Skywire® 4G LTE Cat 3 Embedded Cellular Modem Datasheet

NimbeLink Corp

Updated: April 2018

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1. Introduction

1.1 Orderable Part Numbers

Orderable Device	Firmware Revision	Operating Temperature	LTE Bands	Fallback?	Network Type
NL-SW-LTE-TSVG	17.01.571	-40 to +85˚C	B4, B13	No	Verizon
NL-SW-LTE-TSVG-B	17.01.573	-40 to +85˚C	B4, B13	No	Verizon
NL-SW-LTE-TEUG	17.00.523	-40 to +85˚C	B3, B7, B20	HSPA: B1, B5, B8	Europe
NL-SW-LTE-TNAG	17.00.503	-40 to +85˚C	B2, B5, B4, B17	HSPA: B2, B5	AT&T/T-Mobile
NL-SW-LTE-TNAG-B	17.01.502	-40 to +85˚C	B2, B5, B4, B17	HSPA: B2, B5	AT&T/T-Mobile
NL-SIM-COM		-35˚C to +85˚C			Verizon
NL-SIM-IND		-40˚C to +105˚C			Verizon
NL-SIM-ATT		-25˚C to +85˚C			AT&T
NL-SIM-TMO		-25˚C to +85˚C			T-Mobile
NL-SIM-VOD		-25˚C to +85˚C			Vodafone

1.2 Additional Resources

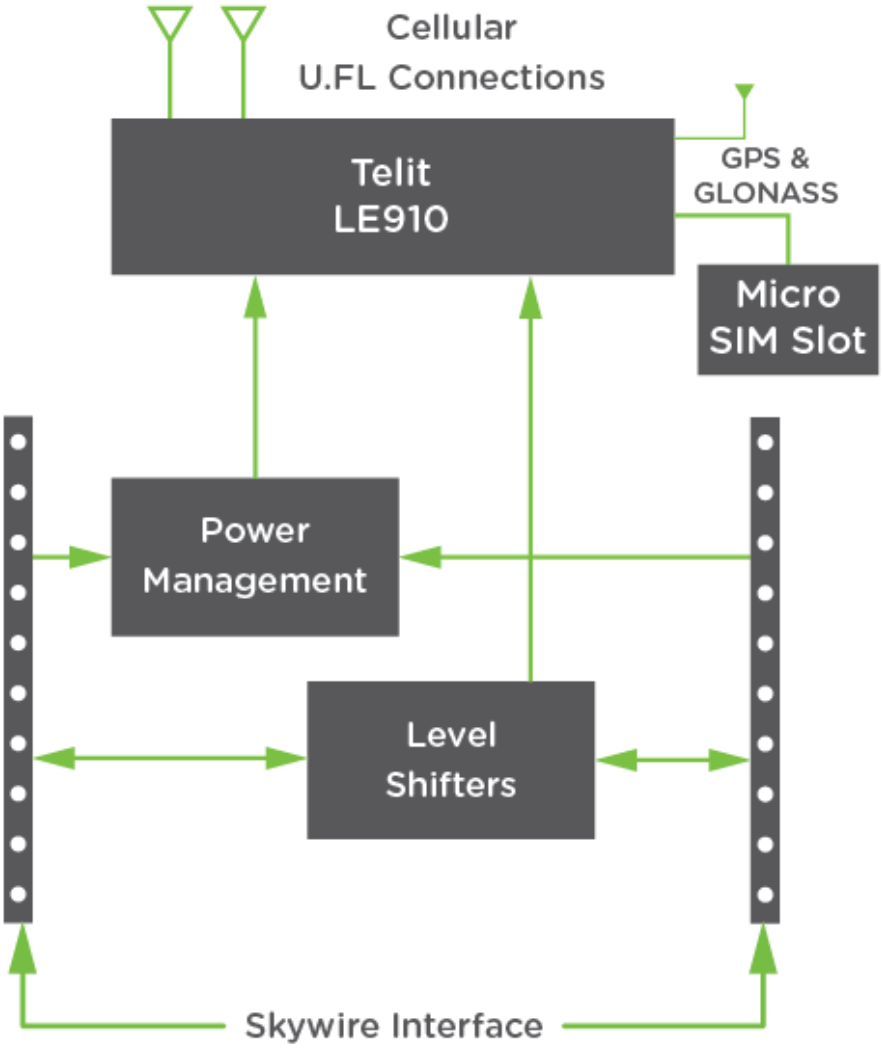
The following documents or documentation resources are referenced within this document.

