User Guide to Q4000/QPRO

Document #1135-4713
Revision G

SENSITIVITY LEVEL: **GREEN**

Revision History

Date	Revision Number	Description
October 2010	A	Initial Production Release
December 2010	B	Add TIME_SYNC event with parameter which specifies the amount of time added to real-time clock. Add description of SMTP message handling when message is too large. Add description of CAN bus loading. Add description of “dR” to save configuration parameters when they are changed. Add note that QCT doesn’t work with Iridium to change Turnkey parameters. Update DemoApp descriptions and add DemoAppFFS and DemoAppTCP. Add information on changed configuration parameters via the debug menu. Condense verbose text throughout document. Add power down requirements.
April 2011	C	Add Iridium logging information Support for Over-the-Air Turnkey Parameters Additional demo program for ADC Add note about 0xE000 to 0xEFFF space for user application return codes. Change description of DemoAppSERIAL. Add Quick Start Guide Add support for Inmarsat Add description of Network Independent Message Manager (NIMM)
July 2011	D	Added additional NIMM information Added information about debug menus Additional configuration parameters listed for Orbcomm
October 2011	E	Add sample program DemoAppRTOS Update with recommendations from “Replicating Customer Experience” Added debug menus
November 2011	F	Fix AUX port speed parameters and add info about losing data at high speeds
December 2011	G	Formatting and language overhaul

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1 Introduction

1.1 Overview

The QUAKE Q4000/QPRO is a highly configurable, dual mode solution that is ready for global use. The Q4000/QPRO is designed to communicate with terrestrial GSM cellular network systems when a cellular signal is available, and to slide seamlessly into its back-up mode to communicate with a satellite system when a cellular signal is not available. The Q4000/QPRO has additional processing power, memory, and input/outputs that allow sophisticated customer applications to run within the modem.

1.2 Scope

This document covers the key features of the Q4000/QPRO, a description of the operating environment, instructions for setting up the modem including the installation, editing and downloading of 'C' code, as well as an overview of the software architecture of the Q4000/QPRO modem. This interface allows programmers to prepare custom 'C' code applications. With use of the tools included in the API development environment, these applications can be embedded in the modem to take maximum advantage of the power and functionality of QUAKE products.

This manual is divided into 13 chapters and 6 appendices, which are summarized below:

Chapter 1: INTRODUCTION to the Q4000/QPRO modem contains the scope of the document, a list of related documents and information for contacting QUAKE.

Chapter 2: QUICK START GUIDE explains how to set up the modem, activate and provision it, and configure and run the sample Turnkey application.

Chapter 3: ANTENNA SET UP describes how to set up the satellite and GSM/GPRS antennas for the best possible reception.

Chapter 4: ACTIVATING, PROVISIONING AND CONFIGURING THE MODEM discusses how to set up the connections between the modem and the satellite and terrestrial networks.

Chapter 5: LOGGER MESSAGES contains a description of different types of Logger Data.

Chapter 6: QUAKE COMMUNICATIONS PROTOCOL (QCP) demonstrates the QUAKE AT command set for communicating over the serial port with the modem.

Chapter 7: QUAKE CONFIGURATION PARAMETERS outlines the different types of parameters and how to configure them.

Chapter 8: INSTALLING THE IAR INTEGRATED DEVELOPMENT ENVIRONMENT discusses installation of the Integrated Development Environment.

Chapter 9: SAMPLE APPLICATIONS gives instructions on how to run short applications that demonstrate many features of the modem.

Chapter 10: SATELLITE NETWORKS describes the ORBCOMM, Iridium and Inmarsat networks, as well as their respective configuration parameters.

Chapter 11: OVER THE AIR UPDATE describes how to update the modem's firmware remotely using satellite and GSM.

Chapter 12: EVENT DRIVEN ARCHITECTURE discusses the various events that make up the software architecture of the Q4000/QPRO modem.

Chapter 13: QUAKE FIRMWARE AND API'S discusses the main modules of the modem foundation software and their interactions.

Appendix A - ORBCOMM configuration parameters

Appendix B - QUAKE's ORBCOMM configuration parameters (QCFG)

Appendix C - QUAKE's Iridium & Inmarsat configuration parameters (QCFG).

Appendix D - Debug and utility menus

Appendix E - Software file naming convention

Appendix F - Glossary of terms

CONFIDENTIALITY OBLIGATIONS.

1.3 Related documents

The following documents contain valuable information:

[1] 1135-0902, Technical Data Sheet Q4000
[2] 1137-0901, Technical Data Sheet QPRO
[3] Q4000/QPRO API Function Reference – From QUAKE Global Website
[4] 1135-4711 QUAKE Configuration Tool (QCT)
[5] 1135-4715 QUAKE Communications Protocol (QCP) User Manual

For Q4000/QPROs with an ORBCOMM satellite transceiver installed, the following ORBCOMM documentation may assist in application development (see www.ORBCOMM.com)

[6] ORBCOMM Serial Interface Specification, Rev. G or greater
[7] ORBCOMM Gateway Customer Access Interface Specification, Rev. C or greater
[8] ORBCOMM Messaging Services Description
[9] ORBCOMM Application Development for Roaming Phase 1

For Q4000/QPROs with an Iridium satellite transceiver installed, the following Iridium documentation may assist in application development (see www.iridium.com)

[10] Iridium SBD Developer's Guide
[11] 4000-3000 Rev. D. AT Command Set Manual

For Q4000/QPROs with an Inmarsat satellite transceiver installed, the following Inmarsat documentation may assist in application development (see www.skywave.com)

[12] N200_IsatData_Pro_Network_services_Overview
[13] N201_IsatData_Pro_Tateway_Web_service_User_Guide
[14] T203_IDP_100_Modem_series_developers_Guide

The built-in and on-line help provided by IAR Systems for their Integrated Development Environment (IDE) are valuable references.

The API Function Reference listed above [3] is necessary for any custom 'C' programming involving calls to supported API functions. It should be viewed as a companion piece to this document. You may obtain the most current version of this document from the QUAKE Global website at www.quakeglobal.com.

1.4 Contacting QUAKE

To contact QUAKE Global Inc. regarding the QUAKE modem development environment, API, or other issues, please refer to the following information:

QUAKE Global
4933 Paramount Dr
San Diego CA 92123

Phone Number: (858) 277-7290
Fax Number: (858) 277-7259

Website: www.quakeglobal.com

Email: customersupport@quakeglobal.com

2 Quick Start Guide

The Q4000/QPRO operates from 6VDC to 32VDC. For satellite applications, optimal performance requires at least 10.5 VDC.

In order to communicate with the Q4000 or QPRO the following is required:

- a computer with at least one available serial port or a USB-to-serial adapter (Keyspan, part number USA-19HS)
- a power supply capable of providing at least 3 amps at 12 V
- a Q4000 or QPRO assembly data cable
- a Q4000 or QPRO modem.

2.1 Connecting the modem

2.1.1 Connecting the Q4000

The QUAKE part number for the Q4000 assembly data cable is QUAKE P/N 1135-0211.

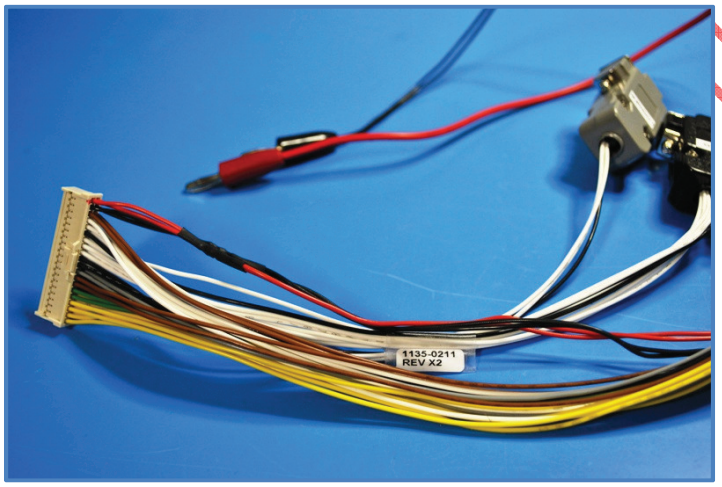


Figure 2-1: Q4000 assembly data cable

There are three main components of the Q4000 assembly data cable:

1. the locking connector
2. five serial DB9 connectors for use with the Logger port, MTS, AUX, GPS and GSM)
3. power (red) and ground (black) banana plugs.

Figure 2-2: Q4000 assembly data cable components

Note: Additional serial connections, I/O, and other signal lines are also available as non-terminated wires that come shrink-wrapped together in the assembly cable.

Plug the locking connector into the modem. The connector can only fit one way as shown below.

