FN990 Family

HW Design Guide

1VV0301752 Rev. 2 – 2022-05-16

Telit Technical Documentation

APPLICABILITY TABLE

PRODUCTS	Description
FN990A28	3G / 4G (16 Layer) / Sub-6 (BW : 120MHz) cellular module
FN990A40	3G / 4G (20 Layer) / Sub-6 (BW : 200MHz) cellular module

CONTENTS

1. INTRODUCTION

1.1. Scope

This document introduces the Telit FN990 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 are applicable to all FN990 Family variants 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 FN990 Family module.

1.2. Audience

This document is intended for Telit customers, especially system integrators, about to implement their applications using the Telit FN990 Family module.

1.3. Contact Information, Support

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

- *TS-EMEA@telit.com*
- *TS-AMERICAS@telit.com*
- *TS-APAC@telit.com*
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Alternatively, use:

https://www.telit.com/support

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

https://www.telit.com

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

Telit appreciates the user feedback on our information.

1.4. Symbol Conventions

	**Danger:** This information MUST be followed or catastrophic equipment failure or personal injury may occur.
	**Warning:** Alerts the user on important steps about the module integration.
	**Note/Tip:** Provides advice and suggestions that may be useful when integrating the module.
	**Electro-static Discharge:** Notifies the user to take proper grounding precautions before handling the product.

Table 1: Symbol Conventions

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

1.5. Related Documents

- FN990 SW User Guide, 1VV0301750
- FN990 AT Commands Reference Guide, 80691ST11097A
- Generic EVB HW User Guide, 1VV0301249
- Telit EVB 2.0 HW User Guide, 1VV0301732
- FN990 TLB HW User Guide, 1VV0301753
- FN990 Thermal Design Guide, 1VVXXXXXXX (TBD)
- FN990 CA / EN-DC list, XXXXXNTXXXXXA (TBD)

2. GENERAL PRODUCT DESCRIPTION

2.1. Overview

The aim of this document is to present the possible and recommended hardware solutions useful for developing a product with the Telit FN990 Family M.2 module.

FN990 Family 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
- Designed for industrial grade quality

Front-end for mobile products, offering mobile communication features to an external host CPU through its rich interfaces.

FN990 Family is available in hardware variants as listed in the APPLICABILITY TABLE.

The designated RF band set for each variant are detailed in Section 2.2. Frequency Bands and CA / EN-DC Combinations.

2.2. Frequency Bands and CA / EN-DC Combinations

2.2.1. Frequency Bands

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

Below is the list of operating frequencies on 5G, LTE and WCDMA mode.

5G NR Sub-6 Bands Supportive

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
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

NR BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels	SCS (kHz)
n28 - 700 APT	FDD	703 - 748	758 - 803	Tx: 140600 - 149600 Rx: 151600 - 160600	15
n29 – 700 d	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
n66 - AWS-3	FDD	1710 - 1780	2110 - 2200	Tx: 342000 - 356000 Rx: 422000 - 440000	15
n71 - 600	FDD	663 - 698	617 - 652	Tx: 132600 - 139600 Rx: 123400 - 130400	15
n75 – DL 1500+	SDL	-	1432 – 1517	Rx: 286400 - 303400	30
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

Table 2: 5G NR Sub-6 Bands supportive

LTE Bands supportive

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

E-UTRA BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels
B18 - 800 Lower	FDD	815 - 830	860 - 875	Tx: 23850 - 23999 Rx: 5850 - 5999
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	FDD	N/A	717 - 728	Rx: 9660 - 9769
B30 - 2300 WCS	FDD	2305 - 2315	2350 - 2360	Tx: 27660 - 27759 Rx: 9770 - 9869
B32 - 1500 L	FDD	N/A	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	TDD	5150 – 5925 (DL only)		Rx: 46790 - 54539
B48 - 3600	TDD	3550 - 3700		T/Rx: 55240 - 56739
B66 - AWS-3	FDD	1710 - 1780	2110 - 2200	Tx: 131972 - 132671 Rx: 66436 - 67335
B71 - 600	FDD	663 - 698	617 - 652	Tx: 133122 - 133471 Rx: 68586 - 68935

Table 3: LTE Bands supportive

WCDMA Bands supportive

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

UTRA BAND	Duplex Mode	Uplink Frequency (MHz)	Downlink Frequency (MHz)	Channels
B6 - 850 Japan	FDD	830 - 840	875 - 885	Tx: 4162 - 4188 Rx: 4387 - 4413
B8 - 900 GSM	FDD	880 - 915	925 - 960	Tx: 2712 - 2863 Rx: 2937 - 3088
B19 - 800 Japan	FDD	830 - 845	875 - 890	Tx: 312 - 363 Rx: 712 - 763

Table 4: WCDMA Bands supportive

2.2.2. CA / MIMO / EN-DC

The FN990 Family supports 2CA, 3CA, 4CA, 5CA, 6CA and 7CA for LTE CA combinations and EN-DC for NR FR1 configuration.

Note: Refer to the FN990 Family CA / EN-DC list, XXXXXNTXXXXXA (TBD) for detailed combinations of CA and EN-DC.

2.3. Target Market

The FN990 Family can be used for telematics applications where tamper-resistance, confidentiality, integrity, and authenticity of end-user information are required, for example:

- Industrial equipment
- Home network
- Internet connectivity

2.4. Main Features

The FN990 Family of industrial grade cellular modules features 5G Sub-6, LTE and multi-RAT module together with an on-chip powerful application processor and a rich set of interfaces.

Main functions and features are listed below:

Function	Features
Physical	M.2 Type 3052-S3-B
Cellular technology	• FN990A28 5G: FR1(Sub 6G), Rel 16 4G: CAT. 19 (1.6Gbps) on DL, CAT. 18 (211Mbps) on UL, Rel 16 3G: HSPA+ Rel9 up to 42/5.7Mbps in DL/UL • FN990A40

Function	Features
	5G: FR1(Sub 6G), Rel 16 4G: CAT. 20 (2Gbps) on DL, CAT. 18 (211Mbps) on UL, Rel 16 3G: HSPA+ Rel9 up to 42/5.7Mbps in DL/UL
4x4 MIMO	5G: n1/n2/n3/n7/n25/n30/n38/n40/n41/n48/n66/n75/n77/n78/n79 4G: B1/B2/B3/B4/B7/B25/B30/B32/B34/B38/B39/B40/B41/B42/B43/B48/B66
Diversity/2nd Rx	4G: all operating bands 3G: all operating bands
GNSS	Upper L-band: GPS/Glonass/Beidou/Galileo
USIM port – Dual Voltage	Two SIM support (UIM2 can be assigned as optional eSIM) Class B and Class C support
Application processor	Application processor to run customer application code 32 bit ARM Cortex-A7 up to 1.8 GHz running the Linux operating system 4Gbit NAND Flash + 4Gbit LPDDR4 2133 MHz MCP is supported
Main Interfaces	PCIe Gen4 x 1-lane USB 3.1 Gen 2 Peripheral Ports – GPIOs
Antenna connection	4 x MHF-4 type Cellular/GNSS antenna connectors 1 x MHF-4 type Dedicated GNSS antenna connector
From factor	M.2 Form factor (30 * 52 * 2.25 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.
RTC	Real time clock is supported.
Operating temperature	Range -40 degC to +85 degC (conditions as defined in Section 2.8.1, Temperature Range)

Table 5: Main Features

2.4.1. Configurations Pins

Telit M.2 module indicates the main serial interface applicable on the combination of 4 configuration pins. FN990 Family is configured as an USB 3.1 Gen 2.

Pin	Signal	State	Interface Type
21	CONFIG_0	GND	USB 3.1 Gen 2 Port Configuration 2 (Applicable to WWAN only)
69	CONFIG_1	GND	

Pin	Signal	State	Interface Type
75	CONFIG_2	NC	
1	CONFIG_3	NC	

Table 6: Configurations Pins

Note: On the platform 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 4-bit logic state that required decoding.

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

2.5. Block Diagram

The figure below shows an overview of the internal architecture of the FN990 Family module.

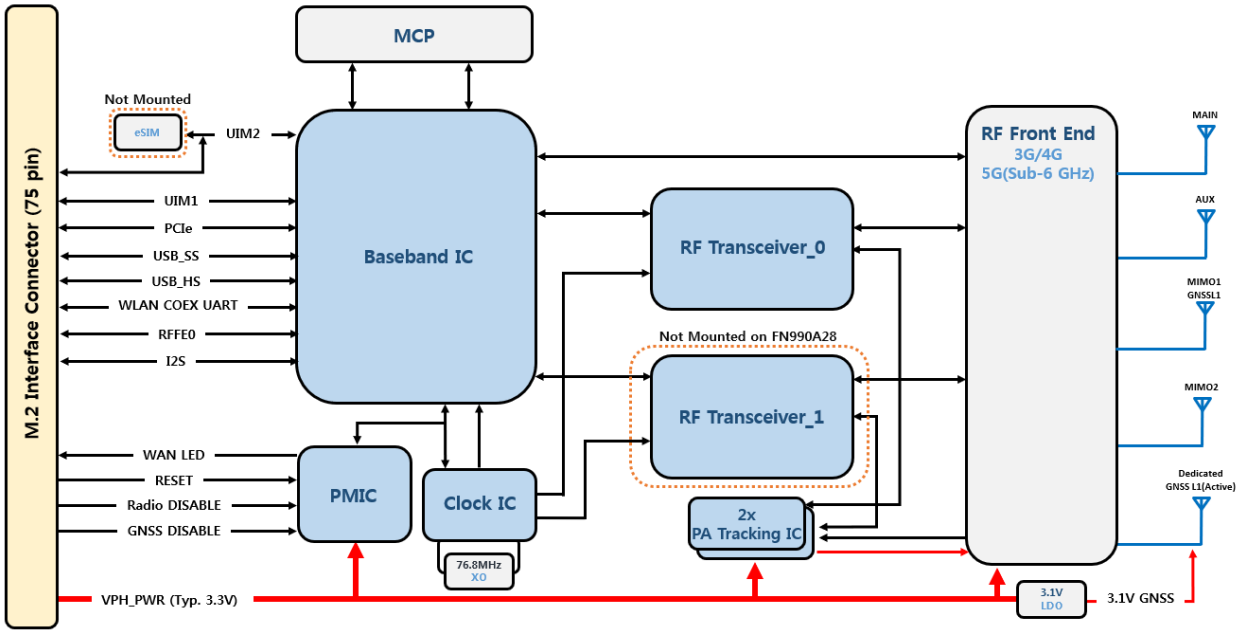


Figure 1: FN990 Family Block Diagram

2.6. RF Performance

The RF performance in 5G, LTE and WCDMA modes conforms to the 3GPP specifications.

2.6.1. Conducted Transmit Output Power

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

Band	Power class	RF Power (dBm)
5G NR Sub-6 n1, n2, n3, n5, n7, n8, n20, n25, n28, n30, n38, n40, n41, n48, n66, n71, n77, n78, n79	3 (0.2W)	23 (+2dB / -2dB)
5G NR Sub-6 n41, n48(TBD), n77, n78, n79 Supports Power Class 2	2 (0.4W)	26 (+2dB / -2dB)
LTE All Bands B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B30, B34, B38, B39, B40, B41, B42, B43, B48, B66, B71	3 (0.2W)	23 (+2dB / -2dB)
LTE B38(TBD), B40(TBD), B41, B42(TBD) Supports Power Class 2	2 (0.4W)	26 (+2dB / -2dB)
3G WCDMA B1, B2, B4, B5, B6, B8, B19	3 (0.2W)	23 (+2dB / -2dB)

Table 7: Conducted Transmit Output Power

2.6.2. Conducted Receiver Sensitivity (TBD)

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

Technology	3GPP Compliance
5G NR Sub-6	Throughput >95%
4G LTE	Throughput >95%
3G WCDMA	BER <0.1% 12.2 Kbps

Table 8: 3GPP compliance for Conducted Receiver Sensitivity

NR Band	Typical Conducted Rx Sensitivity (dBm) *						
	SCS (kHz)	BW (MHz)	ANT0	ANT1	ANT2	ANT3	Combined
NR FDD n1	15	20	(TBD)	(TBD)	(TBD)	(TBD)	-99
NR FDD n2	15	20	(TBD)	(TBD)	(TBD)	(TBD)	-99
NR FDD n3	15	20	(TBD)	(TBD)	(TBD)	(TBD)	-99
NR FDD n5	15	20	(TBD)	NA	(TBD)	NA	-96
NR FDD n7	15	20	(TBD)	(TBD)	(TBD)	(TBD)	-99

