NM7371

Hardware Integration Guide

2400338 Rev 3

NETGEAR®

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the NETGEAR® modem are used in a normal manner with a well-constructed network, the NETGEAR modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. NETGEAR accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the NETGEAR modem, or for failure of the NETGEAR modem to transmit or receive such data.

Safety and Hazards

Do not operate the NETGEAR modem in areas where blasting is in progress, where explosive atmospheres may be present, near medical equipment, near life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the NETGEAR modem **MUST BE POWERED OFF.** The NETGEAR modem can transmit signals that could interfere with this equipment.

Do not operate the NETGEAR modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the NETGEAR modem **MUST BE POWERED OFF.** When operating, the NETGEAR modem can transmit signals that could interfere with various onboard systems.

The driver or operator of any vehicle should not operate the NETGEAR modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

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1: Introduction

The NETGEAR NM7371 PCI Express Mini Card is a compact, lightweight, wireless LTE- and CDMA-based modem used to enable rapid development and deployment of NETGEAR WWAN-enabled devices.

The NM7371 provides LTE, CDMA, and GNSS connectivity for NETGEAR Wireless WWAN-enabled Gateway & Router products.

This module is intended for internal NETGEAR use only and will not be offered for sale through OEM channels or sold through direct retail (end-user install) channels.

Required connectors

Table 1-1 describes the connectors used to integrate the NM7371 into your host device.

Table 1-1: Required host-module connectors[a]

Connector type	Description
RF cables	• Mate with Hirose U.FL connectors (model U.FL #CL331-0471-0-10) • Two connector jacks
EDGE (52-pin)	• Industry-standard mating connector • Some manufacturers include Tyco, Foxconn, Molex • Example: UDK board uses Molex 67910-0001
SIM	• Industry-standard connector. Type depends on how host device exposes the SIM socket • Example: UDK board uses ITT CCM03-3518

a. Manufacturers/part numbers are for reference only and are subject to change. Choose connectors that are appropriate for your own design.

2: Power

Power supply

The host provides power to the NM7371 through multiple power and ground pins. The host must provide safe and continuous power at all times; the module does not have an independent power supply, or protection circuits to guard against electrical issues.

For detailed pinout and voltage/current requirements of this module, see the NM7371 Product Technical Specification Document & Customer Design Guidelines.

Module power states

The module has four power states, as described in Table 2-1.

Table 2-1: Module power states

State	Details	Host is powered	Module is powered	USB interface active	RF enabled

Normal (Default state)	• Module is active
	• Default state when VCC is first applied
	• Module is capable of placing/receiving calls, or establishing data connections on the wireless network
	• Current consumption is affected by several factors, including:
	  • Radio band being used
	  • Transmit power
	  • Receive gain settings
	  • Data rate
	  • Number of active Tx time slots
		✔	✔	✔	✔

Low power ('Airplane mode')	• Module is active
	• Module enters this state:
	  • Under host interface control
	  • Automatically, when critical temperature or voltage trigger limits have been reached
		✔	✔	✔	✘

Table 2-1: Module power states (Continued)

State	Details	Host is powered	Module is powered	USB interface active	RF enabled
Sleep	• Normal state of module between calls or data connections • Module cycles between wake (polling the network) and sleep, at network provider-determined interval.	✔	✔	✘	✘
Disconnected	• Host power source is disconnected from the module and all voltages associated with the module are at 0 V.	✘	✘	✘	✘

3: RF Specifications

The NM7371 operates on the frequency bands listed below.

RF connections

When attaching antennas to the module:

- Use Hirose U.FL connectors (3 mm x 3 mm, low profile; model U.FL #CL331-0471-0-10) to attach antennas to the module's connection points.
- Match coaxial connections between the module and antenna to 50 Ω.
- Minimize RF cable losses to the antenna; the recommended maximum cable loss for antenna cabling is 0.5 dB.
- To ensure best thermal performance, if possible use the mounting holes to attach (ground) the device to the main PCB ground or a metal chassis.

Note: To disconnect the antenna, make sure you use the Hirose U.FL connector removal tool (P/N UFL-LP-N-2(01)) to prevent damage to the module or coaxial cable assembly.

Note: If the antenna connection is shorted or open, the modem will not sustain permanent damage.

Shielding

The module is fully shielded to protect against EMI and must not be removed.

