

Data Sheet / WW-4131

4G LTE Cat1 (for Docomo/Japan)

Wireless WAN Mini PCIe Card

With SIM Card Holder

and Support

Options of

UART TTL, RS232



RoHS
Compliant

Version 0.1

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Revision History

Ver.	Date	Description
0.1	Jul. 6 th , 2017	Initial setup

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1 Introduction

1.1 Overview

WW-4131 PCI Express Mini Card is designed with Gemalto / Cinterion 4G wireless WAN technologies. It supports up to **3 LTE bands** (4G). It is designed for Japan market with core engine Docomo-certified.

Industrial grade operating temperature makes it an ideal solution for industrial PC (IPC) applications. **Automatic shutdown** feature protects itself from working in an unexpected harmful environment – extreme voltage or temperature.

Following the PCI Express Mini Card standard, it could be easily applied in devices with PC architecture. Extended features facilitate more useful functions.

SIM card holder releases one from wiring external SIM holder. The usage becomes compact and easy. It also protects the SIM card from taking away easily.

Option of TTL UART/RS232 makes WW-4131 a powerful modem. It provides legacy industrial control benefits

Not only exhibits excellent hardware/radio frequency performance, it also supports rich software for fast product development. Various operating systems such as **Windows**, CE, Mobile, Pocket PC, **Linux**, **Andorid**, **MAC OS/X** are well supported.

1.2 Applications

The LTE Cat1 card provides sufficient data rate and reliable communication. Any application requires real time communication benefits from this card.

It is an ideal solution for the vast number of M2M and industrial IoT applications that are not dependent on speed but that requires the longevity of LTE networks.

Following is a few applications for your reference. There should be more and more applications in the future.

- Industrial PC / Notebook PC / Tablet PC

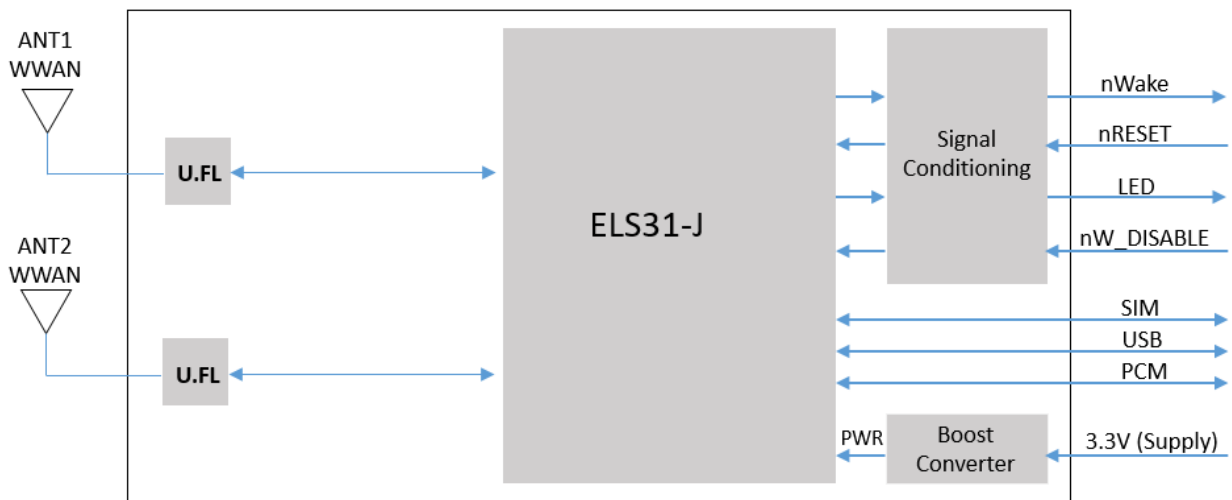
- Financial / Security / Payment / Inventory
- Kiosk / Digital Signage / Intelligent Vending Machine
- Point-of-Sale / Smart Grid / Automatic Meter Reading
- School Bus / Transit / Taxi / Fleet Management / Car Infotainment / Surveillance
- Mobile Internet Terminal / Fixed Wireless Terminal
- Remote Monitoring / Telematics / Tele-health

1.3 Main Features

- Industrial grade operating temperature
- PCI Express Mini Card standard V1.2 compliant
 - Communication via USB
 - Network status indication
 - Remote host wakeup support
- Powered by Gemalto / Cinterion ELS31-J engine
 - 4-band LTE Cat1 (Bands 1, 18, 19)
 - ◆ 2100, Japan lower, upper 800 (MHz)
- LTE Downlink 10.2 Mbps/Uplink 5.2Mbps, UE CAT1 supported
- Abnormal temperature protection (module board temperature out of -40~90°C)
- Rich driver/RIL support for various platforms
- Rich internet communication protocol support
 - TCP/IP stack access via AT commands
 - FTP, ICMP, DNS, TCP server & client, UDP client etc.
 - HTTP, SMTP, POP3, Transparent mode
- Micro-SIM card holder
- Customer's IMEI on request
- Certificates of ELS31-J

- Japan JATE
- Japan TELEC
- Japan NTT Docomo
- Least adoption efforts

1.4 Block Diagram



As shown above, a WW-4131 card is equipped with a Gemalto ELS31-J module.

1.5 Wireless WAN Characteristics

Core Engine	Gemalto/Cinterion ELS31-J module
Frequency bands	LTE (Bands 1, 18, 19) 2100, Japan lower 800, Japan upper 800 MHz
Output power	<ul style="list-style-type: none"> ● Class 3 (+23dBm +/-2dB) for LTE 2100, LTE Bd1 ● Class 3 (+23dBm +/-2dB) for LTE 800, LTE FDD Bd18 ● Class 3 (+23dBm +/-2dB) for LTE 850, LTE FDD Bd19
LTE Features	UE CAT 1 supported
3GPP Release 9	Down Link 10.2Mbps, Up Link 5.2Mbps
SMS	Point-to-point MT and MO Text mode Storage in mobile equipment
AT commands	Hayes 3GPP TS 27.007, TS 27.005, product specific

SIM Application Toolkit	SAT Release 99.
UICC Interface	Support of 3V and 1.8V SIM/USIM cards
USB	USB 2.0 High Speed (480Mbit/s) device interface. Full Speed (12Mbit/s) compliant

1.6 USB Driver Support

USB driver for following Windows platforms are available.

