

# SOLO4 Telemetry Users' Manual

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## 2 Change History

Version	Main Changes from Previous Version	Edited By
v1.0	Initial Release	CB
v1.1	Additions and modifications particularly around part numbers and 'Get Going' guide.	MB
v1.2	Corrected Alarm led description	JB
v1.3	Added explanation of audio cable numbers	MB
V1.4	Fixed typo in model types	JGS
V1.5	Audio levels corrected	MM
V1.6	Corrected number of carriers	CB
V1.7	Correction to control cable reference	MB
V1.8	Antenna Ground Warning	MB

## 3 About this Manual

This manual describes the operation of domo SOLO4 Telemetry wireless system. The manual is divided into three main sections.

- **Getting started and basic operation**

This section describes to users how to deploy and use a SOLO4 Telemetry system.

- **Advanced operation**

This section describes the operation of the system in more detail, concentrating particularly on how to store and recall configurations, with use of the PC Controller Application.

- **Technical reference**

This section provides technical specification and control protocol data and will be of interest to those integrating the SOLO4 system into larger systems.

## 4 Introduction

The SOLO4 Telemetry system is a COFDM transmitter and receiver, designed specifically for the transmission of audio, IP and telemetry data. The SOLO4 Telemetry system can be configured into different user selectable bandwidths, to satisfy a variety of requirements. Bandwidths from 20kHz to 100kHz are available offering user capacity from 14.7Kb/s (QPSK) to 147kb/s(16QAM). This capacity can be shared between audio, IP and user RS232 telemetry data, in any combination. The SOLO4 Telemetry system is designed to fit into existing channel plans of 25kHz.

The SOLO4 Telemetry System employs a unique narrow band COFDM modulation and will transmit telemetry data and audio in a non line of sight environment up to 5km depending on mode and frequency. The SOLO4 Telemetry System is typically employed to provide talk back and telemetry data for PTZ control in domo wireless video systems, especially mobile systems. The system may also be used to form an IP back link in conjunction with the Netstream series of SOLO products.

Supplied in a rugged, light weight weather proof aluminium chassis, the SOLO4 Telemetry System can be used in body worn applications, or prolonged outdoor deployments.

The SOLO4 Audio and Telemetry Receiver is supplied in two builds to suit the two standard telemetry bands centred on 868MHz and 458MHz.

### IMPORTANT NOTE

The SOLO4 product range has been specifically designed for government security and law enforcement users, the equipment will tune across frequencies that are only available to licensed government users. Non-government users should employ the equipment restricted to the license exempt bands only typically 868-870MHz & 458MHz.

## 5 Warranty and Support

### 5.1 Warranty Cover

domo offers a 12 month standard product warranty. During this period, should the customer encounter a fault with the equipment we recommend the following course of action:

- Check the support section of the website for information on that product and any software/firmware upgrades. If fault persists;
- Call our support line and report the fault. If fault persists and you are informed to return the product please obtain an RMA number from the domo support department, and ship the equipment with the RMA number displayed and a description of the fault. Please email the support section the airway bill/consignment number for tracking purposes.
- If you have extended warranty provisions then **domo** will send an immediate advance replacement to you. Under most circumstances this must be returned once the fault item is repaired.

Depending on the nature of the fault domo endeavor to repair the equipment and return it to the customer within 14 days of the item arriving at our workshops.

Obviously it is impossible to cater for all types of faults and to manage 100% replacement part availability, and delays are sometimes inevitable. This is why domo recommend that its customers take out an extended warranty (which includes advanced replacement of faulty items), and/or hold a basic level of spare parts, which can be held by domo on the customer's behalf.

Please contact domo for details of packages that can be tailored to meet your individual needs, whether they are service availability, technical training, local geographic support or dedicated spares holdings.

## 6 Safety, Compliance and Approvals

### 6.1 Safe Operating Procedures

- Ensure that the power supply arrangements are adequate to meet the stated requirements of each SOLO4 product.
- Operate within the environmental limits specified for the product.
- Do not subject the indoor equipment to splashing or dripping liquids.
- Only authorized, trained personnel should open the product. There are no functions that required the User to gain access to the interior of the product.

### 6.2 EMC / Safety and Radio Approvals

The equipment has been designed to meet and has been tested against the following harmonized EMC and safety standards:

- EN 301 489-1 & EN 301 489-5
- EN 61000-3-2:2000
- EN 61000-3-3:1995
- EN 55022:1998, Class B
- EN 61000-4-2:1995
- EN 61000-4-3:1996
- EN 61000-4-4:1995
- EN 61000-4-5:1995
- EN 61000-4-6:1996
- EN 61000-4-11:1994
- EN 60950:2000

### 6.3 CE marking

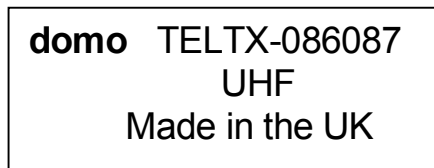
The CE mark is affixed to all SOLO4 products, and the CE Declaration of Conformity, as well as the technical file are available on request.

## 7 Getting Started and Basic Operation

### 7.1 Which Model do I have?

Each unit in the domo SOLO4 product range is marked with two panels.

- Product Code Panel. Give product code and manufacturers information.
- CE and Serial Number Panel. Gives CE mark and product serial number.



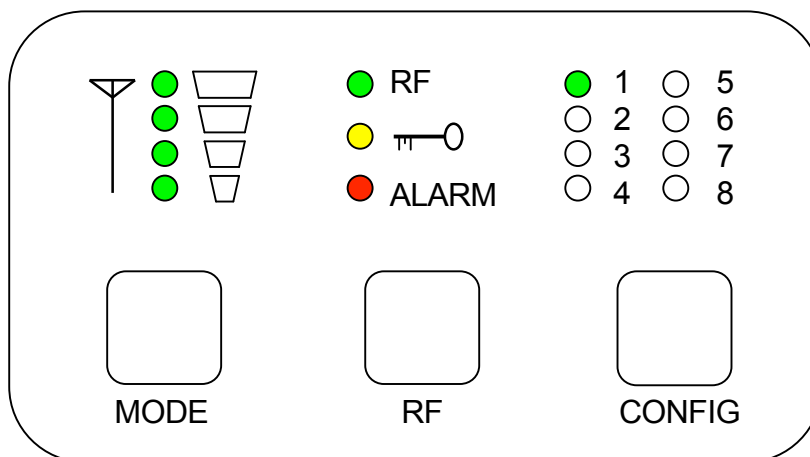
The **domo** product code can be referenced in the table below.

Product Code	Product	Accompanying items
TELTX-086087	SOLO4 Telemetry Transmitter supporting data only at 25 and 50KHz	Cables: 868MHz Omni Antenna Audio 2m Control Cable 3m Data Cable 3m DC Power 2m CD with operating software and manual
TELTXA-086087	SOLO4 Telemetry Transmitter supporting all bandwidths and audio	Cables: 868MHz Omni Antenna Audio 2m Control Cable 3m Data Cable 3m DC Power 2m CD with operating software and manual
TELRX-086087	SOLO4 Telemetry Receiver supporting data only at 25 and 50KHz	Cables: Two 868MHz Omni Antenna Audio 2m Control Cable 3m Data Cable 3m

		DC Power 2m CD with operating software and manual
TELRXA-086087	SOLO4 Telemetry Receiver supporting all bandwidths and audio	Cables: Two 868MHz Omni Antenna Audio 2m Control Cable 3m Data Cable 3m DC Power 2m CD with operating software and manual

## 7.2 Controls

SOLO4 Telemetry transmitters and receivers are equipped with a standard LED (Light Emitting Diode) and push button panel. The panel is as depicted below, and the buttons and LEDs have meanings as explained in the table.