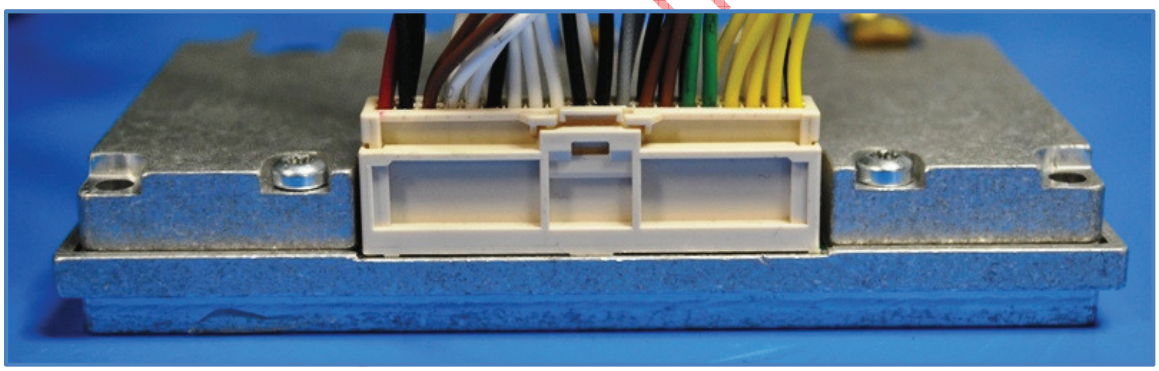


Figure 2-3: Q4000 locking connector

Note: The AUX port

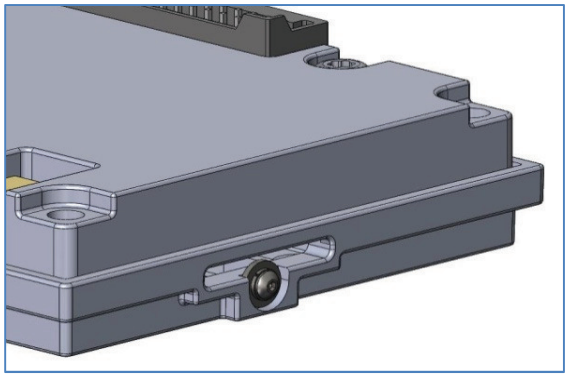
- maximum speed is 57600 bps.
- may **not** be available on certain configurations of the Q4000. The Q4000 with Iridium, for example, does not have the AUX port available.

On the opposite side of the modem, attach the antenna cable to the appropriate connector (Figure 2-4).

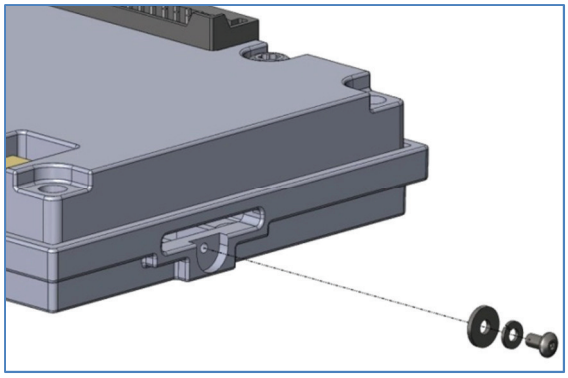
Figure 2-4: Q4000 antenna connections

2.1.1.1 Inserting the SIM card in the Q4000

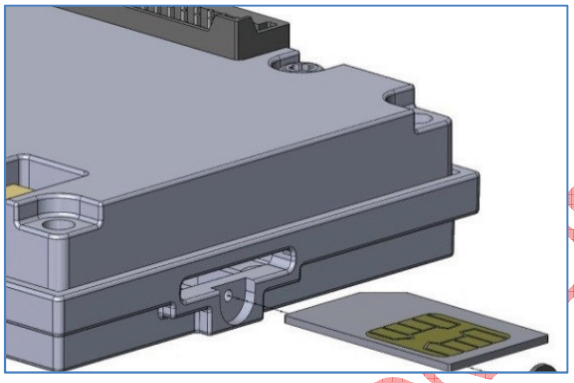
One of two types of screw is used to attach the SIM card to the modem. The screw will be a round head screw, Phillips, 0-80 X 3/16, SS, or a hex screw, size 0-80, 50th.



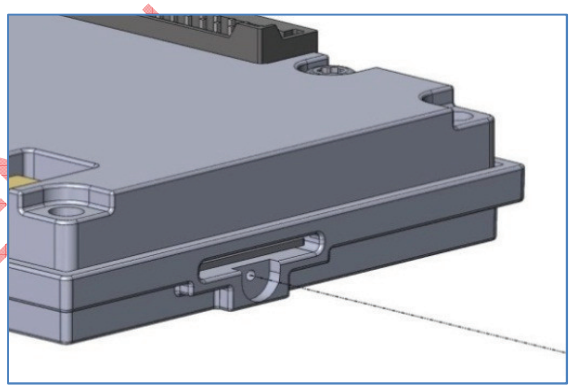
1. Find side of case with screw and washers.



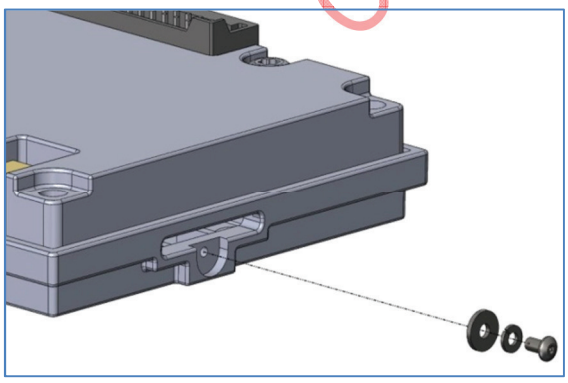
2. Remove screw and washers from side of case.



3. Insert SIM card with the metal contacts facing upward.



4. Ensure SIM card clicks into place.



5. Replace the washers and screw.

2.1.2 Connecting the QPRO

The QUAKE part number for the QPRO assembly data cable is QUAKE P/N 1137-0211.

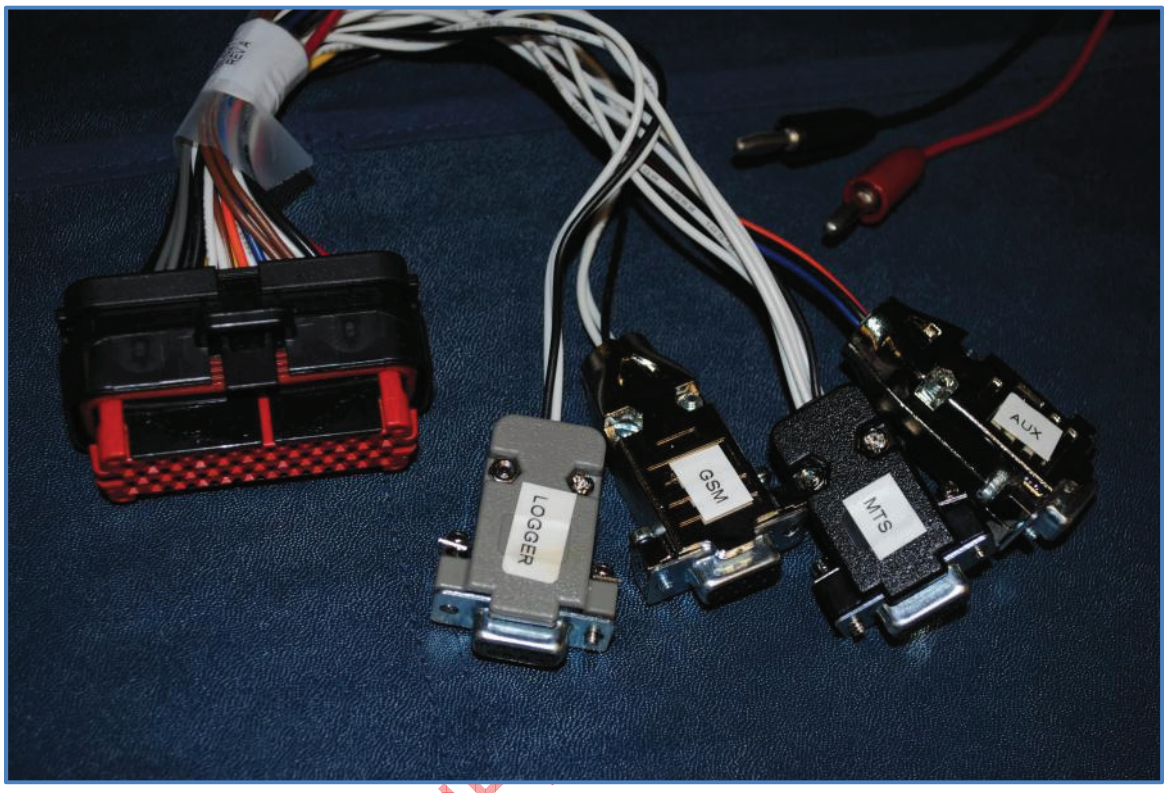


Figure 2-5: QPRO assembly data cable

There are three main components to the QPRO assembly data cable:

1. the locking connector
2. four serial DB9 connectors for use with the Logger port, MTS, AUX, and GSM
3. power (red) and ground (black) banana plugs.

Figure 2-6: QPRO assembly data cable components

Note: Additional serial connections, I/O, and other signal lines are also available as non-terminated wires that come shrink-wrapped together in the assembly cable.

Plug the locking connector into the modem. The connector can only fit one way, as shown below.

