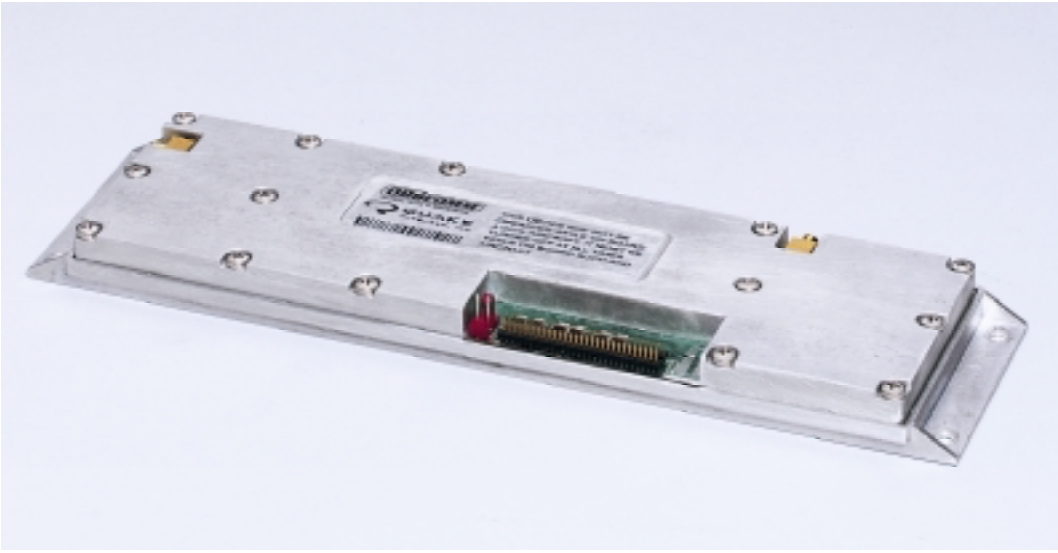
QUAKE WIRELESS, INC.

1500 Product Data Sheet

VERSION 1.1



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1 Scope

This document contains a description of the overall operation and characteristics of the **Q1500**. It also describes the specifications of the input/output signals used to interface the **Q1500** to a customer interface board. Included is a description of the signals on the 60-pin connector, which is the customer's interface to the OEM module. Also included is a list of the normal operating modes along with an explanation of each.

2 What is the ORBCOMM System?

The ORBCOMM System is a wireless, two-way global satellite communications network. It consists of 28 Low Earth Orbit (LEO) satellites, national or regional Gateway Earth Stations and Network Control Centers, and the global Network Operations Center in Dulles, Virginia. The system provides data communications between mobile subscriber equipment and the operator via the Internet or dedicated leased lines for high volume operators.

3 GENERAL INFORMAION

The **Q1500** Core Modem has a custom built ASIC for ORBCOMM message processing and customer interfacing, a high performance Radio Frequency (RF) design for to communicating with the ORBCOMM satellite system, and an on-board Global Positioning System (GPS). The **Q1500** includes application software and an easy to use customer interface that enables each modem to be tailor fit for a wide variety of customer specific applications. The unit can support five analog inputs, eight digital Input/Outputs (I/O), and two Serial Interfaces. (Refer to the "Interfacing to the Core Modem" section for more detailed information.)

3.1 Power

Table 1: Current Draw

MODE	CURRENT
Sleep	Less than 50uA
Standard Operating Modes	80mA-140mA
ORBCOMM Transmit	2A

Input Power Requirements:

- 12VDC +/- 10%, 20mVpp ripple
- Maximum current draw: 2 A

3.2 Environmental Specifications

- Operating Temperature: -40 C to +85 C
- Storage Temperature: -50C to +85 C

3.3 Certifications

CE, FCC, and ETSI (pending approval)

3.4 Communications

Transmit Frequency: 148.000 to 150.050 MHz
Receive Frequency: 137.000 to 138.000 MHz
Transmit Power: 5W (Min)
Data Rates : 2400 bps Uplink
: 4800 bps Downlink

3.5 Global Positioning System

The **Q1500** uses an "EXACT" Philips GPS chip-set. Some features include: Eight parallel channels capable of tracking eight satellites at the same time, Rapid-Time-To-First-Fix (TTFF), and accuracy within 25-100 meters.

3.6 External Connectors

There are three external connectors that interface to the **Q1500**.