- Telit's LE910 Hardware User Guide

1.3 Product Overview

Add robust cellular connectivity to your M2M devices with scalable radio technology with Nimbelink's 4G LTE Cat 3 Skywire® cellular modem family. Nimbelink's extensive experience in designing and building embedded solutions has made the NimbeLink Skywire embedded cellular modem family the smallest on the market while allowing for easy integration of cellular connectivity into new and existing products. Skywire modems end-device certification eliminates the considerable cost, time and risk of the certification process, driving your products to market faster. The Skywire's small footprint and standard 20 pin interface simplies migration to other cellular technologies, ensuring long product life while allowing for easy product integration. The modem is designed for volume production and is intended for OEMs to embed into end equipment designs.

1.4 Block Diagram



2. Technical Specifications

2.1 Electrical Specifications

2.1.1 Absolute Maximum Ratings

Parameter	Signal	Maximum Rating
Main Power Supply	VCC	4.3V
I/O Voltage Reference	VREF	5.5V

2.1.2 Recommended Ratings & Module Pin out

2.1.2.1 Connectors J1 and J2

Pin	Name	Direction	Description	Min	Typical	Max	If not used
1	VCC	Input	Main Power supply	3.5V	3.9V	4.3V	Must be implemented
2	DOUT	Output	UART data out, I/O level tied to VREF	VOL: GND to 0.55V		VOH: VREF x 0.67 to VREF	Must be implemented if USB not used, No connection
3	DIN	Input	UART data in, I/O level tied to VREF	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Must be implemented if USB not used, No connection
4	GND	Input	Ground Pin		0		Must be implemented
5	RESET_nIN	Input	Controls HW_SHUTDOWN input on Telit LE910, tie low for 200mS and released to activate. Internally pulled up to 1.8V. Drive with open collector output only. Do not drive high. Assert only in an emergency as the module will not gracefully exit the cellular network when asserted.	0		1.8V	No connection
6	VUSB	Input	Supply for USB interface	3.0V	5V	5.25V	No connection
7	USB_D+	I/O	USB differential Data + signal				No connection
8	USB_D-	I/O	USB differential Data - signal				No connection
9	DTR	Input	Modem Data Terminal Ready input	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Tie to GND
10	GND	Input	Ground Pin		0		Must be implemented
11	GND	Input	Ground Pin		0		Must be implemented
12	CTS	Output	Modem Clear to Send hardware flow control output	VOL: GND to 0.55V		VOH: VREF x 0.67 to VREF	No connection

13	ON/nSLEEP	Output	Signal drives the onboard LED indicating network status. OFF = Device OFF, Permanently ON = Searching for Network & Not Registered, Slow Blink = Registered with full service, Permanently on = call is active. See TelitLE910 manual for additional information.	0		1.8V	No connection
14	VREF	Input	Voltage reference for offboard I/O signals. This signal drives the input voltage side of an onboard buffer which converts all external I/O voltage from VREF range to 1.8V range to drive the onboard TelitLE910 modem module.	1.65V	1.8V or 3.3V	5.5V	Must be implemented
15	GND	Input	Ground Pin		0		Must be implemented
16	RTS	Input	Modem Request to Send hardware flow control input	VIL: GND to 0.15V		VIH: VREF-0.4 V to VREF	Tie to GND
17	DIO3	I/O	Programmable GPIO_03 on TelitLE910 module	0		1.8V	No connection
18	DIO2	I/O	Programmable GPIO_02 on TelitLE910 module	0		1.8V	No connection
19	ADC1	Input	ADC_IN1 input on Telit LE910 module (8bit resolution, <6.6mV)	0		1.7V	No connection
20	ON_OFF	Input	Modem On/Off signal. Assert low for 1 to 2 seconds and then release to activate start sequence. Drive with open collector output. Internally pulled up to internal I/O rail with pull up. Do not use any external pull ups. **Note:** If you want modem to turn on automatically when power is applied, permanently tie this signal to GND.	0		1.8V	Must be implemented.