LED / Button	Colour	Meaning / Use
Alarm LED	Red	When lit indicates alarm or fault condition on equipment.
Front Panel Lock LED	Yellow	When lit indicates front panel is locked
RF LED	Green	<p>Transmitter:</p> <p>When lit indicates RF output is active.</p> <p>When blinking indicates transmitter is operating in discontinuous mode and is not currently transmitting (waiting for data).</p> <p>Receiver:</p> <p>When lit indicates receiver has signal lock.</p>

LED 1 to 8	Green	Indicates which of the eight stored configurations is currently selected.
Signal Strength LED's	Green	Transmitter: Indicates output power level 5,10,15 & 20 dBm.  Receiver: Indicates received signal quality.
RF Button	-	Transmitter: Pressing the RF button toggles the units RF output between OFF and ON.  Transmitter & Receiver: Holding down button toggles unit into standby mode.
Config Button	-	The config button when pressed selects the next configuration from memory.  Holding down button toggles front panel lock.
Mode Button	-	Transmitter: Turns on RF output when transmitter is operating in discontinuous mode.

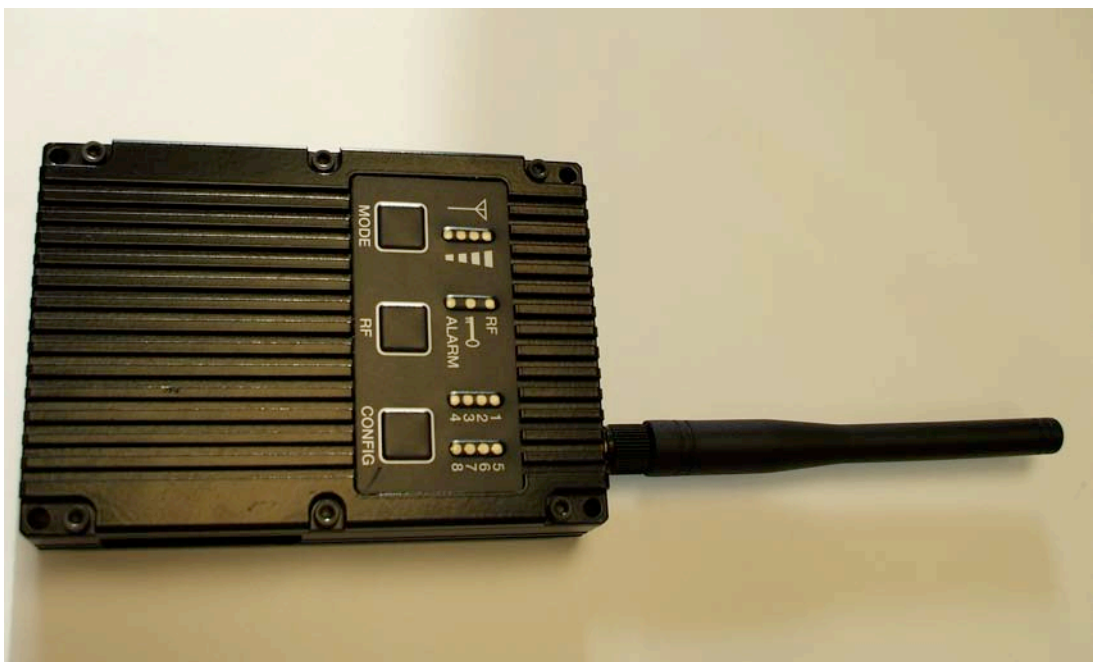
## 7.3 Getting Started with the Telemetry Transmitter

### 7.3.1 Cables and Connections

This section describes how to connect the following demo model numbers.

- TELTX-086087
- TELTXA-086087

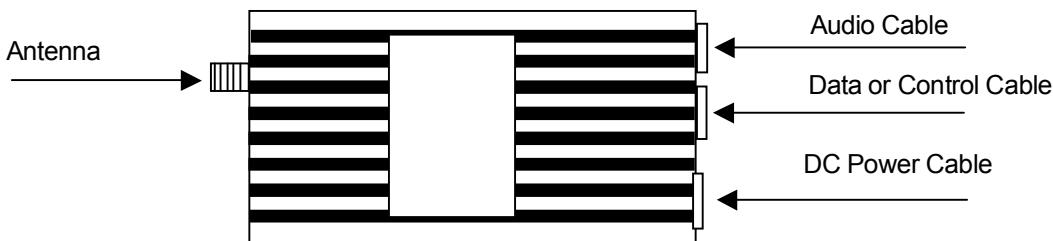
The picture below shows the demo Telemetry transmitter.



The domo Telemetry transmitter is supplied with the following cables.

- Audio Cable 2m (labeled AUDIO IN or CA0066)
- Data Cable 3m
- Control Cable 3m
- DC Power 2m

The domo Telemetry transmitter should be connected as shown below.



### 7.3.2 DC Power Connection

The SOLO4 Telemetry units can be powered from either a nominal 12V DC supply or from an external battery.

Push the LEMO connector on the DC power cable into the socket labelled 12V, taking care to align the connectors. Connect the banana connectors on the other end of the cable to a suitable DC source.

The 12V DC input has the following characteristics:

- Input Voltage Range 5.5V to 18V, reverse voltage protected.
- Power dissipation <3W

domo can supply optional AC to DC converter blocks to power the SOLO4 Telemetry units, the domo part number is **PSU12**

#### IMPORTANT NOTE

Do not try and force the 12V DC input into the audio connector. This will result in permanent damage the audio circuitry of the unit.

If the unit is in standby press and hold down the RF button to power up the unit.

### 7.3.3 Audio Connection

The audio input cable will be labeled 'AUDIO IN' or CA0066

Push the LEMO connector into the 5 pin audio socket, taking care to align the connectors. Connect the audio sources.

Connector	Signal
Audio Plugs	Line / Microphone level audio, switchable. Line level -2dBu clip level low impedance source (< 600 ohm) Microphone level 12, 24, 36 and 48dB preamp stages software switchable

Microphone power is provided on the audio connectors at approximately 3V (suitable for Electret microphones)

Typically the audio source will be an Electret microphone.

### 7.3.4 Data and Control Connections

The 16 way Hirose connection on the centre of the base of the telemetry transmitter, is used for data and control interfacing. The unit is supplied with individual data and control cables, that can be connected sequentially.

Connecting either the 16 pin Data or Control Cable, is achieved by aligning and carefully inserting the Hirose connector until it clicks into position.

The data cable is used for data input: RS232 data input for transmission, at user selectable baud rates.

The control cable is used for Control: RS232 control interface for connection to the domo PC GUI application or an embedded control application.

### 7.3.5 Antennas

The unit is supplied with 868MHz (or 458MHz) omni-directional flexible antennas as standard. These can be screwed directly to the panel mount SMA RF Out connector, however doing so will limit the range, because these antennas require a 'Ground Plane'. Care should be taken to not over tighten the antenna. It is recommended that the transmit antenna should be connected directly to the unit and not via a cable. Any cable in this position will reduce the range performance of the equipment.

WARNING. For best performance the supplied antennas should be connected to a ground plane surface.

Additional antennas may be ordered from **domo**. For longer range, more specialized antennas such as Yagis can be supplied.

### 7.3.6 Installation notes

The domo Telemetry transmitter is supplied in a rugged chassis with mounting holes for ease of integration. It is designed for simple integration into any system.

The Telemetry transmitter can be mounted in an outdoor situation. In an outdoor situation care should be taken to mount the unit with the RF connectors pointing upwards. The cable connectors are NOT weather proof and must be protected by the drip ledge.

## 7.4 Getting Started with the Telemetry Receiver

### 7.4.1 Cables and Connections

This section describes how to connect the following domo model numbers.