- Windows 7
- Windows 8
- Windows 10

The installation wizard will install USB drivers so that one can start to use the card immediately after the installation.

1.7 Windows Support

USB, MUX driver for Microsoft®

- Windows 7
- Windows 8
- Windows 10

1.8 Linux Support

Compatible with standard USB kernel drivers. The USB interface enumerates as multi-channel device comprising CDC ACM devices and CDC ECM devices.

1.9 Mac OS/X support

Mac OS/X runs a FreeBSD kernel inside, which is similar to Linux open source kernel.

1.10 Radio Interface Layer (RIL) Support

RIL software support for Android and Embedded Windows is available free of charge. Please note that the support list keeps updating. Please let us know if your platform is not listed below.

- RIL Driver for Android versions KitKat(V4.x), Lollipop (V5.x), and Marshmallow

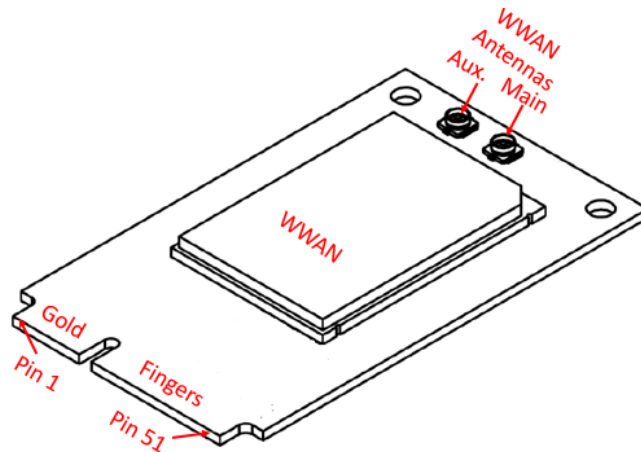
(V6.x)

- RIL, USB driver for Microsoft® Windows Embedded Handheld™ >= 6.x

2 Digital Interface - Pin Functions

2.1 Pin Overview

1	nWAKE	VCC	2
3	TXD	GND	4
5	RXD	NC	6
7	NC	SIM_VCC	8
9	GND	SIM_DATA	10
11	NC	SIM_CLK	12
13	NC	SIM_RESET	14
15	GND	NC	16
17	RTS	GND	18
19	CTS	NC	20
21	GND	NC	22
23	NC	VCC	24
25	NC	GND	26
27	GND	NC	28
29	GND	NC	30
31	NC	NC	32
33	NC	GND	34
35	GND	USB_DM	36
37	GND	USB_DP	38
39	VCC	GND	40
41	VCC	LED	42
43	GND	NC	44
45	NC	NC	46
47	NC	NC	48
49	NC	GND	50
51	NC	VCC	52



2.2 Pin Assignment

WW-4131 connects to Mini PCI Express slot via gold finger contact. There are totally 52 signals (pins) summarized as shown below:

Name	PINs	Function	I/O
VCC	2,24,39,41,52	3.3V power supply, Min 3.0V, Max 3.6V	Input
GND	4,9,15,18,21,26,27,29,34,35,37,40,43,50	Ground	Input
USB_DM	36	USB data signal minus	I/O
USB_DP	38	USB data signal plus	I/O
LED	42	Card operating status indicator Open Drain active Low	Output
SIM_VCC	8 [!]	Power for SIM card; 1.8V and 3V supported	Output
SIM_DATA	10 [!]	SIM data signal	I/O
SIM_CLK	12 [!]	SIM clock signal	Output
SIM_RESET	14 [!]	SIM reset signal	Output
nWAKE	1 [∨]	Wakeup signal, open drain, active low	Output
TXD^{#&}	3	UART/RS232 data into card	Input
RXD^{#&}	5	UART/RS232 data out of card	Output
RTS^{#&}	17	UART/RS232 request to send	Input
CTS^{#&}	19	UART/RS232 clear to send	Output
NC	Remaining pins	No connection	-

[!] Leave these pins open if they were not used.

[∨] No connect (NC) for some model, please see section 8 Ordering Information for the detailed data.

[#] Reserved pins used, proprietary

[&] Optional, default is NC

2.3 Power Supply (VCC)

Stable DC power supply to the card is required.

During operation, the current drawn from VCC can vary by some order of magnitude, especially due to a surging consumption profile with unmatched antenna.

It is important that the system power supply circuit is able to support the peak power demand. Otherwise, unexpected anomalies may happen. E.g. the established COM (/dev/tty/ACM*) port may disappear etc.

According to PCI Express Mini Card standard, the peak current is 2,750 mA, the

normal current is 1,100mA.

2.4 Universal Serial Bus (USB_DM, USB_DP)

WW-4131 includes a USB 2.0 High Speed (480Mbit/s) interface. The USB interface is primarily intended for use as command and data interface and for downloading firmware. It is the main interface for transferring high speed data between a WW-4131 card and a host processor.

By default, WW-4131 enumerates, i.e., registers with the USB host, as a USB device supporting two separate functions/ports. Following is the Default Composite Communication enumeration.