NR Band	Typical Conducted Rx Sensitivity (dBm) *						
NR FDD n8	15	20	(TBD)	NA	(TBD)	NA	-98
NR FDD n20	15	(TBD)	(TBD)	NA	(TBD)	NA	(TBD)
NR FDD n25	15	20	(TBD)	NA	(TBD)	NA	-99
NR FDD n28	15	20	(TBD)	NA	(TBD)	NA	-98
NR FDD n29	15	(TBD)	(TBD)	NA	(TBD)	NA	(TBD)
NR FDD n30	15	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
NR TDD n38	30	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
NR TDD n40	30	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
NR TDD n41	30	100	(TBD)	(TBD)	(TBD)	(TBD)	-91
NR TDD n48	30	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
NR FDD n66	15	20	(TBD)	(TBD)	(TBD)	(TBD)	-99
NR FDD n71	15	20	(TBD)	NA	(TBD)	NA	-98
NR TDD n75 (DL only)	30	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)	(TBD)
NR TDD n77	30	100	(TBD)	(TBD)	(TBD)	(TBD)	-92
NR TDD n78	30	100	(TBD)	(TBD)	(TBD)	(TBD)	-92
NR TDD n79	30	100	(TBD)	(TBD)	(TBD)	(TBD)	-92

Table 9: Typical Conducted Receiver Sensitivity - NR Bands
**3.3 Voltage / Room temperature*

E-UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
	ANT0	ANT1	ANT2	ANT3	Combined
LTE FDD B1	-97	-96.5	-96.5	-96.5	-103
LTE FDD B2	-97	-96	-96	-96	-103
LTE FDD B3	-97	-96	-96	-96	-103
LTE FDD B4	-97	-96	-96	-96	-103
LTE FDD B5	-99	NA	-99	NA	-102
LTE FDD B7	-97	-96	-96	-96	-103
LTE FDD B8	-99	NA	-99	NA	-102
LTE FDD B12	-99	NA	-99	NA	-102

E-UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
LTE FDD B13	-99	NA	-99	NA	-102
LTE FDD B14	-99	NA	-99	NA	-102
LTE FDD B17	-99	NA	-99	NA	-102
LTE FDD B18	-99	NA	-99	NA	-102
LTE FDD B19	-99	NA	-99	NA	-102
LTE FDD B20	-99	NA	-99	NA	-102
LTE FDD B25	-97	-96	-96	-96	-103
LTE FDD B26	-99	NA	-99	NA	-102
LTE FDD B28	-99	NA	-99	NA	-102
LTE FDD B29 (DL only)	-99	NA	-99	NA	-101
LTE FDD B30	-96	-95	-95	-95	-102
LTE FDD B32 (DL only)	-97	-97	-97	-97	-101
LTE TDD B34	-96.5	NA	-98	NA	-100
LTE TDD B38	-97	-96.5	-96.5	-96.5	-103
LTE TDD B39	-97	-97	-97	-97	-103
LTE TDD B40	-96.5	-96.5	-96.5	-96.5	-103
LTE TDD B41	-96	-96	-96	-96	-102
LTE TDD B42	-97	-96	-96	-96	-102
LTE TDD B43	-97	-96	-96	-96	-102
LTE TDD B46 (DL only)	-92	NA	-90	NA	-93
LTE TDD B48	-97	-96	-96	-96	-103
LTE FDD B66	-97	-96	-96	-96	-103
LTE FDD B71	-99	NA	-99	NA	-102

Table 10: Typical Conducted Receiver Sensitivity - LTE Bands
**3.3 Voltage / Room temperature*

UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
	ANT0	ANT1	ANT2	ANT3	Combined
WCDMA FDD B1	-110	NA	-109	NA	NA

UTRA Band	Typical Conducted Rx Sensitivity (dBm) *				
WCDMA FDD B2	-110	NA	-110	NA	NA
WCDMA FDD B4	-110	NA	-109	NA	NA
WCDMA FDD B5	-110	NA	-110	NA	NA
WCDMA FDD B6	-110	NA	-110	NA	NA
WCDMA FDD B8	-110	NA	-110	NA	NA
WCDMA FDD B19	-110	NA	-110	NA	NA

Table 11: Typical Conducted Receiver Sensitivity - WCDMA Bands
**3.3 Voltage / Room temperature*

Note: The sensitivity level has 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.

LTE level is measured at BW 10 MHz except Band 46

B46 BW = 20 MHz

2.7. Mechanical Specifications

2.7.1. Dimensions

The overall dimensions of FN990 Family are:

- Length: 52 mm
- Width: 30 mm
- Thickness: 2.25 mm

2.7.2. Weight

The nominal weight of the FN990A40 is 8.2 grams.

The nominal weight of the FN990A28 is 8.0 grams.

2.8. Environmental Requirements

2.8.1. Temperature Range

Mode	Temperature	Note
Operating Temperature Range	-20°C ~ +55°C	This range is defined by 3GPP (the global standard for wireless mobile communication). Telit guarantees that its modules comply with all 3GPP requirements and that it has the full functionality of the module in this range.
	-40°C ~ +85°C	Telit guarantees full functionality within this range as well. However, there may possibly be some performance deviations in this extended range related to 3GPP requirements, which means that some RF parameters may deviate from the 3GPP specification on the receiver or the maximum output power may be slightly degraded. Even so, all functionalities, such as connection to calls, SMS, USB communication, UART activation and so on, will be maintained, and the effect of such degradations will not lead to malfunctions.
Storage and non-operating Temperature Range	-40°C ~ +85°C	

Table 12: Temperature Range

Warning: The application processor temperature which is in the FN990 Family must be kept below 95 degC for the best performance. Depending on the various application, a heat sink, thermal pad or other cooling system may be required to dissipate the heat well.

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

2.8.2. RoHS Compliance

As a part of the Telit corporate policy of environmental protection, the FN990 Family complies with the RoHS (Restriction of Hazardous Substances) directive of the European Union (EU directive 2011/65/EU).

3. PINS ALLOCATION

3.1. Pin-out

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 3.0 super-speed transmit – Minus	Analog	
31	USB_SS_TX_P	O	USB 3.0 super-speed transmit – Plus	Analog	
35	USB_SS_RX_M	I	USB 3.0 super-speed receive – Minus	Analog	
37	USB_SS_RX_P	I	USB 3.0 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	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	Default PU
52	PCIE_CLKREQ_N	O	PCIe reference clock request signl	VPH_PWR	Internal 100k PU
54	PCIE_WAKE_N	O	PCIe wake-up	VPH_PWR	Internal 100k PU
SIM Card Interface 1					
36	UIM1_VCC	O	Supply output for an external UIM1 card	1.8V / 2.95V	Power

Pin	Signal	I/O	Function	Type	Comment
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	
66	UIM1_PRESENT	I	UIM1 Card Present Detect	1.8V	Internal 100k PU
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
Miscellaneous Functions					
6	FULL_CARD_POWER_OFF_N	I	Module On/Off	1.8V / VPH_PWR	Internal 47k PD
8	W_DISABLE_N	I	RF disable	VPH_PWR	Internal 100k PU
10	LED_N	O	LED control		Open Drain
23	WAKE_ON_WAN_N	O	Wake Host	1.8V	Default PU
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 Can be COEX_RX	1.8V	
64	TGPIO_04	I/O	General Purpose I/O Can be COEX_TX	1.8V	
20	USB_PCIE_SWITCH	I	Swich Host Interface	1.8V	Internal 10k PU
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
38	TGPIO_12	I/O	General Purpose I/O Can be 1PPS/TSN	1.8V	
26	W_DISABLE2_N	I	GNSS disable	VPH_PWR	Internal 100k PU
MIPI Control					
61	RFFE0_DATA	I/O	Data	1.8V	
63	RFFE0_CLK	O	Clock	1.8V	
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	

Pin	Signal	I/O	Function	Type	Comment
69	CONFIG_1	-		Ground	
75	CONFIG_2	-		Floating	
1	CONFIG_3	-		Floating	
Reserved for Future Use					
59	RFU (WLAN_TX_EN)				
60	RFU (N79_TX_EN_TO_WLAN)				

Table 13: FN990 Family Pin-out Information

Warning: Reserved pins must not be connected.

3.2. FN990 Family Signals That Must be Connected

Below table specifies the FN990 Family signals that must be connected for a debugging purpose even if not used by end application:

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 an USB connector
9	USB_D-	

Table 14: Mandatory Signals

3.3. Pin Layout

Top side Odd pins		Bottom side Even pins	
NC	1	2	VPH_PWR
GND	3	4	VPH_PWR
GND	5	6	FULL_CARD_POWER_OFF_N
USB_HS_DP	7	8	W_DISABLE_N
USB_HS_DM	9	10	LED_N
GND	11		
KEY B		KEY B	
		20	USB_PCIE_SWITCH
GND	21	22	TGPIO_06
WAKE_ON_WAN_N	23	24	TGPIO_07
TGPIO_02	25	26	W_DISABLE2_N
GND	27	28	TGPIO_08
USB_SS_TX_M	29	30	UIM1_RESET_N
USB_SS_TX_P	31	32	UIM1_CLK
GND	33	34	UIM1_DATA
USB_SS_RX_M	35	36	UIM1_VCC
USB_SS_RX_P	37	38	TGPIO_12
GND	39	40	UIM2_PRESENT
PCIE_TX0_M	41	42	UIM2_DATA
PCIE_TX0_P	43	44	UIM2_CLK
GND	45	46	UIM2_RESET_N
PCIE_RX0_M	47	48	UIM2_VCC
PCIE_RX0_P	49	50	PCIE_RESET_N
GND	51	52	PCIE_CLKREQ_N
PCIE_REFCLK_M	53	54	PCIE_WAKE_N
PCIE_REFCLK_P	55	56	I2C_SDA
GND	57	58	I2C_SCL
RFU	59	60	RFU
RFFE0_DATA	61	62	TGPIO_03
RFFE0_CLK	63	64	TGPIO_04
VREG_L6B_1P8	65	66	UIM1_PRESENT
SYS_RESIN_N	67	68	TGPIO_01
GND	69	70	VPH_PWR
GND	71	72	VPH_PWR
GND	73	74	VPH_PWR
NC	75		

Figure 2: FN990 Family Pin out

4. POWER SUPPLY

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

4.1. Power Supply Requirements

The FN990 Family power requirements are as follows:

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

Table 15: Power Supply Requirements

4.2. Power Consumption (TBD)

Mode	Average [Typ.]	Mode Description
IDLE Mode		
CFUN=1	35mA	No call connection USB is connected to a host
Airplane Mode (PSMWDISACFG=1, W_DISABLE_N: Low)		
CFUN=4	< 3mA	Tx and Rx are disabled; module is not registered on the network (Airplane mode) USB is disconnected
Standby Mode (PSMWDISACFG=1, W_DISABLE_N: Low)		
CFUN=1	< 5mA(TBD)	Module cycles between wake and sleep USB is disconnected
Operative Mode (WCDMA)		
WCDMA Voice	(TBD) mA	WCDMA B1 voice call (Tx=23dBm)
WCDMA HSPA	(TBD) mA	WCDAM data call (DC-HSDPA up to 42Mbps, Max through-put)
Operative Mode (LTE)		
Single mode (1DL/1UL SISO)	(TBD) mA	Non-CA ,B2 BW 5MHz, 1 RB, 23dBm, QPSK DL / QPSK UL
2DLCA(4x4MIMO) with 2ULCA(SISO)	(TBD) mA	CA_2A-66A, BW 20MHz, Full RB, 256QAM DL / 256QAM UL(800Mbps DL / 170Mbps UL)

Mode	Average [Typ.]	Mode Description
7DLCA(2x2MIMO)	(TBD) mA	CA_2A-13A-46D-66A-66A, Full RB, 256QAM DL/ 64QAM UL(1300Mbps DL / 75Mbps UL)
with 1UL(SISO)		
5DLCA (4x4MIMO)	(TBD) mA	CA_1A-3C-7C, Full RB, 256QAM DL/ 64QAM UL(2Gbps DL / 75Mbps UL)
With 1UL(SISO)		
Operative Mode (NR-FR1)		
NSA mode	1000mA	EN-DC_1A(1DL/UL SISO)-n78A(1DL/1UL SISO)
1CC+1FR1		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
NSA mode	2000mA	EN-DC_1A(DL2x2/1UL SISO)-3C(DL4x4)-7C(DL4x4)_28A(DL2x2) -n78(1DL 4x4MIMO/1UL SISO/60M)
6CC+1FR1		LTE : BW 20MHz, Full RB, 256QAM DL / 64QAM UL(2Gbps DL / 75Mbps UL)
		FR1 : BW100MHz, Full RB, 256QAM DL / 256QAM UL(1.6Gbps DL/118Mbps)

Table 16: FN990 Family Current Consumption

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

*** Loop-back mode in call equipment*

**** 3.3 voltage / room temperature*

4.3. General Design Rule

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

- Electrical design
- Thermal design
- PCB layout

4.3.1. Electrical Design Guidelines

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

4.3.1.1. +5V Source Power Supply Design Guidelines

- The desired output for the power supply 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 consumption.
- 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 FN990 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 power input to protect the FN990 Family module from power polarity inversion.

4.3.2. Thermal Design Guidelines

The aim of this chapter is to provide thermal design guidelines useful for developing a product with the Telit FN990 Family.

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

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

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

Note: FN990 Family supports various RAT such as 3G, 4G and 5G Sub-6.

Based on the RF transmission mode, the FN990 Family can consume a lot of current. Therefore proper thermal designs are essential to dissipate heat well.

Note: There is the large solder resist opening area on the bottom side of the module. Adding a TIM on that area with a heatsink is one of the best way to dissipate heat well.

The temperature can be read via AT commands.