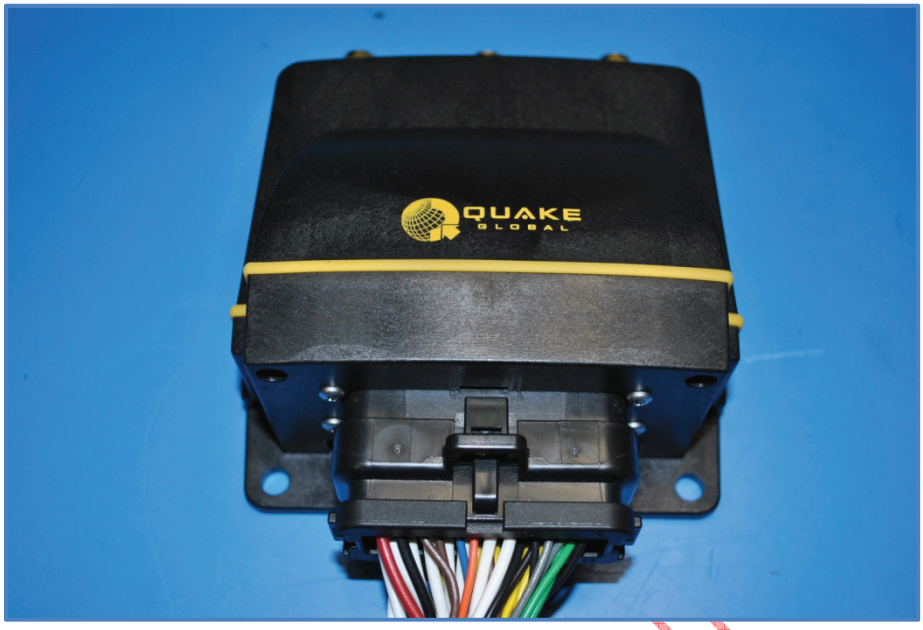


Figure 2-7: QPRO locking connector

2.1.2.1 Installing the SIM card in the QPRO

All SIM cards for the QPRO are installed by QUAKE. For a Development Kit, the SIM card number is available on a white tag connected to the QPRO.

2.2 Serial port connections

There are four or five serial ports that come terminated with DB9 connectors:

1. the Logger port - provides diagnostic data for the user
2. the MTS port - implements QUAKE's Communication Protocol (QCP)
3. the AUX port - can be used by application developers as they choose
4. the GSM port – used to update the GSM module firmware
5. the GPS port – streams NMEA data from the GSM module (Q4000 only).

Note:

The AUX port:

- maximum speed is 57600 bps.
- may **not** be available on certain configurations of the QPRO. The QPRO with Iridium or Inmarsat, for example, does not have the AUX port available.

2.3 Antenna setup

Follow the instructions in Chapter 3 - Antenna setup to install the modem's antenna.

2.4 Downloading code to the modem

The Q4000/QPRO uses two separate code packages: the **foundation** and the **application**. The foundation is supplied by QUAKE Global. The application may be written by the user or a third party to perform operations unique to the customer's requirements. Both can be loaded into the modem using the QUAKE Configuration Tool (QCT).

The **application code package** is a loadable software file that may or may not be present in the modem. If this file is not present, the modem acts as a simple satellite or GPRS/GSM modem that is controlled externally via a serial interface. Alternatively, for more complex applications, a developer can create a custom application in C code to be embedded in the modem. QUAKE provides a number of sample applications that were developed using QUAKE's Application Programming Interface (API) and development environment.

The **foundation code package** consists of code to implement the Session, Transport and Network layers of the satellite/terrestrial protocol. The application and the foundation are independent tasks within the modem. The application sends and receives messages to and from the foundation, and the foundation sends and receives messages over the RF or GPRS/GSM links.

The modem is loaded with foundation code when it leaves the factory. New foundation code may be obtained from the Downloads page at www.quakeglobal.com, using your assigned username and password.

2.4.1 QUAKE Configuration Tool (QCT)

The QUAKE Configuration Tool (QCT) provides a Graphical User Interface (GUI) to download code and modify configuration parameters in the modem. QCT is available on the Downloads page on the QUAKE website.

To download code or modify configuration parameters, load and run QCT on a PC connected to the modem's MTS serial port. When connecting to the MTS port, the default settings are:

Baud rate: 4800 bps
Data bits: 8
Parity: None
Stop bits: 1
Flow control: None

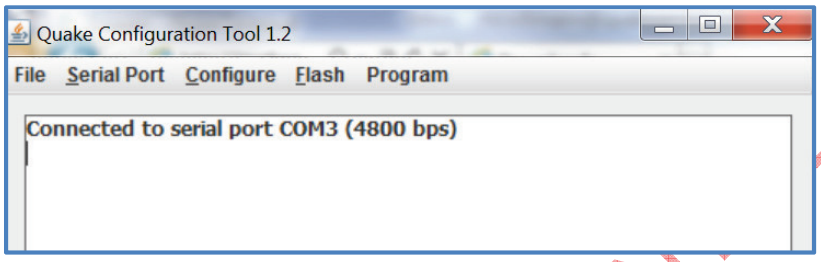


Figure 2-8: QCT – Initial screen

2.4.1.1 Downloading foundation code

If it is necessary to update the foundation (firmware) code, download the zip file from the QUAKE Global website. After unzipping the file, you should have a foundation file with the name format of **Q4Kf-xGT-n.n.nnnn.nnn-ENC.bin.**

Note: See Appendix E - Software file naming convention for the key to the file names.

1. In QCT, select **Flash →Load Firmware**

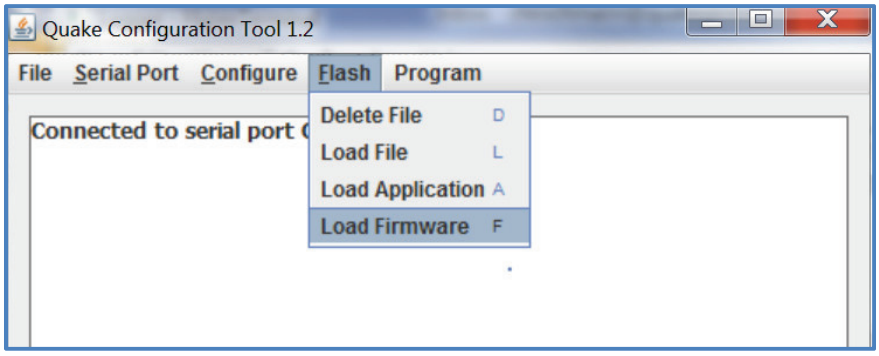


Figure 2-9: QCT – Update the firmware (1)

2. Enter the foundation file's address and select **Update**.

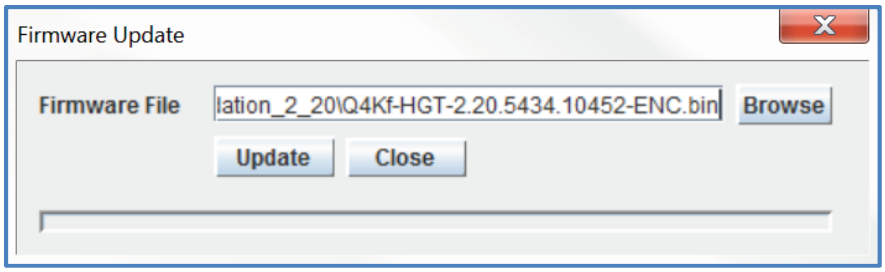


Figure 2-10: QCT – Update the firmware (2)

3. QCT starts the firmware update. Power cycle the modem.

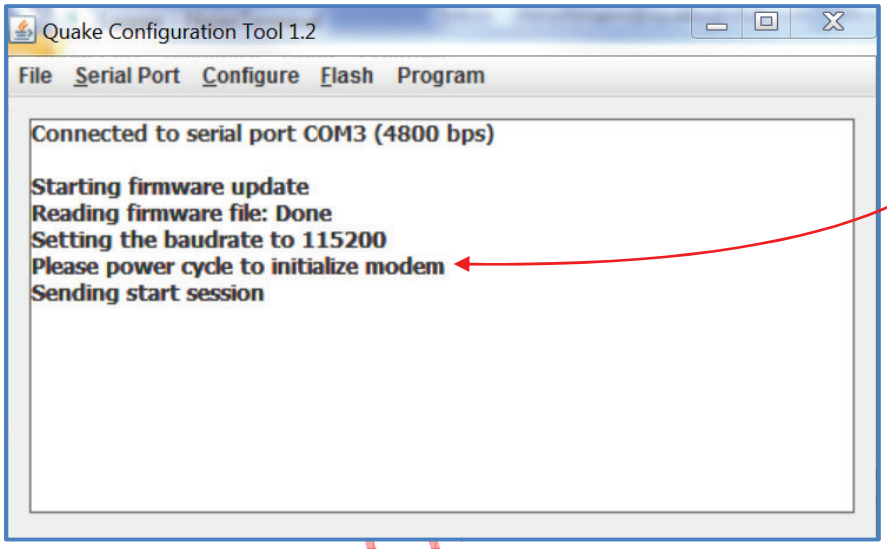
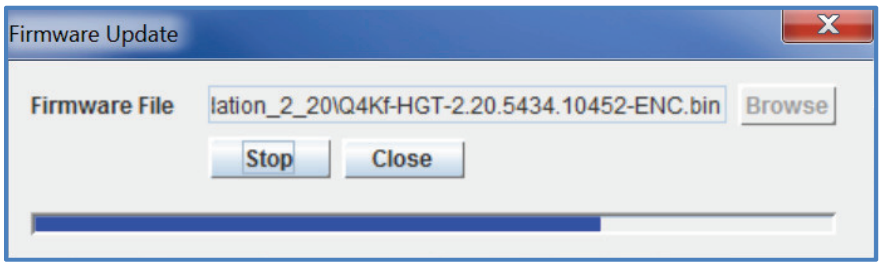