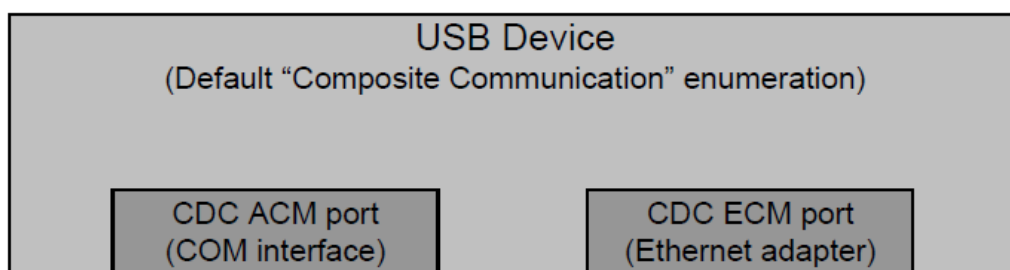


Figure 1: Default USB interface enumeration

2.4.1 Windows USB Interface


Under **Microsoft® Windows 7**, the default USB device implements a CDC ACM port (a virtual USB COM port), as well as a CDC ECM port (wireless Ethernet adapter).

Each interface is controlled by a separate device driver running on the Windows host. These drivers can be the standard USB drivers integrated in Windows. The driver configuration files for Windows (.inf files) are supplied by Gemalto M2M and need to be installed before the USB interface device can be used.

- Gemalto CDC/ACM USB COM Port: Control & Data
 - Serves as a USB COM port intended for command and data connections.
- GTOusbVDevice: Control & Data
 - Serves as a wireless Ethernet adapter intended for data connections.

Example of Device Manager

COM & LPT

 Gemalto CDC/ACM USB COM Port (COM4)

Network Interface Card

GTOusbV Device

A user can concurrently use the AT command interface on one port and Packet-Switched / Circuit-Switched Data communication on another port.

2.4.2 Linux USB Interface

Some **Linux systems** - e.g., Ubuntu 10.04 LTS - will automatically detect and enumerate the USB device:

If WW-4131 is powered on, the following port will be created based on the “cdc_acm” USB host driver available by default for the Ubuntu Linux system:

`/dev/ttyACM0 --> CDC ACM port`

In addition, if the USB host drivers “usbnet” and “cdc-ether” are installed in the Linux system, an Ethernet port (“USB0”) will be created and a default IP address in the range 192.168.15.1/255 will be assigned to the interface. Information about the Ethernet port can be displayed using the command `ifconfig`, and the port can be found under:

`/dev/bus/usb/devices/usb0 --> CDC ECM port`

Please note that with every module **re-start** the USB port will be **re-enumerated**.

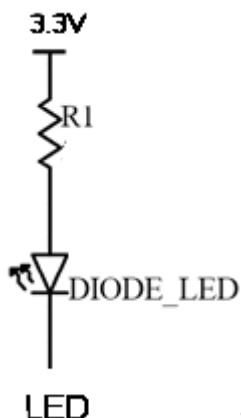
With other Linux systems the USB device (i.e. WW-4131) may not automatically be detected and enumerated. For these systems possible USB host drivers like “cdc_acm”, “usbnet” and “cdc_ether” compiled as loadable module may have to be loaded to create the ports. Please note that the command to load such a driver module may vary for different Linux distributions.

Please also note that each USB bus has different numbers and different devices generated, so the port numbers depend on the number of USB hosts, ports on PC main board, or the external USB hub.

2.5 Network Status Indication (LED)

LED

Please connect the LED pin to the negative side of an LED as shown below. R1 is a current limit resistor.



2.6 (U)SIM interface (SIM_VCC, SIM_DATA, SIM_CLK, SIM_RESET)

3GPP 31.102 and ETSI 102 221 compatible UICC/SIM/USIM interface is provided on the gold finger pins. Option of an on-board SIM card holder is provided. The high-speed SIM/ME interface is implemented as well as automatic detection of the required SIM supporting voltage.

Both 1.8 V and 3 V SIM types are supported (1.8 V and 3 V ME). Activation and deactivation with automatic voltage switch from 1.8 V to 3 V is implemented, according to ISO-IEC 7816-3 specifications. The SIM driver supports the PPS (Protocol and Parameter Selection) procedure for baud-rate selection, according to the values proposed by the SIM Card.

The total cable length between the ELS31-J module pads (soldered on the WW-4131 miniPCle card) and the pads of an external SIM card holder must not exceed 100mm in order to meet the specifications of 3GPP TS 51.010-1 and to satisfy the requirements of EMC compliance.

To avoid possible cross-talk from the SIM_CLK signal to the SIM_DATA signal, be careful that both lines are not placed closely next to each other. A useful approach is using a GND line to shield the SIM_CLK line from the SIM_DATA line.

If on-card SIM card holder option is available, external SIM card holder is unnecessary.

- ☞ Simultaneous operation of an external and the onboard SIM/UICC is not possible. Only one SIM/UICC card must be connected to the ELS31-J module.
- ☞ No guarantee can be given, nor any liability accepted, if loss of data is encountered after removing the SIM card during operation. Also, no guarantee can be given for properly initializing any SIM card that the user inserts after having removed the SIM card during operation. In this case, the miniPCle must

be restarted.

2.7 Remote Host Wakeup (nWAKE)

While a USB connection is active, the card will never switch into SLEEP mode. Only if the USB interface is in Suspended state, the module is able to switch into SLEEP mode thereby saving power. There are two possibilities to enable power reduction mechanisms:

Recommended implementation of USB Suspend/Resume/Remote Wakeup

The USB host should be able to bring its USB interface into the Suspended state as described in the “Universal Serial Bus Specification Revision 2.0”. On incoming calls and other events WW-4131 will then generate a Remote Wakeup request to resume the USB host controller.

