

SIMATIC RTLS

nanoPAN V5 Module User Manual

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1 Overview

The transponders in Siemens RTLS represents mobile devices designed for localization within the SIMATIC REAL TIME LOCATION SYSTEM network. The transponders transmit its position information to the localization network's nodes (gateways) which sends the data to the localization server for computation and visualization.

The Gateways represents a base point for the localization within the SIMATIC REAL TIME LOCATION SYSTEM. The gateways can be connected to the local IT-infrastructure via Ethernet. Through this connection the transponders exchange the localization data gathered and customer specific data between the localization network and the localization server.

The nanoPAN V5 Module is used as radio module in all RTLS products using the CHIRP technology. The module will only be integrated by Siemens into their host products and will not be sold to third parties.

The nanoPAN V5 Module integrates all the required components for a complete RF module based on 2.4 GHz nanoLOC TRX Transceiver. Through its SPI interface, this module connects to almost any microcontroller forming a complete subsystem with only very few external components.

2 nanoPAN V5 Module

With dimensions of only 29 mm by 15 mm and a thickness of less than 4 mm, the module includes two baluns, a band-pass filter, two clock crystals, an RF switch, a +20 dBm RF power amplifier, as well as the nanoLOC chip and required circuitry.

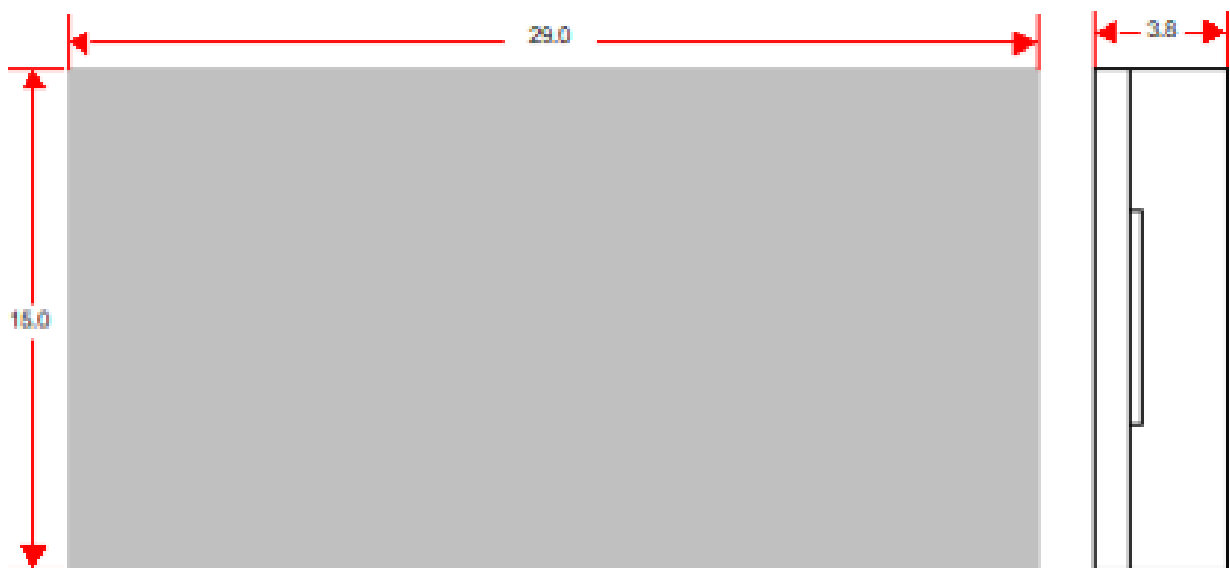


Figure 1: nanoPAN V5 Module - Top View

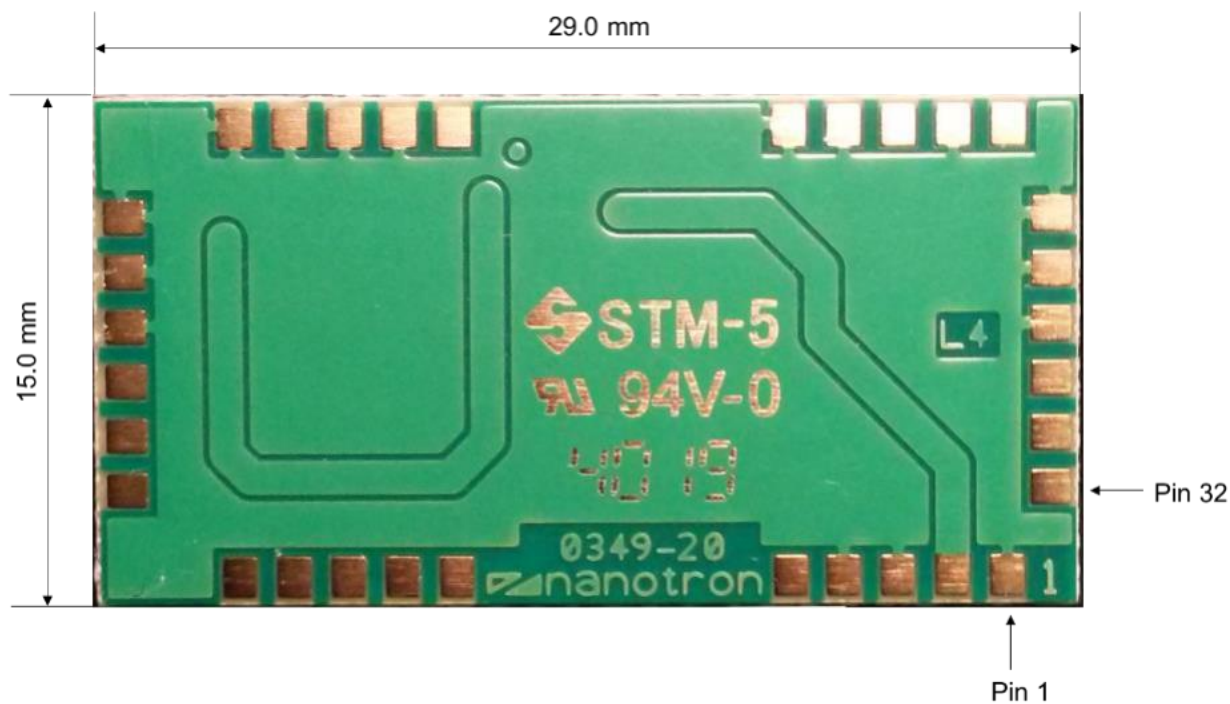


Figure 2: nanoPAN V5 Module - Bottom View

3 Absolute Maximum Ratings

Parameter	Value	Unit
Min. operating temperature	-40	°C
Max. operating temperature	+85	°C
Max. supply voltage	+2.7	V
Max. DC current per I/O pin	2.0	mA
Max. digital input voltage	VDDD + 0.2	V
Min. digital input voltage	VDDD - 0.2	V
Moisture Sensitivity Level (MSL)	3	

4 Electrical Characteristics

4.1 Nominal Conditions

- $T_{op} = +25^{\circ}\text{C}$
- $V_{SSA} = V_{SSD} = \text{GND}$
- $V_{DDA} = V_{CC} = +2.5 \text{ V}$
- CRC OFF
- FEC ON
- Encryption OFF
- Bit scrambler ON
- BER = 0.001 during receive mode
- RF output power during transmit is +20 dBm measured during continuous transmission
- All RF ports have a 50Ω load
- All RF power measurements are done at pin 24 (ANT) of the module

