RN93xx

Product Technical Specification

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ROLLING WIRELESS

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Legal Notice

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1 Introduction

1.1 Modem Features

- Legacy radio access technologies – 4G LTE, 3G (HSDPA, HSUPA, HSPA+, and DC-HSPA+ / WCDMA), 2G (GSM/GPRS/EDGE)
- 5G NR Sub-6 3GPP R16 NSA/SA FDD/TDD[1]
- 5G NR Option 2 for SA and Option 3/3x for NSA EN-DC
- Dynamic Spectrum Sharing (DSS) –5G NR and LTE FDD bands
- PAN eCall / ERA-Glonass
- Emergency calls (E911/E112) over LTE/NR
- VoLTE and VoNR
- SMS over IMS (LTE or NR) / SGs
- Up to 12 PDN support, 4/12 can support IPA
- Support embedded Data calls or USB tethering data calls with IPv4 and IPv6 dual stack
- SIM application tool kit with proactive SIM commands
- Traditional modem COM port support for AT commands
- Power saving modes for minimum idle power draw
- MF-GNSS (L1/L5)
- Concurrent GNSS constellations: GPS, GLONASS, Galileo, Beidou, QZSS
- Assisted GNSS: GPS OneXtra, SUPL and A-GPS via Control Plane (US e911)

NOTE: 1. FDD NSA EN-DC is not supported.

2 Technical Specifications

2.1 Environmental

The RN93xx module complies with the environmental specifications in Table 3-1. Final product conformance to these specifications depends on the OEM device implementation.

Table 2-1 Environmental Specifications

PARAMETER	DETAILS
Operating Temperature	-40ºC to +85ºC

2.2 Input/output Power Supplies

Table 2-2 Input Power Supplies Requirements

CAUTION: To be updated in the future.

SPECIFICATION	MIN	TYP	MAX	UNIT
Voltage range	3.4	4.0	4.2	V

2.3 Recommended WWAN Antenna Specifications

Table 2-3 Antenna Requirements[1]

PARAMETER	REQUIREMENTS	COMMENTS
Antenna System	External multi-band antenna system (WWAN_ANT1/WWAN_ANT2/WWAN_ANT3/WWAN_ANT4)	
Operating Bands	All supporting Tx and Rx frequency bands.	
VSWR of Antennas	< 2:1	On all bands including band edges
Total Radiated Efficiency	> 50% on all bands.	Includes mismatch losses, losses in the matching circuit, and antenna losses, excluding cable loss.

PARAMETER	REQUIREMENTS	COMMENTS
		Rolling Wireless recommends using antenna efficiency as the primary parameter for evaluating the antenna system. Peak gain is not a good indication of antenna performance when integrated with a host device (the antenna does not provide omni-directional gain patterns). Peak gain can be affected by antenna size, location, design type, etc. — the antenna gains patterns remain fixed unless one or more of these parameters change.
Maximum Antenna Gain	Must not exceed antenna gains due to RF exposure and ERP/EIRP limits, as listed in the module's FCC grant.	Refer to the Important Compliance Information for the United States and Canada section.
Isolation	*TBD*	If antennas can be moved, test all positions for both antennas. Make sure all other wireless devices (Bluetooth or WLAN antennas, etc.) are turned OFF to avoid interference.
Power Handling	>2W	Measure power endurance over 4 hours (estimated talk time) using a 2 W CW signal — set the CW test signal frequency to the middle of each supporting Tx band. Visually inspect the device to ensure there is no damage to the antenna structure and matching components. VSWR/TIS/TRP measurements taken before and after this test must show similar results.

1. These worst-case VSWR figures for the transmitter bands may not guarantee RSE levels to be within regulatory limits. RN93xx module alone meets all regulatory emissions limits when tested into a cabled (conducted) 50Ω system and radiated spurious emissions with the antenna in our development kit. The antenna system may need to be tuned in order to meet the RSE limits as the complex match between the module and antenna can cause unwanted levels of emissions. Tuning may include antenna pattern changes, phase/delay adjustment, and passive component matching. Examples of the application test limits would be included in FCC Part 22, Part 24 and Part 27, test case 4.2.2 for WCDMA (ETSI EN 301 908-1), where applicable.