Antenna

When selecting antennas for use with NM7371, refer to MPE requirements and limitations defined within the FCC application and available on the FCC website.

Choosing the correct antenna cabling

When matching antennas and cabling:

- The antenna (and associated circuitry) should have a nominal impedance of 50 Ω with a return loss of better than 10 dB across each frequency band of operation.

Determining the antenna's location

When deciding where to put the antennas:

- Antenna location may affect RF performance. Although the module is shielded to prevent interference in most applications, the placement

of the antenna is still very important — if the host device is insufficiently shielded, high levels of broadband or spurious noise can degrade the module's performance.

- Connecting cables between the module and the antenna must have 50 Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.
- Antenna cables should be routed, if possible, away from noise sources (switching power supplies, LCD assemblies, etc.). If the cables are near the noise sources, the noise may be coupled into the RF cable and into the antenna.

Ground connection

When connecting the module to system ground:

- Prevent noise leakage by establishing a very good ground connection to the module through the host connector.
- Connect to system ground using the two mounting holes at the top of the module.
- Minimize ground noise leakage into the RF.
  Depending on the host board design, noise could potentially be coupled to the module from the host board. This is mainly an issue for host designs that have signals traveling along the length of the module, or circuitry operating at both ends of the module interconnects.

Interference and sensitivity

Several interference sources can affect the module's RF performance (RF desense). Common sources include power supply noise and device-generated RF.

RF desense can be addressed through a combination of mitigation techniques (Methods to mitigate decreased Rx performance on page 13) and radiated sensitivity measurement.

Note: The NM7371 is based on ZIF (Zero Intermediate Frequency) technologies. When performing EMC (Electromagnetic Compatibility) tests, there are no IF (Intermediate Frequency) components from the module to consider.

Interference from other wireless devices

Wireless devices operating inside the host device can cause interference that affects the module.

To determine the most suitable locations for antennas on your host device, evaluate each wireless device's radio system, considering the following:

- Any harmonics, sub-harmonics, or cross-products of signals generated by wireless devices that fall in the module's Rx range may cause spurious response, resulting in decreased Rx performance.
- The Tx power and corresponding broadband noise of other wireless devices may overload or increase the noise floor of the module's receiver, resulting in Rx desense.

The severity of this interference depends on the closeness of the other antennas to the module's antenna. To determine suitable locations for each wireless device's antenna, thoroughly evaluate your host device's design.

Host-generated RF interference

All electronic computing devices generate RF interference that can negatively affect the receive sensitivity of the module.

Proximity of host electronics to the antenna in wireless devices can contribute to decreased Rx performance. Components that are most likely to cause this include:

- Microprocessor and memory
- Display panel and display drivers
- Switching-mode power supplies

Methods to mitigate decreased Rx performance

It is important to investigate sources of localized interference early in the design cycle. To reduce the effect of device-generated RF on Rx performance:

- Put the antenna as far as possible from sources of interference. The drawback is that the module may be less convenient to use.
- Shield the host device. The module itself is well shielded to avoid external interference. However, the antenna cannot be shielded for obvious reasons. In most instances, it is necessary to employ shielding on the components of the host device (such as the main processor and parallel bus) that have the highest RF emissions.
- Filter out unwanted high-order harmonic energy by using discrete filtering on low frequency lines.
- Form shielding layers around high-speed clock traces by using multi-layer PCBs.
- Route antenna cables away from noise sources.

Radiated Spurious Emissions (RSE)

When designing an antenna for use with NETGEAR embedded modules, the host device with a NETGEAR embedded module must satisfy the radiated spurious emissions (RSE) test cases described in 3GPP2 (CDMA) and 3GPP (LTE).

Note that antenna impedance affects radiated emissions, which must be compared against the conducted 50-ohm emissions baseline. (NETGEAR embedded modules meet the 50-ohm conducted emissions requirement.)

4: Regulatory Compliance and Industry Certfications

This module is designed to meet, and upon commercial release, will meet the requirements of the following regulatory bodies and regulations, where applicable:

- Federal Communications Commission (FCC) of the United States

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Safety and hazards

Do not operate your NM7371 modem:

- In areas where blasting is in progress
- Where explosive atmospheres may be present including refuelling points, fuel depots, and chemical plants
- Near medical equipment, life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the NM7371 modem **MUST BE POWERED OFF**. Otherwise, the NM7371 modem can transmit signals that could interfere with this equipment.

