Tx (2x2 UL MIMO)/4Rx (4x4 DL MIMO)	5G: n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n66/n70/n77/n78/n79
TX Power calss (HPUE)	PC2: n2/n25/n66/n41/n77/n78/n79 UL MIMO PC1.5: n41/n77/n78/n79 UL MIMO
1Tx / 1Rx (2nd Rx Diversity)	4G: all operating bands 3G: all operating bands
GNSS	GPS/Glonass/Beidou/Galileo/QZSS/SBAS Two GNSS paths to support simulatneous L1, L5
USIM port – Dual Voltage	Two SIM support (UIM2 can be assigned as optional eSIM) Class B and Class C support
Application processor	Quad-core Arm Cortex A55 processor at up to 2.2 GHz running the Linux operating system. 8Gbit NAND Flash + 8Gbit LPDDR4x 2133 MHz MCP is supported

Function	Features
	4Gbit NAND Flash + 4Gbit LPDDR4x, 2133 Mhz MCP is supported
Main Interfaces	PCIe Gen 3 or 4 - one lane USB 2.0 / 3.1 Gen 2 Peripheral Ports – GPIOs
Antenna connection	4 x MHF-4 type Cellular connectors 1 x MHF-4 type Dedicated GNSS antenna connector
Form factor	M.2 Form factor (30 * 52 * 2.3 mm), accommodating the multiple RF bands
Environment and quality requirements	The device is designed and qualified by Telit to satisfy environmental and quality requirements.
Single supply module	The module internally generates all its required internal supply voltages.
Operating temperature	Operating temperature range: - 40 deg C ~ + 85 deg C Storage Temperature range: - 40 ~ +85 deg C
Operating Humidity	≤95%, non-condensing

3.4.1 Configurations Pins

FN990B Family module can be configured as USB 3.1 Gen 2 or PCIe devices. The primary host interface can be set using the four pins listed in the table below.

Table 4: Configurations Pins

Pin	Signal	State	Interface Type
21	CONFIG_0	GND	PCIe or USB 3.1 Gen 2 Port Configuration 2 (Applicable to WWAN only)
69	CONFIG_1	GND	
75	CONFIG_2	NC	
1	CONFIG_3	NC	

Note: On the host side, each of the CONFIG_0 to CONFIG_3 signals must be equipped with a pull-up resistor. Based on the state of the configuration pins on the Add-in Card, being tied to GND or left No Connect (NC), the detected pins will create a 4-bit logic state that requires decoding.

Used by an Add-in Card where USB 3.1 Gen2 is present on the connector and PCIe is No Connect.

Only a single lane of PCIe is available in these configurations.

For more details, refer to the PCI Express M.2 Specification document.

3.5 Mechanical Specifications

3.5.1 Dimensions

Overall FN990B Family dimensions are:

- Length: 52 mm
- Width: 30 mm
- Thickness: 2.3 mm

3.5.2 Weight

- The nominal weight of the FN990B Family is 9.6 grams.

3.6 Environmental Requirements

3.6.1 Temperature Range

Table 5: Temperature Range

Mode	Temperature	Note
Operating Temperature Range	–20°C ~ +55°C	The module is fully functional(*) in all the temperature range and it fully meets the 3GPP specifications.
	–40°C ~ +85°C	The module is fully functional (*) in all the temperature range, might slightly deviate from the 3GPP specifications. GNSS functionality may be affected at temperatures below -30°C.
Storage and non-operating Temperature Range	–40°C ~ +85°C	The module is not powered and not connected to power supply

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

Warning: The application processor temperature which is in the FN990B FAMILY must be kept below 95°C for the best performance. Depending on the various application, a heat sink, thermal pad, or, other cooling systems may be required to properly dissipate the heat.

A large solder-resist opening area is located on the bottom side of the module. Adding a TIM on that area with a heatsink is one of the best ways to dissipate the heat well. The temperature can be read via AT commands. For more details, please refer to the SW user guide or thermal design guideline.

Warning: Under temperature conditions at or below -40°C, the standby mode (CFUN=5) may not function as expected.

4 Pins Allocation

4.1 Pin-out

Table 6: FN990B FAMILY Pin-out Information

Pin	Signal	I/O	Function	Type	Comment
USB Communication Port					
7	USB_HS_DP	I/O	USB 2.0 Data Plus	Analog	
9	USB_HS_DM	I/O	USB 2.0 Data Minus	Analog	
29	USB_SS_TX_M	O	USB 3.1 super-speed transmit – Minus	Analog	
31	USB_SS_TX_P	O	USB 3.1 super-speed transmit – Plus	Analog	
35	USB_SS_RX_M	I	USB 3.1 super-speed receive – Minus	Analog	
37	USB_SS_RX_P	I	USB 3.1 super-speed receive – Plus	Analog	
PCIe Communication Port					
41	PCIE_TX0_M	O	PCIe transmit 0 – Minus	Analog	
43	PCIE_TX0_P	O	PCIe transmit 0 – Plus	Analog	
47	PCIE_RX0_M	I	PCIe receive 0 – Minus	Analog	
49	PCIE_RX0_P	I	PCIe receive 0 – Plus	Analog	
53	PCIE_REFCLK_M	I/O	PCIe differential reference clock – Minus	DI/DO	
55	PCIE_REFCLK_P	I/O	PCIe differential reference clock – Plus	DI/DO	
50	PCIE_RESET_N		Functional reset to PCIe bus		Internal 10k PU Input: Slave Output: Master
52	PCIE_CLKREQ_N		PCIe reference clock request signal		Internal 10k PU Input: Master Output: Slave
54	PCIE_WAKE_N		PCIe wake-up		Internal 10k PU Input: Master Output: Slave
SIM Card Interface 1					
36	UIM1_VCC	O	Supply output for an external UIM1 card	1.8V / 2.95V	Power
34	UIM1_DATA	I/O	Data connection with an external UIM1 card	1.8V / 2.95V	Internal 20k PU
32	UIM1_CLK	O	Clock output to an external UIM1 card	1.8V / 2.95V	
30	UIM1_RESET_N	O	Reset output to an external UIM1 card	1.8V / 2.95V	

Pin	Signal	I/O	Function	Type	Comment
66	UIM1_PRESENT	I	UIM1 Card Present Detect	1.8V	Internal 100k PU Active HIGH
SIM Card Interface 2					
48	UIM2_VCC	O	Supply output for an external UIM2 card	1.8V / 2.95 V	Power
42	UIM2_DATA	I/O	Data connection with an external UIM2 card	1.8V / 2.95 V	Internal 20k PU
44	UIM2_CLK	O	Clock output to an external UIM2 card	1.8V / 2.95 V	
46	UIM2_RESET_N	O	Reset output to an external UIM2 card	1.8V / 2.95 V	
40	UIM2_PRESENT	I	UIM2 Card Present Detect	1.8V	Internal 100k PU Active HIGH
Miscellaneous Functions					
6	FULL_CARD_POWER_OFF_N	I	Module On/Off	1.8V / 3.3V	Internal 100k PD
8	W_DISABLE1_N	I	RF disable	1.8V / 3.3V	
10	LED_N	O	LED control		Open Drain
23	WAKE_ON_WAN_N	O	Wake Host	1.8V	
65	VREG_L6B_1P8	O	Reference Voltage	1.8V	Power
67	SYS_RESIN_N	I	Reset Input	1.8V	Internal 100k PU
68	TGPIO_01	I/O	General Purpose I/O Can be I2S_CLK	1.8V	
25	TGPIO_02	I/O	General Purpose I/O Can be DPR	1.8V	
62	TGPIO_03	I/O	General Purpose I/O	1.8V	
64	TGPIO_04	I/O	General Purpose I/O	1.8V	
20	USB_PCIE_SWITCH	I	Switch Host Interface	1.8V	
22	TGPIO_06	I/O	General Purpose I/O Can be I2S_DIN	1.8V	
24	TGPIO_07	I/O	General Purpose I/O Can be I2S_DOUT	1.8V	
28	TGPIO_08	I/O	General Purpose I/O Can be I2S_WS	1.8V	
56	I2C_SDA	I/O	I2C Data Can be TGPIO_09	1.8V	Internal 2.2k PU
58	I2C_SCL	I/O	I2C Clock Can be TGPIO_10	1.8V	Internal 2.2k PU
38	1PPS	O	1PPS/TSN	1.8V	
26	W_DISABLE2_N	I	GNSS disable	1.8V / 3.3V	
MIPI Control					
61	RFFE0_DATA	I/O	Data	1.8V	
63	RFFE0_CLK	O	Clock	1.8V	

Pin	Signal	I/O	Function	Type	Comment
Power Supply					
2	VPH_PWR	I	Power supply	Power	
4	VPH_PWR	I	Power supply	Power	
70	VPH_PWR	I	Power supply	Power	
72	VPH_PWR	I	Power supply	Power	
74	VPH_PWR	I	Power supply	Power	
GROUND					
3	GND	-	Ground	Ground	
5	GND	-	Ground	Ground	
11	GND	-	Ground	Ground	
27	GND	-	Ground	Ground	
33	GND	-	Ground	Ground	
39	GND	-	Ground	Ground	
45	GND	-	Ground	Ground	
51	GND	-	Ground	Ground	
57	GND	-	Ground	Ground	
71	GND	-	Ground	Ground	
73	GND	-	Ground	Ground	
Config					
21	CONFIG_0	-		Ground	
69	CONFIG_1	-		Ground	
75	CONFIG_2	-		Floating	
1	CONFIG_3	-		Floating	
Reserved for Future Use					
59	RFU				
60	RFU				

Warning: Reserved pins must not be connected.

4.2 Mandatory Signal Connections

The below table specifies FN990B Family signals that must be connected for debugging purposes, even if they are not used in the final application.

Table 7: Mandatory Signals

Pin	Signal	Notes
2, 4, 70, 72, 74	VPH_PWR	
3, 5, 11, 27, 33, 39, 45, 51, 57, 71, 73	GND	
6	FULL_CARD_POWER_OFF_N	
7	USB_D+	If not used, connect to a test point or a USB connector.

Pin	Signal	Notes
9	USB_D-	If not used, connect to a test point or a USB connector.

4.3 Pin Layout

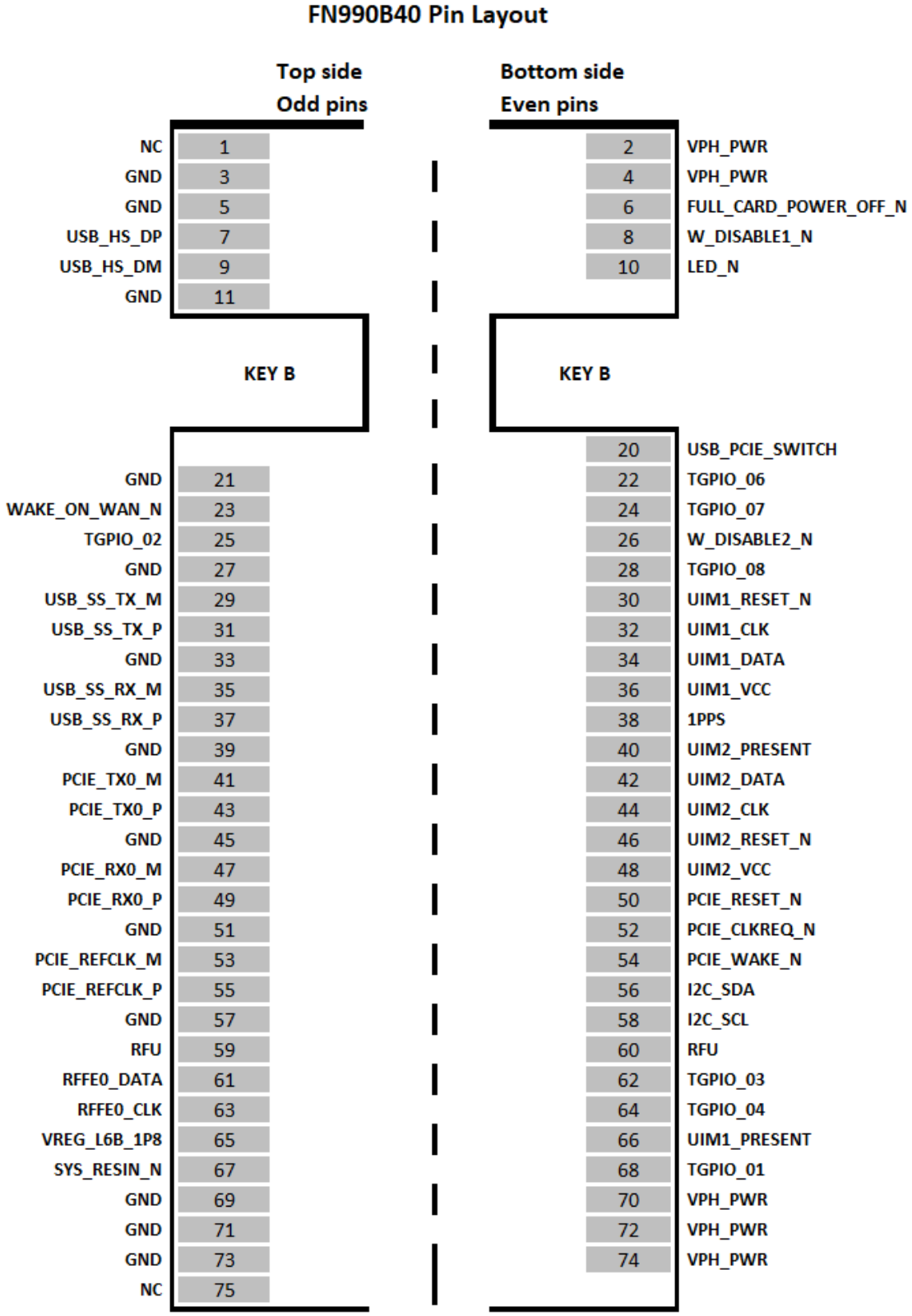

Figure 1: FN990B FAMILY Pinout

5 Power Supply

The power supply circuitry and board layout are very important areas of the whole product design, with a critical impact on the overall product performance. Please follow carefully the following requirements and guidelines to ensure a reliable and stable design.

5.1 Power Supply Requirements

The FN990B FAMILY power requirements are as follows:

Table 8: Power Supply Requirements

Power Supply	Value
Nominal Supply Voltage	3.3V
Supply Voltage Range	3.135 V – 4.4 V
Maximum ripple on the module input supply	30 mV
Peak current consumption*	3.3 V @ 4 A

*** The peak current must be higher than the average current due to TDD bands and power class 1.5.**

5.2 Power Consumption

Table 9: FN990B FAMILY Current Consumption

Mode	Average [Typ.]	Mode Description
IDLE Mode		
CFUN=1	109mA	No call connection USB is connected to a host
Airplane Mode (PSMWDISACFG=1, W_DISABLE1_N: Low)		
CFUN=0	3.7mA	Tx and Rx are disabled; the module is not registered on the network (Airplane mode) USB is disconnected
Standby Mode (PSMWDISACFG=1, W_DISABLE1_N: Low)		
CFUN=1	4.0mA	LTE FDD CDRX with 320 ms long CDRX cycle, 20 MHz, USB is disconnected
Operative Mode (WCDMA)		
WCDMA Voice	850mA	WCDMA B1 voice call (Tx=23dBm)
WCDMA HSPA	850mA	WCDAM data call (DC-HSDPA up to 42Mbps, Max through-put)
Operative Mode (LTE)		
Single-mode (1DL/1UL SISO)	800mA	Non-CA, B3 BW 10MHz, 1 RB, 23dBm, QPSK DL / QPSK UL
NSA mode 5CC	900mA	CA_1A-42E, DL 4x4, Full RB, 256QAM DL / 256QAM UL
Operative NSA Mode (NR-FR1)		
1CC+1FR1	800mA	EN-DC_1A (1DL/UL SISO) -n78A (1DL/1UL SISO)
		LTE: BW 20MHz, 1 RB, QPSK DL / QPSK UL, 23dBm
		FR1: BW 100MHz, Inner RB 137(Number)@64(Position), QPSK DL / QPSK UL, 23 dBm
4CC+1FR1	1100mA	EN-DC_1A-42D_n78A, DL 4x4MIMO/1UL SISO/60M)
		LTE : BW 20MHz, Full RB, 256QAM DL / 256QAM UL

Mode	Average [Typ.]	Mode Description
		FR1 : BW100MHz, Full RB, 256QAM DL / 256QAM UL
Operative SA Mode (NR-FR1)		
1FR1	300mA	FR1(n78A): BW100MHz, Full RB, 256QAM DL / 256QAM UL (1.89Gbps DL/1.25Mbps)
2FR1	500mA	FR1(CA_n78A_n78A): BW200MHz, Full RB, 256QAM DL / 256QAM UL (3.8Gbps DL/1.25Mbps)

*** Loop-back mode in call equipment**

*** 3.3 voltage/room temperature**

Note: Worst/best-case current consumption values depend on mobile network configuration – not under module control.

5.3 General Design Rule

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

- Electrical design
- Thermal design
- PCB layout

5.3.1 Electrical Design Guidelines

The electrical design of the power supply is highly dependent on the power source from which the power is drained.

5.3.1.1 +5v Source Power Supply Design Guidelines

- The desired power supply voltage output is 3.3V. Being the difference between the input source and the desired output moderate, a linear regulator can be used. A switching power supply is preferred to reduce power dissipation.
- When using a linear regulator, a proper heat sink must be provided to dissipate the power generated.
- A low ESR bypass capacitor of adequate capacity must be provided to cut the current absorption peaks close to the FN990B FAMILY module. A 100 µF tantalum capacitor is usually suitable on VPH_PWR.
- 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 modem power input to protect the FN990B FAMILY module from power polarity inversion.

5.3.2 Thermal Design Guidelines

This section provides thermal design guidelines useful for developing a product with a Telit FN990B FAMILY modem.

Proper thermal protection design protects against human or component damage under worst-case conditions.

Furthermore, it reduces the probability of failure and does not adversely affect the use of the module, and greatly extends the operation time with maximum performance.

For more details, please refer to the thermal design guidelines.

Note: FN990B FAMILY supports different RATs: 3G, 4G, and 5G Sub-6.