- TELRX-086087
- TELRXA-086087

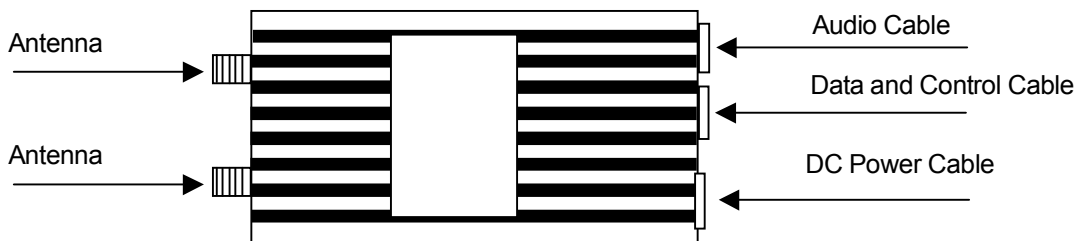
The picture below shows the domo Telemetry Receiver.



The domo Telemetry Receiver is supplied with the following cables.

- Audio Cable 2m (labeled AUDIO OUT or CA0067)
- Data Cable 3m
- Control Cable 3m
- DC Power 2m

The domo Telemetry transmitter should be connected as shown below.



#### 7.4.2 DC Power Connection

The SOLO4 Telemetry units can be powered from either a nominal 12V DC supply or from an external battery.

Push the LEMO connector on the DC power cable into the socket labelled 12V, taking care to align the connectors. Connect the banana connectors on the other end of the cable to a suitable DC source.

The 12V DC input has the following characteristics:

- Input Voltage Range 5.5V to 18V, reverse voltage protected.
- Power dissipation <3W

domo can supply optional AC to DC converter blocks to power the SOLO4 Telemetry units, the domo part number is **PSU12**

#### IMPORTANT NOTE

Do not try and force the 12V DC input into the audio connector. This will result in permanent damage the audio circuitry of the unit.

If the unit is in standby press and hold down the RF button to power up the unit.

#### 7.4.3 Audio Connection

The audio input cable will be labeled 'AUDIO OUT' or CA0067

Push the LEMO connector into the 5 pin audio socket, taking care to align the connectors. Connect the audio sources.

Connector	Signal
Audio Plugs	Line level audio Line level, +5dBu clip level, low impedance source (20 ohm)

Typically the audio output device will be monitoring speakers.

#### 7.4.4 Data and Control Connection

The 16 way Hirose connection on the centre of the base of the telemetry receiver, is used for data and control interfacing. The unit is supplied with individual data and control cables, that can be connected sequentially.

Connecting either the 16 pin Data or Control Cable, is achieved by aligning and carefully inserting the Hirose connector until it clicks into position.

The data cable is used for data input: RS232 data input for transmission, at user selectable baud rates.

The control cable is used for Control: RS232 control interface for connection to the domo PC GUI application or an embedded control application.

#### 7.4.5 Antennas

The unit is supplied with two 868MHz (or 458MHz) omni-directional flexible antennas as standard. These can be screwed directly to the panel mount SMA RF Out connector, however doing so will limit the range, because these antennas require a 'Ground Plane'. Care should be taken to not over tighten the antenna. It is recommended that the receive antennas should be connected directly to the unit and not via a cable. Any cable in this position will reduce the range performance of the equipment.

Two Receive antenna inputs are provided, a sophisticated diversity algorithm is employed to receive the optimum signal between the two inputs.

WARNING. For best performance the supplied antennas should be connected to a ground plane surface.

Additional antennas may be ordered from **domo**. For longer range, more specialized antennas such as Yagis can be supplied.

#### 7.4.6 Installation notes

The domo Telemetry transmitter is supplied in a rugged chassis with mounting holes for ease of integration. It is designed for simple integration into any system.

The Telemetry transmitter can be mounted in an outdoor situation. In an outdoor situation care should be taken to mount the unit with the RF connectors pointing upwards. The cable connectors are NOT weather proof and must be protected by the drip ledge.

## 7.5 Powering on the System

All external connection to the SOLO4 Telemetry products should be made, as described in the previous sections, before proceeding to power on the system.

### 7.5.1 Applying power to the Solo4 Telemetry Receiver

On powering the SOLO4 Telemetry receiver, one of the eight green configuration LEDs on the control panel will light (which one depends on which configuration was active when the receiver was switched off). The red Alarm LED may light if the receiver is unable to lock to a signal.

If none of the LEDs on the control panel light then the Receiver may be in standby mode. If this is the case then press, and hold the RF button for more than one second.

### 7.5.2 Applying power to the SOLO4 Telemetry Transmitter

When powering the SOLO4 Telemetry transmitter directly from a DC source, the following will be observed.

If none of the LEDs on the control panel light then the transmitter may be in standby mode. If this is the case then press, and hold the RF button for more than one second.

One of the eight green configuration LEDs on the control panel will light (which one depends on which configuration was active when the receiver was switched off).

The alarm LED may be lit, typically if there is a serious error with the unit.

### 7.5.3 Switching on the RF

On the transmitter unit control panel, press the RF button briefly until the RF LED lights. This indicates that the RF output is active, and that the unit is transmitting. In discontinuous mode the RF LED will blink to indicate the unit is waiting for data. Push and hold down the MODE button to temporarily override and transmit.

If the receiver is able to receive the transmitted signal, the receiver RF LED will light indicating receiver lock, and the receiver ALARM LED should go out. The signal strength LEDs will indicate the received signal quality.

Data and audio signals will be presented automatically at the receiver outputs.

#### NOTE:

The signal quality may be degraded if the units are placed too close together and the signal is too strong. Move the units further apart.

#### 7.5.4 Changing Configuration

domo SOLO4 equipment features eight user selectable and programmable configurations. By default, all 8 configurations are available to the user. The configuration that is currently active is indicated by which of the eight configuration LEDs is lit on the control panel. Pressing the 'CONFIG button on the control panel of any domo SOLO4 equipment will select the next configuration in order.

On the SOLO4 transmitters, changing a configuration turns off the RF output to prevent accidental transmission and potential interference. The RF output must manually be re enabled once the user is confident that the correct configuration has been selected.

Modifying the default configurations is done from the PC control application, as described in the section on Advanced Operation.

#### 7.5.5 Front Panel Lock

Pressing and holding down the CONFIG button for more than 1 second will toggle the front panel lock feature. This prevents accidental key presses on the panel affecting the unit's operation.

#### 7.5.6 Standby

Any of the SOLO4 transmitters and receivers can be placed in a low current consumption standby mode by pressing and holding the RF button for one second. The LEDs will go out indicating that the unit is in standby mode.

Pressing and holding the RF button for one second brings the unit back out of standby mode.

## 8 Advanced Operation

### 8.6 Technical Overview

#### 8.6.1 OFDM Transmission

The SOLO4 Telemetry transmitter and receiver utilise Orthogonal Frequency Division Multiplex for modulation. This modulation scheme provides excellent protection against multi-path and interference. The system employs interleaving and two levels of error correction (Low Density Parity Codes & BCH decoding) to further enhance performance.

The modulator channel width may be set in multiples of 25kHz. This determines spectrum bandwidth and the gross bit rate of the system in multiples of 14.7Kbits/s. The bandwidth of the modulated signal is roughly 4/5 of this channel spacing. The units provide QPSK and 16QAM modulation. For 16QAM the available data rates are doubled at the expense of about 5.5dB of receiver sensitivity.

The Telemetry receiver has two RF inputs allowing the best signal to be recovered using Maximum Ratio Combining. A combination of IF and digital filtering provide receiver selectivity. The demodulator allows the user to read various parameters such as the input signal level, the signal to noise ratio and raw error rates via the remote control interface.

#### 8.6.2 RS232 data pipe

The main RS232 data is handled using dedicated interfaces on the telemetry module. The transmitter must be configured for the correct baud rate and parity. This information is signalled over the RF link to set the receiver into the correct mode.