4.2 General / DC Parameters

Symbol	Parameter	Condition				Unit	Note
			Min	Typ	Max		
T _{op}	Operating temperature	-	-40	-	+85	°C	2
V _{cc}	Supply voltage	-	+2.3	-	+2.7	V	2
I _{cc}	Supply current TX modes 1,2, low power	Reg 0x00	-	116	148	mA	2
I _{cc}	Supply current TX mode 3, low power	Reg 0x00	-	112	145	mA	2
I _{cc}	Supply current TX modes 1,2, mid power	Reg 0x1F	-	123	155	mA	2
I _{cc}	Supply current TX mode 3, mid power	Reg 0x1F	-	118	150	mA	2
I _{cc}	Supply current TX modes 1,2, full power	Reg 0x3F	-	195	219	mA	1
I _{cc}	Supply current TX mode 3, full power	Reg 0x3F	-	179	205	mA	2
I _{cc}	Supply current RX mode 1, synchronized	-	-	45	60	mA	1
I _{cc}	Supply current RX mode 1, unsynchronized	-	-	50	60	mA	2
I _{cc}	Supply current RX mode 2, synchronized	-	-	48	-	mA	2
I _{cc}	Supply current RX mode 2, unsynchronized	-	-	69	-	mA	2
I _{cc}	Supply current RX mode 3, synchronized	-	-	34	-	mA	2
I _{cc}	Supply current RX mode 3, unsynchronized	-	-	37	-	mA	2
I _{cc}	Ready mode	-	-	4	-	mA	2,3
I _{cc}	Standby mode	-	-	2.5	-	mA	2,4
I _{cc}	Power Up mode	-	-	750	-	μA	2
I _{cc}	Power Down PAD mode	-	-	0.6	2.5	mA	1
I _{cc}	Power Down FULL mode	-	-	1.5	10	μA	1

Note 1: Tested in production @ V_{cc} = +2.5 V, 50 Ω load, T_{op} = +25 °C ± 5 °C.

Note 2: Not tested in production. Only by characterization.

Note 3: RX off, TX off, nanoLOC internal baseband clock on.

Note 4: RX off, TX off, nanoLOC internal baseband clock off.

4.3 RF Parameters

Symbol	Parameter	Condition				Unit	Note
			Min	Typ	Max		
Z_0	Nominal load impedance	-	-	50	-	Ω	-
R_{data}	Raw data rate mode 1	-	-	1000	-	Kbps	-
R_{data}	Raw data rate mode 2,3	-	-	250	-	Kbps	-
P_{sens}	Receiver sensitivity mode 1	FEC on BER= 10^{-3}	-87	-89	-	dBm	2,3
P_{sens}	Receiver sensitivity mode 2	FEC on BER= 10^{-3}	-93	-95	-	dBm	2,3
P_{sens}	Receiver sensitivity mode 3	FEC on BER= 10^{-3}	-94	-96	-	dBm	2,3
P_{TXMIN}	Transmit Min power	TX Reg 0x00	-17	-15	-13	dBm	2
P_{TXMID}	Transmit Mid power	TX Reg 0x1F	+2	+6	+9	dBm	2
P_{TXFULL}	Transmit Full power	TX Reg 0x3F	+18	+20	+21	dBm	1
P_{TX2}	Transmit power 2 nd harmonic	TX Reg 0x3F	-	-60	-55	dBm	2
P_{TX3}	Transmit power 3 rd harmonic	TX Reg 0x3F	-	-65	-60	dBm	2

Note 1: Tested in production @ $V_{cc} = +2.5\text{ V}$, 50 Ω load, $T_{op} = +25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

Note 2: Not tested in production. Only by characterization.

Note 3: The displayed value is the minimum receive signal power required for BER = $10e-3$

4.4 Clock Frequency Offsets

Symbol	Parameter	Condition				Unit	Note
			Min	Typ	Max		
Δf_{32M}	32.000 MHz Offset	+25 $^{\circ}\text{C}$, +2.5 V	-15	0	+15	ppm	1
Δf_{32k}	32.768 kHz Offset	+25 $^{\circ}\text{C}$, +2.5 V	-35	0	+35	ppm	1

Note 1: Tested in production @ $V_{cc} = +2.5\text{ V}$, 50 Ω load, $T_{op} = +25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

4.5 Digital Interface

Table below lists the parameters and values for the following digital IOs:

- DII00, DII01, DII02, DII03
- UCRESET, UCIRQ
- SPITXD, SPIRXD, SPICLK, SPISSN
- /TX_RX
- /PONRESET

Symbol	Parameter	Condition				Unit
			Min	Typ	Max	
	Number of general-purpose input/outputs		-	4	-	-
C _{IN}	Logic Input Capacitance		-	2.5	-	pF
V _{IL}	Logic low input voltage		0	-	0.2 x V _{CC}	V
V _{IH}	Logic high input voltage			-	V _{CC}	V
V _{OL}	Logic low output voltage		0	-	0.3	V
V _{OH}	Logic high output voltage			-	V _{CC}	V
I _{OUT}	Output current		-	-	2	mA
R _{UP}	Equivalent pull-up resistor ¹		50	-	193	kΩ
R _{DN}	Equivalent pull-down resistance ¹		50	-	275	kΩ

¹ Can be programmed in nanoLOC TRX. Default is off.

