# Quest™ Modem Quick Start Guide

V2.5, August 2020

TXMission Inc
30 S. Calle Cesar Chavez, Suite D
Santa Barbara, CA 93103, USA
Tel: +1 805 965 3669

TXMission Ltd
CP House, Otterspool Way
Watford, WD25 8HU, UK
Tel: +44 1923 889 542

https://txmission.com

# Contents

# 1 Introduction

The **Quest™** software defined radio (**Figure 1-1**) is a highly integrated, low-power communications processor board for smallsat and airborne payload processing and data communications.

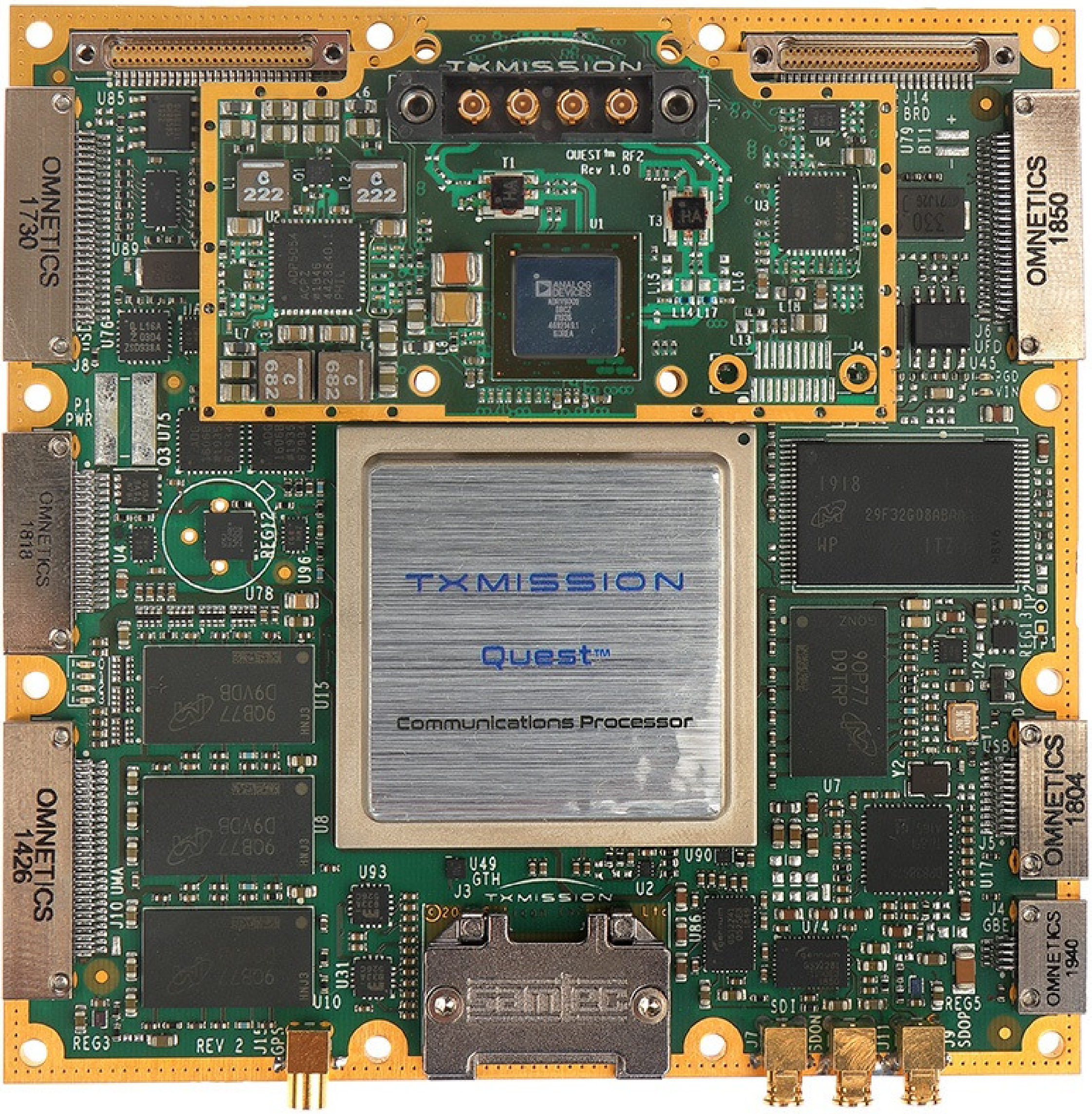


**Figure 1-1: Quest™ Onboard Modem**

It is built around a powerful system-on-chip that incorporates a quad-core central processor, a dedicated graphics processor, memory and programmable logic. This is closely coupled to a high-performance software defined radio (SDR) that supports a wide range of satellite modem communication standards, including DVB-S2/S2X and CCSDS. DVB-S2X brings considerable advantages to communications links, requiring only 25% of the power (SNR) of a conventional system to achieve the same quality of service. It supports ACM (Adaptive Coding and Modulation) which continuously changes the data transfer rate to maximize throughput for the ever-changing SNR conditions encountered (such as when a LEO satellite passes over a ground station). Proprietary extensions to these standards improve the performance of LEO applications further and include optimised Doppler tracking, low peak-to-average-power (PAPR) modes and transmit pre-distortion to enhance signal quality.