In an aircraft, the NM7371 modem **MUST BE POWERED OFF**. Otherwise, the NM7371 modem can transmit signals that could interfere with various onboard systems and may be dangerous to the operation of the aircraft or disrupt the cellular network.

Important compliance information for North American users

Note: Details are preliminary and subject to change.

The NM7371 modem has been granted modular approval for mobile applications. Integrators may use the NM7371 modem in their final products without additional FCC certification if they meet the following conditions. Otherwise, additional FCC approvals must be obtained.

IMPORTANT: The integrator must include the antenna–body separation distance (point 1) and RF exposure (point 2) information detailed below within the user's manual or operator instruction guide for the final product.

1. At least 20 cm separation distance between the antenna and the user's body must be maintained at all times.
2. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed:
   - 7.9 dBi in Cellular (BC0/BC10)
   - 8.0 dBi in PCS band (BC1)
   - 8.0 dBi in LTE Band 25
   - 7.9 dBi in LTE Band 26
   - 9.5 dBi in LTE Band 41
3. The NM7371 modem may transmit simultaneously with other collocated radio transmitters within a host device, provided the following conditions are met:
   - Each collocated radio transmitter has been certified by FCC for mobile application.
   - At least 20 cm separation distance between the antennas of the collocated transmitters and the user's body must be maintained at all times.
   - The output power and antenna gain must not exceed the limits and configurations stipulated in the following table.

Device	Technology	Band	Frequency (MHz)	Maximum conducted power (dBm)	Maximum antenna gain (dBi)
NM7371	LTE	25	1850–1915	24	8.0
		26	817–849	24	7.9
		41	2496–2690	23.5	9.5
	CDMA	BC0	824–849	25	7.9
		BC1	1850–1910	25	8.0
		BC10	817–824	25	7.9

Device	Technology	Band	Frequency (MHz)	Maximum conducted power (dBm)	Maximum antenna gain (dBi)
Collocated transmitters	WLAN		2400–2500	27	4.0
			5150–5850	27	4.0

4. A label must be affixed to the outside of the end product into which the NM7371 modem is incorporated, with a statement similar to the following:
   - **This device contains FCC ID: PY3NM7371**

The end product with an embedded NM7371 modem may also need to pass the FCC Part 15 unintentional emission testing requirements and be properly authorized per FCC Part 15.

Note: If this module is intended for use in a portable device, additional testing will be required to satisfy RF Exposure, including SAR requirements of FCC Part 2.1093.

A: Acronyms

Table A-1: Acronyms and definitions

Acronym or term	Definition
3GPP	3rd Generation Partnership Project
API	Application Programming Interface
BER	Bit Error Rate — A measure of receive sensitivity
BLER	Block Error Rate
CDMA	Code Division Multiple Access. A wideband spread spectrum technique used in digital cellular, personal communications services, and other wireless networks. Wide channels (1.25 MHz) are obtained through spread spectrum transmissions, thus allowing many active users to share the same channel. Each user is assigned a unique digital code, which differentiates the individual conversations on the same channel.
dB	Decibel = 10 x $\log_{10}$ (P1/P2) P1 is calculated power; P2 is reference power Decibel = 20 x $\log_{10}$ (V1/V2) V1 is calculated voltage, V2 is reference voltage
dBm	A logarithmic (base 10) measure of relative power (dB for decibels); relative to milliwatts (m). A dBm value will be 30 units (1000 times) larger (less negative) than a dBW value, because of the difference in scale (milliwatts vs. watts).
EDGE	Enhanced Data rates for GSM Evolution
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FCC	Federal Communications Commission The U.S. federal agency that is responsible for interstate and foreign communications. The FCC regulates commercial and private radio spectrum management, sets rates for communications services, determines standards for equipment, and controls broadcast licensing. Consult www.fcc.gov.
GLONASS	Global Navigation Satellite System — A Russian system that uses a series of 24 satellites in middle circular orbit to provide navigational data.
GNSS	Global Navigation Satellite Systems (GPS plus GLONASS)
GPS	Global Positioning System An American system that uses a series of 24 satellites in middle circular orbit to provide navigational data.
Host	The device into which an embedded module is integrated
Hz	Hertz = 1 cycle/second
LED	Light Emitting Diode. A semiconductor diode that emits visible or infrared light.
LTE	Long Term Evolution—a high-performance air interface for cellular mobile communication systems.

