SB2025NT BASE STATION

TECHNICAL AND USER MANUALS

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PREFACE

DECLARATION

This Manual covers the SB2025NT Base Station. It is broken down into two parts: Part 1 is the Technical Manual for the base station; and Part 2 is the User Manual for the Engineering Terminal (ET).

Any performance figures quoted are subject to normal manufacturing and service tolerances. The right is reserved to alter the equipment described in this manual in the light of future technical development.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE.

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In the interests of improving the performance, reliability or servicing of the equipment, Simoco reserves the right to update the equipment or this document or both without prior notice.

ERRORS AND OMISSIONS

The usefulness of this publication depends upon the accuracy and completeness of the information contained within it. Whilst every endeavour has been made to eliminate any errors, some may still exist. It is requested that any errors or omissions noted should be reported to either of the following who are part of the Simoco group:

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RELATED DOCUMENTS

Nil.

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PERSONAL SAFETY

Safety Precautions

These Safety Precautions, Warnings and Cautions advise personnel of specific hazards which may be encountered during the procedures contained in this document and that control measures are required to prevent injury to personnel, and damage to equipment and/or the environment.

Before commencing the installation or any maintenance of this equipment, personnel are to acquaint themselves with all risk assessments relevant to the work site and the task. They must then comply with the control measures detailed in those risk assessments.

References covering safety regulations, health hazards and hazardous substances are detailed under the **WARNINGS** section below. These are referred to in the tasks, when encountered.

Adequate precautions must be taken to ensure that other personnel do not activate any equipment that has been switched off for maintenance. Refer to the Electricity at Work regulations 1992.

Where dangerous voltages are exposed during a task, safety personnel are to be provided as detailed in the Electricity at Work regulations 1992. Where safety personnel are required for any other reason, management are to ensure that the personnel detailed are aware of the hazard and are fully briefed on the action to be taken in an emergency.

Where equipment contains heavy components or units that require lifting, lowering, pulling or pushing operations to be performed on them during maintenance tasks, all managers and tradesmen are to be conversant with the Manual Handling Operations Regulations 1992, ISBN 0110259203.

Hazardous Substances

Before using any hazardous substance or material, the user must be conversant with the safety precautions and first aid instructions:

- On the label of the container in which it was supplied.
- On the material Safety Data Sheet.
- In any local Safety Orders and Regulations.

WARNINGS

Radio Frequency Radiation

	**WARNING** **RADIO FREQUENCY (RF) RADIATION. A RF RADIATION HAZARD EXISTS IN THIS EQUIPMENT. TO AVOID RF INJURY, DO NOT TOUCH THE ANTENNA WHEN THE TRANSMITTER (TX) IS IN USE. DO NOT OPERATE TX WITH ANTENNA DISCONNECTED. REFER TO EU DIRECTIVE 2004/40/EC DATED 29 APRIL 2004.**
	**WARNING** **THERMAL OR RF BURNS. <u>DO NOT</u> ATTEMPT INTERNAL SERVICING WHILE TRANSMITTING. THERMAL OR RF BURNS MAY RESULT FROM TOUCHING CERTAIN COMPONENTS WITHIN THE POWER AMPLIFIER MODULE WHILE TRANSMITTING OR OPERATING THE TX.**

Dangerous Voltages

Although there are no mains voltages present within the equipment, other voltages do exist in the equipment. The following general safety precautions as would normally apply, should be observed during all phases of operation, service and repair of this equipment.

WARNING

TO MINIMISE ANY POSSIBLE SHOCK HAZARD FROM AN EXTERNAL POWER SUPPLY OR LIGHTNING STRIKE, THE CHASSIS OF THE EQUIPMENT CABINET MUST TO BE CONNECTED TO AN ELECTRICAL SAFETY EARTH CONNECTION.

WARNING

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

DO NOT OPERATE THIS EQUIPMENT IN THE PRESENCE OF FLAMMABLE GASES OR FUMES. OPERATION OF ANY ELECTRICAL EQUIPMENT IN SUCH AN ENVIRONMENT CONSTITUTES A DEFINITE SAFETY HAZARD.

WARNING

DO NOT SUBSTITUTE PARTS OR MODIFY THE EQUIPMENT.

BECAUSE OF THE DANGER OF INTRODUCING ADDITIONAL HAZARDS, DO NOT INSTALL SUBSTITUTE OR LOWER VOLTAGE PARTS TO THE EQUIPMENT. RETURN TO YOUR AUTHORISED DISTRIBUTOR.

Beryllium and Beryllia

WARNING

BERYLLIUM AND BERYLLIA. MOST RF POWER TRANSISTORS AND SOME RF POWER HYBRIDS CONTAIN BERYLLIUM OXIDE. REFER TO THE CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS (COSHH) 2002 AND/OR THE APPROPRIATE SAFETY DATA SHEET. CONSULT YOUR LOCAL AUTHORITY FOR CORRECT DISPOSAL THEREOF.

EQUIPMENT SAFETY

Installation and Maintenance

The SB2025NT Series of base stations should only be installed and maintained by qualified personnel.

Cautions

CAUTION

The Antenna System must to be protected against lightning by means of an earthing system and surge protection device.

Do not connect Antenna Lightning conductors to the base station or Mains Earth.

Maintenance Precautions

CAUTION

Electrostatic Discharge Sensitive Devices (ESDS Devices). This equipment contains ESDS Devices, the handling procedures detailed in BS EN 61340-5-1:2007 or ANSI/ESD S20.20-1999 are to be observed.

WARRANTY CONDITIONS AND PRECAUTIONS

The following conditions are not covered by the warranty of the SB2025. Please ensure that the SB2025 is not subject to:

1. Over voltage or Reverse Power Supply Voltage.

2. Operation in locations subject to abnormal environmental conditions such as extreme temperatures or ingress of moisture.

3. Operation of the SB2025 Tx output into an open or short circuit or an incorrectly terminated load.

WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) NOTICE

The Waste Electrical and Electronic Equipment (WEEE) Directive became law in most EU countries during 2005. The directive applies to the disposal of waste electrical and electronic equipment within the member states of the European Union.

As part of the legislation, electrical and electronic equipment will feature the crossed out wheeled bin symbol (see image at left) on the product or in the documentation to show that these products must be disposed of in accordance with the WEEE Directive.

In the European Union, this label indicates that this product should not be disposed of with domestic or “ordinary” waste. It should be deposited at an appropriate facility to enable recovery and recycling.

GENERAL NOTES

MANUAL COMPILATION

This manual provides detailed information on the SB2025NT base station. It is divided into two parts.

Part 1 – Technical Manual

Part 1 is the Technical Manual, which includes information on Installation and Operation, General Description, Technical Description, Alignment and Testing, Fault Finding and Drawings for the base stations.

Details of both “basic” and “optional units” have been included in the Technical Manual, therefore, some material may not be relevant to every system. Configuration is dependent upon the specification by the customer when the equipment was ordered and installed.

The manual has been compiled with a two-tier maintenance policy in mind, i.e. first-line fault location and repair by replacement, followed by subsequent bench-testing of sub-assemblies to specification. Consequently, some “overlap” and/or duplication of information has resulted.

Part 2 – User Manual

Part 2 is the User Manual for the ET software application. The ET is the primary source for controlling, configuring and monitoring the Solar 2 Modules fitted within the SB2025 series of base stations.

PAGINATION

Each part of the manual is divided into a number of sections, each section deals with one aspect of the system.

Following initial issue, any page that has been amended or updated will also bear an updated reference.

PARTS LISTING

A Composite List of Replaceable Assemblies (i.e. a list of all components used in the system) is included at **Part 1, Section 9**.

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ABBREVIATIONS

The following abbreviations are used throughout this document. Wherever practicable, whenever the abbreviation is first used, the full meaning is given with the abbreviation in parenthesis, after that only the abbreviation will be used.

Abbreviation	Meaning
1PPS	One Pulse Per Second (timing signal)
1U	One Unit
AC	Alternating Current
Ae	Aerial/Antenna
AFSI	Analogue Fixed Station Interface
AMBE+2	Advanced Multi-Band Excitation+2
BER	Bit Error Rate
BNC	Bayonet Neill-Concelman
C4FM	Continuous 4 Level Frequency Modulation
CDCSS	Continuous Digital Coded Squelch System
CMOS	Complementary Metal Oxide Semiconductor
COR	Carrier Operated Relay
COSHH	Control Of Substances Hazardous to Health
csv	comma separated variables
CTCSS	Continuous Tone Coded Squelch System
CTS	Communications Test Set
DC	Direct Current
DCS	Digital Coded Squelch
DFSI	Digital Fixed Station Interface
DHCP	Dynamic Host Configuration Protocol
DIP	Dual In-line Package
DSP	Digital Signals Processor
EEPROM	Electrically Erasable Programmable Read Only Memory
EEROM	Electrically Erasable Read Only Memory
EMI	Electromagnetic Interference
EPROM	Erasable Programmable Read-Only Memory
ESDS Devices	Electrostatic Discharge Sensitive Devices
ET	Engineering Terminal
FET	Field Effect Transistor
FFSK	Fast Frequency Shift Keying
FM	Frequency Modulation
FW	FirmWare
GPS	Global Positioning System
ID	IDentification
IF	Intermediate Frequency
I/O	Input/Output
IP	Internet Protocol
I/P	Input
LDMOS	Laterally Diffused Metal Oxide Semiconductor
LED	Light Emitting Diode
MDR	Mini Data Ribbon

Abbreviation	Meaning
MIB	Management Information Base
MMIC	Monolithic Microwave Integrated Circuit
MTBF	Mean Time Between Failure
NAC	Network Access Code
NC	Not Connected
NI	Network Interface
NMEA	National Marine Electronics Association
NMS	Network Management System
OEM	Original Equipment Manufacturer
OIDs	Object IDentifiers
O/P	Output
PA	Power Amplifier
PAT	Packet Arrival Time
PC	Personal Computer
PCB	Printed Circuit Board
PIC	Programmable Intelligent Computer
PLL	Phase Locked Loop
PMR	Private Mobile Radio
PSL	Peak System Level
PSU	Power Supply Unit
PTT	Press (Push) To Talk
PWM	Pulse Width Modulation
RAM	Random Access Memory
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
RFI	Radio Frequency Interference
RSSI	Received Signal Strength Indicator
RTN	Return
RTS	Radio Test Set
Rx	Receive, Receiver
SBC	Signal Board Computer
SINAD	SIgnal to Noise and Distortion
SNMP	Simple Network Management Protocol
SNR	Signal to Noise Ratio
TCXO	Temperature Controlled Crystal Oscillator
TGID	Talk Group IDentification
TIA	Telecommunications Industry Association
TM	Traffic Manager
TOT	Total Output Time
TRC	Tone Remote Control
T/T	TalkThrough
TTL	Transistor Transistor Logic
Tx	Transmit, Transmitter
UART	Universal Asynchronous Receiver/Transmitter
UHF	Ultra High Frequency
USB	Universal Serial Bus

Abbreviation	Meaning
UTC	Universal Time Coordinated
VCO	Voltage Controlled Oscillator
VF	Voice Frequency
VHF	Very High Frequency
VoIP	Voice over Internet Protocol
VSWR	Voltage Standing Wave Ratio
WEEE	Waste Electrical and Electronic Equipment

GLOSSARY OF TERMS

The following terms are used through out this document.

Term	Meaning
'……'	Reference to a setting or feature (exactly as it is displayed) that may be selected or enabled either directly or through a software application, e.g. 'Button', 'Control', 'Switch'.
0 V	The internal negative supply line to which the internal circuitry is referenced.
1PPS	A One Pulse Per Second timing signal (timed from the leading or rising edge).
Audio Frequency	A composite audio band signal that may include tones.
CTCSS	A sub-audio tone used for validating a received signal (also known as a PL tone).
Closed Contact	Connects to the common or pole contact when a relay is not energised (off).
Firmware	The embedded code that makes SB2025 function.
Ground/Gnd	A connection that is the same potential as the chassis or case (earth).
Go/GO	A signal that flows towards the base station Tx.
In	A signal that is entering the SB2025 base station.
Key/Keyed	A signal that can cause transmit mode or the transmit condition itself.
Loader	The software application used to install the Programmable Intelligent Computer (PIC) Firmware.
Open Contact	Connects to the common or pole contact when a relay is energised (on).
Out	A signal that is leaving the SB2025 base station.
PAT	Packet Arrival Time – a value indicating the network latency.
Press To Talk	The action or signal that causes the equipment to be placed into transmit mode or to be keyed.
RS422	A balanced/differential line serial data signal.
Return/RTN	A signal that flows from the base station Rx (receive).
SELV	Safety Extra Low Voltage – within the definition used by EN60950.
Sig/Signalling	A state or tone that is used to indicate a defined condition.
TTL	A logic signal where a 'Low' is represented by a voltage of less than 0.7 V and a 'High' by a voltage >3 V but ≤5 V.
Vote/voting	The selection of the best received signal from a collection of signals presented individually and simultaneously.

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PART 1

SB2025NT TECHNICAL MANUAL

PART 1

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1 INTRODUCTION

The SB2025 Series of Base Stations are based on the SB2000 base station with integrated Solar 2 hardware to give additional functionality.

They employ state of the art design and construction methods to deliver a range of high performance, ultra reliable radio transceivers. They are ideally suited for use in Very High Frequency (VHF) or Ultra High Frequency (UHF) two-way analogue and P25 voice radio systems, however, the SB2025 can perform in a range of applications.

The **SB2025NT** is an SB2000 with integrated Solar 2 Traffic Manager (TM) and Network Interface (NI) units.

1.1 SB2025 APPLICATIONS

The flexibility of the SB2025 series allows it to be configured for a wide range of applications.

Standard SB2025 applications include:

- Solar Analogue/P25 Repeater (with Digital Fixed Station Interface (DFSI) – SB2025NT).
- Full duplex or simplex base station.
- Voice Repeater.
- Simulcast Tx.
- Quasi-Sync offset Tx.

The SB2025 incorporates special technical features, of which the key ones are listed below:

- Extremely low conducted emissions.
- Extremely low Tx spurious.
- Very Wide RF switching bandwidth.
- No re-tune Rx or Tx.
- Fully software programmable.
- Built in diagnostics.

In addition, the SB2025 can be fitted with many options, not being limited to the following:

- Programmable channel spacing.
- External reference oscillator input.
- High stability options.
- Special high performance Rx options.
- Other custom features on special request.

For further information, please contact Simoco.

1.2 SOLAR 2 – BRIEF DESCRIPTION

The Solar NI System enables the connection of multi RF Base Stations over an Internet Protocol (IP) network using wideband Voice over IP (VoIP) techniques to construct a wide area coverage Analogue or P25 Private Mobile Radio (PMR) channel. There are additional, secondary features integral to Solar that are designed to be of use to systems integrators in the building of a radio system to meet user requirements without the use of additional hardware.

A radio system will necessitate the use of a number of Solar NIs and one or more Solar TMs, which together are configured to meet the operational requirement. The Solar NI operates as a Central NI or a Station NI; they are the same unit. They are fully duplex and include all the features; it is a matter of system configuration to define which is which and how they are used. System configuration, base station Rx selection, packet organisation and distribution are the core functions performed by the Solar TM unit. Solar network changes for operational purposes can also be made via the Solar TM Unit.

All variants of the SB2025 contain a Station NI, which can be associated with either a separate TM or, in the case of the SB2025NT, a TM built into the same unit. The interface between the Station NI and the base station is entirely internal to the SB2025. There is no analogue audio interface to the unit.

As well as managing the operation of a channel, the TM provides a standard DFSI conforming to TIA-102.BAHA.

1.2.1 Method of Operation

The Solar Central NI is designed as the analogue interface, port, or gateway, to a packet switching network; the network is entirely the responsibility of the systems integrator. The Solar TM routes all Solar traffic and maintains the system configuration information. To fulfil this role the TM is configured to communicate with all other Solar elements on the network, as defined by the system design. Provided the network has sufficient data carrying capacity, there is no requirement for the network traffic to be uniquely Solar.

1.2.2 Basic I/O Facility

With Solar TMs and Solar NIs inter-connected by an IP network, in analogue mode the result will be that what goes into one NI will come out of another NI. The full audio bandwidth has been profiled at 300 Hz to >3.4 kHz and has a true transfer profile. This means that control and selective calling tones will be faithfully reproduced at the output Solar NI. The input signal is digitized, packetized and delivered to the network – at the destination Solar NI unit(s) the reverse process takes place ensuring that the output is a true reflection of the original input. In P25 mode, audio into the Central NI will be Advanced Multi-Band Excitation +2 (AMBE+2) coded and output from the Station NI(s) and, hence, from the SB2025 Tx(s) as a TIA-102 P25 compliant signal. A received and voted P25 signal will be AMBE decoded and output from the Central NI as audio.

1.2.3 PMR Wide-Area Cover Facilities

A number of Solar NIs and a minimum of one Solar TM are required to provide infrastructure facilities for wide area coverage, multi RF Base Stations, PMR system; not including Packet Switching Network or Control Console – all other requirements for a common PMR system are included. The Solar NI System would usually be configured to connect an operator/dispatcher terminal/console through a Central NI or DFSI connection via a Solar TM to a number of Station NIs each wired directly to a Base Station. Solar will also deliver all the signalling functions necessary for system operation.

1.3 SOLAR 2 – STYLE

Solar can be used in PMR systems in several styles but the style can only be activated by the factory programmed “Facility Key” in the TM. The basic information on the three core styles is as follows:

(a). Simulcast Style.

Solar has facilities for the synchronization of audio as follows:

- GO path – Talk Out direction.

- Return (RTN) path – Talk In direction.

The synchronization process requires access to a globally available 1PPS (Global Positioning System (GPS)); when configured as 'enabled' the process is automatic; there is no manual version, although the average value of delays being experienced across the network will be displayed on the Engineering Terminal (ET).

(b). Multicast style

Solar will operate in systems that are built as Multicast, i.e. where multiple Base Tx's are triggered simultaneously but there is no requirement for GO audio synchronization as the Tx's are on different frequencies. Therefore, this mode of operation does not require GPS.

(c). Transmitter Steering Style

Solar is able to be configured to operate in a Tx Steering Mode using commands from a host console system via an IP connection. This feature is implemented to suit specific console models.

(d). Single Tx, Voted Receivers Style

A Solar SB2025NT can be configured to operate as a receive-only unit to provide better receive coverage for hand portable users.

1.4 SOLAR 2 P25

Solar 2 provides the means to deliver synchronised audio that is carried over an IP network to multiple base station transmitters for simulcast operation. Building upon this well proven "synchronising engine" the SB2025 supports simulcast analogue and P25.

A Solar 2 P25 system will comprise of at least one Solar TM and a number of Station NIs. A single TM may be used as a standalone entity or be paired with a second unit working in duplicated mode for enhanced resilience (1+1 operation).

As with the original version of Solar, the TM is capable of controlling a maximum of 32 Station NIs, which may be deployed across more than one channel to a maximum of four. A DFSI connection can be made to each channel in the TM or one or more NIs may be used in Central mode (Central NI) to provide the console Analogue Fixed Station Interface (AFSI) to an analogue or P25 channel.

On Solar P25 systems, a channel may be configured to operate in either analogue only mode, P25 only mode, or automatic mode. The latter mode enables mixed operation on a call-by-call basis as might be necessary during system migration.

All Solar 2 P25 Station NIs and TM units must be provided with a global timing signal to achieve system wide synchronisation; this is not mandatory for Central NI units, which can take timing from the TM. The global timing signal is normally derived from a GPS Rx, and equipment that meets that requirement and is a direct plug-in to Solar 2 is available from DTS.

The TM receives IP packets from, and sends IP packets to, every NI on the system. The IP packets are formatted in exactly the same way as for Solar 1, in order to maintain commonality as well as using time-proven format and simplifying processing when signals are conventional analogue and not P25.

In the Tx direction (outgoing), the TM constructs the P25 frames from the voice data bit stream coming from the Central NI or DFSI in IP packets or from the voted Station NI if in Talkthrough (T/T) mode. The TM sends out the P25 frames in IP packets to every Station NI on the channel. In non-P25 mode, the packets from the Central NI or voted Station NI are basically replicated for each Station NI. In the Rx direction (incoming), the TM reads the data in the packets to determine the mode of signal. For P25 signals, the TM checks for errors and applies error correction. Received Signal Strength Indication (RSSI) information is used for signal quality comparison measurements, so that the site offering the best incoming signal is selected or voted.

The site that is presenting the best quality signal will be selected and data packets passed to the Central NI or DFSI, which will decode the plain or P25 audio as appropriate and output analogue audio to the console system with any corresponding signalling.

2 SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Table 1. General Specifications.

Antenna Connections	Tx and Rx both 50 Ω Female N-type connectors. (N-type Female simplex option).
Modulation	Analogue – Direct Frequency Modulation (FM) two point method.
	±2.5 kHz narrow band, ±5 kHz wide band
Channel Spacing	Analogue – Programmable 25/12.5 kHz.
Channels	255 PC software selectable.
Supply Voltage	13.8 V DC ±20% or optional AC mains input.
Operating Temperature	-30 ℃ to +60 ℃ (-22 ℉ to 140 ℉)
Frequency Bands:	A full list of available frequency bands is contained in **Appendix A**.
Size	2U Height 19” rack mountable.
Weight	<9 kg

2.2 TRANSMITTER SPECIFICATIONS

Table 2. Transmitter Specifications.

Power Output	1 W to 50 W (100 W option).
Frequency Stability	1.5 ppm std; UHF - 2.5 ppm; VHF – 5 ppm; VHF-Low – 20 ppm; 800 MHz – 1.0 ppm
Analogue Audio Response	Flat within +1 dB, -3 dB across B/W.
Analogue Audio Bandwidth	300 Hz – 3000 Hz.
Analogue Modulation Distortion	<2% @ 60% deviation.

2.3 RECEIVER SPECIFICATIONS

Table 3. Receiver Specifications.

Sensitivity	Better than -117 dB for 12 dB SINAD, typically -120 dB. P25 – better than -117 dB for 5% BER.
Audio Bandwidth	300 Hz – 3000 Hz (+1/-3 dB)
Intermodulation Immunity	Better than 82 dB
Blocking	Better than 100 dB at ±1 MHz point
Distortion	<2% @ 60% deviation.

2.4 P25 (APCO-25) SPECIFICATIONS

- Repeats Mixed Mode P25 Digital and Analogue transmissions.
- Automatically switches to P25 mode on reception of P25 carrier.
- Passes P25 Network Access Codes (NACs) unchanged if required.
- Passes P25 private calls and group calls.
- Passes P25 clear or encrypted.

3 INSTALLATION AND OPERATION

3.1 INSTALLATION

SB2025 series radios are securely packed for transport with special moulded packers within a pasteboard container. Before unpacking the SB2025 radio, please inspect the packaging for signs of damage and report any damage to your SB2025 distributor.

Upon unpacking of the SB2025 radio, please ensure that all items shipped were received, report any missing items to your SB2025 distributor.

All ports on the rear of the radio should be carefully examined to ensure that packaging has not become wedged inside them. It is very important to examine the fan as operation of the radio will be affected if any packaging or shipping damage causes the fan to stop working.

If you intend to install the radio in an equipment rack consult the supplier's instructions for your system. Simoco recommends that the radio be secured into the rack system using four screws through the mounting holes in the front panel and supported on a rack shelf. If the radio is to be used in a stand-alone configuration, ensure that it is in a secure, dry location with sufficient air space around it to allow for adequate ventilation.

It is recommended that the chassis is earthed to the equipment rack. A grounding screw terminal is provided on the left side of the main chassis for connection to the site ground point (Protective Earth). The wire is terminated with a closed loop ring terminal (eyelet) connector which is fixed to the earthing screw with a lock washer to stop them working loose. It is important that the earth wire connector is located at bottom, closest to the chassis.

The earthing conductor should be connected to the best possible earth, such as an earthed mounting plate or an earth rod. Remember that the earthing conductor must be as short as possible and lowest resistance typically <0.1 Ω.

It is recommended to protect the Base Station from lightning, by using a lightning arrestor. There are many publications covering antennas and their installation. Consult with your local dealer for more information and recommendations.

Equipment connection details are located in **Section 4**. The SB2025 will draw approximately 10 A (band dependent) on transmit and the gauge of the DC cable fitted to the 12 V supply connector should be adequate to ensure less than 0.5 V volt-drop at this current. To maintain compliance with Radio and Telecommunications Terminal Equipment (R&TTE) (CE) approval, the DC cable length should not exceed three metres.

Note.

The SB2025 contains No reverse polarity protection. Ensure both the positive (red) and negative (black) terminals are correctly connected and an inline 15 Amp fuse is fitted on the Positive wire. See example in picture below (Not include).

3.2 OPERATION

The SB2025 can operate in stand alone repeater mode as part of a Solar channel, or, in the case of the SB2025NT, may be remotely controlled through the Ethernet port using the Telecommunications Industry Association (TIA) DFSI protocol. Setting up the SB2025 to operate in the wanted mode is straightforward and involves four main steps.

1. Using the SB2025 programming utilities 'MxTools' and the ET to set the software configurable parameters.

2. Setting the hardware jumpers on the Micro Controller for the required options.

3. Adjusting the levels where necessary.

4. Making the necessary electrical connections to the radio and your system.

Generally, if the requirements have been fully specified at time of purchase, Steps 1 to 3 will already have been done at the factory.

In the following sections, the hardware aspects of the setup procedure are described.

3.2.1 MxTools Utility

MxTools is a programming utility used to program channel data, configure and perform remote diagnostics on the SB2025. It runs on a compatible Personal Computer (PC) and the MxTools Inbuilt help menus cover use of the program.

3.2.2 Setting to Work

The following sections describe the steps necessary to set the SB2025 to operate as required.