Note: Based on the Radio Access Technology, the FN990B FAMILY modem might exhibit high current consumption, thus proper thermal designs are essential to dissipate heat well.

Note: There is a large solder-resist opening area on the bottom side of the module. Adding a TIM on that area with the solder-resist opening area is highly recommended to ensure proper heat dissipation.

The modem temperature value can be read via AT command.

Note: For optimal RF performance, thermal dissipation, and mechanical stability, the FN990B FAMILY must be connected to the ground and metal chassis of the host board.

It is recommended that between the shield cover of the module and the heatsink or the metal chassis of the host device use a TIM for better heat dissipation.

5.3.3 Power Supply PCB Layout Guidelines

As described in the electrical design guidelines, a low ESR capacitor should be connected to the power supply output to reduce current peaks. A protection diode on the modem power supply input should be connected to protect the FN990B FAMILY from spikes and polarity inversion.

Placement of these components is crucial for correct operation: a misplaced component can badly affect power supply performance:

- The bypass low ESR capacitor must be placed close to the FN990B FAMILY power input pins or - if the power supply is of a switching type - it can be placed close to the inductor to reduce ripple, as long as the PCB trace from the capacitor to FN990B FAMILY is wide enough to avoid significant voltage drop even during the 4A current peaks.
- The protection diode must be placed close to the modem connector.
- 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 4A current peaks.
- The PCB traces connecting the FN990B FAMILY and bypass capacitor must be wide enough to avoid voltage drops even when 4A current absorption peaks occur. These traces should be kept 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 as close as possible to the power switching IC (only for the switching power supplies). This is done to reduce the radiated field (noise) at the switching frequency (usually 100-500kHz).
- Use a good common ground plane.
- Place the power supply on the board to ensure that the high current return paths in the ground plane do not overlap any noise-sensitive circuitry, such as microphone amplifier/buffer or earphone amplifier.
- The power supply input cables must be kept separate from noise-sensitive lines, such as microphone/earphone cables.

5.4 RTC

The RTC within the FN990B FAMILY module does not have a dedicated RTC supply pin. The RTC block is supplied by the VPH_PWR supply.

If the VPH_PWR power is removed, RTC is not maintained so if it is necessary to maintain an internal RTC, VPH_PWR must be supplied continuously.

5.5 Reference Voltage

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

The table below lists the reference voltage of the FN990B FAMILY modules.

Table 10: FN990B FAMILY Reference Voltage

Pin	Signal	I/O	Function	Type	Comment
65	VREG_L6B_1P8	O	Reference Voltage	Power	1.8V

5.6 Internal LDO for GNSS Bias

The LDO for GNSS bias is applied inside the FN990B FAMILY model.

The voltage supply is generated internally by the FN990B FAMILY (LDO) and is fed to GNSS active antenna.

The table below lists the LDO for GNSS bias of FN990B FAMILY modules.

Table 11: LDO for GNSS bias of FN990B FAMILY

Symbol	Parameter	Min	Typ	Max	Unit
$V_{GNSS\ DC\ bias}$	Voltage of internal LDO for GNSS bias	2.9	3.1	3.15	[V]
$I_{GNSS\ DC\ bias}$	Current of internal LDO for GNSS bias	-	-	100	[mA]

6 Electrical Specifications

6.1 Absolute Maximum Ratings – Not Optional

No functionality is guaranteed outside the following operating specifications.

Warning: A deviation from the value ranges listed below could damage the FN990B FAMILY module.

Table 12: Absolute Maximum Ratings - Not Optional

Symbol	Parameter	Min	Max	Unit
VPH_PWR	Battery supply voltage on pin VPH_PWR	-0.3	+4.7	[V]

6.2 Recommended Operating Conditions

Table 13: Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
T_{amb}	Ambient temperature	-40	+25	+85	[degC]
VPH_PWR	Battery supply voltage on pin VPH_PWR	3.135	3.3	4.4	[V]
I_{VPH_PWR}	Peak current on pin VPH_PWR	-	-	4	[A]

7 Digital Section

7.1 Logic Levels

Unless otherwise specified, all FN990B FAMILY interface circuits 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 FN990B FAMILY interface circuits.

The data specified in the tables below are valid throughout all drive strengths and the whole temperature range.

Warning: Do not connect FN990B FAMILY digital logic signal directly to the application digital logic signals with a voltage higher than 2.134V for 1.8V CMOS signals.

7.1.1 1.8V Standard GPIOs

Table 14: Operating Range - Interface Levels (1.8V CMOS)

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.26	2.1	[V]	
V_{IL}	Input low level	-0.3	0.36	[V]	
V_{OH}	Output high level	1.44	1.8	[V]	
V_{OL}	Output low level	0	0.4	[V]	

7.1.2 1.8V UIM1/UIM2 Pins

Table 15: Operating Range - UIM Pins Working at 1.8V

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.155	2.25	[V]	
V_{IL}	Input low level	-0.3	0.39	[V]	
V_{OH}	Output high level	1.32	1.95	[V]	
V_{OL}	Output low level	0	0.4	[V]	

7.1.3 2.95V Pins – Absolute Maximum Ratings

Table 16: Absolute Maximum Ratings - Not Functional

Parameter	Min	Max
Input level on any digital pin when on	-	+3.344 V
Input voltage on analog pins when on	-	+3.344 V

7.1.4 2.95V SIM Card Pins

Table 17: Operating Range - UIM Pins Working at 2.95V

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.89	3.05	[V]	
V_{IL}	Input low level	-0.3	0.61	[V]	
V_{OH}	Output high level	2.16	3.05	[V]	
V_{OL}	Output low level	0	0.4	[V]	

7.1.5 VPH_PWR Level I/O Pins

Table 18: Operating Range - I/O Pins Working at VPH_PWR

Parameter		Min	Max	Unit
V_{IH}	Input high level	0.65 x VPH_PWR	VPH_PWR + 0.3	[V]
V_{IL}	Input low level	-0.3	0.35 x VPH_PWR	[V]
V_{OH}	Output high level	VPH_PWR – 0.45	VPH_PWR	[V]
V_{OL}	Output low level	0	0.45	[V]

7.2 Power ON/OFF/RESET

The following tables show the description of power control pins.

Table 19: Power Interface Signals

Pin	Type
Module On/Off	1.8V / VPH_PWR
Reset Input	1.8V
Reference Voltage	1.8V
Power ON/OFF Status Check	1.8V

7.2.1 Power On

To turn on the FN990B FAMILY data card, the FULL_CARD_POWER_OFF_N pin must be asserted high.

Note: To turn on the FN990B FAMILY module, the SYS_RESIN_N pin must not be asserted low. If asserted low for more than one second, the FN990B FAMILY modem will be reset. Power on can be triggered by the SYS_RESIN_N pin (low level) as well. Even so, please control the FN990B FAMILY ON/OFF status using the FULL_CARD_POWER_OFF_N pin.

7.2.1.1 Initialization and Activation State

After turning on the FN990B FAMILY module, the device is not yet fully functional because the software boot and initialization process takes some time to complete. For this reason, it is not recommended to start communicating with the FN990B FAMILY module during the initialization phase.

The AT command interface is accessible via USB or PCIe port. In general, as shown in the figure below, the FN990B FAMILY modems become fully operational (in the Activation state) at least 50 seconds after the FULL_CARD_POWER_OFF_N is asserted.

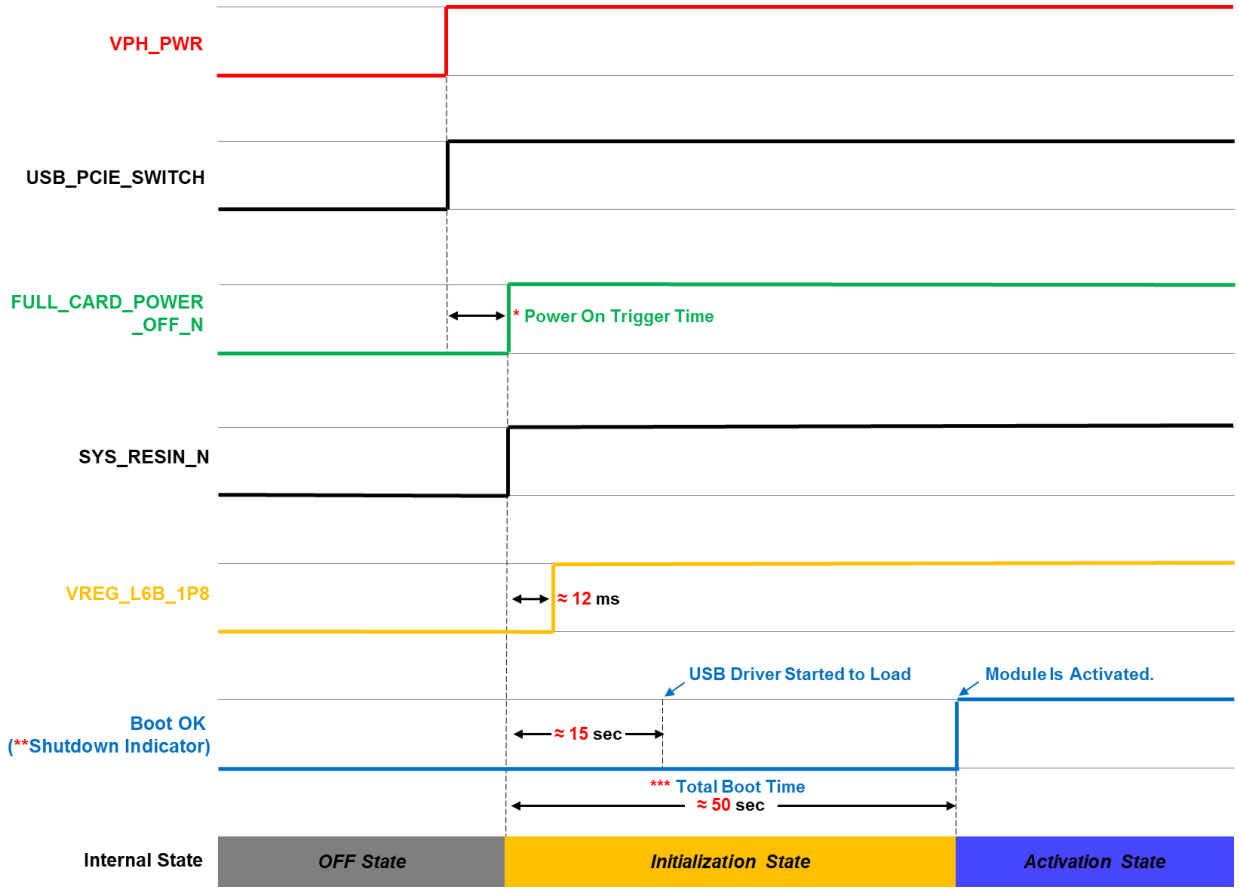

Figure 2: FN990B FAMILY Power ON Sequence - USB mode (USB_PCIE_SWITCH: High, Default) [TBD]

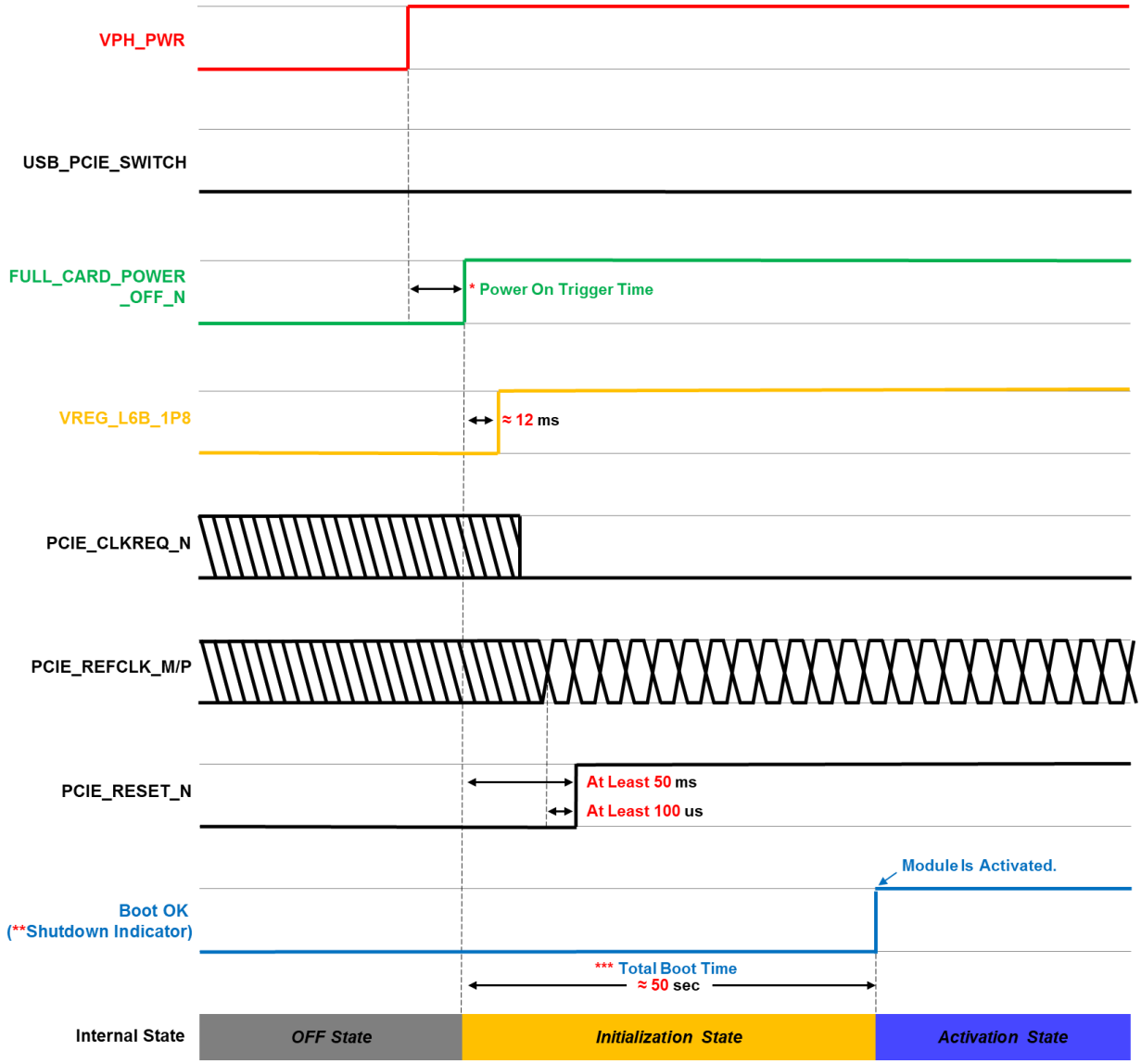

Figure 3: FN990B FAMILY Power ON Sequence – PCIe EP mode (USB_PCIE_SWITCH: Low) [TBD]

Note: To verify if the FN990B FAMILY has powered up properly, please follow the indications below:

* Power on trigger time is the interval between VPH_PWR to FULL_CARD_POWER_OFF_N: this could be null (0 ms) if the customer application requires turning on the module automatically.

** Monitoring BOOT_OK (Shutdown indicator) pin. When the status translates to high, the module boot-up process is complete. To use BOOT_OK (Shutdown indicator), the shutdown indication function must be enabled through the AT#SHDNIND command. (please refer to the AT Reference Guide document)

*** The stated total boot time is an approximate measure of the latest SW and HW configuration. The boot time may be lengthened or shortened depending on the module configuration, firmware, or hardware version.

Note: Active low signals are labeled with a name ending with "_N".

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

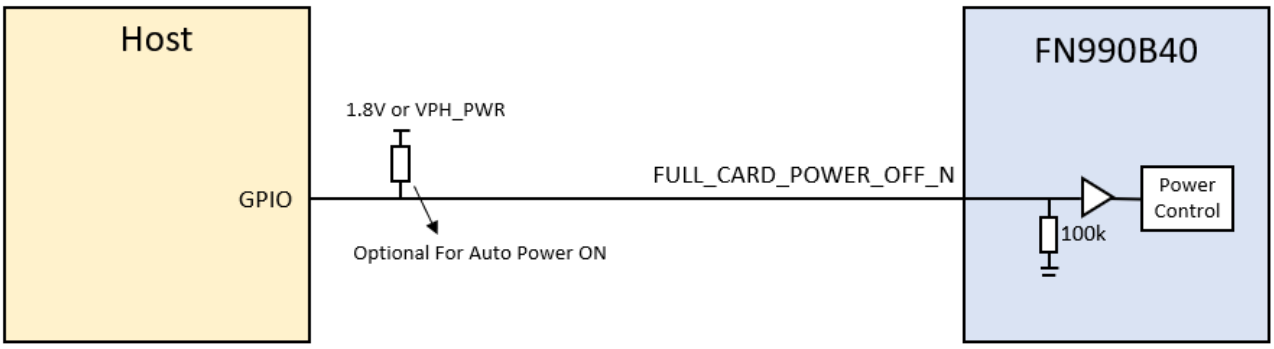

Figure 4: Example Circuit for ON/OFF by FULL_CARD_POWER_N

7.2.2 Power Off

Power off of the device can be done in two different ways:

- Graceful shutdown by FULL_CARD_POWER_OFF_N
- Fast shutdown by GPIO triggered

7.2.2.1 Graceful Shutdown

To shutdown the FN990B FAMILY module safely, the host can use the graceful shutdown function.

The graceful shutdown can be triggered by:

- FULL_CARD_POWER_OFF_N

Graceful Shutdown by FULL_CARD_OFF_N

To gracefully shutdown the FN990B FAMILY, FULL_CARD_POWER_OFF_N should be asserted to Low.

Once FULL_CARD_POWER_N is asserted to Low, the FN990B FAMILY enters the finalization state, terminates active processes, and prepares to turn off safely.

As shown in the diagram below, VREG_L6B_1P8 will indicate when the module is ready to be turned off.