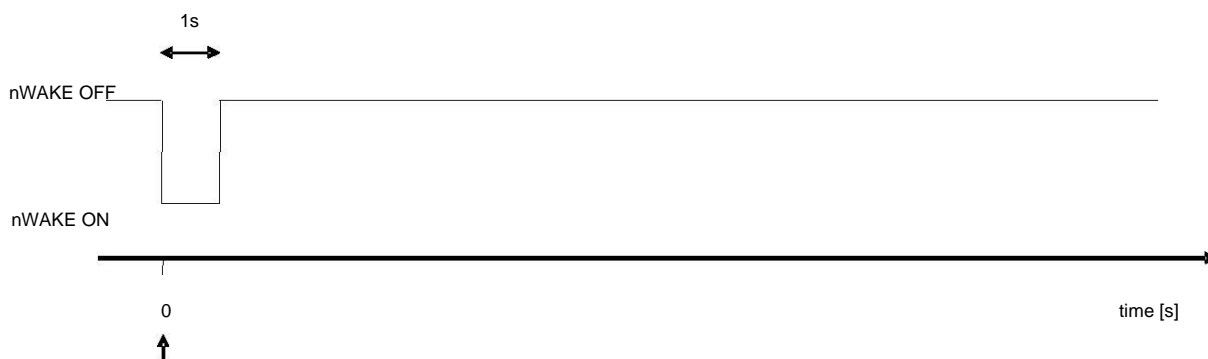
See also “USB Specification Revision 2.0”, Section 10.2.7, p.282.

"If USB System wishes to place the bus in the Suspended state, it commands the Host Controller to stop all bus traffic, including SOFs. This causes all USB devices to enter the Suspended state. In this state, the USB System may enable the Host Controller to respond to bus wakeup events. This allows the Host Controller to respond to bus wakeup signaling to restart the host system."

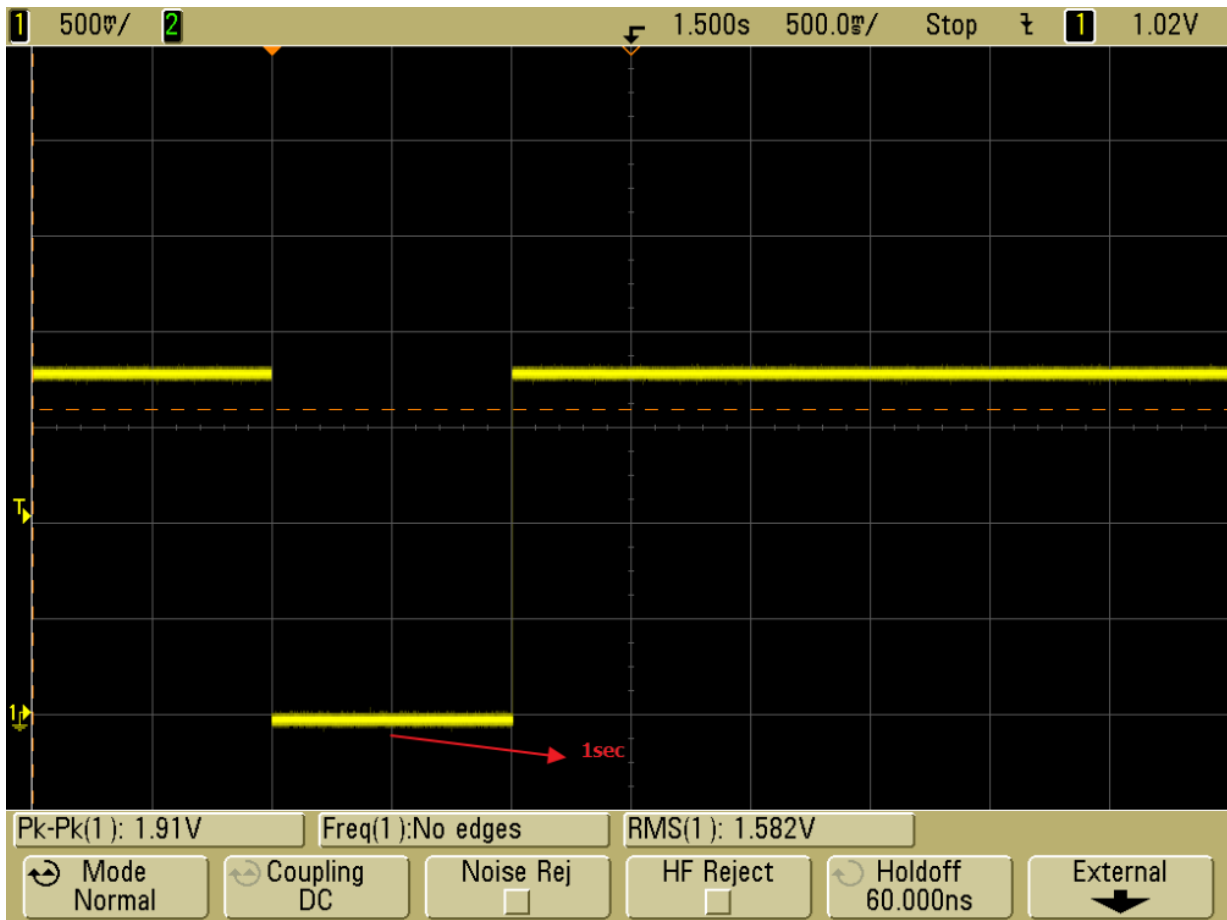
Implementation for legacy USB applications not supporting USB Suspend/Resume

As an alternative to the regular USB suspend and resume mechanism it is possible to employ the nWake (RING) line to wake up the host application in case of incoming SMS or events signaled by URCs while the USB interface is in detached state. Every wakeup event will force a new USB enumeration. Therefore, the external application has to carefully consider the enumeration timings to avoid losing any signaled events.

The wakeup signal is connected to an internal ring (RI) pin. That is to say, an incoming SMS message will bring this nWAKE pin up and down as shown below.