Note: The FN990 Family must be connected to the ground and metal chassis of the host board for the best RF performance, thermal dispersion and also fixing the module.

- The module shield and the main board of the host device or the metal chassis of the host device should be connected by means of conductive materials.

4.3.3. Power Supply PCB Layout Guidelines

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

- The bypass low ESR capacitor must be placed close to the FN990 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 FN9990 Family is wide enough to ensure a drop-less connection even during the TBD current peaks.
- The protection diode must be placed close to the input connector where the power source is drained.
- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure that no voltage drops occur during the TBD current peaks.
- The PCB traces to FN990 Family and the bypass capacitor must be wide enough to ensure that no significant voltage drops will occur when the TBD current peaks are absorbed. This is necessary for the same above-mentioned reasons. 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 very close to the power switching IC (only for the switching power supply). This is done to reduce the radiated field (noise) at the switching frequency (usually 100-500 kHz).
- Use a good common ground plane.

- Place the power supply on the board to ensure that the high current return paths in the ground plane do not overlap any noise sensitive circuitry, such as the microphone amplifier/buffer or earphone amplifier.
- The power supply input cables must be kept separate from noise sensitive lines, such as microphone/earphone cables.

4.4. RTC

The RTC within the FN990 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.

4.5. 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 shutdown.

This table lists the reference voltage of FN990 Family.

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

Table 17: FN990 Family Reference Voltage

4.6. Internal LDO for GNSS Bias

The LDO for GNSS bias is applied inside the FN990 Family model.

The voltage supply come from FN990 Family's LDO to GNSS active antenna.

This table lists the LDO for GNSS bias of FN990 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]

Table 18: LDO for GNSS bias of FN990 Family

5. ELECTRICAL SPECIFICATIONS

5.1. Absolute Maximum Ratings – Not Optional

Warning: A deviation from the value ranges listed below could damage the FN990 Family module.

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

Table 19: Absolute Maximum Ratings - Not optional

5.2. 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	-	-	TBD	[A]

Table 20: Recommended Operating Conditions

6. DIGITAL SECTION

6.1. Logic Levels

Unless otherwise specified, all FN990 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 FN990 Family interface circuits. The data specified in the tables belows are valid throughout all drive strengths and the entire temperature ranges.

Warning: Do not connect FN990 Family's digital logic signal directly to the OEM's digital logic signal with a level higher than 2.134V for 1.8V CMOS signals.

6.1.1. 1.8V Pins – Absolute Maximum Ratings

Parameter	Min	Max
Input level on any digital pin when on	-	+2.134 V
Input voltage on analog pins when on	-	+2.134 V

Table 21: Absolute Maximum Ratings - Not Functional

6.1.2. 1.8V Standard GPIOs

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.26	2.1	[V]	
V_{IL}	Input low level	-0.3	0.54	[V]	
V_{OH}	Output high level	1.35	1.8	[V]	
V_{OL}	Output low level	0	0.45	[V]	

Table 22: Operating Range - Interface Levels (1.8V CMOS)

6.1.3. 1.8V UIM1/UIM2 Pins

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.17	2.1	[V]	
V_{IL}	Input low level	-0.3	0.63	[V]	

Parameter		Min	Max	Unit	Comment
V_{OH}	Output high level	1.35	1.8	[V]	
V_{OL}	Output low level	0	0.45	[V]	

Table 23: Operating Range - UIM Pins Working at 1.8V

6.1.4. 2.95V Pins – Absolute Maximum Ratings

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

Table 24: Absolute Maximum Ratings - Not Functional

6.1.5. 2.95V SIM Card Pins

Parameter		Min	Max	Unit	Comment
V_{IH}	Input high level	1.843	3.25	[V]	
V_{IL}	Input low level	-0.3	0.73	[V]	
V_{OH}	Output high level	2.21	2.95	[V]	
V_{OL}	Output low level	0	0.368	[V]	

Table 25: Operating Range - UIM Pins Working at 2.95V

6.1.6. VPH_PWR Level I/O Pins

Parameter		Min	Max	Unit
V_{IH}	Input high level	0.65 x VPH_PWR	-	[V]
V_{IL}	Input low level	-	0.35 x VPH_PWR	[V]
V_{OH}	Output high level	0.8 x VPH_PWR	VPH_PWR	[V]
V_{OL}	Output low level	0	0.2 x VPH_PWR	[V]

Table 26: Operating Range - I/O Pins Working at VPH_PWR

6.2. Power ON/OFF/RESET

The following tables show the description of power control pins.

Pin	Signal	I/O	Function	Type	Comment
6	FULL_CARD_POWER_OFF_N	I	Module On/Off	1.8V / VPH_PWR	Internal 47k PD
67	SYS_RESIN_N	I	Reset Input	1.8V	Internal 100k PU
65	VREG_L6B_1P8	O	Reference Voltage	1.8V	Power
*	BOOT_OK / Shutdown Indicator	O	Power ON/OFF Status Check	1.8V	* Can be assigned to GPIO

Table 27: Power Interface Signals

6.2.1. Power On

To turn on the FN990 Family, the FULL_CARD_POWER_OFF_N pin must be asserted high.

Note: To turn on the FN990 Family module, the SYS_RESIN_N pin must not be asserted low. If pressed for more than 1 second, FN990 Family will be reset.

Also, power on can be triggered by SYS_RESIN_N pin (low level). Even so, please control the FN990 Family's ON/OFF status with FULL_CARD_POWER_OFF_N. (TBD)

6.2.1.1. Initialization and Activation State

After turning on the FN990 Family module, the FN990 Family is not yet activated because the SW initialization process take some time to complete. For this reason, it is recommended not to communicate with the FN990 Family module during the initialization phase.

The AT command interface is accessible via USB or PCIe port, but this does not mean that it works fully. In general, as shown in figure below, the FN990 Family becomes fully operational (in the Activation state) at least 50 seconds after the FULL_CARD_POWER_OFF_N is asserted.

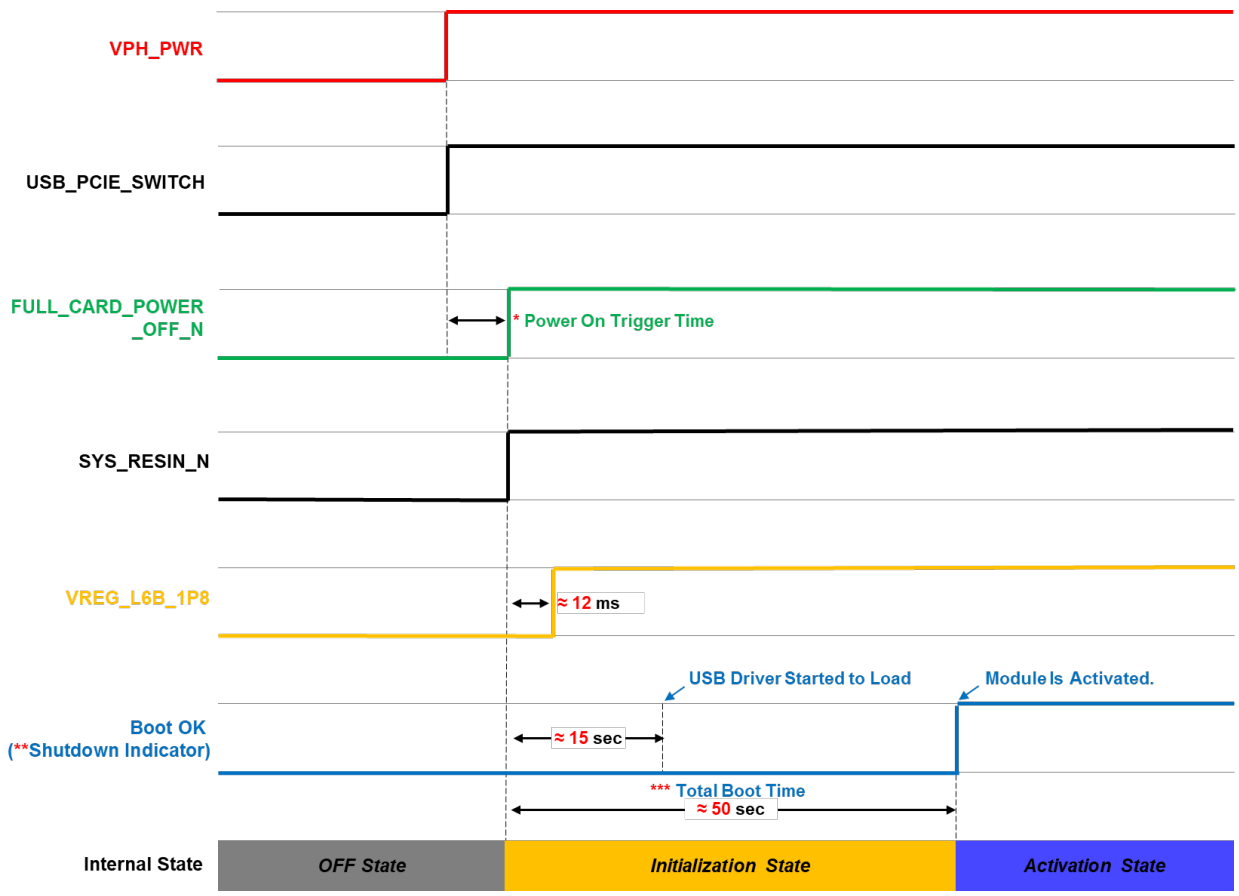


Figure 3: FN990 Family Power ON Sequence - USB mode (USB_PCIE_SWITCH: High, Default)

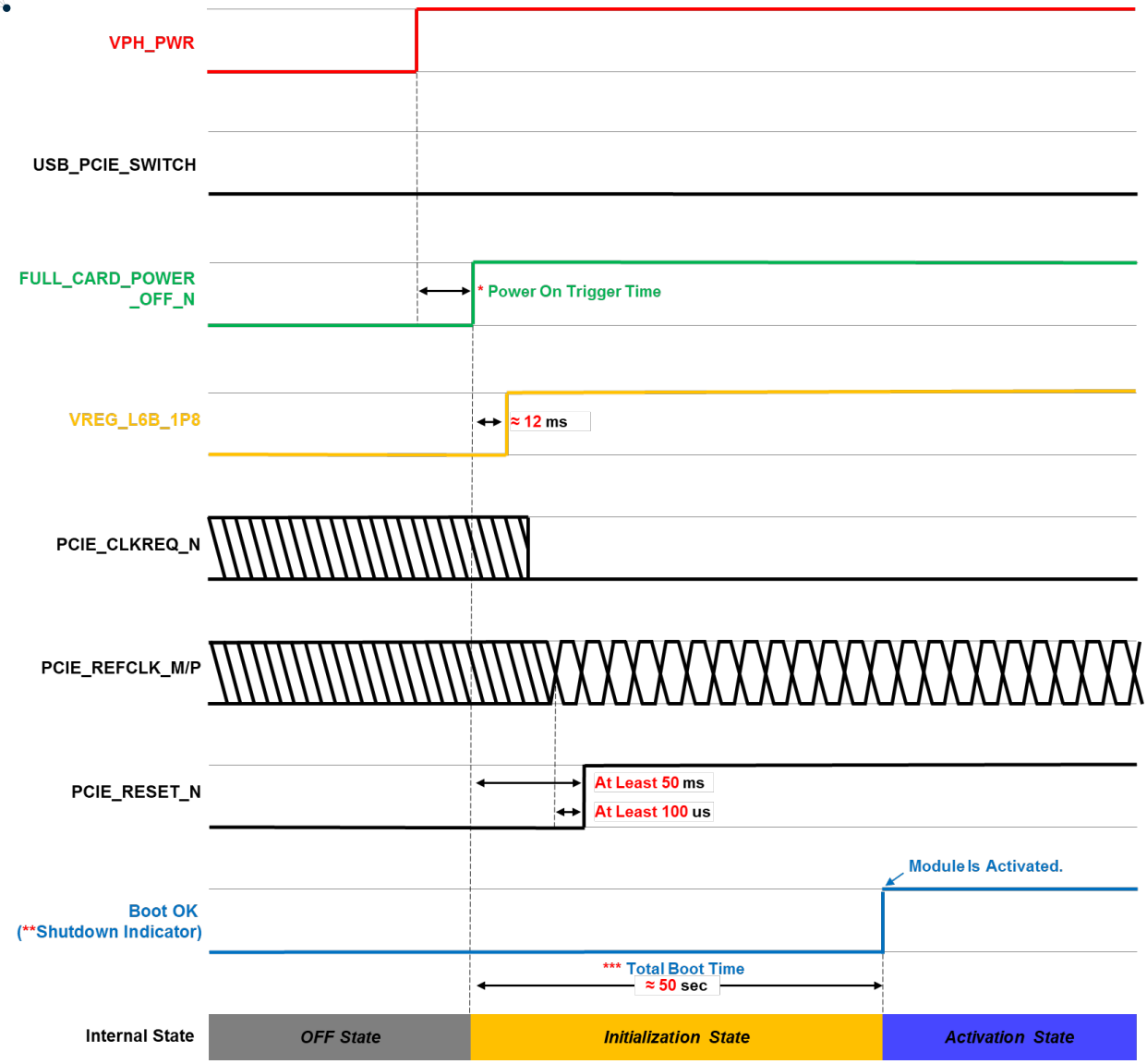


Figure 4: FN990 Family Power ON Sequence – PCIe EP mode (USB_PCIE_SWITCH: Low)

Note: To verify if the FN990 Family has powered up properly, please check through the below explanation:

* Power on trigger time is interval between VPH_PWR to FULL_CARD_POWER_OFF_N. This could be 0 ms if customer wants to turning on module automatically.