5 Pin Layout

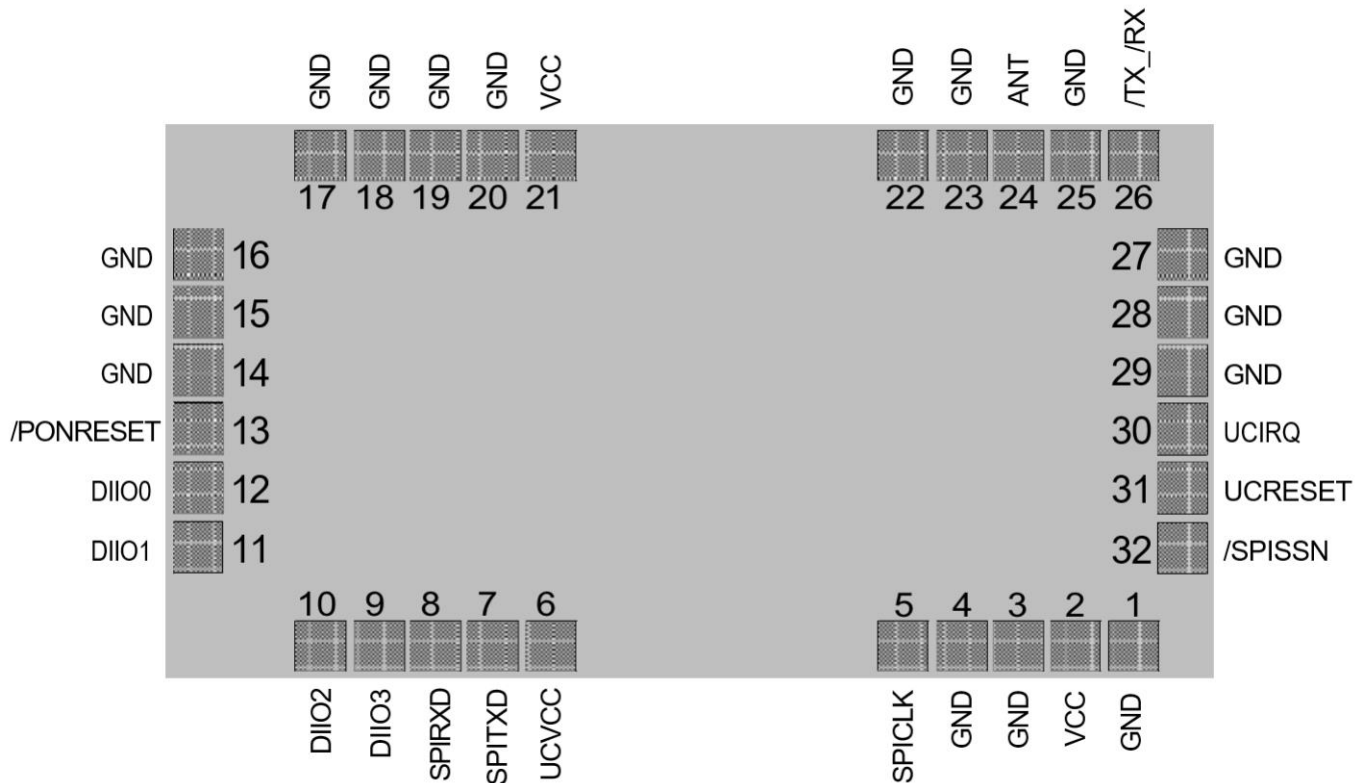


Figure 3: nanoPAN V5 Module - Pin Layout Bottom View

Pin	Signal	Description	Direction	Note
1	GND	Ground	-	
2	VCC	Supply voltage	Power	
3	GND	Ground	-	
4	GND	Ground	-	
5	SPICLK	SPI: CLK ³	Input	3
6	UCVCC ¹	Power Supply for MCU	Output	1
7	SPITXD ²	SPI: TX Transmit Data (MISO) ³	Output	2.3
8	SPIRXD	SPI: RX Receive Data (MOSI) ³	Input	3
9	DII03 ⁴	Digital I/O pin 3 for nanoLOC IC	Input / Output	4
10	DII02 ⁴	Digital I/O pin 2 for nanoLOC IC	Input / Output	4
11	DII01 ⁴	Digital I/O pin 1 for nanoLOC IC	Input / Output	4
12	DII00 ⁴	Digital I/O pin 0 for nanoLOC IC	Input / Output	4
13	/PONRESET	Power On Reset	Input	
14	GND	Ground	-	
15	GND	Ground	-	

16	GND	Ground	-	
17	GND	Ground	-	
18	GND	Ground	-	
19	GND	Ground	-	
20	GND	Ground	-	
21	VCC	Supply voltage	Power	
22	GND	Ground	-	
23	GND	Ground	-	
24	ANT	50 Ω TX / RX connection to antenna	Input / Output	
25	GND	Ground	-	
26	/TX_RX ⁵	TX / RX status ⁶	Output	5,6
27	GND	Ground	-	
28	GND	Ground	-	
29	GND	Ground	-	
30	UCIRQ ⁷	Interrupt request for MCU	Output	7
31	UCRESET ⁸	Reset for MCU	Output	8
32	/SPISSN ⁹	SPI: Sub Select	Input	9

¹ Should have a pull-down resistor of between 100 k Ω and 1 M Ω if power-down mode is used.

² SPITXD is SPI data output from the module to the MCU. This pin is Open-Drain as default and must have a pull-up to VCC . The pin is driven only when a logical 0 is sent from nanoLOC to the SPI main. Recommended value is 100 k Ω . This pin can be programmed as push-pull output.

³ nanoLOC IC is always used as an SPI sub device.

⁴ If not used, this pin should have a pull-down resistor to GND. Recommended value is 1 M Ω .

⁵ /TX_RX is Open-Drain output. It must have a pull-up to UCVCC if used. I_{max} = 2mA.

⁶ Should be used as input signal to a logical input.

⁷ This pin should have a pull-up to VCC if used. Recommended value is 1 M Ω . Default is Open-Drain, and can be programmed as Push-Pull.

⁸ This pin should have a pull-up resistor of 15 k Ω and a capacitor of 1 nF to GND if used as controller input signal.