3.2.2.1 Setting Micro Controller Jumpers

The Micro Controller component layout is shown in **Figure 20** in **Section 8 – Drawings**. The functions and default positions of the jumpers and Dual In-line Package (DIP) switches are shown below.

The jumpers and DIP switches are used for setting the general configuration of the audio processing for both the Tx and Rx paths as well as various miscellaneous functions.

A summary of the functions of the Micro Controller Jumpers is shown below in **Table 4**.

Table 4. Functions and Default Positions of the Micro Controller Jumpers.

Jumper	Function/Description	Default Selection	Default Position
JMP1	Selects either default RUN or EMULATE mode for the microprocessor.	Run	2-3
JMP2	Enables the WATCHDOG auto reset function in the microprocessor.	Enabled	1-2
JMP3	No effect in SB2025.		1-2
JMP4	No effect in SB2025.		1-2
JMP5	No effect in SB2025.		2-3
JMP6	No effect in SB2025.		2-3
JMP7	No effect in SB2025.		2-3
JMP8	Enables a direct connection to the Tx modulator. Select either Wide Band or Wide Band filtered and limited or nil.	DC-FM	2-3
JMP9	No effect in SB2025.		1-2

Jumper	Function/Description	Default Selection	Default Position
JMP10	Controls the direction of the RS-232 Tx and Rx data.	Swap	2-3
JMP11	Controls the direction of the RS-232 Tx and Rx data.	Swap	2-3
JMP12	No effect in SB2025.		1-2
JMP13	No effect in SB2025.		1-2
JMP14	No effect in SB2025.		1-2
JMP15	No effect in SB2025.		2-3
JMP16	No effect in SB2025.		2-3
JMP17	Selects the Mute/Squelch output polarity to either normally high or low.	Active low	1-2
JMP18	No effect in SB2025.	Active low	1-2
JMP19	No effect in SB2025.	Pull up	2-3
JMP22	No effect in SB2025.	Low gain	Not fitted
JMP23	No effect in SB2025.	Disabled	Not fitted
JMP24	No effect in SB2025.		1-2
JMP25	Mute defeat enable. Mute defeat cannot be used if RX TALK line is required. To use mute defeat remove JMP12 and fit JMP 25. The control signal polarity can be inverted by changing the position of JMP25. Active low control: JMP25 2-3 Active high control: JMP25 1-2	Disabled	Not fitted
JMP26	CTCSS O/P / Tx VF Loopback control	Tx VF Loopback	2-3
JMP27	CTCSS I/P / WB DCFM I/P	WB DCFM I/P	2-3
T99	Option Link		IN

When the SB2025 option card is not fitted, there is no connection made to SKK (Aux 2 connector) on the Micro Controller. Links should be placed across SKK1-2 (Discriminator audio), SKK11-12 (Tx supply) and SKK13-14 (Rx supply). These links are normally fitted in production.

3.2.2.2 Select Operating Mode

The SB2025 can operate in a number of different modes. The primary alternatives are full duplex, which is the default mode, repeater and simplex. Using MxTools, the operating mode is programmed for each channel. When a channel is selected in operation, the SB2025 adopts the mode programmed for that channel.

The operating mode programmed in the software can be modified by the settings of DIP Switch 2. The functions of this switch are detailed overleaf in **Table 5**.

Table 5. DIP Switch 2 Settings.

SW 2	Function	Description	Default Select
1	PTT Delay	Enables 50 ms delay of PTT for use with simplex function.	OFF
2	Simplex Enable	Enables simplex function*	ON
3	Tx Timer	Sets programmable Tx time out timer on	ON
4	Repeater Enable	Enables repeater function*	ON
5	Tx VCO on continuously	Switches Tx VCO on continuously.	OFF
6	Scan on	Selects the Rx to enable the scanning of programmed scan channels.	OFF

Note.

For the Repeater Enable functions, if the switch is ON and the channel is programmed as a repeater channel (using MxTools) the SB2025 will act as a repeater. If the switch is OFF the SB2025 will remain in full duplex mode even if the channel is programmed as a repeater. The Simplex Enable operates in a similar way.

3.2.2.3 Select Operating Channel

The SB2025 has a channel capacity of 255. The RF and Continuous Tone Coded Sub-audible Squelch (CTCSS) frequencies for each channel are programmed using the MxTools Channel Information screen. There are two ways of selecting the operating channel.

1. **DIP Switch 8-way**. DIP switch SW1 provides a binary channel selection facility. When a switch is ON it is read as a logical 1. When all switches are off the software channel select mode is enabled.

2. **Software Channel Select**. If DIP switch SW1 is set to 0 (zero) then it is possible to send a software command to the radio to select the channel.

The following rules apply.

Note.

The assumptions of logic levels are base on the factory default setup. The Active state is Low.

DIP1 switches have priority over channel change. If any of DIP1 switches are set to ON (logic low), the rear inputs and the software Channel command will be ignored.

If DIP1 switches are set to OFF (logic high), the software commands will select the channel.

3.2.2.4 Configure Alarms/M Lead

The SB2025 has three open collector outputs. Two of these are assigned as alarm outputs and one (Output 1) may be configured as either an alarm output or an M Lead output. However, Output 1 should be configured as an M Lead, this line is active when mute is open and CTCSS/DCS (Digital Coded Squelch) is decoded. These outputs are assigned on the Configuration screen of MxTools.

3.2.2.5 Configure Digital I/O

The SB2025 has 16 digital Input/Output (I/Os). These are configured using the ET.

3.2.3 Adjustments

There are two categories of adjustable parameters in the SB2025:

- those that are controlled by conventional potentiometers, which may be manually adjusted; and

- those controlled by digital potentiometers, which are under the control of the Micro Controller.

The latter category of items comprises Tx power, Tx Voltage Controlled Oscillator (VCO) deviation, Tx reference oscillator deviation and Tx reference oscillator frequency. All of these are adjusted with the aid of the MxTools programming utility, and all except Tx power should only be adjusted as a part of a full Tx VF path alignment procedure.

Following adjustment of a digipot controlled parameter, the value must then be saved to the radio to make the change permanent.

Refer to **Section 6 – Alignment and Testing** for details.

4 GENERAL DESCRIPTION

The SB2025 series employs state of the art design and construction methods to deliver a range of high performance, ultra reliable radio transceivers. They are ideally suited for use in VHF or UHF two way voice radio systems, however, the SB2025 can perform in a range of applications where the added advantage of linear frequency and phase response from DC to 3.4 kHz can be utilised. The SB2025 uses a two-point modulation method synthesiser for extended low-end Voice Frequency (VF) transmit frequency response. The Receiver, Exciter and Power Amplifier (PA) are contained in their own specialised aluminium module and can be easily removed from the main chassis.

The flexibility of the SB2025 series allows it to be configured for a wide range of applications.

4.1 PHYSICAL DESCRIPTION

The SB2025 base station is a compact lightweight standard 19" rack mounting transceiver. It is designed to mount horizontally in a 19" rack frame and occupies 2U (89mm). The depth of the unit is 330 mm and the weight is less than 10 kg.

The unit consists of six main sub assemblies an Exciter Module, a Rx Module, a PA Module, a Micro Controller Board, and Solar 2 NI and, optionally, a TM unit. These modules are housed in a fully welded steel case.

The SB2025 base stations feature a high degree of Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) screening throughout the design and construction. The Rx and Exciter (low power Tx) modules are contained in solid aluminium enclosures and, for additional screening, each interface pin in the modules is individually filtered. The PA module is contained in a special compact efficient extrusion for minimum harmonic radiation. This design results in low conducted and radiated emissions and minimal susceptibility to RFI and EMI.

User interface is via the front and rear panels. The rear panel provides access to all connectors and the standard front panel provides six Light Emitting Diode (LED) indicators of the radio status.

For reference purposes, the top and rear views of a typical SB2025NT are shown overleaf in **Figure 1**.

In **Figure 1**, the main modules and Printed Circuit Boards (PCBs) are numbered and refer to the following:

1. Rx Module.
2. Exciter Module.
3. T36 Option – Tx Reference Oscillator.
4. Micro Controller PCB.
5. Network Interface PCB.
6. Compact Flash Adapter PCB.
7. Pico ITX Motherboard.
8. Rear Panel Ethernet PCB.
9. Power Distribution and LED PCB.
10. Environment PCB.
11. Management PCB.
12. Switch PCB.
13. Power Amplifier.

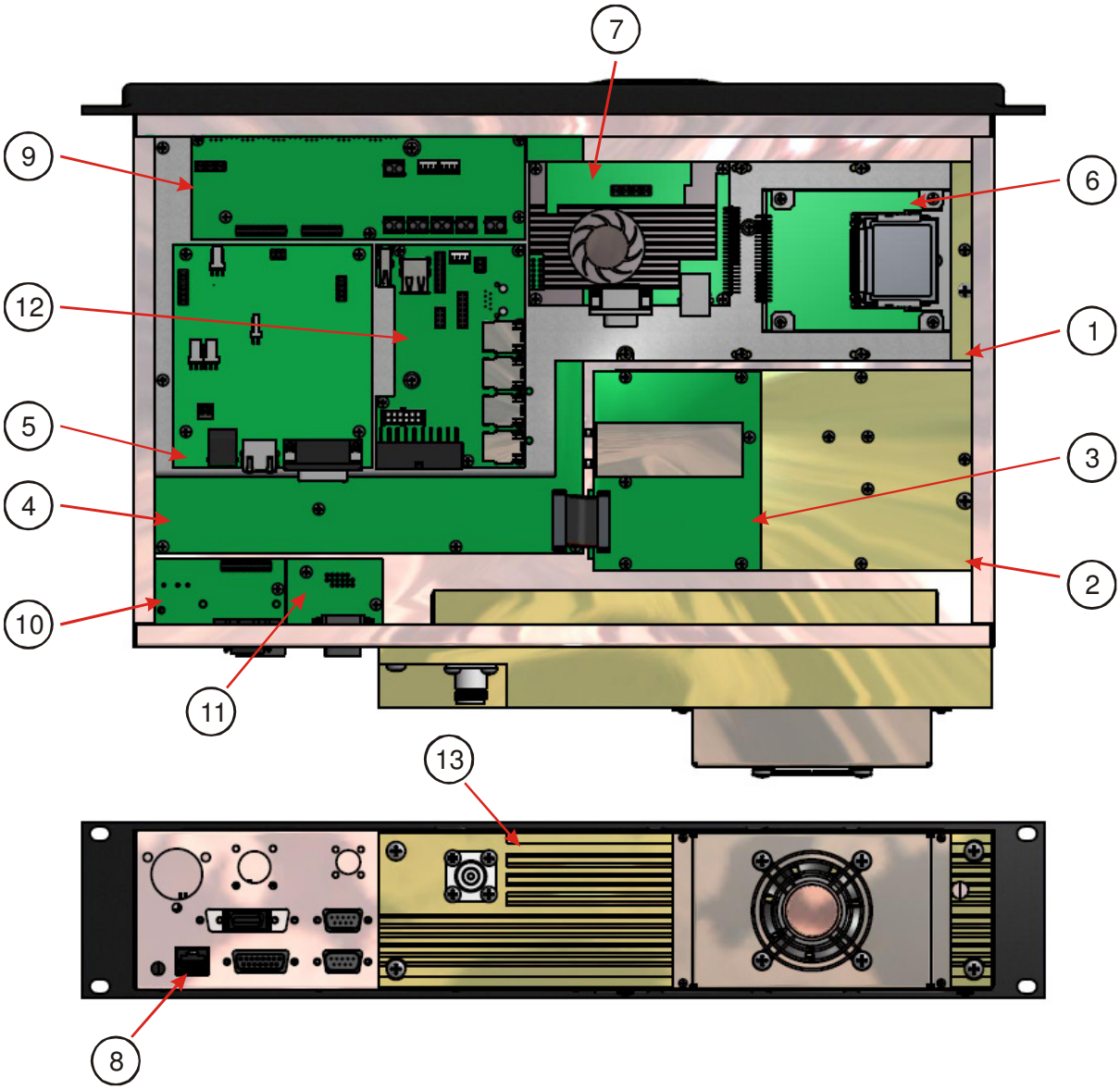


Figure 1. SB2025NT Top and Rear Views.

4.1.1 Front Panel

The SB2025NT front panel is illustrated below in **Figure 2**. Custom versions of the front panel can be supplied to Original Equipment Manufacturer (OEM) customers.

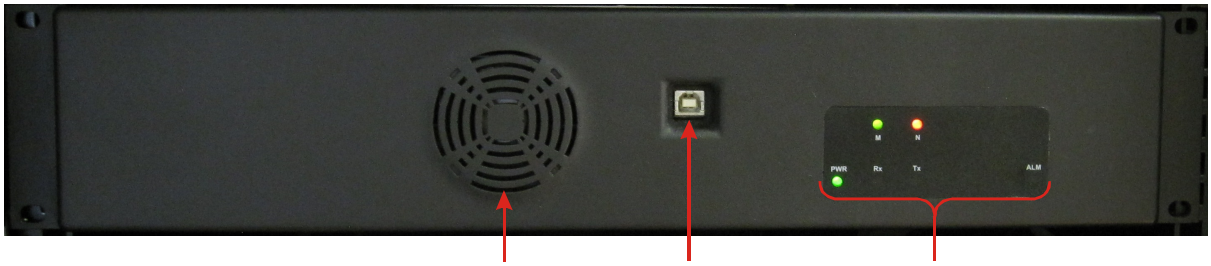


Figure 2. SB2025NT Front Panel.

4.1.1.1 LED Indicators

The functions of the front panel LEDs are explained in **Table 6** below. Each LED indicates the status of the SB2025NT in real time.

Table 6. SB2025NT LED Functions.

LED	FUNCTION
PWR	Indicates the power supply voltage is within software selectable limits.
Rx	The Rx is receiving a signal or the receiver's squelch is open.
Tx	The Tx is transmitting RF power.
ALARM	A pre-arranged alarm condition exists.
M	This is a tri-colour status LED that indicates the condition of the TM module if fitted. The conditions that can be indicated are detailed in **Table 7** below.
N	This is a tri-colour status LED that indicates the condition of the NI module. The conditions that can be indicated are detailed in **Table 8** below.

4.1.1.2 Traffic Manager LED Indicator

The conditions indicated by the state and colour of the tri-colour status LED for a TM Module are listed below in **Table 7**.

Table 7. TM Status Indicator.

Colour	State	Condition
Green	Steady	Normal Operation
Yellow	Flashing (approx 1 Hz)	Power ON and booting, for about 40 s from Power ON.
Green	Flashing (approx 1 Hz)	Traffic Manager firmware starting (about 40 s after a Power ON or immediately after a firmware change)
Red	Steady	Unacknowledged system alarm
Yellow	Steady	Acknowledged system alarm still present

4.1.1.3 Network Interface LED Indicator

When power is first applied to the NI, the LED will not show the valid status of the module for several seconds. The unit becomes operational in under 5 seconds, although it will take longer for the Phase Locked Loop (PLL) to become locked when absolute synchronisation is achieved assuming that the 1PPS timing signal is present at Power ON. If a GPS Rx is being powered by the Solar unit, the GPS acquisition time will need to be included.

The conditions indicated by the state and colour of the tri-colour LED for a NI Module are listed overleaf in **Table 8**.

Table 8. NI Status Indicator.

Colour	State	Condition	Precedence
Green	Steady	Normal Operation – Idle	5
Yellow	Flashing (approx 0.5 Hz)	Central NI = Voted Signal is present Station NI = Rx Signal/squelch active	4
Yellow	Steady	Central NI = Tx Key I/P is present Station NI = Tx Keyed	3
Red	Flashing (approx 0.5 Hz)	Loss of 1PPS signal or an inhibit condition is applied	2
Red	Steady	No Network Communications	1

The precedence column shows what indication will be displayed when two or more states coincide; the highest level is 1, the lowest level is 5.

4.1.1.4 USB Connector

The Universal Serial Bus (USB) Type B connector is used for basic connection of the ET.

4.1.2 Rear Panel

The rear panel of the SB2025 series base station is identical for all models and is illustrated below in **Figure 3**. The functions of each connector on the rear panel are detailed overleaf in **Table 9**.

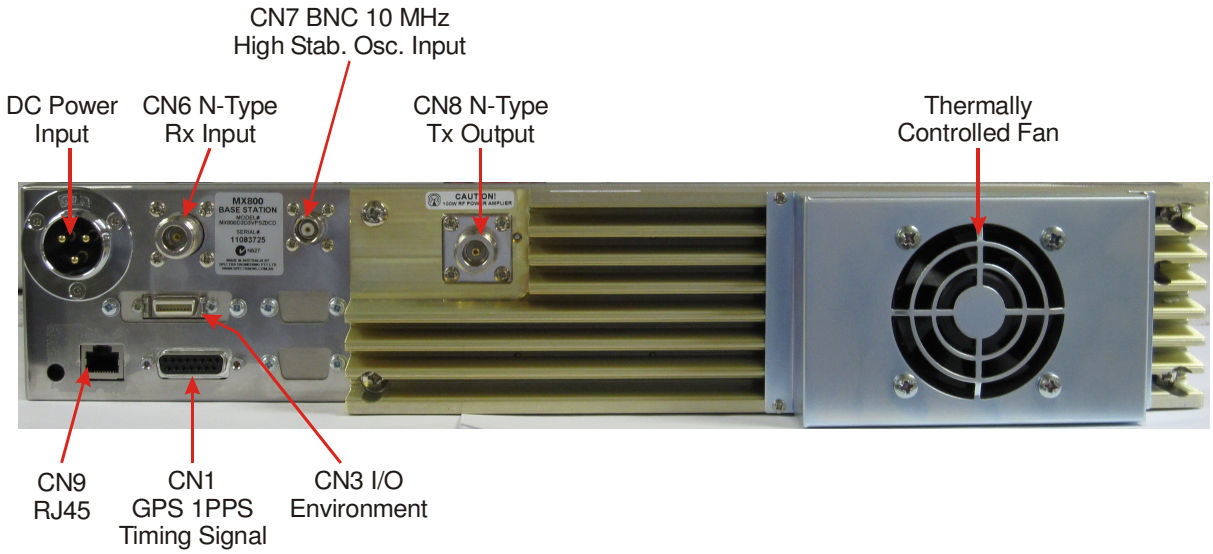


Figure 3. SB2025NT Rear Panel.

Table 9. Rear Panel Connections.

Connector #	Conn Type	Function	Description
CN5	3 PIN	DC Power I/P	13.8 V DC power I/P. Also +28 V I/P on spare pin if required.
CN6	N TYPE	N type Rx I/P	N-Type connector can used for the I/P to the Rx for full duplex operation.
CN7	BNC	Rx I/P	Standard BNC connector for the 10 MHz High Stability Oscillator I/P.
CN8	N TYPE	Tx O/P	The RF power O/P from the Tx for full duplex operation.
CN9	RJ45	Ethernet	10/100 base-T RJ45 Ethernet connector.
CN3	20-way MDR-F	Environment I/O	Provided for monitoring and control of external devices. Has 16 configurable I/Os.
CN1	DB15-F	GPS 1PPS Timing	Provides the GPS interface, if required.

4.1.2.1 GPS (1PPS Timing Signal Input)

The 1PPS input can be accepted in either RS422 or TTL voltage format; the connections made to this connector must match the input type and be correctly identified in the configuration parameters. GPS National Marine Electronics Association (NMEA) data such as presented by the Dalman GPS Rx 40762 will be displayed on the GPS page of the ET, however, this data input can only be accepted in RS422 format.

4.1.2.2 Environment I/O

Integral to Solar is the provision for monitoring and control of external devices. All signals are relative to ground and have voltage input and current switching limits. A low current 12 V supply is also available from this connector to drive switching circuits (see **Section 4.2 – Environment I/O Overview**).

4.1.2.3 DC Power Input

DC power is connected to the base station via this three pin male connector. For 50 W transceivers, pins 2 and 3 are used for the 12 V DC pin 1 is unused. The DC input is fully isolated from chassis and the equipment supply rails, making this option suitable for any supply earth arrangement.

4.1.2.4 Transmitter Output

The Tx antenna connection on the SB2025 base stations is provided with a 50 Ω female N-type socket.

The antenna cable connections must be made with 50 Ω N-types on flexible tails. The Voltage Standing Wave Ratio (VSWR) of these connections should be tested prior to use by using of a suitable test set, e.g. an Anritsu/Wiltron S331A. A good VSWR of 1.5:1 or better at the relevant Tx and Rx frequencies should be ensured.

Mating connectors should be galvanically compatible with nickel outer and gold centre pin to minimise passive intermodulation.

A minimum of 85 dB transmit-receive isolation should be provided by the antenna system and associated filters.

It is recommended that a good quality flexible co-axial cable is used, e.g. with double-screening braid and multi-strand copper inner.

CAUTION

The Antenna System must to be protected against lightning by means of an earthing system and surge protection device.

Do not connect Antenna Lightning conductors to the base station or Mains Earth.

4.1.2.5 Receiver Input

This is a 50 Ω female N-type socket, which is used for the RF Rx input in duplex operation.

4.1.2.6 High Stability Oscillator Input (BNC)

This is a Bayonet Neill-Concelman (BNC) connector used as the 10 MHz high stability input.

4.1.2.7 Ethernet

The Ethernet socket is a 10/100 base-T RJ45 connection. The Ethernet socket provides a 10Base Ethernet connection for the NI module and/or the TM module. If only the NI module is fitted, the connection speed will be 10 Mbps, half duplex. If the TM module is fitted, the connection speed will be 10/100Mbps as negotiated with the host Ethernet network.

4.1.3 Connector Pin-outs

4.1.3.1 Environment I/O

The connector pin-outs for the 20-way Mini Data Ribbon (MDR) Environment I/O socket are shown below in **Table 10**.

Table 10. 20-way MDR Socket – Environment I/O.

Pin	Function	Pin	Function
1	Input/Output # 1	11	Input/Output # 9
2	Input/Output # 2	12	Input/Output # 10
3	Input/Output # 3	13	Input/Output # 11
4	Input/Output # 4	14	Input/Output # 12
5	Input/Output # 5	15	Input/Output # 13
6	Input/Output # 6	16	Input/Output # 14
7	Input/Output # 7	17	Input/Output # 15
8	Input/Output # 8	18	Input/Output # 16
9	0 V – Common/Ground	19	0 V – Common/Ground
10	+12 V supply (max 300 mA)	20	+12 V supply (max 300 mA)

4.1.3.2 GPS (1PPS Timing Signal Input)

The connector pin-outs for the 15-way D GPS/1PPS Timing Signal socket are shown overleaf in **Table 11**.

Table 11. 15-way D Socket – GPS/1PPS Timing Signal.

Pin	Function
1	+12 V supply (reverse feed & current limited protection)
2	GPS Data I/P – RS422 'A'
3	GPS Data I/P – RS422 'B'
4	1PPS Signal I/P – RS422 'A'
5	1PPS Signal I/P – RS422 'B'
6	Not Connected (NC)
7	NC
8	NC
9	NC
10	Data to GPS Rx – RS422 'A' (not normally used)
11	Data to GPS Rx – RS422 'B' (not normally used)
12	0 V – Common/Ground
13	NC
14	1PPS Signal TTL Input – reference to 0 V
15	NC
Shell	Cable screen

4.1.3.3 DC Power Input

DC – 3-pin male connector: only two pins are wired to suit the voltage range.

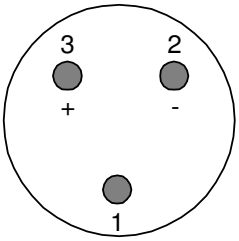


Table 12. DC Power Connector.

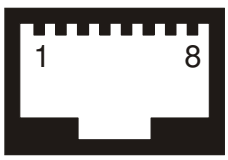
Pin	Function
1	Unused
2	Ground
3	+13.8 VDC

4.1.3.4 Ethernet

The standard network cable wiring for an RJ45 is shown below in **Table 13**.

Table 13. RJ45 – Standard Network wiring.

Pin	Description	Pin	Description
1	Tx Data+, balanced I/P 1	5	NC
2	Tx Data–, balanced I/P 2	6	Rx Data–, balanced O/P 2
3	Rx Data+, balanced O/P 1	7	NC
4	NC	8	NC



4.2 ENVIRONMENT I/O OVERVIEW

The Environment I/O interface module in Solar provides a facility to monitor and control external devices in a simple “ON/OFF” or “Active/Inactive” state. This information is conveyed via the data packet protocol such that a change in input status and output change command will be notified, typically within 1 second.

There are sixteen connection points; each point can be designated as an input or an output to suit the needs of the equipment environment. The input conditions are signalled back to the TM for display or notification, which is also the point of operation of the control outputs. Monitoring of inputs and operation of outputs may also be conducted locally.

Their purpose may be a mixture of anything the user finds useful – e.g. radio base station alarms, monitoring the building state, control equipment switching, etc.

4.2.1 Inputs and Outputs

The I/Os are in binary form, i.e. On/Off, High/Low etc. Setting the “polarity” of the inputs (monitor points) is important if they are to be used as Alarm triggers. Each port can be “named” to assist in identification of the function connected to it; these names are entered into the unit via the ET. The names are passed down to the TM as part of the Supervision Data link.

Connection to these I/O ports is not intended to be ‘universal’ and, therefore, requires some thought in order to achieve the required functionality. Particularly, the external wiring of the Inputs (Monitor Points) needs to be addressed with some care both from the electrical as well as the functional point of view.

Bear in mind the effect on the function if the plug connecting the Environment is disconnected. If the function has been wired to be open circuit in its normal state and closed circuit to show an alarm or error, then, with the connector removed, the alarm state can never be detected. Perhaps it would be an advantage to wire the other way round, then an alarm is detected – even if it is only to show the connector has been removed.

4.2.2 Input ‘Polarity’

In order to assist with the detection of an “error” state or at least to get the status indicators to work in a logical sense, a method of inverting the “polarity” of the sense is provided via the ET. If a spare input is available, it may be useful to link this to ground within the mating connector and, therefore, reflect the state of the connector being present or not.