The transmitter may be set such that the baud rate is higher than that sustainable by the link. In this case the transmit character rate must be limited or Xon/Xoff flow control used to prevent loss of data. The receiver also supports Xon/Xoff control but this may result in loss of data if the Xoff period becomes too long.

#### 8.6.3 Audio

Mono speech quality audio may be sent across the link with the SOLO4 Telemetry modules. G726 ADPCM codec is used operating at either 24kbits/s or 32kbits/s sampling at 8kHz. The 24Kbits/s mode provides a toll quality link, while the 32kbits/s mode is similar to standard phone quality. Audio can only be supported above certain bit rates.

The Telemetry transmitter supports both line level and microphone level inputs. The Telemetry receiver unit provides two mono outputs which can be used to drive headphones directly.

#### 8.6.4 IP Pipe

The SOLO4 Telemetry units may also be used to handle IP data. In this mode of operation the Netstream's RS232 data port is connected to the data port of the telemetry module. A special protocol (with flow control) is used between the units operating at 230400 baud that optimizes the transit delay and makes efficient use of the available bandwidth for the IP data.

The unit can also allow transmission of both data and IP simultaneously. Please contact domo for more information.

#### 8.6.5 RC Servo Control

The SOLO4 Telemetry units are capable of reading analogue joysticks and controlling servo units for applications such as servos/motor drives on small UGV's. Contact domo for more details if required.

#### 8.6.6 Transmit Continuous/Discontinuous mode

The transmitter may be operated either in continuous or discontinuous mode. In continuous mode the RF output is on all the time regardless of whether there is data to send.

In discontinuous mode the transmitter will only turn on the RF output when data is available. Two parameters 'Ton' and 'Toff' allow the transmit data delay on period, and the transmitter off timeout to be set. The 'Ton' period is time period between the transmitter turning on and the first data sent. This period allows time for the receiver to relock to the transmitted signal. The 'Toff' period sets the time between the last character being sent and the transmitter turning RF off.

These parameters are programmable for each configuration, and some experimentation may be required for reliable operation.

#### 8.6.7 License Exempt operation

This unit may be licensed for either licensed use or license exempt operation. In licensed mode no restriction is placed on frequency, bandwidth and power level. The unit may be tuned to any frequency in 12.5kHz steps.

In license exempt mode the transmitter uses a frequency plan based on the unit type. This restricts the frequency, bandwidth and power levels available. The transmitter will try to tune to the nearest available frequency based on the input frequency, selecting the bandwidth and power level accordingly. Some frequency bands allow only discontinuous mode of operation with a limited duty cycle. It is up to the user not to exceed this duty cycle.

The receiver is not affected by the license exempt mode of operation and will tune over the whole band.

#### 8.6.8 AES Encryption

The telemetry module supports both AES128 and AES256 encryption. These provide a very secure method of handling data and audio. Both AES128 and AES256 are licensable features. To enable encryption a 32 digit hex key, (or in the case of AES256 two 32 digit hex keys) must be written to the unit. The scrambling mode must then be set to the appropriate mode of operation.

The AES128+ and AES256+ options in the receiver can be used to prevent the receiver accepting unscrambled streams which may be useful in some applications. Note that having mismatched keys between Tx and Rx may allow a small amount of encrypted data to pass through the data pipes.

AES128 and AES256 are licensable features and are only supported in certain countries.

## 8.1 SOLO4 System PC Controller Application Software

Advanced control of the SOLO4 system is available by using PC control applications.

Typically users may want to customize the default configurations to control settings such as frequency, scrambling keys, modulation parameters etc.

- Both the SOLO4 Telemetry Transmitter and Receiver are controlled with the same application `telemetry_ctrl.exe` which auto-detects the type of unit it is connected to.

Note that exact file names may change as software version information is a part of demo file names.

A PC is required with two RS232 Serial COM ports to control both a transmitter and receiver simultaneously. Where changes are to be made to either a transmitter, or a receiver, at different times, a PC with a single RS232 Serial COM port can be used.

Installation of the two control programs is as simple as copying them from the CD to a suitable location on the PC. No install shield routine is launched. Note that the controllers generate their own log and initialisation files, so it is best to create a dedicated directory for these applications, perhaps with links to the applications from the desktop of the PC.

Use the supplied cables to connect the chosen COM port(s) of the PC to unit(s) to be configured.

Launch each application in turn by double clicking or using the run command.

Connection with a SOLO4 Telemetry product should be automatic, but the user can force selection of the correct COM port using the drop down, followed by the "Connect" button.

Errors such as the following may appear during the connection process if the PC is unable to automatically ascertain which unit is connected to which COM port.

- Error attempting to read invalid address
- Error has occurred during polling, polling has been disabled

Changes can be made to the unit configuration using the drop down and data entry fields.

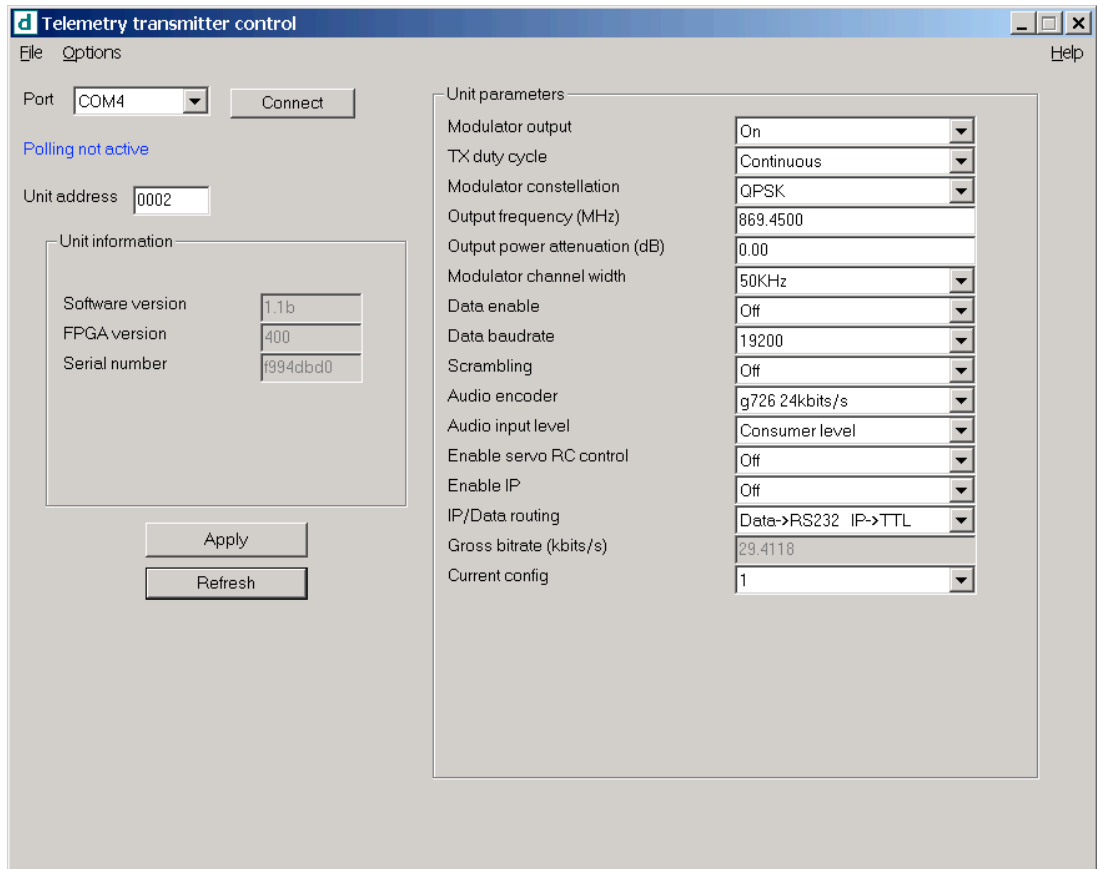
Changes are only applied to the unit when the “Apply New Values” button is clicked.