Figure 2-11: QCT – Update the firmware (3)

4. The progress bar will indicate when the file is loaded.



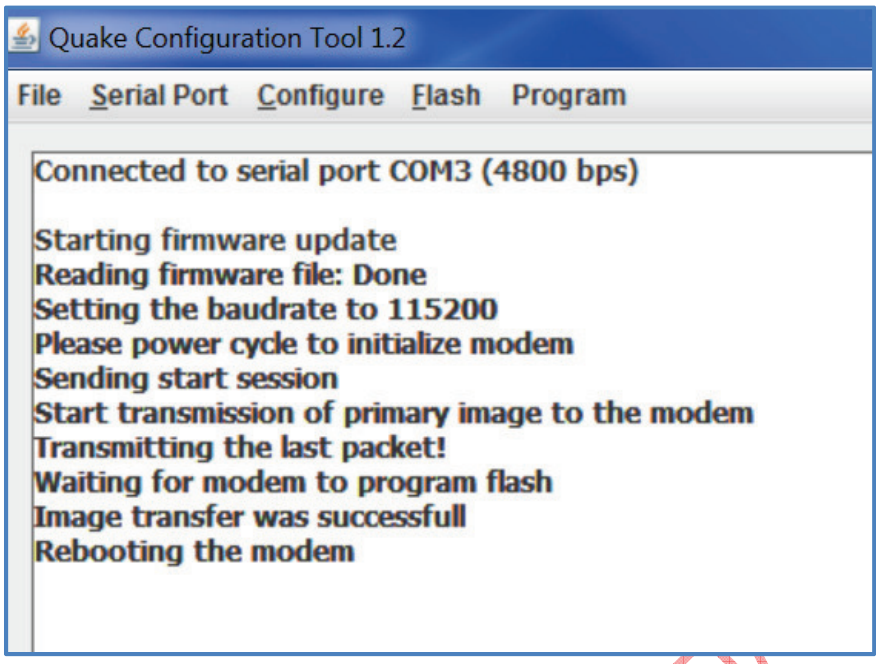


Figure 2-12: Completion of successful download (using QCT)

2.5 Logger messages

All Q4000/QPRO modems have an RS-232 serial port called the Logger port. This port provides system information so that users can monitor modem operations, and examine variables such as satellite reception, signal strength and message status. The Logger port can be connected to any terminal emulation program, such as Windows HyperTerminal, running on a PC.

Connect one of the PC's terminal serial ports to the Logger serial port of the modem. If using a serial port to USB connector, a Keyspan High-Speed USB to Serial Adapter is recommended.

Set the PC program's parameters to the following settings:

Baud rate: 115200 bps
Data bits: 8
Parity: None
Stop bits: 1
Flow control: None

After setting up the terminal, power-up the modem with an appropriate DC power supply (12 V). Readable ASCII text should begin to scroll down the screen and in some cases may continue scrolling. If this has not occurred, either the serial port is not configured properly, is not connected to the modem, or the log debug level may be set to zero.

2.6 Turnkey sample application

QUAKE Global provides a sample **Turnkey** application which creates a message containing the GPS location and current values of the Digital Input/Outputs (DIOs), Analog inputs and Controller Area Network (CAN) bus data, and then sends out the message over a network. The interval and network used to send the message are configurable. The data sent by the message may be

included or excluded in the message by setting bits in the message mask, but it is not possible to add additional fields..

Turnkey can be used by customers who need a basic tracking or monitoring system. The application requires only the configuration of message and transmission parameters in order to run. This allows customers to use the Q4000/QPRO as an 'out of the box' solution.

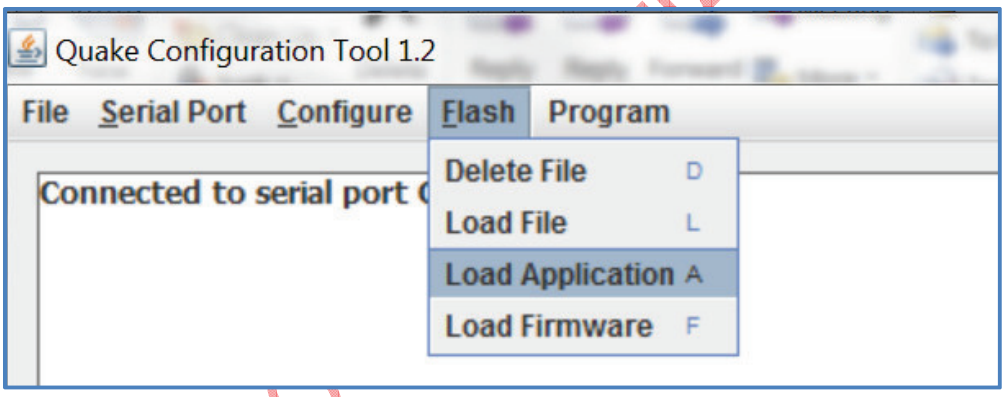
If you have purchased an Evaluation Kit or Development Kit from QUAKE, the foundation code and application code for Turnkey will already be installed on the modem. If not, or if you wish to reload the modem, perform the steps in Section 2.4.

2.6.1 Downloading Turnkey application code

1. Download the latest Turnkey .bin file from the QUAKE website. After unzipping the file, you should have a Turnkey file with the name format of **Q4Ka-xGT-x.x.x.x-TurnKey.bin**.

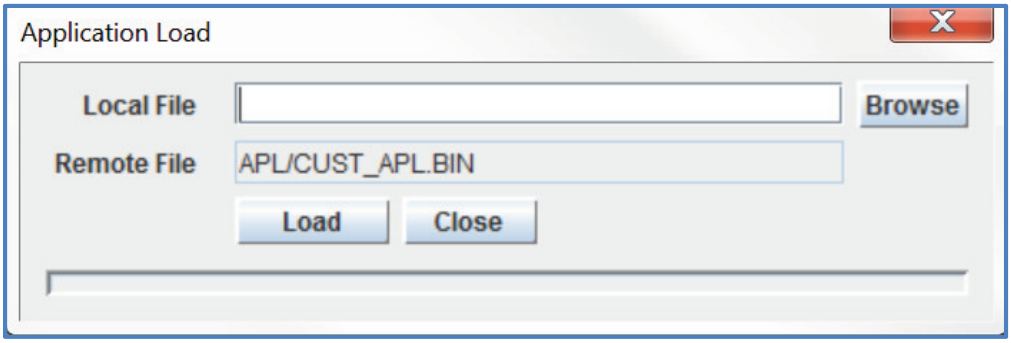
> See Appendix E - Software file naming convention for the key to the file names.

2. On the QCT screen, select **Flash →Load Application**.



A new screen will open for the application file's address.

3. After entering the address, select Load.



For more information on QCT and downloading the application, see Section 12.2.2.

2.6.2 Parameters used by Turnkey: (TK_) and (QCFG_)

The Turnkey application uses two different types of parameters: (**TK**_) and (**QCFG**_).

The parameters unique to the Turnkey application (**TK**_) are defaulted to send a message every ten minutes. The default message will contain the current time, the GPS location, the value of the Digital I/Os (DIOs) and analog inputs, and Parameter Group Number (PGN) information for PGN 65253. By default, the message is attempted over the GSM/GPRS network first. If that is not successful (or available), the application sends the message over satellite (depending on the modem type).

Turnkey also uses several QUAKE foundation configuration (**QCFG**_) parameters which specify the preferred network and SMTP and POP address information (if GSM/GPRS is used).

Note: All parameters used by Turnkey (TK_ and QCFG_) may be changed whether Turnkey is running or not. However, Turnkey must be restarted for the parameter change to take effect.