4.2.3 Output ‘Polarity’

The “CONDITION ON” state for each input may be defined as input low or input high as appropriate on an individual input basis. Similarly, the “ON” state for each output may be defined as “Button IN” or “Button OUT” on an individual output by output basis to suit the required purpose.

4.2.4 Electrical Constraints

The source of an input signal may be in the form of dry switch contacts, open collector, or ‘Hi/Lo’ voltages where a “Hi” voltage is ≥1.3 V and <50 V, and a “Lo” voltage is ≤1.0 V. An open circuit will ‘float’ up to approximately 3 V as a 3.3 kΩ pull-up resistor is used and, therefore, an external input must present less than a 2 kΩ resistance to be registered as a low state.

The outputs are high current open-collector Darlington arrays and can be used on loads supplied externally to a maximum voltage of 50 V and switch a maximum current of 350 mA. At this current, the ‘ON’ output voltage will be approximately 1 V.

The environment I/O is arranged into two groups where each group connects to the same physical device (integrated circuit). To keep the power dissipation of each device within operating limits, the total current that may be switched by all the control outputs in one group must not exceed 500 mA when all outputs are “ON”.

4.3 MODULE FUNCTIONAL DESCRIPTION

4.3.1 Exciter Module

The Exciter module generates the low level, on frequency, RF Tx signal that is later amplified to nominal output power level by the PA module. The Exciter consists of a VCO and associated main RF board, which, in conjunction with the reference oscillator and the PLL circuitry, forms a two-point modulation programmable frequency synthesiser. Frequency programming data is received from the Micro Controller via a 3-wire serial data bus.

The Exciter module features a modulation bandwidth from DC with an ultra wide RF bandwidth of 20 MHz to 1000 MHz at an average RF output power of 300 mW. To change from one band to another, all that is required is to change the plug-in VCO board and reprogram the radio. No other manual adjustment or change is required.

Should a high stability reference be required, the exciter can be fitted with a connector for an external reference oscillator input.

The fractional N synthesiser provides ultra low spurii while still maintaining fast lock times even at 6.25 kHz step size.

An optional built-in turn around mixer provides advanced diagnostics such as Rx sensitivity tests.

4.3.2 Receiver Module

The Rx module accepts the low level RF input signal and amplifies, filters and conditions the signal prior to detecting the wanted audio component. The Rx module features the same advanced synthesiser and wide bandwidth as the Exciter. Only the front-end bandpass filter and VCO need to be changed in order to support different frequency bands, resulting in significant flexibility and end-user cost savings. The purpose built front-end bandpass filter has a wide no-adjust bandwidth equal to the band allocation (refer to **Appendix A** for details of the band allocations).

The Rx has high sensitivity while maintaining excellent intermodulation immunity and adjacent channel rejection. A dual first Intermediate Frequency (IF) filter provides excellent rejection to common known spurious responses. High blocking of over 100 dB typical ensures that strong interfering signals do not desensitise the Rx when receiving weak signals.

4.3.3 Power Amplifier Module

RF from the Exciter passes via a coaxial cable to the input of the PA Module and is first attenuated by a 50 Ω pad, which is used to provide a good 50 Ω source impedance for the first Laterally Diffused Metal Oxide Semiconductor (LDMOS) driver amplifier. The RF is amplified to around 5 Watts at the driver output, and is band dependant. (Note. This point does not have 50 Ω impedance and the drive power cannot be measured directly with a 50 Ω Wattmeter). The signal from the driver is then matched by a broadband network to drive the low input impedance associated with the final transmit LDMOS PA transistor. The transistor’s low drain impedance is then also matched back to 50 Ω by a broadband matching network covering a very wide bandwidth. Prior to transmission, a low loss 13 element elliptical low pass filter, filters out the unwanted harmonics to less than –90 dBc.

A dual directional coupler consists of coupled microstrip transmission lines fabricated on the PCB artwork. The sampled RF energy is rectified to provide a proportional DC voltage output.

The Press (Push) To Talk (PTT) signal enables the amplifier circuit by providing bias to the transistors. A thermistor TS1, physically located on the PA heatsink monitors the heatsink's temperature and is monitored by the Micro Controller.

The PA is very compact and efficient for high reliability and low cost. The heatsink has minimal temperature rise even under continuous operation, ensuring the best Mean Time Between Failure (MTBF) obtainable for a practical design.

4.3.4 Micro Controller Board

The Micro Controller Board is physically located behind the rear panel connectors and all signal connections (apart from the RF connections) external to the transceiver are made via the controller card. User settable jumpers and DIP switches are located on the card as are level adjustment potentiometers.

The Micro Controller controls the operation of the RF modules and acts as the interface between the Solar NI, indicators and the RF modules. It also processes transmit and received audio to and from the Exciter and Rx modules.

The circuit board has an onboard Electrically Erasable Read-Only Memory (EEROM), which stores all of the user channel related data such as frequencies. A serial port at the front of the SB2025 provides access to the NI and Controller card and, in conjunction with the Simoco 'Engineering Terminal' and 'MxTools' programming utilities, allows the user fully configure the SB2025 base stations.

Digipots under the control of the processor ensure that user set up levels for Tx deviation and power levels are correctly set for each channel.

4.3.5 Network Interface

The Network Interface is physically located on a sub-chassis mounted above the Micro Controller Board. Signal connections are made to the Micro Controller Board for audio, Tx/Rx control and a serial data link for configuration of the Micro Controller. Other connections are made via Molex and RJ45 connectors for serial data, 1PPS timing/NMEA data and Ethernet. On receive, the Network Interface samples the Rx demodulator output at 24 kHz and processes the data before sending it to the TM. On an analogue call, the Digital Signals Processor (DSP) carries out CTCSS/Continuous Digital Coded Squelch System (CDCSS) decoding and g.726 encoding of the received audio. The micro controller adds additional information such as RSSI and any detected sub-audio tone/code before packaging and sending to the TM. On a P25 call the DSP provides Continuous 4 Level Frequency Modulation (C4FM) demodulation.

On transmit, the NI receives Ethernet packets from the TM and generates appropriate analogue or P25 signals for passing to the wideband modulation input of the Exciter via the Micro Controller Board. CTCSS/CDCSS is generated in the correct phase and mixed with the analogue audio.

A PLL is maintained locked to the 1PPS timing reference and along with time stamps in the Ethernet packets ensures transmitted audio/P25 data is correctly in phase for simulcast transmission.

4.3.6 ITX

The ITX (also known as Single Board Computer (SBC)) uses the Linux operating system and runs the TM application.

4.3.7 Compact Flash

Contains the operating system, the TM application and its configuration files.

4.3.8 SBC Support PCB

This PCB includes a 5-port Ethernet switch, two USB sockets, physical support for the Pico Power Supply Unit (PSU), USB Universal Asynchronous Receiver/Transmitter (UART) and RS232 interfaces for the ITX.

4.3.9 Aux PCB

This PCB contains a micro controller that monitors the operation of the ITX and will attempt to reboot it if necessary. Also included are LEDs and drivers, DC distribution for other PCBs, Environment I/O, GPS interface and a 4-port USB UART for connection to the PC Engineering Terminal Application.

4.3.10 Pico PSU

The Pico PSU takes the 12 V DC supply and provides all the voltage rails needed by the ITX and supporting PCBs.

5 TECHNICAL DESCRIPTION

The internal design of the SB2025NT is of a modular nature allowing for simple configuration and maintenance while ensuring minimal downtime. For reference purposes, the block diagram of the SB2025NT is shown in **Figure 4**.

5.1 EXCITER MODULE

RF from the VCO on SKU-1 at a nominal level of +3 dBm is applied to the fractional-N synthesiser IC10 main divider input. This signal is compared with the reference oscillator frequency and the correction voltage from the synthesiser's charge pump output is filtered then amplified by the non-inverting low noise operational amplifier IC9A. This correction voltage is fed back to the VCO to maintain loop lock, as well as being fed to the Micro Controller via SKD-14. A lock detect signal from IC10 is also fed to the Micro Controller via SKD-16. The operational amplifier uses a 25 V power supply (generated on the Micro Controller) in order to provide a wide tuning range voltage to the frequency control varicaps located on the VCO board. Frequency programming data for the Exciter is sent to the synthesiser chip from the Micro Controller via a serial data line on SKD-18 under the control of the Clock (SKD-15) and Strobe (SKD-17) lines.

Provision is made for the optional injection of an external reference frequency. If this option is selected, CN3 is fitted and X1 is not fitted. Components R30 and TR7 are also omitted.

A second RF output from the VCO on SKT-6 also at +3 dBm is used as the main transmit RF amplifier signal source. This main signal is first buffered by a very high isolation circuit consisting of a 10 dB pad and a Monolithic Microwave Integrated Circuit (MMIC) amplifier (IC1). The signal is further amplified by IC2 and a variable gain wide band amplifier with 40 dB control range and power output of 300 mW. The drive power of this stage is used to set the output power to the main PA under the control of the DC voltage on SKD-4 from the Micro Controller board.

The VCO boards and synthesiser circuits are the same for the Exciter and Rx modules. The VCO consists of a 10 mm ceramic coaxial resonator with common base oscillator for low phase noise for bands 805 MHz - 960 MHz. Frequencies below 520 MHz use a LC tank circuit. The power supply to the VCO consists of an 8 V regulator and active filter for maximum noise rejection. It is controlled by the Micro Controller through SKD-7, which connects to switch TR6. For standard modulation, transmit audio is fed on SKD-8 to the conventional point of the VCO varactor. For two point modulation, audio is also fed via SKD-19 to the voltage control pin of the VC-TXCO, this in effect cancels out the PLL error that would otherwise have occurred for low audio frequencies, therefore, resulting in a flat VF response.

5.2 RECEIVER MODULE

The Rx signal from the antenna enters on CN1 a three section bandpass filter, which provides the initial filtering for the front-end amplifier. The front-end amplifier IC12 is a broadband high performance MMIC with a gain of 18 dB, noise figure of 3 dB and third order intermodulation intercept of +36 dB. A 4 dB pad and a second three section bandpass filter follow this, and a high level double balanced mixer M1.

The Rx uses high side local oscillator injection for bands A to M and low side injection for all other bands. RF from the VCO main output on SKT-6 is buffered and amplified to +17 dBm by IC4 and injected in the high level mixer, which down converts the signal to the first IF frequency of 90 MHz (45 MHz for bands A and B, and 70 MHz for bands A4). This IF signal from the mixer is terminated by a bi-directional constant impedance network and is then amplified by a bipolar amplifier TR2 with a gain of 15 dB and third order intermodulation intercept of +35 dB. This provides a high degree of intermodulation rejection for the Rx. A 4-pole crystal filter FL3A/B with its associated matching networks follows this stage. The signal is further amplified and filtered by a transistor amplifier TR3 and its associated 2-pole crystal filter FL4 before being fed into the main IF demodulator chip IC1 with a second IF frequency of 455 kHz. The resulting audio is passed out to

the Micro Controller board on SKD-3. The RSSI from IC1 is buffered by IC5A and connected to the Micro Controller board via SKD-4.

RF from the VCO on SKU-1 at a nominal level of +3 dBm is applied to the fractional-N synthesiser (IC10) main divider input. This signal is compared with the reference oscillator frequency and the correction voltage from the synthesiser's charge pump output is filtered then amplified by the non-inverting low noise operational amplifier (IC11A). This correction voltage is fed back to the VCO to maintain loop lock as well as being fed to the Micro Controller via SKD-14. A lock detect signal from IC10 is also fed to the Micro Controller via SKD-16. The operational amplifier uses a 25 V power supply (generated on the Micro Controller) in order to provide a wide tuning range voltage to the frequency control varicaps located on the VCO board. Frequency programming data for the Rx is sent to the synthesiser chip from the Micro Controller via the a serial data line on SKD-18 under the control of the Clock (SKD-15) and Strobe (SKD-17) lines

The Micro Controller, through an enable signal on SKD-8, controls the local oscillator signal to the mixer. This signal switches the supply to the local oscillator amplifier and is used to enable or disable the Rx.

Provision is made for the optional injection of an external reference frequency. If this option is selected, CN3 is fitted.

5.3 POWER AMPLIFIER MODULE

The SB2025NT now supports Simoco's new full switching bandwidth PA Module (Wide Band PA), which requires no tuning, equals, exceeds or covers several of Simoco's band allocations, (refer to **Appendix A** for details of the band allocations). This new generation PA features much wider RF bandwidth, higher efficiency, greater stability out of band and to zero power levels.

This PA is now being rolled out as the standard production PA.

5.3.1 Wide Band PA (50 Watt Model)

RF from the Exciter passes via a coaxial cable to the input of the PA Module and is first attenuated by a 50 Ω pad, which is used to provide a good 50 Ω source impedance for the first LDMOS driver amplifier. The RF is amplified to around 5 W at the driver output, and is band dependant. (Note. This point does not have 50 Ω impedance and the drive power cannot be measured directly with a 50 Ω Wattmeter). The signal from the driver is then matched by a broadband network to drive the low input impedance associated with the final transmit LDMOS PA transistor. The transistor's low drain impedance is then also matched back to 50 Ω by a broadband matching network covering a very wide bandwidth. Prior to transmission, a low loss 13 element elliptical low pass filter, filters out the unwanted harmonics to less than –90 dBc.

A dual directional coupler consists of coupled microstrip transmission lines fabricated on the PCB artwork. The sampled RF energy is rectified to provide a proportional DC voltage output.

The PTT signal enables the amplifier circuit by providing bias to the transistors. A thermistor, TS1, physically located on the PA heatsink, monitors the heatsink's temperature and is monitored by the Micro Controller.

5.3.2 Wide Band PA (100 Watt Model)

The 100 W models are base on the 50 W technology, using two LDMOS final PA transistors to achieve a 100 W RF output power rating. The final transistor's low drain impedance is then also matched back to 50 Ω by a broadband matching network covering a very wide bandwidth. Prior to transmission, a low loss 13 element elliptical low pass filter, filters out the unwanted harmonics to less than –90 dBc.

Table 14. 100 W PA Banding Information.

100 W Wide Band PA	
Model	**Frequency Coverage**
A3V	39 MHz – 47 MHz
ABV	66 MHz – 88 MHz
CDV	135 MHz – 175 MHz
FV	217 MHz – 222 MHz
NWV	400 MHz – 435 MHz
OWV	435 MHz – 470 MHz
PWV	450 MHz – 495 MHz

5.4 MICRO CONTROLLER BOARD

The SB2025 Micro Controller Board has four main functions:

- Overall radio management.
- Tx and Rx signal processing.
- RF power control.
- User interface.

5.4.1 Overall Radio Management

In addition to analogue signal processing circuitry, the Micro Controller board accommodates an 80C552 microprocessor IC1, a 64 kb Erasable Programmable Read-Only Memory (EPROM) IC3, 32 kb Random Access Memory (RAM) IC4, a 16 kb Electrically Erasable Programmable Read Only Memory (EEPROM), as well as address decoding, I/O latches and other miscellaneous circuitry. The Micro Controller is responsible for ensuring that the radio acts as programmed by the user. It stores the user-entered parameters for each channel in the EEPROM. This information includes Rx and Tx RF frequencies; Rx and Tx CTCSS frequencies, as well as RF output power and operating mode. An eight channel analogue to digital converter allows the microprocessor to read eight analogue values internal to the radio, which, in conjunction with the digital inputs to the microprocessor, allow the operating status of the radio to be monitored and controlled.

The analogue items that are read are listed below in **Table 15**.

Table 15. Microprocessor Port Parameters.

Port	Parameter
ADC0	Received Signal Strength Indication (RSSI)
ADC1	Detected Discriminator Output Level
ADC2	DC Operating Voltage
ADC3	Rx VCO Tuning Voltage
ADC4	Tx VCO Tuning Voltage
ADC5	PA Temperature
ADC6	PA Forward Power
ADC7	PA Reflected Power

The Micro Controller sends programming data to the synthesiser ICs on the Rx and Exciter modules each time the channel is changed as well as on PTT. This information is communicated to the Rx and Exciter modules by way of bussed data and clock lines on SKC/D-18 and SKC/D-15 (Exciter/Rx) and an individual module strobe on SKC/D-17. A lock detect signal from each module on SKC/D-16 is read by the Micro Controller.

In addition to the synthesiser programming bus, an I^2C bus goes to each of the modules. This bus is currently unused.

5.4.2 Tx Signal Processing

Tx audio may be sourced from a number of different paths. These include VF from line, T/T audio, the microphone, and DC FM/Wideband input, Tone generator from the Micro Controller, Test Tx VF inject from the Monitor port, CTCSS generator and the internal RF modem.

The Tx VF path is readily user configurable with most major functional blocks being possible to either select or bypass by means of links (refer to **Table 4 – Micro Controller Jumpers** for details of link settings). The VF from line enters the board on SKH-14 and RV4 (Tx VF gain) provides gain adjustment to accommodate different line levels. This is followed by a selectable compressor (IC34A) with 30 dB dynamic range. The output of the compressor, apart from being fed to the main Tx audio path, is also connected to the input side of the “Line” Fast Frequency Shift Keying (FFSK) modem and via a gain control pot the speaker amplifier (IC60). Following the main Tx audio path, IC36B serves to switch the VF further on the Tx audio path or, under the control of the external input on SKH-13, to loop it back to the line output via RV7, which provides level adjustment for the looped back signal. From this switch, the VF passes though a second switch IC32B under the control of the Micro Controller and the external Tx talk line on SKH-10. This switch is used to disable the line Tx VF path. From here the VF passes through a pre-emphasis stage C66, R67 and a 300 Hz high pass filter (IC30B and IC29A) each of which is selectable through links. The output of this filter is fed to IC30A a summer/limiter amplifier.

The summing point of this amplifier also serves to combine the audio from the T/T path, which is level adjusted by RV3, the microphone which is processed through a similar compression, pre-emphasis and filtering chain as the line VF, the tone (Morse code) signal from the microprocessor, the DC FM input, which enters the board on SKH-6 and the Test Tx VF injection from SKE-2. The latter three inputs are all at fixed levels. RV2 on IC30A provides overall gain adjustment. Following the limiter amplifier is the Tx VF low pass filter. The standard Bessel filter has a 3.4 kHz cut off frequency. A second summing amplifier IC24B follows, which combines the CTCSS, optional modem (IC52 and IC54) and Wideband audio inputs with the Tx VF. Level adjustment of the CTCSS signal is in three 0.85 dB steps either above or below the nominal level (10% of max dev). These level steps are setup using the Configure screen of MxTools. The output of this final stage is fed to two microprocessor-controlled digipots, which serve to adjust the modulating signal level to the VCO and the reference oscillator. A third digipot is used to provide an offset null for the reference oscillator centre frequency. Adjustment of these levels is also by way of MxTools using the Channel Edit screen.

5.4.3 Rx Signal Processing

In a similar fashion to the Tx audio path, the major functional elements of the Rx audio path are capable of being selected or bypassed by means of links.

Discriminator audio enters the board on SKD-3 and is fed to a selectable 300 Hz high pass filter comprising IC37 and IC38B. This output or an unfiltered version of the discriminator audio is fed via a switch IC32A to the TTR (repeater) path. The switch is used to disable talk through audio under the control of the microprocessor and the external Tx talk line on SKH-10. Following the high pass filter, a selectable 3.4 kHz cut-off low pass filter IC38A and IC39B connects to the de-emphasis circuit IC39A. From here the audio passes through the mute switch IC32C that is under control of the microprocessor and on to the Rx talk switch IC36C, which is controlled externally from SKH-3. This second switch is used to disable Rx audio to line. A final switch IC36A selects

between Rx audio and Tx looped back audio for output to line via amplifiers IC40A and IC40B. Secondary inputs to these amplifiers are the Tx audio from the line modem and microphone audio to line. The output on SKH-2 forms an unbalanced 600 Ω VF output to line and, alternatively, outputs SKH-2 and SKH-11 form a differential output.

Discriminator audio is also fed via a low pass filter IC31 to the CTCSS decoder as well as to a level detector D9 the output of which is connected to ADC1 on the microprocessor.

Discriminator audio is also fed to the mute detection circuit. This comprises a high pass filter IC41 followed by RV6/6B, which sets the mute threshold. Following amplification by IC42A and rectification by IC42B and IC43A, a comparator, IC43B, determines when the detected signal passes a fixed threshold. The output of the comparator is fed to the microprocessor and via a selectable inverter to SKH-4.

Discriminator audio is also fed to Rx port of the RF modem IC54.

5.4.4 RF Power Control

Forward power is controlled by the microprocessor through two mechanisms. Based on pre-programmed per channel adjustments, the microprocessor sets the digipot IC10 to a reference setting. IC23A serves as a comparator and, with the non-inverting input connected to the wiper of the digipot, is set up with a reference voltage. The detected actual PA forward power is fed to the inverting input of IC23A. The error voltage at the output of IC23A is fed to the exciter output power control circuit via SKC-4 and the action of the control loop is to set the RF power such that the actual detected volts equals the reference volts. The digipot setting is static for each channel unless the required forward power is changed.

The voltage to the top of the digipot is set up by the microprocessor through the Pulse Width Modulator (PWM) output PWM1. On PTT, the ON duty cycle of the PWM1 output is progressively increased and the filtered result of this forms a ramp to the top of the power control digipot. Once 100% duty cycle is reached, full power is produced. This results in a fast but controlled RF power rise characteristic.

5.4.5 User Interface

All user interfaces to the SB2025, except the RF connections, are made by way of the front panel USB interface on the Aux PCB and then via an internal serial connection to the NI or ITX for the ET. The MxTools application for radio configuration also uses this route to the NI but is passed on over another serial connection to the Micro Controller Board.

Output latch IC18 drives the six LED indicators on the front panel. The function is described in **Section 4.1.1**.

Input latch IC14 serves to accept the programmed status of the eight bit binary channel select DIP switch SW1. Refer to **Appendix B** for programming instructions.

Input latch IC13 serves to accept the programmed status of the six bit binary mode select DIP switch SW2. Refer to **Section 3.2.2.2** for mode selection instructions.

IC22 provides CMOS to RS232 conversion for the serial port.

5.5 SOLAR TRAFFIC MANAGER

The TM is a software application running on the ITX board and manages all aspects of a channel including NIs other than its physically associated one if necessary and a DFSI conforming to TIA.102-BAHA.

This application receives packets from one or more NIs every 20 ms, votes the best quality signal and presents it to a dispatcher either via a DFSI connection or as an analogue 4-wire using an additional stand-alone Network Interface.

Outgoing analogue or P25 audio/data from analogue dispatcher, DFSI or voted call is time-stamped and sent to all associated NIs for transmission. If multiple NIs are connected they can be synchronised to create a simulcast channel.

The TM application stores the complete configuration for the channel on its internal compact flash memory card. All the configurable settings on all the connected NIs are stored here and are kept synchronised with the NIs over a control channel that is multiplexed into the 20 ms Ethernet packet structure.

A number of conditions are monitored throughout the channel and alarms can be raised if necessary. These can be displayed and acknowledged by the ET or by SNMP using a third party Network Management System (NMS) using the supplied Management Information Base (MIB).

5.6 SOLAR NETWORK INTERFACE

The NI provides the connection between the Ethernet link and the radio base station hardware. Traffic and control information is multiplexed into fixed length packets and sent to/from the TM every 20 ms.

There are two CPUs in the NI. One, a PIC, manages the Ethernet interface, the control of the base station (RSSI, PTT, alarms etc.), the PLL that is locked to the external 1PPS timing signal for simulcast transmission, the serial ports for the ET and connection to the Micro Controller board, and the handling of all the configuration data to/from the TM. The other, a DSP, manages all the analogue signal processing including the C4FM modulation/demodulation, tone detection, generation and synchronisation, deviation limiter, FM pre/de-emphasis, g.726 encoding/decoding and in the case of a Central NI, AMBE +2 vocoding.

The Network Interface has two analogue ports. A duplex wide band unbalanced port connects directly to the Rx's discriminator output and the Tx's wideband input. This has a flat frequency response from virtually DC to over 3.2 kHz to enable P25 C4FM.

The other analogue port is duplex, 600R transformer coupled and is provided for when the NI is used as an analogue dispatcher interface. This is not used in the SB2025.

There are two serial ports. One connects to the USB serial interface on the Aux PCB and allows connection of the ET and MxTools applications. The other connects internally to the Micro Controller PCB and passes information to control the operating condition of the base station, channel, Tx power etc.

1PPS timing and optionally NMEA data is provided by the Aux PCB when a GPS Rx is connected to the SB2025.

The 26 way Facilities connector carries the two analogue ports described above an analogue input for an RSSI voltage from the receiver. Three relay change-over contacts and three opto-isolated inputs are provided. One relay keys the Tx and two of the inputs are used for Rx mute indication and alarm status. An RJ45 socket provides the 10BaseT Ethernet interface and is connected internally to the Ethernet switch on the SBC Support PCB.

Power to the NI is 12 V DC and is supplied by the Aux PCB.