⁹ This pin should have a pull-up resistor to VCC if used. Recommended value is 1 M Ω .

6 Approvals

6.1 UK Declaration of Conformity

The UK declaration of conformity is available to all responsible authorities at:

Siemens Aktiengesellschaft
Process Industries and Drives Division,
Process Automation
DE-76181 Karlsruhe
Germany

Importer UK:

Siemens plc,
Manchester M20 2UR

You can find the current UK Declaration of Conformity for these products on the Internet pages under Siemens Industry Online Support (<https://support.industry.siemens.com/cs/en/en/view/109801531>).

The SIMATIC RTLS products described in this document meet the requirements of the following directives/regulation:

- Radio Equipment Regulations:
SI 2017/1206 Radio Equipment Regulations 2017, and related amendments
- RoHS Regulations:
SI 2012/3032 Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012, and related amendments

6.2 RoHS directive (restriction of the use of certain hazardous substances)

The products described in these operating instructions meet the requirements of the EU directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Applied standard:

- IEC 63000
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

6.3 Article 3 (1) b) EMC

- ETSI EN 301 489-1
Electromagnetic compatibility and radio spectrum matters (ERM) - Electromagnetic compatibility for radio equipment and services - Part 1: Common technical requirements
- ETSI EN 301 489-17
Electromagnetic compatibility and radio spectrum matters (ERM) - Electromagnetic compatibility for radio equipment and services - Part 17: Specific conditions for broadband data transmission systems
- EN 55011
Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics – Limits and methods of measurement
- EN 55032 Class A, Class B
Electromagnetic compatibility of multimedia equipment – Emission requirements
- EN 55035
Electromagnetic compatibility of multimedia equipment - Immunity requirements