2.6.2.1 (TK_): Parameters unique to the Turnkey application

Table 2-1: Turnkey application parameters

Name	Description	Default Value	Config Type
TK_POWER_DOWN_AFTER_MSG	After Turnkey message is successfully sent, Power down modem = 1 Stay awake = 0	0	UINT8
TK_XMIT_INTERVAL	Time in seconds between successive messages sent from modem over GSM/GPRS or satellite.	600	UINT32
TK_RX_INTERVAL	Time in seconds between successive message receive attempts over GSM/GPRS. Set to 0 to disable unsolicited POP messages.	0	UINT32
TK_PARAM_MASK	Turnkey Parameter Mask, which controls the fields of data included in the message to transmit (shown in more detail below).	0xFFFFFFFF	UINT32
TK_POWER_DOWN_GSM_AFTER_MSG	After Turnkey message is successfully sent, Power down GSM/GPRS = 1, Do not power down = 0.	0	UINT8
TK_ENABLE	Enable Turnkey Application = 1, Disable Turnkey Application = 0	1	UINT8
TK_PGN0_NUMBER	PGN for desired J1939 message	65253	UINT16

The **TK_PARAM_MASK** bit fields are expanded in more detail in Table 2-2 below:

Table 2-2: Turnkey TK_PARAM_MASK bit fields

Bit Position in Mask	Description	Default Value
1	Message counter is incremented for every message sent while the modem is on	On
2	Julian time in seconds	On
3	Latitude	On
4	Longitude	On
5	Altitude in meters	On
6	Speed in kph	On
7	Heading	On
8	DIO readings	On
9	Unused	On
10	Value of Analog0	On
11	Value of Analog1	On
12	CAN data	On
13-32	Unused	On

The Turnkey parameter mask controls which fields are present in the message sent to the network. For example, if you want only the Julian time, Latitude, Longitude, Altitude, and Speed in your message, the value of **TK_PARAM_MASK** would be "0x3e" and your message size would be 20 bytes.

2.6.2.2 (QCFG_): Foundation configuration parameters

Turnkey has several parameters which are used by the QUAKE foundation code rather than by the Turnkey application. These QUAKE parameters control the network that Turnkey uses to send its messages, and the SMTP and POP addresses.

The default is to attempt to send messages via GPRS, and then via the satellite network on which the modem was activated and provisioned.

For more information on the foundation configuration parameters, see Chapter 7 - Configuration parameters.

2.6.2.2.1 GSM/GPRS configuration parameters

If GSM/GPRS will be used to send and receive Turnkey messages, it is necessary to configure the following SMTP and POP parameters:

Table 2-3: SMTP and POP configuration parameters

Name	Value (Hex)	Sample Values
QCFG_MODEM_APN_ADDRESS	0x9D	orbcomm.t-mobile.com
QCFG_SMTP_USER	0xA6	username@gmx.com
QCFG_SMTP_PASS	0xA7	password
QCFG_POP_USER	0xAC	username@gmx.com
QCFG_POP_PASS	0xAD	password
QCFG_SMTP_SERVER_ADDR	0xA4	mail.gmx.com
QCFG_POP_SERVER_ADDR	0xAA	pop.gmx.com
QCFG_SMTP_TO_ADDR	0xA8	username@quakeglobal.com
QCFG_SMTP_SUBJ	0xA9	This is a test subject…

2.6.3 Changing parameters used by Turnkey

A different method is used for modifying Turnkey application parameters than that used for setting foundation parameters.

2.6.3.1 Setting Turnkey (TK_) parameters

There are a number of ways to change the default values of the Turnkey application parameters. Two methods of changing the parameters will be shown here.

2.6.3.1.1 Via the MTS port

1. Close the QCT program if it is open, and start a Terminal Emulation program on a PC's serial port connected to the MTS port with the following settings:

   Baud rate: 4800 bps
   Data bits: 8
   Parity: None
   Stop bits: 1
   Flow control: None

2. The command to change a parameter is:

   ```
   AT+QKECA PARAMETER NAME, VALUE
   ```

   For example, to change the message transmit interval to send every minute, type:

   ```
   AT+QKECA TK_XMIT_INTERVAL,60
   ```

3. To examine the Turnkey settings, type:

   ```
   AT+QKECA?
   ```

The following data will be displayed:

```
+qkeca: TK_POWER_DOWN_AFTER_MSG=0
+qkeca: TK_XMIT_INTERVAL=60
+qkeca: TK_RX_INTERVAL=0
+qkeca: TK_PARAM_MASK=4294967295
+qkeca: TK_POWER_DOWN_GSM_AFTER_MSG=0
+qkeca: TK_ENABLE=1
+qkeca: TK_PGN0_NUMBER=65263
```

2.6.3.1.2 Via Over the Air (OTA)

It is possible to update the Turnkey parameters by sending an email or satellite message to the modem. The parameters can be in any order and any number of them may be updated at a time.

Note: The SMTP and POP parameters must have been previously configured over the MTS if using GSM/GPRS.

2.6.3.1.2.1 Sending OTA parameters via ORBCOMM

To send OTA Turnkey parameters via ORBCOMM, the "TO:" address must be in the format: ***modemIDx1@orbcomm.net.*** The subject line of the message can be anything. The body of the email must have the following format:

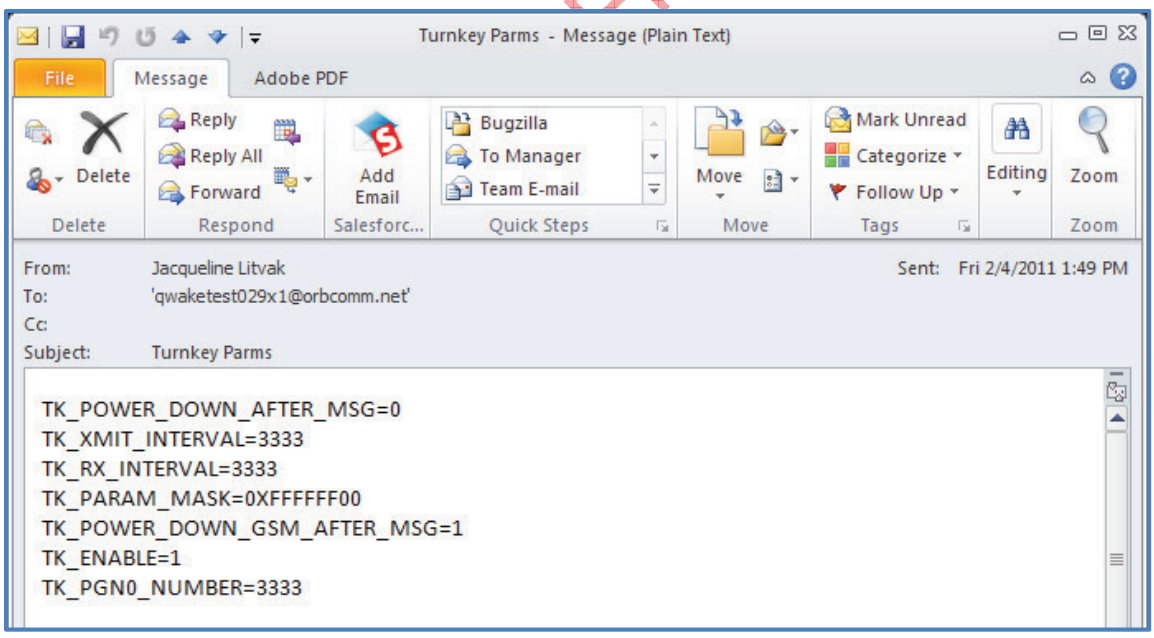


Figure 2-13: Sending OTA Turnkey parameters via ORBCOMM

2.6.3.1.2.2 Sending OTA parameters via Iridium

To send OTA Turnkey Parameters via Iridium, the "TO:" address is **data@sbd.iridium.com.** The subject line of the message must be the IMEI number of the modem. You must use an

attachment file to specify the parameters. The body of the email is blank. Figure 2-14 is an example of the Iridium email.

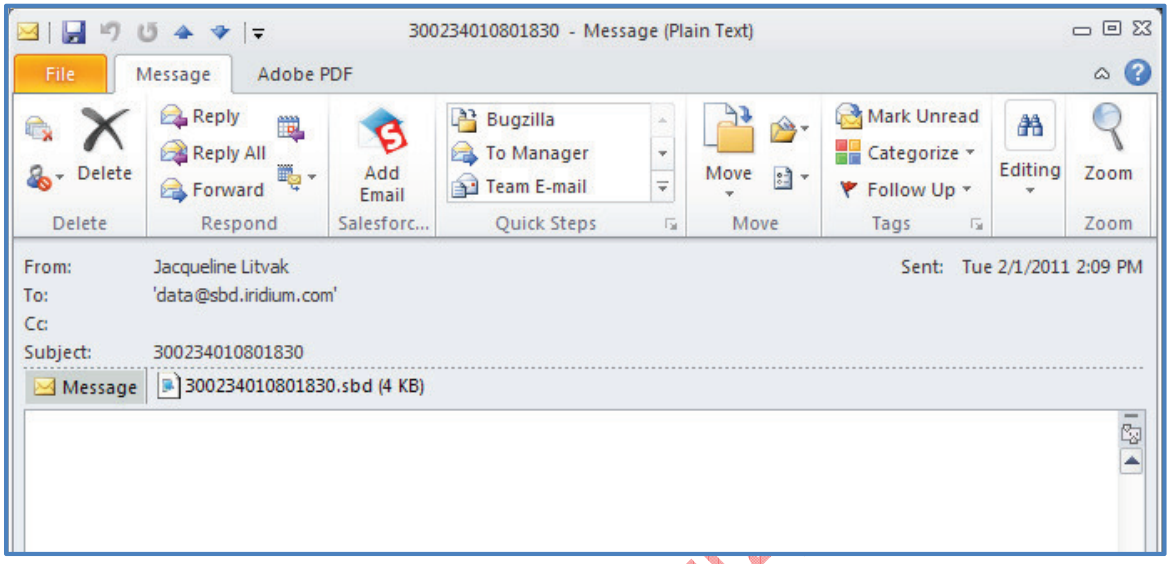


Figure 2-14: Sending OTA Turnkey parameters via Iridium (email)

Figure 2-15 is an example of the attached file.