2.4 GNSS

2.4.1 Recommended GNSS Antenna Specifications

Table 2-4 GNSS Passive Antenna Requirements (RN93xA/B)

CAUTION: To be updated in the future.

PARAMETER	REQUIREMENTS
Frequency Range	GPS L1/ BDS B1/GLO G1/GALE1: 1559 MHz to 1610MHz (~50 MHz) L5/E5/B2a: 1164 MHz to 1215 MHz (~ 50 MHz)
Isolation between GNSS and WWAN_ANT1	>15dB
VSWR	<=2:1

Table 2-5 GNSS Active Antenna Requirements (RN93xR/N)

The table below defines the key characteristics to consider for the GNSS Active antenna. And the pre-SAW is strongly suggested to be added between the antenna and GNSS LNA for better out-of-band rejection into the whole active antenna system.

PARAMETER	REQUIREMENTS
Frequency range	GPS L1/ BDS B1/GLO G1/GALE1: 1559 MHz to 1610MHz (~50 MHz) L5/E5/B2a: 1164 MHz to 1215 MHz (~ 50 MHz)
Isolation between GNSS and Ant1	> 15 dB in all uplink bands
Maximum Voltage applied to the antenna	30 Volts
Antenna System Gain (Antenna + SAW filter + LNA + Cable + Attenuation Network)	14-17 dB
VSWR	<=2:1

Table 2-6 GNSS Pre-SAW Rejection Requirements

SAW FILTER REJECTION REQUIREMENTS		NOTES
777MHz-798MHz	>50dB	65dB required if B13 exists[1]
814MHz-915MHz	>40dB	50dB is preferred
925MHz-960MHz	>30dB	50dB is preferred
1427MHz-1463MHz	>35dB	Ensure the out of band suppression is enough
1710MHz-1785MHz	>35dB	
1850MHz-1980MHz	>40dB	
2010MHz-2025MHz	>40dB	
2305MHz-2315MHz	>40dB	

SAW FILTER REJECTION REQUIREMENTS		NOTES
2401MHz-2483MHz	>40dB	
2500MHz-2570MHz	>35dB	

1. The out of band rejection includes the prefilter (only needed if the B13 exists), the unbalanced SAW filter, and the external LNA.

NOTE: RN93xA has GNSS LNA built-in and is required to use a passive antenna for both GNSS L1 and L5. When an active antenna is used, the customer must make sure the total gain between the RN93xA GNSS antenna port and the active antenna doesn't exceed 0dB. It means the attenuation network must be added after the active antenna.

2.4.2 GNSS Application

RN93xA/B has GNSS LNA build-in and the detailed block diagram is as below. The typical gain between GNSS_ANT1/GNSS_ANT2 input and GNSS_OUT_ANT is 9dB. The GNSS_OUT_ANT can be regarded as another GNSS processor input if having one additional GNSS processor on the customer board.

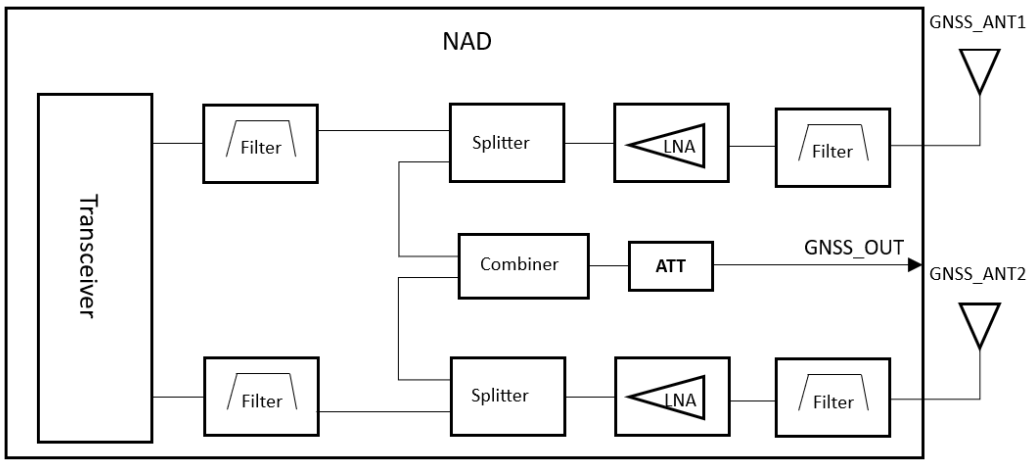


Figure 2-1 RN93xA/B GNSS Block Diagram

RN93xR/N doesn't have GNSS LNA build-in and the detailed block diagram is as below. The active antenna is a must for RN93xR/N due to no GNSS LNA build-in. GNSS_ANT1 supports both GNSS L1 and GNSS L2/5 by default. GNSS_ANT2 is not used by default.

