

# NL-SW-LTE-QBG96-x to NL-SW-LTE-QBG95-x Migration Guide

NimbeLink Corp

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# 1. Introduction

The aim of this document is to serve as a migration guide between the NL-SW-LTE-QBG96-x and the NL-SW-LTE-QBG95-B Skywire modems. Throughout this document the NL-SW-LTE-QBG96-x will often be referred to as the "QBG96" and the NL-SW-LTE-QBG95-B will be referred to as the "QBG95".

This document is updated often; please be sure to download the latest version from NimbeLink's website prior to beginning any design work.

## 1.1 Contact Information

NimbeLink's goal is to make integrating the Skywire modem into your product as easy as possible. Please send any feedback, documentation requests, or technical support questions to NimbeLink's product support team at:

[product.support@nimbelink.com](mailto:product.support@nimbelink.com)

For purchasing information, please visit the "Part Ordering Information" section on the modem's product page. Any additional sales questions or requests for quotation can be directed to NimbeLink's sales team at:

[sales@nimbelink.com](mailto:sales@nimbelink.com)

## 1.2 Orderable Part Number

Orderable Device	Operating Temperature	Cellular Technologies	GNSS
NL-SW-LTE-QBG95-B	-40 to +85°C	LTE CAT M1, LTE CAT NB2, 2G	GPS, GLONASS, BeiDou, Galileo, QZSS

## 1.3 Additional Resources

- [Skywire Hardware Design Developers Guide](#)
- [Skywire Hardware Design Checklist](#)
- [Skywire Software Developers Guide](#)

## 2. Migration Overview

The QBG96 and the QBG95 Skywire modems are designed as compatible products. Both modems use the same 20 pin Skywire form factor and allow for easy migration between any of the Skywire modems. They both also support the same Quectel AT command set, GNSS<sup>1</sup>, and LTE Cat M1 with 2G fallback. The QBG96 supports NB1 whereas the QBG95 supports NB2. The QBG95 modem makes use of a new 3GPP Power Class with less output, Power Class 5, which supports a maximum output power of +20 dBm.

Notes:

- <sup>1</sup> - Due to hardware limitations, the QBG95 can not use GPS and Cellular concurrently. By default, the QBG95 modem is configured into the GNSS priority mode, which can be switched to the WWAN priority mode with the command:

```
AT+QGPSCFG="priority",1,1
```

The command takes effect immediately.

To revert back to GNSS priority mode use the command:

```
AT+QGPSCFG="priority",0,1
```

To query which system is prioritized use the command `AT+QGPSCFG="priority"`. For additional information on this command please refer to the BG95 GNSS AT command manual.

## 2.1 Comparison Table

Item	NL-SW-LTE-QBG96	NL-SE-LTE-QBG95
<b>Chipset</b>	Qualcomm MDM9206	Qualcomm MDM9205
<b>Module</b>	Quectel BG96	Quectel BG95-M3
<b>Power Class</b>	Power Class 3 (23dBm)	Power Class 5 (20dBm)
<b>Supported Bands</b>	Cat M1: LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/B26/B28 LTE-TDD: B39 Cat NB1: LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B28 EGPRS: 850/900/1800/1900MHz	Cat M1: LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B14/B18/ B19/B20/B25/B26/B27/B28/B66/B71/B 85 Cat NB2: LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/ B20/B25/B26/B28/B66/B71/B85 EGPRS: 850/900/1800/1900MHz
<b>GNSS</b>	GPS, GLONASS, BeiDou/Compass, Galileo, QZSS	GPS, GLONASS, BeiDou/Compass, Galileo, QZSS
<b>Input Voltage</b>	3.4V to 4.3V	3.4V to 4.3V
<b>Current Requirements (Max)</b>	2.0A	2.0A
<b>Temperature Range</b>	-40 to +85°C	-40 to +85°C
<b>Main UART Interface</b>	Baud rates: 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps, 115200bps by default Flow control: RTS/CTS	Baud rates: 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps, 115200bps by default Flow control: RTS/CTS
<b>GNSS UART</b>	N/A	Supported
<b>USB Interface</b>	USB 2.0 (Slave only) Full speed and high speed	USB 2.0 (Slave only) Low speed and full speed
<b>Dimensions (mm)</b>	33.6 x 29.0 x 10.7 mm	33.9 x 29.0 x 10.2 mm
<b>Weight (g)</b>	8	8
<b>Total Capacitance</b>	592uF ± 20%	382uF ± 20%
<b>Total Inductance</b>	7.9uH ± 20%	1.65uH ± 20%

## 2.2 Pin Assignments

This section describes the pin assignments on the modems.