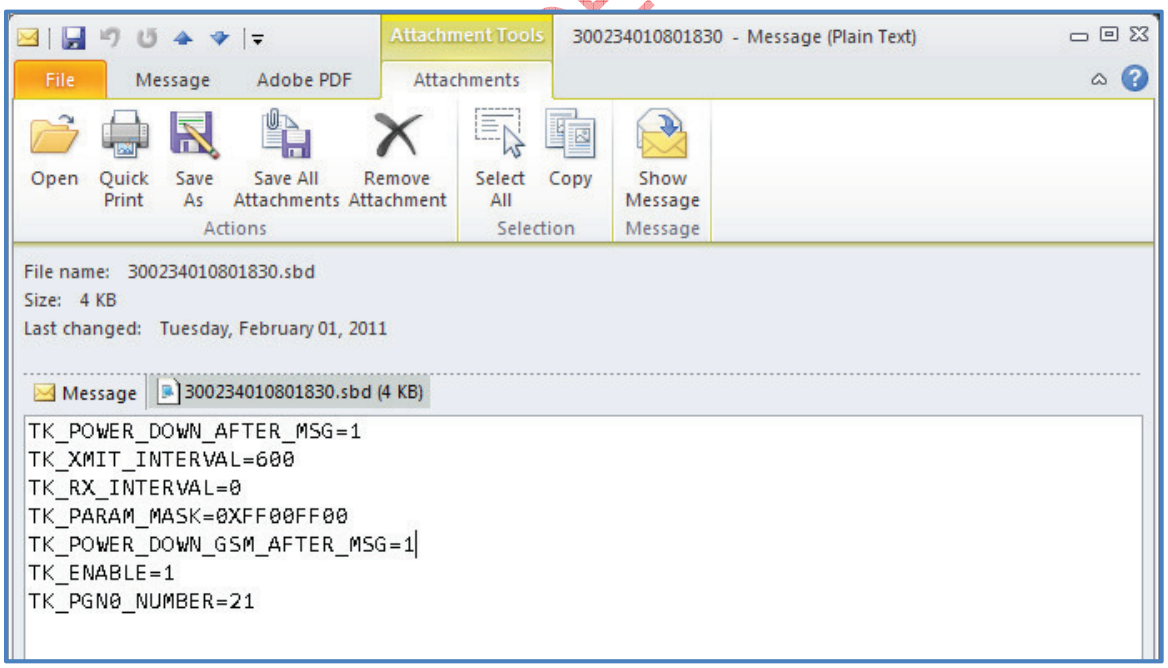


Figure 2-15: Sending OTA Turnkey parameters via Iridium (email attachment)

2.6.3.2 Setting foundation (QCFG_) parameters

The Logger port can be used to change the preferred network designation and also to set the SMTP and POP addresses.

1. Connect a Terminal Emulation program to the Logger port with the following settings:

   Baud rate: 115200 bps
   Data bits: 8
   Parity: None
   Stop bits: 1
   Flow control: None

2. Type the letters: 'U' 'C' 's'.
3. At the prompts, type the parameter's value in hex from Table 2-3, and then the new value.
4. The new values must be written to flash and the modem must be rebooted to save these new values. To do this, type 'd' 'R'.
5. After rebooting, Turnkey will use the new configuration parameter values.

For more information on the foundation configuration parameters, see Chapter 7 - Configuration parameters.

2.6.4 Turnkey message format

The modem-originated Turnkey message has the following format if all the fields in the **TK_PARAM_MASK** are set (0xFFFFFFFF):

Table 2-4: Turnkey message format

Size	Field Name	Description
4	messageCount	message count
4	timeJS	time of data collection in Julian seconds
4	gpsLatitude	latitude
4	gpsLongitude	longitude
4	gpsAltitude	altitude in meters
4	gpsSpeed	speed in kph
2	gpsHeading	heading in degrees * 100
1	allDig	all 8 digital inputs
1	spare0	spare input 0
4	ana0	analog0
4	ana1	analog1
2	canPgn0DataLen	size of PGN0 data
1	canPgn0Data [MAX_NUM_J1939_DATA_BYTES]	J1939 data from PGN0

Note: If the bit value in TK_PARAM_MASK is turned off, the associated bytes will not be in the message and the message size will change.

2.6.5 Running the Turnkey application

The Turnkey application operates as follows:

1. At power-up, a GPS fix is started.
2. When the transmit timer expires (**TK_XMIT_INTERVAL**), a message with GPS and additional configuration information (based on the contents of **TK_PARAM_MASK**) is sent to the preferred network.
3. When the message has been successfully sent, the application either:
   a. powers down GSM/GPRS module if **TK_POWER_DOWN_GSM_AFTER_MSG** is set
   b. powers down the modem if **TK_POWER_DOWN_AFTER_MSG** is set, or
   c. stays awake and attempts to transmit again after **TK_XMIT_INTERVAL**.
4. If the unit stays awake between transmissions, the application checks for unsolicited POP messages every **TK_RX_INTERVAL** (if greater than 0).

2.6.6 Turnkey Logger messages

2.6.6.1 Turnkey messages at boot up

When the modem boots with the Turnkey application loaded, the current settings of the Turnkey parameters will be displayed on the **Logger** port. If SMTP and POP addresses are configured, they will be displayed also. This log information provides the dates and version numbers of the QUAKE Turnkey and foundation code, as well as the values for Turnkey parameters and SMTP and POP address information.

Below is a sample log file:

```
Copyright (C) 2010 QUAKE Global Inc.
All rights reserved. This work is the copyrighted intellectual property
of QUAKE Global Incorporated, and may not be copied, decompiled,
modified,or distributed, in whole or in part, without the express
written permission of the copyright holder. The copyright notice above
does not evidence any actual or intended publication of such source
code.

Boot Loader Version 2.1
Built at 15:01:55 on Jun  9 2010
Verifying the image...
Loading Version 1.3 of the QUAKE Foundation
Noted: 3030.10065
Product: 1, Feature: a
Starting the image

CP Code version Mar 14 2011 11:03:38
Configuring RTC...
SYS_setTime: Updated system time status (Src RTC Sync 0)
Current Time: 14Mar11 00:00:00

This unpublished source file is the copyrighted intellectual property
of QUAKE Global Incorporated, and may not be copied, decompiled,
modified, or distributed, in whole or in part, without the express
written permission of the copyright holder. The copyright notice above
does not evidence any actual or intended publication of such source
code.

THIS PRODUCT IS COVERED BY THE FOLLOWING US PATENTS: 7,289,533.
OTHER PATENTS PENDING.

UTL_nvmProtectedRead: Updating /tffs0/BACKUP/CFGMGR.CM
desired_gwy_id: 1
QUAKE Global SC #QWAKETEST029
TL Code version 1.12.1
No ETS_CHANNEL_MODES; default to elapsed times inactive.
No SMH_WRITE_INTERVAL; default to 720 seconds.

Reading 1 MSN LL elements from NVM
MSN LL[0] Gwy 1 SCT: Msg 0 980167696 Gg 0 984084496 SCO: Msg 14 Gg 1
Rpt 1
Starting customer application
```

```
QUAKE Turnkey APL Version Apr  1 2011, 15:16:20
Turnkey parameters may be set using the CfgMgr Utils (type U C M to
access)


Parameter names and current settings are:
  TK_POWER_DOWN_AFTER_MSG      0
  TK_XMIT_INTERVAL             60
  TK_RX_INTERVAL               0
  TK_PARAM_MASK                0xffffffff
  TK_POWER_DOWN_GSM_AFTER_MSG  0
  TK_ENABLE                    1
  TK_PGN0_NUMBER               65263
TK: ORBCOMM Modem Startup
TK: TERR Modem Startup
---accessPointName = orbcomm.t-mobile.com
---serverName = mail.gmx.com
---serverPort = 25
---smtpUser = quaketest11@gmx.com
---smtpPass = Quaketest11
---smtpToAddress = jlitvak@quakeglobal.com
---smtpDefaultSubject = Testing
---accessPointName = orbcomm.t-mobile.com
---popServerName = pop.gmx.com
---popServerPort = 110
---popUser = quaketest11@gmx.com
---popPass =
TIMER_set: Timer 0 (timerType VOLATILE) Duration 60 Secs
TIMER_set: Timer 3 (timerType VOLATILE) Duration 360 Secs
```

2.6.6.2 Turnkey messages during transmission

Below is an example of a Turnkey message sent over GSM/GPRS (terrestrial network). For more information on Logger messages, see Chapter 5.

```
APL: TX Interval Timer - Sending message
No new GPS data
msg 1)len = 38: 0 0 0 0 97 CC D0 3A 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 4D D  0 0 3D D 0 0 0 0

Sending TKMsg from TERR!!!
```

2.7 Provisioning and activation

Upon receipt of the Q4000/QPRO, it is necessary to activate and provision the GSM/GPRS service and/or the satellite service before using the modem to transmit messages.