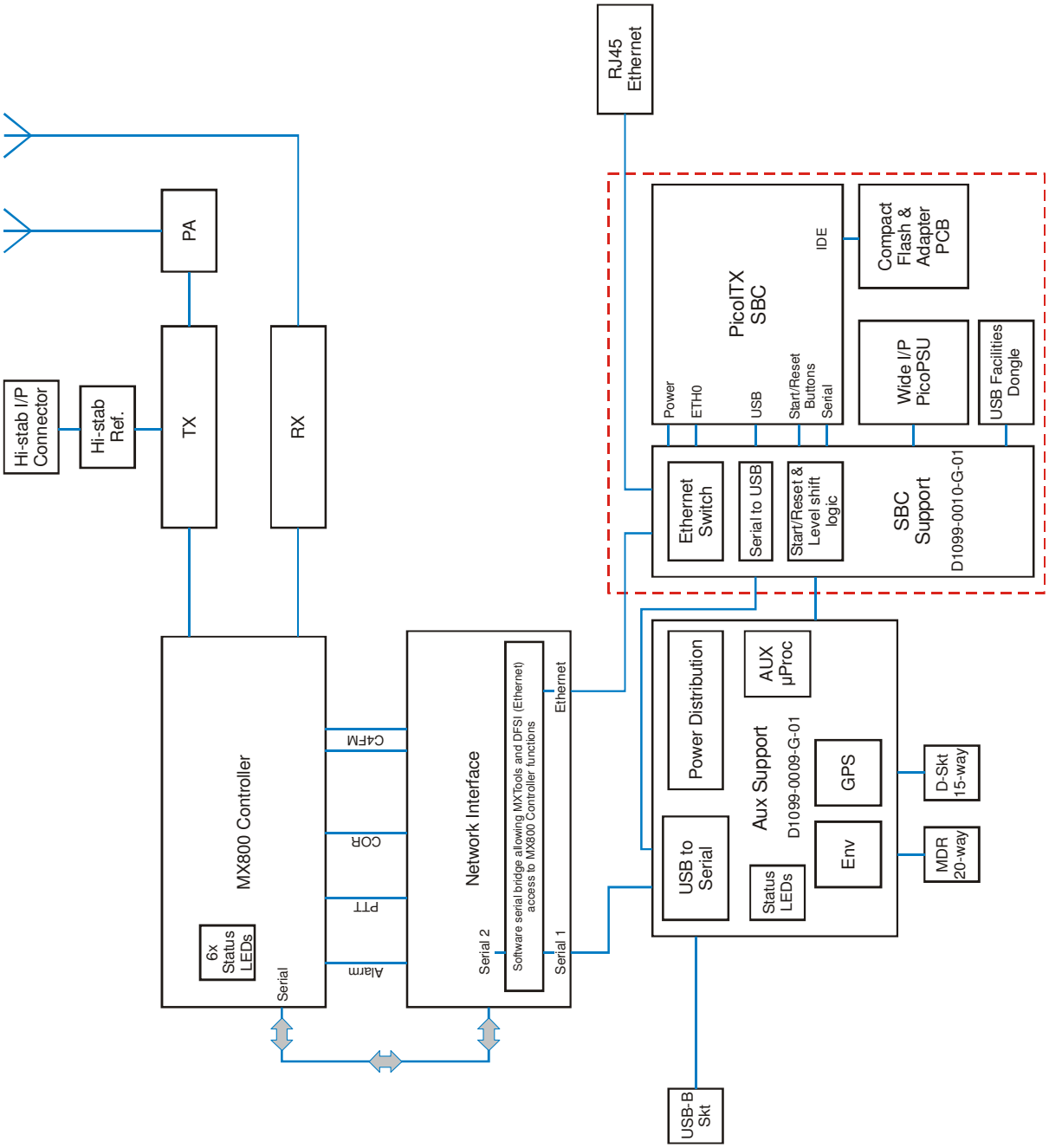


Figure 4. SB2025NT Block Diagram.

6 ALIGNMENT AND TESTING

The SB2025NT test and alignment procedures are divided into two main sections. The first section is a transceiver level procedure, which assumes that the radio is fitted with working modules. The second section contains the individual module test procedures.

6.1 TRANSCEIVER SETUP, CALIBRATION AND ALIGNMENT

This section explains how to setup, calibrate and align the complete SB2025NT Base Station. A number of procedures are required to fully initialise the SB2025NT. The following test equipment will be needed:

- PC with MxTools and ET (SB2025 Base Station Programming Utilities).
- RF Test Set (HP 8920) or equivalent.
- Oscilloscope.
- RF Power Meter (Watts).
- RF Signal Generator.
- Multimeter.
- +13.8 V DC Power Supply

The order of some, but not all, of the procedures is important to ensure correct setup of the radio. The order of the procedures as described is recommended and those that are critical are mentioned. If the radio has been previously setup and the user intends to recalibrate and align the radio then **Sections 6.1.1, 6.1.2 and 6.1.3** can be ignored as the model number, serial number, configuration and channel information will have already been loaded.

For any procedure that involves the use of the MxTools programming utility, further information and assistance can be found in the relevant part of the MxTools Help menu/screens.

6.1.1 Sending Model Number and Serial Number to the Radio

The model number is entered or updated using MxTools. To edit the model number, carry out the following:

1. On the MxTools main screen, on the menu bar, select ‘Setup’ > ‘Radio Model Number’. The Radio Model Number dialogue box will be displayed.

2. On the Radio Model Number dialogue box, enter the model number, according to the configuration of the radio.

3. Once the radio Model Number information has been completed, select the ‘Send’ button to send the information to the radio.

4. To return to the MxTools main screen, select the ‘Exit’ button.

Notes:

(i). The model number should not be altered unless the hardware within the SB2025 base station is changed. For example, a module is changed or an option has been added to the radio.

(ii). The serial number cannot be altered, as this is factory set.

6.1.2 Sending Configuration Information

Firstly, the configuration file for the radio needs to be setup. Using MxTools the configuration information needs to be entered on the Configuration Screen. This information needs to be saved to a configuration file. If an existing radio already contains the desired configuration, this configuration can be downloaded and saved. This configuration information then needs to be 'Sent to the SB2025'. A warning message will appear that indicates that the SB2025 Base Station has not yet been calibrated, this may be ignored.

Once the configuration information has been sent, all of the programmable parameters within the SB2025 Base Station are initialised.

6.1.3 Sending Channel Information

The channel information setup is similar to that of the configuration. The channel frequencies, sub-tones and other parameters are setup in the Channel Screen in MxTools. At this stage, it is not necessary to set the values of the digital potentiometers. This will be done in the following procedures. After entering in the channel details, the information needs to be saved to a file. If another radio already contains the desired frequencies, these can be downloaded from that radio and saved to a file. The digital potentiometer values from one radio to the next will differ, therefore, it is advisable to save the information in a new channel file and not save over the top of any backup copies of existing radios. The saved channel information is then sent to the SB2025NT.

After sending the configuration and channel information, the SB2025NT is fully programmed and will now operate. The radio will not function without sending both the configuration and channel information and, therefore, the following procedures will be unable to be completed.

Note.

> ***The buttons for sending and loading the channel information may be disabled if MxTools did not successfully 'Connect to SB2025'. If this is the case, simply choose to 'Connect to the Radio' after the configuration information is sent.***

6.1.4 Setting Alignment Channel

When setting up the radio, it is recommended that all measurements and adjustments are done on a channel that is in the centre of the frequency spread of the channels. This minimises any errors due to frequency changing. Alternatively, if the frequency spread of the channels is too large, you may wish to calibrate and align every channel. (In most cases this will not be necessary.) Both individual and group alignment will be covered.

The channel may be selected either via the Channel Screen in MxTools using the software channel select or in hardware via the internal channel DIP switch. (Refer to **Section 3.2.2.3** for additional help.) This channel will then be used when performing the following procedures.

6.1.5 Power Calibration

This procedure must NOT be used to set the Tx Output Power. For the Tx Power Adjustment procedure, refer to Section 6.1.8.

Power calibration affects the forward and reflected power meters on the Diagnostics Screen, as well as the low forward power trip point for the SB2025NT. This procedure requires a RF Power Meter and the relevant leads to connect the Tx output to the meter. Power calibration is done using MxTools via the Calibration Screen.

To complete the power calibration, carry out the following:

1. On the MxTools main screen, on the tool bar, select the 'Calibration' icon. The calibration screen will be displayed.

2. On the calibration screen, select the 'Calibrate' button for the Power Calibration and follow the on screen instructions that MxTools provides.

Once the power calibration has been completed, the configuration information must be sent again. Check that the low forward power trip point is set correctly. The calibration affects the low forward power trip point and, therefore, the configuration information must be sent to update it according to the new calibration information.

6.1.6 RSSI Calibration

The RSSI calibration is used to calibrate the RSSI meter on the MxTools Diagnostics Screen. The procedure requires an RF Signal Generator and the relevant leads to connect the signal generator to the RF input of the SB2025NT Base Station. RSSI calibration is done via the MxTools Calibration Screen.

To complete the RSSI calibration, carry out the following:

1. On the MxTools main screen, on the tool bar, select the 'Calibration' icon. The calibration screen will be displayed.

2. On the calibration screen, select the 'Calibrate' button for the RSSI Calibration and follow the on screen instructions that MxTools provides.

6.1.7 Temperature Calibration

The temperature calibration is used to calibrate the temperature meter on the MxTools Diagnostics Screen and the temperature controlled switch/alarm points. The procedure requires a dummy cable for SKB on the micro controller having a 2060 Ω resistor between pins 4 and 6 of this connector of the SB2025NT Base Station. Temperature calibration is done via the MxTools Calibration Screen.

To complete the temperature calibration, carry out the following:

1. On the MxTools main screen, on the tool bar, select the 'Calibration' icon. The calibration screen will be displayed.

2. On the calibration screen, select the 'Calibrate' button for the Temperature Calibration and follow the on screen instructions that MxTools provides.

6.1.8 Tx Power Adjustment

The Tx power setup is used to set the correct power for each channel. This can be done either on a per channel basis or all channels can be set at once. Power setup is done using the Channel Screen in MxTools. To complete this test the Tx output needs to be connected to a RF Power Meter.

To complete the Tx power adjustment, carry out the following:

1. On the MxTools main screen, on the tool bar, select the 'Channel Info' icon. The channel screen will be displayed.

2. On the Channel screen, to set all channels at once, select the 'Lock Data' tick box.

Note.

If the 'Lock Data' option is selected, any changes made to the current channel are duplicated on all channels.

3. Click on the alignment channel to open the 'Channel Edit' screen.

4. On the Channel Edit screen, carry out the following:

    4.1. Select the 'Continuous Update Enabled' tick box. (This allows real-time updating of the digital potentiometer values and, therefore, any changes made will be immediately reflected in the radio).

    4.2. Alter the 'Tx RF Power' digital potentiometer until the power meter reads the required output power.

    4.3. Select the 'OK' button to accept the changes made and close the Channel Edit screen.

5. On the Channel screen, on the dynamic tool bar, select 'Write Channel' button to save the changes made to the radio.

To calibrate each channel individually, ensure that the 'Lock Data' option is not selected and repeat the above procedure for each channel.

6.1.9 Peak Deviation and Modulation Balance Configuration

6.1.9.1 Station NI/SB2025

All level setting is carried out with the SB2025 equipment in analogue mode using an analogue Radio Test Set. A final check of P25 Modulation Fidelity can be carried out at the end if a P25 Test Set is available.

Notes.

(i). When injecting tones into the NI of the SB2025 base station, it is important to avoid exactly 1 kHz as the measuring bar graph on the ET is a little unstable at exact sub-multiples of the 8 kHz sample rate. The level measurement is subject to the 6 dB/octave receive de-emphasis so it is advisable to stay close to 1 kHz. The test tone frequency used for P25 testing is 1011 Hz, therefore, this can easily be used for analogue testing as well.

(ii). On the ET, before any changes to settings can be made, the 'Eng' button must be selected. Once any change has been made, the 'Apply' button must be pressed for the change to take effect. Multiple changes may be made and implemented together with a single 'Apply' action. Failure to apply a change will result in the attempted change being abandoned and settings will revert to their previous state when the corresponding 'Eng' button is released.

Tools, Test Equipment and Materials Required

The following Tools, Test Equipment and Materials will be required to perform this procedure:

- Analogue Radio Test Set (RTS) with external frequency reference for accurate carrier measurement.
- T36 Module Serial Cable (refer to **Appendix C** for the required cable details).
- PC with the following software installed:
    - Solar 2 Engineering Terminal.
    - MxTools.
    - HyperTerminal (or similar serial terminal).

Procedure

1. On the SB2025 base station, carry out the following:

1.1. Ensure that the power is switched off.

1.2. Refer to **Appendix D** and check that all the internal links are set correctly.

1.3. Check that the T36 External Reference option is correctly configured.

2. Using the T36 Module Serial cable, connect the PC with the HyperTerminal software or similar serial communications program installed to the pin header HDR1 on the T36 Module in the SB2025 base station.

3. Connect the Tx antenna connector to the RTS input.

4. On the PC, set the serial communications parameters to: 9600, 8, None, 1, None.

5. On the NI ET main window, check that the NI is not outputting any audio or tones by carrying out the following:

5.1. Select the 'Eng' button to access the 'NI Engineering' window.

5.2. On the NI Engineering window, select the 'Facilities' tab.

5.3. On the 'Facilities' tab, check that the 'Test Tone' is disabled and that the 'CTCSS Tone' level is set to 0 (zero) (slider to minimum).

6. On the MxTools main window, on the tool bar, select the Channel Info icon. The Channel screen will be displayed.

7. From the MxTools Channel screen, access the Channel Edit window and enter all of the frequency pairs that are required for the SB2025 base station and select a channel in the middle of the range of frequencies.

8. On the SB2025 base station, switch on the power and, on the PC, check that the following HyperTerminal menu as shown below in **Figure 5** is displayed.

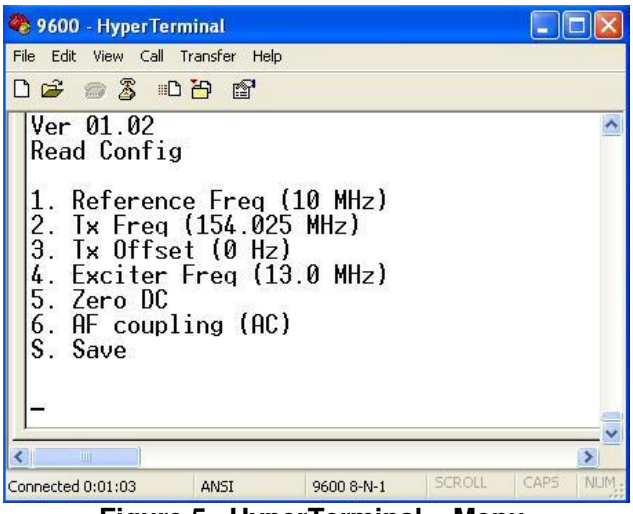


Figure 5. HyperTerminal – Menu.

9. On the PC, using the HyperTerminal, carry out the following:

9.1. If not already set, adjust the 'Tx Freq' to the Tx frequency of the channel in use.

9.2. Ensure AF Coupling is set to AC. If necessary, press '6' to toggle it.

9.3. Press '5' to zero the DC offset followed by 'S' to save the new settings.

10. On the MxTools main window, on the tool bar, select the Remote icon. The Remote page will be displayed.

11. On the MxTools Remote page, select the 'Software PTT' button. A message will be displayed warning that the radio will be keyed up for 2 minutes.

12. On the warning message, select the 'OK' button. The radio should transmit on the selected channel.

13. On the RTS, ensure that the received carrier signal from the base station is as specified on the radio base. Ensure that the 'Tx Offset' is less than 1 – 2 Hz, if necessary carry out the following:

    13.1. On the PC, using the HyperTerminal, use the < or > keys on the keyboard to adjust the Tx Offset to zero.

    13.2. When the Tx Offset is set to zero, press 'S' to save the settings.

14. On the TM ET, carry out the following:

    14.1. On the Channel Status panel of the channel in use, select the 'Setup' button to access the Channel Setup page.

    14.2. On the Channel Setup page, on the 'P25' tab, using the drop-down list, set the Audio Mode to Analogue and either 12.5 kHz or 25 kHz to match the SB2025 channel bandwidth.

15. On the NI ET, carry out the following:

    15.1. On the main window, select the 'Eng' button to access the 'NI Engineering' window.

    15.2. On the NI Engineering window, select the 'Main Audio' tab,

    15.3. On the Main Audio tab, ensure that the Audio Mode is set to 'Remote'. If necessary, use the drop-down list to change the audio mode (see **Figure 6** below).

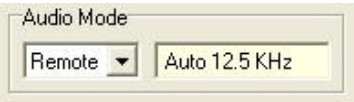


Figure 6. NI ET – Audio Mode to 'Remote'.

16. Using the Analogue RTS, inject a signal at the appropriate Rx frequency, modulated at 100% FM deviation at 1011 Hz at a level of -80 dBm into the Rx antenna socket of the SB2025. Check that there is no CTCSS tone on this signal.

17. On the NI ET, on the Main Audio tab of the NI Engineering window, adjust the 'In Audio Sensitivity' controls for an indication of 10,000 with the blue bar close to the middle of the green section (see **Figure 7** overleaf). Approximate settings are: the coarse control to 0 dB and the fine control to around 112. (Expect small variations between receivers).

Note.

If the SB2025 is configured to use CTCSS, it will be necessary to temporarily change Isolated Input #1 to 'Monitor' mode on the Signalling tab to make this adjustment. Once the adjustment has been made, change it back to Auto mode immediately afterwards.

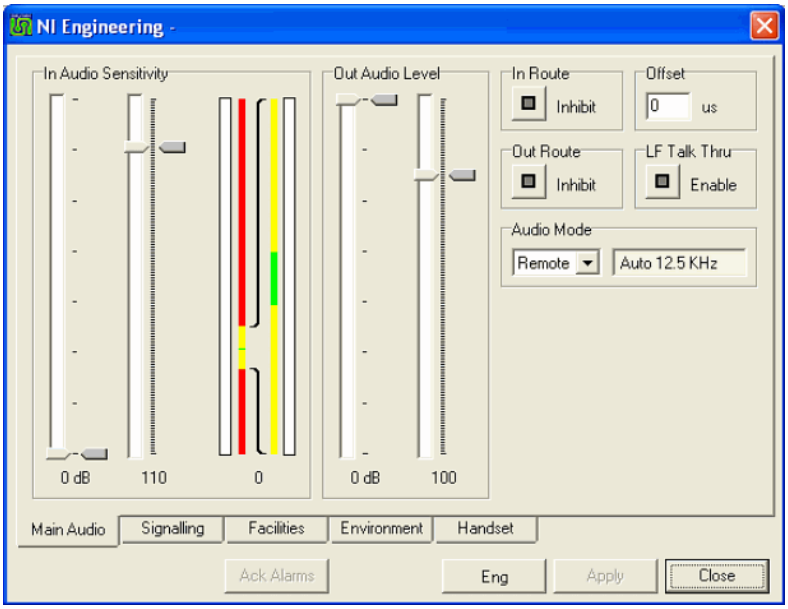


Figure 7. NI Engineering – Main Audio tab, 'In Audio Sensitivity' settings.

18. On the SB2025 base station, connect the Analogue RTS to the Tx RF O/P.

19. On the NI ET, on the NI Engineering window, carry out the following:

    19.1. On the Main Audio tab, carry out the following:

        19.1.1. Set the Audio Mode to 'Analog'.

        19.1.2. Set the coarse and fine 'Out Audio Level' controls to 0 dB and 100 respectively.

    19.2. On the Facilities tab, carry out the following:

        19.2.1. Set the 'CTCSS Tone' slider to 0 (zero).

        19.2.2. Set the Test Tone 'Frequency' to 1011 Hz and at a level of -4.4 dB.

        19.2.3. Set the Test Tone Route to 'External' (see **Figure 8** overleaf).

    19.3. On the Signalling tab, select 'Manual Trigger' (see **Figure 9** overleaf).

    19.4. Select the 'Apply' button.

20. On the PC, start/open the MxTools software.

21. On the MxTools main window, on the tool bar, select the 'Channel Info' icon. The Channel screen will be displayed.

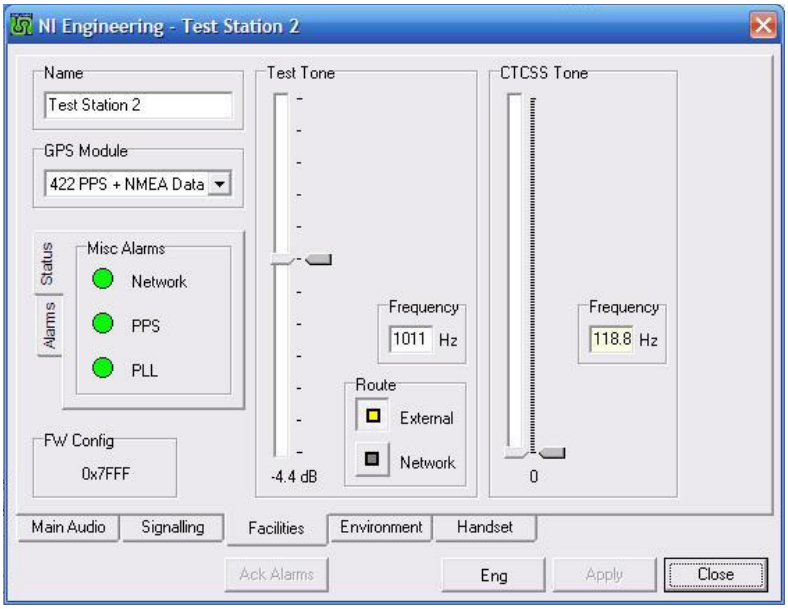


Figure 8. NI Engineering – Facilities tab, Test Tone settings.

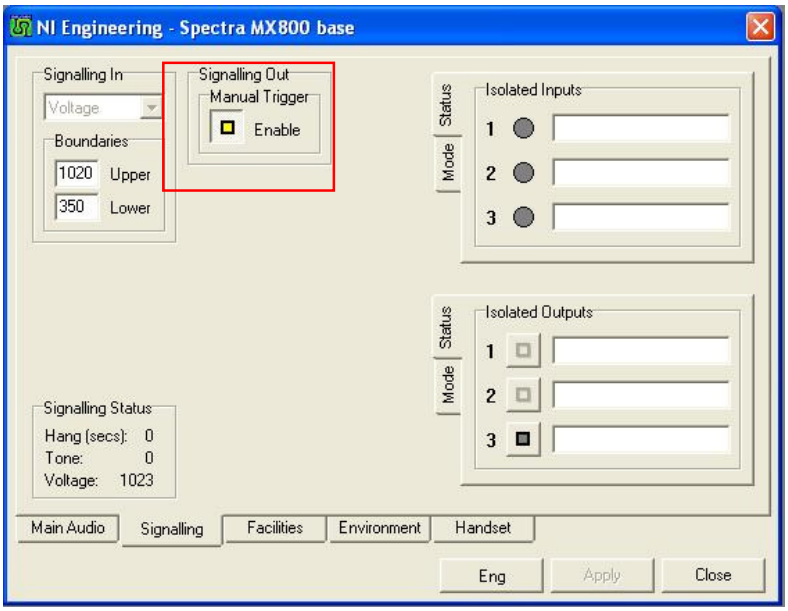


Figure 9. NI Engineering – Signalling tab, Manual Trigger.

22. On MxTools Channel screen, select channel No 1 and select the 'Set Software Channel To' tick button (see **Figure 10** overleaf).

23. On the RTS, set it to either Auto Tune or to the Tx frequency.

24. On the PC, on the MxTools Channel screen, double click on channel No.1 to access the Channel Edit screen.

25. On the Channel Edit screen, carry out the following:

    25.1. Select the 'Continuous Update Enabled' tick box.

    25.2. Set the 'Ref Osc Level (LF Audio)' digital potentiometer to 210.

25.3. Adjust the 'VCO Level (LF Audio)' digital potentiometer to obtain 1.5 kHz deviation on the Radio Test Set.

25.4. Select the 'OK' button to accept the changes made and close the Channel Edit screen.

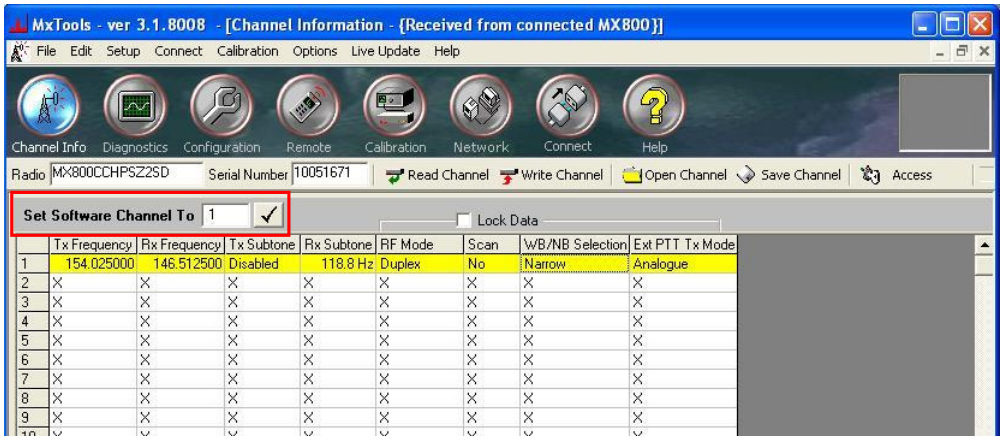


Figure 10. MxTools – Set Software Channel to tick button.

26. On the MxTools Channel screen, on the dynamic tool bar, select 'Write Channel' button to save the changes made to the radio.

27. On the NI ET, on the Engineering window, carry out the following:

27.1. On the Facilities tab, set the Test Tone 'Frequency' to 200 Hz.

27.2. Select the 'Apply' button.

27.3. On the Facilities tab, check that the Test Tone 'Frequency' has changed to 'MOD' indicating that the SB2025 Modulation Balance test signal is being generated (see **Figure 11** overleaf). The SB2025 Tx will be keyed and modulated with a 200 Hz square wave.

28. On the RTS, use a Wide Band AF Filter setting with a response of at least 15 kHz and monitor the SB2025 Tx modulation.

29. On the PC, on the MxTools main window, on the tool bar, select the 'Channel Info' icon and, on the channel table, double click on the channel in use to access the MxTools 'Channel Edit' screen.

30. On the MxTools Channel Edit screen (see **Figure 12** overleaf), adjust the various settings as per **Table 16** below.