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

*** The stated total boot time is an approximate measure of the current SW and HW combination. The boot time may be lengthened or shortened depending on the feature, sw version, or hw 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.

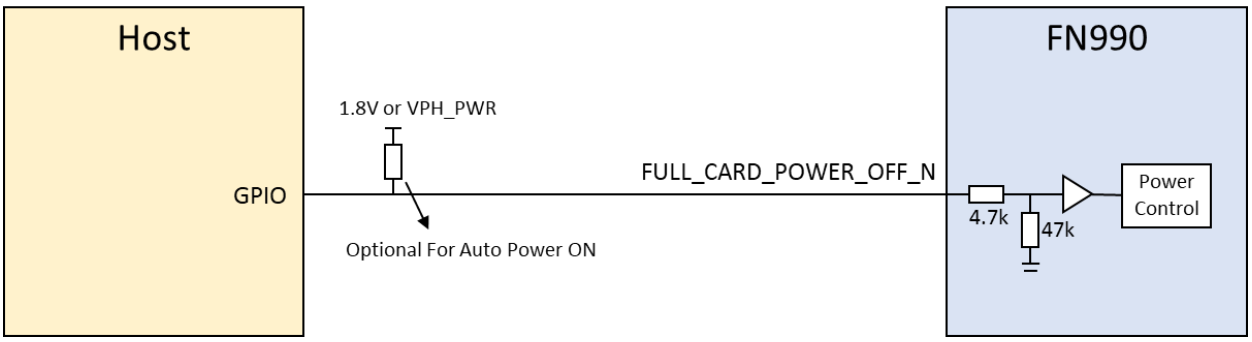


Figure 5: Example Circuit for ON/OFF by FULL_CARD_POWER_N

6.2.2. 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

6.2.2.1. Graceful Shutdown

To shutdown the FN990 Family module safely, host can use the graceful shutdown function.

The graceful shutdown can be triggered by:

- FULL_CARD_POWER_OFF_N

6.2.2.1.1. Graceful Shutdown by FULL_CARD_OFF_N

To gracefully shutdown the FN990 Family module, FULL_CARD_POWER_OFF_N should be asserted to Low.

Once FULL_CARD_POWER_N should be asserted to Low, the FN990 Family module enters 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.

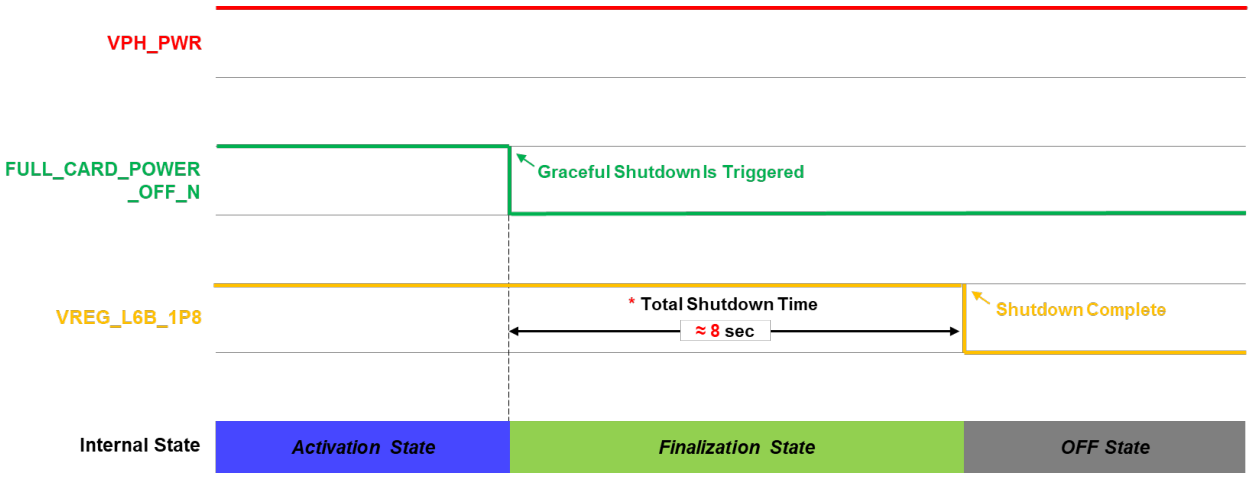


Figure 6: Graceful Shutdown by FULL_CARD_POWER_OFF_N

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

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

6.2.2.2. Fast Shutdown

For a quicker shutdown of the FN990 Family module, the host can use the fast shutdown function.

Fast shutdown can be triggered by:

- GPIO (+ optional shutdown indicator)

6.2.2.2.1. Fast Shutdown by GPIO

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

Once the fast shutdown trigger senses a High to Low transition, fast shutdown is triggered.

Then the FN990 Family module enters 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 detail about enabling the shutdown indicator and fast shutdown trigger.

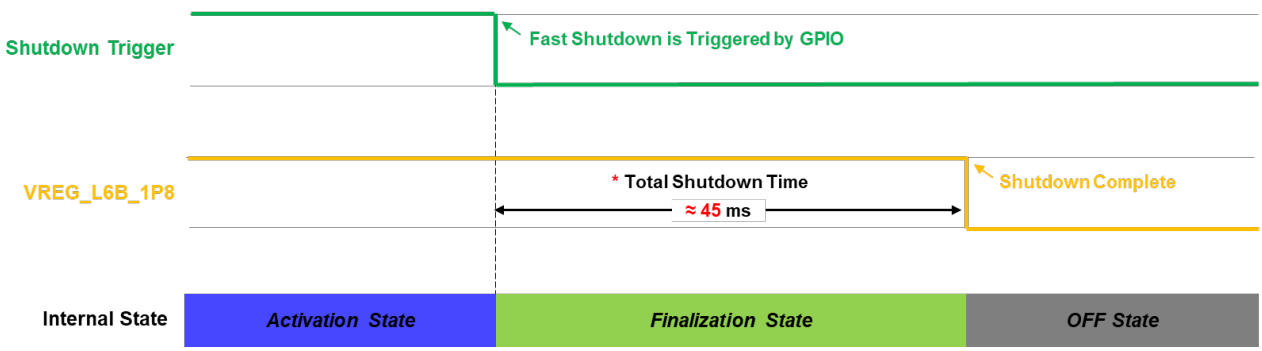


Figure 7: Fast Shutdown by GPIO

Note: Using a fast shutdown without shutdown indicator function, FULL_CARD_POWER_N pin should be controlled to prevent the FN990 module 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 current SW and HW combination. The shutdown time may be lengthened or shortened depending on the feature, sw version, or hw version.

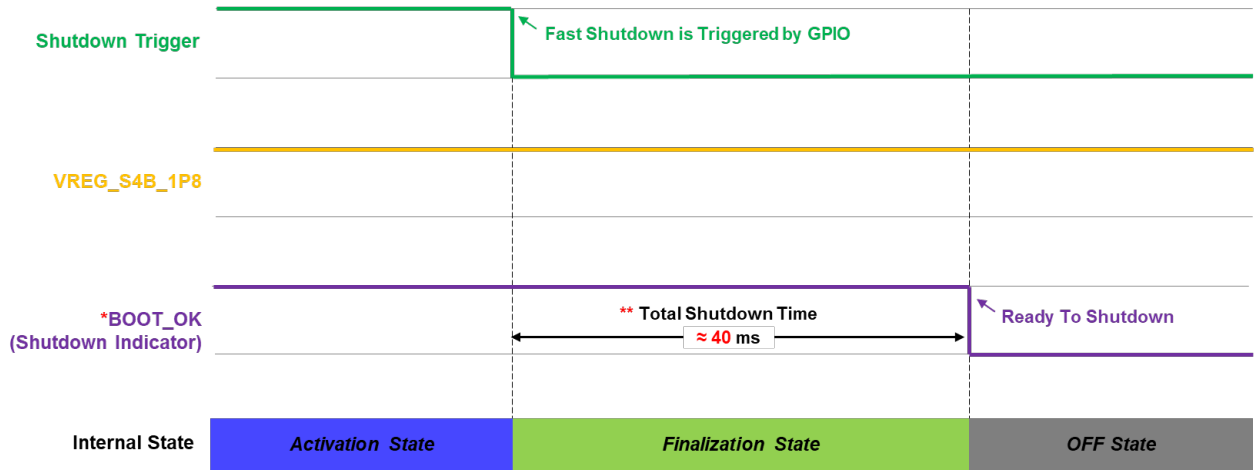


*Figure 8: Fast Shutdown by GPIO (*SHDNIND Enable, Optional)*

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

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 fast shutdown function, please refer to the AT Commands Reference Guide and SW User Guide document.

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

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

6.2.3. Reset

Device reset can be achieved as follows:

- Unconditional reset using the SYS_RESIN_N

6.2.3.1. Unconditional Hardware Reset

To unconditionally restart the FN990 Family module, the SYS_RESIN_N pin must be asserted low more than 1 second and then released.

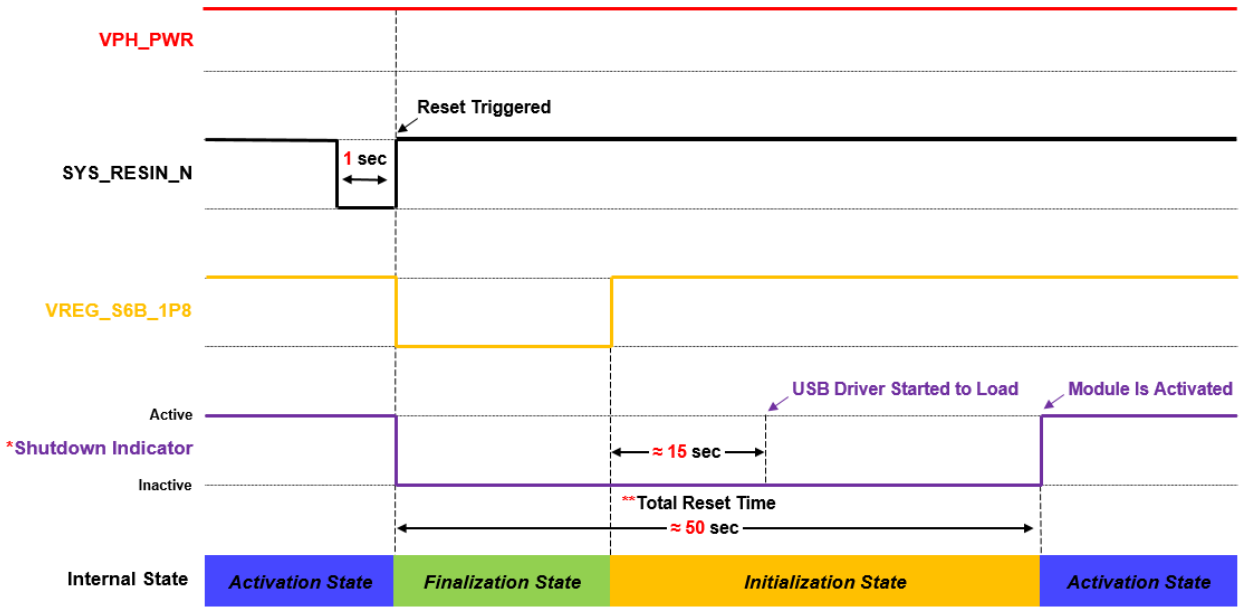


Figure 9: Unconditional Hardware Reset by SYS_RESIN_N

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

Please refer to the AT commands user guide document.

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

Note: Unconditional hardware reset must be used only as an emergency exit 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 FN990 Family power regulator and improper functioning on the module.

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

Below figure shows a simple circuit for this action.

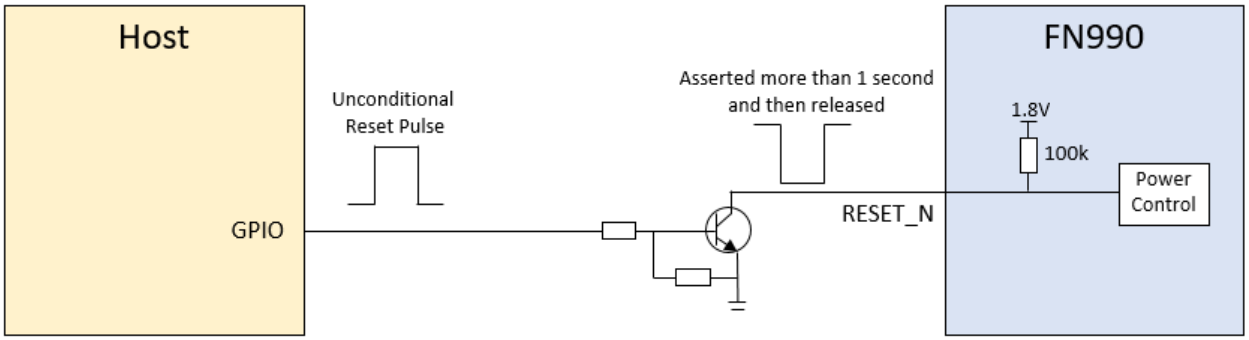


Figure 10: Example Circuit for RESET by SYSTEM_RESET_N

6.3. Communication Ports

The below table summarizes all the hardware interface of the FN990 Family module.