- GSM/GPRS customers must obtain a SIM card from their carrier and place it into the SIM slot located on the side of the Q4000. See Section 2.1.1.1 on how to install the SIM card.
- QPRO customers: the SIM card is installed at the factory and is inaccessible after that. The customer may provide un-activated SIM cards to QUAKE during production and activate them with their cellular provider upon deployment.

QUAKE Global evaluation and development kits include a demo account that can be activated for at least 60 days and will allow unlimited ORBCOMM or Iridium satellite data to be sent and received during this time. The GPRS data plan must be provisioned by the customer. Contact customersupport@quakeglobal.com for more information on provisioning for evaluation and development kits. Getting the demo account activated and provisioned for email usually takes about 1 day or less once QUAKE Global receives the desired destination email address.

Initially, many users create a new email address for modem messages. It is best to set up this new mailbox for testing purposes to avoid a flood of modem messages into your daily use email. See Chapter 4 for more information on activating and provisioning the modem.

2.8 Powering On/Off

2.8.1 Power on

The modem can be powered on in one of three ways:

1. the application of power;
2. the Real Time Clock;
3. assert Data Terminal Ready (DTR).

A typical operating scenario for a Q4000/QPRO is to power on (wake from sleep mode), perform a number of activities, and power off again (enter low-power sleep mode). It is important to understand the various ways to power the Q4000/QPRO on and off.

Application of Power - When an external power source is first connected to the modem, the device powers on, the software boots, and the device begins operation. When the modem has powered itself down and is in sleep mode, its power consumption is low.

Real Time Clock (RTC) - The on-board Real Time Clock (RTC) may generate a signal that causes the modem to power on from sleep mode. The RTC does not maintain the time when the power source is removed. The time is reset when the modem establishes communication with the first available network (GSM, GPS or Satellite Communication).

Data Terminal Ready (DTR) - If ORBCOMM configuration parameter 0x2f, pwr_dwn_mode=0, is configured and the MTS DTR line is asserted, the unit powers up or awakens from sleep mode (as long as power is applied). If the MTS DTR line is deasserted, the modem will initiate a controlled power-down sequence. For Iridium and Inmarsat modems, use QCFG parameter 0xb5 (QCFG_POWER_DOWN_MODE) instead of 0x2f. See Section 7.2 for information on changing QCFG parameters.

The DTR line has two functions:

1. It behaves as a Wakeup for the Q4000. In this functionality, a 1.8 V rise on the DTR line will wake up the Q4000.
2. It is a normal RS-232 signal on the MTS port. During this operation of the MTS port, it utilizes normal RS-232 levels with a 6V threshold, as specified in the Technical Data Sheet.

The DTR line does not support CMOS levels when it is behaving as a regular RS-232 serial port.

2.8.2 Power off

There are a number of ways in which a controlled power-down sequence can be initiated on the Q4000/QPRO modem:

- through a QCP call on the MTS port;
- by de-asserting the DTR line if the “power down mode” configuration parameter has been set;
- function calls from custom applications written in ‘C’ can be used to initiate controlled power downs from an internal application. Both QCP and the “C” programming library utilize the function “SYS_pwrDownModem(duration)”. This command can be used to:
    - power down the modem for a specific time interval;
    - wake at a specific time with the use of the RTC;
    - power down indefinitely and only be awakened by an external event such as assertion of DTR or the application of power.

Please see the QCP and API reference for more details.

3 Antenna setup

3.1 Antenna recommendations

3.1.1 ORBCOMM

3.1.1.1 Voltage Standing Wave Ratio (VSWR)

VSWR is a measure of how well the antenna is matched to the receiver/transmitter port(s). It is a measure of how much power is reflected from the antenna back to the transmitter output. If power is reflected back to the transmitter, it is being lost as heat.

- 1:1 – best case. This is a perfect match between the cable and antenna.
- 1.5:1 – good.
- > 2:1 – poor match. The antenna is both not receiving signals as efficiently as possible, and is prevented from radiating as much power as the transmitter PA is capable of putting out.

We recommend using an antenna with less than 2:1 VSWR. Use of an antenna with larger VSWR results in decreased messaging performance. Satisfactory operation can be achieved with a VSWR as high as 3:1; however, message delivery latencies could be increased by 100% or more. To determine the optimal VSWR and antenna for your specific application, we recommend testing various antennas, cabling, and mounting options over an extended period to determine which gives the best results.

An ORBCOMM antenna must be 50 ohm 137-150.05 MHz. Due to the fairly wide frequency range used by ORBCOMM and the variety of installation factors between antenna size, cost, and performance, it is not practical to achieve a VSWR of below 1.5:1 throughout the entire frequency range. To tune an antenna to ORBCOMM frequencies, the transmit band is best at 149 MHz.

Note: RF antennas connected to QUAKE modems should not be mounted closer than six feet to each other. There is a risk of overpowering the receiver if two modem antennas are mounted too closely to one another.

3.1.1.2 ORBCOMM satellite basics

- Direction of travel – West to East.
- Degrees of elevation – For Contiguous United States (CONUS): 85% of the time, satellite will be between 5˚ and 45˚ elevation.
- Satellite Footprint ~ 3000 miles.
- Pass is 10 to 12 minutes for regions between 20° and 50° latitude - North and South Hemisphere.

The figure below shows a typical Orbcomm satellite pass:

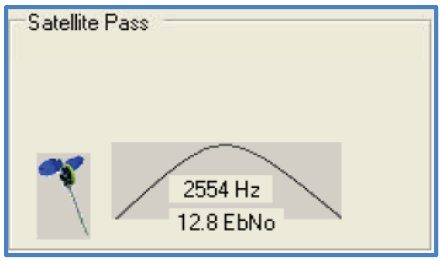


Figure 3-1: ORBCOMM satellite pass

Note that in the figure below, the area of weakest radiation is directly above 90° using a whip antenna. The area of strongest radiation is at 1/2λ. The gain increases as the angle approaches 0. The size of the ground plane affects the look angle of the antenna pattern. Maximum gain is at 10° - 30° above ground plane. Reducing the ground plane raises the look angle vertically; increasing the ground plane lowers the look angle horizontally.

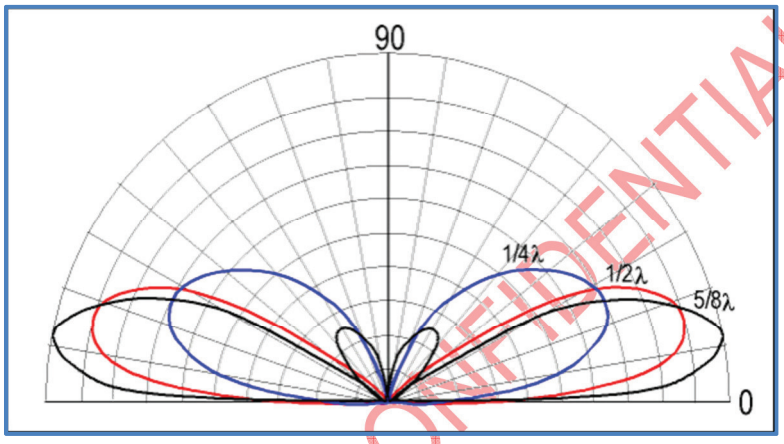


Figure 3-2: ORBCOMM areas of radiation

3.1.1.3 ORBCOMM ground plane

The most common means of producing a low angle of radiation from an antenna is to work the radiator against a simulated ground called a **Ground Plane**. A ground plane may be made from a large metal sheet or several wires or rods radiating from the base of the radiator.

Table 3-1: Ground plane - simulated ground

Antenna	Ground Plane
1/8 Whip	12” Diameter 12” x 12”
1/4 Whip	24” Diameter 24” x 24”
1/2 Wave	Not required

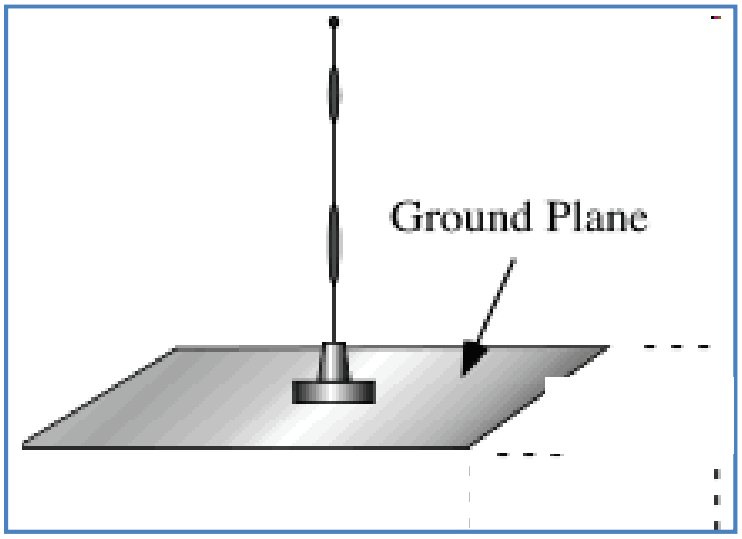


Figure 3-3: Ground Plane

Frequency		λ	λ/2	λ/4
137-138 MHz	2.2 m	85.9 in	42.9 in	21.5 in
148-150 MHz	2 m	79.3 in	39.6 in	19.8 in

Table 3-2: Antenna wavelength and gain

Antenna	Gain (dB)
Whip ¼, 1/2 , 5/8	Unity (0)
1/8	-4dB
Low Profile	-2 to -4
Quad-Helix	+3
Dipole *	+3 to +6

3.1.2 GPS

The GPS antenna should be 3.3 VDC active. For long cable lengths, we recommend gain of 25 dB in the Low Noise Amplifier. Ensure that the GPS antenna is located so it has an unobstructed view of the sky. Active antennas are usually low-profile patch types.