SMS arrives

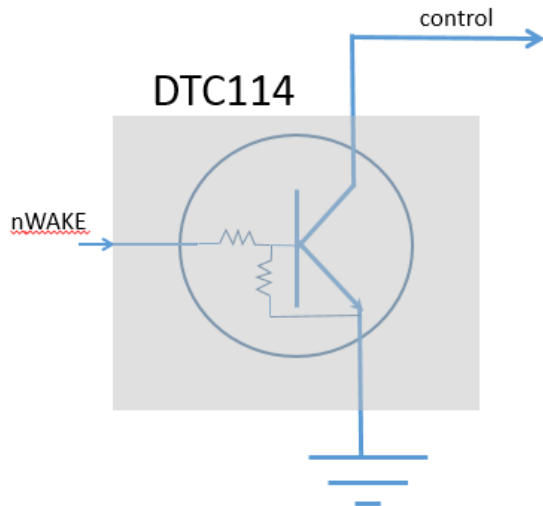


Please note that the SMS ring line function may not be supported by earlier samples. [At the moment of preparing this document \(V0.1\), this function is ready.](#)

Please also note that for SMS, the ring signal comes only when there is no unread SMS messages in the queue. That is to say, there would be no ring signal if there is any unread SMS messages.

- To make sure the ring signal always comes, it is the user's sole obligation to read any incoming SMS messages.
- ☞ Please note that this pin is not connected (NC) for some sub-models. Please see section 8 Ordering Information for the details.

The suggested pin connection is shown below.



2.8 UART TTL/RS232 Interface

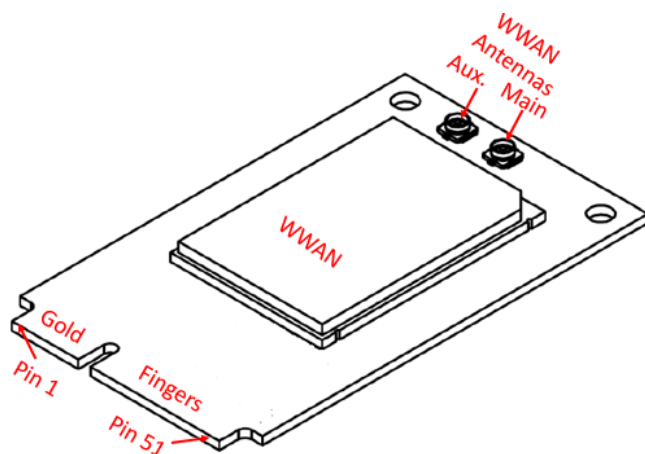
In addition to standard USB interface, WW-4131 optionally supports UART TTL or RS232 interfaces for such kind of applications. For this application, WW-4131 becomes a powerful modem under your command.

Totally 4 pins are supported – TX, RX, CTS, RTS. Please note that UART/RS232 is not a standard interface of mini PCIe. These 4 pins are proprietary. Please refer to the spec for correct connection.

3 RF Interface

3.1 Antenna Connectors

WW-4131 includes **two** RF connectors for host-supplied antennas.



As shown above, there are two antenna connectors for this card.

- The primary (main) antenna interface is used for Tx/Rx.
- The secondary (auxiliary) antenna interface is used for Rx diversity antenna.
 - The integrated diversity receiver provides improved wireless link quality and reliability on all 4G operating bands.
 - ◆ Two antennas may experience different interference effects (signal delay, distortion etc.). When one antenna receives a degraded signal, another one may not be similarly affected.
 - ◆ The antenna for the Rx diversity connected to the secondary antenna connector should be carefully separated from the main Tx/Rx antenna connected to the primary antenna connector: the distance between the two antennas should be at least greater than half a wavelength of the lowest used frequency (i.e. distance greater than ~20 cm, for 4G low bands) to distinguish between different multipath channels, for proper spatial diversity implementation.
- The **WWAN** connectors are basically for cellular communications.
 - The RF interface has an impedance of 50ohm. WW-4131 is capable of sustaining a total mismatch at the antenna lines without any damage, even when transmitting at maximum RF power.
 - The external antenna must be matched properly to achieve best performance regarding radiated power, modulation accuracy and harmonic suppression.

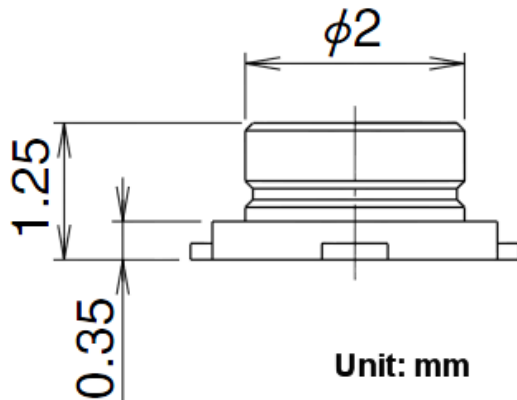
Antenna matching networks should be placed in the host application if the antenna does not have an impedance of 50ohm.