In addition, the communications processor board includes a wide variety of physical control and data interfaces designed to ensure compatibility with the numerous buses used to interconnect the various satellite and airborne payload subsystems. Although a standard PC104 connector is not included, PC104 is supported functionally down to pin level and, if required, a cable can be supplied that allows the board to be connected to the user's mating equipment via a standard PC104 connector.

Several variants of the board are available. Image and video compression, along with radiation tolerance, are supported only on the High-Performance board variant. Radiation tolerance is achieved using radiation hardened components in the key areas that are fundamental to reliability, namely, power supply, watchdog monitor and the non-volatile memory in which the software application is stored. Should a severe radiation event occur that causes the application to crash then the watchdog monitor will intervene, causing the board to be reset and the application to be reloaded from the non-volatile storage, all from radiation hardend parts. For less severe radiation events, other mechanisms ensure the correction of errors such as the data contents of specific memory locations that have been corrupted.

Various RF solutions are available. Direct support is included for UHF, VHF, IF, L-band, S-band and C-band. Other bands (C, Ku and Ka) are supported through custom solutions that are developed on a project-by-project basis. Compact, all-in-one solutions can be designed to incorporate SSPA, LNA and diplexer/duplexor/filter arrangements, as required.

For users who have their own RF solution, a high-speed JESD digital interface is available that provides a digital modulated signal for onward transmission. This can be fed a down-converted digital version of the received signal for onboard demodulation. The S-band board provides direct up/down conversion at all frequencies up to 6GHz (covering IF, L-band and S-band). The modulated output from this board is an analog signal that connects to the user's power amplification. Likewise, the user's received signal from the antenna can be connected to the S-band board for (further) down conversion and demodulation. It is also possible to take the modulated RF output from the S-band board at any frequency up to 6GHz and then up-convert this again using the user's own high-frequency RF solution (and likewise for down conversion).

The **Quest™** board supports up to 128GB of mass storage for storing the payload mission data prior to download. A software development kit allows the satellite's onboard computer (also known as the flight computer) application to be hosted on the **Quest™** board. The support for hosting payload and onboard computer processing potentially negates the need for any other processing elements on the satellite, allowing them all to be integrated on the communications processor board. TXMission hardware products are all based on the use of Yocto Linux.

The **Connect™** ground station modem has similar functional capabilities to the **Quest™** board. However, the extent that the user can interface to the **Connect™** modem is limited to the connectors brought out on the back panel of the modem.

Please contact us regarding other requirements, such as full radiation hardening, support for higher data rates, etc. As well as supporting earth observation applications, TXMission is actively pursuing other application areas including IoT edge networking, 5G, software defined networks, UAVs, quantum encryption key distribution in space, etc.

# 2 Quick Start Guide

## 2.1 Bench Setup

The Quest modem can be provided as a board product or within an enclosure. When provided as a board product, it is convenient to interface to the modem via a TXMission test jig, as this simplifies the cable and power arrangements. For modems in an enclosure, a set of custom cables are required, for mating to whichever connectors are being used.

When used as a board product, the modem runs from a 5V supply. When fitted inside TXMission's standard enclosure, however, the modem requires a 12V supply.

The general Quest modem setup for board products is shown in **Figure 2-1**. If the modem is in an enclosure then the same setup can be used but, as mentioned, the test jig is replaced by a set of custom cables and a source of 12V power input.

The various components are described in the following sections.