2.1.2.2 Connectors J3, X1, X2, X3

Connector Designator	Description	Connector Location
J3	Micro SIM Connector	Bottom Side of Module
X1	Primary Antenna Connection	Topside of Module
X2	Diversity Antenna Connection	Topside of Module
X3	GPS/GNSS Satellite Receiver	Bottom Side of Module

2.2 Mechanical Specifications

2.2.1 Mechanical Characteristics

Parameter	Typical	Unit
Dimensions (excluding pin height, for solder to board applications)	29.0 x 33.60 x 6.63	mm
Dimensions (including pin height, for board to board connector applications)	29.0 x 33.60 x 10.73	mm
Weight	8	Grams
Connector Insertion/Removal	hundreds	Cycles

2.2.2 Mating Connectors

Connector Designator	Manufacture	Populated on Module	Recommended Mate	Mate Manufacture
J1, J2	3M	951110-2530-AR-PR	950510-6102-AR	3M
			Acceptable alternate: NPPN101BFCN-RC	Sullins Connector Solutions
J3	Molex	786463001	Micro SIM Card	Micro SIM Card
X1, X2, X3	Hirose	U.FL-R-SMT(10)	CAB.011	Taoglas

2.2.3 Device Placement

⚠ **Make sure the Skywire is installed in the correct orientation; failure to do so will damage the device and void the warranty.**

2.3 Environmental Specifications

Parameter	Min	Typical	Max	Unit	Note
Operating Temperature	-40	25	+85	˚C	
Storage Temperature	-40	25	+85	˚C	
Operating Humidity	20		90	%	Non-condensing

3. Important Design Considerations

3.1 ON_OFF Signal

To conserve power, the Telit LE910 does not automatically startup when power is applied. The baseboard design must supply a means to assert the ON_OFF signal for the specified time (between 1 to 2 seconds) and then released to startup the module. After asserting the ON_OFF signal, software must wait for 15 seconds before attempting to communicate with the LE910. To make module automatically start when power is applied, tie ON/OFF signal to GND permanently. See Telit Hardware User Guide for additional details regarding the ON_OFF signal.

3.2 Power Supply Requirements

The module will regularly consume high amounts of current on the Main Power Supply (VCC), up to 1.5A during active transmits and receives. The baseboard power supply should be designed to support peak currents up to 2 Amps. A 100uF capacitor should be placed near the VCC pin on the module to ensure ample energy is available, with a low inductance path to the VCC pin. For example power supply designs, there are multiple references available. See the NimbeLink Skywire Development Kit schematic for a switching regulator example, or reference the Telit Hardware User Guide which has an example of both Linear and Switching regulator designs.

3.3 Serial Communications

The LE910 can communicate over UART and/or USB. Design should implement one or both serial interfaces to be able to send commands to the modem.

3.4 Network Connection Status LED

The ON/nSLEEP signal on pin 13 drives the on-board LED indicating network status. By default, the 4G LTE CAT3 module has this setting disabled. Use the following commands to enable and save this feature.

First, configure the GPIO for alternate function:

AT#GPIO = 1,0,2

The modem should respond with:

OK

Next, set the desired LED behavior with this command:

AT#SLED=2,10,10

The modem should respond with:

OK

Finally, commit the changes to non-volatile memory so the setting will persist across power down/power up:

AT#SLEDSAV

The modem should respond with:

OK

LED Status	Network Status Indication
Permanently OFF	Device OFF or setting disabled (see above)
Permanently ON	Searching for Network & Not Registered
Slow Blinking	Registered with full service
Permanently ON	Call is active (Module has been registered)

3.5 FOTA

LTE networks are constantly being updated, improved, and enhanced with new features. As a result, carriers are making frequent network changes. Most will not negatively affect devices connected to those networks, but occasionally an update will prevent an unprepared device from re-connecting to the network permanently.