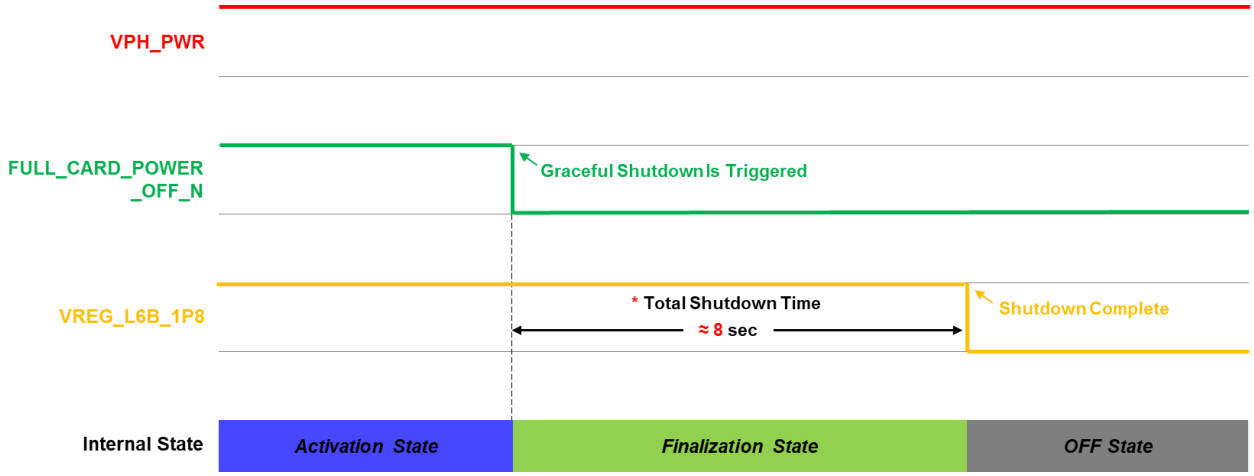

Figure 5: Graceful Shutdown by FULL_CARD_POWER_OFF_N

Note: Graceful Shutdown triggered by FULL_CARD_POWER_OFF_N is only effective after the module boots up completely.

* The stated total shutdown time is an approximate measure of the latest SW and HW combination. The shutdown time may be lengthened or shortened depending on the SW configuration, SW, or HW version.

7.2.2.2 Fast Shutdown

For quicker FN990B FAMILY module shutdown, the host application can use the fast shutdown function, which can be triggered by:

- GPIO (+ optional shutdown indicator)

Fast Shutdown by GPIO

To leverage the fast shutdown feature, one of the GPIO lines should be assigned as Fast Shutdown Trigger using the AT commands.

Once the fast shutdown trigger senses a High to Low transition, the fast shutdown is started: the FN990B FAMILY enters a finalization state, terminates active processes, and prepares to turn off safely. As shown in the figure below, when the module is ready to be turned off, it will be indicated via VREG_L6B_1P8.

Please refer to the AT User Guide for more details on how to enable the shutdown indicator and fast shutdown trigger.

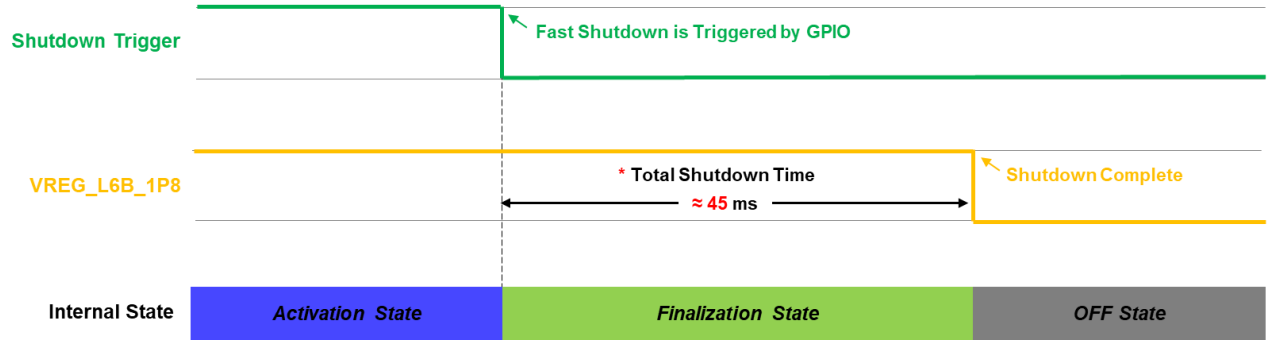

Figure 6: Fast Shutdown by GPIO

Note: Using a fast shutdown without a shutdown indicator function, the FULL_CARD_POWER_N pin should be controlled to prevent the FN990B FAMILY from rebooting.

For more information, please refer to the AT commands reference guide and SW user guide document.

* The stated total shutdown time is an approximate measure of the latest SW and HW combination. The shutdown time may be lengthened or shortened depending on the SW configuration, SW, or HW version.

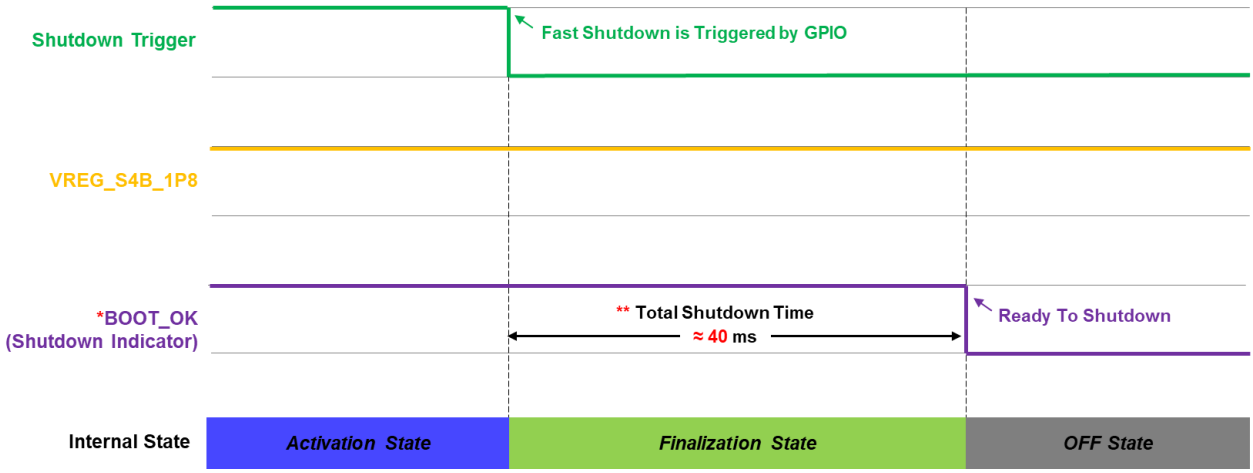

Figure 7: Fast Shutdown by GPIO (*SHDNIND Enable, Optional)

Warning: If the VPH_PWR is to be kept at a high status, the module will reboot. (Not applicable to the Shutdown Indicator function).

Warning: Failure to follow recommended shut-down procedures might damage the device and consequently void the warranty.

Note: *Shutdown Indicator is an optional function and is disabled by default. The host can verify the module entered the OFF state by monitoring the shutdown indicator pin status. To turn on the module after using a fast shutdown with a shutdown indicator function, it should be re-powered or rebooted.

For more information, please refer to AT Commands Reference Guide and SW User Guide document.

Note: Fast shutdown function is disabled by default. To use the fast shutdown function, please refer to the AT Commands Reference Guide and SW User Guide document.

7.2.3 Reset

Device reset can be achieved as follows:

- Unconditional reset using the SYS_RESIN_N

7.2.3.1 Unconditional Hardware Reset

To unconditionally restart the FN990B FAMILY module, the SYS_RESIN_N pin must be asserted low for more than 1 second and then released.

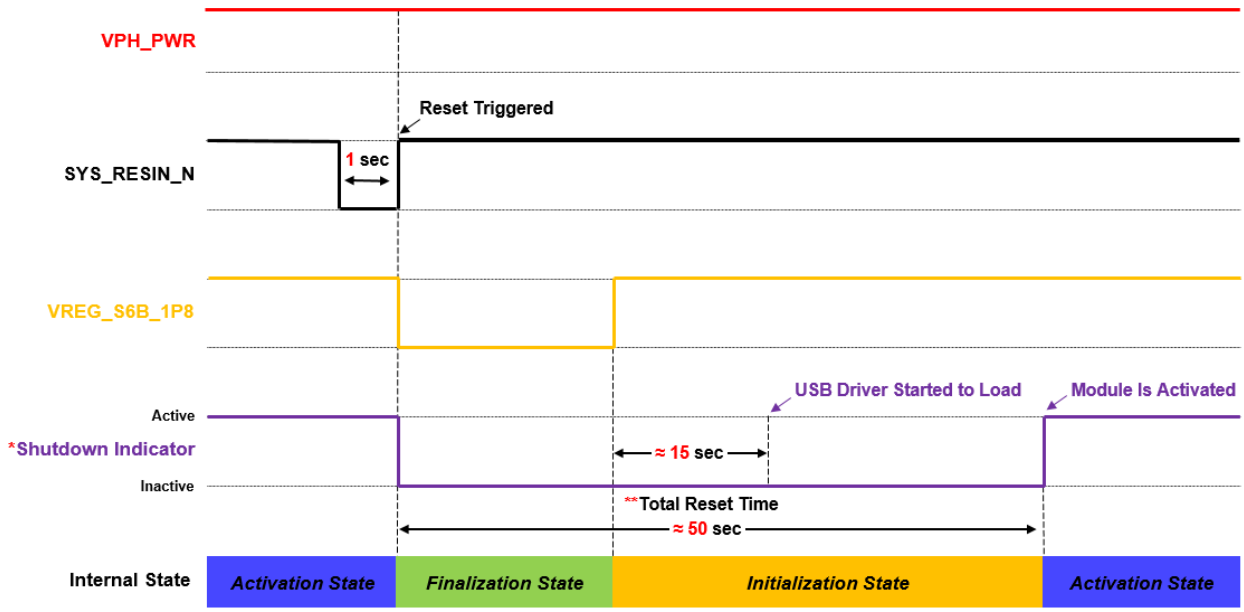

Figure 8: Unconditional Hardware Reset by SYS_RESIN_N

Note: *Shutdown Indicator is an optional function. If SHDIND is enabled, it can verify the status via the SHDIND function.

Please refer to the AT commands user guide document.

** The stated total reset time is an approximate measure of the latest SW and HW combination. The shutdown time may be lengthened or shortened depending on the SW configuration, SW, or HW version.

Note: Unconditional hardware reset must be used only as an emergency procedure, and not as a normal power-off operation.

Note: 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 FN990B FAMILY power regulator and improper functioning on the module.

The RESET_N line must be connected only in an open-collector configuration.

The below figure shows a simple circuit for this action.

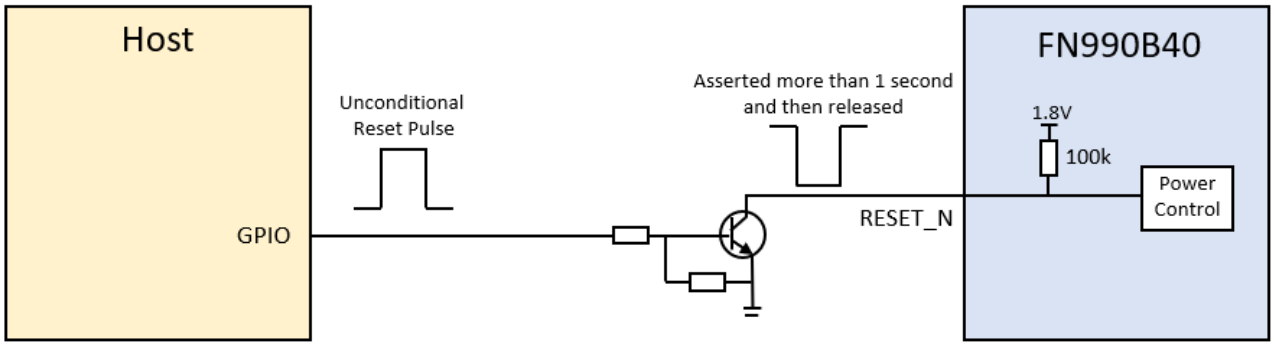

Figure 9: Example Circuit for RESET by SYSTEM_RESET_N

7.3 Communication Ports

The below table summarizes all the hardware interfaces of the FN990B FAMILY modules.

Table 20: FN990B FAMILY Hardware Interfaces

Interface	Description
PCIe	Peripheral Component Interconnect Express Gen 4.0
USB	USB 2.0 / 3.1 Gen 2 interface
USIM	x2 dual voltage each (1.8V / 2.95V)
eSIM	Embedded SIM (optional)
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
Control Interfaces	W_DISABLE_N, WAKE_ON_WAN_N, LED, DPR
Antenna ports	x4 Cellular, 1 for GNSS

7.3.1 Host Interface

Note: FN990B FAMILY M.2 data card supports USB 3.1 Gen 2 and PCIe Gen 2 respectively.

7.3.1.1 Host Interface Switch Function

This section describes the host interface switch functions.

Note: The meaning of the name USB/PCIe switch implies which interface provides the main function.

Please refer to the 1VV0301987, FN990B FAMILY Software User Guide, regarding each function.

Table 21:Host Interface Switch Pin

Pin	Signal	I/O	Function	Type	Comment
20	USB_PCIE_SWITCH	I	Switch Host Interface	1.8V	

Table 22: USB/PCIe Switch Pin

USB/PCIe Switch	Mode	USB	PCIe EP	PCIe RC
High (Default)	USB	Available	Not support	Available**
Low	PCIe	Available*	Available	Not support

FN990B FAMILY M.2 Card determines the host interface by checking the status of the USB_PCIE_SWITCH pin at the beginning of the power-on sequences.

Note: When using PCIe EP, PCIe RC cannot be used, and basic functions such as mobile data and AT commands are provided through PCIe EP, while USB is provided only for debugging and specific purpose.

For more details, please refer to the 1VV0301987, FN990B FAMILY Software User Guide.

Note: FN990B FAMILY supports the following devices as EP for data interface:

- Qualcomm WCN7856 or QFW71x4 WLAN / BT
- Marvell AQR113C WLAN

Please consult Telit if a different EP device is used as a data interface since the EP device kernel driver needs to be modified to use the FN990B FAMILY network hardware accelerator.

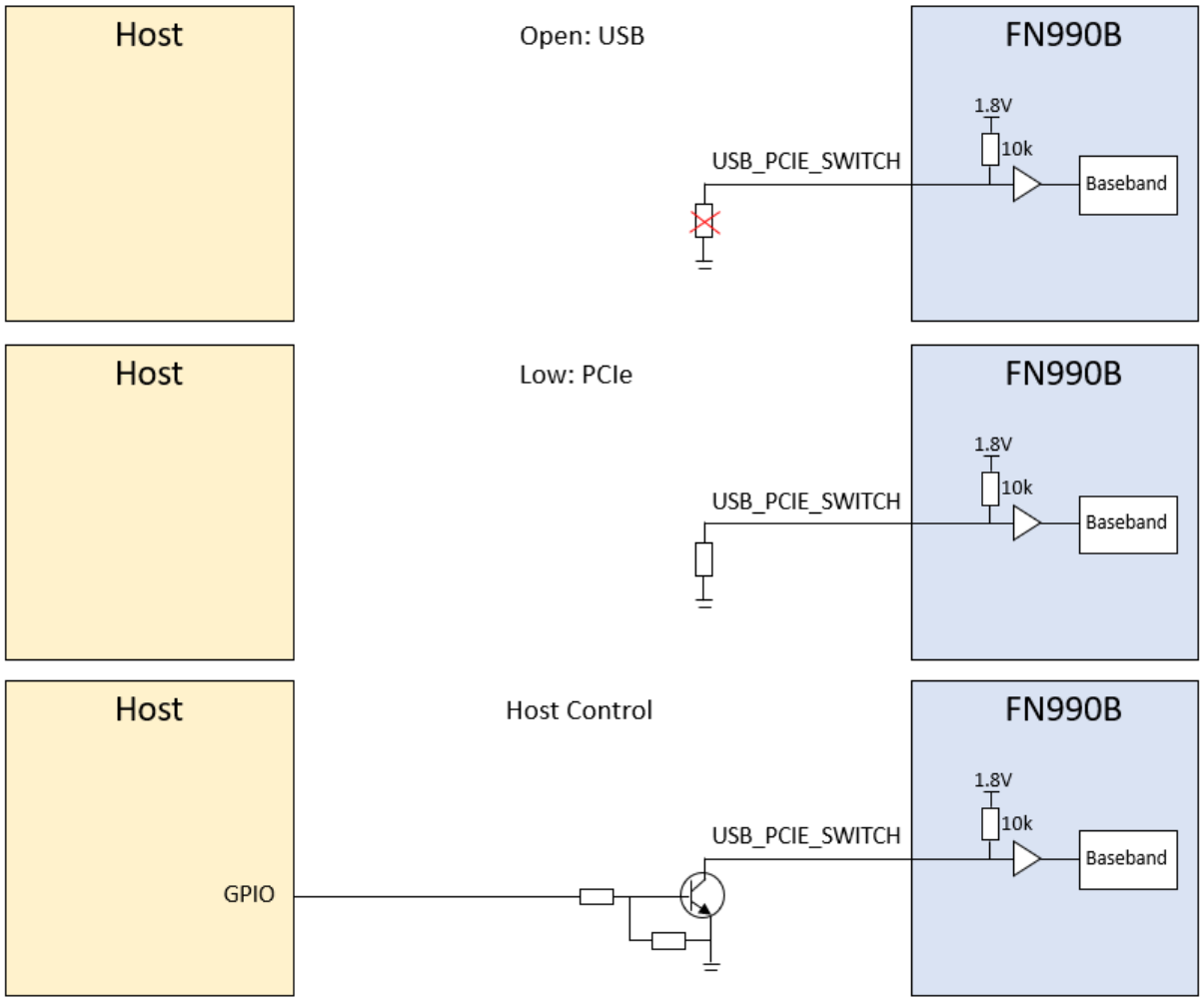

Figure 10: Example Circuit for HOST Interface Switch Function

7.3.1.2 PCIe Interface

The FN990B FAMILY module includes a PCIe interface. PCIe needs AC coupling series capacitors on the TX lines in both directions. To interface PCIe with the application board that controls the modem, 0.22 uF capacitors should be installed on PCIE_RX_P/M lines of the FN990B FAMILY. The series capacitors are already placed on PCIE_TX_P/M lines inside the FN990B FAMILY.