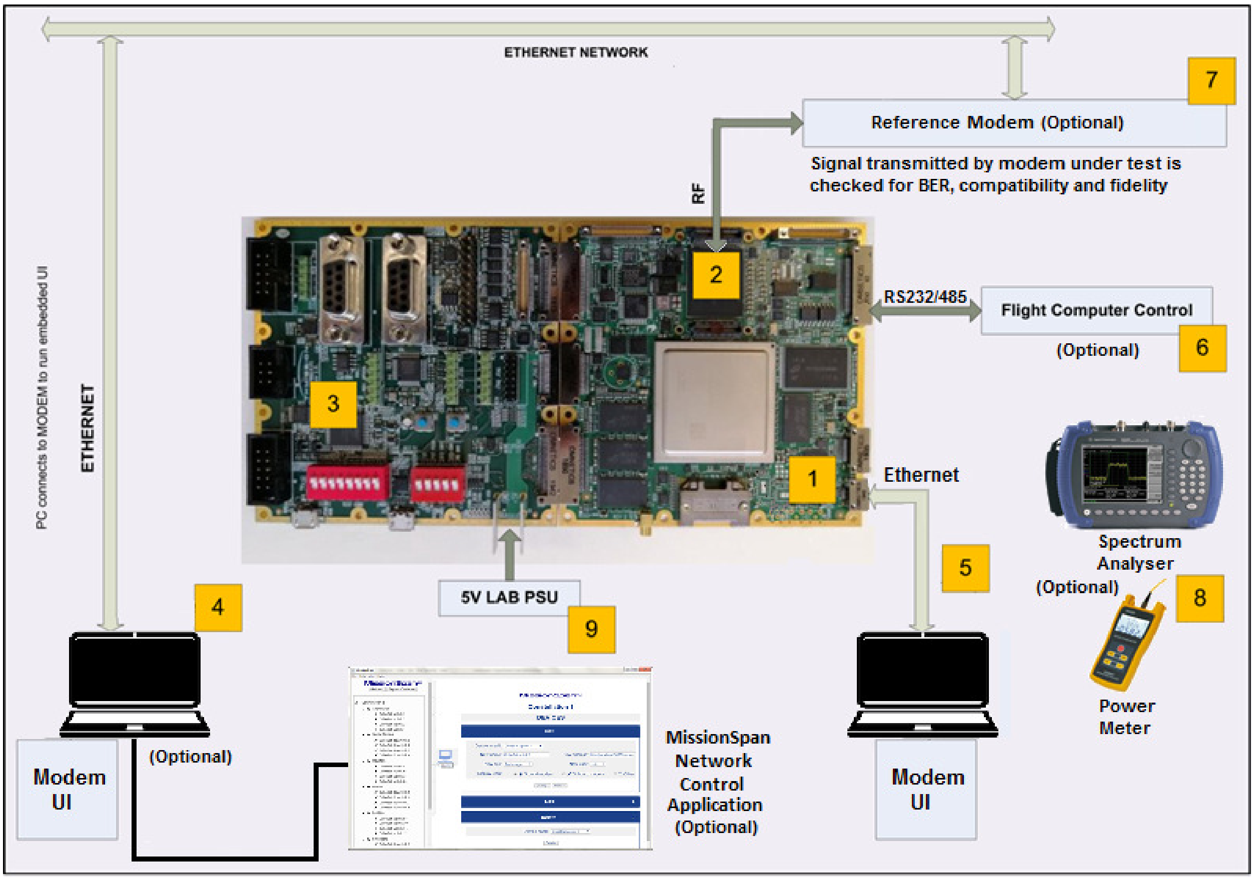


**Figure 2-1 General Modem Bench Setup**

### 2.1.1 Quest (Block 1)

The Quest provides the digital processing needed to generate a DVB-S2/S2X baseband signal for transmission. The modem is capable of internally generating a PRBS data payload for use in BER testing. In this mode, PRBS data replaces any data present with respect to the payload source interface, which is effectively ignored. A digital modulated baseband IQ signal is generated and passed to the Quest's RF Mezzanine Board for digital to analogue conversion and RF up-conversion.

When testing bidirectional communications, the modem receives and demodulates a signal passed to it from a reference modem.

The Quest and the reference modem transmit/receive RF interfaces are cross-coupled so that each receives the transmitted carrier from the other.

### 2.1.2 Quest RF Mezzanine Card (Block 2)

This card takes the digital I/Q modulated baseband signal from the modem (1) and up-converts it to the desired frequency.

### 2.1.3 Production Test Jig (Block 3)

The Production Test Jig provides a convenient way of interfacing to the Quest modem at a board level, as it removes the need for special cable harnesses to be procured. (When the modem is placed in an enclosure then the test jig is redundant and special cable sets are used instead.)

The test jig provides a convenient connection to an external power supply via FASTON connectors.

### 2.1.4 Laptop PC (Blocks 4 & 5)

The laptops provide access to the modem user interface for configuration and monitoring purposes. They can also run any software that represents the user's data processing application (or standard packet generator/analyser software for throughput testing). The laptops require an Ethernet connection to the relevant modem.

### 2.1.5 Flight Computer Control (Block 6)

The Flight Computer Control, if required, is normally implemented via a serial interface (such as LVDS or RS485). When configured, this interface can be used to send TXMission OOPS! commands to the modem (see OOPS! protocol specification on our website).

For applications that require very low-level control of the modem, TXMission supports a set of C libraries that can be accessed via the flight computer interface as an alternative to OOPS!

TXMission can also support custom protocols as required by the user's application.

### 2.1.6 Reference Modem (Block 7)

A reference modem can be a useful data source/sink and can be used to test the Quest modem input, output and performance. This is normally a TXMission Connect modem or customer-supplied modem if checking third-party interoperability.

It should be configured to interoperate with the Quest modem and the transmit/receive RF interfaces should be cross-coupled as required.

### 2.1.7 Miscellaneous Test Equipment (Block 8)

The user may wish to add test equipment such as a power meter and spectrum analyser, as required.

### 2.1.8 Power Supply (Block 9)

The Quest modem board product runs from a regulated 5V supply at up to 6A. A standard analogue bench power supply as used in a test laboratory is suitable for this. Alternatively, TXMission can provide a mains power supply unit that generates the required DV voltage and has a suitable terminal mating connector for plugging power directly onto the board.

Once fitted into an enclosure, a Quest modem requires a 12V input, while the Connect modem is provided with a power supply (90 to 264V AC) and mains plug suitable for the country that it is being shipped to.

## 2.2 Installation Procedure

### 2.2.1 Cable Harnesses

If a test jig is being provided, then this will come with its own set of cables shown in **Figure 2-2** to **Figure 2-6**. For connecting to a Quest in an enclosure, a set of special cables are required. These can be obtained from TXMission or can be built using the pinout and mating connector information provided in the document *Interface Control Document Part 2: Electrical & Mechanical Specification.*

**Figure 2-2 Mains Power Supply**

Note that the mains power supply will be provided with the type of mains plug requested by the user.