- The return loss of active bands

State of module	Return loss of module	Recommended return loss of application
Receive	≥ 8dB	≥ 12dB
Transmit	not applicable	≥ 12dB

3.2 RF Connector Data

RF Connector: I-PEX MHF1 Receptacle



Note. Corresponding plug cable: diameter of 1.13mm

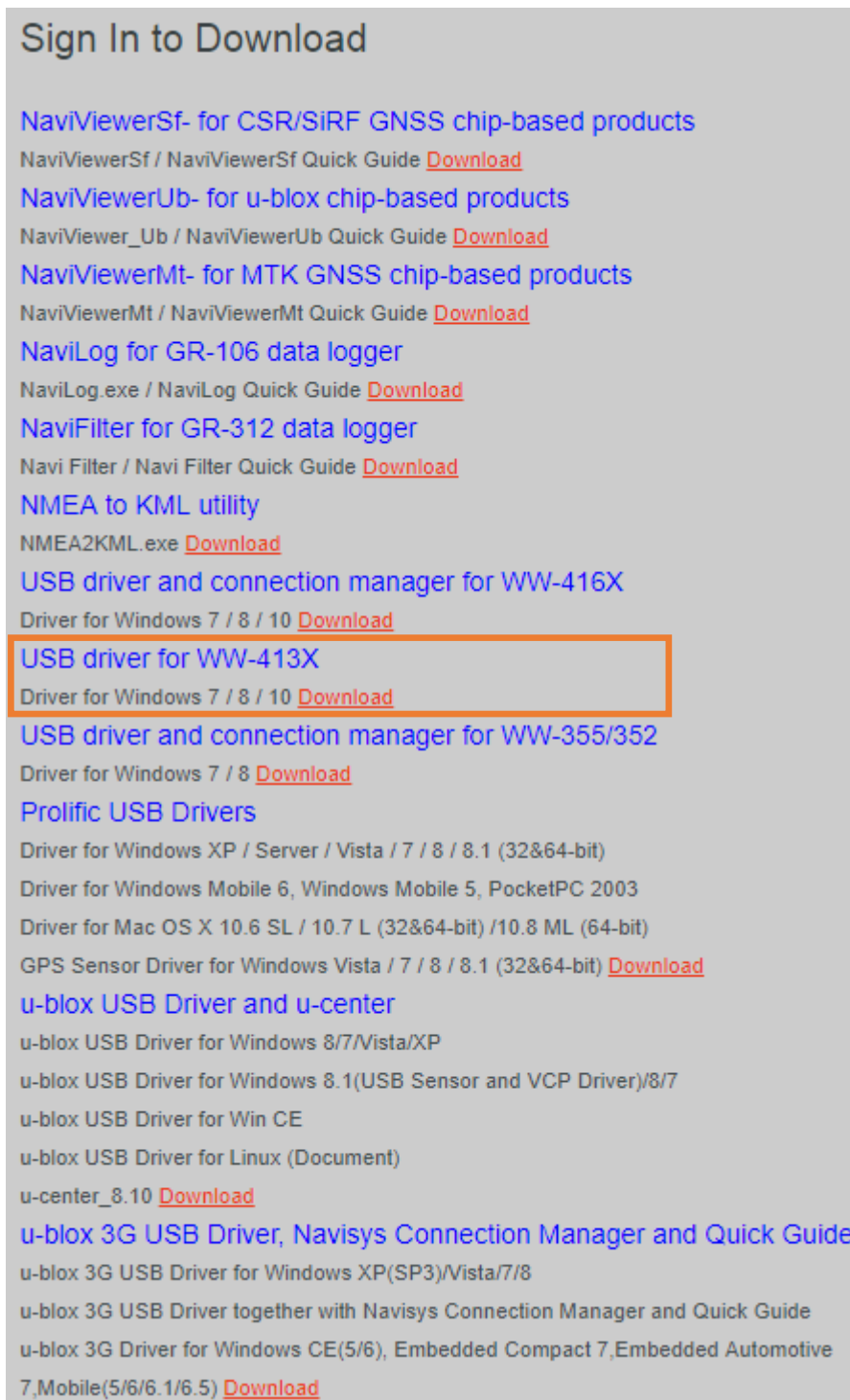
- Connecting cables between the module and the antenna must have 50 Ω impedance. If the impedance of the module is mismatched, RF performance is reduced significantly.

4 USB Driver

The Windows-based USB Driver is available on Navisys official web site.

Download USB Driver

Visit <http://www.navisys.com.tw/support.html> to download directly.



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- [USB driver and connection manager for WW-416X](#)
Driver for Windows 7 / 8 / 10 [Download](#)
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Driver for Windows 7 / 8 / 10 [Download](#)
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Driver for Windows XP / Server / Vista / 7 / 8 / 8.1 (32&64-bit)
Driver for Windows Mobile 6, Windows Mobile 5, PocketPC 2003
Driver for Mac OS X 10.6 SL / 10.7 L (32&64-bit) /10.8 ML (64-bit)
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[NaviViewerUb](#)- for u-blox chip-based products

[NaviViewerMt / NaviViewerMt Quick Guide](#) - for MTK GNSS chip-based products

[NaviLog.exe / NaviLog Quick Guide](#) - for GR-106 data logger

[Navi Filter / Navi Filter Quick Guide](#) - for GR-312 data logger

[NMEA](#) to KML utility

[USB driver and connection manager](#) - for WW-416X

[USB driver](#) - for WW-413X

[USB driver and connection manager](#) - for WW-355/352

Prolific USB Drivers

[Win XP / Server / Vista / 7 / 8 / 8.1\(32& 64-bit\)](#)

[WinCE 4.2-5.2 Driver for x86 Standard SDK](#)

[WinCE 4.2-5.2 Driver for ARM/xScale Processor Standard SDK](#)

[Mac OS X 10.6 SL / 10.7 L \(32&64-bit\) /10.8 ML \(64-bit\)](#)

[GPS Sensor Driver for Windows Vista / 7 / 8 / 8.1 \(32&64-bit\)](#)

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[u-center_8.10](#)

u-blox 3G USB Driver, Navisys Connection Manager and Quick Guide

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[u-blox 3G USB Driver together with Navisys Connection Manager and Quick Guide](#)

[u-blox 3G Driver for Windows CE\(5/6\), Embedded Compact 7, Embedded Automotive 7, Mobile\(5/6/6.1/6.5\)](#)

5 Power Consumption

Current consumption ratings¹.