Internally, the VPH_PWR level 10k pull-up resistor is already mounted on PCIE_WAKE_N, PCIE_CLKREQ_N, and PCIE_RESET_N.

The suggested PCIe interface connection is shown in the diagram below:

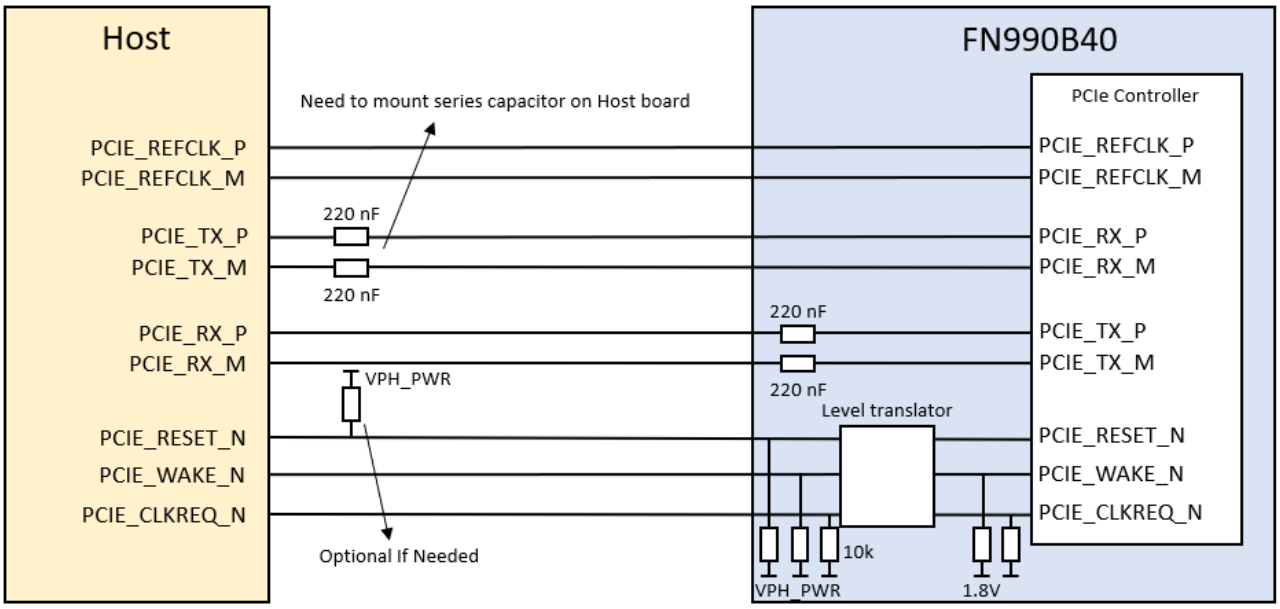

Figure 11: Connection for PCIe Interface

Note: FN990B FAMILY supports PCIe root complex (RC) mode.

Depending on the EP device such as NIC or something else, may require a suitable value of pull-up resistor on the PCIE_RESET_N line.

Customers interested in using PCIe RC mode can contact Telit Technical Support at:

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

Note: The PCIe signals traces must be routed carefully: minimize trace lengths, number of vias, and capacitive loading. The impedance value should be as close as possible to the 85 Ohm differential.

Table 23: PCIe Interface Signals

Pin	Signal	I/O	Function	Type	Comment
41	PCIE_TX0_M	O	PCIe transmit 0 – Minus	Analog	
43	PCIE_TX0_P	O	PCIe transmit 0 – Plus	Analog	
47	PCIE_RX0_M	I	PCIe receive 0 – Minus	Analog	
49	PCIE_RX0_P	I	PCIe receive 0 – Plus	Analog	
53	PCIE_REFCLK_M	I	PCIe differential reference clock – Minus	Analog	
55	PCIE_REFCLK_P	I	PCIe differential reference clock – Plus	Analog	
50	PCIE_RESET_N	I	Functional reset to PCIe bus	VPH_PWR	Internal 10k PU
52	PCIE_CLKREQ_N	O	PCIe reference clock request signal	VPH_PWR	Internal 10k PU

Pin	Signal	I/O	Function	Type	Comment
54	PCIE_WAKE_N	O	PCIe wake-up	VPH_PWR	Internal 10k PU

Warning: In the case of EP mode, FN990B FAMILY data cards are not designed or intended to support Hot-Swap or Hot-Plug connection. Performing How-Swap or Hot-Plug may pose a danger to the FN990B FAMILY module, to the host device, and to the person handling the device.

Note: PCIE_RESET_N operates as digital input in PCIe end point mode and open drain in PCIe root complex mode. PCIE_CLKREQ_N and PCIE_WAKE_N operate as an open drain in PCIe end point mode, and digital input in PCIe root complex mode.

The default of the FN990B FAMILY is end point mode.

Note: Consider placing a low-capacitance ESD protection component to protect the FN990B FAMILY against ESD spikes.

PCIe Layout Guidelines

The below guidelines will provide general guidelines for the PCIe interface to improve signal integrity.

- All other sensitive/high-speed signals and circuits must be protected from PCIe corruption.
- PCIe signals must be protected from noisy signals (clocks, SMPS, and so forth).
- Pay extra attention to crosstalk, ISI, and intra-lane skew and impedance discontinuities.
- PCIe Tx AC coupling capacitors are better placed close to the source or receiver side to keep good SI of the route on the PCB.
- To maintain impedance balance, maintain positive and negative traces as balanced as possible in terms of the signal and its return path.
- Trace length matching between the reference clock, Tx, and Rx pairs is not required.
- External capacitors also should keep differential traces. Ensure not to stagger the capacitors. This can affect the differential integrity of the design and can create EMI.

Table 24: PCIe Routing Constraints

Type of guidance	Guideline	Requirement
General	Data rate	16 Gbps*
	Insertion loss at 2.5 GHz (dB)	-13.5 dB
	Impedance	85 ohms differential
	Bus length	200 mm**
Length matching	Intra pair match	< 0.7mm

Type of guidance	Guideline	Requirement
Spacing	To all other signals	> 4 x line width
	Tx lane to Rx lane	> 4 x line width
Component	AC capacitance	220 nF

***Actual throughput at the system level could be lower due to overheads.**

****PCIe trace length in FN990B Family: about 15 mm.**

7.3.1.3 USB 3.1 Interface

The FN990B FAMILY includes super-speed USB 3.1 Gen 2 with high-speed USB 2.0 backward compatibility. The interface with the Universal Serial Bus Specification, revision 3.1 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 FN990B FAMILY module and application hardware. USB 3.1 needs AC coupling series capacitors on the TX lines in both directions. To interface USB 3.1 with the application board controlling the modem, it is necessary to install 220 nF capacitor on the USB_SS_RX_P/M lines of the FN990B FAMILY module.

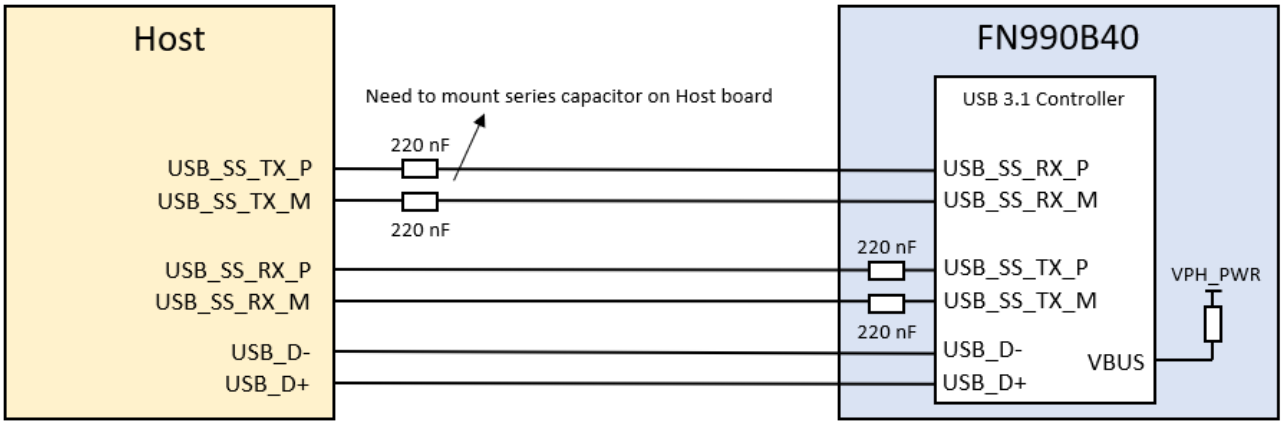

Figure 12: Connection for USB Interface

Note: The USB signal traces must be carefully routed: minimize trace lengths, number of vias, and capacitive loading. The impedance value should be as close as possible 85 Ohm differential.

Note: Consider placing a low-capacitance ESD protection component to protect FN990B FAMILY against ESD strikes.

USB OTG Feature

FN990B Family supports USB On-The-Go (OTG) function.

Note: Since the FN990B FAMILY does not support a USB_ID pin, a TPGIO pin should be set as the purpose of USB_ID using the #OTGCFG command. The module will be in host mode if the TGPIO pin is connected to the ground. External 5 V power is required on an

application board to supply 5 V power to the OTG device because the FN990B FAMILY does not supply power for the OTG device.

USB Layout Guidelines

- If third-party components are required for signal improvement, place them closer to the USB connector.
- There are relatively fast edge rates, so must be routed away from sensitive circuits and signals (RF, audio, and XO).
- Maintain good isolation between the USB connector and RF antennas (especially 2.4 GHz).
- Route the RF signals operating 2.4 GHz frequency with the highest isolation possible from USB_SS_TX/RX traces.
- USB SS Tx AC coupling capacitors are better placed close to the source or the ESD/connector side to keep good SI of the main route on the PCB.
- Route differential pairs in the inner layers with a solid GND reference to have good impedance control and to minimize discontinuities.
- Keep isolation between the DP/DM to avoid crosstalk.
- The SS-USB Tx and Rx differential pair maximum length is recommended to be less than 135 mm.
- For USB 2.0 signal, the maximum trace length should be less than 230 mm.

Table 25:USB Routing Constraints

Type of guidance	Guideline	Requirement	
		USB 3.1 Gen 2	USB 2.0
General	Data rate	10 Gbps	480Mbps
	Insertion loss at 5 GHz (dB)	-7 dB	N/A
	Impedance	85 ohms differential	
	Bus length	130 mm	230 mm
Length matching	Intra length match	< 0.7 mm	< 2 mm
Spacing	To all other signals	> 4 x line width	> 3 x line width
	Tx lane to Rx lane	> 4 x line width	N/A
Component	AC capacitance	220 nF	N/A

7.3.2 SIM Interface

The FN990B FAMILY modem family supports an external SIM interface. (1.8V or 2.95V)

Note: UIM2 can be assigned as an optional eSIM. In that case, UIM2 can't be used as an external SIM interface.

Table 26: SIM Interface Signals

Pin	Signal	I/O	Function	Type	Comment
SIM Card Interface 1					
36	UIM1_VCC	O	Supply output for an external UIM1 card	1.8V / 2.95V	Power
34	UIM1_DATA	I/O	Data connection with an external UIM1 card	1.8V / 2.95V	Internal 20k PU

Pin	Signal	I/O	Function	Type	Comment
32	UIM1_CLK	O	Clock output to an external UIM1 card	1.8V / 2.95V	
30	UIM1_RESET_N	O	Reset output to an external UIM1 card	1.8V / 2.95V	
66	UIM1_PRESENT	I	UIM1 Card Present Detect	1.8V	Internal 100k PU Active High*
SIM Card Interface 2					
48	UIM2_VCC	O	Supply output for an external UIM2 card	1.8V / 2.95V	Power
42	UIM2_DATA	I/O	Data connection with an external UIM2 card	1.8V / 2.95V	Internal 20k PU
44	UIM2_CLK	O	Clock output to an external UIM2 card	1.8V / 2.95V	
46	UIM2_RESET_N	O	Reset output to an external UIM2 card	1.8V / 2.95V	
40	UIM2_PRESENT	I	UIM2 Card Present Detect	1.8V	Internal 100k PU Active High*

Note: *The default UIM_PRESENT pin setting has been changed from low to high to comply with the M.2 specification standard.

Pin settings can be changed through AT#SIMINCFG, please refer to the AT commands reference guide for details.

If you have any special requirements, please contact Technical Support or Sales.

7.3.2.1 SIM Schematic Example

The diagram below shows in particular how the SIM part of the application interface should be designed.

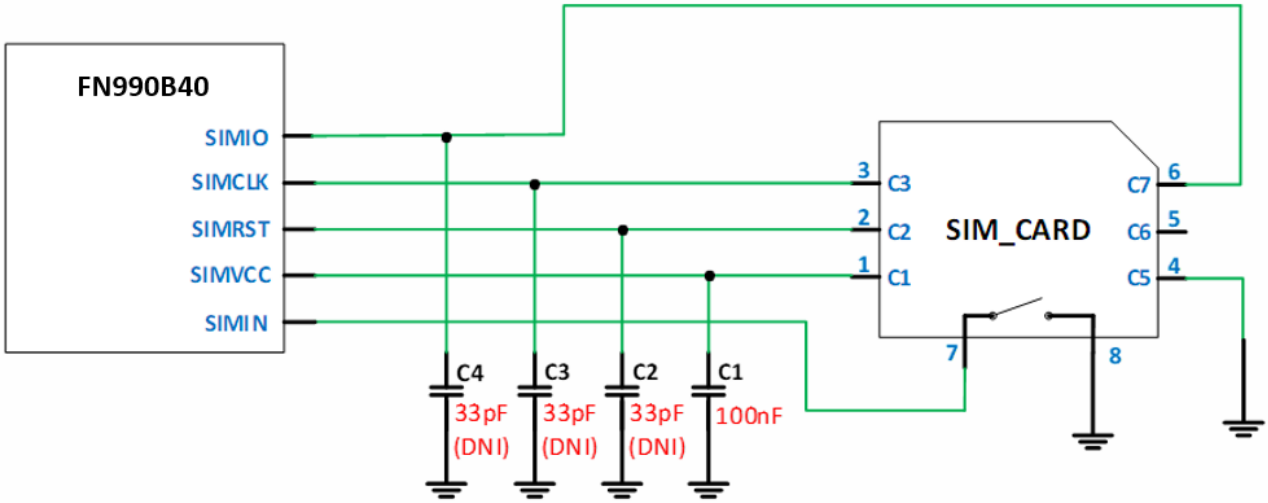

Figure 13: SIM Schematic Example

Note: FN990B FAMILY modems contain an internal pull-up resistor on SIMIO. It is not necessary to install an external pull-up resistor.

7.3.3 eSIM Interface

FN990B Family modems include pads for an optional embedded SIM.

Customers interested in using an embedded SIM mounted on the FN990B FAMILY can contact Telit Technical Support at:

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

7.3.4 I2C – Inter-integrated Circuit

The FN990B FAMILY supports an I2C interface: the table below lists the I2C signals of the modem.

Table 27: I2C Signal

Pin	Signal	I/O	Function	Type	Comment
56	I2C_SDA	I/O	I2C Data Can be TGPIO_09	1.8V	Internal 2.2k PU
58	I2C_SCL	I/O	I2C Clock Can be TGPIO_10	1.8V	Internal 2.2k PU

7.3.5 Control Interface

Table 28: Control Interface Pins

Pin	Signal	I/O	Function	Type	Comment
8	W_DISABLE_N	I	WLAN disable	1.8 / 3.3 V	
26	W_DISABLE2_N	I	GNSS disable	1.8 / 3.3 V	
10	LED_N	O	LED control		Open Drain
23	WAKE_ON_WAN_N	O	Wake Host	1.8V	
25	TGPIO_02	I/O	General Purpose I/O Can be DPR	1.8V	

7.3.5.1 WLAN/GNSS Disable

The W_DISABLE_N signal is provided to disable the WLAN/GNSS function:

- W_DISABLE_N
  - Low: Airplane mode
  - High or Floating: Normal operation
- W_DISABLE2_N
  - Low: GNSS Disable
  - High or Floating: Normal operation

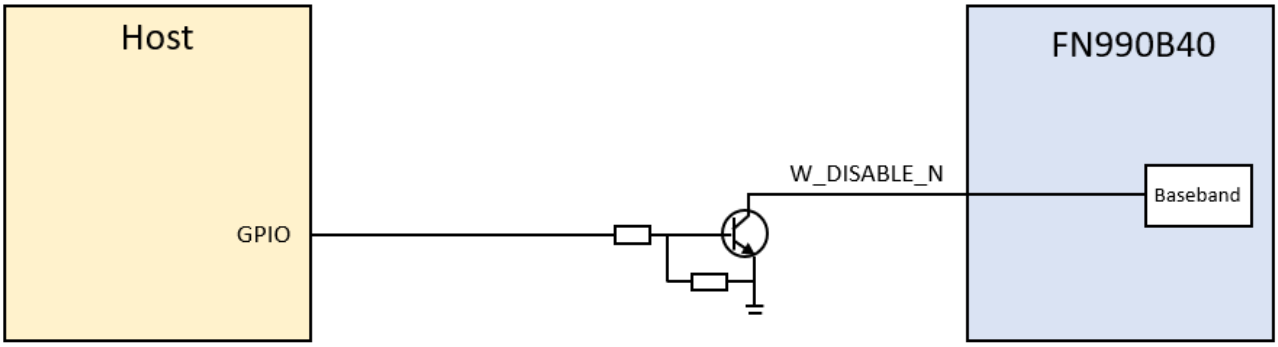

Figure 14: Example Circuit for WLAN/GNSS Disable Function

Please refer to the AT commands guide for setting the WLAN/GNSS disable function.