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

Table 28: FN990 Family Hardware Interfaces

6.3.1. Host Interface

Note: FN990 Family M.2 Card supports USB 3.1 Gen 2 and PCIe Gen 4 respectively. That means USB 3.1 and PCIe 4.0 interface cannot be used at the same time.

Basically, the host interface operates as USB 3.1 Gen 2, and if customer want to use PCIe Gen 4.0, you have to use host interface switch function.

6.3.1.1. Host Interface Switch Function

This chapter describes the host interface switch functions.

Pin	Signal	I/O	Function	Type	Comment
20	USB_PCIE_SWITCH	I	Swich Host Interface	1.8V	Internal 10k PU

Table 29: Host Interface Switch Pin

FN990 Family M.2 Card determines the host interface by checking the status of USB_PCIE_SWITCH pin at the beginning of the power on sequences.

High(Default): USB 3.1 or USB 2.0

Low: PCIe 3.0 + (USB 3.1 or USB 2.0)*

*USB interface is only used as debugging purposes when USB/PCIe Switch pin is low.

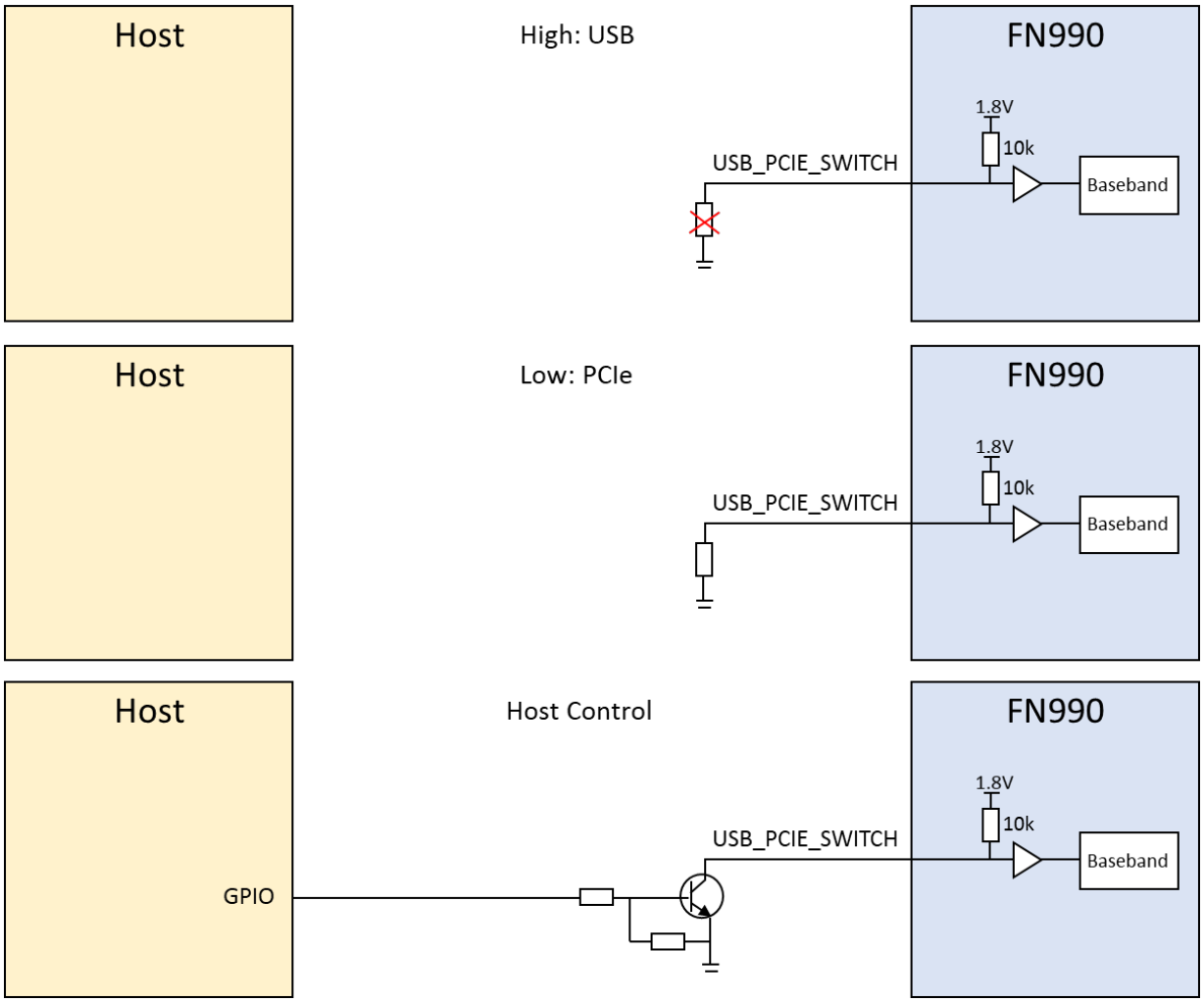


Figure 11: Example Circuit for HOST Interface Switch Function

6.3.1.2. PCIe Interface

The FN990 Family module includes PCIe interface. PCIe needs AC coupling series capacitors on the TX lines in both directions. In order 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 FN990 Family. The series capacitors are already placed on PCIE_TX_P/M lines inside FN990 Family module.

Internally VPH_PWR level 100k pull-up resistor is already mounted on PCIE_WAKE_N and PCIE_CLKREQ_N.

The PCIe interface suggested connection is the following:

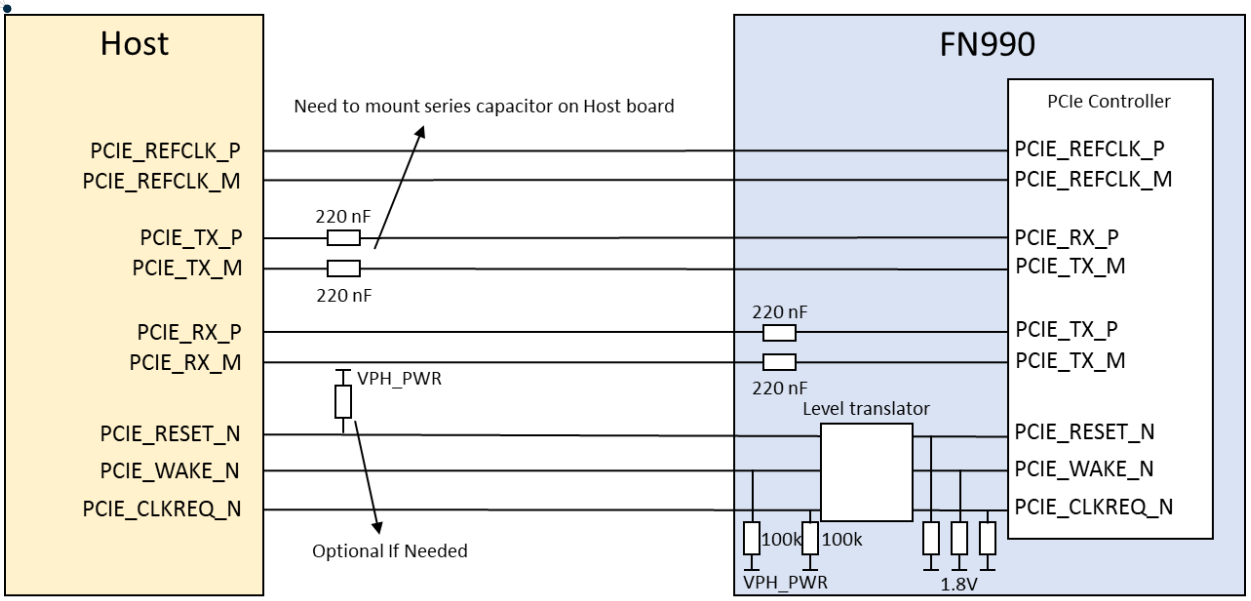


Figure 12: Connection for PCIe Interface

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

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	Default PU
52	PCIE_CLKREQ_N	O	PCIe reference clock request signl	VPH_PWR	Internal 100k PU
54	PCIE_WAKE_N	O	PCIe wake-up	VPH_PWR	Internal 100k PU

Table 30: PCIe Interface Signals

Note: Consider placing a low-capacitance ESD protection component to protect FN990 Family against ESD strikes

Warning: FN990 Family Add-in Card is not designed or intended to support Hot-Swap or Hot-Plug connections. Performing How-Swap or Hot-Plug may pose danger to the FN990 Family Add-in Card, to the system platform, and to the person performing this act.

6.3.1.3. USB 3.1 Interface

The FN990 Family module includes super-speed USB 3.1 Gen 2 with high-speed USB 2.0 backward compatibility. It complies with the Universal Serial Bus Specification, revision 3.0 and can be used for control and data transfers as well as for diagnostic monitoring and firmware update.

The USB port is typically the main interface between the FN990 Family module and OEM 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 FN990 Family. The series capacitors are already placed on USB_SS_TX_P/M lines inside FN990 module.

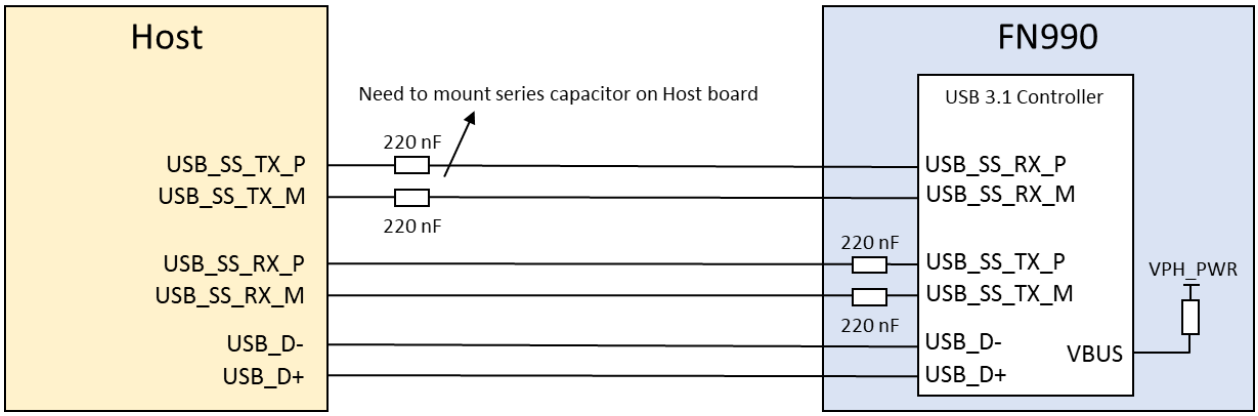


Figure 13: Connection for USB Interface

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 to 85 ohm differential.

Pin	Signal	I/O	Function	Type	Comment
7	USB_HS_DP	I/O	USB 2.0 Data Plus	Analog	
9	USB_HS_DM	I/O	USB 2.0 Data Minus	Anallog	
29	USB_SS_TX_M	O	USB 3.0 super-speed transmit – Minus	Analog	
31	USB_SS_TX_P	O	USB 3.0 super-speed transmit – Plus	Analog	
35	USB_SS_RX_M	I	USB 3.0 super-speed receive – Minus	Analog	
37	USB_SS_RX_P	I	USB 3.0 super-speed receive – Plus	Analog	

Table 31: USB Interface Signals

Note: Consider placing a low-capacitance ESD protection component to protect FN990 Family against ESD strikes.

6.3.2. SIM Interface

The FN990 Family supports an external SIM interface. (1.8 V or 2.95 V)

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

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
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
SIM Card Interface 2					
48	UIM2_VCC	O	Supply output for an external UIM2 card	1.8V / 2.95V	Power

Pin	Signal	I/O	Function	Type	Comment
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

Table 32: SIM Interface Signals

6.3.2.1. SIM Schematic Example

The following figures illustrate in particular how the application interface should be designed.