- EN 61000-6-1
Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
- EN 61000-6-2
Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
- EN 61000-6-3
Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
- EN 61000-6-4
Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

6.4 Article 3 (2) Efficient use of the radio spectrum

- ETSI EN 300 328
Wideband transmission systems; Data transmission equipment operating in the 2.4 GHz ISM band and using wide band modulation techniques. Harmonized standard covering the essential requirements of article 3.2 of the EU Directive 2014/53/EU

6.5 FCC information; FCC ID SCFNANOPAN5375V5

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Important Note: Radiation Exposure Statement This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated at a minimum distance of 20cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. Country Code selection feature to be disabled for products marketed to the US/Canada. This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna

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

End Product Labelling: The final end product must be labelled in a visible area with the following "Contains FCC ID: SCFNANOPAN5375V5"

Limited module procedures: This radio module is approved under Limited Modular Approval (LMA). Therefore, Compliance for this module is evaluated in accordance with FCC KDB 996369 D01 Module Certification Guide v04r02, which defines the requirements for Limited Modular Approval devices. For each new host or antenna configuration, the final product shall demonstrate continued compliance by evaluation of, at a minimum, the following test set:

1. Compliance with FCC 47 CFR Part 1
 - §1.1310 – RF exposure Exemption
2. Compliance with FCC 47 CFR Part 15 C
 - §15.203 / §15.247 (b) – Antenna requirement
 - §15.247 (b)(3) – Output Power
 - §15.247 (d) – Frequency Band Edge
 - §15.247 (d) – Spurious Emissions conducted
 - §15.205 / §15.209 – Spurious Emissions radiated

All required tests shall be performed by an accredited FCC-recognized test laboratory in a semi-anechoic chamber or Open Area Test Site (OATS) at a measurement distance of 3 m or 10 m, as applicable. Testing shall be conducted under ambient conditions (Temperature: 15 °C to 35 °C, Humidity: 20 % to 75 %). A representative production-equivalent module, configured for worst-case RF operating parameters, shall be used as the test sample. Testing shall be performed in a representative host device, including power supply, clocking, and I/O interfaces representative of the final OEM application. Antennas, cables, and peripherals shall be configured to produce worst-case emissions.

For each new host device or antenna configuration, the resulting test report shall be submitted to the FCC as a Class II Permissive Change.

RF exposure considerations: This modular transmitter complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated at a minimum distance of 20 cm between the radiator and the human body. This device and its antenna(s) must not be co-located or operated in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures.

This radio transmitter has been approved by Federal Communications Commission to operate with the antenna listed

Label and compliance information: The final end product must be labelled in a visible area with the following “Contains FCC ID: SCFNANOPAN5375V5”.

Information on test modes and additional testing requirements: The host manufacturer installing this limited-approved module must perform radiated emission and spurious emission testing according to FCC Part 15C.

End devices (EUTs) embedding this radio module shall be tested according to the specifications set forth in CFR 47, Part 15C, §15.209 “Radiated emission limits; general requirements”

Independent of the Limited Modular Approval limitations, the host manufacturer is responsible for ensuring that the final host system complies with all other applicable FCC requirements, including FCC Part 15 Subpart B for unintentional radiators.

Information to the End User:

The end user manual shall include all required Regulatory information/warning as follows: Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. 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.

RF Radiation Exposure Statement: This product complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated at a minimum distance of 20 cm between the radiator and the human body. This device and its antenna(s) must not be co-located or operated in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures.

Antenna Restrictions: This product uses a Reverse-SMA antenna interface within a specific and controlled antenna configuration to maintain compliance with FCC requirements. Therefore, only the documented antennas are allowed to be used.

6.6 ISED information; IC 267X-MN5375V5

NOTICE (RSS-Gen Issue 5)

This device complies with Industry Canada license-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.

Host labelling guidance for the end integrator:

This is an advise for host manufacture to provide a physical / e-label on their host product stating, "Contains IC: 267X-MN5375V5": A permanently affixed label must be used. The modular transmitter must be labeled with its own IC identification number, and, if the IC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module IC: 267X-MN5375V5" or "Contains IC: 267X-MN5375V5". Any similar wording that expresses the same meaning may be used.