**Figure 2-3  USB to Serial Cable (for Linux user access)**

Note that the USB to serial cable is primarily intended for users who are doing board-level integration of third-party software or hardware and who therefore require access to the operating system. It is not generally supplied to users who interact with the modem purely at a web user interface level or command line level, although in some situations it can be useful to view debug and low-level operational messages from the modem. Operating system login details are confidential and are provided only to our users who need access to the operating system and our low-level development toolset – contact us for further information.

**Figure 2-4  9-pin Nano-D to Standard RJ45 Ethernet Converter**

Note that a standard Ethernet cable (shown in yellow) is not provided.

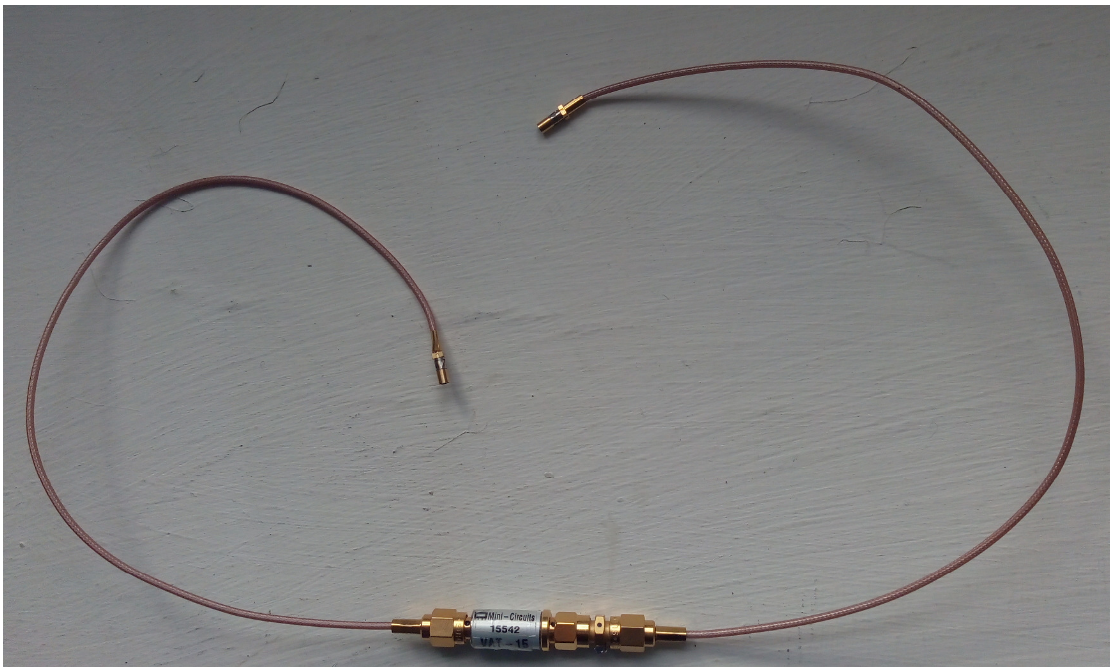


**Figure 2-5  RF Loopback & Interconnect Cable**

### 2.2.2 Settting up the Test Jig & Modem

After unpacking the modem and checking all the contents are correct, the following steps should be taken.

- Set up of a working area, making sure to take anti-static electro-static discharge precautions.

- Connect the test jig to the modem as shown in **Figure 2-1**, taking care to orientate the two boards correctly. Ensure the mating connectors are firmly in place.

- Do not apply power to the modem until all connectors have been fitted.

- Fit the USB to serial cable as shown in **Figure 2-6**, making sure that the black wire is at the top and the blue wire at the bottom. Fit the USB end of the cable to a spare USB port on the computer to be used to control the modem.