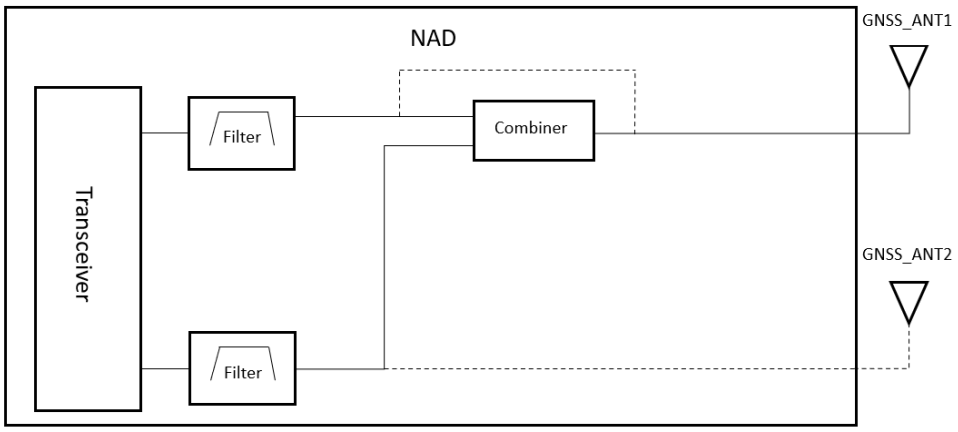


Figure 2-2 RN93xR/N GNSS Block Diagram

3 Routing Constraints and Recommendations

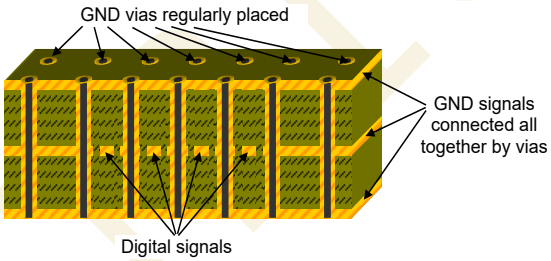
Layout and routing of the RN93xx device in the application are critical to maintaining the performance of the radio. The following sections provide guidance to the developer when designing their application to include an RN93xx device and achieve optimal system performance.

3.1 Digital Signals Recommendations

3.1.1 Routing on inner layers

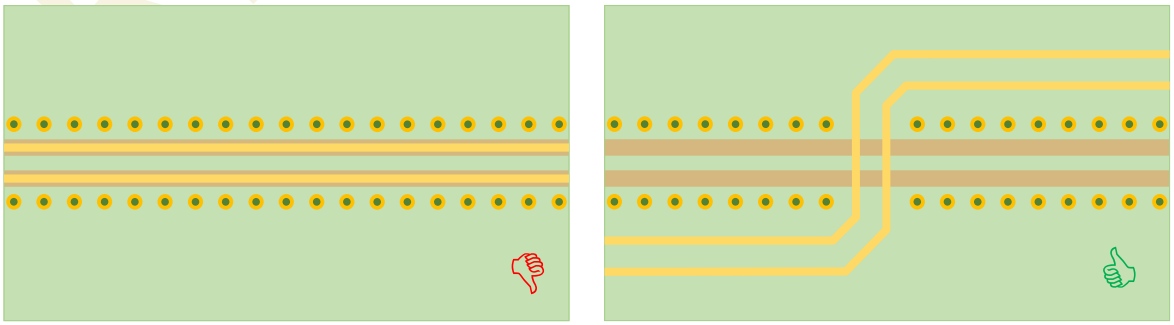
When routed in outer layers, digital signals can be a source of noise affecting highly sensitive receivers. They also can generate unwanted harmonic emissions (spurious) if subjected to an incident or reflected radiated waves from on-board antennas.