Current values, as running in the unit, can be read using the “Refresh” button.

Parameters that are status information only appear in greyed in the application.

Further engineering and configuration controls can be found within the “Options” and “File” drop down menus in the application title bars.

## 8.2 Telemetry Transmitter Control Application



### 8.2.1 Modulation Output

This control is used to turn on and off the RF output. After a configuration change, the output always reverts to OFF.

### 8.2.2 TX Duty Cycle

This determines whether the transmitter operates in continuous or discontinuous mode.

### 8.2.3 Modulator Constellation

The COFDM mode can be changed between QPSK and 16QAM. QPSK is the default mode and will give the strongest most rugged RF link performance. Selecting 16QAM reduces the link performance by 5.5dB but doubles the link data throughput..

### 8.2.4 Output Frequency (MHz)

The transmit frequency can be changed by entering the new desired frequency in this field. Values outside the range supported by a particular transmitter type will be rounded to the highest or lowest supported frequency as appropriate.

The transmit frequency can be set in step sizes of 12.5kHz. In License exempt mode of operation the frequency, bandwidth power level and TX duty cycle will be adjusted accordingly.

### 8.2.5 Output Power Attenuation

This sets the output attenuation in dB. 0dB corresponds to a nominal maximum level of 100mW.

### 8.2.6 Modulator Channel Width

Sets the modulator channel width in 25kHz steps. The width of the spectrum is about 4/5 of this channel width.

### 8.2.7 Data Enable/Parity

With this control the user can select whether the transmitter passes serial RS232 data across the RF link to the receiver. A choice of no parity, even & odd parity is selectable.

### 8.2.8 Data Baud Rate

This field is used to select the baud rate of any RS232 serial data component to be passed from the transmitter to the receiver across the RF link.

### 8.2.9 Scrambling

If the AES scrambling option has been purchased for the SOLO4 Telemetry system in use, then it is possible to encrypt the link. Scrambling must be enabled at the transmitter by selecting either AES128 or AES 256 in the scrambling field. At this point the user will need to ensure that the correct key is in use and this is done by using **Options / Write AES Key**.

The key is a 128bit key for AES128 and a 256bit key for AES256 and is entered as either 32 or 64 ASCII hexadecimal characters (0..F).

### 8.2.10 Audio Encoder

The Audio can be enabled with this control. Audio is off by default, and there are 2 mono modes available to the user. 24Kbits/s toll quality and 32Kbits/s telephone quality may be selected both at 8KHz sampling rate. Some bit-rates will not support audio.

### 8.2.11 Audio Input Level

This control is used to define the audio gain to be applied to the audio input signal. 0dB is used for line level audio and various options up to 48dB of gain can be applied for microphone inputs.

### 8.2.12 Enable RC servo control

Enables the 2 channel joystick and servo interfaces.

### 8.2.13 IP Enable

Enables the IP interface for the Netstream unit

#### 8.2.14 IP/Data Routing

The IP/data routing can be set to allow the IP pipe to use the RS232 data input on the Telemetry unit (default is RS232 data pipe). Alternatively the IP data between the Netstream and the Telemetry unit can use the TTL interface.

#### 8.2.15 Gross Bit Rate (Status Only)

This give an indication of the channel bit rate available. This can be useful in calculating data throughput.

#### 8.2.16 Current Config

This field reports the last loaded configuration number. Note that for the SOLO transmitter, changes applied after the configuration has been loaded are saved immediately into the current configuration.

#### 8.2.17 Unit Address

This is the unit address of the unit being controlled.

#### 8.2.18 Software Version (Status Only)

This status information describes the version of the software running the SOLO4 transmitter product.

#### 8.2.19 FPGA Version (Status Only)

This information is for domo engineering use only.

#### 8.2.20 Serial Number (Status Only)

This status information is the electronic serial number of the transmitter PCB. This number can be exchanged with domo to purchase extra licensable features, such as upgrades to support AES encryption.

#### 8.2.21 Options

**Timeouts** – access to change timeouts used during the serial communications between the unit and the controller.

**Engineering** – access to further diagnostic and calibration features.

**Write License Code** – open box for entering license codes for the activation of licensable features (e.g. AES scrambling) in the transmitter. Contact **domo** for support in applying new licenses as required.

**Change RS232 address** – prompts the user to change the units RS232 address, which can be useful when connecting multiple units together via a multi drop RS485 bus for control purposes.

**Write AES Key** – opens a dialogue box for entering a 128bit and 256bit AES scrambling key, as 32 ASCII hexadecimal characters (0...F)

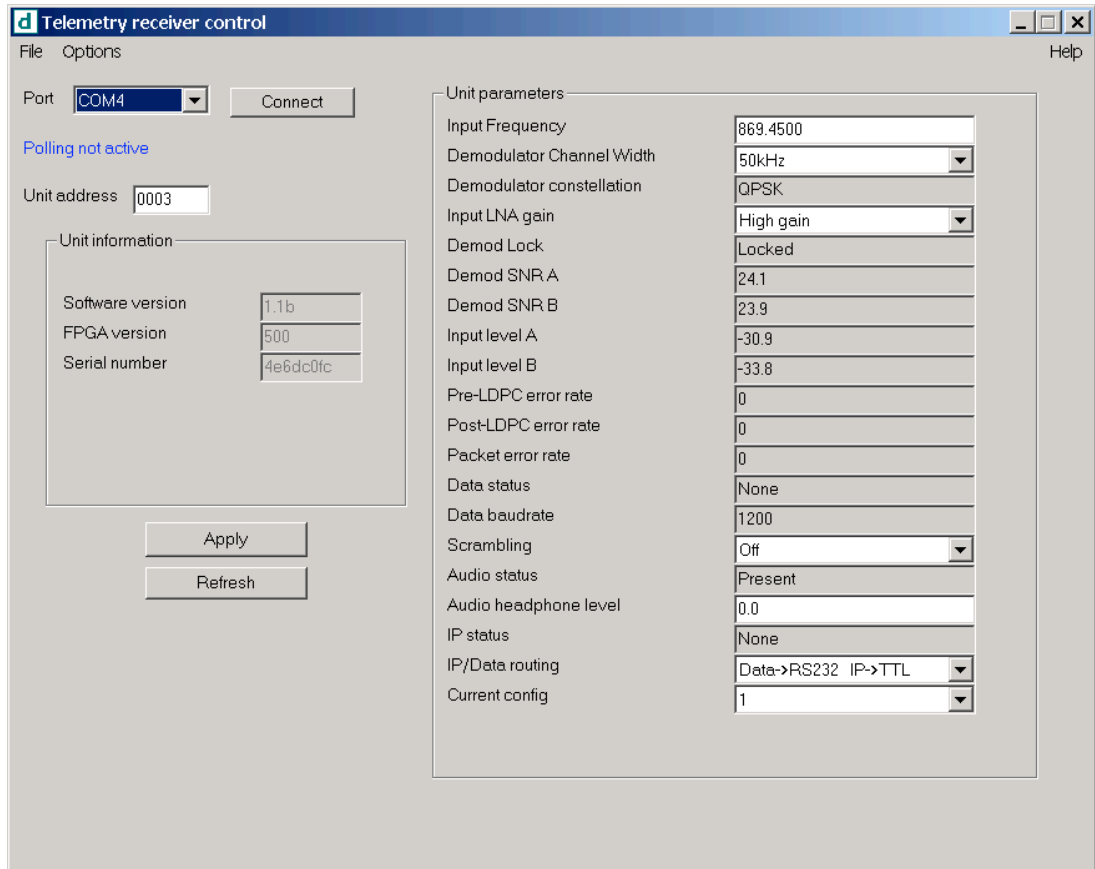
**Restore Defaults** – restores factory default settings in the transmitter.