Item	Description	Conditions	Typ	Unit	
I _{vcc} ²	Airplane mode ³		2.6	mA	
	LTE Idle	RRC Paging cycle @ 2.56 s	4.3	mA	
		RRC Paging cycle @ 1.28 s	5.8	mA	
	LTE Data	LTE cDRX mode No traffic	cDRX period 320ms	65.8	mA
		LTE FDD Cat1 DL/ UL 10Mbps/5Mbps	B18/19 10MHz 23dBm	737	mA
			B1 20MHz 23dBm	853	mA
			B18/19 10MHz, 0dBm	422	mA
		Cell search	10.6	mA	

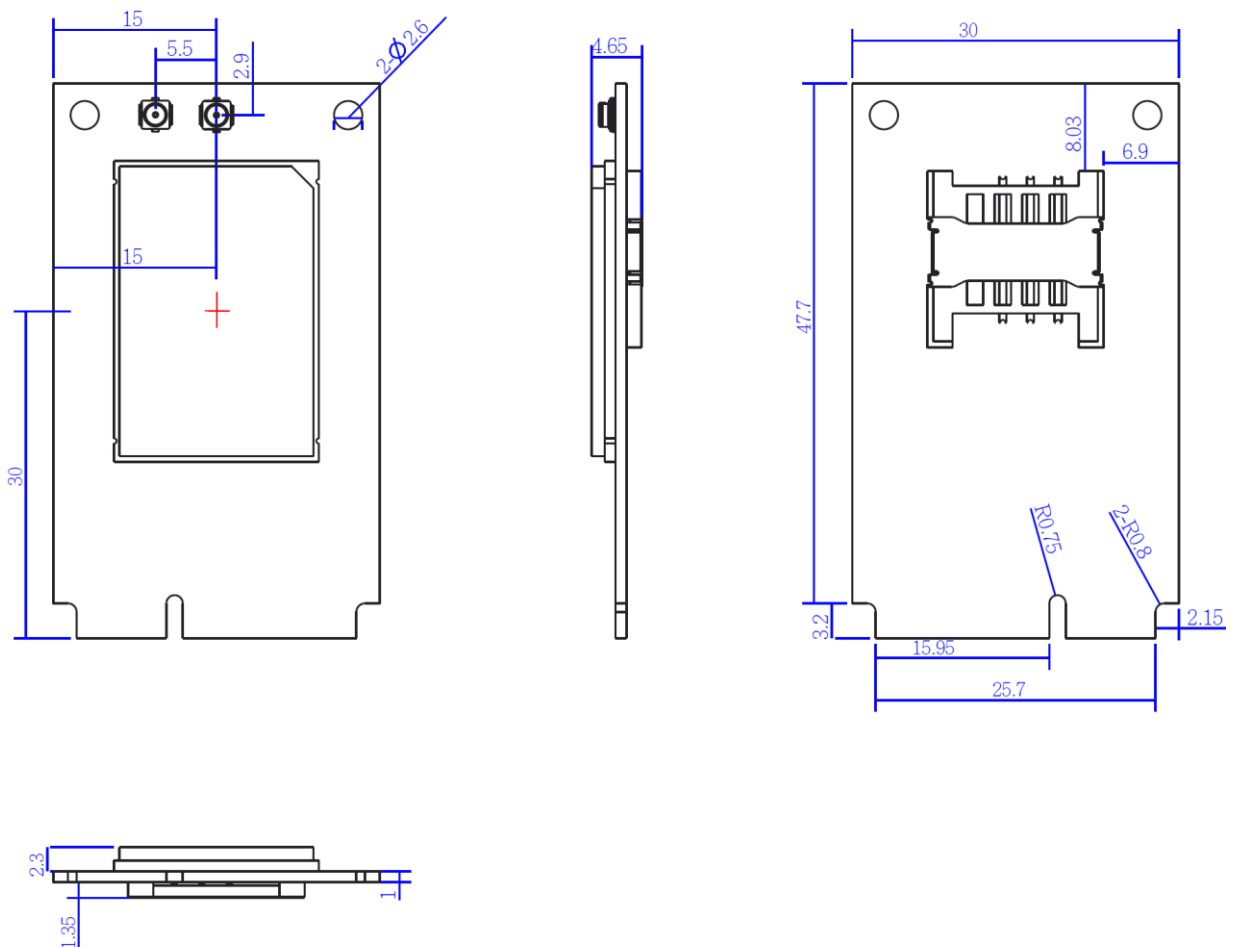
1. According to module Spec; average power efficiency of boost converter at 95%; subject to change
2. With an impedance of Z_{LOAD}=50Ω at the antenna connector measured at 25°C.
3. Entered by command AT+CFUN=4, for the detailed information, please refer to AT command set.

6 Mechanical & Environmental Data

6.1 Dimension

30 x 50.9 x 4.65 (w/ SIM holder)

- Mechanical drawing – Unit: mm, Tolerance: ± 0.25 mm



6.2 Operating Temperature

ELS31-J board temperature of WWAN	<p>-40 ~ 85°C^{++&}</p> <p>-30 ~ 85°C^{&} (fully functional)</p> <p>-40 ~ 30°C^{*&} (extended)</p> <p>85 ~ 95°C^{*&} (extended)</p>
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* Extended operation allows normal mode speech calls or data transmission for limited

time until automatic thermal shutdown takes effect. Within the extended temperature range (outside the normal operating temperature range) the specified electrical characteristics may be in- or decreased.

& Because of temperature measurement uncertainty, a tolerance of $\pm 3^{\circ}\text{C}$ on the thresholds may occur.

+ Airflow: min. 1 m/s

Thermal protection including automatic shutdown is implemented for protection against extreme temperature (if ELS31-J board temperature is beyond $-40^{\circ}\text{C} \sim 90^{\circ}\text{C}$).