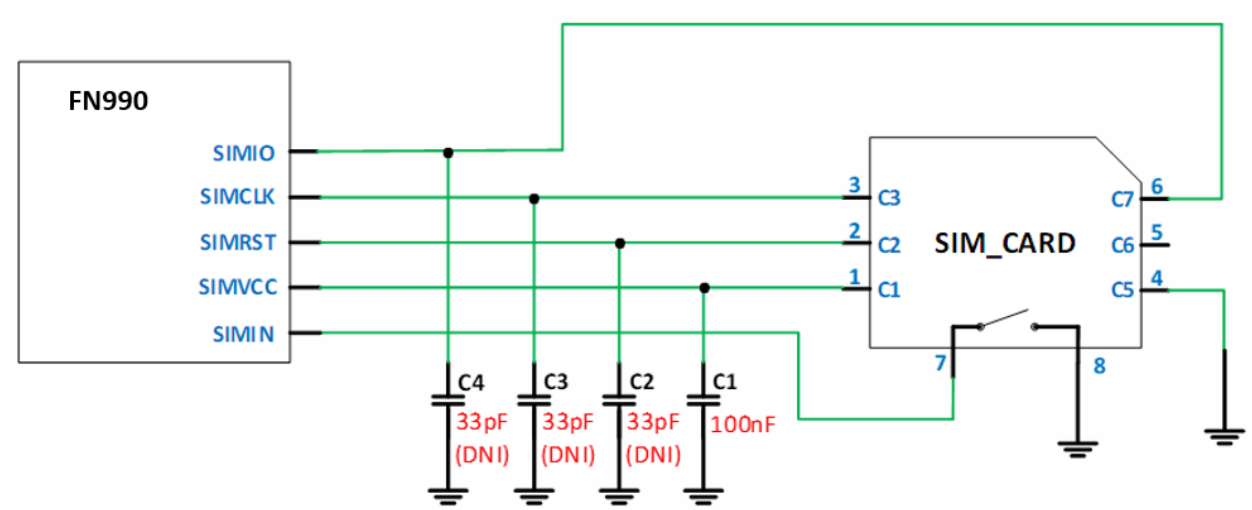


Figure 14: SIM Schematic Example

Note: FN990 Family contains an internal pull-up resistor on SIMIO. It is not necessary to install external pull-up resistor.

6.3.3. eSIM Interface

There is an optional embedded SIM (WLCSP package) on FN990 Family.

If you want to use the embeded SIM which is mounted on FN990 Family, please contact Telit Techical Support at

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

6.3.4. I2C – Inter-integrated Circuit

The FN990 Family supports an I2C interface on the following pins:

Below table lists the I2C signals of FN990 Family.

Pin	Signal	I/O	Function	Type	Comment
56	I2C_SDA	I/O	I2C Data Can be TGPIO_08	1.8V	Internal 2.2k PU
58	I2C_SCL	I/O	I2C Clock Can be TGPIO_09	1.8V	Internal 2.2k PU

Table 33: I2C Signal

6.3.5. Coexistence Interface (TBD)

6.3.6. Control Interface

Pin	Signal	I/O	Function	Type	Comment
8	W_DISABLE_N	I	WLAN disable	VPH_PWR	Internal 100k PU
26	W_DISABLE2_N	I	GNSS disable	VPH_PWR	Internal 100k PU
10	LED_N	O	LED control		Open Drain
23	WAKE_ON_WAN_N	O	Wake Host	1.8V	Default PU
25	TGPIO_02	I/O	General Purpose I/O Can be DPR	1.8V	

Table 34: Control Interface Pins

6.3.6.1. 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

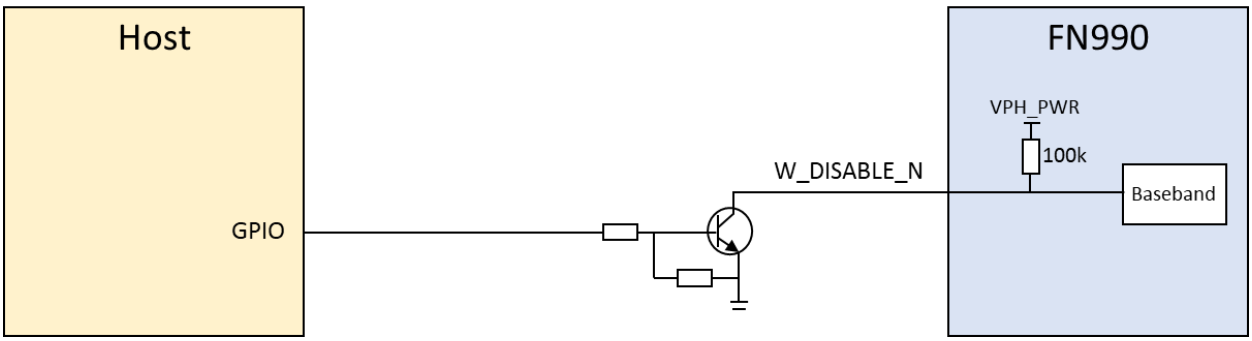


Figure 15: Example Circuit for WLAN/GNSS Disable Function

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

6.3.6.2. LED

The LED signal drives the LED output.

The recommended LED connection is the following:

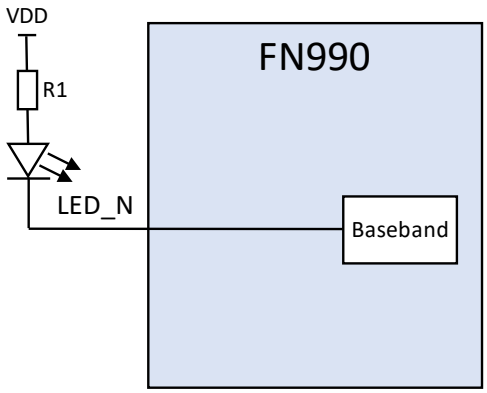


Figure 16: Recommended LED Connection

R1 and VDD determine the brightness of LED and forward current.

When VDD is 3.3V and LED's forward voltage is 2.0V, it is recommended to use the value of R1 from 66 ohm to 250 ohm.

However, the resistor value must be calculated considering the specification of the LED to be use. And recommend to use VDD under VPH_PWR level.

Note: If enable the LED function and connect the LED to the LED_N pin, the current consumption may be increased. And current sinking mode (up to 10mA) can be supported.

6.3.6.3. Wake Host

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

- SMS
- Network de-registration
- Voice Call

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

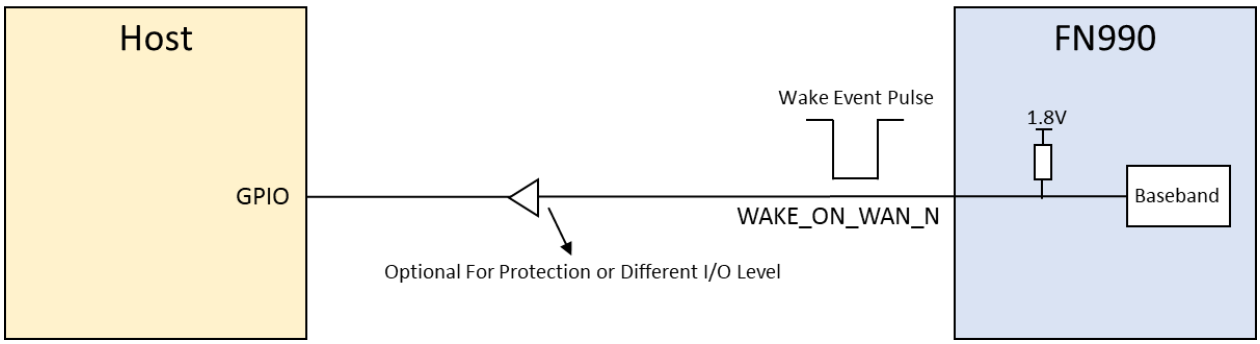


Figure 17: Recommended LED Connection

6.3.6.4. DPR

This signal is an input directly to the FN990 Family module from a suitable SAR sensor. Then FN990 Family module will reduce output tx power.

DPR function is not implemented yet. The specific implementation will be determined as customer request.

If you want to use DPR function on FN990 Family, please contact Telit Techical Support at

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

6.4. General Purpose I/O

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

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

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

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

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 Can be COEX_RX	1.8V	
64	TGPIO_04	I/O	General Purpose I/O Can be COEX_TX	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	TGPIO_12	I/O	General Purpose I/O Can be 1PPS/TSN	1.8V	

Table 35: General Purpose I/O

6.4.1. 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.

6.4.2. 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.

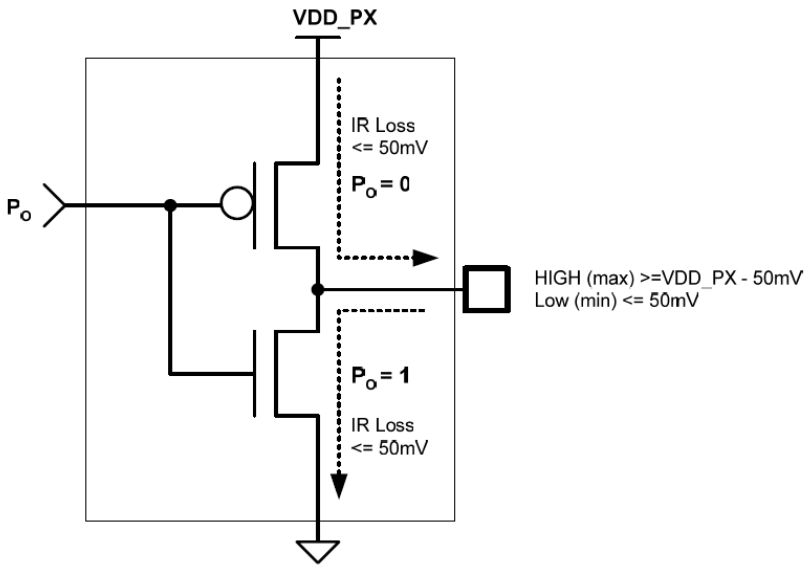


Figure 18: GPIO Output Pin Equivalent Circuit

7. RF SECTION

7.1. Antenna Interface

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

FN990 Family provides four MHF-4 type RF connectors covering the 5G FR1/LTE/WCDMA bands including GNSS, one MHF-4 type RF connector for dedicated GNSS.

Warning: Be careful cables and RF connectors assembly not to damage when Antenna cables for LTE/FR1/GNSS are connected.

7.1.1. Antenna Configuration

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

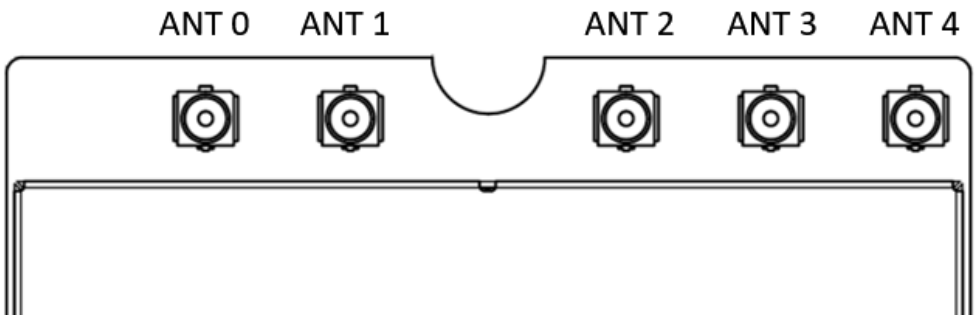


Figure 19: Antenna Configration

Refer to the following antenna configuration assigned.

Antenna port	Technology	Tx	Rx	GNSS
ANT 0	WCDMA	B1, B2, B4, B5, B6, B8, B19	B1, B2, B4, B5, B6, B8, B19	-
	LTE	B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B30, B34, B38, B39, B40, B41, B66, B71	B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B29(DL), B30, B32(DL), B34, B38, B39, B40, B41, B42, B43, B46(DL), B48, B66, B71	
	5G NR FR1	n1, n2, n3, n5, n7, n8, n20, n25, n28, n30, n38, n40, n41, n66, n71	n1, n2, n3, n5, n7, n8, n20, n25, n28, n29(DL), n30, n38, n40, n41, n48, n66, n71, n75(DL), n77, n78, n79	
ANT 1	WCDMA	-	-	

Antenna port	Technology	Tx	Rx	GNSS
	LTE	-	B1, B2, B3, B4, B7, B25, B30, B32(DL), B34, B38, B39, B40, B41, B42, B43, B48, B66	GPS L1, Galileo E1, Beidou B1, Glonass G1
	5G NR FR1	n48, n77, n78, n79	n1, n2, n3, n7, n25, n30, n38, n40, n41, n48, n66, n75(DL), n77, n78, n79	
ANT 2	WCDMA	-	B1, B2, B4, B5, B6, B8, B19	-
	LTE	B38, B41	B1, B2, B3, B4, B5, B7, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B29(DL), B30, B32(DL), B34, B38, B39, B40, B41, B42, B43, B46(DL), B48, B66, B71	
	5G NR FR1	n48, n77, n78, n79	n1, n2, n3, n7, n25, n30, n38, n40, n41, n48, n66, n75, n77, n78, n79	
ANT 3	WCDMA	-	-	-
	LTE	B42, B43, B48	B1, B2, B3, B4, B7, B25, B30, B32(DL), B34, B38, B39, B40, B41, B42, B43, B48, B66	
	5G NR FR1	n48, n77, n78, n79	n1, n2, n3, n7, n25, n30, n38, n40, n41, n48, n66, n75(DL), n77, n78, n79	
ANT 4	GNSS	-	-	GPS L1, Galileo E1, Beidou B1, Glonass G1

Table 36: Antenna Configuration

7.2. Antenna Connector

The FN980 Family is equipped with a set of 50 Ω RF MHF-4 Receptacle from I-PEX 20449-001E.