To limit the risk of your device being exposed to those problems, avoid routing any digital signals on the outer layers. These signals are recommended to be routed on inner layers and surrounded by GND planes evenly punched by GND vias:



3.1.2 Minimize the crosstalk

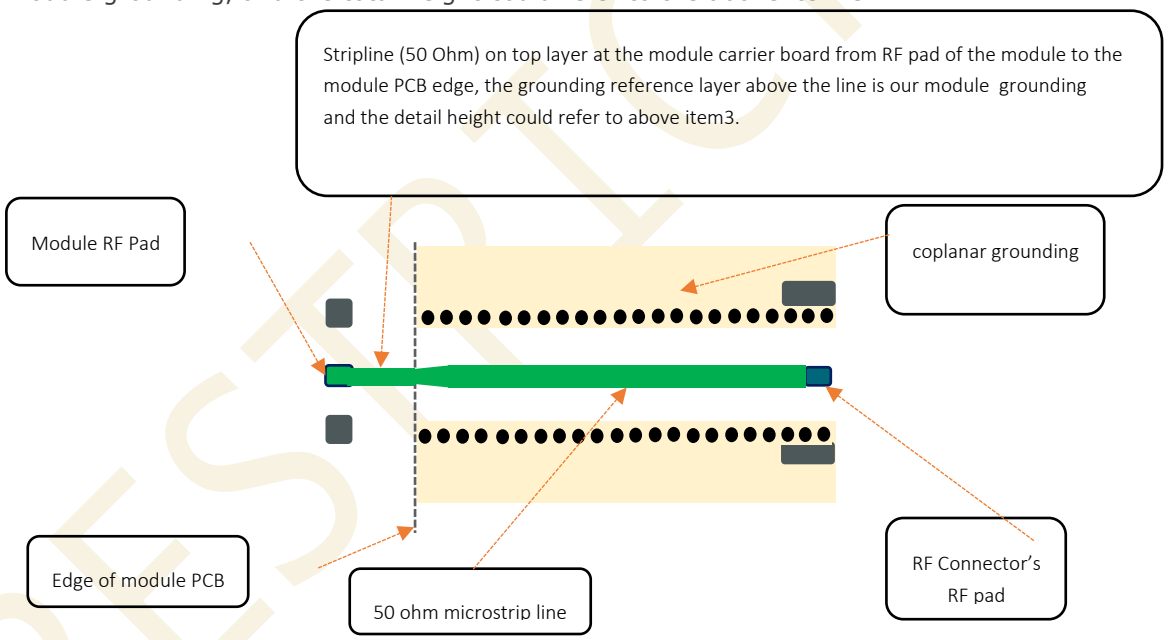
Avoid having parallel and overlapping tracks on adjacent layers. The digital traces on adjacent layers should be routed orthogonally to minimize the crosstalk risk.



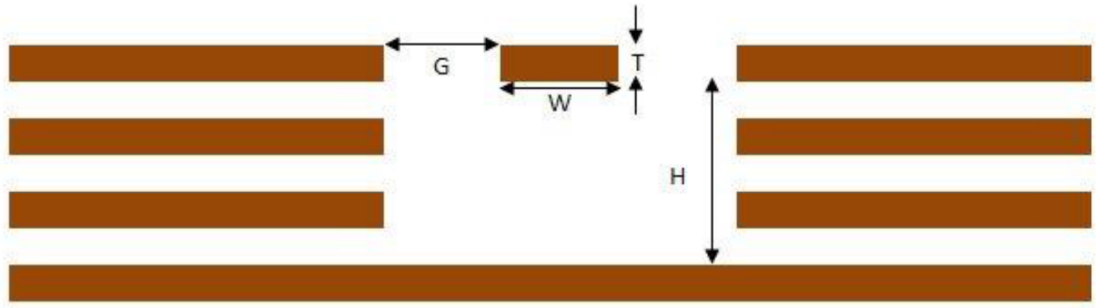
3.2 RF Routing Recommendations

To route the RF antenna signals, the following recommendations shall be taken into consideration on PCB layout:

1. The requirement for RF trace impedance is 50Ω ±10%
2. Microstrip line is recommended to avoid via transition from module to customer board then to RF antenna, which significantly reduced the RF path loss.
3. The RF microstrip line shall be perpendicularly routed from the RF pad and to the edge of the module. Because the module's RF pads have been optimized with good keepout for better RF impedance for the customer, the keepout height is 1039 um for RN934A all antennas. For other variants, the keepout height will be updated in the future.
4. The width of the microstrip line is as close to the RF pads' width as better, the RF pads include the RN93xx RF pad and also the customer antenna pad.
5. For further optimization of RF loss and better impedance, the RF traces under the module can be optimized by routing them as stripline whose up reference grounding layer will be our module grounding, and the total height could refer to the above item 3.