Pin #	NL-SW-LTE-QBG96			NL-SW-LTE-QBG95		
	Pin Name	IO	Description	Pin Name	IO	Description
1	VCC	Input	Main Power Supply	VCC	Input	Main Power Supply
2	DOUT	Output	Primary UART Data Output	DOUT	Output	Primary UART Data Output
3	DIN	Input	Primary UART Data Input	DIN	Input	Primary UART Data Input
4	GND	-	Ground	GND	-	Ground
5	nRESET	Input	Emergency Reset Line	nRESET	Input	Emergency Reset Line
6	VUSB	Input	USB Voltage Detection	VUSB	Input	USB Voltage Detection
7	USB_D+	IO	USB Differential Data Bus (+)	USB_D+	IO	USB Differential Data Bus (+)
8	USB_D-	IO	USB Differential Data Bus (-)	USB_D-	IO	USB Differential Data Bus (-)
9	DTR	Input	Data Terminal Ready	DTR	Input	Data Terminal Ready
10	GND	-	Ground	GND	-	Ground
11	GND	-	Ground	GND	-	Ground
12	CTS	Output	Primary UART Clear to Send	CTS	Output	Primary UART Clear to Send
13	STATUS	Output	Modem Status	STATUS	Output	Modem Status
14	VREF	Input	Modem IO Voltage Reference	VREF	Input	Modem IO Voltage Reference
15	GND	-	Ground	GND	-	Ground
16	RTS	Input	Primary UART Request to Send	RTS	Input	Primary UART Request to Send
17	I2C SDA	IO	I2C Serial Data	GNSS_UART_RXD	Input	GNSS UART RXD
18	I2C SCL	IO	I2C Serial Clock	GNSS_UART_TXD	Output	GNSS UART TXD
19	RING	Output	Ring Indicator	RING	Output	Ring Indicator
20	ON_OFF	Input	Modem ON/OFF Signal	ON_OFF	Input	Modem ON/OFF Signal

The pinout for the two modems is identical except for two functionality changes. The I2C interface on pins 17 and 18 on the QBG96 has been remapped to connect to the GNSS UART interface on the QBG95 to better enable GNSS tracking applications.

## 2.3 Functionality

### 2.3.1 RF Power Class

The QBG96 modem is a Power Class 3 device and supports a maximum output power of +23 dBm. The QBG95 modem makes use of a new 3GPP Power Class with less output, Power Class 5, which supports a maximum output power of +20 dBm.

The lower output power of the QBG95 means that the modem will consume less power during RF transmissions at the cost of a reduction in coverage. This means that the QBG95 may enter Coverage Enhancement Mode A or B sooner than the QBG96 which may cause the modem to expend additional energy when attempting to resend data to the tower, or it may not be able to connect in some locations.

### 2.3.2 AT Commands

Both modems support Quectel's AT command set. AT commands between the two modems will be similar. However, due to differences in the underlying chipsets, there may be some differences when using more advanced functionality. NimbeLink has tested the following application notes and confirmed that the AT commands are the same between the two modems.

- [Sending and Receiving data with Socket Dials](#)
- [Sending and Receiving SMS messages](#)
- [Sending and Receiving data with PPP](#)
- [Using GNSS Location Services](#)

### 2.3.3 Power Requirements

Both modems are low power wide area network devices with low quiescent and leakage current, and they support 2G networks. The power supply for the modems must be able to provide sufficient current for 2G network transactions. The output current of the modem's power supply cannot be lower than 2.0A to meet the modem's current requirements when transmitting on 2G networks.

The input voltage range for both modems is 3.4V to 4.3V with a typical power supply voltage of 3.8V. The VCC input for either modem should have both a 100uF and a 0.1uF decoupling capacitor placed close to the VCC pin. NimbeLink offers multiple power supply reference designs in order to assist customers with their designs at no extra charge. Two of the designs are linked to below:

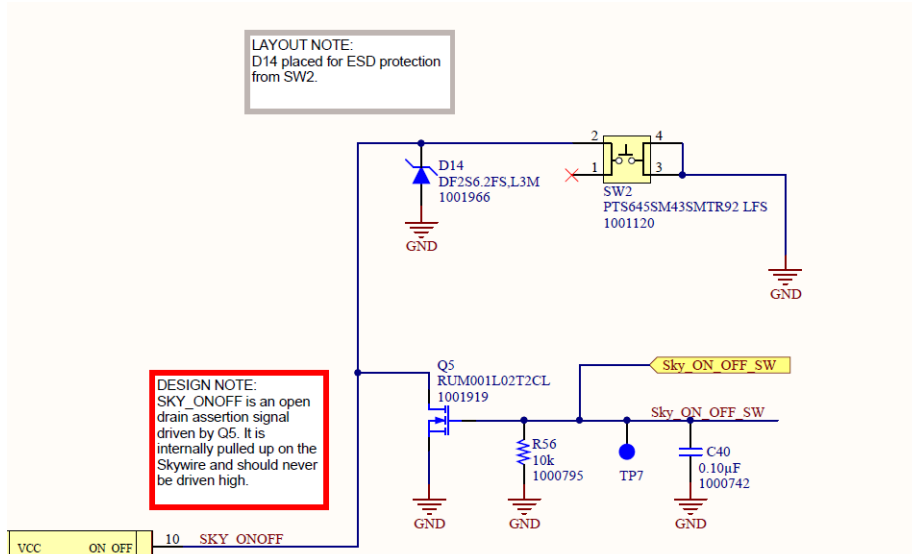
[NL-AB-BBCL Reference Schematic](#)

[NL-SWDK Reference Schematic](#)

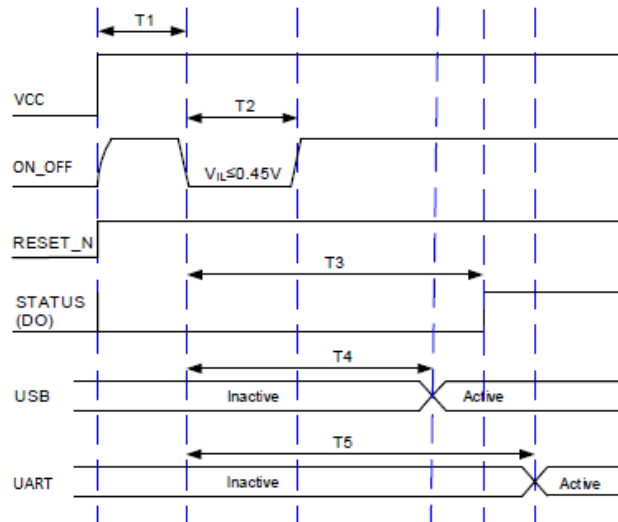
### 2.3.4 Power On

The method to power on both modems is the same. To turn on either device, the modem's ON\_OFF pin must be pulsed with an open drain assertion. The ON\_OFF pin on the QBG96 is internally pulled up to 0.8V and the ON\_OFF pin on the QBG95 it is internally pulled up to 1.5V.

The following is a reference design example for the turn-on circuit for the modems.



The power on timing for the two modems are different. The following figure shows the power-on scenarios and timing differences.



Modem	T1	T2	T3	T4	T5
NL-SW-LTE-QBG96	≥30 ms	≥500 ms	≥4.8 s	≥4.2 s	≥ 4.9s
NL-SW-LTE-QBG95	≥30 ms	500 to 1000 ms	≥2.1 s	≥2.55 s	≥2.5 s