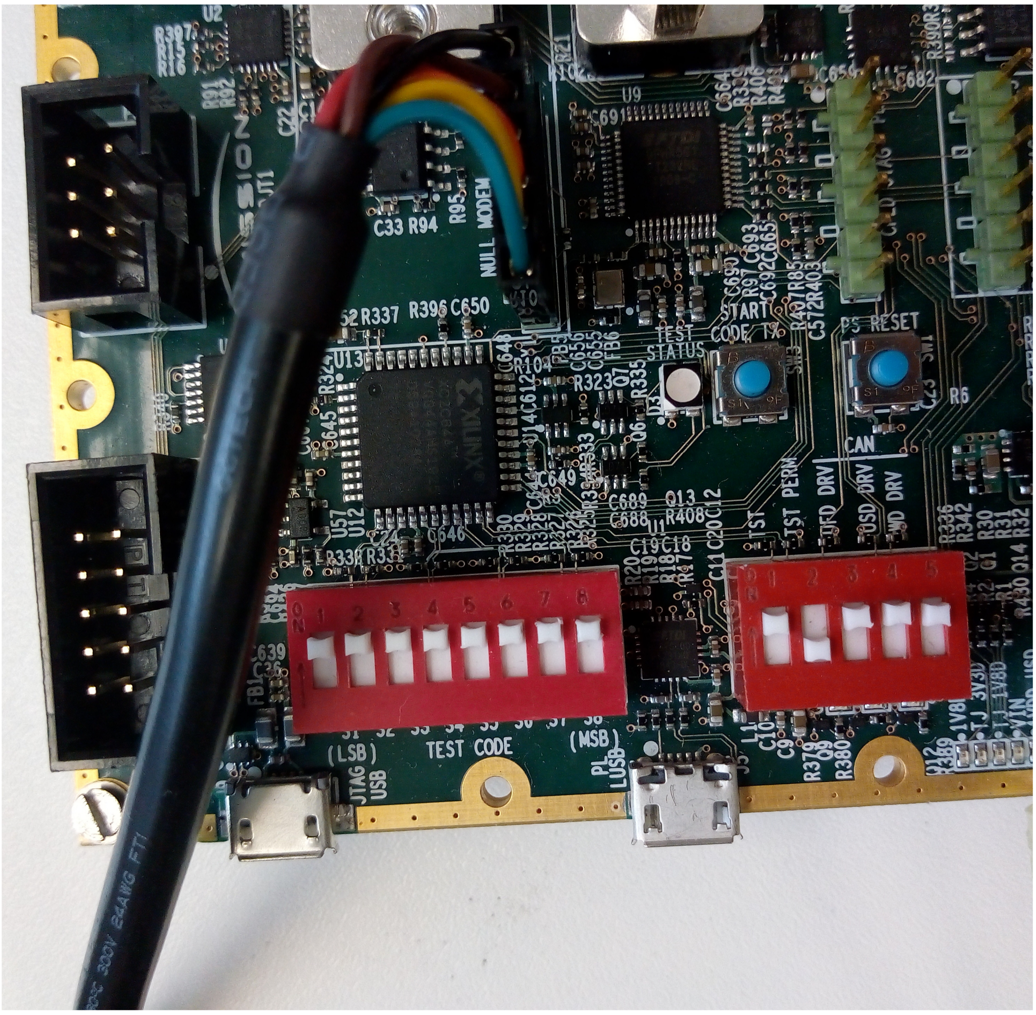


**Figure 2-6 Connecting the USB to Serial Cable**

- Set the two blocks of white dip switches in the configuration shown in **Figure 2-6**.

- Connect the Ethernet adapter cable to the Quest modem 9-way Nano D connector (bottom right) as shown in **Figure 2-7**, making sure that the narrower side of the connector is uppermost when mating the cable to the board. Fit a standard Ethernet cable between the cable's RJ45 socket end and the computer to be used to control the modem.

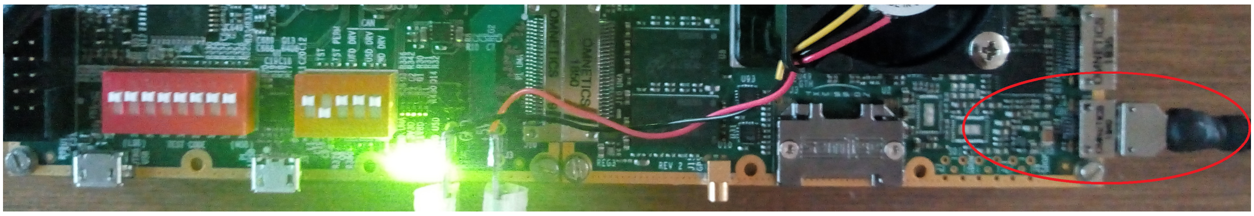

**Figure 2-7 Connecting the Ethernet Adapter**

- To use the Quest modem in an RF loopback mode, fit the RF cable to the modem's RF mezzanine card as shown in **Figure 2-8**. There are four pins on the connector and the first and fourth ones should be used, connecting transmit output and receive inputs together. Note in the red circle in **Figure 2-8**, the outermost dark circles you can see at either end of the connector are mounting jacks and not pins.

  An internal digital loopback mode can be selected on the user interface menus and is an alternative to the RF loopback in situations where the modem's RF performance is not critical to the operations being performed by the user.

  (To interconnect two Quest modems, two RF cables are required, and need to be cross-coupled pin 1 to pin 4 and vice versa between the two modems. To connect a Quest board product to a Connect modem, special cables are required to go between the RF mezzanine connector and the SMA transmit and receive connectors on the Connect. These cables are available from TXMission. When the Quest is in an enclosure, then standard SMA cables can be used to interconnect the Quest and Connect modems.)

**Figure 2-8  RF Loopback Cable Configured for RF Loopback**

- Connect the power supply cable to the modem as shown in **Figure 2-9**, making sure that the terminal with the red wire is rightmost and the terminal with the blue wire is to the left-hand side. Plug the other end of the cable into the mains but do not switch the power on at this stage.