To account for these future changes, FOTA (Firmware over the Air) capability is being added to all cellular modules by each module manufacturer, and NimbeLink supports this functionality in the Skywire family of embedded modems. However, there is often a requirement to implement support for this FOTA functionality in your device firmware.

As a developer using the Skywire modem, it is required that your device firmware plan to accommodate FOTA updates after deployment. Failure to do so may result in interruption of your device's cellular connectivity if the carriers implement a network change. If the device can no longer access the network, FOTA cannot be used to resolve the situation after the fact. The only way to restore connectivity will be physical access to the device to perform the updates directly on the device.

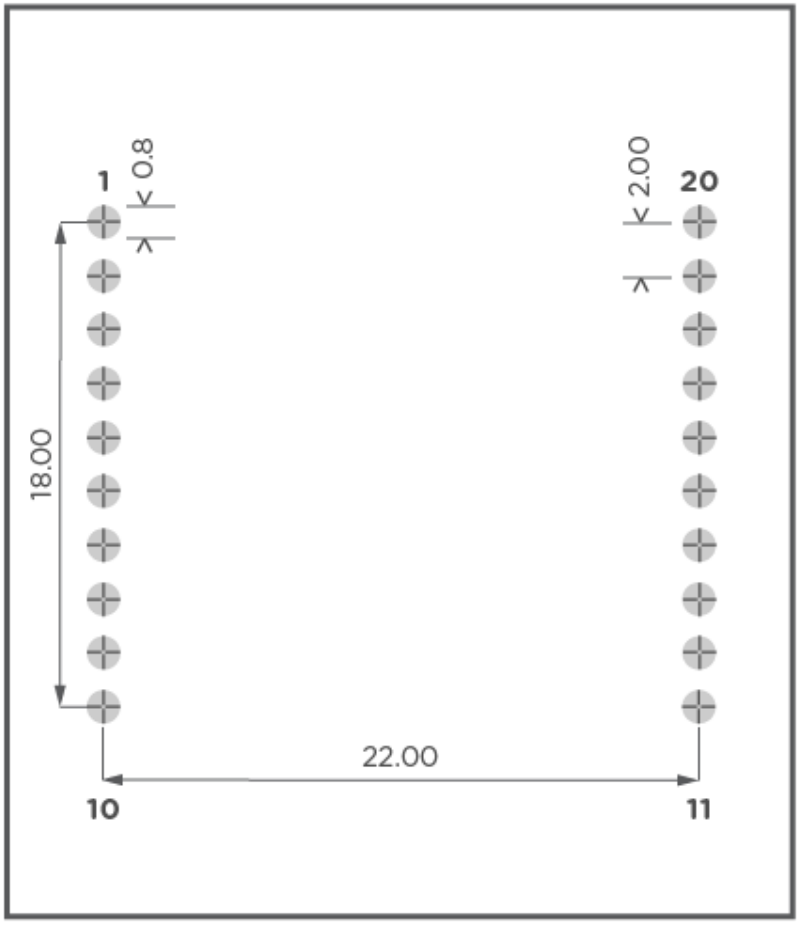
FOTA Instructions are available by contacting Nimbelink's product support team at product.support@nimbelink.com.

4. Mounting Guidelines

The Skywire embedded cellular modem supports multiple connection methods, the two primary methods are board to board connectors and soldering directly to the baseboard.

4.1 Board to Board connectors approach

The Skywire interface calls for two, 10 pin, 2mm pitch female receptacles spaced 22 mm apart.