## 2.3.5 Power Off

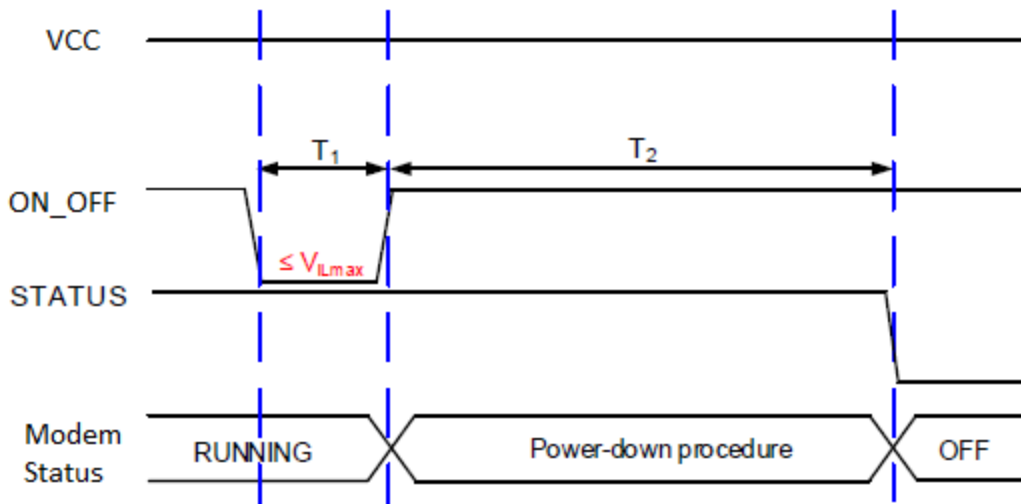
### 2.3.5.1 Power Off via AT command

Both modems may be powered down either by AT command or by toggling the ON\_OFF pin. The AT command, AT+QPOWD, can be issued over either interface to power down the modems. The command will force the modem to properly detach from the network and allow the firmware to save important data before shutting down. The shutdown process, including the network detach, will typically take several seconds. The total shutdown time will depend on how long the network detach takes. If an immediate power down is required, users should use the fast shutdown option documented in the modems AT command manual.

To avoid firmware corruption, the power supply for the modem cannot be disconnected before the module's STATUS pin is set low and the URC "POWERED DOWN" is outputted.

### 2.3.5.2 Power Off Via ON\_OFF

Both modems may also be powered off by toggling the ON\_OFF pin low, with an open drain assertion, for a period of time when the modem is operating. The power down timing is illustrated in the figure and table below.

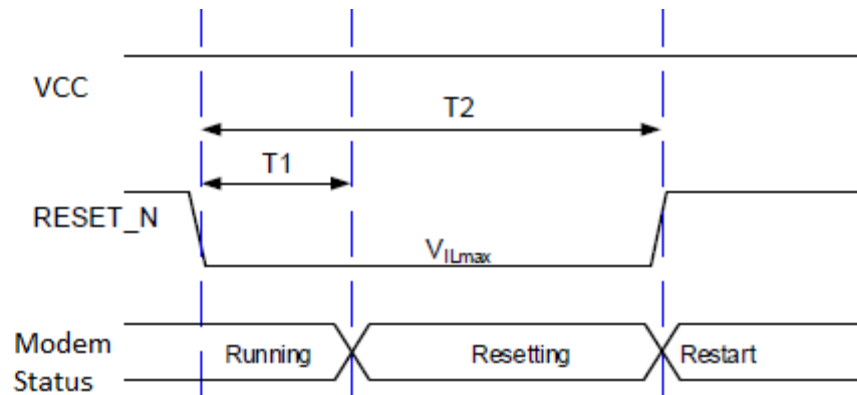


Modem	$V_{IL, Max}$	T1	T2
NL-SW-LTE-QBG96	0.5V	$\geq 650$ ms	$\geq 2000$ ms
NL-SW-LTE-QBG95	0.45V	650 to 1500 ms	$\geq 1300$ ms

### 2.3.6 Reset

The QBG96 and QBG95 modems can be reset by driving the nRESET line low with an open drain collector for a period of time. The reset line should only be used as a last resort recovery method when the modem is non-responsive. Due to hardware limitations of the chipset in the QBG95 modem, the nRESET and the ON\_OFF signals are internally tied together.

The following figure and table shows the reset timing for the two modems.



Modem	$V_{IL, Max}$	T1	T2
NL-SW-LTE-QBG96	0.5V	$\geq 150$ ms	$\leq 460$ ms
NL-SW-LTE-QBG95	0.45V	$\geq 2000$ ms	$\leq 3800$ ms

### 2.3.7 SIM Interfaces

The SIM interface on the QBG96 and the QBG95 meets ETSI and IMT-2000 requirements. The QBG96 supports 1.8V/3.0V U(SIM) cards and the QBG95 only supports 1.8V (U)SIM cards.

Both modems are designed to support both an external 3FF SIM and an onboard MFF2 Verizon SIM. The SIM selection commands on both modems are the same. They make use of an onboard GPIO, GPIO 26, to select the desired SIM interface. The modems will default to using the 3FF SIM interface.