Table 16. MxTools, Channel Edit Settings.

Area	Setting	Setting Required
RF Mode	TTR Channel	All unchecked
	Simplex Channel	
	Scan Channel	
	Wide Band or Narrow Band	As required (25 or 12.5 kHz bandwidth)
Frequency Settings	Tx Subtone (Hz)	Disabled

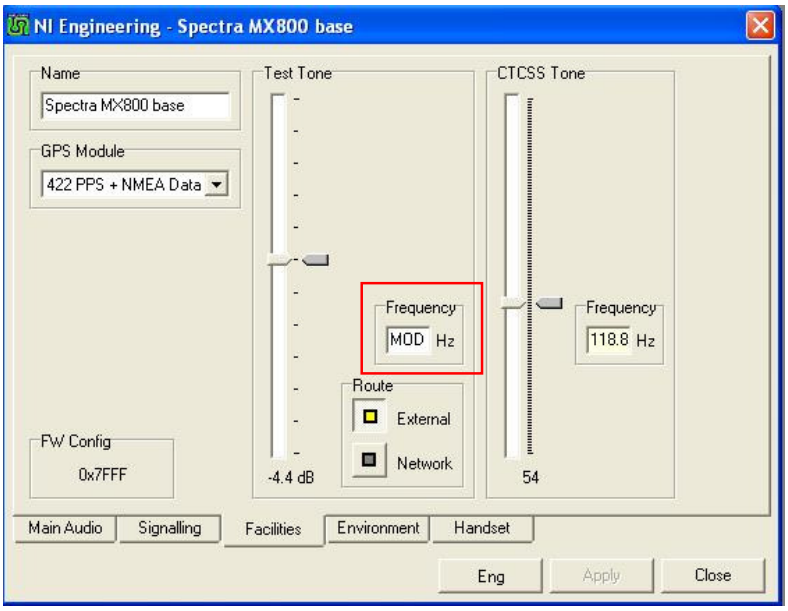


Figure 11. NI Engineering – Facilities tab, Test Tone Frequency.

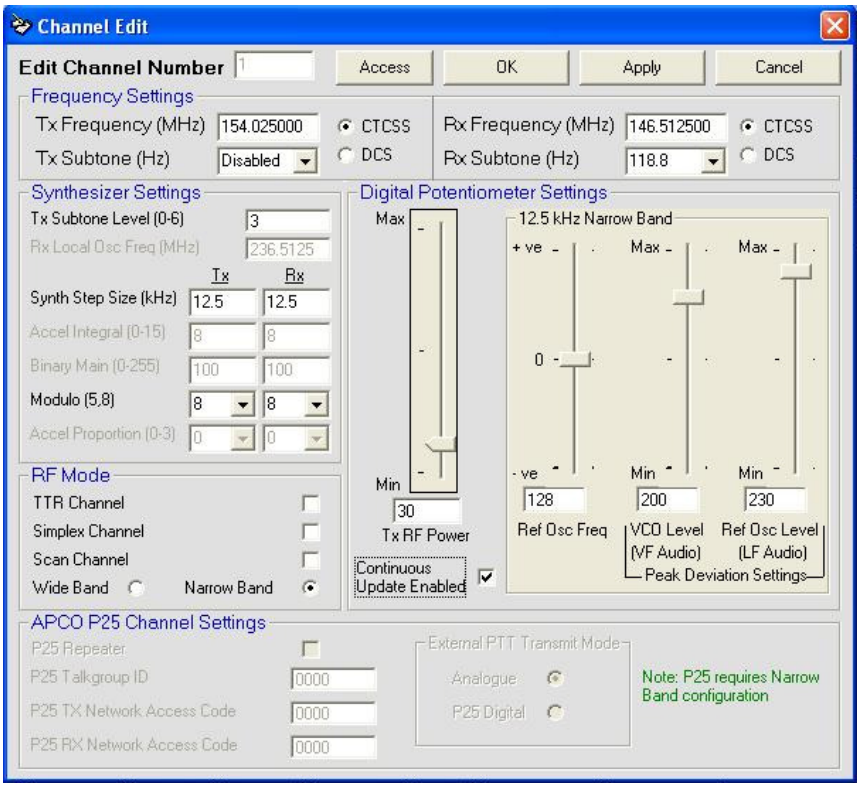


Figure 12. MxTools – Channel Edit page.

31. On the MxTools Channel Edit screen, adjust the 'Ref Osc Level (LF Audio)' digital potentiometer so that the top and bottom of the 200 Hz square wave displayed on the RTS is as flat as possible (see **Figure 13** overleaf).

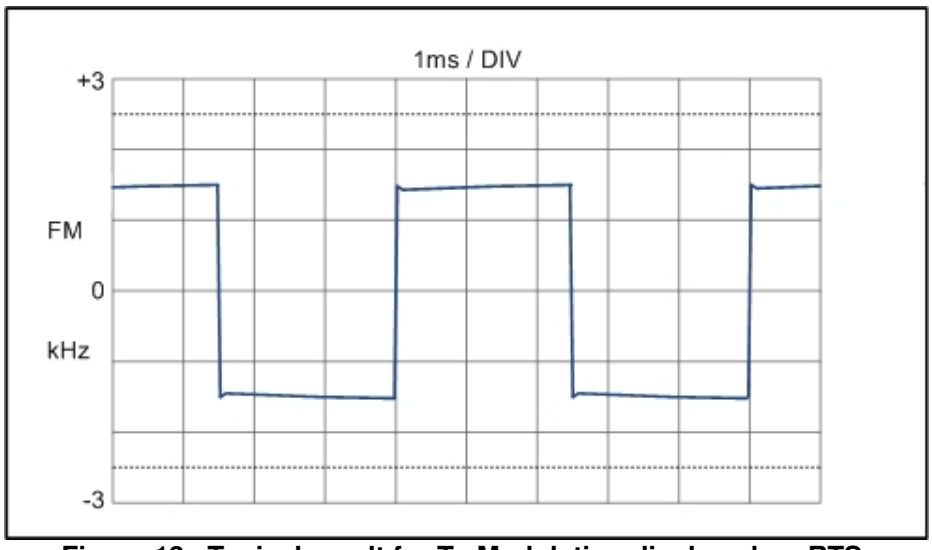


Figure 13. Typical result for Tx Modulation displayed on RTS.

32. **DO NOT** adjust the 'VCO Level (VF Audio)' digital potentiometer.

Note.

When making the adjustment in Para 31, any overshoot near the transitions can be ignored.

33. On the MxTools Channel Edit page, when adjustment of the 200 Hz square wave is completed, carry out the following:

    33.1. Note the 'Ref Osc Level (LF Audio)' level as it will be used when setting the deviation on all channels.

    33.2. Select the 'OK' button.

Note.

When selecting the 'OK' button in the Para above, if any significant adjustment of the 'Ref Osc Level (LF Audio)' has been made in Para 31, an "Information" message will be displayed advising that changes have been made and they have to be saved and sent to the base station to take effect.

34. If the Information message is displayed, select the 'OK' button to save the changes and prepare the data to be sent to the base station.

35. On the MxTools main window, on the dynamic tool bar, select the 'Write Channel' button to store the settings back to the SB2025 base station.

36. On the NI ET, on the NI Engineering window, carry out the following:

    36.1. On the Facilities tab, set the 'Test Tone' to a frequency of 1011 Hz and to a level of –4.4 dB. Set the Route to 'External' (see **Figure 8**).

    36.2. Select the 'Apply' button.

37. On the MxTools Channel screen, select one of the configured channels and carry out the following:

    37.1. On the MxTools Channel screen, select the 'Set Software Channel To' tick button.

37.2. On the RTS, check that it is set to Auto tune or re-tune to the require frequency.

37.3. On the MxTools Channel screen, double click on the select channel to access the Channel Edit screen.

37.4. On the Channel Edit screen, carry out the following:

37.4.1. Select the 'Continuous Update Enabled' tick box.

37.4.2. Set the 'Ref Osc Level (LF Audio)' digital potentiometer to value noted earlier in Para 33.1.

37.4.3. Adjust the 'VCO Level (LF Audio)' digital potentiometer to obtain 1.5 kHz deviation on the Radio Test Set.

37.4.4. Select the 'OK' button to accept the changes made and close the Channel Edit screen.

37.5. On the MxTools Channel screen, on the dynamic tool bar, select 'Write Channel' button to save the changes made to the radio.

38. Repeat Para 37 to Para 37.5 for all the configured channels.

39. On the NI ET, on the Engineering window, carry out the following:

39.1. On the Facilities tab, set the Test Tone 'Frequency' to 200 Hz.

39.2. Select the 'Apply' button.

40. On the Facilities tab, check that the Test Tone 'Frequency' has changed to 'MOD' indicating that the SB2025 Modulation Balance test signal is being generated.

41. On the MxTools Channel screen, select one of the configured channels and carry out the following:

41.1. On the MxTools Channel screen, select the 'Set Software Channel To' tick button.

41.2. On the RTS, check that it is set to Auto tune or re-tune to the require frequency.

41.3. On the RTS, use a Wide Band AF Filter setting with a response of at least 15 kHz and monitor the SB2025 Tx modulation.

41.4. On the MxTools Channel screen, double click on the select channel to access the Channel Edit screen.

41.5. On the MxTools Channel Edit screen, carry out the following:

41.5.1. Adjust the 'Ref Osc Level (LF Audio)' digital potentiometer so that the top and bottom of the 200 Hz square wave displayed on the RTS is as flat as possible.

Note.

When making the adjustment in Para 41.5.1 above, only a small adjustment of the 'Ref Osc Level (LF Audio)' control should be required to achieve the required square wave.

41.5.2. **DO NOT** adjust the 'VCO Level (VF Audio)' digital potentiometer.

41.5.3. Select the 'OK' button to accept the changes made and close the Channel Edit screen.

41.6. On the MxTools Channel screen, on the dynamic tool bar, select 'Write Channel' button to save the changes made to the radio.

42. Repeat Para 41 to Para 41.6 for all the configured channels.

43. On the NI ET, on the NI Engineering window, carry out the following:

43.1. On the Facilities tab, set the 'Test Tone' to a frequency of 1011 Hz and to a level of –4.4 dB. Set the Route to 'External'.

43.2. Select the 'Apply' button.

44. On the MxTools Channel screen, select one of the configured channels and carry out the following:

44.1. On the MxTools Channel screen, select the 'Set Software Channel To' tick button.

44.2. On the RTS, carry out the following:

44.2.1. Check that it is set to Auto tune or re-tune to the require frequency.

44.2.2. Check that the deviation of the 1011 Hz tone is 1.5 kHz.

45. Repeat Para 44 to Para 44.2.2 for all the configured channels.

Note.

After successful completion of the above procedure, the 'Ref Osc Level (LF Audio)' digital potentiometer slider should be at approximately the same level on all channels. The 'VCO Level (VF Audio)' digital potentiometer slider will be set lower on higher frequency channels as the SB2025 produces greater modulation on higher frequencies. The deviation should be the same on all channels with a constant level in from the NI.

6.1.10 Mute Threshold Setting

The Mute Threshold Setting RV6 is used to set the level at which the mute opens.

Procedure

1. On the MxTools main screen, on the tool bar, select the 'Remote' icon. The Remote screen will be displayed.

2. On the Remote screen, select the Mute Control 'Open' button to force the mute open.

3. Inject the correct RF frequency into the Rx for the test channel.

4. Set the Rx modulation frequency to 1 kHz at nominal deviation.

5. Alter the amplitude of the RF signal until the Rx audio has an 8 dB Signal to Noise and Distortion (SINAD).

6. On the MxTools Remote Screen, select the Mute Control 'Normal' button to set the mute back to normal.

7. Adjust the mute level potentiometer, RV6, until the mute opens then wind it back until it just closes.

New Motherboards (PCB Rev >R), have a new software digital controlled mute function. This provides the user with the ability to program the SB2025NT with three different mute settings. These setting can be changed on the fly by a PC when connected via RS232. These controls are located within MxTools Configuration screen, under Mute/Squelch settings tab. They are named as 'NORMAL', 'User Preset 1' and 'User Preset 2'. Please see MxTools help screen for further assistance in setting these presets.

6.2 MODULE LEVEL TEST PROCEDURES

The following alignment and testing procedures are based upon using a working transceiver as the test environment. It is also assumed that test fixtures to the radio are available to exercise control lines and monitor outputs and that a PC with MxTools is connected to the radio.

There are four modules in the SB2025 – the Exciter, Rx, PA and Micro Controller. The Exciter and the Rx have VCO daughter boards. The Rx and Exciter VCOs are similar.

6.2.1 Exciter Module

Test Equipment Required:

- Tested SB2025NT with Exciter removed.
- Tested Tx VCO board (in wanted band).
- PC with MxTools software.
- RF Communications Test Set (CTS).
- Multimeter.
- Oscilloscope.
- +13.8 VDC Power Supply.

Preliminaries:

1. On the MxTools Channel screen, program the upper, middle and lower frequencies of the frequency band (refer to **Appendix A** for band split details) into three channels.

Note.

The 'Continuous Update Enabled' option on the MxTools Channel Edit screen should be selected for these tests.

2. Remove the top cover from Exciter module under test and fit a known working VCO tuned for the band to be tested.

3. Connect the Exciter to a working Micro Controller via 16-way ribbon cable.

4. Disconnect Exciter RF drive output CN1 from PA.

Procedure

5. Switch on DC power and check that the output voltage on pin 1 of IC5 is 5 V ± 0.2 V and that the output voltage on pin 1 of IC3 and IC8 is 8 V ± 0.2 V.

6. Assert PTT and check that 8 V is switched through to SKU-3.

7. On the centre pin pad of CN3, check that the reference oscillator signal is >3 Vp-p.

8. Select the mid channel.

9. Connect the CTS RF input port to CN1.

10. Assert PTT and check that Lock Detect (LD) on SKD-16 goes high indicating that the loop is locked.

11. Check that the power control volts on SKD-4 is >10 V and that the RF output on CN1 is >300 mW.

12. On the MxTools Channel Edit screen, adjust the 'Tx RF Power' digital potentiometer slider to 0 (zero) and check that the power control volts on SKD-4 drops to 0 V and that the RF power out drops to <1 mW.

13. On the MxTools Channel Edit screen, set the the 'Tx RF Power' digital potentiometer slider back to mid position.

14. Select the lowest channel.

15. Assert PTT and check that LD goes high and that the VCO tuning volts on SKD-14 is >2 V.

16. Select the highest channel.

17. Assert PTT and check that LD goes high and that the VCO tuning volts on SKD-14 is <18 V. Check that the RF output in both cases is >300 mW.

18. Select the mid channel.

19. Assert PTT. Note the RF output carrier frequency.

20. On the MxTools Channel Edit screen, check that, by adjusting the 'Ref Osc Freq' digital potentiometer slider, the carrier frequency can be adjusted to ±3 ppm of the nominal frequency.

21. Select the mid channel.

22. Assert PTT and carry out the **Section 6.1.9 – Peak Deviation and Modulation Balance** part of the Tx VF alignment procedure to check the function of the VCO and Reference oscillator modulation inputs.

6.2.2 Receiver Module

Test Equipment Required:

- Tested SB2025NT with Rx removed.
- Tested Rx VCO board (in wanted band).
- PC with MxTools software installed.
- RF Communications Test Set.
- Spectrum Analyser with Tracking Generator.
- Multimeter.
- High Frequency (89.545 MHz) Pick up Loop.
- Oscilloscope.
- +13.8 VDC Power Supply.

Preliminaries

1. On the MxTools Channel screen, program the upper, middle and lower frequencies of the frequency band (refer to **Appendix A** for band split details) into three channels.

Note.

The 'Continuous Update Enabled' option on the MxTools Channel Edit screen should be selected for these tests.

2. Remove the top cover from Exciter module under test and fit a known working VCO tuned for the band to be tested.

3. Connect the Exciter to a working Micro Controller via 16-way ribbon cable.

Procedure

The test procedure for the Rx is divided into the Front-end Alignment and the IF Alignment procedures.

Front-end Alignment

4. Switch on the DC power and check that the output voltage on pin 1 of IC8 is 5 V ± 0.2 V, on pin 1 of IC2 is 8 V ± 0.2 V, on output of IC9 (on C66) is 8 V ± 0.2 V and on pin 1 of IC3 is 9 V ± 0.2 V.

5. Remove Jumpers E and D, and install Jumper C.

6. Connect the Tracking Generator output to CN1 and Spectrum Analyser input to CN4.

7. Set the Tracking Generator to sweep the band.

8. Adjust A4, A10 and A16 for a symmetrical pass-band around the band centre frequency.

9. Check that the gain over the band is 12 dB and that the ripple is < ±1.5 dB.

10. Check that the attenuation at the first IF image is >50 dB.

11. Remove Jumpers C and I, and install Jumpers E and H.

12. Connect the Tracking Generator output to CN4 and Spectrum Analyser input to CN5.

13. Set the Tracking Generator to sweep the band.

14. Adjust B4, B10 and B16 for a symmetrical passband around the band centre frequency.

15. Check that the maximum loss over the band is <3 dB and that the attenuation at the first IF image is >50 dB.

16. Remove Jumper E and install Jumper D.

17. Connect the Spectrum Analyser input to CN5 and Tracking Generator output to CN1.

18. Set tracking generator to sweep the band.

19. Check for symmetrical passband around band centre frequency.

20. Check that the gain over the band is 10 dB and that the ripple is <1.5 dB.

21. Remove Jumper H and install Jumper J.

IF Alignment

22. Select the mid channel.

23. Check that LD on SKD-16 goes high indicating that the synthesiser is in lock.

24. Remove S3 (0 Ω local oscillator connection to mixer) and solder a 50 Ω coax test lead across C60 position (Note C60 position is near a retaining screw and C60 is not fitted).

25. Connect the CTS to this lead and check that the RF local oscillator power is +17 dBm ± 2dB.

26. Measure the local oscillator frequency, this should be F_{RX} -90 MHz. Using a non-metallic trimmer tool carefully adjust the TCXO (X2) frequency until the correct frequency is obtained.

27. Remove the test lead and solder S3 back in position.

28. Place the high frequency pick up loop in close proximity to IC1 in order to pick up the second IF oscillator frequency (do not probe directly on the chip as test lead capacitance will affect oscillator frequency).

29. Adjust CT1 for 89.545 MHz.

30. Inject an RF signal at -80 dBm (un-modulated) at F_{RX} into CN5 (Jumper I out, Jumper J in).

31. Measure the DC voltage at VF output SKD-3 and ensure it is 2.5 V. If necessary, adjust L14 for the required voltage.

32. Inject an RF signal at -80 dBm with standard modulation at F_{RX} into CN5.

33. Monitor the line Rx out and adjust T1 and T2 for minimum distortion.

34. Reduce the RF signal level and check that sensitivity is better than -112 dBm for 12 dB SINAD.

35. Remove Jumper J and install Jumper I.

36. Inject an RF signal with standard modulation at F_{RX} into CN1.

37. Monitor the line Rx out and check that sensitivity is better than -117 dBm for 12 dB SINAD.

38. Repeat the IF Alignment test for the upper and lower channels.

6.2.3 Power Amplifier Module

Test Equipment Required

- Tested SB2025NT with PA removed.
- PC with MxTools software.
- RF Power Meter.
- RF Signal Generator.
- Multimeter.
- +13.8 VDC, 15 A Power Supply.

Preliminaries

1. On the MxTools Channel screen, program the upper, middle and lower frequencies of the frequency band (refer to **Appendix A** for band split details) into three channels.

Note.

The 'Continuous Update Enabled' option on the MxTools Channel Edit screen should be selected for these tests.

2. Do not connect the Exciter RF drive output CN1 to the PA.

Procedure

3. Remove PA top cover.

4. Measure the resistance of the thermistor between CN4-6 and CN4-4, this should be approximately 2 kΩ.

5. Connect DC power lead and 10-way connector from SB2025NT.

6. Connect the PA RF output to the RF Power Meter and the PA RF input (CN1) to RF Signal Generator.

7. Set the Signal Generator to centre frequency of PA under test and reduce the RF drive level (from signal generator) to zero.

8. Switch on DC power and check that supply is present on L6.

9. Assert PTT (check that no output RF power is emitted from the PA) and check that the 13.8 V supply is switched through to source of TR1 and TR2.

10. With PTT ON, measure the PA bias current at the gates of the Field Effect Transistors (FETs). The Bias current is band dependent. This is done by monitoring the current drain of the whole PA with CN1 disconnected.

11. Link the gate of TR2 to GND.

12. Measure current consumption (VHF Low Band 400 mA, VHF High Band 200 mA, UHF 400 mA.) This can be adjusted by RV2. Measure gate volts ≈ 3.4 V.

13. Remove link from TR2.

14. Measure the current consumption and adjust RV1 so that current is 2 Amp total for the VHF High Band & UHF Band, and 1 Amp for VHF Low Band. Measure gate volts ≈ 3.9 V.

15. With PA transmitting at 50 W into 50 Ω load, measure DC volts FWD power sense CN4-8 and REFL power sense CN4-5. These voltages should be approx. 2.8 V and <250 mV respectively.

16. Reduce the RF drive until the PA output is 10 W. Disconnect the PA RF output cable.

17. Measure the DC voltage on CN4-8 and CN4-5 again. These should now both read lower approximately 1 V.

18. Remove PTT.

6.2.4 VCO Board

Test Equipment Required

- Tested SB2025NT with Exciter VCO removed.
- PC with MxTools software installed.
- RF Communications Test Set.
- Multimeter.
- Oscilloscope.
- +13.8 VDC Power Supply.

Preliminaries

1. On the MxTools Channel screen, program the upper, middle and lower frequencies of the frequency band (refer to **Appendix A** for band split details) into three channels.

Note.

The 'Continuous Update Enabled' option on the MxTools Channel Edit screen should be selected for these tests.

2. Remove the top cover from Exciter module and fit the VCO under test. As the Tx and Rx VCOs are identical, the Rx VCO may also be tested in an Exciter. As the Rx VCO operates at the frequencies F_{RX} – 90 MHz.

3. Connect the Exciter to a working Micro Controller via 16-way ribbon cable.

4. Disconnect Exciter RF drive output CN1 from PA.

Procedure

5. Select mid channel.

6. Connect SKU from the Exciter to VCO.

7. Switch on the DC power.

8. Assert PTT and measure the RF output power on VCO SKT-6. This should be in the range 0 dBm to +3 dBm.

9. Measure the RF output level on SKU-1. This should be in the range 0 dBm to +3 dBm.

Note.

If SKU-1 is disconnected from the Exciter the loop will lose lock.

10. Reconnect SKT and SKU to Exciter.

11. Select lower channel.

12. Assert PTT and check that loop is locked.

13. Adjust trim cap CT1 on VCO for 3 VDC (2 VDC for N2 band) on SKT-1.

14. Select upper channel and check that the loop is locked and that the voltage on SKT-1 is <18 VDC.

    The following test is not required for the Rx VCO.

15. Connect the Exciter output to the CTS. Inject 1 kHz tone at nominal line input level and check that Exciter RF output is modulated and that the depth of modulation can be controlled through the MxTools Channel screen.

6.2.5 Microcontroller Module

Comprehensive testing of the Micro Controller can only be carried out at the Factory.

7 FAULT FINDING PROCEDURES

The following test equipment may be required for the tests detailed in this section:

- PC with MxTools (SB2025 Base Station Programming Utility).
- RF Test Set (e.g. HP 8920 or equivalent).
- Oscilloscope.
- RF Power Meter (capable of measuring to 60 Watts continuously).
- Multimeter.
- +13.8 V DC Power Supply (capable of supplying 15 Amps).
- Network Analyser.
- SB2025 Test Jig (Optional).

7.1 SB2025 BASE STATION

The following tests will help diagnose faulty modules.

1. Check that all of the required connections to the SB2025 Radio are made.

2. Check that all of the interconnecting cables to each of the modules and to the Motherboard are correctly installed.

3. Check the voltage supply to the SB2025 by measuring both sides of Fuse 1 located on the Micro Controller PCB. If necessary, replace the fuse.

4. Check that the 'PWR' LED is lit. If not, go to **Section 7.2**.

5. Using MxTools, check that the frequency tables and configuration settings are correct.

7.1.1 Transmitter Section

1. Connect the output of the PA Module to a Comms test set or a RF power meter.

2. Using MxTools Diagnostic's, check the Tx VCO locking voltage is between 2 V – 18 V and there is no Tx VCO 'Unlock' alarm displayed.

3. If the locking voltage is out of specification or an 'Unlock' alarm is displayed then go to **Section 7.4**.

4. Using the Software PTT in MxTools, key up the Tx.

5. If the output power of the SB2025 is LOW, using MxTools, check that the 'Transmit Power' control is not on a low setting.

6. Adjust the 'Transmit Power' control towards maximum looking for an increase in the RF power output level. If there is no substantial change, go to the diagnostics screen and check that the Forward power and the Reflected power levels are not abnormal.

Note.

If there is a high reflected power indication, the SB2025 Firmware would hold the PA power low.

7. If the Diagnostics shows abnormal, on the Motherboard, check the voltage on pin 62 of IC1. If the voltage is low (i.e. <200 mV), the likely fault is IC1. If the voltage is >200 mV, the likely fault is within the PA module.

8. If the Diagnostics shows normal, check the RF level from the Exciter module by connecting a Power Meter directly to the Exciter RF connector. In MxTools, adjust the 'Transmit Power' control to maximum, the RF level should be >+23 dBm (200 mW). If the RF level is correct, the PA is probably faulty, go to **Section 7.5**. If the RF level is not correct, go to **Section 7.4**.