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

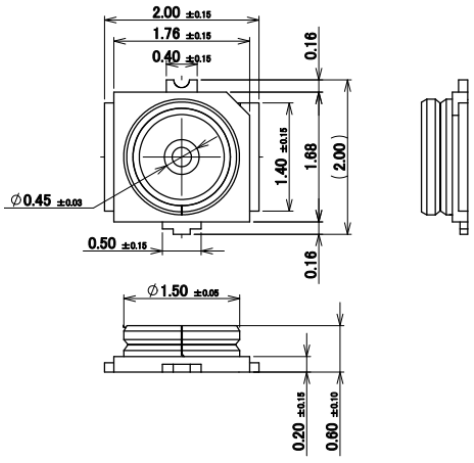


Figure 2019: MHF-4 RF connector

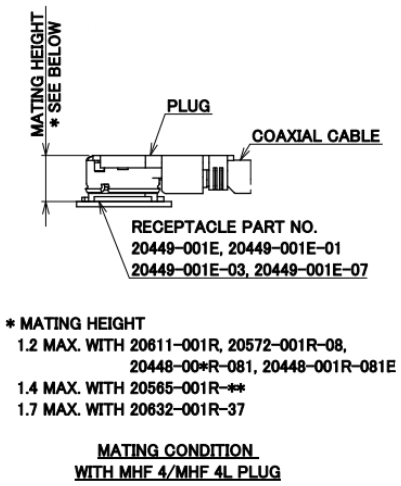


Figure 21: MHF-4 Receptacle

7.3. Antenna Requirements

The antenna for the FN990 Family module must meet the following requirements.

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 FN990 Family is 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

Table 37: WCDMA / LTE / 5G Sub-6 Antenna Requirements

7.3.1. Antenna Cable

Connecting cables between the module the antenna of LTE/Sub-6 must have 50 ohm impedance.

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

Item	Value
Impedance	50 Ohm

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

Table 38: Minimize Antenna Cable Recommendations

Warning: Impedance of RF connector and RF cable must be matched to 50 ohm, mismatching will cause negative RF performance, especially high insertion loss of RF cable affects on Tx power and Rx sensitivity.

7.3.2. Antenna Installation Guidelines

- Each antenna must be installed with 20 dB isolation.
- Install the antenna in a location with access to the network radio signal.
- The antenna must be installed in such a way as 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.
- The antenna must not be installed inside metal cases.
- The antenna must be installed according to the antenna manufacturer's instructions.

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

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

The antenna(s) used for this transmitter must be installed to provide a seperation distance of at least 20 cm from all persons and must not be co-located or operating in conjuction with any other antennas or transmitters. End-users must be provided with transmitter operation conditions to meet RF exposure compliance. OEM integrators must ensure that the end user does not have manual instructions to remove or install the FN990 Family module. The antennas used for this OEM module must not exceed the gain in the table below for mobile and fixed operating configurations.

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

Note: Manual Information to the End User The OEM integrator should be aware not to provide end user information on how to install or remove this RF module in the end product user manual which integrates this module. The end user manual must include all required regulatory information/warning as shown in this manual.

7.4. GNSS Receiver

The FN990 Family integrates a GNSS receiver that could be used in Standalone mode and in A-GPS(assisted GPS), according to the different configurations.

FN990 Family supports an active antenna.

Item	Value
Frequency range	• Wide-band GNSS: 1559 – 1606 MHz recommended • GPS: 2.046 MHz BW NB GPS (centered on 1575.42 MHz) • 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)
Passive Antenna Gain	1.5 dBi < Gain < 3dBi[1]
Impedance	50 Ohm
External Amlification Gain	7.5 dB < Gain < 26 dB for nominal performance[2,3] 1.5 dB < Gain < 7.5 dB for nominal performance[4,5]
Supply Voltage	3.1 V

Table 39: GNSS Receiver

Note:

[1] Configured as AT$GPSANTPORT= 1 or 2 (Internal LNA Active in either configuration)

[2] Configured as AT$GPSANTPORT= 3 (Internal LNA bypassed)

[3] Must not exceed 26 dB

[4] Configured as AT$GPSANTPORT= 4 (Internal LNA active)

[5] Must not exceed 7.5 dB

Total gain applied at FN990 RF input connector (Passive Antenna gain + External LNA gain-losses)

7.4.1. GNSS RF Front End Design

The FN990 Family contains an integrated LNA and pre-select SAW filter.

This allows the module to work well with a passive GNSS antenna. If the antenna cannot be located near the FN990 Family, then an active antenna (that is, an antenna with a low noise amplifier built in) can be used with an external dedicated power supply circuit.

GNSS receive path uses either the dedicated GNSS connector #4 or the shared antenna connector #3.

Note: Please refer to the FN990 Family AT Commands Reference Guide, 80691ST11097A for detailed information about GNSS operating modes and GNSS antenna selection.

7.5. GNSS Characteristics

The below table specifies the GNSS characteristics and expected performance:

Parameters		Typical Measurement	Notes
Sensitivity	Tracking Sensitivity	-161 dBm	Standalone or MS based
	Acquisition	-148 dBm	
	Cold Start	-146 dBm	
TTFF	Hot	1 sec	Open Sky, mean TTFF
	Warm	27 sec	Open Sky, mean TTFF
	Cold	28 sec	Open Sky, mean TTFF
Min update rate		1Hz	
CEP		<2m	Open sky conditions. Standalone

Table 40: GNSS Characteristics

8. MECHANICAL DESIGN

8.1. General

The FN990 Family module was designed to be compliant with a standard lead-free SMT process.

8.2. Finishing & Dimensions

The FN990 Family module's overall dimensions are:

- Length: 52.00 mm
- Width: 30.00 mm
- Thickness: 2.25 mm

8.3. Drawing

This figure shows the mechanical dimensions of the FN990 Family module.

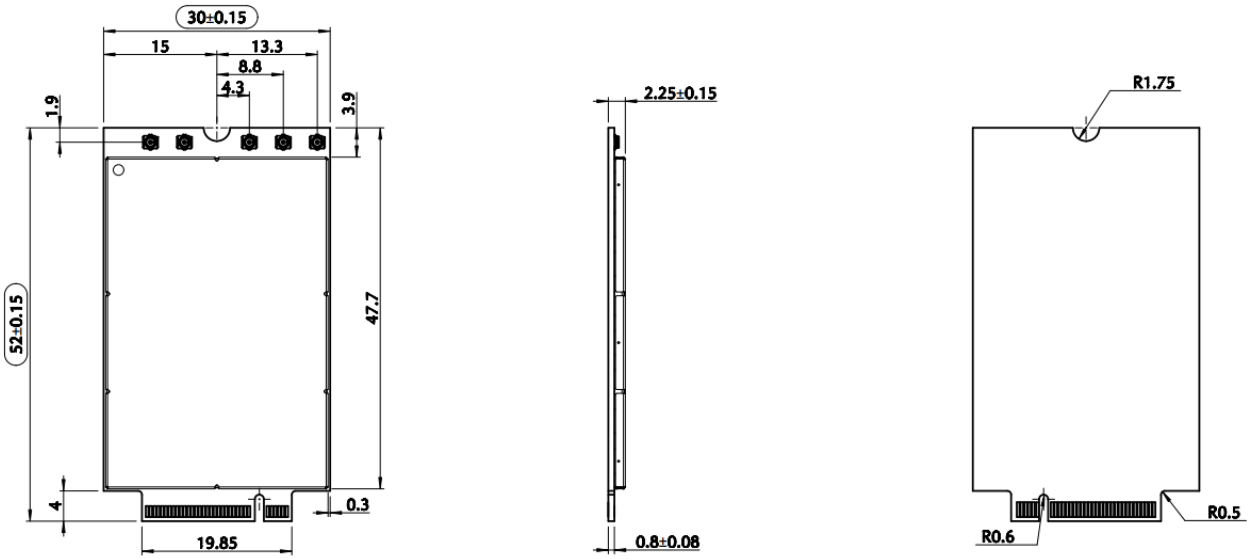


Figure 202: FN990 Family Module Mechanical Dimensions

9. APPLICATION GUIDE

9.1. Debug of the FN990 Family Module in Production

To test and debug the FN990 Family module integration, we strongly recommend to add several test pins on the host PCB for the following purposes:

- Checking the connection between the FN990 Family itself and the application
- Testing the performance of the module by connecting it with an external computer

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

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

9.2. 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. Customers must pay special attention to this issue when they design their application board.

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

The capacitor will also prevent power supplies ripple and the swiching 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 uF for VPH_PWR

It must be taken into account that the capacitance mainly depends on the application board.

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

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

9.3. EMC Recommendations

EMC protection on all the pins of FN990 Family should be designed by application side according to the customer's requirement.

ESD rating on all pins of FN990 Family:

Human Body Model (HBM): +/- 1000 V

Charged Device Model (CDM): +/- 250 V

All antenna pins up to +/- 4 kV

Electro-static Discharge: 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.

10. PACKAGING

10.1. Tray

The FN990 Family modules are packaged on trays of 15 pieces each. These trays can be used in SMT processes for pick & place handling.

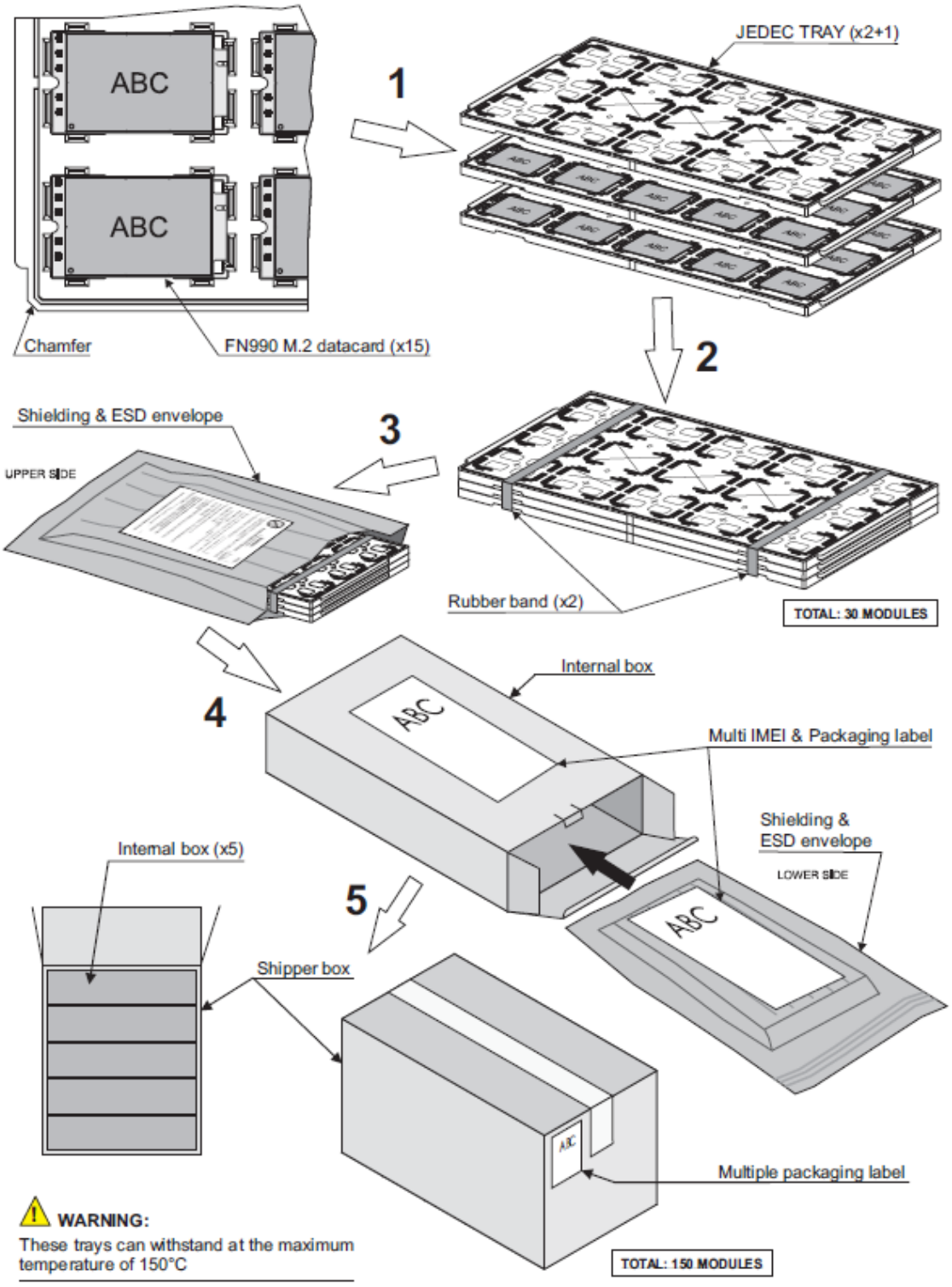
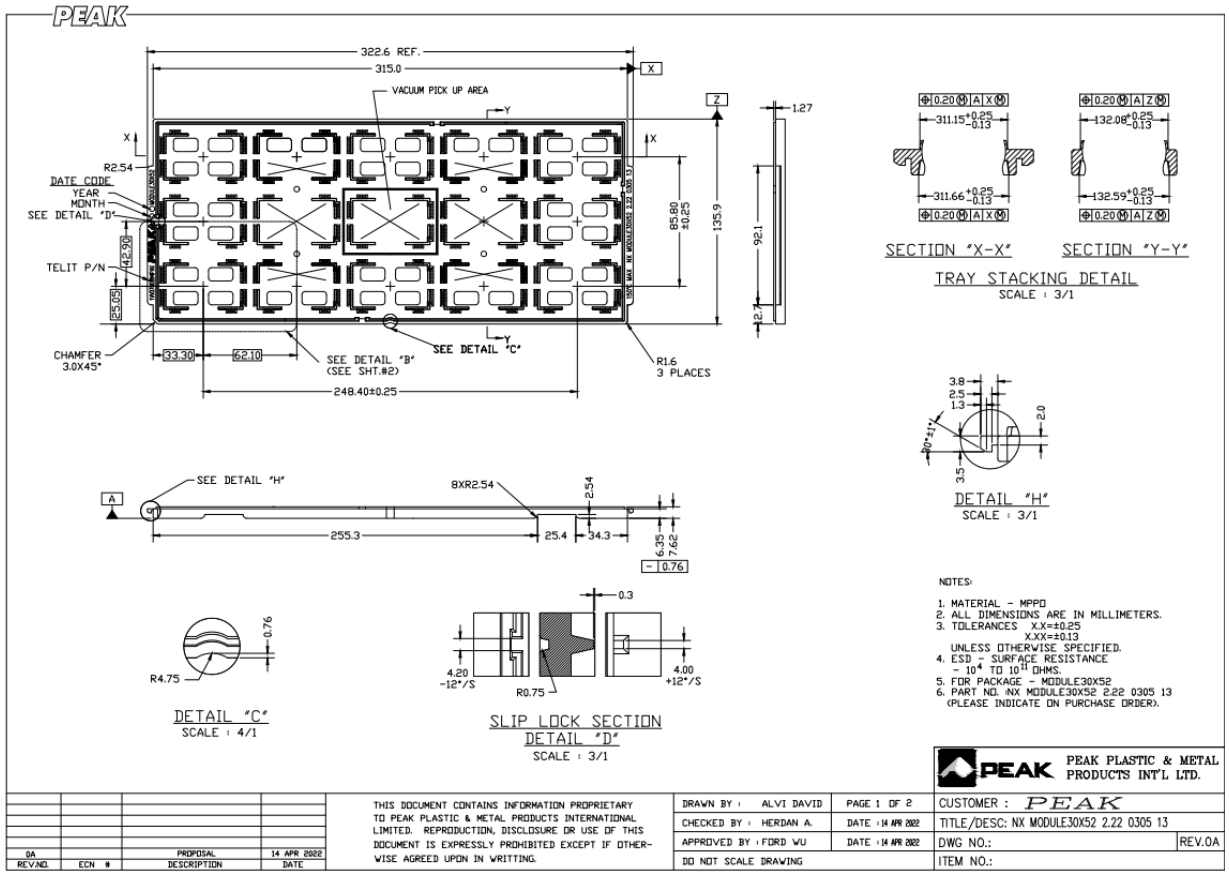