Table 2: External Connectors

Name	OEM Module	Customer Interface
Interface Conn. 60 pin Header (.050milx.100mil)	Male 30x2 keyed (AMP 103911-3)	Female 30x2 keyed cable style
RF Antenna (50ohm input impedance)	Female OSX/MCX type*	Male OSX/MCX type
GPS Antenna (50 ohm input impedance)	Female OSX/MCX type*	Male OSX/MCX type

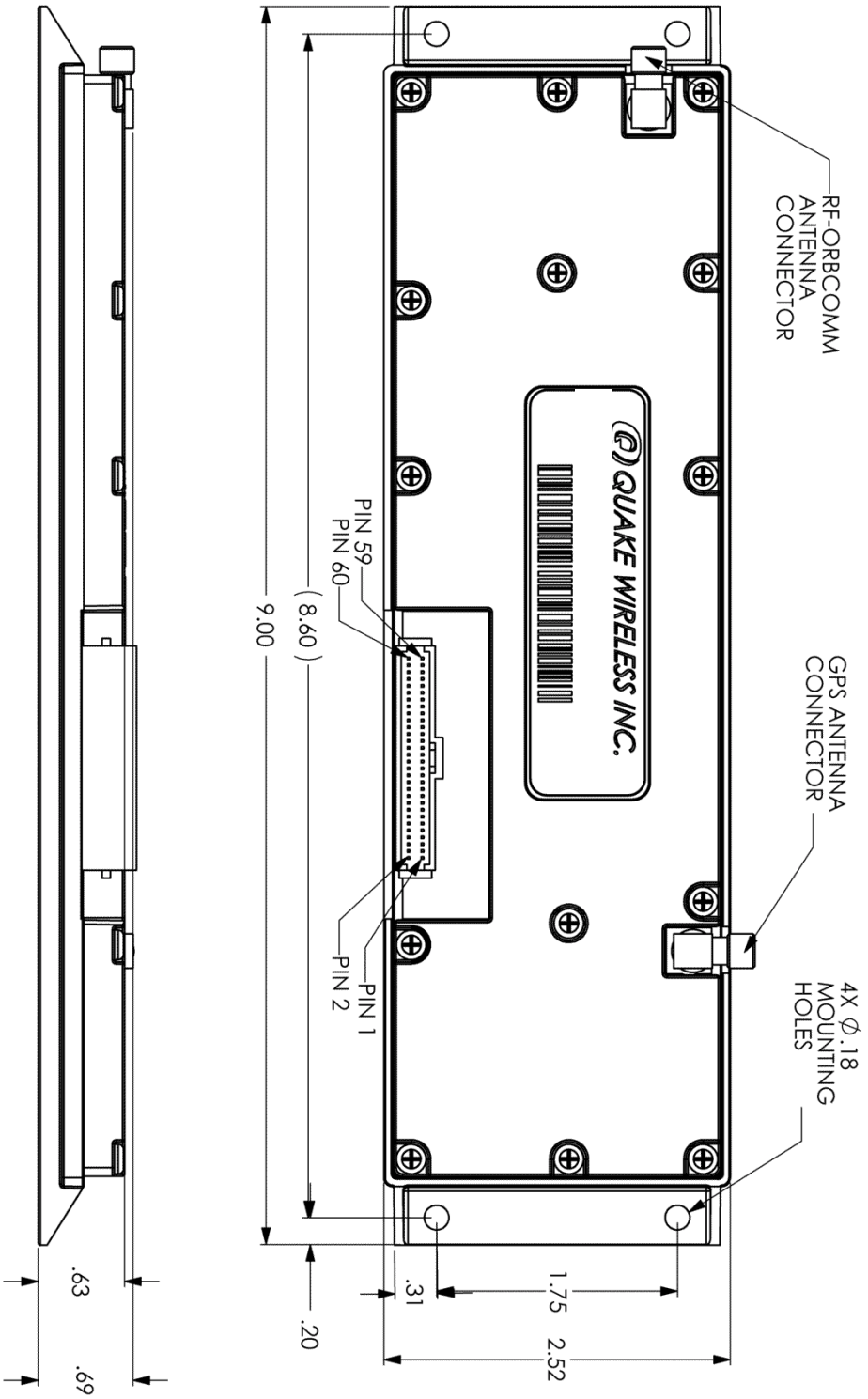
*** Consult with Quake Wireless for connector options and suitable antennae.**

3.7 Physical Specifications

The **Q1500** is encased in a rugged clamshell style shield assembly.

- Size: 9" x 2.6" x 0.7"
- Weight: 0.5 lbs

Figure 1: Physical Dimensions



4 INTERFACING TO THE Q1500:

4.1 Interface Connector

The **Q1500** has a 60-pin interface connector which includes power and data lines. The **Q1500** used in the OEM version has a polarized male connector. The signals are alternated with grounds to allow for the use of a ribbon cable.