7.3.5.2 LED

The LED signal drives the LED output. The recommended LED connection is the following:

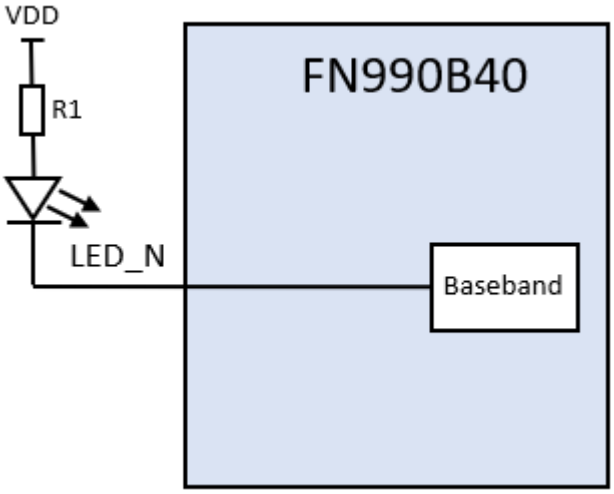

Figure 15: Recommended LED Connection

R1 and VDD determine the LED brightness and forward current.

When VDD is 3.3V and LED's forward voltage is 2.0V, the recommended R1 value ranges from 66 to 250 Ohm.

However, the resistor value must be calculated considering the LED specifications. It is recommended to use VDD below the VPH_PWR level.

Note: If the LED function is enabled and a LED is connected to the LED_N pin, current consumption may be slightly increased. And current sinking mode (up to 10mA) can be supported.

7.3.5.3 Wake Host

WAKE_ON_WAN_N is an active low signal and is used to wake the Host when specific events occur.

- SMS
- Network de-registration
- Voice Call (if supported by the modem)

Please refer to the AT commands guide for setting the Wake function.

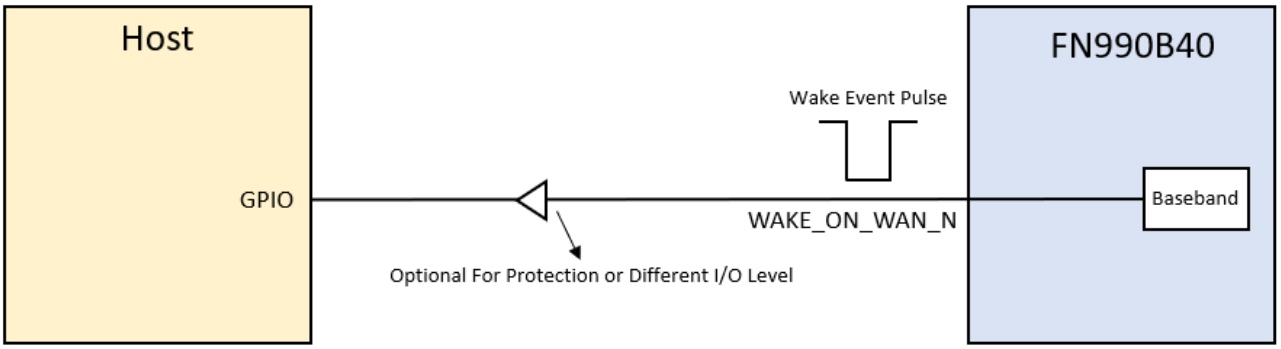

Figure 16: Example Circuit for WAKE_ON_WAN_N

7.3.5.4 DPR

This signal is input directly to the FN990B FAMILY module from a suitable SAR sensor. Then FN990B FAMILY module will reduce output tx power.

DPR function is not available yet: specific implementation will be determined on customer request.

For further information on the DPR function on the FN990B FAMILY modem family, please contact Telit Technical Support at:

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

7.4 General Purpose I/O

The general-purpose I/O (GPIO) pins can be configured in four modes:

- Input
- Output
- Fast shutdown
- Dedicated function (Customer requirement)

Input pins can only report digital values (high or low) present on the pin at the read time.

Output pins can only be set or the pin level can be queried.

Table 29: General Purpose I/O

Pin	Signal	I/O	Function	Type	Comment
General Purpose I/O					
68	TGPIO_01	I/O	General Purpose I/O Can be I2S_CLK	1.8V	
25	TGPIO_02	I/O	General Purpose I/O Can be DPR	1.8V	
62	TGPIO_03	I/O	General Purpose I/O	1.8V	
64	TGPIO_04	I/O	General Purpose I/O	1.8V	
22	TGPIO_06	I/O	General Purpose I/O Can be I2S_DIN	1.8V	

Pin	Signal	I/O	Function	Type	Comment
24	TGPIO_07	I/O	General Purpose I/O Can be I2S_DOUT	1.8V	
28	TGPIO_08	I/O	General Purpose I/O Can be I2S_WS	1.8V	
56	I2C_SDA	I/O	I2C Data Can be TGPIO_09	1.8V	Internal 2.2k PU
58	I2C_SCL	I/O	I2C Clock Can be TGPIO_10	1.8V	Internal 2.2k PU

7.4.1 Using a GPIO 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 47K ohm pull-up resistor to 1.8V.

7.4.2 Using a GPIO as OUTPUT

GPIO pins, when used as output, 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.

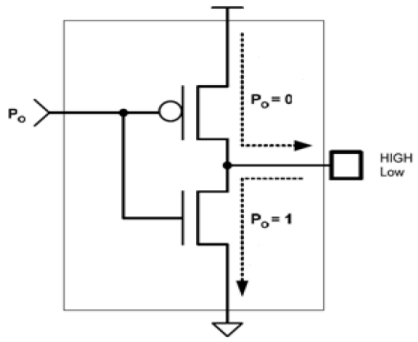

Figure 17: GPIO Output Pin Equivalent Circuit

8 RF Section

8.1 Frequency Bands

Operating frequencies in 5G, LTE, and WCDMA modes conform to 3GPP specifications.

The table below lists the FN990B FAMILY operating frequencies on 5G, LTE, and WCDMA modes.

8.1.1 Supported 5G NR Sub-6 Bands

Table 30: supported5G NR Sub-6 Bands

NR BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels	SCS (kHz)
n1 - 2100	FDD	1920 - 1980	2110 - 2170	Tx: 384000 - 396000 Rx: 422000 - 434000	15
n2 - 1900 PCS	FDD	1850 - 1910	1930 - 1990	Tx: 370000 - 382000 Rx: 386000 - 398000	15
n3 - 1800	FDD	1710 - 1785	1805 - 1880	Tx: 342000 - 357000 Rx: 361000 - 376000	15
n5 - 850	FDD	824 - 849	869 - 894	Tx: 164800 - 169800 Rx: 173800 - 178800	15
n7 - 2600	FDD	2500 - 2570	2620 - 2690	Tx: 500000 - 514000 Rx: 524000 - 538000	15
n8 - 900	FDD	880 - 915	925 - 960	Tx: 176000 - 183000 Rx: 185000 - 192000	15
n12 - 700 a	FDD	699 - 716	729 - 746	Tx: 139800 - 143200 Rx: 145800 - 149200	15
n13 - 700 c	FDD	777 - 787	746 - 756	Tx: 155400 - 157400 Rx: 149200 - 151200	15
n14 - 700 PS	FDD	788 - 798	758 - 768	Tx: 157600 - 159600 Rx: 151600 - 153600	15
n18 - 800 Lower	FDD	815 - 830	860 - 875	Tx: 163000 - 166000 Rx: 172000 - 175000	15
n20 - 800	FDD	832 - 862	791 - 821	Tx: 166400 - 172400 Rx: 158200 - 164200	15
n25 - 1900+	FDD	1850 - 1915	1930 - 1995	Tx: 370000 - 383000 Rx: 386000 - 399000	15
n26 - 850+	FDD	814 - 849	859 -894	Tx: 162800 - 169800 Rx: 171800 - 178800	15
n28 - 700 APT	FDD	703 - 748	758 - 803	Tx: 140600 - 149600 Rx: 151600 - 160600	15
n29 - 700d	SDL	-	717 - 728	Rx: 143400 - 145600	15
n30 - WCS	FDD	2305 - 2315	2350 - 2360	Tx: 461000 - 463000 Rx: 470000 - 472000	15
n38 - 2600	TDD	2570 - 2620		T/Rx: 514000 - 524000	30
n40 - 2300	TDD	2300 - 2400		T/Rx: 460000 - 480000	30
n41 - 2600+	TDD	2496 - 2690		T/Rx: 499200 - 537996	30
n48 - 3600	TDD	3550 - 3700		T/Rx: 636668 - 646666	30
n53 - 2500	TDD	2483.5 - 2495		T/Rx: 496700 - 499000	30
n66 - AWS-3	FDD	1710 - 1780	2110 - 2200	Tx: 342000 - 356000 Rx: 422000 - 440000	15

NR BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels	SCS (kHz)
N67 – 700 EU	SDL	-	738 - 758	Rx: 147600 - 151600	15
n70 - AWS-4	FDD	1695 - 1710	1995 - 2020	Tx: 339000 - 342000 Rx: 399000 - 404000	15
n71 - 600	FDD	663 - 698	617 - 652	Tx: 132600 - 139600 Rx: 123400 - 130400	15
n75 - DL 1500+	SDL	-	1432 - 1517	Rx: 286400 - 303400	-
n76 - DL 1500-	SDL	-	1427 - 1432	Rx: 285400 - 286400	-
n77 - 3700	TDD	3300 - 4200		T/Rx: 620000 - 680000	30
n78 - 3500	TDD	3300 - 3800		T/Rx: 620000 - 653332	30
n79 - 4700	TDD	4400 - 5000		T/Rx: 693334 - 733332	30
n91 - 1500-	FDD	832 - 862	1427 - 1432	Tx: 166400 – 172400 Rx: 285400 - 286400	15
N92 - 1500+	FDD	832 - 862	1432 - 1517	Tx: 166400 – 172400 Rx: 286400 - 303400	15
n93 - 1500-	FDD	880 - 915	1427 - 1432	Tx: 176000 – 183000 Rx: 285400 - 286400	15
N94 - 1500+	FDD	880 - 915	1432 - 1517	Tx: 176000 – 183000 Rx: 286400 - 303400	15

8.1.2 Supported LTE Bands

Table 31: Supported LTE Bands

E-UTRA BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels
B1 - 2100	FDD	1920 - 1980	2110 - 2170	Tx: 18000 - 18599 Rx: 0 - 599
B2 - 1900 PCS	FDD	1850 - 1910	1930 - 1990	Tx: 18600 - 19199 Rx: 600 - 1199
B3 - 1800+	FDD	1710 - 1785	1805 - 1880	Tx: 19200 - 19949 Rx: 1200 - 1949
B4 - AWS-1	FDD	1710 - 1755	2110 - 2155	Tx: 19950 - 20399 Rx: 1950 - 2399
B5 - 850	FDD	824 - 849	869 - 894	Tx: 20400 - 20649 Rx: 2400 - 2649
B7 - 2600	FDD	2500 - 2570	2620 - 2690	Tx: 20750 - 21449 Rx: 2750 - 3449
B8 - 900 GSM	FDD	880 - 915	925 - 960	Tx: 21450 - 21799 Rx: 3450 - 3799
B12 - 700 a	FDD	699 - 716	729 - 746	Tx: 23010 - 23179 Rx: 5010 - 5179
B13 - 700 c	FDD	777 - 787	746 - 756	Tx: 23180 - 23279 Rx: 5180 - 5279
B14 - 700 PS	FDD	788 - 798	758 - 768	Tx: 23280 - 23379 Rx: 5280 - 5379
B17 - 700 b	FDD	704 - 716	734 - 746	Tx: 23730 - 23849 Rx: 5730 - 5849
B18 - 800 Lower	FDD	815 - 830	860 - 875	Tx: 23850 - 23999 Rx: 5850 - 5999

E-UTRA BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels
B19 - 800 Upper	FDD	830 - 845	875 - 890	Tx: 24000 - 24149 Rx: 6000 - 6149
B20 - 800 DD	FDD	832 - 862	791 - 821	Tx: 24150 - 24449 Rx: 6150 - 6449
B25 - 1900+	FDD	1850 - 1915	1930 - 1995	Tx: 26040 - 26689 Rx: 8040 - 8689
B26 - 850+	FDD	814 - 849	859 - 894	Tx: 26690 – 27039 Rx: 8690 - 9039
B28 - 700 APT	FDD	703 - 748	758 - 803	Tx: 27210 - 27659 Rx: 9210 - 9659
B29 - 700 d	SDL	-	717 - 728	Rx: 9660 - 9769
B30 - 2300 WCS	FDD	2305 - 2315	2350 - 2360	Tx: 27660 - 27759 Rx: 9770 - 9869
B32 - 1500 L	SDL	-	1452 - 1496	Rx: 9920 - 10359
B34 - 2000	TDD	2010 – 2025		T/Rx: 36200 - 36349
B38 - 2600	TDD	2570 - 2620		T/Rx: 37750 - 38249
B39 - 1900+	TDD	1880 - 1920		T/Rx: 38250 - 38649
B40 - 2300	TDD	2300 - 2400		T/Rx: 38650 - 39649
B41 - 2600+	TDD	2496 - 2690		T/Rx: 39650 - 41589
B42 - 3500	TDD	3400 - 3600		T/Rx: 41590 - 43589
B43 - 3700	TDD	3600 – 3800		T/Rx: 43590 – 45589
B46 - 5200	SDL	5150 – 5925		Rx: 46790 - 54539
B48 - 3600	TDD	3550 - 3700		T/Rx: 55240 - 56739
B53 - 2500	TDD	2483 - 2496		T/Rx: 60140- 60254
B66 - AWS-3	FDD	1710 - 1780	2110 - 2200	Tx: 131972 - 132671 Rx: 66436 - 67335
B67 – 700 EU	SDL	738 - 758		Rx: 67336 - 67535
B68 – 700 ME	FDD	698 - 728	753 - 783	Tx: 132672 - 132971 Rx: 67536 - 67835
B70 - AWS-4	FDD	1695 - 1710	1995 - 2020	Tx: 132972 - 133121 Rx: 68336 - 68585
B71 - 600	FDD	663 - 698	617 - 652	Tx: 133122 - 133471 Rx: 68586 - 68935
B106 - 900	FDD	896 - 901	935 - 940	Tx: 134292 - 134341 Rx: 70656 - 70705

8.1.3 Supported WCDMA Bands

Table 32: Supported WCDMA Bands

UTRA BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels
B1 - 2100	FDD	1920 - 1980	2110 - 2170	Tx: 9612 - 9888 Rx: 10562 - 10838
B2 - 1900 PCS	FDD	1850 - 1910	1930 - 1990	Tx: 9262 - 9538 Rx: 9662 - 9938
B4 - AWS-1	FDD	1710 - 1755	2110 - 2155	Tx: 1312 - 1513 Rx: 1537 - 1738
B5 - 850	FDD	824 - 849	869 - 894	Tx: 4132 - 4233 Rx: 4357 - 4458
B8 - 900 GSM	FDD	880 - 915	925 - 960	Tx: 2712 - 2863 Rx: 2937 - 3088

8.2 CA / MIMO / EN-DC

The FN990B40 supports 2CA, 3CA, 4CA, 5CA, 6CA, and 7CA for LTE CA combinations and EN-DC for NR FR1 configuration.

Note: Refer to the FN990B40 CA / EN-DC list, XXXXNTXXXXXA[TBD] for detailed list of CA and EN-DC combinations.

8.3 RF Performance

Modem RF performance in 5G, LTE, and WCDMA radio access technologies conforms to 3GPP specifications.

8.3.1 Conducted Transmit Output Power

TX power follows the measurement conditions and specifications defined in 3GPP.

Table 33: Conducted Transmit Output Power

Band	Power class	RF Power (dBm) Nominal*
5G NR Sub-6 n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/ n30/n38/n40/n41/n48/n53/n66//n70/n71/n77/n78/n79/ n91/n92/n93/n94	3 (0.2W)	23
5G NR Sub-6 n41, n77, n78, n79, n2, n25, n26, n71 Supports Power Class 2	2 (0.4W)	26
5G NR Sub-6 n41, n77, n78, n79 UL MIMO Supports Power Class 1.5***	1.5 (0.8W)	29
LTE All Bands B1/B2(B25)/B3/B4(B66)/B26(B5,B18,B19)/B7/B8/B12(B17)/B13/ B14/B20/B28/B30/B106/B34/B38/B39/B40/B41/B42**/B43**/B48**/ B53/B68/B70/B71	3 (0.2W)	23
LTE	2 (0.4W)	26

Band	Power class	RF Power (dBm) Nominal*
B38/B41/B42/B43		
3G WCDMA B1, B2, B4, B5, B8	3 (0.2W)	23

*** Max output power tolerance according to 3GPP TS 38.521-1, 3GPP TS 36.521-1 and 3GPP TS 34.121-1 or better**

**** These bands may show lower power due to Country-type approvals constraints**

***** Single NR band has two PC2 Tx paths and UL MIMO capability.**

Note: For Power Class 1.5, please follow the SW guide documentation to check the F/W version.

The FCC states that in regions where LTE Band 38 supports only power class 3.

8.3.2 Conducted Receiver Sensitivity

The Sensitivity of the receiver follows the measurement conditions and specifications defined by 3GPP.