Figure 23: Tray Packaging



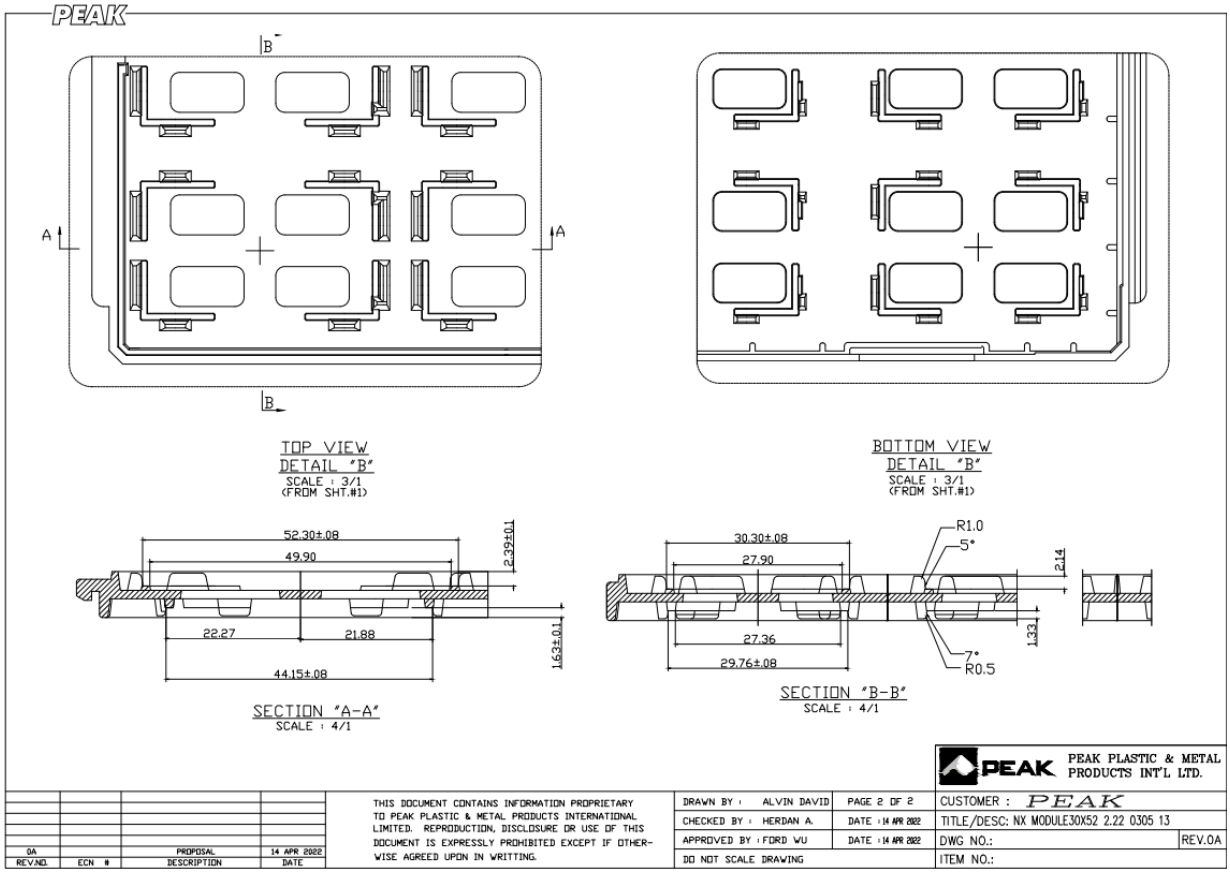


Figure 24: Tray Construction

11. CONFORMITY ASSESSMENT ISSUES (TBD)

11.1. Approval

Module	Europe RED	US FCC	CA ISED
FN990A28			
FN990A40			

Table 41: Approvals Summary

11.2. Europe Approvals

11.2.1. RED Declaration of Conformity

Hereby, Telit Communications S.p.A declares that the FM990A28 and FN990A40 Modules are in compliance with Directive 2014/53/EU.

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

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

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

11.2.2. 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.

Model	Antenna Type
FN990A28	Omnidirectional Dipole Antenna
FN990A40	

Table 412:RED Antenna Type

Max Gain for RED (dBi)				
UMTS	Ant Gain to meet CE MPE limit	Max Gain to consider same Frequency with LTE	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
B1				
B3				

Max Gain for RED (dBi)				
UMTS	Ant Gain to meet CE MPE limit	Max Gain to consider same Frequency with LTE	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
B8				

Table 43: Max Gain for RED – WCDMA bands

Max Gain for RED (dBi)				
LTE	Ant Gain to meet CE MPE limit	Max Gain to consider EN-DC Active	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
B1				
B3				
B7				
B8				
B20				
B28				
B38				
B40				
B42				
B43				

Table 44: Max Gain for RED – LTE bands

Max Gain for RED (dBi)				
NR	Ant Gain to meet CE MPE limit	Max Gain to consider EN-DC Active	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
n1				
n3				
n7				
n8				
n20				
n28				
n38				
n40				
n41				

Max Gain for RED (dBi)				
NR	Ant Gain to meet CE MPE limit	Max Gain to consider EN-DC Active	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
n77				
n78				

Table 425: Max Gain for RED – NR bands

11.3. FCC and ISED Approval / *FCC et ISDE Approvation*

11.3.1. FCC Certificates

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

11.3.2. ISED Approvals / *ISDE Approbation*

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

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

11.3.3. Applicable FCC and ISED Rules / *Liste des Règles FCC et ISDE Applicables*

Model *Modèle*	Applicable FCC Rules	Applicable ISED Rules *Règles ISDE applicables*
FN990A28	47 CFR Part 2, 22, 24, 27, 90,96	RSS: 130 Issue 2, 132 Issue 3, 133 Issue 6, 139 Issue 3, 140 Issue 1, 195 Issue 2, 199 Issue 3; RSS-Gen Issue 5
FN990A40		

Table 46: Applicable FCC and ISED Rules

11.3.4. FCC and ISED Regulatory Notices / *Avis Réglementaires de FCC et ISDE*

Modification statement / *Déclaration de modification*

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

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

Interference statement / *Déclaration d'interférence*

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

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

Wireless notice / *Wireless Avis*

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

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

FCC Class B digital device notice (Fcc Only)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

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

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

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

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

11.3.5. Antennas / *Antennes*

FCC

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

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

ISED / ISDE

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

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

(le tabelle ISED sono comprese nelle tabelle FCC)

Model *Modèle*	Antenna Type *Type d'Antenne*
FN990A28	Omnidirectional Dipole Antenna *Antenne dipolaire omnidirectionnelle*
FN990A40	

Table 437: FCC Antenna Type

Max Gain for FCC (dBi) Gain maximum pour ISED (dBi) */ Gain maximum pour ISDE (dBi)*				
UMTS	Max Gain to meet FCC ERP/EIPP and MPE limit	Max Gain to meet IC ERP/EIPP and MPE limit	Max Gain to consider the same Frequency	Max gain allowed
B2				
B4				
B5				

Table 44: Max Gain for FCC – WCDMA bands

Max Gain for FCC (dBi) Gain maximum pour ISED (dBi) */ Gain maximum pour ISDE (dBi)*				
LTE	Max Gain to meet FCC ERP/EIRP and MPE limit	Max Gain to meet IC ERP/EIRP and MPE limit	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
B2				
B4				
B5				
B7				
B12				
B13				
B14				
B17				
B25				
B26				
B30				
B38				
B41				
B42				
B43				
B48				
B66				
B71				

Table 49: Max Gain for FCC – LTE bands

Max Gain for FCC (dBi) Gain maximum pour ISED (dBi) */ Gain maximum pour ISDE (dBi)*				
NR	Max Gain to meet FCC ERP/EIRP and MPE limit	Max Gain to meet IC ERP/EIRP and MPE limit	Max Gain to consider EN-DC Transmit with WLAN	Max gain allowed
n2				
n5				
n7				
n12				
n25				
n41				
n66				
n71				

Table 450:Max Gain for FCC – NR bands

11.3.6. FCC Label and Compliance Information

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

Below list of all the models and related FCC ID:

Model	FCC ID
FN990A28	
FN990A40	

Table 461: FCC ID

11.3.7. ISED Label and Compliance Information/*ISED Étiquette et Informations de Conformité*

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

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

Contains IC: XXXXXX-YYYYYYYYYY

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

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

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

Contient IC : XXXXXX-YYYYYYYYYY

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

Model *Modèle*	ISED Certification Number *Num. de certification ISDE*
FN990A28	
FN990A40	

Table 472:ISED Certification Number

11.3.8. Information on Test Modes and Additional Testing Requirements / *Informations sur les Modes de Test et les Exigences de Test Supplémentaires*

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

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

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

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

11.3.9. Fcc Additional Testing, Part 15 Subpart B Disclaimer

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

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12.3. Safety Recommendations

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

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

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

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

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

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

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

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

13. GLOSSARY

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
SIM	Subscriber Identification Module
SOC	System-on-Chip
TDD	Time Division Duplex
TTSC	Telit Technical Support Center
UART	Universal Asynchronous Receiver Transmitter
UMTS	Universal Mobile Telecommunication System
USB	Univeral Serial Bus
VNA	Vector Network Analyzer
VSWR	Voltage Standing Wave Radio
WDMA	Wideband Code Division Muliple Access

14. DOCUMENT HISTORY

Revision	Date	Changes
2	2022-05-16	Section 2.2.1, 2.6.1, 7.1.1 Updated Frequency Bands Section 2.5 Updated Block Diagram Section 2.6 Updated RF Performance Section 6.2 Updated Power ON/OFF/RESET Section 2.4, 6.3.2, 6.3.3 Updated eSIM description Section 4.2 Updated Power consumption Section 8.3, 10, Added Drawing & PACKAGING Section 11 Added CONFORMITY ASSESTMENT ISSUES
1	2022-04-22	Section 2.4 Updated Processor Clock Section 3.1 Updated Pin-out Section 3.3 Updated Pin Layout Section 4.1 Updated Power Supply Requirements Section 4.2 Updated LPM Power Consumption Section 6.1 Updated I/O Operating Range Section 6.2 Updated Power ON/OFF/RESET Section 6.3 Added and updated information about interfaces
0	2021-12-16	First Draft

From Mod.0818 rev.2

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