Table 3: Interface Connector Pinout

Q1500 CONNECTOR			
3V3	1	2	GND
RESET_B	3	4	GND
PS_SYNC	5	6	GND
BAT_PRESENT	7	8	GND
LVOLT_INT	9	10	GND
PM_COUT_B	11	12	GND
DIG_IO0	13	14	GND
DIG_IO1	15	16	GND
DIG_IO2	17	18	GND
DIG_IO3	19	20	GND
DIG_IO4	21	22	GND
DIG_IO5	23	24	GND
DIG_IO6	25	26	GND
DIG_IO7	27	28	GND
A_IN0	29	30	GND
A_IN1	31	32	GND
A_IN2	33	34	GND
A_IN3	35	36	GND
A_IN4	37	38	GND
SCL	39	40	GND
SDA	41	42	GND
LOGGER_RX	43	44	GND
MTS_DTR	45	46	MTS_RTS
MTS_TX	47	48	MTS_CTS
LOGGER_TX	49	50	MTS_DSR
MTS_RX	51	52	MTS_CD
NOT USED	53	54	NOT USED
12V	55	56	NOT USED
12V	57	58	NOT USED
12V	59	60	NOT USED

4.2 Signal Descriptions

The signals on the interface connector perform the following functions:

- Power
- Power control
- Digital I/O
- Analog Inputs
- I2C
- Serial Ports

Power

- **12V**

12V Power is supplied through 3 pins to the **Q1500**. This is the sole power source for the **Q1500**. The power supply must be able to provide 2 Amps maximum current drive at 12V +/- 10%, with less than 20mVpp ripple. High current drive is required during transmits, with duration of no more than a few seconds.

Note:
For applications where the 60-pin connector is not necessary, an alternate 2-pin header is available for the purpose of applying 12V power to the **Q1500**.

- **3V3**

The **Q1500** regulates 3.3V from the 12V supply. The majority of the **Q1500** operates at 3.3V. The 3.3V power line is available for customer interface logic. The maximum current load a customer can place on this line is 0.5A.

Power Control

The following four signals were designed into the **Q1500** specifically for use with the QHE2500 Interface Board. These signals would generally not be used in OEM applications.

- **PS_SYNC**

This signal is an output from the ASIC on the **Q1500**. It is a programmable 3V square wave used to synchronize the on-board power supply to a frequency which has been selected to minimize interference on the **Q1500**.

- **V_STBY**

The Standby Voltage line is an input to the **Q1500**. It is used as a low power standby signal during Sleep Mode. The voltage may be 5–12V. This signal works in conjunction with the IF_SLEEP signal to enable a low power mode on an interface board. External circuitry and even the 12V regulator can be powered off or held in a low power state while the Core Modem is in Sleep Mode. If the 12V regulator is disabled during Sleep Mode, this signal is required to remain high in order for the **Q1500** to wake from Sleep. If the 12V input power remains high through Sleep Mode, this signal is not used.

- **SLEEP**

The Interface Board Sleep line is an output of the wake-up circuitry on the **Q1500**. It is an active high signal which indicates that the **Q1500** is in Sleep Mode. It may be used to control circuitry on the customer's interface card. For example, in the QHE2500, this signal is used to enable the 12V regulator when in a low state, and disable it when high. This minimizes the overall current draw when in Sleep Mode.

- **RESET_B**

The Reset line is an output of the power supervisory circuit on the **Q1500**. It is a 3V active low signal, which is held low for 350ms upon power up, and triggered when the 3.3V bus falls below 2.9V. This signal is used as the main reset for the **Q1500** and is also available to the customer interface card.

Digital I/O

- **DIG_IO0:7**

Eight digital lines are provided for interfacing with customer logic or collecting sensor data. Each line may be individually configured through software as either an input or an output. Outputs may be LVCMOS, or Open Collector. It is important that the hardware on the interface card corresponds with the input/output configuration of the software. The interface card must provide protection circuitry which will prevent a conflict of drivers on the digital I/O lines. A digital I/O line configured as an output may be damaged if the customer drives the line as an input. Signals are referenced to system ground (BATTERY-).

Analog Inputs

- **AIN0:4**

Five Analog Input lines are available for interfacing with customer sensors. Signal conditioning may be required to scale sensor data to match the range of the **Q1500**'s analog to digital converter. The input voltage range is 0 to 1V. Signals are referenced to system ground (BATTERY-).