To configure the modem to use the soldered down SIM, issue the following commands to the modem in the order they appear below:

```

AT+CFUN=0
AT+QCFG="gpio",1,26,1,0,0,1
AT+QCFG="gpio",3,26,1,1
AT+CFUN=1

```

To configure the modem to use the SIM in the 3FF SIM card socket, issue the following commands to the modem in the order they appear below:

```
AT+CFUN=0
```

```
AT+QCFG="gpio",1,26,1,0,0,1
```

```
AT+QCFG="gpio",3,26,0,1
```

```
AT+CFUN=1
```

Note: GPIO states will persist after reset, and the above AT commands will not need to be reissued each time the modem is powered on. Firmware updates may overwrite saved GPIO states, however.

### **2.3.8 UART Interfaces**

The QBG96 modem supports a single, primary UART interface with hardware flow control on Skywire pins 2 (DOUT), 3 (DIN), 12 (CTS), and 16 (RTS). This interface is internally level shifted to the VREF voltage provided to the modem. The default baud rate for the modems UART interface is 115200 8N1.

The QBG95 modem supports a primary UART interface with hardware flow control on Skywire pins 2 (DOUT), 3 (DIN), 12 (CTS), and 16 (RTS) along with a GNSS UART interface on pins 17 (GNSS\_UART\_RXD) and 18 (GNSS\_UART\_TXD).

The primary UART interface is used for data transmission and AT command communication. It is internally level shifted to the VREF voltage provided to the modem.

The GNSS UART interface is used for GNSS data and NMEA sentence output. This interface is not level shifted and is a 1.8V interface to maintain compatibility with legacy Skywires. A level translator, such as Texas Instruments TXS0108EPWR, should be used if the customer's application requires a different IO voltage. The default baud rate for the modems GNSS UART interfaces is 115200 8N1.

### **2.3.9 USB Interfaces**

The QBG96/QBG95 modems both support a USB 2.0 interface and can only be used as a slave device. The QBG96 supports high speed (480 Mbps) and full speed (12Mbps) operation, while the QBG95 supports full speed (12 Mbps) and low speed (1.5 Mbps) operation.

### **2.3.10 RF Antenna Interfaces**

Both the QBG96 and QBG95 modems support a primary LTE RF interface (X1) and a GNSS interface (X3) on the top side of the modem. The modems are designed to use 50 ohm impedance antennas.

The modems' GNSS interfaces are designed to support the use of active GNSS antennas. A 3.3VDC, 100 mA source is available on the modem to bias the GNSS line in order to power the active antenna. Control of the GNSS power source is done via GPIO64 on the modem. To conserve power, the GNSS power is off by default. The command sequence for both modems is the same.

To turn on the DC power to the GNSS antenna, and save it in this state across power off, issue the following commands to the modem:

```
AT+QCFG="gpio",1,64,1,0,0,1
```

```
AT+QCFG="gpio",3,64,1,1
```

To turn off the DC power to the GNSS antenna, and save this state after power off, issue the following commands to the modem:

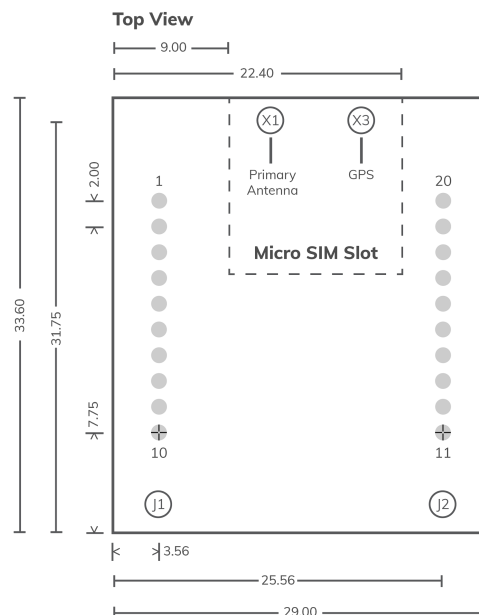
```
AT+QCFG="gpio",1,64,1,0,0,1
```

```
AT+QCFG="gpio",3,64,0,1
```

**Note:** GPIO states will persist after reset, and the above AT commands will not need to be reissued each time the modem is powered on. Firmware updates may overwrite saved GPIO states, however.

### 2.3.11 Skywire Footprint

Both modems use the same 20 pin Skywire interface and have the same mechanical footprint as shown in the figure below.



### 3. Document Version Information

Revision	Description	Date
1	-Initial Release	2020/09/15
2	-Updated comparison table to use BG95-M3 part number.	DRAFT
3	- Added Notes to section 2. Migration Overview to indicate the QBG95 modem's hardware limitation for using GPS and Cellular concurrently	2021/04/08