6. RF traces with sharp corners shall be avoided, a smooth radius is recommended.
7. The reference ground of the traces shall be a solid integrated plane.
8. The coplanar ground design for the RF trace must be used for better isolation, and the coplanar clearance (G, below) from the trace to the ground should be at least the trace width (W) and at least twice the height (H). This reduces the parasitic capacitance, which potentially alters the trace impedance and increases the losses. E.g., If W = 100 microns then G = 200 microns in an ideal setup. G = 150 microns would also be acceptable if space is limited.



9. The ground vias must be placed at the surrounding of the RF traces.
   All RF traces must be well isolated to other noise circuits such as USB, PCIe, external XO, DC power supply, etc.

3.3 High-Speed Interface Recommendations

3.3.1 USB Routing Recommendations

3.3.1.1 USB2

High-Speed USB signals (USB_D_P / USB_D_M) are a differential pair and must be routed with the following considerations/constraints:

- 70~110Ω differential trace impedance
- Differential trace length pair matching < 2mm (15 ps)
- Solid GND reference planes
- Trace lengths < 250 mm
- 3x trace width separation to all adjacent signals

3.3.1.2 USB3

Super-Speed USB signals (USB_SSTX / USB_SSRX) are 2 differential pairs and must be routed with the following considerations/constraints:

- 70~110Ω differential trace impedance
- Differential trace length pair matching < 0.7mm (5 ps)
- Solid GND reference planes
- Trace lengths < (TBC) mm
- 4x trace width separation to RX and TX signals
- 4x trace width separation to all adjacent signals

3.3.2 PCIE Routing Recommendations

PCIE signals are very high-speed signals and must be routed with the following considerations/constraints:

- 70~110Ω differential trace impedance,
- Intra pair matching < 0.7 mm (5 ps),
- Inter-lane length match < 2mm,
- Trace lengths < 300 mm,
- 3x line width separation within interface signals and 4x line width separation with a cross interface,
- Solid reference planes.

3.3.3 USXGMII Routing Recommendations

USXGMII signals must be routed with the following considerations/constraints:

- 90~110Ω differential trace impedance
- Intra pair matching < 0.7 mm (5 ps)
- Solid GND reference planes
- Trace lengths < (TBC) mm
- 4x trace width spacing for Tx lane to Rx Lane
- 4x the trace width separation to all adjacent signals

3.3.4 SGMII Routing Recommendations

SGMII signals must be routed with the following considerations/constraints:

- 90~100Ω differential trace impedance
- Intra pair matching < 0.7 mm (5 ps)
- Solid GND reference planes
- Trace lengths < (TBC) mm
- 4x trace width spacing for Tx lane to Rx Lane
- 4x the trace width separation to all adjacent signals

3.3.5 RGMII Routing Recommendations

RGMII signals must be routed with the following considerations/constraints:

- 50Ω single-ended trace impedance
- Length matching < 1.4mm
- Max trace Length < 152 mm
- Solid GND reference planes
- Interconnect loss < 0.85 dB @ 125 MHz
- 1.5x trace width spacing for Tx bus to Rx bus
- 3x the trace width separation to all adjacent signals

3.3.6 SDIO Routing Recommendations

SDIO signals are very high-speed signals and must be routed with the following considerations/constraints:

- 36~50Ω single-ended trace impedance
- CLK to DATA/CMD length matching < 2 mm
- Solid GND reference planes
- Total routing length < 50 mm recommended.
- Bus capacitance < 5 pF
- 1.5x trace width separation to all adjacent signals

3.3.7 High speed clocks

I2S_MCLK, TCXO_OUT1 and TCXO_OUT2 are high frequency clocks and must be routed with the following considerations/constraints:

- 50Ω single-ended trace impedance
- Solid GND reference planes
- Total routing length < (TBC) mm recommended.
- (TBC)x trace width separation to all adjacent signals

3.4 Power and Ground Recommendations

Power and ground routing are critical to achieving optimal performance of the RN93xx devices when integrated into an application.
Recommendations:

- Connections to GND from the RN93xx should be flooded plane using thermal reliefs to ensure reliable solder joints.
- VBATT is recommended to be routed as a wide and short trace(s) directly from the power supply to the LGA pad.