Table 34: 3GPP Compliance for Conducted Receiver Sensitivity

Technology	3GPP Compliance
5G NR Sub-6	Throughput >95% According to 3GPP 38.521-1
4G LTE	Throughput >95% According to 3GPP 36.521-1
3G WCDMA	BER <0.1% According to 3GPP 34.121-1

Table 35: Typical Conducted Receiver Sensitivity - NR Bands

NR Band	Typical Conducted Rx Sensitivity (dBm) *						
	SCS(kHz)	BW(MHz)	PRx	DRx	MIMO0	MIMO1	Combined
NR FDD n1	15	10	-99.0	-98.0	-99.0	-98.0	-103.5
NR FDD n2	15	10	-99.0	-98.0	-98.0	-98.0	-103.0
NR FDD n3	15	10	-98.0	-98.0	-99.0	-98.0	-103.5
NR FDD n5	15	10	-99.0	-101.0	-	-	-103.0
NR FDD n7	15	10	-98.0	-97.0	-98.0	-98.0	-102.0
NR FDD n8	15	10	-98.0	-101.0	-	-	-102.0
NR FDD n12	15	10	-99.0	-101.0	-	-	-103.0
NR FDD n13	15	10	-99.0	-100.0	-	-	-103.0
NR FDD n14	15	10	-99.0	-101.0	-	-	-103.0
NR FDD n18	15	10	-100.0	-101.0	-	-	-103.0

NR Band	Typical Conducted Rx Sensitivity (dBm) *						
NR FDD n20	15	10	-99.0	-101.0	-	-	-103.0
NR FDD n25	15	10	-99.0	-98.0	-99.0	-97.0	-103.5
NR FDD n26	15	10	-100.0	-101.0	-	-	-103.0
NR FDD n28	15	10	-99.0	-101.0	-	-	-103.0
NR FDD n29	15	5	-102.0	-102.0	-	-	-104.0
NR FDD n30	15	10	-95.0	-97.0	-98.0	-97.0	-101.5
NR TDD n38	30	20	-95.0	-95.0	-96.0	-96.0	-101.0
NR TDD n40	30	20	-96.0	-95.0	-96.0	-97.0	-101.5
NR TDD n41	30	100	-88.0	-87.0	-88.0	-89.0	-94.0
NR TDD n48	30	20	-96.0	-96.0	-97.0	-97.0	-102.0
NR TDD n53	30	10	-95.0	-97.0	-98.0	-97.0	-101.5
NR FDD n66	15	10	-98.0	-98.0	-98.0	-99.0	-103.5
NR FDD n67	15	20	-97.5	-98.0	-	-	-100
NR FDD n70	15	15	-97.0	-97.0	-97.0	-98.0	-102
NR FDD n71	15	10	-100.0	-101.0	-	-	-103.0
NR SDL n75	15	10	-97.0	-98.0	-97.0	-97.0	-102.5
NR SDL n76	30	5	-	-	-	-	-
NR TDD n77	30	100	-89.0	-90.0	-89.0	-89.0	-96.0
NR TDD n78	30	100	-89.0	-90.0	-89.0	-89.0	-95.5
NR TDD n79	30	100	-89.0	-89.0	-89.0	-89.0	-95.0
NR FDD n91	15	5	-99.0	-101.0	-100.0	-99.0	-105.5
NR FDD n92	15	20	-95.0	-94.0	-95.0	-94.0	-100.5
NR FDD n93	15	5	-99.0	-100.0	-100.0	-99.0	-105.5
NR FDD n94	15	20	-94.0	-94.0	-95.0	-94.0	-100.0

***3.8 Voltage / Room temperature**

Table 36: Typical Conducted Receiver Sensitivity - LTE Bands

E-UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
	PRX	DRX	MIMO0	MOMO1	Combined
LTE FDD B1	-98.0	-99.0	-98.0	-97.0	-103.0
LTE FDD B2	-97.0	-97.0	-97.0	-97.0	-103.0
LTE FDD B3	-98.0	-98.0	-98.0	-97.0	-103.0
LTE FDD B4	-97.0	-98.0	-97.0	-97.0	-103.0

E-UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
LTE FDD B5	-99.4	-100.0	-	-	-102.0
LTE FDD B7	-97.0	-98.0	-98.0	-96.0	-102.0
LTE FDD B8	-98.0	-99.0	-	-	-101.5
LTE FDD B12	-99.3	-100	-	-	-102.0
LTE FDD B13	-99.0	-100	-	-	-102.0
LTE FDD B14	-99.0	-99.0	-	-	-102.0
LTE FDD B17	-99.0	-100.0	-	-	-102.0
LTE FDD B18	-99.0	-100.0	-	-	-102.0
LTE FDD B19	-99.0	-100.0	-	-	-102.0
LTE FDD B20	-99.0	-100.0	-	-	-102.5
LTE FDD B25	-98.0	-98.0	-98.0	-97.0	-102.5
LTE FDD B26	-99.0	-100.0	-	-	-102.0
LTE FDD B28	-98.0	-100.0	-	-	-102.0
LTE SDL B29	-99.0	-99.0	-	-	-101.5
LTE FDD B30	-94.0	-97.0	-96.0	-97.0	-101.0
LTE FDD B106	-98.0	-99.0	-	-	-101.5
LTE SDL B32	-96.0	-99.0	-97.0	-97.0	-102.5
LTE TDD B34	-99.0	-99.0	-99.0	-98.0	-103.5
LTE TDD B38	-99.0	-99.0	-99.0	-98.0	-102.5
LTE TDD B39	-100.0	-99.0	-100.0	-98.0	-104.5
LTE TDD B40	-99.0	-98.0	-100.0	-98.0	-104.0
LTE TDD B41	-98.0	-98.0	-98.0	-98.0	-103.0
LTE TDD B42	-98.0	-99.0	-99.0	-99.0	-103.5
LTE TDD B43	-98.0	-99.0	-99.0	-99.0	-103.5
LTE SDL B46[1)]	-93.0	-94	-	-	-96.0
LTE TDD B48	-98.0	-100.0	-99.0	-99.0	-103.5
LTE TDD B53	-98.0	-100.0	-99.0	-99.0	-103.5
LTE FDD B66	-97.0	-99.0	-98.0	-97.0	-102.5
LTE SDL B67	-	-	-	-	-
LTE SDL B68	-98.0	-100.0	-	-	-102.0
LTE FDD B70	-98.0	-97.0	-98.0	-98.0	-103.0
LTE FDD B71	-99.0	-100.0	-	-	-102.0

1) B46 DL only 20M BW.

***3.8 Voltage / Room temperature**

Table 37: Typical Conducted Receiver Sensitivity - WCDMA Bands

UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
	PRX	DRX	MIMO0	MIMO1	Combined
WCDMA B1	-109.0	-109.0	-	-	-111.0
WCDMA B2	-109.0	-109.0	-	-	-111.0
WCDMA B4	-109.0	-109.0	-	-	-111.0
WCDMA B5	-110.0	-110.0	-	-	-112
WCDMA B8	-110.0	-110.0	-	-	-112

***3.8 Voltage / Room temperature**

Note: The sensitivity level can show a deviation of approximately +/- <2dB, device, and channel because the level shows a typical value.

The sensitivity level of the NR bands has a deviation of approximately +/- <3dB depending on the EN-DC combinations, but the combined sensitivity performance meets the 3GPP requirements.

Except for band 46, where 20 MHz BW is used, LTE level is measured at BW 10 MHz.

8.4 Antenna Interface

The antenna connection is one of the most important aspects of the whole application design as it strongly affects the overall radio performance. Hence, please read and follow the requirements and the guidelines as carefully as possible.

FN990B FAMILY modules provide four MHF-4 type RF connectors covering 5G FR1/LTE/WCDMA bands including GNSS and one MHF-4 type RF connector dedicated to GNSS.

Warning: When connecting cellular and GNSS antennas to the module, pay special attention not to damage RF connectors.

8.4.1 Antenna Configuration

Please refer to the picture below for the connector position.

Figure 18: Antenna Configuration

Refer to the following antenna configuration assigned.

Table 38: Antenna Configuration

Antenna port	Band group	Frequency range (MHz)
ANT 0	LB_TRX	617 - 960
	MHB_PRX, MHB_TX0	1427 - 2690
	LAA (B46) PRX	5150 - 5925
	(n77-n79) PRX and TX0	3300 - 5000
ANT 1	AUX GNSS L5	1166 - 1176
	MHB_PMRX (P-MIMO)	1427 - 2690
	(n77-n79)_MDRX, D-MIMO	3300 - 5000
ANT 2	MHB_DMRX(D-MIMO), MHB_TX1	1427 - 2690
	(n77-79)_DRX and TX1	3300 - 5000
ANT 3	LB_DRX	617 - 960
	MHB_DRX	1427 - 2690
	AUX GNSS L1	1560 -1610
	(n77-79)_PMRX, P-MIMO	3300 - 5000
	LAA(B46) DRX	5150 - 5925
ANT 4	GNSS Active L1/L5 (Dedicated)	1166 – 1176, 1560 – 1610

Table 39: Antenna Support bands Configuration

Antenna port	Technology	Tx	Rx	GNSS
ANT 0	WCDMA	B1, B2, B4, B5, B8	B1, B2, B4, B5, B8	-
	LTE	B1/B2/B3/B4/B5B7/B8/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B30/B106/B34/B38/B39/B40/B41/B42/B43/B48/B53/B66/B68/B70/B71	B1/B2/B3/B4/B5/B7/B8/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B29(SDL)/B30/B106/B32(SDL)/B34/B38/B39/B40/B41/B42/B43/B46(SDL)/B48/B53/B66/B67(SDL)/B68/B70/B71	
	5G NR FR1	n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n30/n38/n40/n41/n48/n53/n66/n70/n71/n77/n78/n79/n91/n92/n93/n94	n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29(SDL)/n30/n38/n40/n41/n48/n53/n66/n67(SDL)/n70/n71/n75(SDL)/n76(SDL)/n77/n78/n79/n91/n92/n93/n94	
ANT 1	WCDMA	-	-	GPS L5

Antenna port	Technology	Tx	Rx	GNSS
	LTE	-	B1/B2/B3/B4/B7/B25/B30/B32(SDL)/B34/B38/B39/B40/B41/B42/B43/B48/B53/B66/B70	Galileo Beidou QZSS
	5G NR FR1	-	n1/n2/n3/n7/n25n30/n38/n40/n41/n48/n53/n66/n70/n75(SDL)/n76(SDL)/n77/n78/n79/n91/n92/n93/n94	
ANT 2	WCDMA	-	-	-
	LTE	B1/B2/B3/B4/B7/B25/B30/B34/B38/B39/B40/B41/B42/B43/B48/B66/B70	B1/B2/B3/B4/B7/B25/B30/B32(SDL)/B34/B38/B39/B40/B41/B42/B43/B48/B53/B66/B70	
	5G NR FR1	n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n66/n70/n77/n78/n79	n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n53/n66/n70/n75(SDL)/n76(SDL)/n77/n78/n79/n91/n92/n93/n94	
ANT 3	WCDMA	-	B1, B2, B4, B5, B8	GPS L1 Galileo Beidou Glonass G1 QZSS SBAS
	LTE	-	B1/B2/B3/B4/B5/B7/B8/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B29(SDL)/B30/B32(SDL)/B106/B34/B38/B39/B40/B41/B42/B43/B46(SDL)/B48/B53/B66/B67(SDL)/B68/B70/B71	
	5G NR FR1	-	n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29(SDL)/n30/n38/n40/n41/n48/n53/n66/n67(SDL)/n70/n71/n75(SDL)/n76(SDL)/n77/n78/n79/n91/n92/n93/n94	
ANT 4	GNSS Active (Dedeicate)	-	-	GPS L1/L5 Galileo Beidou Glonass G1 QZSS SBAS

Table 40: Antenna Configuration for NR

NR Band				
	ANT0	ANT1	ANT2	ANT3
NR FDD n1	PRX/TX0	MOMO0	MOMO1/TX1	DRX

NR Band				
NR FDD n2	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n3	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n5	PRX/TX0	NA	NA	DRX
NR FDD n7	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n8	PRX/TX0	NA	NA	DRX
NR FDD n12	PRX/TX0	NA	NA	DRX
NR FDD n13	PRX/TX0	NA	NA	DRX
NR FDD n14	PRX/TX0	NA	NA	DRX
NR FDD n18	PRX/TX0	NA	NA	DRX
NR FDD n20	PRX/TX0	NA	NA	DRX
NR FDD n25	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n26	PRX/TX0	NA	NA	DRX
NR FDD n28	PRX/TX0	NA	NA	DRX
NR FDD n29	PRX	MOMO0	MOMO1	DRX
NR FDD n30	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR TDD n38	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR TDD n40	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR TDD n41	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR TDD n48	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR TDD n53	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n66	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR SDL n67	PRX	MOMO0	MOMO1	DRX
NR FDD n70	PRX/TX0	MOMO0	MOMO1/TX1	DRX
NR FDD n71	PRX/TX0	NA	NA	DRX
NR SDL n75	PRX	MOMO0	MOMO1	DRX
NR SDL n76	PRX	MOMO0	MOMO1	DRX
NR TDD n77	PRX/TX0	MOMO1	TX1/DRX	MOMO0
NR TDD n78	PRX/TX0	MOMO1	TX1/DRX	MOMO0
NR TDD n79	PRX/TX0	MOMO1	TX1/DRX	MOMO0
NR FDD n91	PRX/TX0	NA	NA	DRX
NR FDD n92	PRX/TX0	NA	NA	DRX
NR FDD n93	PRX/TX0	NA	NA	DRX
NR FDD n94	PRX/TX0	NA	NA	DRX

Table 41: Antenna Configuration for E-UTRA

E-UTRA Band				
	ANT0	ANT1	ANT2	ANT3
LTE FDD B1	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B2	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B3	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B4	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B5	PRX/TX0	NA	NA	DRX
LTE FDD B7	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B8	PRX/TX0	NA	NA	DRX
LTE FDD B12	PRX/TX0	NA	NA	DRX
LTE FDD B13	PRX/TX0	NA	NA	DRX
LTE FDD B14	PRX/TX0	NA	NA	DRX
LTE FDD B17	PRX/TX0	NA	NA	DRX
LTE FDD B18	PRX/TX0	NA	NA	DRX
LTE FDD B19	PRX/TX0	NA	NA	DRX
LTE FDD B20	PRX/TX0	NA	NA	DRX
LTE FDD B25	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B26	PRX/TX0	NA	NA	DRX
LTE FDD B28	PRX/TX0	NA	NA	DRX
LTE SDL B29	PRX	NA	NA	DRX
LTE FDD B30	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE SDL B32	PRX	MOMO0	MOMO1	DRX
LTE FDD B106	PRX/TX0	NA	NA	DRX
LTE FDD B34	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B38	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B39	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B40	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B41	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B42	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE TDD B43	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE SDL B46	PRX	NA	NA	DRX
LTE TDD B48	PRX/TX0	MOMO0	MOMO1/TX1	DRX

E-UTRA Band				
LTE TDD B53	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B66	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE SDL B67	PRX	NA	NA	DRX
LTE FDD B68	PRX/TX0	NA	NA	DRX
LTE FDD B70	PRX/TX0	MOMO0	MOMO1/TX1	DRX
LTE FDD B71	PRX/TX0	NA	NA	DRX

Table 42: Antenna Configuration for UTRA

UTRA Band				
	ANT0	ANT1	ANT2	ANT3
WCDMA B1	PRX/TX0	NA	NA	DRX
WCDMA B2	PRX/TX0	NA	NA	DRX
WCDMA B4	PRX/TX0	NA	NA	DRX
WCDMA B5	PRX/TX0	NA	NA	DRX
WCDMA B8	PRX/TX0	NA	NA	DRX

8.5 Antenna Connector

The FN990B FAMILY is equipped with a set of 50 Ω RF MHF-4 Receptacles from I-PEX 20449-001E.

For more information about mating connectors, please consult https://www.i-pex.com

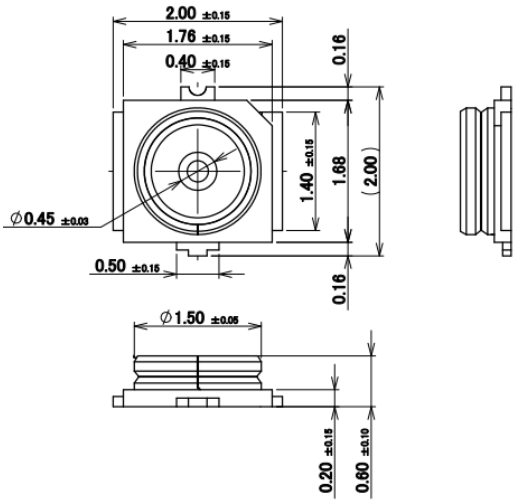

Figure 19: MHF-4 RF connector

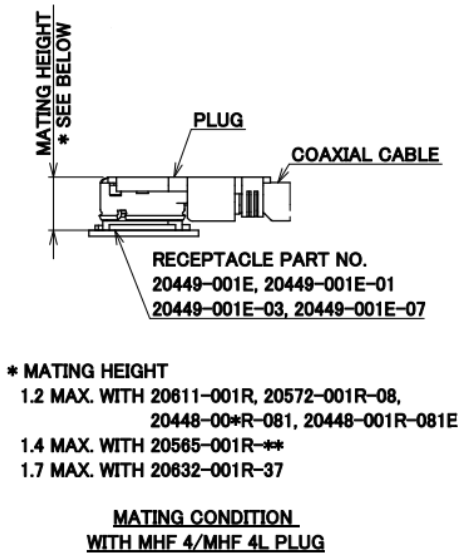

Figure 20: MHF-4 Receptacle

8.6 Antenna Requirements

Antennas for FN990B FAMILY modules must meet the requirements listed in the table below.

8.6.1 WCDMA/LTE/5G Sub-6 Antenna Requirements

Table 43: WCDMA / LTE / 5G Sub-6 Antenna Requirements

Item	Value
Frequency range	Depending on the frequency band(s) provided by the network operator, the customer must use the most suitable antenna for that/those band(s). The bands supported by the FN990B FAMILY are provided in Section 2.2 Frequency Bands and CA / EN-DC Combinations
Impedance	50 Ohm
Input power	> 24 dBm average power in WCDMA & LTE & 5G Sub-6
VSWR absolute max	<= 10:1
VSWR recommended	<= 2:1

8.7 Antenna Cable

Connecting cables between the module and LTE/Sub-6 antenna must have a 50 Ohm impedance.

If the impedance of the module does not match, RF performance is significantly reduced.

Table 44: Minimize Antenna Cable Recommendations

Item	Value
Impedance	50 Ohm
Max cable loss	Less than 0.5 dB
Avoid coupling with other signals.	

Warning: Impedance of antenna connector and RF cable must be matched to 50 Ohm: mismatch will affect RF performance; especially high insertion loss of RF cable will cause Tx power and Rx sensitivity degradation.

Warning: The FN990B FAMILY should be located away from noise sources: RF cables and antennas should be installed away from noise sources such as SMPS, USB/PCIe interfaces, etc.