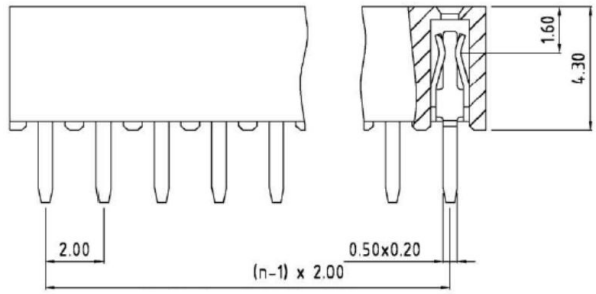
*tolerance ± 0.05
*all measurements in mm

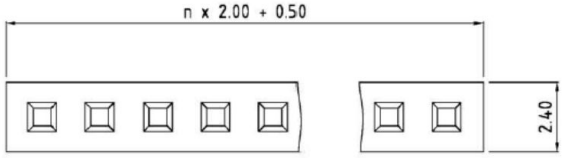
There are many connector manufacturers that can be used; below is one readily available product:

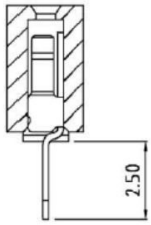
Manufacturer: Sullins Connector Solutions

Part Number: NPPN101BFCN-RC

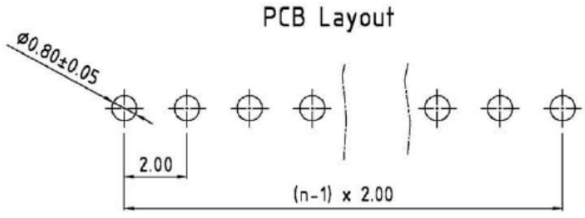
Typical part drawing and footprint information for the connector:







PCB Layout



4.2 Solder to Board connection approach

The module can be soldered directly to a PCB. The PCB should be designed with two rows of ten, 0.8mm plated thru holes spaced 2mm apart. The two rows should be 22mm apart. See drawing below for recommended footprint. Measurements are in millimeters. U.FL locations are marked with circles, X1 and X2 on top side of board, X3 is on the bottom side of the board. J3 is Micro SIM card slot on bottom side of board.

5. Antenna Considerations

5.1 Primary Antenna Requirements

These tables are copied from Telit LE910 Hardware User Guide. Designers should review latest LE910 Hardware User Guide to ensure the information is up to date.

ANTENNA REQUIREMENTS for LE910-SVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE Band IV(1700) : 445 MHz LTE Band XIII(700) : 41 MHz
Impedance	50 ohm
Input power	> 24dBm Average power
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

ANTENNA REQUIREMENTS for LE910-NVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band II(1900) : 140 MHz WCDMA band V(850) : 70 MHz
Bandwidth (LTE)	LTE Band IV(1700) : 445 MHz LTE Band XIII(700) : 41 MHz
Impedance	50 ohm
Input power	> 24dBm Average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

ANTENNA REQUIREMENTS for LE910-EUG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (GSM/EDGE)	GSM850 : 70 MHz GSM900 : 80 MHz GSM1800(DCS) : 170 MHz GSM1900(PCS) : 140 MHz
Bandwidth (WCDMA)	WCDMA band I(2100) : 250 MHz WCDMA band VIII(900) : 80 MHz
Bandwidth (LTE)	LTE band III(1800) : 170 MHz LTE Band VII(2600) : 190 MHz LTE Band XX(800) : 71 MHz
Impedance	50 ohm
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

5.2 Diversity Antenna Requirements

These tables are copied from Telit LE910 Hardware User Guide. Designers should review latest LE910 Hardware User Guide to ensure the information is up to date.