Table A-1: Acronyms and definitions (Continued)

Acronym or term	Definition
MHz	Megahertz = 10e6 Hz
MEID	Mobile Equipment Identifier — The unique second-generation serial number assigned to the minicard for use on the wireless network.
MIMO	Multiple Input Multiple Output—wireless antenna technology that uses multiple antennas at both transmitter and receiver side. This improves performance.
NAS / AS	Network Access Server
NC	No Connect
NIC	Network Interface Card
NMEA	National Marine Electronics Association
OEM	Original Equipment Manufacturer—a company that manufactures a product and sells it to a reseller.
OFDMA	Orthogonal Frequency Division Multiple Access
OMA DM	Open Mobile Alliance Device Management — A device management protocol.
OTA	'Over the air' (or radiated through the antenna)
PA	Power Amplifier
packet	A short, fixed-length block of data, including a header, that is transmitted as a unit in a communications network.
PCB	Printed Circuit Board
PCS	Personal Communication System A cellular communication infrastructure that uses the 1.9 GHz radio spectrum.
PDN	Packet Data Network
PMI	Pre-coding Matrix Index
PSS	Primary synchronisation signal
PST	Product Support Tools
PTCRB	PCS Type Certification Review Board
QAM	Quadrature Amplitude Modulation. This form of modulation uses amplitude, frequency, and phase to transfer data on the carrier wave.
QMI	Qualcomm MSM/Modem Interface
QOS	Quality of Service
QPSK	Quadrature Phase-Shift Keying
QPST	Qualcomm Product Support Tools
RAT	Radio Access Technology
RF	Radio Frequency

Table A-1: Acronyms and definitions (Continued)

Acronym or term	Definition
RI	Ring Indicator
roaming	A cellular subscriber is in an area where service is obtained from a cellular service provider that is not the subscriber's provider.
RSE	Radiated Spurious Emissions
RSSI	Received Signal Strength Indication
SDK	Software Development Kit
SED	Smart Error Detection
Sensitivity (Audio)	Measure of lowest power signal that the receiver can measure.
Sensitivity (RF)	Measure of lowest power signal at the receiver input that can provide a prescribed BER/BLER/SNR value at the receiver output.
SG	An LTE signaling interface for SMS ("SMS over SGs")
SIB	System Information Block
SIM	Subscriber Identity Module. Also referred to as USIM or UICC.
SIMO	Single Input Multiple Output—smart antenna technology that uses a single antenna at the transmitter side and multiple antennas at the receiver side. This improves performance and security.
SISO	Single Input Single Output—antenna technology that uses a single antenna at both the transmitter side and the receiver side.
SKU	Stock Keeping Unit—identifies an inventory item: a unique code, consisting of numbers or letters and numbers, assigned to a product by a retailer for purposes of identification and inventory control.
SMS	Short Message Service. A feature that allows users of a wireless device on a wireless network to receive or transmit short electronic alphanumeric messages (up to 160 characters, depending on the service provider).
S/N	Signal-to-noise (ratio)
SNR	Signal-to-Noise Ratio
SOF	Start of Frame — A USB function.
SSS	Secondary synchronisation signal.
SUPL	Secure User Plane Location
TIA/EIA	Telecommunications Industry Association / Electronics Industry Association. A standards setting trade organization, whose members provide communications and information technology products, systems, distribution services and professional services in the United States and around the world. Consult www.tiaonline.org.
TIS	Total Isotropic Sensitivity
TRP	Total Radiated Power
UDK	Universal Development Kit (for PCI Express Mini Cards)

Table A-1: Acronyms and definitions (Continued)

Acronym or term	Definition
UE	User Equipment
UICC	Universal Integrated Circuit Card (Also referred to as a SIM card.)
UL	Uplink (mobile to network) or Underwriters Laboratory
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module (UMTS)
VCC	Supply voltage
VSWR	Voltage Standing Wave Ratio
WAN	Wide Area Network
WCDMA	Wideband Code Division Multiple Access (also referred to as UMTS)
WLAN	Wireless Local Area Network
ZIF	Zero Intermediate Frequency

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