## 8.2.22 File

**Change Logfile** – opens a standard Windows file save dialogue box which allows the user to change the path and name of the log file generated by the application.

**Exit** – exits the SOLO4 receiver control application

## 8.3 Telemetry Receiver Control Application



### 8.3.1 Input Frequency

The receive frequency can be changed by entering the new desired frequency in this field.

### 8.3.2 Demodulator Channel Width

Sets the demodulator channel width in 25KHz steps. This must match the modulator channel width.

### 8.3.3 Demodulator Constellation (Status Only)

This field displays the COFDM constellation that is being demodulated at the receiver. In normal operation this will match that selected at the transmitter.

### 8.3.4 Input LNA gain

This allows selection of the input gain at the front end of the demodulator. Low gain mode improves the blocking on the input by about 10dB but has a similar reduction on sensitivity.

### 8.3.5 Demod Lock Status (Status Only)

This indicates whether the demodulators are successfully locked to the RF signal.

### 8.3.6 Input SNR (Status Only)

For each IF input, the SNR (Signal to Noise Ratio) is reported. Values in the order of 18dB to 22dB represent strong received signals, whilst values in the order of 5dB represent poor received signals which will likely give rise to decoding errors.

### 8.3.7 Input Level (Status Only)

This figure indicates the received signal level at the two receiver inputs. Normal Operation will occur when the input level is between  $-25$  and  $-115$  dBm. Signals greater than  $-25$  may be too powerful and cause damage. Signal less than  $-115$ dBm may be too weak and cause data loss (typical link failure will occur between  $-118$ dBm depending on mode). The input level may also increase when the antennas are connected and there is no transmission. This indicates the presence of interference.

### 8.3.8 BER Pre-LDPC (Status Only)

This is the raw error rate prior to the error correction techniques having been applied in the receiver.

### 8.3.9 BER Post-LDPC (Status Only)

This is the error rate before the BCH decoder.

### 8.3.10 Packet Error Rate (Status Only)

This is a measure of the number of un-correctable errors in the system. Any value other than 0 with cause loss of data, break up of audio and is a good indication of link failure.

### 8.3.11 Data Status (Status Only)

This field shows the presence of data in the system by indicating the parity of the data or none if no data is present.

### 8.3.12 Data Baud Rate (Status Only)

This field reports the baud rate of the RS232 serial data component that is present and selected in the stream.

### 8.3.13 Scrambling

If the AES scrambling option has been purchased for the SOLO4 system in use, then it is possible to encrypt the link. Descrambling must also be enabled at the receiver by selecting AES128 or AES256 in the descrambling field. At this point the user will need to ensure that the correct key is in use at the receiver and this is done by selecting **Options / Write AES Key** in the receiver controller.

The key is a 128bit value for AES128 and a 256bit value for AES256, and is entered as 32 or 64 ASCII hexadecimal characters (0...F).

The AES128+ and AES256+ modes prevent clear streams from passing through the system which can be useful in certain applications.

### 8.3.14 Audio Status (Status Only)

This field shows the presence of audio in the system.

### 8.3.15 Audio Headphone Level

This allows the user to adjust the audio output level in the receiver. The nominal level is set to 0dB.

### 8.3.16 IP status

This field indicates the presence of IP data on the link.

### 8.3.17 Data Routing

The IP/data routing can be set to allow the IP pipe to use the RS232 data input on the Telemetry unit (default is RS232 data pipe). Alternatively the IP data between the Netstream and the Telemetry unit can use the TTL interface.

### 8.3.18 Current Config

This field reports the last loaded configuration number. Note that for the SOLO transmitter, changes applied after the configuration has been loaded are saved immediately into the current configuration.

### 8.3.19 Unit Address

This is the unit address of the unit being controlled.

### 8.3.20 Software Version (Status Only)

This status information describes the version of the software running the SOLO4 transmitter product.

### 8.3.21 FPGA Version (Status Only)

This information is for domo engineering use only.

### 8.3.22 Serial Number (Status Only)

This status information is the electronic serial number of the transmitter PCB. This number can be exchanged with domo to purchase extra licensable features, such as upgrades to support AES encryption.

### 8.3.23 Options

**Timeouts** – access to change timeouts used during the serial communications between the unit and the controller.

**Engineering** – access to further diagnostic and calibration features.

**Write License Code** – open box for entering license codes for the activation of licensable features (e.g. AES scrambling) in the transmitter. Contact **domo** for support in applying new licenses as required.

**Change RS232 address** – prompts the user to change the units RS232 address, which can be useful when connecting multiple units together via a multi drop RS485 bus for control purposes.

**Write AES Key** – opens a dialogue box for entering a 128bit and 256bit AES scrambling key, as 32 ASCII hexadecimal characters (0...F)

**Restore Defaults** – restores factory default settings in the transmitter.

**Polling Enabled** – selecting this option makes the control application automatically refresh the data presented to the user every few seconds.

#### 8.3.24 File

**Change Logfile** – opens a standard Windows file save dialogue box which allows the user to change the path and name of the log file generated by the application.

**Exit** – exits the SOLO4 receiver control application

## 9 Fault Finding

### 9.4 Fault Symptoms

Symptom	Suggested Action
No RF Link	Check a suitable transmitter RF transmitter is active, both units on correct frequency, and correct bandwidth settings with antennas connected. Ensure there is no interfering signal.
Poor link performance	<p>Poor performance of the link can occur for the following reasons.</p> <ul style="list-style-type: none"><li>• Interference. Should an interfering RF signal occur on the same frequency the performance of the link will be affected. Remove the interferer or move to an alternative frequency.</li><li>• Using the antennas without a ground plane. For best performance the supplied dome antennas should be fitted to a ground plane.</li><li>• Unsuitable antennas, or out of band antennas. See the antenna sections for guidance on antenna selection and use.</li><li>• Reduced transmit power, ensure that the attenuation setting on the transmitter is appropriate.</li><li>• Receive antenna positioning, where possible mount the receive antennas away from other objects, unobstructed and away from any electronics likely to generate interference.</li><li>• No Diversity operation. Ensure both antennas are operational.</li></ul>
Loss of data	Check link performance, data cables are in good condition and correct use of Xon/Xoff flow control. In discontinuous mode check 'Ton' period is not too short.
No audio	Ensure audio is enabled at the transmitter (disabled by default).

## 10 LED Indicators

### 10.5 SOLO4 Telemetry TX

LED Condition	Meaning
Red ALARM LED lit permanently	Unit is faulty / incorrect software loaded
RF LED blinking	Unit in discontinuous mode, RF inactive
RF LED lit	RF output active
RF LED not lit	RF output inactive
Single CONFIG LED lit	Indicates selected config
Front Panel Lock	Indicates front panel locked
RF Bar Graph	RF output level
No LEDs lit	Unit in standby or Off

### 10.6 SOLO4 Telemetry RX

LED Condition	Meaning
Red ALARM LED lit permanently	Unit is faulty / incorrect software loaded
RF LED off	No RF signal lock
RF LED on	RF signal lock
Single CONFIG LED lit	Indicates selected config
Front Panel Lock	Indicates front panel locked
RF Bar Graph	RF signal quality
No LEDs lit	Unit in standby or Off