DIVERSITY ANTENNA REQUIREMENTS for LE910-SVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE Band IV(1700) : 45 MHz LTE Band XIII(700) : 10 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

DIVERSITY ANTENNA REQUIREMENTS for LE910-NVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band II(1900) : 140 MHz WCDMA band V(850) : 70 MHz
Bandwidth (LTE)	LTE Band IV(1700) : 445 MHz LTE Band XIII(700) : 41 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

DIVERSITY ANTENNA REQUIREMENTS for LE910-EUG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band I(2100) : 250 MHz WCDMA band VIII(900) : 80 MHz
Bandwidth (LTE)	LTE band III(1800) : 170 MHz LTE Band VII(2600) : 190 MHz LTE Band XX(800) : 71 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

5.3 GPS/GLONASS Antenna Requirements

The Skywire forwards the voltage supplied by the VREF pin to the GPS coax connection, X3. This is to provide power to active GNSS antennas. When using a passive antenna installed on the baseboard users must ensure that the coax cable connection is kept as short as possible between the Skywire and the mating PCB. Excess loss in long cables will significantly reduce GPS performance. Users must also ensure that the passive antenna does not behave like a DC short to ground since the Skywire provides voltage on the coax. When using such an antenna you must use a DC blocking capacitor, Nimbelink recommends a Samsung 56pF 0402 CL05C560FB5NNNC.

For GPS/GNSS, circularly polarized antennas are desired over linear and patch topologies because they typically have 3dB improved sensitivity.

These tables are copied from Telit LE910 Hardware User Guide. Designers should review latest LE910 Hardware User Guide to ensure the information is up to date.

The external pre-Filter shall be required for GLONASS application.

The Glonass pre-Filter requirement shall fulfil the following requirements:

- Source and Load Impedance = 50Ohm
- Insertion Loss (1575.42 – 1576.42MHz) = 1.4dB (Max)
- Insertion Loss (1565.42 – 1585.42MHz) = 1.4dB (Max)
- Insertion Loss (1597.5515 – 1605.886MHZ) = 2.0dB (Max)

5.4 Recommended Antennas

Type	Manufacturer	Part Number
Primary & Diversity	Taoglas[1]	TG.30.8113
Primary & GPS	Taoglas[1]	MA250.A.LBI.001

Note 1: U.FL to SMA adapter required.

For applications not using the recommended antennas, developers must ensure that the selected antenna(s) meet certain requirements. In order to maintain FCC and carrier specific certifications the antennas cannot exceed the maximum gain levels listed here:

Frequency	Max Gain (dBi)
700 MHz Band	9.16 dBi
1700 MHz Band	5.00 dBi

6. Certifications

6.1 Carrier Specific

NL-SW-LTE-TSVG	Verizon ODI Certified
NL-SW-LTE-TSVG-B	Verizon ODI Certified
NL-SW-LTE-TNAG	PTCRB Certified, AT&T Certified, Rogers Certified
NL-SW-LTE-TNAG-B	PTCRB Certified, AT&T Certified, Rogers Certified

NL-SW-LTE-TNAG and NL-SW-LTE-TEUG: Each carrier has different requirements for activating the LE910 modem on their networks. For GSM

products, many accept the Telit PTCRB & GCF certification to allow device on the network, however, recent carrier preferences may require the end product to go through PTCRB & GCF certification in the final enclosure, antenna, and software configuration.

6.2 Geography Specific

Federal Communications Commission (FCC47) part 22, 24

Complies with FCC47 Part 15 Class B Radiated and Conducted Emissions

7. Federal Regulatory Licensing

7.1 Export Control Classification Number (ECCN)

ECCNs are five character alpha-numeric designations used on the Commerce Control List (CCL) to identify dual-use items for export control purposes. An ECCN categorizes items based on the nature of the product, i.e. type of commodity, software, or technology and its respective technical parameters.

All Skywire Modems: 5A992.c

7.2 Harmonized Tariff Schedule Code

HTS Code: 8517.62.0010

8. End Product Labeling Requirements

Device Uses Approved Radio: NL-SW-LTE-TSVG

Orderable Device	FCC ID	IC ID
NL-SW-LTE-TSVG	RI7LE910SV	5131A-LE910SV
NL-SW-LTE-TSVG-B	RI7LE910SV	5131A-LE910SV
NL-SW-LTE-TEUG		
NL-SW-LTE-TNAG	RI7LE910NA	5131A-LE910NA
NL-SW-LTE-TNAG-B	RI7LE910NA	5131A-LE910NA

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 interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.