I2C

- **SCL,SDA**

The **Q1500** ASIC has an embedded I2C serial interface host module. The SCL and the SDA signals are the clock and data lines, respectively. Slave components may be connected as peripherals to the processor. The on-board Real Time Clock (RTC) uses this interface. Special considerations must be addressed when using these lines to ensure that the interface to the RTC is not impacted. The maximum capacitive load on each line is limited to 250pF.

Serial Ports

- **MTS**

The complete set of RS-232 lines are available for the MTS port (Rx, Tx, DTR, RTS, CD, DSR, and CTS). The signal names are from the perspective of the customer. The interface protocol for this port complies with the ORBCOMM serial specification. The DTR line is used in the power supply wake-up circuitry to wake up the **Q1500**. It is also used to wake up the ASIC when the power is on, and the ASIC is in a low-power sleep mode.

- **LOGGER**

This Rx/Tx pair is available for a second serial port. This port is named from the perspective of the **Q1500**, as it is typically used for logging and debugging activities.

4.3 Specifications

Table 4: Interface Connector Electrical Specifications

Signal	Type	Max Voltage	Max Current Output Drive	Notes
12V	input	13.2V	----	12V +/-10%, 20mVpp ripple
GND	input	----	----	
3V3	output	3.6V	0.5A	
RESET_B	output	3.6V	30mA	Triggers when **3V3** is < 2.9V
PS_SYNC	output	3.6V	4mA	Variable sync frequency
V_STBY	input	12V	----	5V minimum voltage
SLEEP	output	12V	100mA	
DIG_IO0	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO1	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO2	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO3	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO4	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO5	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO6	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
DIG_IO7	input/output	3.6V/3.6V	--- / 4mA	5V TTL Compatible
AN_IN0	input	1V	----	Range: 0 – 1V
AN_IN1	input	1V	----	Range: 0 – 1V
AN_IN2	input	1V	----	Range: 0 – 1V
AN_IN3	input	1V	----	Range: 0 – 1V
AN_IN4	input	1V	----	Range: 0 – 1V
SCL	input/output	3.6V/3.6V	--- / 4mA	250pF max capacitave load
SDA	input/output	3.6V/3.6V	--- / 4mA	250pF max capacitave load
MTS_RX	output	6V	15mA	RS-232
MTS_TX	input	30V	----	RS-232
MTS_DTR	input	30V	----	RS-232
MTS_RTS	input	30V	----	RS-232
MTS_CD	output	6V	15mA	RS-232
MTS_DSR	output	6V	15mA	RS-232
MTS_CTS	output	6V	15mA	RS-232
LOGGER_TX	output	6V	15mA	RS-232
LOGGER_RX	input	30V	----	RS-232

5 Functions of the Q1500

The **Q1500** is designed to interface to either a mobile or fixed asset. It can sample input from customer sensors or determine location through an on-board GPS receiver. Information can also be transferred to the **Q1500** through a serial port. Short messages may be transmitted through the ORBCOMM system on regular intervals, or based on a specified event. The **Q1500** is highly configurable, and can be easily reconfigured through the serial port or remotely over the air.

5.1 Modes of Operation

Functional Modes

- **Sleep**

The **Q1500** conducts a controlled shutdown that includes a data save consisting of unsent messages and configuration parameters. In this mode the Real Time Clock (RTC) will continue to operate powered by the on-board lithium battery, and will automatically wake up the unit at a preprogrammed time. A power cycle, or external DTR pulse would also wake up the unit.

- **Standby**

In this mode the **Q1500** is in a constant receive mode. (Depending on the availability of the Orbcomm satellite the unit will be receiving satellite downlink information or searching for a downlink.) The RF portion of the modem is active in this mode.

- **Data Collection**

In this mode the control processor (CP) is active. The **Q1500** may be sampling data inputs, interfacing with the customer's equipment through the serial port or digital control logic, or interacting with other **Q1500** Subsystems. The CP is used to power on, control and collect data from the RF and GPS Subsystems. The CP is active during its interaction with these subsystems, but does not need to stay active while the other subsystems run their tasks.

- **Position Calculation**

The GPS Subsystem is available as an option on the **Q1500**. When installed, the GPS is powered on only when the CP requests a position calculation. This subsystem has its own Real Time Clock, which shares the on-board battery during Sleep and Power Down Modes.