## 11 Technical Specifications

### 11.7 Bandwidths and Bitrates

Channel Spacing	Channel Bandwidth	User Bitrate (QPSK)	User Bitrate (16QAM)
25 kHz	20 kHz	14 kbits/s	29 kbits/s
50 kHz	40 kHz	29 kbits/s	58 kbits/s
75 kHz	60 kHz	44 kbits/s	99 kbits/s
100 kHz	80 kHz	58 kbits/s	117 kbits/s
125 kHz	100 kHz	73 kbits/s	147 kbits/s
<b>(W) – Wide Bandwidth Unit only</b>			
150 kHz	120 kHz	88 kbits/s	176 kbits/s
175 kHz	140 kHz	102 kbits/s	-
200 kHz	160 kHz	117 kbits/s	-
225 kHz	180 kHz	132 kbits/s	-
250 kHz	200 kHz	147 kbits/s	-
275 kHz	220 kHz	161 kbits/s	-
300 kHz	240 kHz	176 kbits/s	-

### 11.8 SOLO4 Telemetry Transmitter

<b>Operating Frequency</b>	<b>458MHz or 868-870MHz (ISM)</b>
Modulation	105 carrier OFDM QPSK/16QAM 1/16 guard
Channel Spacing	25,50,75,100,125..300KHz
Channel Bandwidth	20,40,60,80,100..240KHz
Maximum output power	100mW
Power Supply Voltage	5.5-18V
Power dissipation	<3W
RS232 data rates	1200,2400,4800,9600,19200,38400,57600,115200
RS232 parity	None, Even, Odd with Xon/Xoff flow control where necessary
IP data	Support for network engine via RS232 propriety protocol

Audio codec	G726 codec 24/32 Kbits/s with 8KHz sampling
Audio input	Consumer, 12,24,36,48dB microphone level, -2dBu max clip level

## 11.9 SOLO4 Telemetry Receiver

<b>Operating Frequency</b>	<b>458MHz or 868-870MHz (ISM)</b>
Modulation	105 carrier OFDM QPSK/16QAM 1/16 guard
Channel Spacing	25,50,75,100,125KHz, (and 150,175,200,225,250,275,300KHz with wider IF filter)
Antenna	2 way diversity MRC
Input sensitivity	< -113dBm@100KHz 16QAM, -118dBm@100KHz QPSK, -121dBm@50KHz,
Image rejection	> 52dB (10.7MHz IF Hi-Side LO)
Adjacent channel rejection	> 45dB
Error correction/detection	2112 bit rate ½ soft LDPC, 968/1056 BCH
Power Supply Voltage	5.5-18V
Power dissipation	<3W
RS232 data rates	1200,2400,4800,9600,19200,38400,57600,115200
RS232 parity	None, Even, Odd
IP data	Support for network engine via RS232 propriety protocol
Audio codec	G726 codec 24/32 Kbits/s with 8KHz sampling
Audio output	Line/headphone outputs - +5dBu max clip level fully adjustable

## 12 Connector Pin Outs

### 12.1 Power - 4-pin 0B LEMO Socket (Telemetry Tx and Rx)

Pin No	Function
1	12 V
2	12 V
3	GND
4	GND

### 12.2 Control/Expansion - 16-pin Hirose 3500 series connector & 0.1" or OEM header

Pin No	Function
1	VBATT – only 1A on this pin
2	GND
3	RS232 TX1 (Control)
4	RS232 RX1
5	RS232 TX2 (Data)
6	RS232 RX2
7	GPIO
8	GPIO or TTL IP data
9	GND
10	GPIO or TTL IP data
11	GPIO
12	GND
13	GPIO
14	GND
15	n/c
16	n/c

### 12.3 Audio - 5-pin 0B LEMO socket (Telemetry Tx & Rx)

Pin No	Function
1	Spare Audio In
2	Audio In (Tx only)
3	GND
4	Audio Out + (Rx only)
5	Audio Out -

## 13 Control Protocols

The following section describes the control protocol employed on the RS232 link for controlling the SOLO4 transmitters and receiver equipment.

Connection details are detailed in previous sections.

Note that only features that are licensed for use in the SOLO4 units can be controlled. The protocols listed here cover all possible features. Attempting to activate an unlicensed feature will simply result in the command being ignored by the SOLO4 unit.

TX commands sent to an RX unit and visa-versa will be acknowledged have no effect.

### 13.4 RS232 Control – General Principles

The physical interface is RS232 but this can be converted to RS 485 with an external adapter where multiple units are controlled over one RS 485 bus.

Normal operation involves sending a packet from the control device (normally a PC) to the device being controlled. If the packet satisfies an address integrity check, then the controlled device will action the command and send a reply.

For compatibility with modems an ASCII style protocol is used.

Ports are set for 9600 Baud, 8 bits, No parity, 1 stop

### 13.5 Packet Structure Sending (from PC)

ASCII	Value	
STX	02h	Start byte
0-9	30h-39h	4 byte unit address. In range 0-9999
R misc	20h-7Eh	1 byte command type. <b>r</b> read, <b>w</b> write or <b>m</b>
I	20h-7E	1 byte indicator of internal data block
ABC	20h-7Eh	Command –three byte mnemonic
;	3Bh	Separator
PQR	20h-7Eh	Data –Optional, variable length
;	3Bh	Separator
X	20h-7Eh	Sum Check
ETX	03h	End byte

## 13.6 Packet Structure Reply (from controlled device)

ASCII	Value	
STX	02h	Start byte
0-9	30h-39h	4 byte unit address. In range 0-9999
Z	20h-7Eh	Status BYTE
PQR	20h-7Eh	Data –Optional, variable length
;	3Bh	Separator
X	20h-7Eh	Sum Check
ETX	03h	End byte

The Sum check byte is the summation of all bytes in the packet, not including the start and end bytes. Higher order bytes are ignored and the final byte result is modified to prevent ASCII control characters being sent. Bit 7 (highest) is forced high.

Status byte will indicate command performed OK, or indicate an error.

ASCII	Meaning
1	All OK
E	General error, Command could not be actioned

Typically E will be returned if the message is formatted incorrectly (separators in wrong place) or if commands are in upper case, or if commands do not match against the allowed list of commands, or if the checksum is wrong.

Addresses in the range 0001 to 9998 are for general use. Address 0000 is reserved and 9999 is a broadcast address. i.e. any device will reply to this address. Its reply will contain its own specific address.

All data in the transmitter and receiver is stored as one of 5 data types, Double, String, List, Integer or HexInteger. The data type dictates the contents of the data section of the reply.

- List – 1 byte for sending. Value is hexadecimal coded as ASCII. 2 byte reply. Reply represents index into original choice list. e.g. Reply 02 indicates entry 2 in original list.
- Double - variable length. Reply always contains decimal point and 4 decimal places. Can have 1 to 3 digits before decimal.
- Integer - 6byte reply. integer value with stuffed with preceding zeros. e.g. GOP reply 000012 = GOP length 12
- String - Variable length. Reply is string excluding null terminator
- HexInteger – 8byte Hex reply