9. If there is No RF power output, in MxTools, check that the 'Transmit Power' control has not been set to 0 (zero) or at a very low level. If so, apply a PTT and increase the power control until the desired power is achieved. If not, apply a PTT then check that pin 21 of IC1 is LOW, collector of TR3 is LOW and pin 13 of IC7 is HIGH. If these are OK, the Exciter or PA may be faulty. Go to **Section 7.4**, or **Section 7.5**.

10. Using the Engineering Terminal, inject a 1011 Hz tone @ –4.4 with route set to 'External.

11. If the audio deviation is incorrect, go to the Tx alignment procedure in **Section 6**.

12. If there is no audio modulation, check the audio level on pin 13, IC11on the Micro Controller PCB.

13. If there is no audio on the above test point, go to **Section 7.2**, otherwise, go to **Section 7.4**.

7.1.2 Receiver Section

1. Using MxTools Diagnostic's, check the Rx VCO locking voltage is between 2 V – 18 V and there is no Rx VCO 'Unlock' alarm displayed.

2. If the Rx locking voltage is out of specification, go to **Section 7.3**.

3. Inject a –60 dBm RF test signal at the Rx frequency and modulated with a 1 kHz tone @ 1.5 kHz (NB)/3 kHz (WB) deviation into the Rx input connector on the rear of the radio.

4. Check for an audio signal @ -10 dBm on pin 15 of the DB15 connector on the rear of the SB2025.

5. If there is an audio signal @ -10 dbm, check the Rx for correct SINAD, Signal to Noise Ratio (SNR), Audio Distortion and Mute operation. Refer to **Section 7.3**.

6. If there is no audio signal, inject the test signal directly into the Rx module and re-test for an audio signal on the SB2025 test jig.

7. Replace the Rx input coax cable if faulty.

8. Check for an audio signal on pin 2 of SKK on the Micro Controller PCB. If the audio signal is not present, it indicates a Rx fault, go to **Section 7.3**.

9. If there is a signal present at this point, it indicates a fault with the Motherboard audio or mute operation, go to **Section 7.2**.

7.2 MICRO CONTROLLER PCB

1. Check the fuse. If blown, replace with a 5x20 mm 3 A fast blow fuse.

2. Check all jumpers and switch settings are in the correct position for your requirements.

3. The Micro Controller PCB requires specialised test software to check all the hardware input and output ports. Please contact Simoco Customer Services and arrange for the Micro Controller PCB to be returned to Simoco's Service Centre.

7.3 RECEIVER MODULE

7.3.1 VCO Locking.

1. In MxTools, check that all hardware settings are correct.

2. On the Rx Module, check the value of X3 (13 MHz or 14.4 MHz) is the same as the Rx Reference Frequency in the 'Hardware Settings' on the MxTools configuration menu.

3. On the Microcontroller PCB, connect a Digital Voltmeter (DVM) to the Rx VCO TP and check the Rx locking voltage is between 2 V – 18 V.

4. Check that +12 V (SKD-2) and 28 V (SKD-13) supply lines are present.

5. If the Rx locking voltage is out of specification, on the Rx VCO, slowly adjust CT1 a full 360° and check for a change in the locking voltage.

6. If there is a change in the Rx VCO locking voltage, realign the VCO voltage to 9 V at the centre frequency of the Rx band.

7. If there is no change in the Rx VCO locking voltage, check that the VCO supply voltage at SKU-3 is approximately 7 V and, with an Oscilloscope, check the TCXO is oscillating on pin 8 of IC10.

8. If all the above tests fail, the VCO or IC10 may be faulty. Contact Simoco Customer Services and arrange for the Rx Module to be returned to Simoco's Service Centre.

7.3.2 Rx Front End

1. Solder a 2-way Berg header onto a flying coax lead. Remove solder link I near the mixer (M1) and fit solder link J. Inject a RF signal into CN5. Check that the sensitivity is better than –110 dBm.

2. If the sensitivity is OK past this point, check that the supply voltage to IC12 is approx. 8 V. If the supply is OK, replace IC12. If this does not repair the Rx, the alignment may be incorrect or other components on the front end may be faulty. Go to **Section 6.2.2**.

7.3.3 IF Section

1. If the Rx has low sensitivity past this point, increase the RF level to –60 dBm and ensure the Rx DISC voltage is set to 2.50 V. If necessary, adjust L14 for the required voltage.

2. Connect a coax lead with a pickup loop around the end from the antenna input on the HP8920A to the case of X1. Set the HP8920 to Tx test, change the Tune Mode to Manual and change the centre frequency of the CTS to 44.545 MHz for A to B Band and 89.545 MHz for C Band and above.

3. If CT1 cannot be adjusted to match the above frequencies, X1 may be faulty.

4. Set the centre frequency of the HP8920A to the Rx freq. + 45 MHz for A to B band or Rx freq. + 90 MHz for C to M Band or Rx freq. – 90 MHz for N band and above.

5. Adjust the TCXO to within ± 20 Hz.

6. If the Rx centre frequency cannot be adjusted, the TCXO may be faulty.

7. Adjust T1 and T2 for minimum distortion <1%.

8. If the distortion is high, FL3A, FL3B or FL4 may be faulty.

9. If the sensitivity is still poor, contact Simoco Customer Services and arrange for the Module to be returned to Simoco's Service Centre.

7.4 EXCITER MODULE

7.4.1 VCO Locking

1. On the Exciter module, check the reference frequency of X3 (13 MHz or 14.4 MHz) is the same as the Tx Reference Frequency in the 'Hardware Settings' on the MxTools configuration menu.

2. On the Micro Controller PCB, connect a DVM to the 'TX VCO' test point and check the Tx locking voltage is between 2 V – 18 V.

3. Check that +12 V (SKD-2) and 28 V (SKD-13) supply lines are present.

4. If the Tx locking voltage is out of specification, on the Tx VCO, slowly adjust CT1 a full 360° and check for a change in the locking voltage.

5. If there is a change in the Tx VCO locking voltage, realign the VCO voltage to 9 V at centre frequency of the VCO frequency band.

6. If there is no change in the Tx VCO locking voltage, check the VCO supply voltage at SKU-3 is approx. 7 V and, with an Oscilloscope, check the TCXO is oscillating on pin 8 of IC 10.

7. If all the above tests pass, the VCO or IC10 may be faulty. Contact Simoco Customer Services and arrange for the Exciter Module to be returned to Simoco's Service Centre.

7.4.2 RF Power

1. Using MxTools increase the 'Transmit Power' control to maximum and check that the output power is greater than +24 dBm.

2. If the Exciter power is low, check for the +8 V supply voltage at the outputs of IC2 and TR4.

3. Use a RF probe to check for gain through IC2 and TR4.

4. Lift R2 and solder a flying lead to the junction of R1 and R2. Check the output power of the VCO is between 0 and +3 dBm.

5. If all the above tests pass, contact Simoco Customer Services and arrange for the Exciter Module to be returned to Simoco's Service Centre.

7.5 POWER AMPLIFIER

1. Firstly, carry out a visual inspection of all the components on the PA looking for any damaged components.

2. Connect the input of the PA to signal generator with the RF output switched off.

3. With PTT off, measure the +13.8 V supply at the source of the driver and output FET. If out of specification, check voltage at CN2-2, if no volts check the supply cable.

4. With PTT ON, measure the PA bias current at the gates of the FETs. The bias current is band dependent. This is done by monitoring the current drain of the whole PA with CN1 disconnected. Link the gate of TR2 to GND. Measure current consumption (VHF High Band 200 mA, VHF low and UHF 400 mA). This can be adjusted by RV2. Measure gate volts ≈ 3.4 V.

5. Remove the link from TR2. Measure the current consumption and adjust RV1 so that current is 2 Amp total (VHF & UHF) and VHF Low 1 Amp. Measure gate volts ≈ 3.9 V.

6. Using a coax lead, connect the RF output connector CN3 to a power meter. Turn on the supply voltage and the signal generator RF output. PTT the PA and increase the generator output (do NOT exceed +24 dBm) whilst measuring the output power output (≥50 watts @ +24 dBM).

7. If the output power is low, turn the supply voltage OFF and lift one side of the capacitors connecting to the directional coupler and solder a flying lead to the lifted side. Connect the earth of the flying lead to the earth of the PA. Connect the power meter to the flying lead.

8. Turn on the supply voltage and the signal generator RF output. PTT the PA and increase the generator output (do NOT exceed +24 dBm) whilst measuring the output power output (≥55 watts @ +24 dBM).

9. If all the above tests fail, TR1 or TR2 may be faulty. Contact Simoco Customer Services and arrange for the PA to be returned to Simoco's Service Centre.

8 DRAWINGS

8.1 CURRENT DRAWINGS

Table 17. Drawings.

Drawing No.	Description	Band
Figure 14	Rx Component Overlay	All
Figure 15	Exciter Component Overlay	All
Figure 16	PA Component Overlay (Superseded Version)	A to Q
Figure 17	PA Component Overlay (New Wide Band Version)	
Figure 18	Micro Controller Component Overlay (Rev S)	All
Figure 19	Tx and Rx VCO Component Overlay	A to Q3
Figure 20	Tx and Rx VCO Component Overlay	R to X
Figure 21	HP Rx VCO Component Overlay	A to Q
Figure 22	Tx/Rx V3 VCO Component Overlay	All

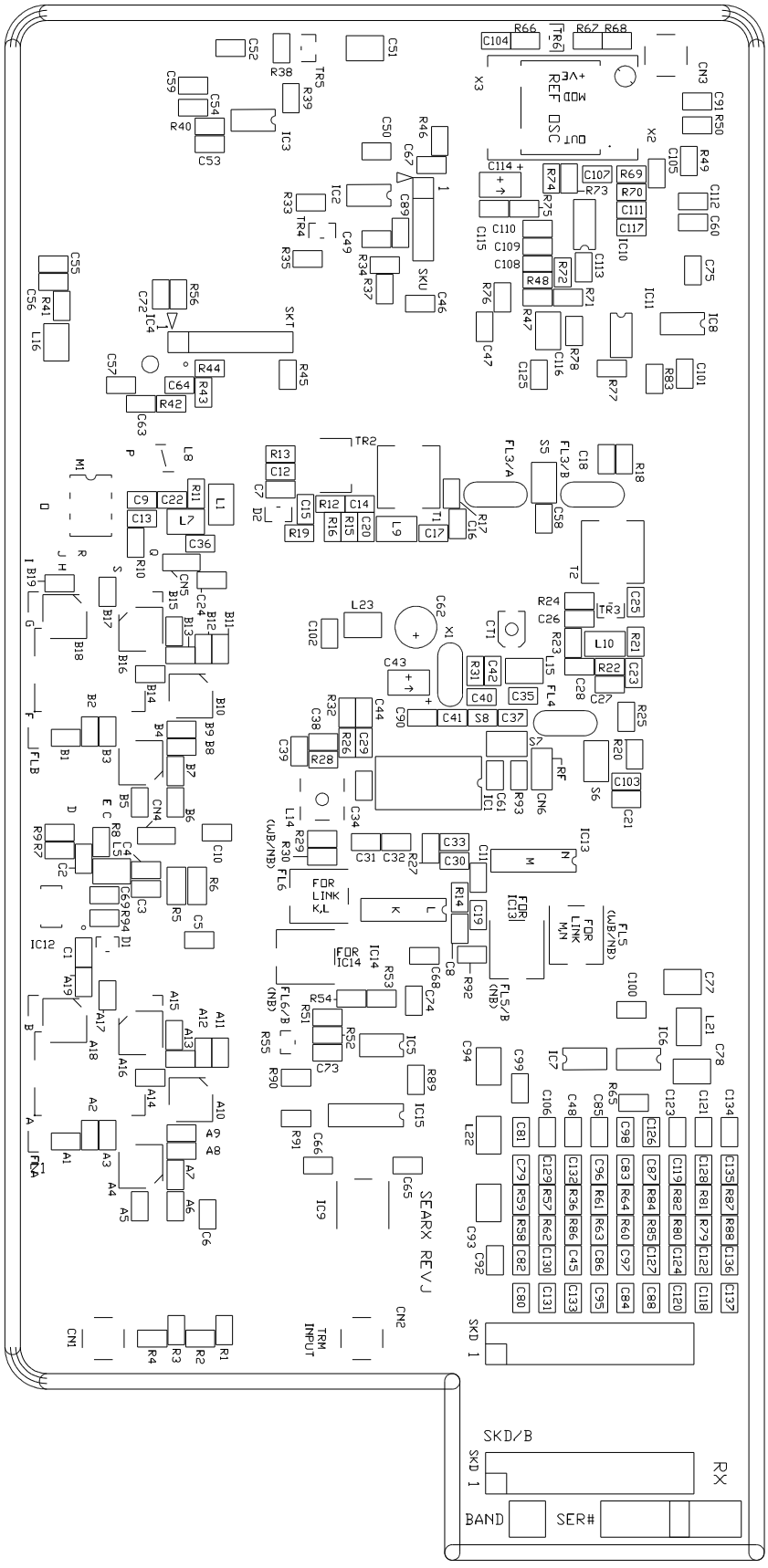


Figure 14. Rx Component Overlay.

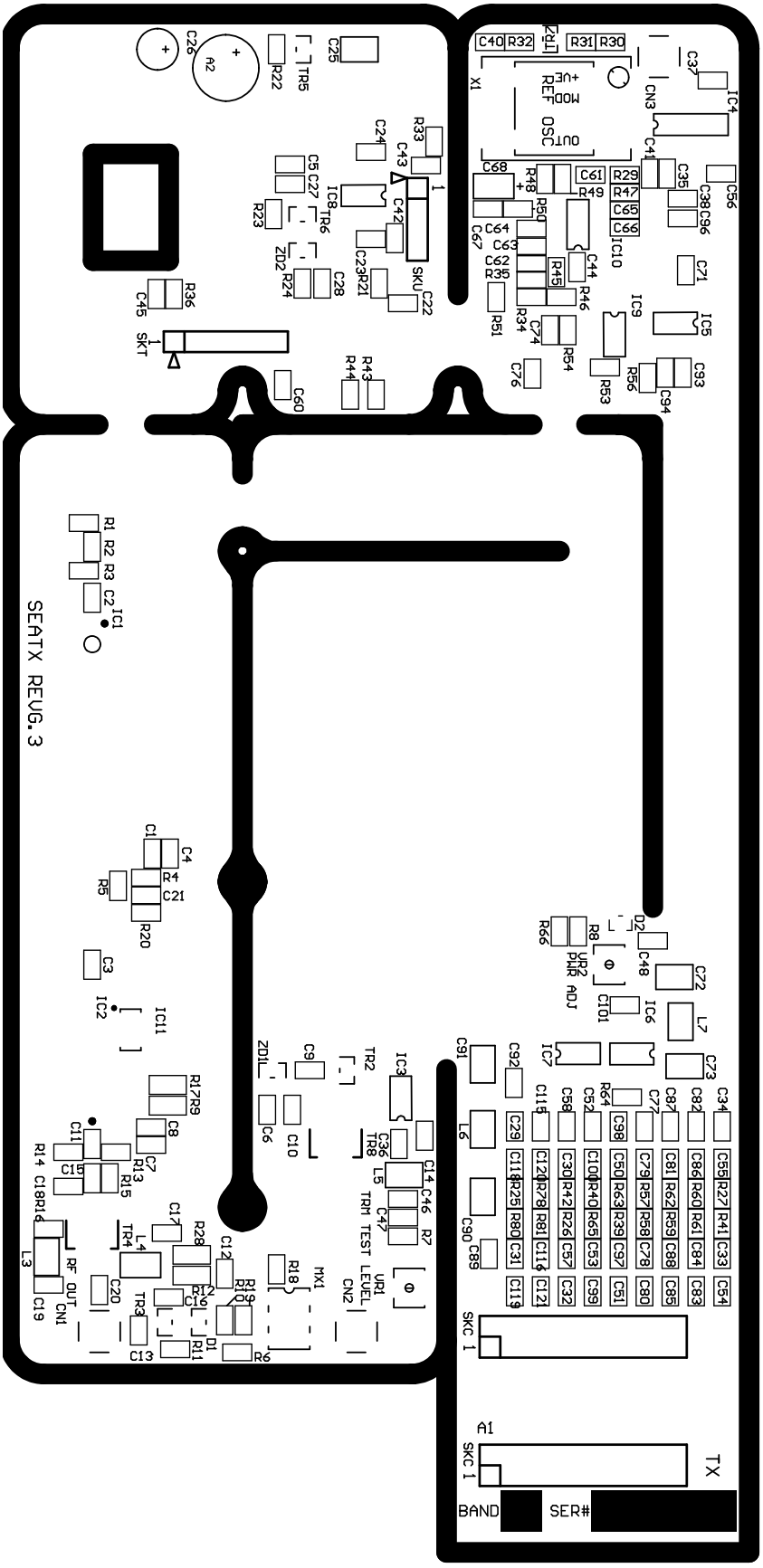


Figure 15. Exciter Component Overlay.

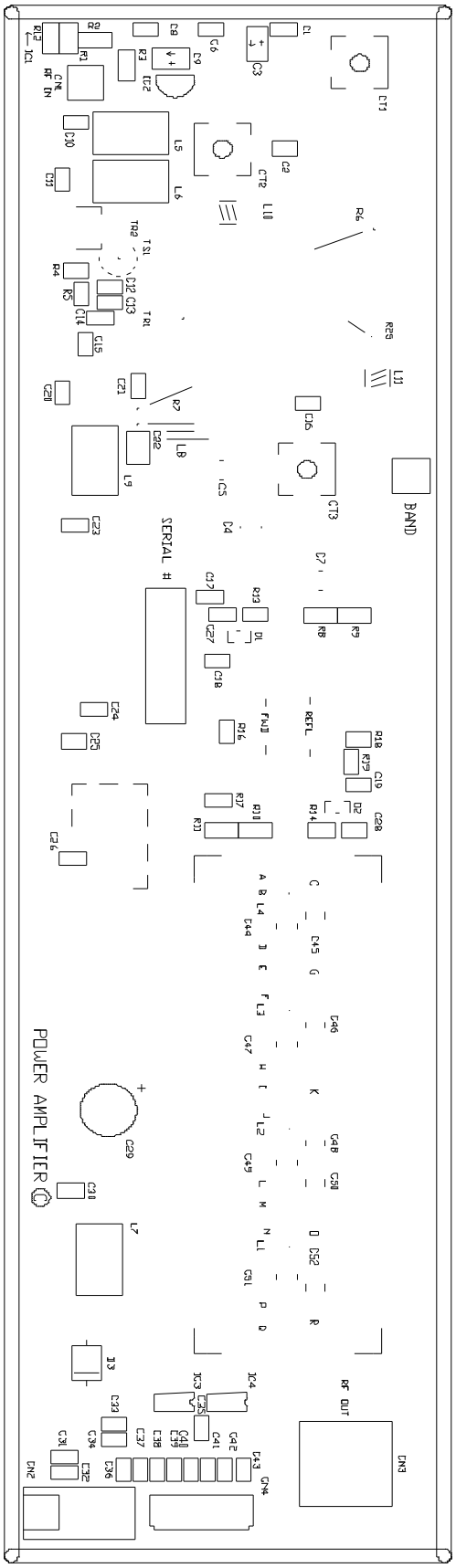


Figure 16. PA Component Overlay – Superseded Version.

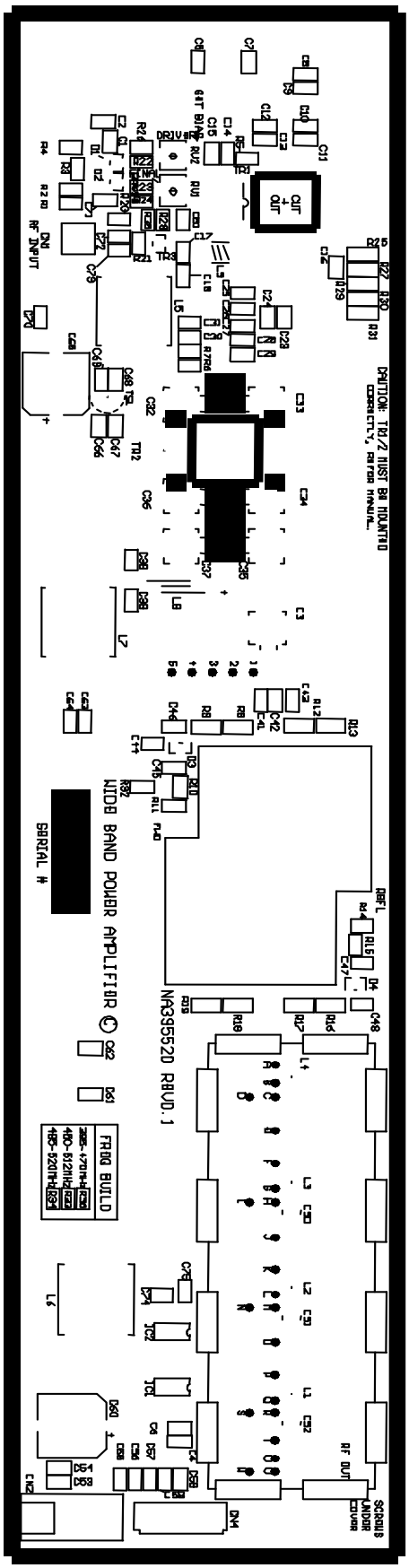


Figure 17. PA Component Overlay – New Wide Band PA Version.

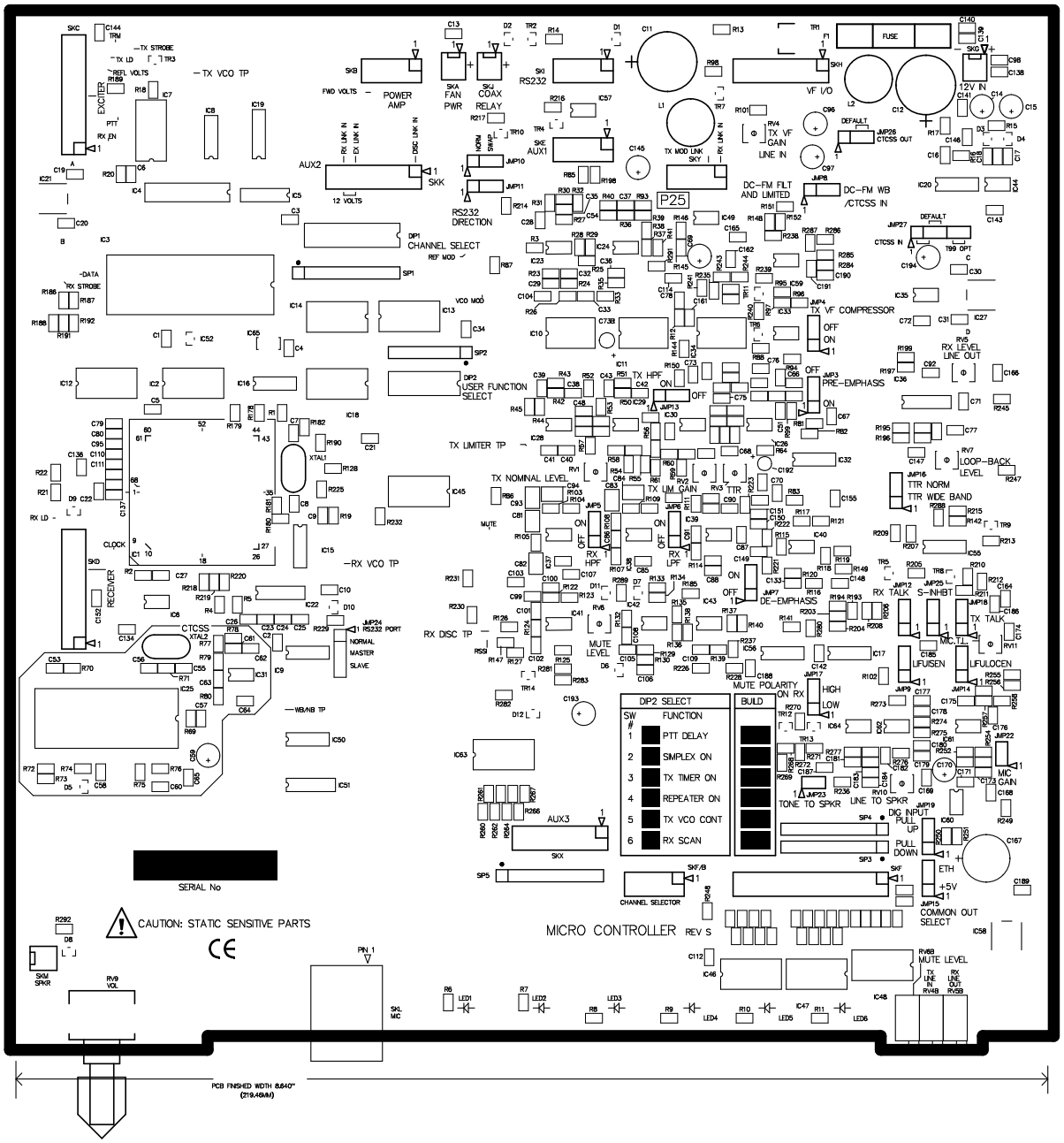


Figure 18. Micro Controller Component Overlay (Rev S).