3.1.3 Iridium

Iridium Antennas must be approved by Iridium before being used on the Iridium network. A list of approved antennas can be found on Iridium's home page at www.iridium.com.

When selecting an Iridium antenna, make sure it is a 50 ohm, Gain 3dBi maximum, polarization Right Hand Circular Polarized (RHCP) and VSWR 1.5:1 or better (in both receive and transmit bands) for optimal messaging. Make sure that the Iridium antenna is located so it has an unobstructed view of the sky.

There cannot be more than a 3 dB loss between the antenna and the modem.

The antenna must be placed greater than 20cm from a person. If antenna is placed within 20cm of a person, the system integrator needs to assess the final product against SAR regulation.

3.1.4 Inmarsat

There is currently one antenna version available for use, which is part number ST901009-ATY. It is a non-standard, custom colored, external antenna with TNC connector. The antenna should be mounted where it has an unobstructed view of the sky and satellite. For a mobile installation, this means at the highest point on the vehicle where it has a clear view in all directions. No object should block the antenna above a 20° elevation angle in order to ensure an optimal line of sight with the satellite.

3.1.5 GSM/GPRS

The GSM/GPRS antenna does not require an unobstructed view of the sky. However, for optimal performance, an unobstructed view is preferable.

GSM antenna requirements

- Gain must be less than 3dBi.
- Must be placed greater than 20cm from a person. If antenna is placed within 20cm of a person, the system integrator needs to assess the final product against SAR regulation.
- If the antenna is co-located and transmitting simultaneously with another antenna, additional FCC/IC testing may be required.
- Antenna cannot be placed within a metal shield and must be installed with care to avoid any interference with other electronic devices.

3.2 Antenna grounding

Grounding may be done in several ways:

- Fixed Site: Grounding Rods should be connected to the antenna shield. Keep grounding systems as short as possible.
- Mobile: Chassis Ground should be connected to the negative side of the battery. Make sure all connections are corrosion free.
- Marine Grounding Systems: Skilled marine electricians should be consulted when adding an ORBCOMM solution.

Beware of high power antennas, urban canyons and other structures that block the line of sight (LOS) to the satellite. Below are some antenna installation mishaps:

Figure 3-4: Antennas with blocked view of sky

Figure 3-5: Tipped over antenna

3.3 Noise problems

To locate noise problems, start with a visual inspection of RF connectors. Look for water leakage or corrosion. A spectrum analyzer, VSWR meter or noise detector is helpful for locating problems. Noise sources for broadband may be electric power lines, electric motors or generators, switching power sources or microprocessors. Noise sources for narrowband may be radio/TV towers, pager transmitters or cell phones.

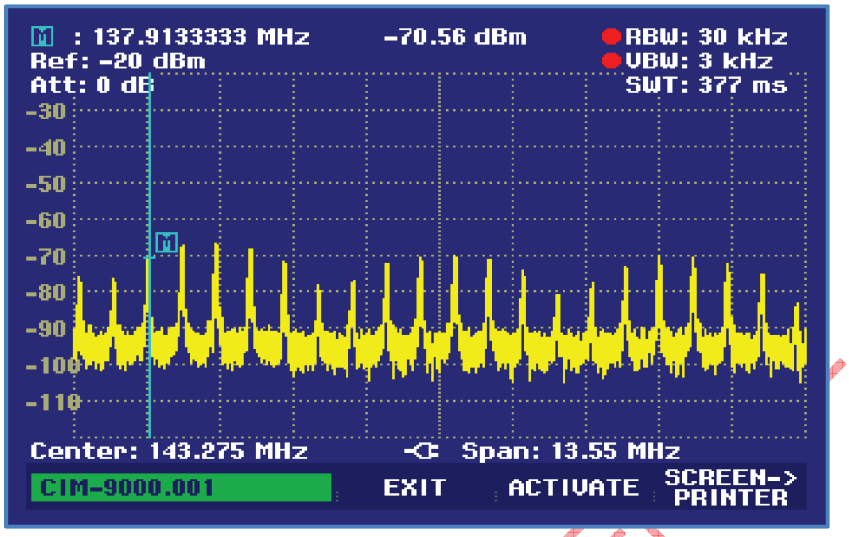


Figure 3-6: Noise - radiated and conducted

Noise suppression parts include ferrite beads, EMI cores and RF filters. Techniques include twisting power lines, separating power from signal, using right angles, covering the band of interest and double wrapping wire and placing it near the noise source.

4 Activating and provisioning the modem

Each Q4000/QPRO must be provisioned and activated on the network(s) supported by the modem. Modems purchased with QUAKE Global Development Kits are supplied with two months of free airtime on the ORBCOMM or Iridium satellite networks. Otherwise, the customer is responsible for activating and provisioning the modem(s). The following information is required for provisioning and activation.

4.1 ORBCOMM

4.1.1 Activation

The Q4000/QPRO uses a serial ID for activation with the ORBCOMM network. This 12-digit number is located on the Q4000's external white label, and is also available by querying configuration parameter 0x31 via the QUAKE Configuration Tool (QCT) interface (see below).

Note: The modem cannot transmit until the serial ID is activated with ORBCOMM. Attempting to use the modem before it is activated by ORBCOMM may cause the modem to be shut out of the ORBCOMM network for 24 hours.

Contact ORBCOMM to activate the Serial ID. You will also need the Type Approval Number (TAN), located on the white label (**819QWI**).

4.1.2 Provisioning

An ORBCOMM modem is provisioned by specifying the following selections to ORBCOMM customer support:

Roaming and Gateway Earth Station - A modem must be provisioned on every ORBCOMM Gateway that it uses. If the modem needs to send messages over multiple Gateways, it must be provisioned on each of those Gateways.

Location Type – The location type determines how the ORBCOMM Gateway delivers messages to the modem.

- "**Fixed**" - for fixed installations or modems limited to a metropolitan area.
- "**Regional Mobile**" - for modems that range over a wider but still limited area—like the Southeastern United States or the Iberian Peninsula.
- "**Mobile**" - for modems that may be found almost anywhere across a continent.

Binary Data in Globalgrams - User applications must be specially provisioned to send **binary** data in Globalgrams.

Addressing – An SMTP email address is assigned to each modem based on its Serial ID. Modems that are accessed via the IP gateway also have a valid SMTP email address.

PIN Code - If a Personal Identification Number (PIN) is used, it must be specified when the modem is provisioned. The PIN code is also programmed into the modem and is verified during most communications between the Gateway and the modem.

Delivery plan – Delivery plan details how ORBCOMM attempts to deliver messages to the modem. There are 4 different Delivery Plans:

1. ***Automatic delivery attempts*:** the number of times immediately upon receipt and at one-minute intervals that the ORBCOMM Gateway attempts to deliver a modem-terminated message.
2. ***Time to hold*:** the maximum time the ORBCOMM Gateway holds the message before returning it as undeliverable.
3. ***Deletion after final attempt*:** whether the message is deleted after the automatic delivery attempts are exhausted, or held until the time to hold has been reached.
4. ***Use of piggybacking*:** whether a message delivery attempt should be triggered by successful delivery of another message in either direction.

IP Gateway - The modem may be activated to use an XML gateway in which data are transferred directly between servers using standard HTTP requests and XML responses instead of email.

Speed Dials - Each serial ID may be provisioned with up to eight email addresses known as speed dials or originator/recipient (O/R) addresses.

SIM Card Number - If the modem supports GSM/GPRS, you must also specify the SIM card number to ORBCOMM. This 19 digit number is located on the attached SIM card (use all numbers minus the 'F' at the end).

4.2 GPRS (non-ORBCOMM modems)

4.2.1 Activation

GPRS SIM cards may be activated using any GSM/GPRS provider with an applicable data plan. The data plan must use **APN addressing** for the modem and must support **data transfer**. For example, ORBCOMM's T-Mobile APN address is **"orbcomm.t-mobile.com".** Different networks have their own requirements for APN addressing, usernames and passwords. Please consult your airtime reseller for more information on using the GPRS network.

Note: Issue QCP command TERR_getInfo() to obtain this info.

4.3 Iridium

4.3.1 Activation

The modem has an **IMEI number** for activation with the Iridium network. This number is located on the modem's white label, and is also available via QUAKE Communications Protocol (QCP) (see below), with the call "**`IRI_getIMEIQCP`**" and through the Application Programming Interface (API) with the call "**`IRI_getIMEI`**".

The IMEI number must be activated with Iridium or an airtime reseller before the modem can be used. If a message is sent without the modem being activated, it is ignored by the Iridium network. For this reason, it is possible to develop and send live messages without the modem being "turned off" by the network.