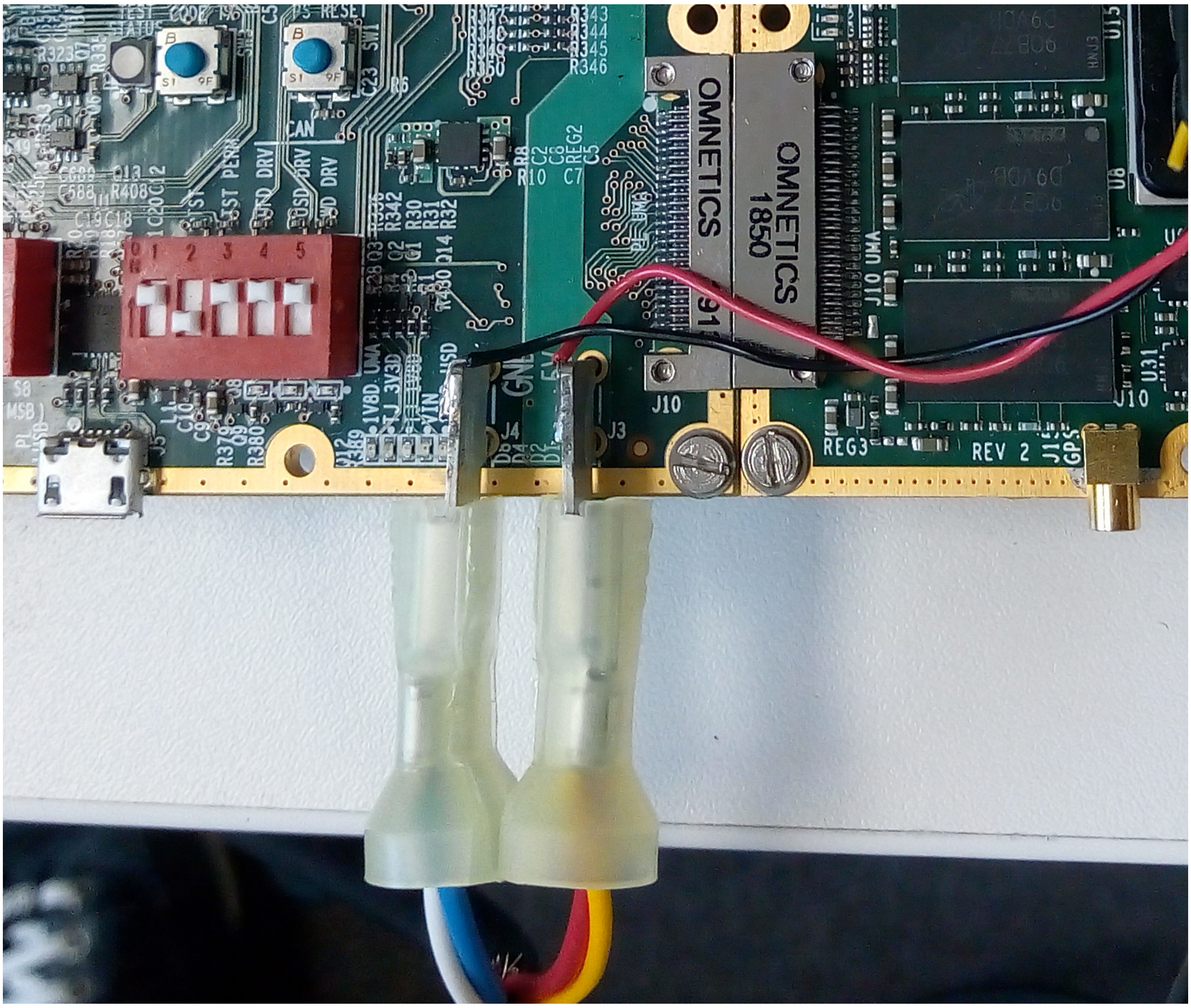


**Figure 2-9 Connecting the 5V Supply to the Modem**

- There are various boot options for the modem, such as to boot from internal non-volatile memory, or from an SD card or to download software images from the host computer. Generally, software is downloaded only when the user is developing an application to run on the modem. Booting from non-volatile memory is the most common method. The modem will have been delivered already configured for the user's desired method of booting the software.

  If the modem software is installed on an SD memory card (**Figure 2-10**) then this should be fitted underneath the modem in the position shown in **Figure 2-11**, with the side containing the copper fingers shown in **Figure 2-10** face upwards.