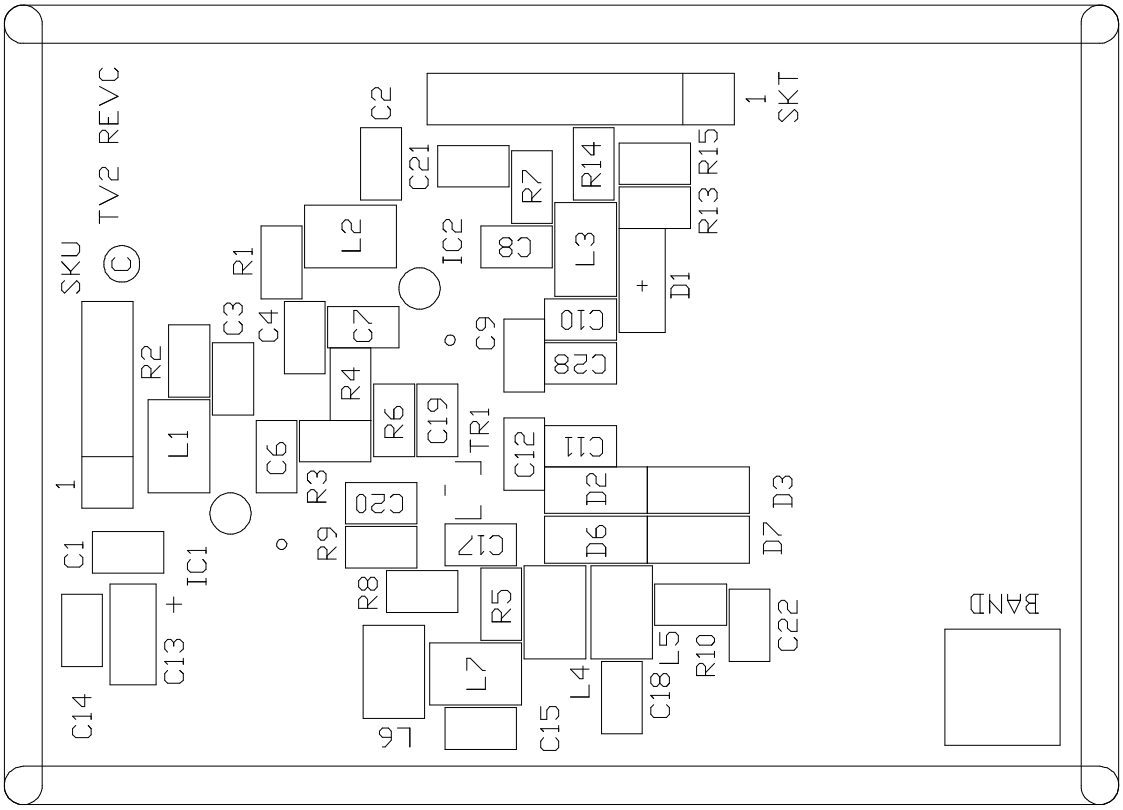


Figure 19. Tx and Rx VCO Component Overlay Bands A to Q3.

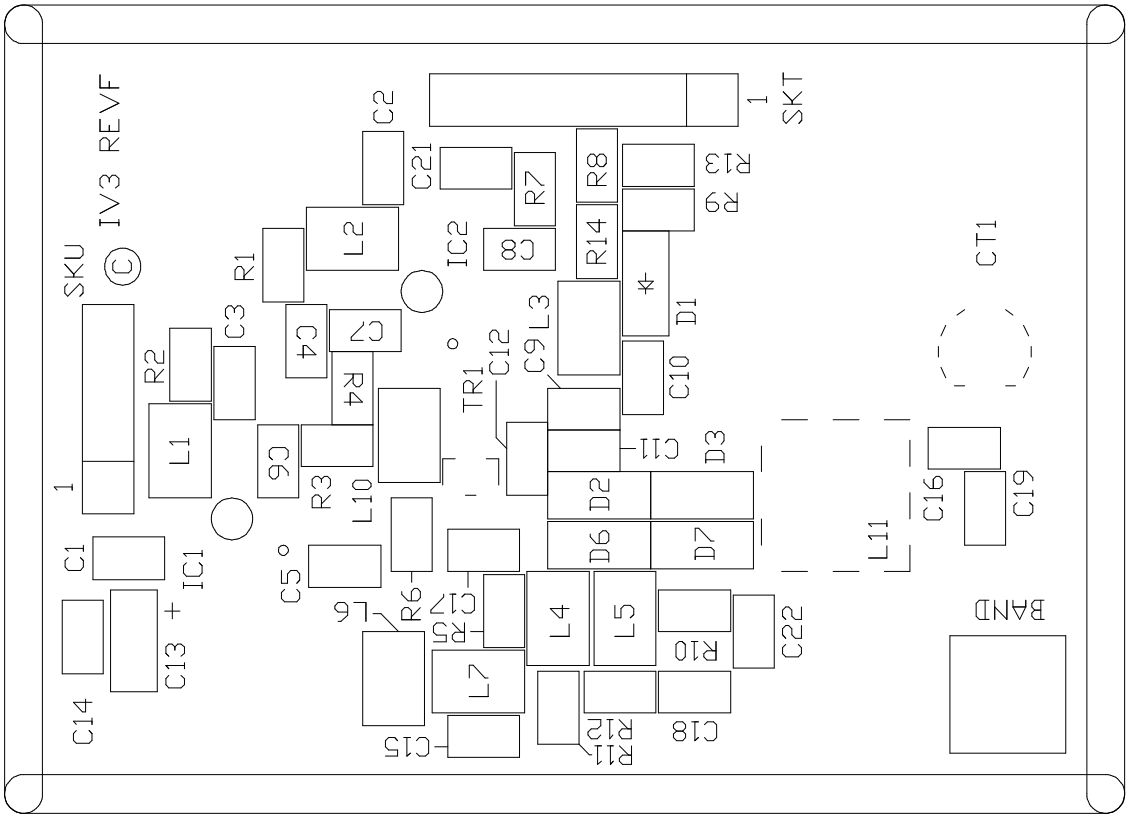


Figure 20. Tx and Rx VCO Component Overlay Bands R to X.

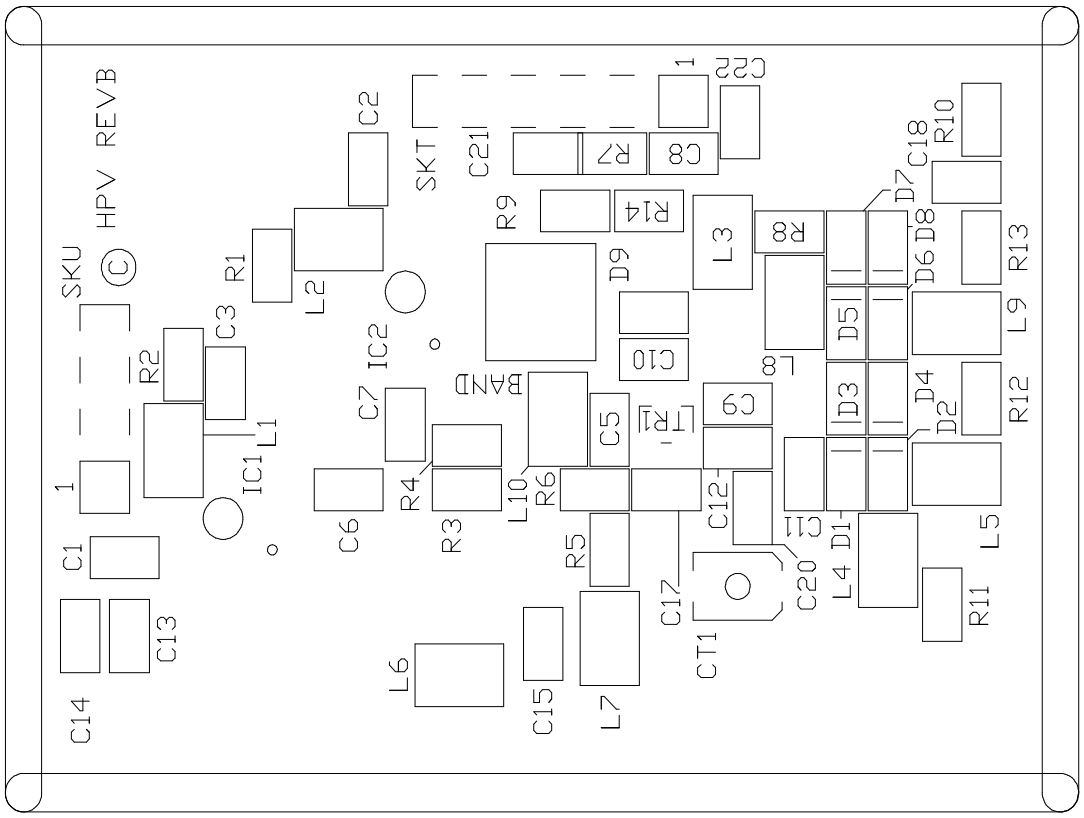


Figure 21. HP Rx VCO Component Overlay Bands A to Q.

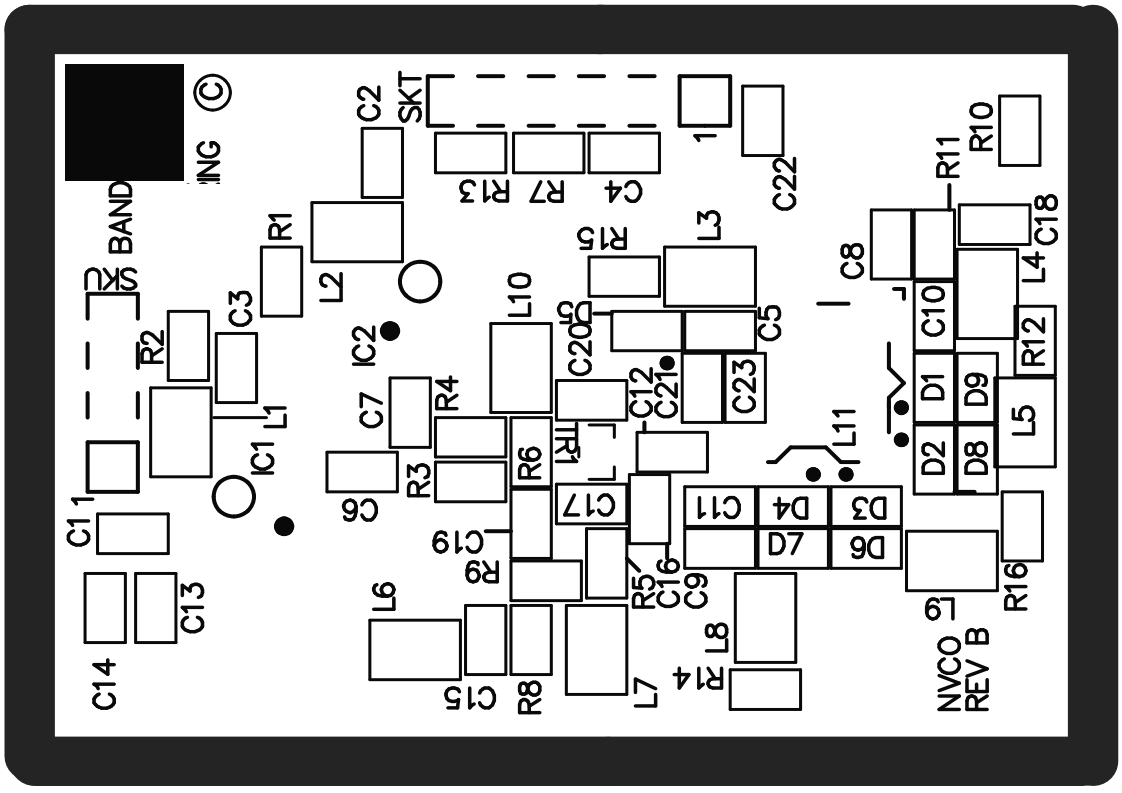


Figure 22. Tx/Rx V3 VCO Component Overlay.

9 SPARES

To be advised.

APPENDIX A

SB2025 FREQUENCY BANDS

The frequency bands available for the SB2025 are specified in **Table A-1** below.

Table A-1. SB2025 Frequency Bands.

Band	Frequency (MHz)	Band	Frequency (MHz)	Band	Frequency (MHz)	Band	Frequency (MHz)
A2	30 – 39	G	220 – 250	O	425 – 460	R3	776 - 794
A3	39 – 50	H	245 – 275	O2	435 – 470	S	824 – 849
A	66 – 80	I	270 – 300	P	455 – 490	T	850 – 870
B°	70 – 88	J	295 – 325	P2°	450 – 485	U	870 – 905
C	135 – 160	J2	300 – 337	P3	475 – 495	V	890 – 915
D	155 – 180	K	320 – 350	Q°	485 – 520	V2	900 – 925
D3°	148 – 174	L	345 – 375	Q2	500 – 532	W	917 – 950
E	177 – 207	M	370 – 400	Q3	485 – 505	X	925 – 960
E2	177 – 185	N	395 – 430	R	805 – 825	Z	None
F	195 – 225	N2°	400 – 435	R2	746 – 764		

Notes:

(i). Band E, L2, R3 Q2 receive only.

(ii). Band E2, R2 and V2 transmit only.

(iii). ° Standard preferred frequency band.

(iv). Band A2, A3: 4 MHz Rx VCO Sw BW.

(v). 100 W only available in 135 MHz – 175 MHz.

Due to ongoing development, please contact Simoco for the latest revision of the document page.

SIMOCO FCC TYPE APPROVALS

The Simoco FCC Type Approvals for the various frequencies bands of the SB2025 are shown in **Table A-2** below.

Table A-2. FCC Type Approvals for SB2025.

To be advised.

APPENDIX B

CHANNEL SELECT DIP SWITCH SETTINGS

Refer to **Section 3.2.2.3** for a description on the alternative methods to select the operating channel. If a hardware channel select method is chosen the following table shows how to set the switches for each channel. Select the fixed channel for the SB2025 by using the DIP switch DIP1 located on the Micro Controller Board. Channel 1 to 255 is available in binary selection. Switch position 1 is channel 1, position 2 is channel 2, position 3 is channel 4, position 4 is channel 8, position 5 is channel 16, position 6 is channel 32, position 7 is channel 64, and position 8 is channel 128.

A table of DIP switch 1 settings follows, where switch ON is indicated by an “X” in a cell and no entry in a cell represents a switch OFF.

Table B-1. Channel Select DIP Switch Settings.

Channel	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
0								
1	X							
2		X						
3	X	X						
4			X					
5	X		X					
6		X	X					
7	X	X	X					
8				X				
9	X			X				
10		X		X				
11	X	X		X				
12			X	X				
13	X		X	X				
14		X	X	X				
15	X	X	X	X				
16					X			
17	X				X			
18		X			X			
19	X	X			X			
20			X		X			
21	X		X		X			
22		X	X		X			
23	X	X	X		X			
24				X	X			
25	X			X	X			
26		X		X	X			
27	X	X		X	X			
28			X	X	X			
29	X		X	X	X			
30		X	X	X	X			
31	X	X	X	X	X			
32						X		
33	X					X		
34		X				X		
35	X	X				X		
36			X			X		
37	X		X			X		
38		X	X			X		
39	X	X	X			X		
40				X		X		
41	X			X		X		
42		X		X		X		
43	X	X		X		X		
44			X	X		X		
45	X		X	X		X		
46		X	X	X		X		
47	X	X	X	X		X		
48					X	X		
49	X				X	X		
50		X			X	X		
51	X	X			X	X		
52			X		X	X		
53	X		X		X	X		
54		X	X		X	X		
55	X	X	X		X	X		
56				X	X	X		
57	X			X	X	X		
58		X		X	X	X		
59	X	X		X	X	X		
60			X	X	X	X		
61	X		X	X	X	X		
62		X	X	X	X	X		
63	X	X	X	X	X	X		
64							X	
65	X						X	
66		X					X	
67	X	X					X	
68			X				X	
69	X		X				X	
70		X	X				X	
71	X	X	X				X	
72				X			X	
73	X			X			X	
74		X		X			X	
75	X	X		X			X	
76			X	X			X	
77	X		X	X			X	
78		X	X	X			X	
79	X	X	X	X			X	
80					X		X	
81	X				X		X	
82		X			X		X	
83	X	X			X		X	
84			X		X		X	
85	X		X		X		X	
86		X	X		X		X	
87	X	X	X		X		X	
88				X	X		X	
89	X			X	X		X	
90		X		X	X		X	
91	X	X		X	X		X	
92			X	X	X		X	
93	X		X	X	X		X	
94		X	X	X	X		X	
95	X	X	X	X	X		X	
96						X	X	
97	X					X	X	
98		X				X	X	
99	X	X				X	X	
100			X			X	X	
101	X		X			X	X	
102		X	X			X	X	
103	X	X	X			X	X	
104				X		X	X	
105	X			X		X	X	
106		X		X		X	X	
107	X	X		X		X	X	
108			X	X		X	X	
109	X		X	X		X	X	
110		X	X	X		X	X	
111	X	X	X	X		X	X	
112					X	X	X	
113	X				X	X	X	
114		X			X	X	X	
115	X	X			X	X	X	
116			X		X	X	X	
117	X		X		X	X	X	
118		X	X		X	X	X	
119	X	X	X		X	X	X	
120				X	X	X	X	
121	X			X	X	X	X	
122		X		X	X	X	X	
123	X	X		X	X	X	X	
124			X	X	X	X	X	
125	X		X	X	X	X	X	
126		X	X	X	X	X	X	
127	X	X	X	X	X	X	X	

Table B-1. Channel Select DIP Switch Settings (continued).

Channel	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
128								X
129	X							X
130		X						X
131	X	X						X
132			X					X
133	X		X					X
134		X	X					X
135	X	X	X					X
136				X				X
137	X			X				X
138		X		X				X
139	X	X		X				X
140			X	X				X
141	X		X	X				X
142		X	X	X				X
143	X	X	X	X				X
144					X			X
145	X				X			X
146		X			X			X
147	X	X			X			X
148			X		X			X
149	X		X		X			X
150		X	X		X			X
151	X	X	X		X			X
152				X	X			X
153	X			X	X			X
154		X		X	X			X
155	X	X		X	X			X
156			X	X	X			X
157	X		X	X	X			X
158		X	X	X	X			X
159	X	X	X	X	X			X
160						X		X
161	X					X		X
162		X				X		X
163	X	X				X		X
164			X			X		X
165	X		X			X		X
166		X	X			X		X
167	X	X	X			X		X
168				X		X		X
169	X			X		X		X
170		X		X		X		X
171	X	X		X		X		X
172			X	X		X		X
173	X		X	X		X		X
174		X	X	X		X		X
175	X	X	X	X		X		X
176					X	X		X
177	X				X	X		X
178		X			X	X		X
179	X	X			X	X		X
180			X		X	X		X
181	X		X		X	X		X
182		X	X		X	X		X
183	X	X	X		X	X		X
184				X	X	X		X
185	X			X	X	X		X
186		X		X	X	X		X
187	X	X		X	X	X		X
188			X	X	X	X		X
189	X		X	X	X	X		X
190		X	X	X	X	X		X
191	X	X	X	X	X	X		X
192							X	X
193	X						X	X
194		X					X	X
195	X	X					X	X
196			X				X	X
197	X		X				X	X
198		X	X				X	X
199	X	X	X				X	X
200				X			X	X
201	X			X			X	X
202		X		X			X	X
203	X	X		X			X	X
204			X	X			X	X
205	X		X	X			X	X
206		X	X	X			X	X
207	X	X	X	X			X	X
208					X		X	X
209	X				X		X	X
210		X			X		X	X
211	X	X			X		X	X
212			X		X		X	X
213	X		X		X		X	X
214		X	X		X		X	X
215	X	X	X		X		X	X
216				X	X		X	X
217	X			X	X		X	X
218		X		X	X		X	X
219	X	X		X	X		X	X
220			X	X	X		X	X
221	X		X	X	X		X	X
222		X	X	X	X		X	X
223	X	X	X	X	X		X	X
224						X	X	X
225	X					X	X	X
226		X				X	X	X
227	X	X				X	X	X
228			X			X	X	X
229	X		X			X	X	X
230		X	X			X	X	X
231	X	X	X			X	X	X
232				X		X	X	X
233	X			X		X	X	X
234		X		X		X	X	X
235	X	X		X		X	X	X
236			X	X		X	X	X
237	X		X	X		X	X	X
238		X	X	X		X	X	X
239	X	X	X	X		X	X	X
240					X	X	X	X
241	X				X	X	X	X
242		X			X	X	X	X
243	X	X			X	X	X	X
244			X		X	X	X	X
245	X		X		X	X	X	X
246		X	X		X	X	X	X
247	X	X	X		X	X	X	X
248				X	X	X	X	X
249	X			X	X	X	X	X
250		X		X	X	X	X	X
251	X	X		X	X	X	X	X
252			X	X	X	X	X	X
253	X		X	X	X	X	X	X
254		X	X	X	X	X	X	X
255	X	X	X	X	X	X	X	X

APPENDIX C

CONFIGURATION PROCEDURE CABLE REQUIREMENTS

T36 MODULE SERIAL CABLE

The details of the cable required to connect the PC to the pin header HDR1 on the T36 Module in the SB2025 base station are shown below in **Figure C-1**.

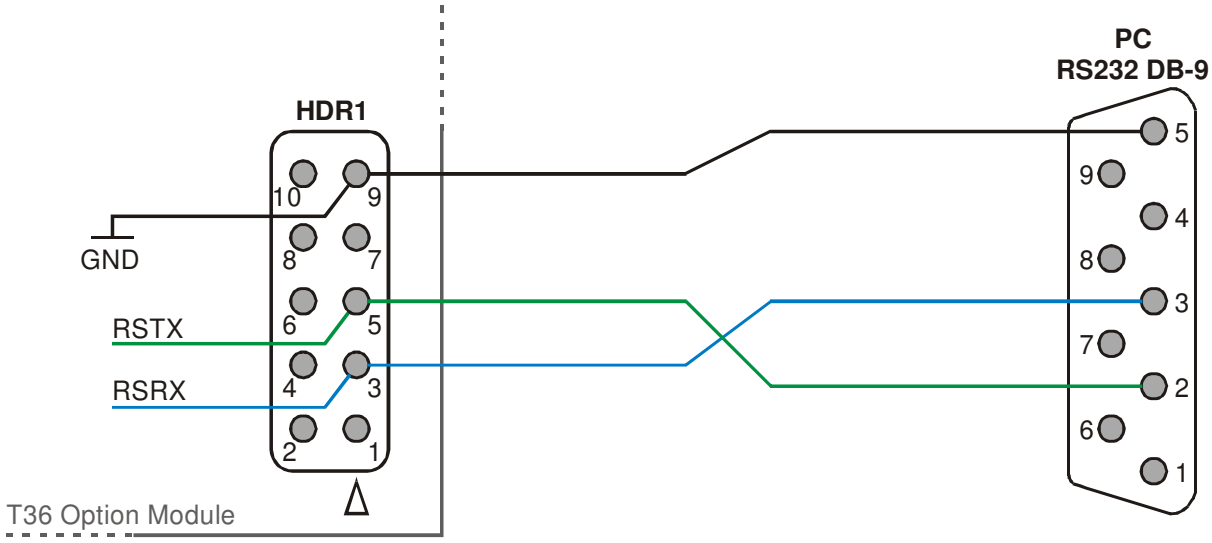


Figure C-1. T36 Module Serial Cable – wiring details.

APPENDIX D

SB2025 MICRO CONTROLLER PCB LINK SETTINGS

The link settings detailed in this Appendix should only be carried out by qualified engineering personnel.

CAUTION

Electrostatic Discharge Sensitive Devices (ESDS Devices). This equipment contains ESDS Devices, refer to the Personal Safety and Equipment Safety pages.

LINK SETTINGS

For correct operation of the Solar 2 P25 NI in the SB2025 base stations, two separate audio paths for the Tx Audio and Rx Audio have to be created through the Micro Controller PCB. This is achieved by adjusting various link and jumper settings on the Micro Controller as detailed below.

For details of the Micro Controller PCB component layout, refer to **Section 8 – Drawings**. The location of the links and jumpers detailed below are shown overleaf in **Figure D-1**.

For details of the functions of the Micro Controller Jumpers, refer to **Section 3 – Installation and Operation**.

Tx Audio

This input from Solar 2 NI enters the SB2025 on Pin 13 of CN1 DB15 Line I/O connector.

- JMP8 2-3 IN.
- JMP27 2-3 IN.
- T99 link IN.

Rx Audio

This output to Solar 2 NI leaves the SB2025 on Pin 14 of CN1 DB15 Line I/O connector.