8.7.1 Antenna Installation Guidelines

- Each antenna must be installed with 20dB isolation.
- Install the antenna in a location with access to the network radio signal.
- The Antenna must not be installed inside metal cases.
- The Antenna must be installed according to the antenna manufacturer instructions.
- Antenna integration should optimize Radiation Efficiency. Efficiency values > 50% are recommended on all frequency bands.
- Antenna integration should not perturb the radiation pattern described in the Antenna manufacturer documentation.
- It is preferable to get an omnidirectional radiation pattern.
- To meet the related EIRP limitations, antenna gain must not exceed the values indicated in regulatory requirements, where applicable. The Typical antenna Gain in most M2M applications does not exceed 2dBi.
- If the device antenna is located farther than 20 cm from the human body and there are no co-located transmitters, then the Telit FCC/IC approvals can be re-used by the end product.
- If the device antenna is located closer than 20 cm from the human body or there are co-located transmitters, then additional FCC/IC testing may be required for the end product (Telit FCC/IC approvals cannot be reused).

Note: GNSS receive path uses either the dedicated GNSS connector or the shared Secondary AUX antenna connector.

8.8 GNSS Receiver

The FN990B FAMILY integrates a GNSS receiver that can be used either in Standalone or in A-GPS (assisted GPS) mode.

FN990B FAMILY modems support active GNSS antennas.

Table 45: GNSS Receiver

Item	Value

Frequency range	• Wide-band GNSS: 1559 – 1606 MHz recommended.
	• GPS L1:
	  ◦ 2.046 MHz BW NB GPS (centered on 1575.42 MHz)
	• GPS L5:
	  ◦ 24 MHz BW (centered on 1176.45 MHz)

Item	Value
	• Glonass (GLO): ~ 8.3 MHz BW (1597.05 ~ 1606 MHz) • BeiDou (BDS): 4.092 MHz BW (1559.05 ~ 1563.14 MHz) • Galileo (GAL): 4.092 MHz BW (centered on 1575.42 MHz) Quasi-Zenith (QZSS): 12 MHz L1 GPS (centered on 1575.42 MHz) SBAS: 12 MHz L1 GPS (centered on 1575.42 MHz)
Passive Antenna Gain	1.5 dBi < Gain < 3dBi[1]
Impedance	50 Ohm
External Amplification Gain	7.5 dB < Gain < 26 dB for nominal performance[2] 1.5 dB < Gain < 7.5 dB for nominal performance[3]
Supply Voltage	3.1 V

Note: [1] Configured as AT$GPSANTPORT= 1 (Enable GNSS on Aux port; internal LNA On, DC-Bias off – Passive antenna)

[2] Configured as AT$GPSANTPORT= 2 (Enable GNSS on GNSS port; internal LNA off, DC bias On – Active antenna)

[3]Total gain applied at FN990B FAMILY RF input connector (Passive Antenna gain + External LNA gain-losses)

8.8.1 GNSS RF Front-End Design

The FN990B FAMILY contains an integrated LNA and front-end SAW filter.

This allows the module to operate properly with a passive GNSS antenna. If the antenna cannot be located near the FN990B FAMILY, then an active antenna (that is, an antenna with a built-in low noise amplifier) can be used with an external dedicated power supply circuit.

GNSS receive path uses either the dedicated GNSS connector #4 or the shared antenna connector #1.

Note: Please refer to the FN990B FAMILY AT Commands Reference Guide, 80691ST11097A for detailed information about GNSS operating modes and GNSS antenna selection.

8.9 GNSS Characteristics

The below table specifies the GNSS characteristics and expected performance:

Table 46: GNSS Characteristics

Parameters		Typical Measurement	Notes
Sensitivity	Tracking Sensitivity	-163 dBm	Standalone or MS-based
	Acquisition	-159 dBm	
	Cold Start	-148 dBm	
TTFF	Hot	1 sec	Open Sky, meanTTFF
	Warm	21 sec	Open Sky, mean TTFF

Parameters		Typical Measurement	Notes
	Cold	25 sec	Open Sky, mean TTFF
Min update rate		1 Hz	
2D positioning error meters (50%, 68%, 95%)		< 1.2m, <1.5m, <3 m	Open sky conditions. Good quality antenna, L1+L5
Speed accuracy (68%, 95%)		0.05ms , 0.1ms	30ms with all signals 130 dBm

9 Mechanical Design

9.1 General

The FN990B FAMILY module was designed to be compliant with a standard lead-free SMT process.

9.2 Finishing & Dimensions

The FN990B FAMILY module's overall dimensions are:

- Length: 52.00 mm
- Width: 30.00 mm
- Thickness: 2.3 mm

9.3 Drawing

This figure shows the mechanical dimensions of the FN990B FAMILY module.

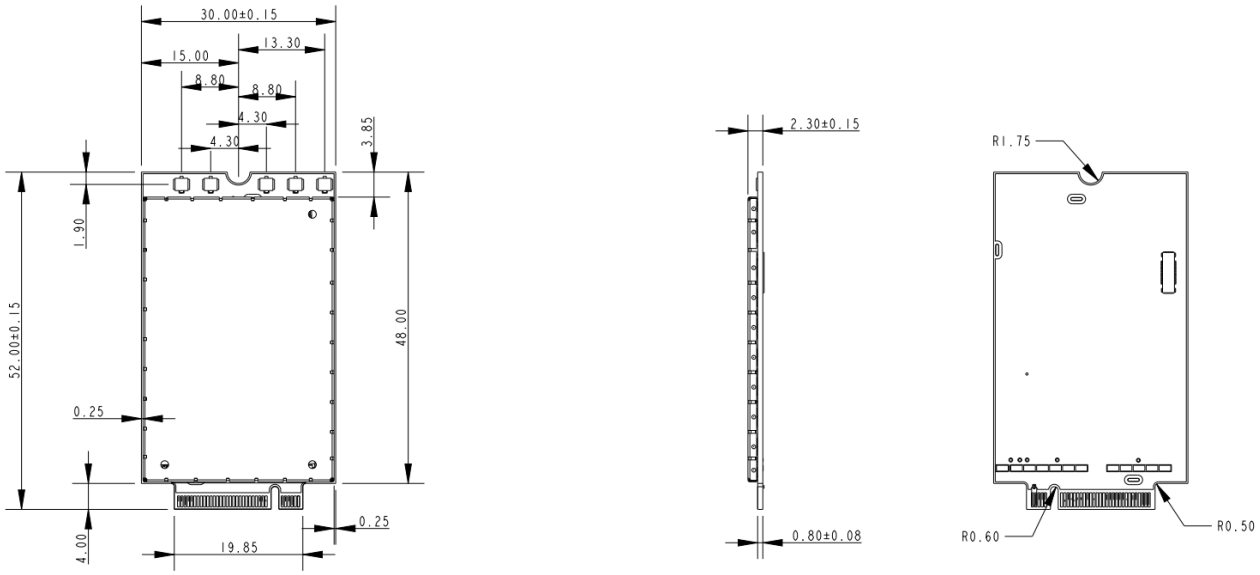

Figure 21: FN990B FAMILY Module Mechanical Dimensions

Warning: The keep-out area (30*2.27 mm) on the bottom side is only for debugging purposes. Please do not use this area for hardware design.

10 Application Guide

10.1 Debug the FN990B FAMILY Module in Production

To test and debug the FN990B FAMILY module integration, it is strongly recommended to add test pins on the host PCB for the following purposes:

- Checking the connection between the FN990B FAMILY itself and the application
- Testing the performance of the module by connecting it to an external computer

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

- FULL_CARD_POWER_N, SYS_RESET_N, W_DISABLE_N, PCIE_WAKE_N
- VPH_PWR, GND
- VREG_L6B_1P8
- USB_D +/-
- PCIE_TX/RX_M/P

10.2 Bypass Capacitor on Power Supplies

When a sudden voltage step is asserted to or a cut from the power supplies, the step transition causes effects such as overshoot and undershoot. This abrupt voltage transition can affect the device causing it to fail or to malfunction.

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

The power lines length and width must be considered carefully, and the capacitors value must be selected accordingly.

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

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

- VPH_PWR

Recommended value:

- 100 µF for VPH_PWR

It must be considered that the capacitance mainly depends on the application board.

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

Furthermore, if the fast power-down function is used, an additional bypass capacitor should be mounted on the application board.

10.2.1 EMC Recommendations [TBD]

EMC protection on all FN990B FAMILY pins should be designed on the application side according to the customer's requirement.

ESD rating on all pins of FN990B FAMILY:

- Human Body Model (HBM): +/- 1000 V
- Charged Device Model (CDM): +/- 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 FN990B FAMILY modules are packaged on trays of 15 pieces each. These trays can be used in SMT processes for pick & place handling.

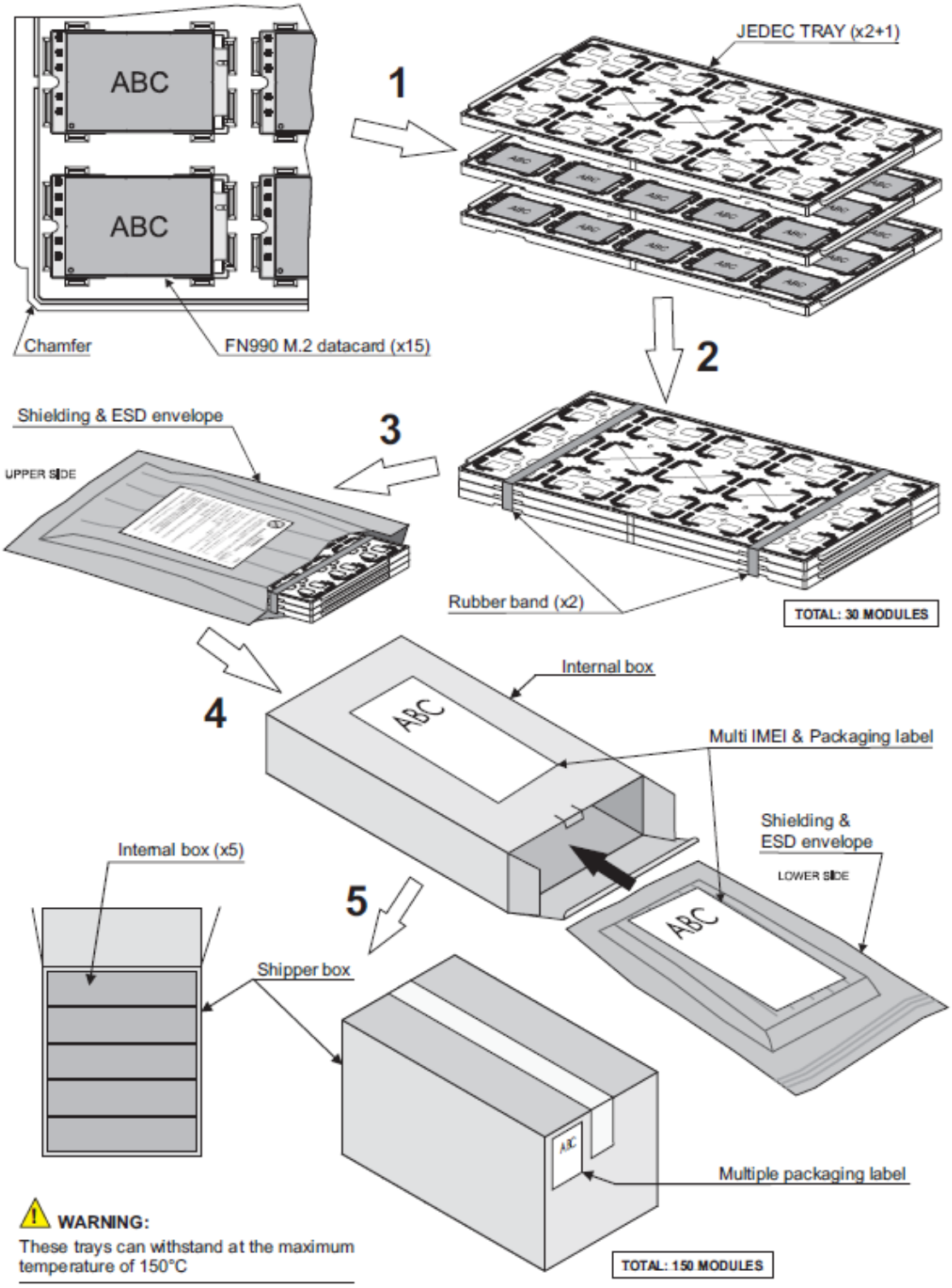

Figure 22: Tray Packaging

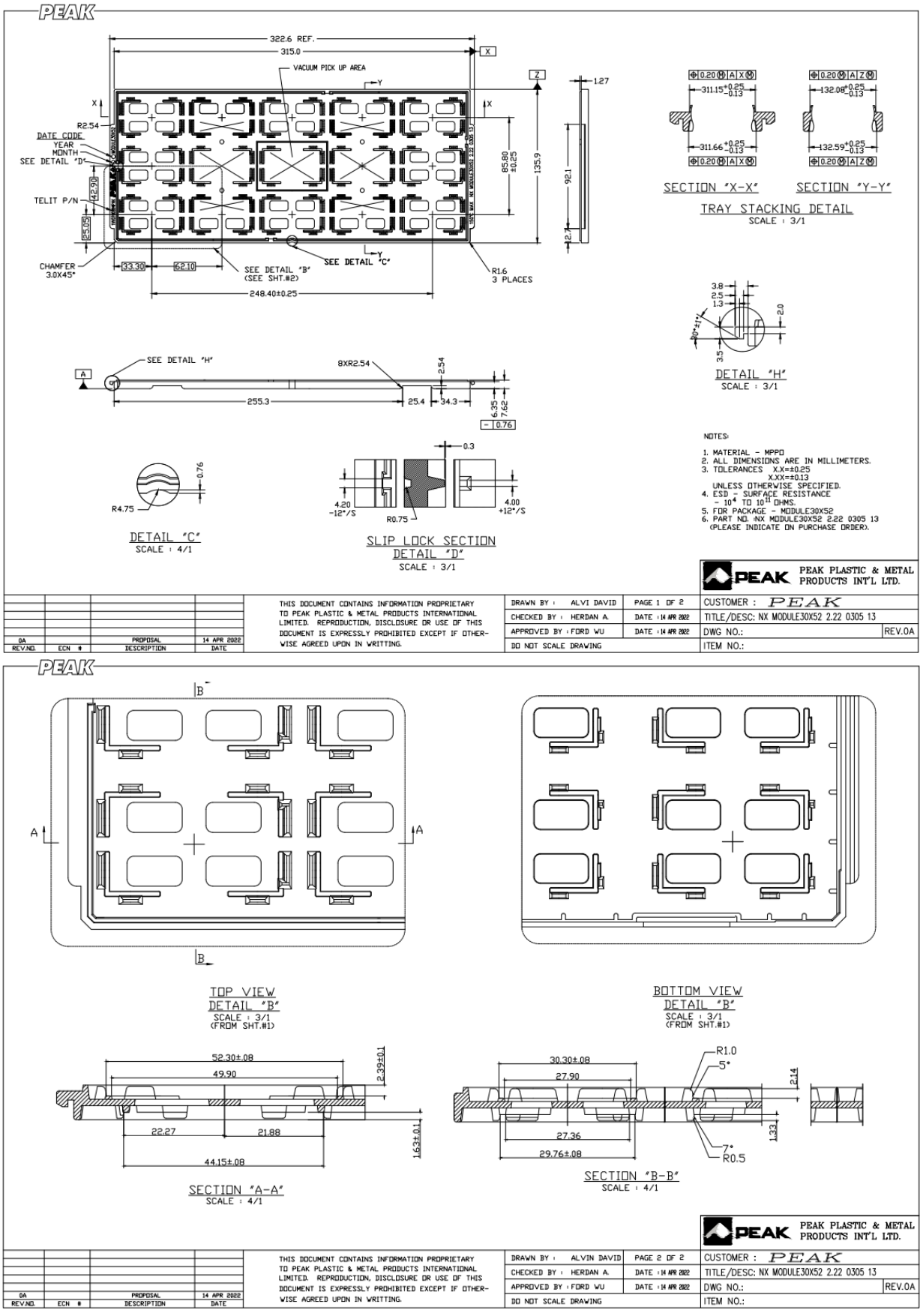

Figure 23: Tray Construction

12 Conformity Assessment Issues [TBD]

12.1 Approvals Compliance Summary

Table 47:Legend Description

Legend	Description
●	The equipment is compliant
●	Type approval is in progress
	The equipment is not compliant

Table 48:Americas Approvals Compliance Summary

Region	Americas						
Country & Type Approval	AR ENACOM	BR ANATEL	CA ISED	CO CRC	MX IFETEL	PE MTC	US FCC
FN990B40			●				●
FN990B34							

Table 49: APAC Approvals Compliance Summary

Region	APAC					
Country & Type Approval	AU RCM	CH CCC	JP JRL / JTBL	SG IMDA	TW NCC	KR KC
FN990B40			●			
FN990B34						

Table 50: EMEA Approvals Compliance Summary

Region	EMEA	
Country & Type Approval	EU RED	UK UKCA
FN990B40	●	
FN990B34		

12.2 Americas Approvals

12.2.1 USA FCC

12.2.1.1 FCC Certificates

The FCC Grants can be found here: https://www.fcc.gov/oet/ea/fccid

12.2.1.2 Applicable FCC Rules

Table 51: Applicable FCC Rules

Model	Applicable FCC Rules
FN990B40	47 CFR Part 2, 22, 24, 27, 90
FN990B34	

12.2.1.3 FCC 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.

Interference Statement

This device complies with Part 15 of the FCC Rules. 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.

Wireless Notice

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

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, according 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 per the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by taking one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment to 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.

Information for the OEMs and Integrators

The following statement must be included with all versions of this document supplied to an OEM or integrator but should not be distributed to the end user.

1 This device is intended for OEM integrators only.
2 Please see the full Grant of Equipment document for other restrictions

Note EMI Considerations

Note that a host manufacture is recommended to use KDB996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties. For standalone mode, reference the guidance in KDB996369 D04 Module Integration Guide and for simultaneous mode; see KDB996369 D02 Module Q&AQuestion 12, which permits the host manufacturer to confirm compliance.

How to make changes

Only Grantees are permitted to make permissive changes, if the module will be used differently than granted conditions, please contact us to ensure modifications will not affect compliance at the following contact points.