The manual needs to include host labelling guidance for the end integrator.

Instructions d'étiquetage de l'hôte pour l'intégrateur final:

Il est conseillé aux fabricants de l'hôte de prévoir une étiquette physique / électronique sur leur produit hôte indiquant : "Contient le CI : 267X-MN5375V5": Utiliser une étiquette apposée de façon permanente. L'émetteur modulaire doit être étiqueté avec son propre numéro d'identification de CI et, si le numéro d'identification de CI n'est pas visible lorsque le module est installé à l'intérieur d'un autre matériel, l'extérieur du matériel dans lequel le module est installé doit également porter une étiquette faisant référence au module joint. Cette étiquette extérieure peut utiliser une formulation telle que la suivante : "Contient le module CI émetteur : 267X-MN5375V5" ou "Contient le CI : 267X-MN5375V5". Toute formulation de signification identique peut être utilisée.

Le manuel doit inclure les instructions d'étiquetage de l'hôte pour l'intégrateur final.

Handling of new host or antenna configurations:

For each new host or antenna configuration, the final product shall demonstrate continued compliance by evaluation of, at a minimum, the following test set:

1. Compliance with ISED RSS-102
 - Clause 5.3.2 – RF exposure Exemption
2. Compliance with ISED RSS-247
 - Clause 5.4.d. – Output Power
 - Clause 5.5 – Frequency Band Edge
 - Clause 5.5 – Spurious Emissions conducted
3. Compliance with ISED RSS-Gen
 - Clause 8.9 / Clause 8.10 – Spurious Emissions radiated

All required tests shall be performed by an accredited ISED-recognized test laboratory in a semi-anechoic chamber or Open Area Test Site (OATS) at a measurement distance of 3 m or 10 m, as applicable. Testing shall be conducted under ambient conditions (Temperature: 15 °C to 35 °C, Humidity: 20 % to 75 %). A representative production-equivalent module,

configured for worst-case RF operating parameters, shall be used as the test sample. Testing shall be performed in a representative host device, including power supply, clocking, and I/O interfaces representative of the final OEM application. Antennas, cables, and peripherals shall be configured to produce worst-case emissions.

For each new host device or antenna configuration, the resulting test report shall be submitted to the ISED as a Class II Permissive Change.

Gestion des nouvelles configurations d'hôte ou d'antenne :

Pour chaque nouvelle configuration d'hôte ou d'antenne, le produit final doit démontrer le maintien de la conformité par une évaluation incluant, au minimum, l'ensemble d'essais suivant :

1. Conformité à l'ISED RSS-102
 - Article 5.3.2 – Exemption relative à l'exposition RF
2. Conformité à l'ISED RSS-247
 - Article 5.4 d. – Puissance de sortie
 - Article 5.5 – Limites de bande de fréquences
 - Article 5.5 – Émissions parasites conduites
3. Conformité à l'ISED RSS-Gen
 - Article 8.9 / Article 8.10 – Émissions parasites rayonnées

Tous les essais requis doivent être réalisés par un laboratoire d'essais accrédité et reconnu par l'ISED, dans une chambre semi-anéchoïque ou sur un site d'essais en champ libre (OATS), à une distance de mesure de 3 m ou 10 m, selon le cas. Les essais doivent être effectués dans des conditions ambiantes (température : 15 °C à 35 °C, humidité : 20 % à 75 %). Un module représentatif, équivalent à la production et configuré selon les paramètres RF les plus défavorables, doit être utilisé comme échantillon d'essai. Les essais doivent être réalisés dans un dispositif hôte représentatif, incluant l'alimentation électrique, l'horloge et les interfaces d'E/S représentatives de l'application OEM finale. Les antennes, câbles et périphériques doivent être configurés de manière à générer les émissions les plus défavorables.

Pour chaque nouvelle configuration de dispositif hôte ou d'antenne, le rapport d'essai résultant doit être soumis à l'ISED dans le cadre d'une modification permissive de classe II.

Radiation exposure statement (RSS-102)

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

Déclaration d'exposition aux radiations

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20 cm entre le radiateur et votre corps.