- **Idle**

When the **Q1500** is powered up, the CP can sit in a low power mode and await an event. The event may be a digital input, a message on either serial port, or a timed wakeup interrupt. The RF and GPS subsystems may be running independently of the central processor. For example, the CP can power on the GPS, go into an idle state while the GPS establishes a position, and then the CP can wake itself up after a fixed time to query the GPS for position data.

- **Transmit**

In this mode the unit is sending an outgoing message. It could be from an alarm condition, an application event, a scheduled report, in response to a remote inquiry, or the **Q1500** may query the ORBCOMM system looking for incoming messages.

Power Consumption

The **Q1500** is designed for low power battery applications. Portions of the modem may be powered on and off independently to minimize current draw. Power consumption is a function of how the **Q1500** is configured to operate. The amount of time the **Q1500** spends in each of its states will determine the overall current draw.

Table 5: Current Draw of Functional Blocks

MODE	CURRENT DRAW
SLEEP	20uA
POWER UP	80mA
RF RECEIVE	20mA
GPS RECEIVE	40mA
TRANSMIT	2A

Note: These are typical, not maximum values

When the **Q1500** is in Sleep Mode, the 12V input is gated off and the 3.3V regulator is shut down. The on-board battery supplies power to the RTC, which may be used as a timer to wake up the Power Subsystem. In the Q2500 Communicators, the PM_COUT_B signal is used to power down the 12V regulator on the customer interface board, so there is no power on the 12V line while in sleep mode. For applications where the 12V line does stay active, the maximum current draw is 50uA.

Standard operating modes would include Standby, Idle, and Data Collection Modes. The lowest power mode would be where the RF and GPS Subsystems are powered off , resulting in 80mA of current draw. Each of the Subsystems may operate independently. The current consumption for each Subsystem is isolated, therefore it is additive. In the case where the modem is in Standby Mode and constantly sensing inputs, but not calculating a GPS location, the current draw would be:

Power Up	80mA	
RF Receive	20mA	
	100mA	Standby & Data Collection

5.2 Configurable parameters

The software for the **Q1500** is extremely flexible, allowing each application to be tailored to the customer's specific needs. The application code is driven by an event table. The actions performed as the result of an event are defined by the event table. Actions may be to collect certain pieces of data, to change modes (Standby, Sleep, etc.), or to send a formatted message. The **Q1500** can cycle through a defined pattern of Sleep, Sample, and Report cycles. Or it could be activated by an external event to take action.

What causes an event?

- **Timers**

The **Q1500** has several timers for scheduling activities, including a Real Time Clock which is always running. Timers can be set to cause the **Q1500** to change modes, scheduling when the **Q1500** is on Standby and how long the **Q1500** sleeps. Events can be scheduled as frequently as every second, and as seldom as once a month.

- **Alarms**

When the **Q1500** is powered on, individual digital inputs may be configured as interrupts. The transition of a digital input from low to high can be considered an event which will interrupt the processor and can wake the CP from the Idle Mode.

- **Queries**

An external device connected to a serial port could be considered an event condition. If in Sleep Mode or Idle Mode, the **Q1500** could be awakened by the DTR signal. Also, an inquiry from the ORBCOMM system could solicit a response from the **Q1500**. The **Q1500** would have to be in Standby Mode to receive the remote inquiry.

What happens when an event occurs?

- **Sample Inputs**

An event could instruct the CP to sample any or all of its active inputs, or to perform a position calculation if GPS is installed. Digital sensors can be configured as active high or active low. Analog sensors can be set to 10-bit resolution or 12-bit resolution (average of 16 10-bit samples). Reporting priority can be associated with sensor readings – immediate, next scheduled, never (wait until polled).

- **Send Control Signal to Customer Equipment**

An event could trigger an output, or start a series of events which sends control signals to the customer's equipment. The Digital I/O lines can be configured as output lines which may control switches to the customer's logic. Also, a message may be sent through the serial port to communicate with customer equipment.

- **Transmit a Message**

An event could instruct the **Q1500** to send a message through the ORBCOMM system. Up to 100 user configurable message formats can be created. Each event could be associated with its own message type.

- **Nothing (Polled Only Modem)**

A **Q1500** may be configured to transmit only when queried remotely through the ORBCOMM system, or through the serial port.

5.3 Setting Parameters

- **Leoutil**

Leoutil is a Windows based application that interfaces to the **Q1500** through the MTS port utilizing the ORBCOMM serial interface protocol. It provides service and support capability allowing the user to perform functions such as configuration, diagnostics, and reprogramming.

- **Remote**

Utilizing the ORBCOMM serial protocol, the **Q1500**'s configuration parameters can be changed with an over the air interface.