Grantee code:	RI7	Grantee name:	Telit Communications S.p.A.
Mailing address:	Viale Stazione di Prosecco 5/b, 34010 Sgonico – Trieste, Italy		
Website:	https://www.telit.com/	Support contact:	TS-EMEA@telit.com

Manual Information to the End User

The OEM integrator should be aware not to provide information to the end-user on 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/warming as shown in this manual

Information on test modes and additional testing requirements

The module has been evaluated in mobile stand-alone conditions. For operational conditions other than a stand-alone modular transmitter in a host (multiple, simultaneously transmitting modules or other transmitters in a host), additional testing may be required (collocation, retesting...). If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements of FCC Part 2.1093.

Additional testing, Part 15 Subpart B disclaimer

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

12.2.1.4 FCC Antenna Info

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

Table 52: Max Antenna Gain for FCC in dBi

Max Gain for FCC (dBi)				
Band	FN990B40	FN990B34		
WCDMA B2	8.0	8.0		
WCDMA B4	5.0	5.0		
WCDMA B5	9.9	9.9		
LTE B2	8.0	8.0		
LTE B4	5.0	5.0		
LTE B5	9.9	9.9		
LTE B7	8.0	8.0		
LTE B12	9.1	9.1		
LTE B13	9.6	9.6		
LTE B14	9.7	9.7		
LTE B17	9.1	9.1		
LTE B25	8.0	8.0		
LTE B26	9.9	9.9		
LTE B30	1.0	1.0		
LTE B38	8.0	8.0		
LTE B41 PC3	8.0	8.0		
LTE B41 PC2	5.0	5.0		
LTE B42	0.5	0.5		
LTE B43	0.5	0.5		
LTE B48	0.5	0.5		
LTE B53	5.5	5.5		
LTE B66	5.0	5.0		

Max Gain for FCC (dBi)				
LTE B70	5.0	5.0		
LTE B71	8.9	8.9		
LTE B106	10.7	10.7		
NR N2	8.0	8.0		
NR N5	9.9	9.9		
NR N7	8.0	8.0		
NR N12	9.1	9.1		
NR N13	9.6	9.6		
NR N14	9.7	9.7		
NR N25	8.0	8.0		
NR N26	9.9	9.9		
NR N30	1.0	1.0		
NR N38	8.0	8.0		
NR N41-PC3	8.0	8.0		
NR N41-PC2	5.0	5.0		
NR N48	0.5	0.5		
NR N53	5.5	5.5		
NR N66	5.0	5.0		
NR N70	5.0	5.0		
NR N71	8.9	8.9		
NR N77-PC3	5.0	5.0		
NR N77-PC2	2.0	2.0		
NR N78-PC3	5.0	5.0		
NR N78-PC2	2.0	2.0		
N2_UL MIMO_PC3	8.0	8.0		
N2_UL MIMO_PC2	5.0	5.0		
N7_UL MIMO_PC3	8.0	8.0		
N25_UL MIMO_PC3	8.0	8.0		
N25_UL MIMO_PC2	5.0	5.0		
N30_UL MIMO	1.0	1.0		
N38_UL MIMO	8.0	8.0		
N41_UL MIMO_PC3	8.0	8.0		
N41_UL MIMO_PC2	5.0	5.0		
N41_UL MIMO_PC1.5	2.0	2.0		
N48_UL MIMO	0.5	0.5		
N66_UL MIMO_PC3	5.0	5.0		
N66_UL MIMO_PC2	2.0	2.0		
N70_UL MIMO	5.0	5.0		
N77_UL MIMO_PC3	5.0	5.0		
N77_UL MIMO_PC2	2.0	2.0		

Max Gain for FCC (dBi)				
N77_UL MIMO_PC1.5	1.0	1.0		
N78_UL MIMO_PC3	5.0	5.0		
N78_UL MIMO_PC2	2.0	2.0		
N78_UL MIMO_PC1.5	1.0	1.0		

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

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 of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as in the below table.

Table 53: Host device FCC Label

Model	Host device FCC label
FN990B40	Contains FCC ID: RI7FN990B40

12.2.2 Canada ISED

12.2.2.1 ISED Database

The products ISED certified can be found here:

Les produits certifiés ISED peuvent être trouvés ici :
https://sms-sgs.ic.gc.ca/equipmentSearch/searchRadioEquipments?execution=e1s1&lang=en

12.2.2.2 Applicable ISED Rules

Table 54: Applicable ISED rules / Règles ISDE applicable

Model	Applicable ISED rules / *Règles ISDE applicables*
FN990B40	RSS: 132 Issue 4, 133 Issue 7, 130 Issue 2, 139 Issue 4, 195 Issue 2, 199 Issue 4, 140 Issue 1, 192 Issue 5, 198 Issue 1; RSS-Gen Issue 5
FN990B34	

12.2.2.3 ISED Regulatory Notices

Modification Statement / *Déclaration de modification*

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

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

Interference Statement / *Déclaration d'interférence*

This device complies with 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 applicables RSS standards d'Industrie Canada. 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.

Radio Exposure Notice */ Avis d'exposition radio*

This device complies with ISED radiation exposure limits set forth for an uncontrolled environment and meets the RSS-102 of the ISED radio frequency (RF) Exposure rules. Antenna gain must be less than the values reported in the table below:

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:

Table 55: Max antenna gain for ISED in dBi / Gain d'antenne max pour ISED en dBi

Gain maximum pour ISED (dBi) / *Gain maximum pour ISDE (dBi)*				
Band	FN990B40	FN990B34		
WCDMA B2	8.0	8.0		
WCDMA B4	5.0	5.0		
WCDMA B5	6.6	6.6		
LTE B2	8.0	8.0		
LTE B4	5.0	5.0		
LTE B5	6.6	6.6		
LTE B7	8.0	8.0		
LTE B12	6.1	6.1		
LTE B13	6.4	6.4		
LTE B14	6.4	6.4		
LTE B17	6.1	6.1		
LTE B25	8.0	8.0		
LTE B26	6.6	6.6		
LTE B30	1.0	1.0		
LTE B38_PC3	8.0	8.0		
LTE B38_PC2	5.0	5.0		
LTE B41_PC3	8.0	8.0		
LTE B41_PC2	5.0	5.0		
LTE B42_PC3	7.5	7.5		
LTE B42_PC2	3.5	3.5		
LTE B43_PC3	7.5	7.5		
LTE B43_PC2	3.5	3.5		

Gain maximum pour ISED (dBi) / *Gain maximum pour ISDE (dBi)*				
LTE B48	7.5	7.5		
LTE B66	5.0	5.0		
LTE B71	5.9	5.9		
NR N2	8.0	8.0		
NR N5	6.6	6.6		
NR N7	8.0	8.0		
NR N12	6.1	6.1		
NR N13	6.4	6.4		
NR N14	6.4	6.4		
NR N25	8.0	8.0		
NR N26	6.6	6.6		
NR N30	1.0	1.0		
NR N38	8.0	8.0		
NR N41_PC3	8.0	8.0		
NR N41_PC2	5.0	5.0		
NR N48	7.5	7.5		
NR N66	5.0	5.0		
NR N71	5.9	5.9		
NR N77_PC3	5.0	5.0		
NR N77_PC2	2.0	2.0		
NR N78_PC3	5.0	5.0		
NR N78_PC2	2.0	2.0		
N2_UL MIMO_PC3	8.0	8.0		
N2_UL MIMO_PC2	5.0	5.0		
N7_UL MIMO_PC3	8.0	8.0		
N25_UL MIMO_PC3	8.0	8.0		
N25_UL MIMO_PC2	5.0	5.0		
N30_UL MIMO	1.0	1.0		
N38_UL MIMO	8.0	8.0		
N41_UL MIMO_PC3	8.0	8.0		
N41_UL MIMO_PC2	5.0	5.0		
N41_UL MIMO_PC1.5	2.0	2.0		
N48_UL MIMO	8.0	8.0		
N66_UL MIMO_PC3	5.0	5.0		
N66_UL MIMO_PC2	2.0	2.0		
N77_UL MIMO_PC3	5.0	5.0		
N77_UL MIMO_PC2	2.0	2.0		
N77_UL MIMO_PC1.5	1.0	1.0		
N78_UL MIMO_PC3	5.0	5.0		
N78_UL MIMO_PC2	2.0	2.0		

Gain maximum pour ISED (dBi) / *Gain maximum pour ISDE (dBi)*				
N78_UL MIMO_PC1.5	1.0	1.0		

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.

This equipment must be installed and operated in accordance with provided instructions and 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 and installers must be provided with antenna installation instructions and consider removing the no-collocation statement.

Cet équipement doit être installé et utilisé conformément aux instructions fournies et la ou les antennes utilisées pour cet émetteur doivent être installées pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doivent pas être co-localisées ou fonctionner en conjonction avec toute autre antenne ou émetteur.

Les utilisateurs finaux et les installateurs doivent recevoir les instructions d'installation de l'antenne et envisager de supprimer la déclaration de non-collocation.

Information on test modes and additional testing requirement / Informations sur les modes de test et exigences de test supplémentaires

The module has been evaluated in mobile stand-alone conditions. For operational conditions other than a stand-alone modular transmitter in a host (multiple, simultaneously transmitting modules or other transmitters in a host), additional testing may be required (collocation, retesting...) If this module is intended for use in a portable device, you are responsible for separate approval to satisfy the SAR requirements IC RSS-102.

Le module a été évalué dans des conditions mobiles autonomes. Pour des conditions de fonctionnement autres qu'un émetteur modulaire autonome dans un hôte (plusieurs modules transmettant simultanément ou d'autres émetteurs dans un hôte), des tests supplémentaires peuvent être nécessaires (colocalisation, retest...) Si ce module est destiné à être utilisé dans un appareil portable , vous êtes responsable de l'approbation séparée pour satisfaire aux exigences SAR IC RSS-102.

Labelling requirements for the host device / Exigences d'étiquetage pour le périphérique hôte

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 IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as in the following table.

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 IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme en tableau suivant.

Table 56: Host device IC label / Ètiquette IC du dispositif hôte

Model / HVIN	Host device IC label / Ètiquette IC du dispositif hôte
FN990B40	Contains IC: 5131A-FN990B40

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.

12.2.3 Brazil ANATEL

12.2.3.1 ANATEL Regulatory Notices

The LN920 module is certified in Brazil by Anatel.

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

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

FN990B40 Homologation # XXXXX-XX-XXXXX

FN990B34 Homologation # XXXXX-XX-XXXXX

12.3 APAC Approvals

12.3.1 Japan Approvals

Telit strongly recommends to customers, deploying the module to Japan, the usage of AT#FWSWITCH command to select the right Japanese carrier profile. The carrier profile has been designed to enable the right LTE and WCDMA bands and also the required carrier settings.

12.3.2 JRL/JTBL Regulatory Notices

Antenna info

According to Japan regulatory rule, module certification is valid only with the specific antennas registered to and approved by Japan Radio Law (JRL) certified body in relation to module certification. Customers who are going to use modules under JRL are

responsible to contact Telit technical support or sales to get the list of these antennas.

12.3.3 Taiwan NCC

12.3.3.1 NCC Regulatory Notices

According to National Communication Commission (NCC) Taiwan requirements, the module, and the packaging shall be identified as described in the following lines. Shall be added also the specified safety warning statement.

- **「減少電磁波影響，請妥適使用」**

  「此模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求平台廠商於平台上標示『本產品內含發射器模組：☐ CCXXxxLPyyyZzW』字樣。」

FN990B40: ☐ CCXXxxLPyyyZzW

FN990B34: ☐ CCXXxxLPyyyZzW

- 「本產品 FN990B40 / FN990B34 **支持** WCDMA Bx, LTE Bx. 」

12.4 EMEA Approvals

12.4.1 EU RED

12.4.1.1 EU Declaration of Conformity

Following the above Approval Compliance Summary table, where applicable (green dot), hereby, Telit Communications S.p.A declares that the equipment complies with Directive 2014/53/EU.

The full text of the EU Declaration of Conformity is available at the following internet address: https://www.telit.com/red

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

12.4.1.2 RED Regulatory Notices

Wireless Notice

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

12.4.1.3 RED Antennas

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

Table 57: Max antenna gain for RED in dBi

Gain maximum pour RED (dBi)				
Band	FN990B40	FN990B34		
WCDMA B1	11.8	11.8		
WCDMA B5	8.7	8.7		
WCDMA B8	8.9	8.9		
LTE B1	11.8	11.8		
LTE B3	11.3	11.3		
LTE B5	8.7	8.7		
LTE B7	12.0	12.0		
LTE B8	8.9	8.9		
LTE B20	8.7	8.7		
LTE B28	8.0	8.0		
LTE B34	12.5	12.5		
LTE B38_PC3	12.0	12.0		
LTE B38_PC2	9.0	9.0		
LTE B40	12.0	12.0		
LTE B41_PC3	12.0	12.0		
LTE B41_PC2	9.0	9.0		
LTE B42_PC3	14.5	14.5		
LTE B42_PC2	10.5	10.5		
LTE B43_PC3	14.5	14.5		
LTE B43_PC2	10.5	10.5		
LTE B68	7.9	7.9		
NR N1	11.8	11.8		
NR N3	11.3	11.3		
NR N5	8.7	8.7		
NR N7	12.0	12.0		
NR N8	8.9	8.9		
NR N20	8.7	8.7		
NR N28	8.0	8.0		
NR N38	12.0	12.0		
NR N40	12.0	12.0		
NR N41_PC3	12.0	12.0		
NR N41_PC2	9.0	9.0		
NR N77_PC3	12.0	12.0		
NR N77_PC2	9.0	9.0		
NR N78_PC3	12.0	12.0		
NR N78_PC2	9.0	9.0		
N1_UL MIMO_PC3	11.8	11.8		
N3_UL MIMO_PC3	11.3	11.3		
N7_UL MIMO_PC3	12.0	12.0		

Gain maximum pour RED (dBi)				
N38_UL MIMO_PC3	12.0	12.0		
N40_UL MIMO_PC3	12.0	12.0		
N41_UL MIMO_PC3	12.0	12.0		
N41_UL MIMO_PC2	9.0	9.0		
N41_UL MIMO_PC1.5	6.0	6.0		
N77_UL MIMO_PC3	12.0	12.0		
N77_UL MIMO_PC2	9.0	9.0		
N77_UL MIMO_PC1.5	8.0	8.0		
N78_UL MIMO_PC3	12.0	12.0		
N78_UL MIMO_PC2	9.0	9.0		
N78_UL MIMO_PC1.5	8.0	8.0		

12.4.2 UK UKCA

12.4.2.1 UKCA Declaration of Conformity

Following the above Approval Compliance Summary table, where applicable (green dot), hereby, Telit Communications S.p.A declares that the equipment complies with the Radio Equipment Regulations 2017 for UKCA.

The full text of the UKCA declaration of conformity is available at the following internet address: https://www.telit.com/ukca

The UKCA requirements can be found here:

https://www.gov.uk/guidance/using-the-ukca-marking

12.5 RoHS, REACH, and WEEE Info

12.5.1 RoHS Info

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

12.5.2 REACH Info

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

12.5.3 WEEE Info

This symbol means that according to local laws and regulations your product and/or its battery shall be disposed of separately from household waste. When this product reaches its end of life, take it to a collection point

designated by local authorities. Proper recycling of your product will protect human health and the environment.

13 Acronyms and Abbreviations

Table 58: Acronyms and Abbreviations

Acronym	Definition
CA	Carrier aggregation
CLK	Clock
CMOS	Complementary Metal – Oxide Semiconductor
DTE	Data Terminal Equipment
EN-DC	E-UTRA – NR Dual Connectivity
ESR	Equivalent Series Resistance
E-UTRA	Evolved UMTS Terrestrial Radio Access
FDD	Frequency Division Duplex
GPIO	General Purpose Input Output
HS	High Speed
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
I/O	Input Output
I2C	Inter-integrated Circuit
I2S	Inter-IC Sound
LTE	Long Term Evolution
NR	New Radio
PCB	Printed Circuit Board
PCIE	Peripheral Component Interconnect Express
RTC	Real-Time Clock
SDL	Supplementary Down Link
SIM	Subscriber Identification Module
SOC	System-on-Chip
SMPS	Switching Mode Power Supply
TDD	Time Division Duplex
TTSC	Telit Technical Support Center
UART	Universal Asynchronous Receiver Transmitter
UMTS	Universal Mobile Telecommunication System
USB	Universal Serial Bus
VNA	Vector Network Analyzer
VSWR	Voltage Standing Wave Radio
WDMA	Wideband Code Division Multiple Access
CA	Carrier aggregation
CLK	Clock
CMOS	Complementary Metal – Oxide Semiconductor
DTE	Data Terminal Equipment
EN-DC	E-UTRA – NR Dual Connectivity

Acronym	Definition
ESR	Equivalent Series Resistance

14 Related Documents

For current documentation and downloads, refer to https://dz.telit.com/.

Table 59: Related Documents

S.no	Doc Code	Document Title
1	1VV0301987	FN990B FAMILY SW User Guide
2	80794ST11210A	FN990B FAMILY AT Commands Reference Guide
3	1VV0301249	Generic EVB HW User Guide
4	1VV0301732	Telit EVB 2.0 HW User Guide
5	1VV030xxxx	FN990B FAMILY TLB HW User Guide [TBD]
6	1VV030xxxx	FN990B FAMILY Thermal Design Guide [TBD]
7	3xxxxxxxxxxA	FN990B40 CA / EN-DC list [TBD]

15 Document History

Table 60: Document History

Revision	Date	Changes
4	2025-08-18	Updated Section 12 Conformity Assessment Issues Updated Table 1: Applicability Table Updated Section 3.4 main features Add to SBAS satellite system Add to Supported MCP group Updated Section 8.3.2 Conducted Receiver Sensitivity Updated Section 8.4.1 Antenna Configuration Table 40, 41, 42 NR, E-UTRA, UTRA configuration
3	2025-03-07	Updated Section 4.1. Pin-out Updated Section 5.2. Power Consumption Updated Table 26: SIM Interface Signal
2	2025-02-18	Updated Table 6: Main features Updated Figure 11: Example Circuit for HOST Interface Switch Function Updated section 9.3. Drawing Updated section 8.6 GNSS Characteristics
1	2025-01-24	Updated chapter Related documents Updated Table 1: Applicability Table Updated section 3.2 Product Variants and Frequency Bands Updated section 3.4 main features Updated section 5.2 Current consumption
0	2024-09-13	First Issue

From Mod.0818 Rev.17