3.5 Interface Circuit Recommendations

The recommended interface implementation is to use a dual-supply bus transceiver with configurable voltage translation. This allows a host processor operating at a different voltage to communicate with the RN93xx using the appropriate voltage levels.
The figure below is a reference circuit for a digital input/output signal to/from the RN93xx device.

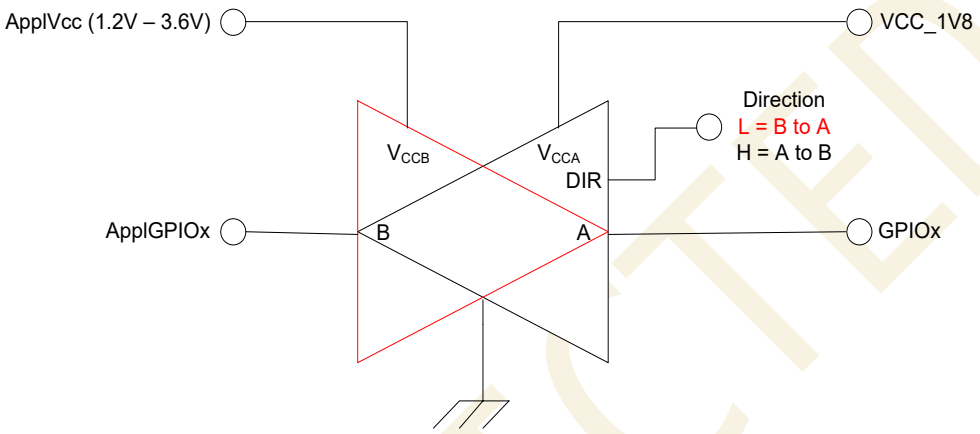


Figure 3-1 RN93xx Interface Reference Circuit

Refer to section 4.1 Pin-out Assignments to identify the appropriate reference voltage and direction of the specific signals.

Product Marketing Name：RN932A
FCC Certification Requirements.
According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.
And the following conditions must be met:

1.This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2.The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3.A label with the following statements must be attached to the host end product: This device contains FCC ID: 2AX2URN932A
4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

radiation, maximum antenna gain (including cable loss) must not exceed: Operating Band	FCC Max Antenna Gain (dBi)
WCDMA B2	8.00
WCDMA B4	8.00
WCDMA B5	9.42
LTE B2/2C	8.50
LTE B4	5.50
LTE B5/5B	9.91
LTE B7/7C	8.50
LTE B12	9.20
LTE B13	9.66
LTE B14	9.73
LTE B17	9.24
LTE B25	8.50
LTE B26(814-824)	9.86
LTE B26(824-849)	9.91
LTE B66/66B/66C	5.50
N2	8.50
N5	9.92
N66	5.50
N71	8.98
N77	3.00
N78	3.00

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5.This module must not transmit simultaneously with any other antenna or transmitter
6.The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.
For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093
If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
For this device, OEM integrators must be provided with labeling instructions of finished products.
Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:
A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).
For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains

Transmitter Module FCC ID: 2AX2URN932A" or "Contains FCC ID: 2AX2URN932A" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.
The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.
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 manufacturer could void the user's authority to operate the equipment.
To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.
Manual Information To the End User
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as show in this manual.

IC Statement

IRSS-GEN

"This device complies with Industry Canada's licence-exempt RSSs. 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." or "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; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."
Déclaration sur l'exposition aux rayonnements RF
L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.
The host product shall be properly labeled to identify the modules within the host product.
The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows:
"Contains IC: 26644-RN932A" or "where: 26644-RN932A is the module's certification number".

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte. L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:
"Contient IC: 26644-RN932A " ou "où: 26644-RN932A est le numéro de certification du module".