The final operating temperature depends on the physical environment. Parameters like antenna performance, cellular signal quality, loading, heat dissipation etc. all affect the physical operating temperature.

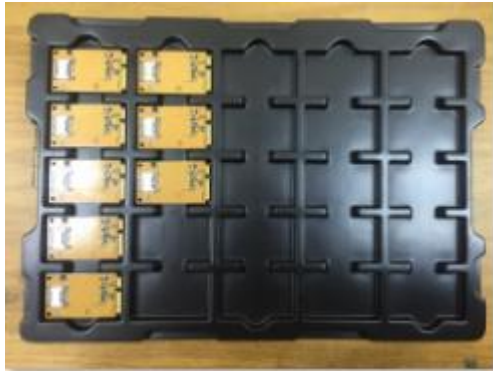
6.3 ESD Sensitive

WW-4131 cards contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling WW-4131 cards without proper ESD protection may destroy or damage them permanently.

- WW-4131 cards are Electrostatic Sensitive Devices (ESD) and require special ESD precautions typically applied to ESD sensitive components.
- Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates WW-4131 cards.
- ESD precautions should be implemented on the application board where the module is mounted.

7 Package

- 25 pcs per tray



- 8 trays + 1 empty cover tray per box; or 200 pcs per box



- Box dimension: 34.5 x 25.5 x 13 (cm)



8 Ordering Information

Each product has a default configuration. Customer is highly advised to check the product configuration before ordering.

WW-4131X

where X = Q, S, V, W as shown below

Feature \ Model	Q	S	V	W
USB	Y	Y	Y	Y
TTL/RS232	TTL	RS232	-	-
Pin 1 (nWAKE)	Y	Y	Y	NC

E.g. WW-4131V: with USB, without UART/RS232, Pin 1 of wakeup is connected

WW-4131V is selected as the default standard product.

Appendix

Related Documents

- [1] 3GPP TS 27.007 V3.13.0 - AT command set for User Equipment (UE) (Release 1999)
- [2] 3GPP TS 27.005 V3.2.0 (2002-06) - Use of Data Terminal Equipment - Data Circuit terminating; Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS) (Release 1999)
- [3] 3GPP TS 27.010 V3.4.0 - Terminal Equipment to User Equipment (TE-UE) multiplexer protocol (Release 1999)
- [4] Universal Serial Bus Specification Revision 2.0, April 27, 2000
- [5] USB Class Definitions for Communication Devices Version 1.1 January 19, 1999
- [6] PCI Express® Mini Card Electromechanical Specification, Revision 2.0, April 21, 2012

Glossary

3GPP	3rd Generation Partnership Project
ACM	Abstract Control Model
ADC	Analog-to-digital converter
AGC	Automatic Gain Control
ANSI	American National Standards Institute
ARFCN	Absolute Radio Frequency Channel Number
ARP	Antenna Reference Point
BER	Bit Error Rate
BIP	Bearer Independent Protocol
BTS	Base Transceiver Station
CBM	Cell Broadcast Message
CDC	Communication Device Class
CE	Conformité Européene (European Conformity)
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
CTM	Cellular Text Telephone Modem
CTS	Clear to Send
DAC	Digital-to-Analog Converter
dBm0	Digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment

DL	Down-link (Reception)
DRX	Discontinuous Reception
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
ECM	Ethernet Control Model
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EIRP	Equivalent Isotropic Radiated Power
EMC	Electromagnetic Compatibility
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FCC	Federal Communications Commission (U.S.)
FDMA	Frequency Division Multiple Access
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GND	Ground
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HiZ	Hi Impedance
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
I2S	Inter-IC Sound Interface
I/O	Input / Output
IC	Integrated Circuit
IEC	International Electrotechnical Commission
IMEI	International Mobile Equipment Identity
ISO	International Standards Organization
ITU	International Telecommunications Union
Kbps	Kilo-bits per second
LED	Light Emitting Diode
LPM	Link Power Management
LTE	Long Term Evolution
Mbps	Mega-bits per second
MMI	Man Machine Interface
MCS	Modulation and Coding Scheme

MNO	Mobile Network Operator
MO	Mobile Originated
MS	Mobile Station (module/mini-PCIe card), also referred to as TE
MSISDN	Mobile Station International ISDN number
MT	Mobile Terminated
NCM	Network Control Model
NMEA	National Marine Electronics Association
NTC	Negative Temperature Coefficient
OEM	Original Equipment Manufacturer
PA	Power Amplifier
PAP	Password Authentication Protocol
PBCCH	Packet Switched Broadcast Control Channel
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect (personal computer bus)
PCL	Power Control Level
PCM	Pulse Code Modulation
PCN	Personal Communications Network, also referred to as DCS 1800
PCS	Personal Communication System, also referred to as GSM 1900
PDU	Protocol Data Unit
PPP	Point-to-point protocol
PSK	Phase Shift Keying
PWM	Pulse Width Modulation
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio Frequency
RLS	Radio Link Stability
RoHS	Restriction of the use of certain hazardous substances in electrical and electronic equipment.
RMC	Reference Measurement Channel
RTS	Request to Send
Rx	Receive Direction
SAR	Specific Absorption Rate
SAW	Surface Acoustic Wave
SIM	Subscriber Identity Module
SMS	Short Message Service
SRAM	Static Random Access Memory
TA	Terminal adapter (e.g. module)
TDMA	Time Division Multiple Access
TE	Terminal Equipment, also referred to as DTE
TLS	Transport Layer Security
Tx	Transmit Direction

UART	Universal asynchronous receiver-transmitter
URC	Unsolicited Result Code
UL	Up-link (Transmission)
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
USB	Universal Serial Bus
USSD	Unstructured Supplementary Service Data
VCOM	Virtual Communication port
WSWR	Voltage Standing Wave Ratio
WWAN	Wireless Wide Area Network