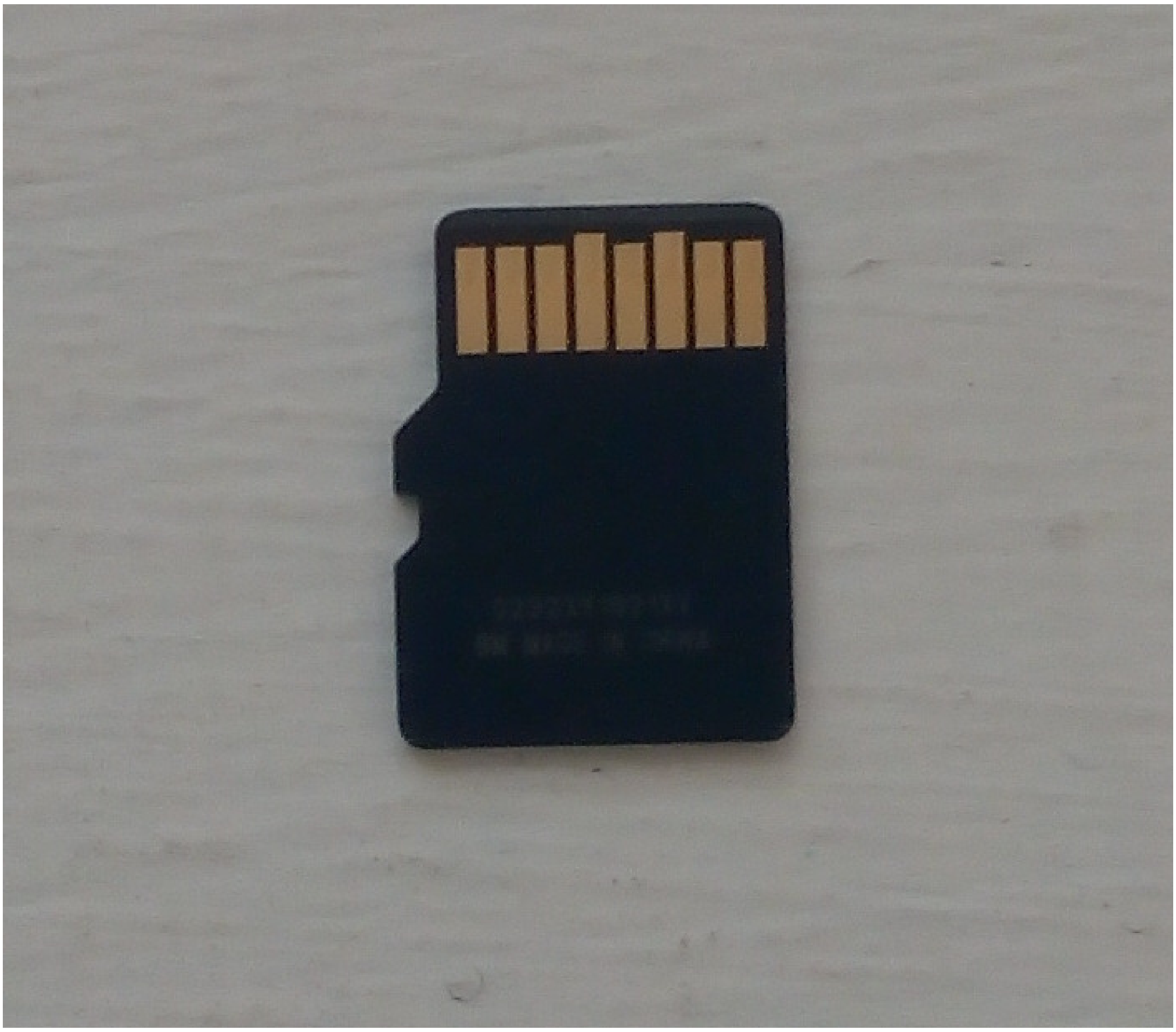

**Figure 2-10  Modem SD Memory Card Option**

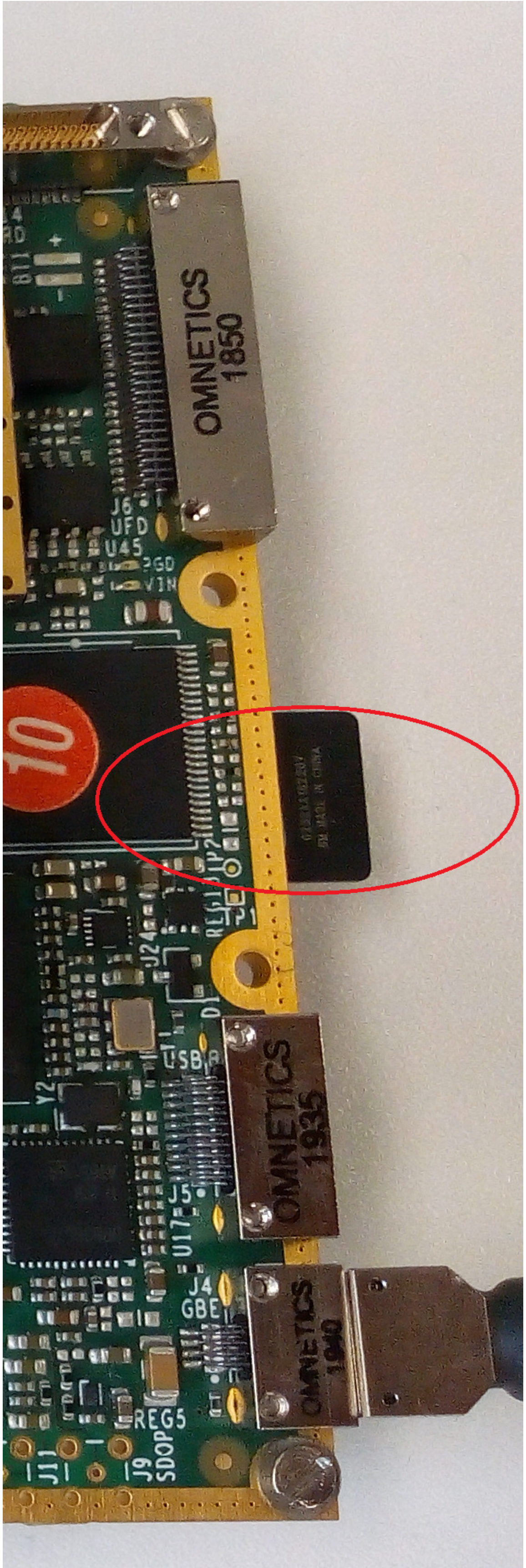


**Figure 2-11  Modem SD Memory Card Location**

- Once the SD card has been mounted on the board, if required, then power should be applied to the modem by switching on the mains or bench power supply, as appropriate.