## 13.7 Telemetry System Command List

Comm	Description	Tx/Rx	RW	Type	Comments	Default
gadd	Unit address	TxRx	RW	Integer	9999 - broadcast address	2-tx,3-rx
gser	Unit serial number	TxRx	R	Hex		
gver	Software version number	TxRx	R	String		
gfpg	FPGA version number	TxRx	R	Hex		
gdef	Restore defaults	TxRx	W	Integer	1 - restore defaults	
glic	License code	TxRx	W	Hex		
gsle	Sleep	TxRx	RW	Integer	0 - active, 1 - sleep mode	0
glod	Config number	TxRx	RW	Integer	1-8 config	1
gtyp	Unit Type	TxRx	R	Integer	bit0=0 Tx, bit 0=1 Rx	
gau2	Set remote command	Tx	RW	Integer	1 - allow remote commands, 0 = off	0
gfpl	Front panel lock	TxRx	RW	Integer	0 - unlocked, 1 = locked	0
gstt	Enable status display	Rx	RW	Integer	0 - disabled, 1 - enabled @ 9600 baud	0
oout	Modulator output	Tx	RW	Integer	0 - Off, 1 - On	0
omod	Modulator constellation	Tx	RW	Integer	0 - QPSK, 1 - 16QAM	0
odut	TX duty cycle	Tx	RW	Integer	0 - Continuous, 1 - Discontinuous operation	0*
ofre	Output frequency	Tx	RW	Float	MHz	869.45*
opwr	Output power attenuation	Tx	RW	Float	dB	0*
onrt	Modulator Channel Width	Tx	RW	Integer	1 - 25KHz ... 5 - 125KHz	4*
omux	Gross TX bit rate	Tx	R	Float	Kbits/s	
cflo	Minimum operating frequency	TxRx	RW	Float	MHz	868
cfhi	Maximum operating frequency	TxRx	RW	Float	MHz	870
cplv	Power level calibration level	Tx	RW	Float	dB	
cton	TX on timeout	Tx	RW	Integer	Timeout before data is sent in discontinuous mode	8
ctof	TX off timeout	Tx	RW	Integer	Timeout before Tx turns off in discontinuous mode	8
dpid	Tx Data PID	Tx	RW	Integer	0x10-0x17	0x10
dinp	Tx Data Enable	Tx	RW	Integer	0 - off, 1 - no parity, 2 - even parity, 3 - odd parity	1
dbau	Tx Data Baudrate	Tx	RW	Integer	0 - 1200,2400,4800,9600,19200,38400,57600,115200	6
drem	Tx Aux Control PID	Tx	RW	Integer	0x28-0x2f	0x28
1fre	Input Frequency	Rx	RW	Float	MHz	869.45*
1nrt	Demodulator Channel Width	Rx	RW	Integer	1 - 25KHz ... 5 - 125 KHz	4*
1lna	Input LNA gain	Rx	RW	Integer	0 - high gain, 1 - low gain	0
1loc	Demod Lock	Rx	R	Integer	0 - No, 1 - Yes	
1snr	Demod SNR A	Rx	R	Float	dB	
1mer	Demod SNR B	Rx	R	Float	dB	
1ina	Input level A	Rx	R	Float	dB	
1inb	Input level B	Rx	R	Float	dB	
1pre	Pre-LDPC error rate	Rx	R	Integer		
1pos	Post-LDPC error rate	Rx	R	Integer		
1pkt	Packet error rate	Rx	R	Integer	0 is good	
1mod	Demodulator constellation	Rx	R	Integer	0 - QPSK, 1 - 16QAM	
fpid	Rx Data PID	Rx	RW	Integer	0x10-0x17	0x10
finp	Rx Data Status	Rx	R	Integer	0 - None, 1 - no parity, 2 - even parity, 3 - odd parity	
fbau	Rx Data Baudrate	Rx	R	Integer	0 1200,2400,4800,9600,19200,384,57600,115200	
frem	Rx Aux Control PID	Rx	RW	Integer	0x28-0x2f	0x28
zscr	Scrambling mode	TxRx	RW	Integer	0-Off, 4-AES128, 5-AES128+, 6-AES256, 7-AES256+	0
zkez	128AES (256AES lower) key	TxRx	W	Hex	32 digit hex key	
zkeX	256AES upper key	TxRx	W	Hex	32 digit hex key	

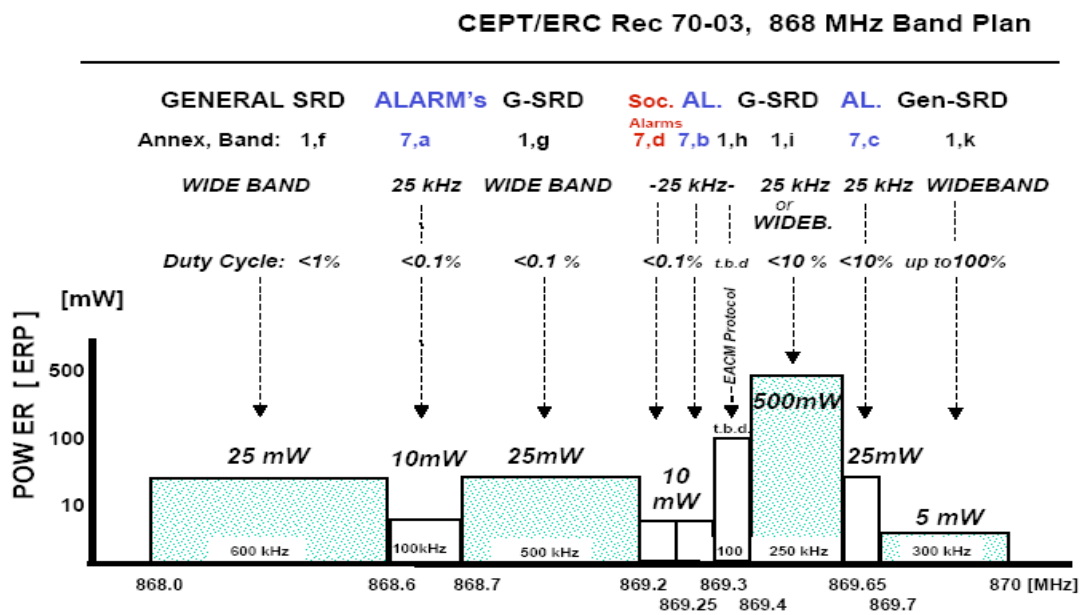
apid	Tx Audio PID	Tx	RW	Integer	0x40-0x47	0x40
aenc	Audio encoding mode	Tx	RW	Integer	0 - Off, 9 - g726 24Kbits/s, 10 - g726 32Kbits/s	0
alev	Audio input level	Tx	RW	Integer	0 - Consumer level, 1..4 - 12,24,36,48dB gain mic level	0
athr	Audio threshold level	Tx	RW	Integer	Audio level which triggers TX on in discontinuous mode	255
rpid	Rx Audio PID	Rx	RW	Integer	0x40-0x47	0x40
raud	Audio status	Rx	R	Integer	0 - Not present, 1 - Present	
rvol	Audio headphone level	Rx	RW	Integer	52 = -102dB, 255 = -.5dB, 0 = 0dB, 24 = +12dB	0
ppid	Tx RC PID	Tx	RW	Integer	0x58-0x5f	0x58
ppen	Enable Tx RC control	Tx	RW	Integer	0 - off, 1 - 2 channel RC	0
qpid	Rx RC PID	Rx	RW	Integer	0x58-0x5f	0x58
ipid	Tx IP PID	Tx	RW	Integer	0x30-0x37	0x30
ipen	Enable Tx IP	Tx	RW	Integer	0 - off, 1 - on (115200 baud), 2 - on (230400 baud)	0
jpid	Rx IP PID	Rx	RW	Integer	0x30-0x37	0x30
jinp	Rx IP Status	Rx	R	Integer	0 - None, 1 - on (115200 baud), 2 - on (230400 baud)	
irou	IP/Data Routing	TxRx	RW	Integer	0 - Data RS232, IP TTL or 1 - Data TTL, IP RS232	0

\* Depends on unit type and license exempt operation



# 14 Frequency Plan

## 14.8 868MHz Frequency Plan



## 14.9 458MHz Frequency plan

Channel Number	Frequency
1	458.525MHz
2	458.550MHz
3	458.575MHz
4	458.600MHz
5	458.625MHz
6	458.650MHz
7	458.675MHz
8	458.700MHz

9	458.725MHz
10	458.750MHz
11	458.775MHz
12	458.800MHz
14	458.850MHz
15	458.875MHz
16	458.900MHz
17	458.925MHz

**Cobham Surveillance**

Domo Products

11 Manor Court, Barnes Wallis Road, Segensworth,  
Hampshire, PO15 5TH, England

T: +44 (0)1489 566 750

F: +44 (0)1489 880 538