## 2.3 Using the Modem Web User Interface

With the Quest modem powered up, the control laptop connected via Ethernet to the modem and the Connect or reference modem powered up and connected (if relevant) then the user can proceed to access the modem's user interfaces.

The most convenient way of controlling and monitoring the modem network is via TXMission's MissionSpan NMS application. This is described in the document *MissionSpan™ Network Management System User Manual*, which is available from the TXMission website (https://txmission.com).

TXMission's modems can be used with all popular web browsers on all types of devices. Details of the web user interface are contained in the document *Quest™ and Connect™ Modem User Interface Manual.*

*The factory default IP address for the Quest and Connect modems is 192.168.70.100 with a subnet mask of 255.255.255.0 and with no default gateway (i.e. gateway is 0.0.0.0). The default username and password are admin, txmission.*

When the modem powers up, it will set its IP address according to the currently selected configuration in its database. This defaults to the factory settings detailed above.

Following initial installation, the IP address and subnet of the control laptop should be set to be compatible with the above IP address. For example, the address 192.168.70.101 can be used, along with a subnet mask of 255.255.255.0.

At this point, open a browser on the control laptop and enter the following into the address bar:

*192.168.70.100:3000*

The login screen shown in **Figure 2-12** should be displayed.

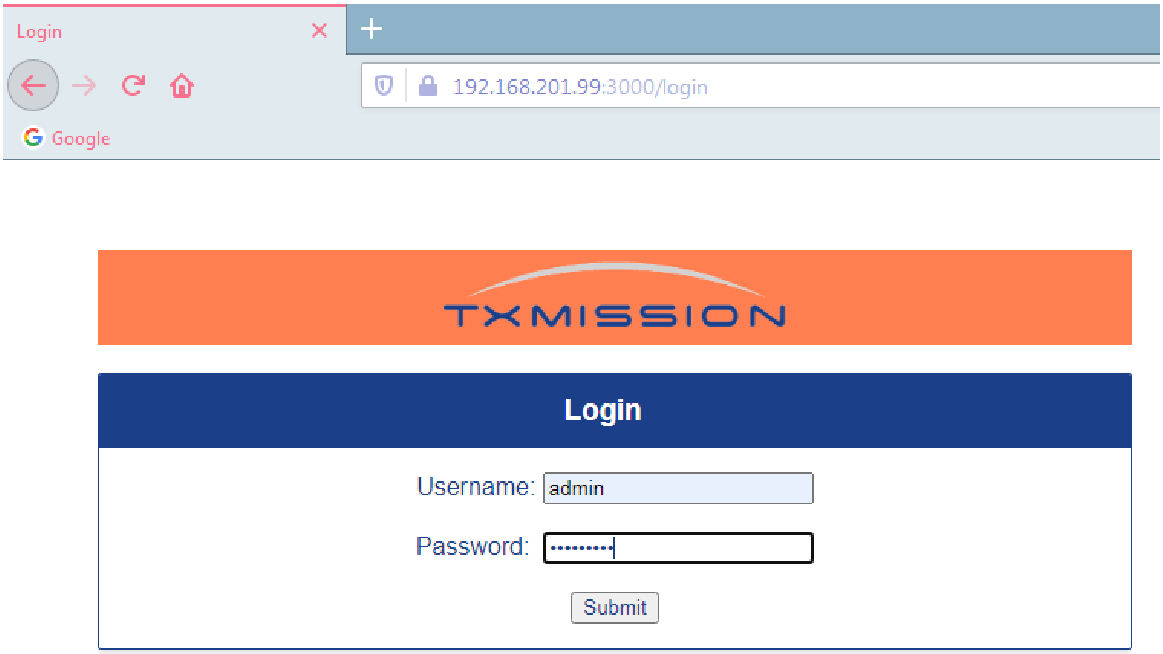


**Figure 2-12  Modem Login Screen**

At this point, the instructions in either or both of the following two documents should be consulted for information on configuring and monitoring the modem(s).

- *MissionSpan™ Network Management System User Manual*
- *Quest™ and Connect™ Modem User Interface Manual*

It is recommended that the password for the *admin* user is changed from its default setting. The modem's IP address can be changed to be compatible with the user's local network settings. Note that the use of CIDR (Classless Inter-Domain Routing) notation (e.g. 192.168.0.1/24) is not supported when defining addresses and subnets on the user interfaces.

TXMission's onboard modems support only a single Ethernet connection, which is used for both network monitor and control, and user traffic. Our ground modems support two Ethernet connections (one for monitor and control and the other for traffic). The modem operates as a Layer 2 switch and does not allow the traffic interface to be assigned an address. This does not prevent the common practice of having the monitor and control function on a separate subnet to the network traffic in order to create traffic separation.

Setting a monitor and control address (or using the default address) is required for accessing the built-in web server and for issuing TXMission OOPS! commands over Ethernet from a command line application.

Although the user interface only accepts and displays IPv4 addresses, all IPv6 packets on the network will be correctly bridged through the modem.