- SKK 1-2 OUT

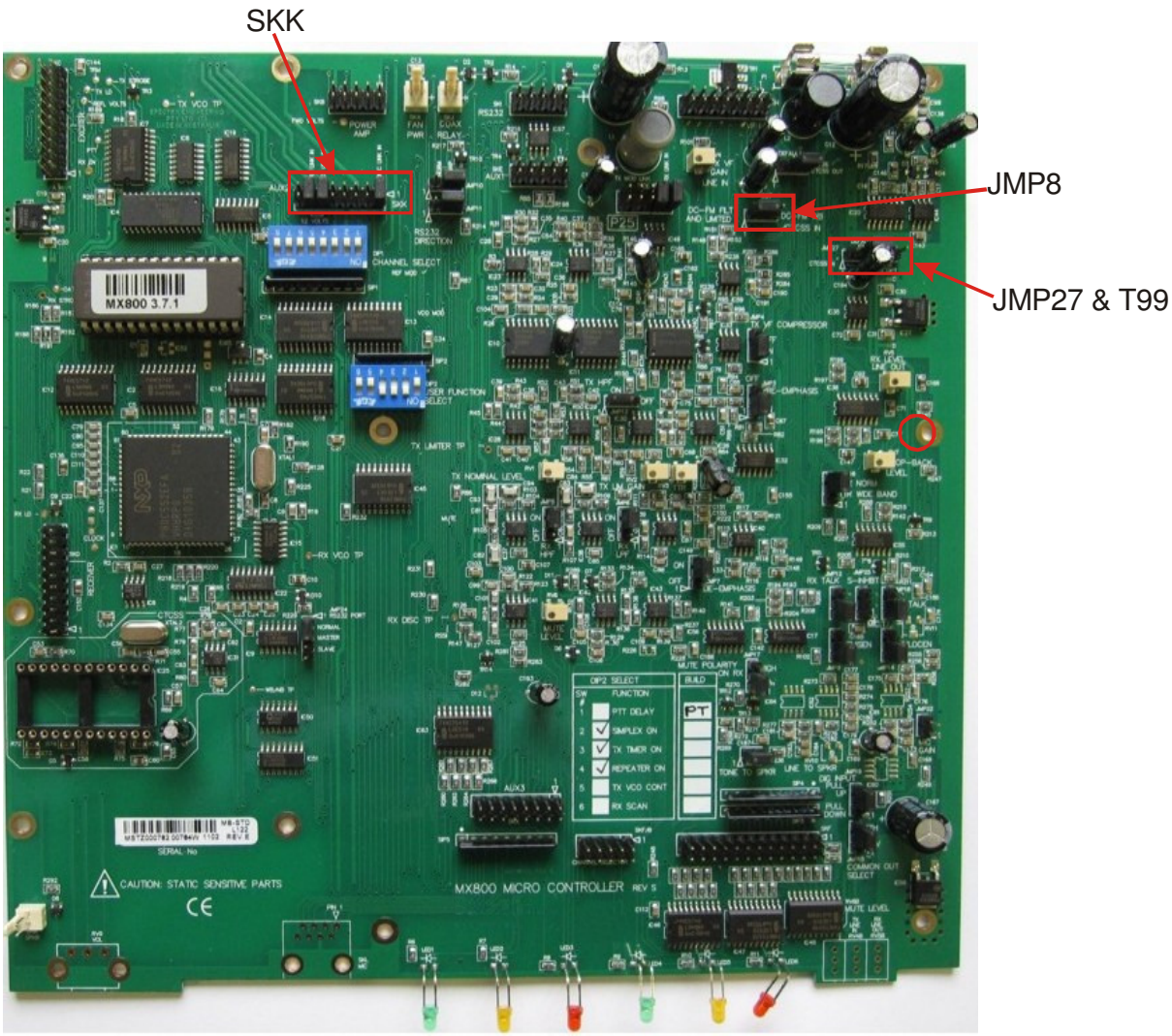


Figure D-1. Micro Controller Jumper and Link locations.

PART 2

ENGINEERING TERMINAL
USER MANUAL

PART 2

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1 INTRODUCTION TO THE ENGINEERING TERMINAL

1.1 ENGINEERING TERMINAL OVERVIEW

In the context of engineering, the ET is the primary source for control and monitoring of a Solar Network for both Analogue and P25 systems. It must be stressed that the ET is not designed for use by a control operator; a bespoke supervisory application or Simple Network Management Protocol (SNMP) is best suited for that task.

Basic connection of the ET is to the front panel USB (Type B) connector. The Solar 2 unit uses a four port USB interface module and, on connection to the PC, four new ports will become available on the PC. Of these, only three ports can be ever be used as each of the main internal modules is connected to one of the ports when fitted; i.e. one port is reserved for the TM and two ports are reserved for each of the NI.

The TM also supports a network connected ET, which allows remote diagnostics and monitoring (subject to network permissions), however, the initial TM configuration can only be made with a locally connected ET.

1.2 ET APPLICATION PACKAGE

A common software application package services all hardware builds of Solar 2 units. The software application will automatically determine the type of module to which it connects and present the corresponding status window for that module; i.e. a TM or a NI. The software application package is available as zipped downloads from the web site at http://www.teamsimoco.com/downloads. This is an executable file that operates under the Windows™ operating system. It does not require an installation process and may be copied freely but remain the intellectual property of Simoco.

Whilst the ET software application is a single, common package, the TM ET and NI ET effectively operate as two separate independent entities and, for the sake of clarity, will be treated as such in this manual. If the user needs to connect to two units of either type at the same time this is perfectly legitimate but requires that two instances of the software are run at the same time.

This can be achieved by making a second copy of the software and placing it in a different folder (directory) on the PC to the first copy. This is necessary so that each copy can keep its own configuration (*ini*) file, which contains the default settings that will be used by that instance of the software and allows the folders to be suitably named to help minimise any confusion.

1.2.1 Traffic Manager ET

The TM ET software provides both system monitoring and access to the system configuration parameters. Engineering control of every NI is an inherent feature and being able to remotely access the system through the TM ET is a major benefit.

1.2.2 Network Interface ET

The NI ET software services NIs operating in both Central and Station mode. The style of presentation is different for the Central and Station functions; there is also a style for units that are not assigned (not yet configured) as either. The style to be used with a particular NI will be picked-up automatically.

1.3 CONNECTING THE ET APPLICATION

When the ET application is started, an opening window will appear as shown in **Figure 2** overleaf.

At the bottom of the opening window on the Status Bar, the TX and RX indicators, when they are lit, show that the serial communications to the PC is active. Also displayed on the Status Bar is the ET Application part number and version (see **Figure 1** overleaf).

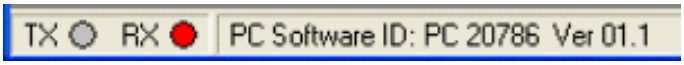

Figure 1. ET window – Status Bar.

1.3.1 Default Setting

If this is the first usage of an ET application, there will be no default settings, otherwise the settings will be those used on the last occasion taking information held in an "*ini*" configuration file. If this file is not found, it will be automatically created in the same folder as that holding the application itself. As long as future ET software application releases are placed in that same folder, the original "*ini*" file will be recognised and previously selected options will be used.

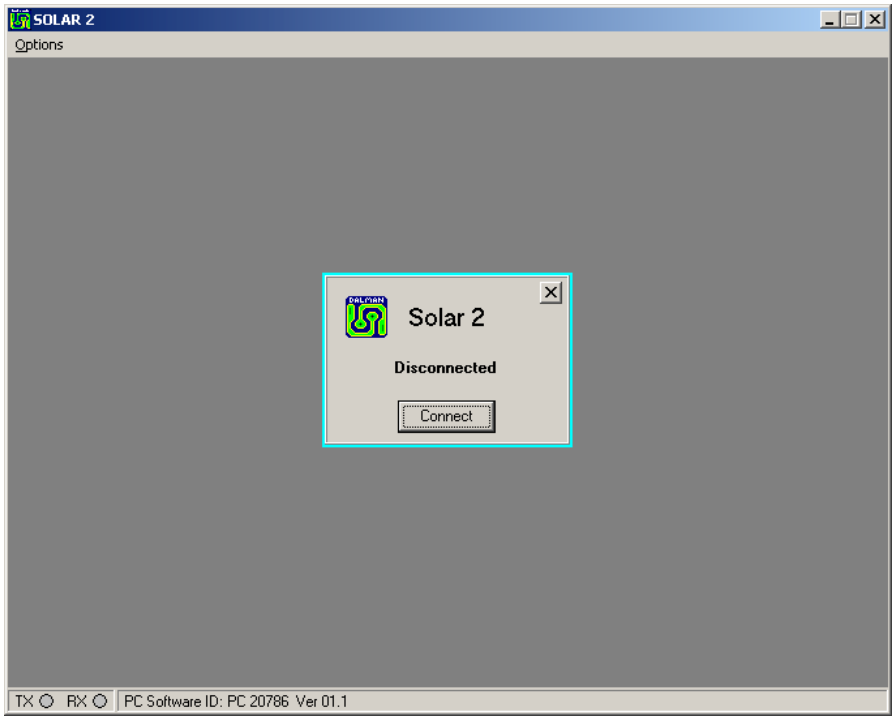

Figure 2. ET opening window.

1.3.2 Com Port

If there is a need to change the Com port setting, then proceed as follows:

1. On the ET window, carry out the following:

   1.1. Close the 'Disconnected' sub-window.

   1.2. From the menu bar select Options > Setup (see **Figure 3** below). The 'ET Setup' window will be displayed.

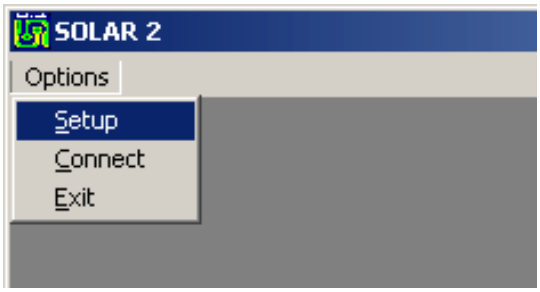

Figure 3. Options Menu.

2. On the ET Setup window (see **Figure 4** below), in the 'Communications Parameters' area, carry out the following:

   2.1. Using the drop-down list, select the 'Direct' Method.

   2.2. Using the drop-down list, select the COM Port required.

Note.

Only valid com port numbers will be available.

   2.3. Select 'Close'.

3. On the ET window, from the menu bar, select Options > Connect to return to the original opening view.

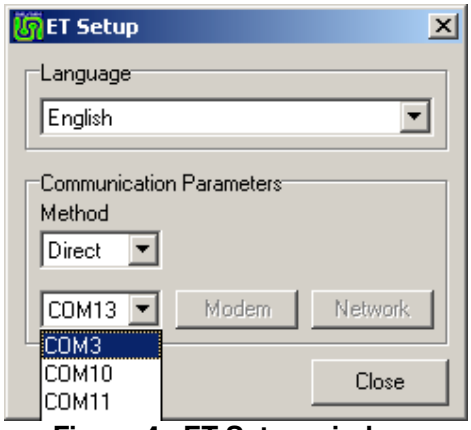

Figure 4. ET Setup window.

1.3.3 Making the Connection

With the PC physically connected to the unit, select 'Connect' to establish the data connection between the ET application and the equipment. The ET will firstly initialise the COM port and then attempt to connect to the Solar unit, each stage being clearly notified. If the main window display does not appear and the connection attempt times out after a short period of time, check that the cable connections are secure and confirm that it is connected to the correct COM port on the PC.

If the ET COM port setting needs to be changed either as a result of a connection failure or the warning message 'COM port error' has been reported, follow the information above to change the ET COM port settings.

1.4 CLOSING THE ET

1.4.1 Disconnecting the ET

To exit the ET, the first task is to "disconnect" the application from equipment; this is a soft (data) disconnection and not a physical disconnection. The disconnection may be initiated by either selecting 'Disconnect' on the Options menu or clicking on the ☒ (Close) icon on the main window. Both actions will cause a 'Connected' sub-window to appear in the middle of the main window where confirmation that a disconnect is required (see **Figure 5**).

Figure 5. Connected sub-window.

On selecting the 'Disconnect' button, the application will terminate the data exchange with the equipment, the PC Com Port will be released and the window view will return to that which was seen when the ET was first run showing the 'Disconnected' sub-window (see **Figure 6**).

Figure 6. Disconnected sub-window.

1.4.2 Exiting the ET

To shut down the ET application completely close the 'Disconnected' sub-window with the ☒ (Close) icon then either select 'Exit' from the Options menu or click on the ☒ (Close) icon on the ET main window which will now be blank. The ET application will then be terminated.

1.4.3 Accidental Disconnection

If the PC is physically disconnected from the equipment in error by unplugging the serial connector while the ET is running, the ET will try to re-establish contact with the equipment for approximately 3 seconds. If the connection is restored within that time, the ET will continue as normal. If the disconnection period exceeds that time, the ET will automatically invoke the disconnection process. The 'Disconnected' sub-window will appear briefly stating 'No response' before returning to the disconnected state.

1.5 RETAINING SOLAR SETTINGS

All of the NI parameter values and settings are held locally in the NI non-volatile memory as well as being stored centrally in the TM. The only exception to this is the IP address which is only stored within the NI itself and cannot be accessed remotely. Changes made to any NI "Engineering" setting are automatically saved to both the NI and the TM irrespective of where the change is initiated.

1.5.1 Engineering Mode

Before any engineering changes may be attempted, it is necessary to deliberately select the 'Eng' button, furthermore, any change will not be invoked until the 'Apply' button is pressed. Multiple changes may be made and implemented together with a single 'Apply' action. Failure to apply a change will result in the attempted change being abandoned and settings will revert to their previous state when the corresponding 'Eng' button is released.

1.5.2 Releasing the Engineering Button

It should be noted that failing to release the 'Eng' button on either the NI or the TM ET will result in any incomplete changes (those not applied) being held in the ET memory, therefore, subsequently applying another change even on a different page will automatically invoke incomplete changes as well. This is also true if a "new" NI has now got the focus of the ET. The "old" settings, still held in memory from previous actions, will be passed to this 'new' unit when the 'Apply' button is selected. This may result in unwanted changes occurring giving the impression that settings have changed on their own. This feature is not a bug but is intended to provide a means of being able to replicate the settings across many units in a quick and simple manner.

Unless using this feature to program multiple units or make multiple changes to a single unit, it is advisable to apply changes as they are made and release the 'Eng' button before moving off the page.

1.5.3 Confirming a Change

When a change is made to the NI either through the ET connected directly to the NI or remotely through the TM ET, the action is not complete until confirmation of the change is received back at the originator. Until the change is confirmed the state is considered to be pending.

A pending change will normally be completed in a few seconds and the interim button state will not be very evident for long. However, if a NI is not in communication with the TM, the pending state will last indefinitely until either communication is re-established or the change is abandoned.

This process is evident by interim colour changes of a button, slider (marker) or text in the following way:

- Button state – IN or OUT – may show a false indication if 'Apply' is pending.
- Colour inside the button shows current state – **Yellow** = Enabled or ON and **Grey** = Disabled or OFF.
- Colour outline shows change progress – **Blue** = pending and **Black** = done.
- Slider marker shows change progress – **Blue** = pending and **Grey** = done; (completion will also be indicated by the marker moving to be level with the slider control).
- Text colour shows change progress – **Blue** = pending and **Black** = done.

In **Figure 7** overleaf, the 'Env O/P' controls show that:

- Outputs 1 and 2 are OFF and no change is pending.
- Outputs 3 and 4 are ON and no change is pending.
- Outputs 6 and 7 have been switched from ON to OFF but the change is pending; i.e. not yet complete.
- Outputs 7 and 8 have been switched from OFF to ON but the change is pending; i.e. not yet complete.

Figure 7. Button options.

2 NETWORK INTERFACE ET

The screen displays for the NI in this section are those that will be seen when directly connected to the NI using the front panel USB connection. When accessing an NI remotely through the TM, the view remains largely the same but only a single 'Eng' function is available (see **Section 3.5 – Remote View of an NI**).

2.1 INTRODUCTION

The initial main window view of an unconfigured and unconnected NI is shown below in **Figure 8**.

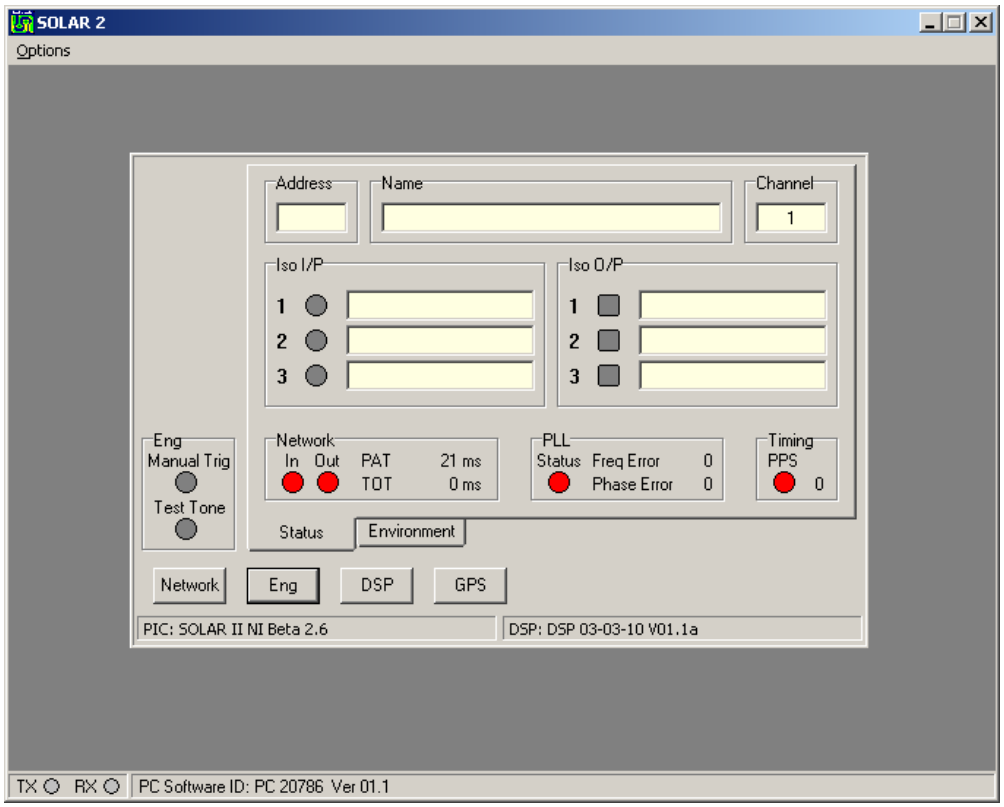

Figure 8. An Unconfigured NI.

Once a basic configuration has been established and the timing and network connections are made, the main window view will change according to the role assigned to the NI by the TM. This is reflected in the left hand column or panel where items and facilities related to use are displayed (see **Figures 9(a) and 9(b)** overleaf). All of the sub-facilities buttons along the bottom of the window lead to the same features regardless of the NI mode of operation.

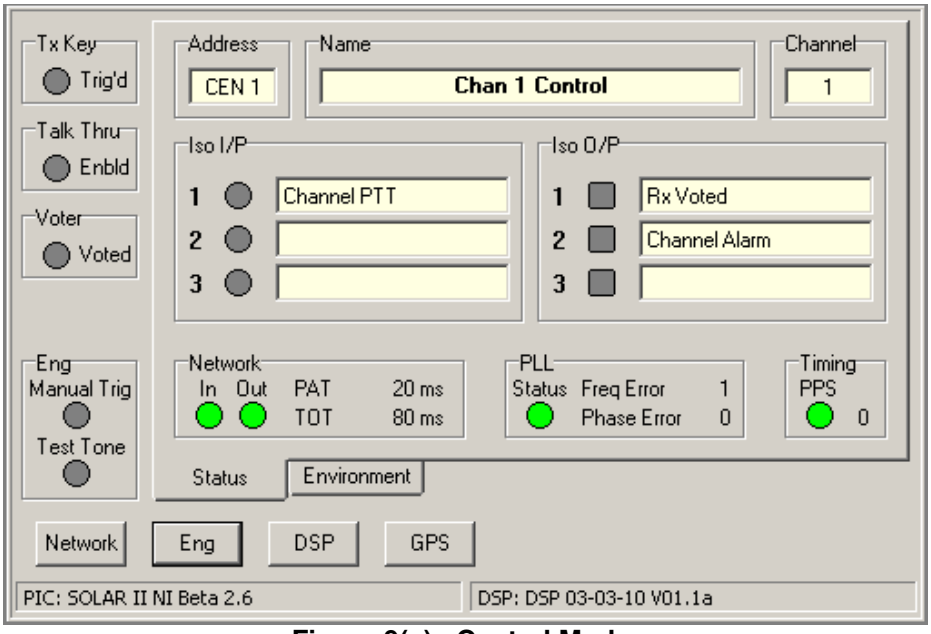

Figure 9(a). Central Mode.

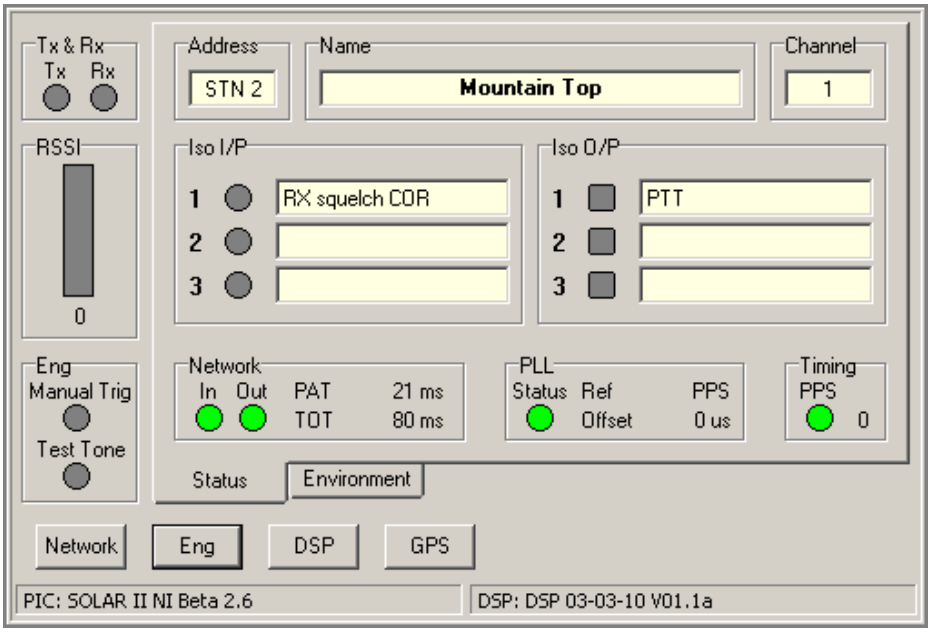

Figure 9(b). Station Mode.

The following sections will outline the meaning of the indications on the NI ET main window. The purpose of the buttons will be described here but their full usage is covered under other sections.

2.2 NI MODE PANEL

All indications shown in the figures overleaf are shown in an inactive state. A Central NI is shown in **Figure 10a** and a Station NI is shown in **Figure 10b**.

The action of changing the IP address of the NI will cause the unit to return to an unconfigured state clearing the NI Mode Panel of detail (see **Figure 8**). Once communications are re-established with the TM, the NI Mode Panel details will re-appear and show the information relating to the role of the NI within the Solar network.

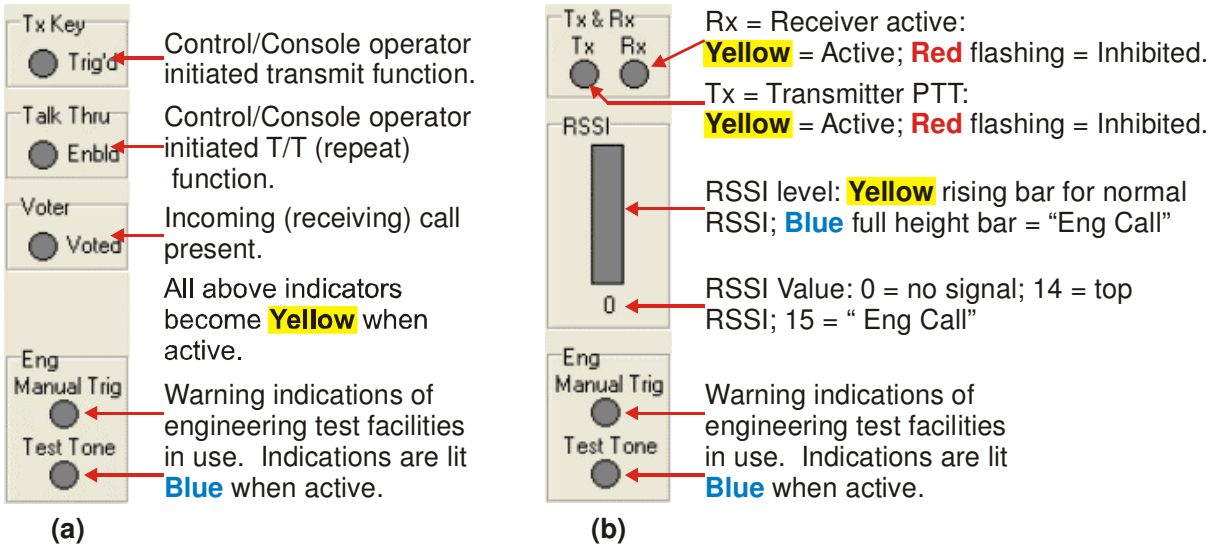

Figure 10. NI Mode Panel views.

2.2.1 Eng Area

2.2.1.1 Manual Trig

This warning indicator is lit **Blue** when the 'Manual Trigger' facility is invoked as this will interfere with normal operation – see **Section 5.2.2.3 – Manual Trigger**.

2.2.1.2 Test Tone

Activating the engineering Test Tone (see **Section 5.2.3.3 – Test Tone**) will cause the 'Test Tone' indicator to be lit **Blue**. This serves as a warning that the NI has been placed in a mode that will interfere with normal operation.

2.3 NI STATUS PAGE – UPPER AREA

The default or opening view of the NI is to display the 'Status' page as shown in **Figure 9**. If this page is not displayed, clicking on the 'Status' tab will open the page.

The NI Status page can be divided into the "Upper Area" (see **Figure 11** below) and the "Lower Area". The upper area comprises of the 'Address', 'Name', 'Channel', 'Iso I/P' and 'Iso O/P' fields/parameters. The lower area comprises of 'Network', 'PLL' and 'Timing' fields/parameters.

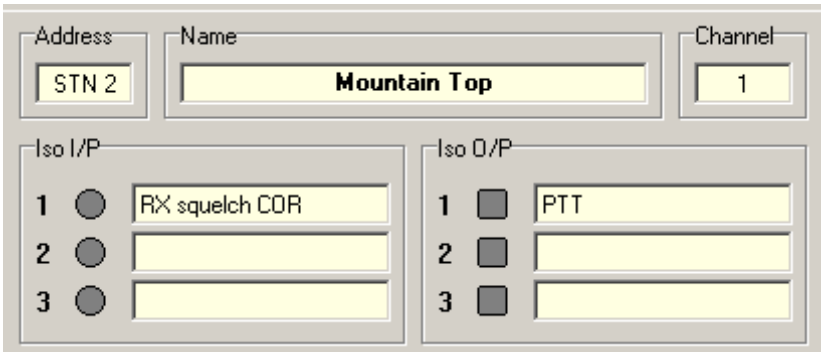

Figure 11. NI Status Page – Upper Area.

Each area and their fields/parameters are now described.

2.3.1 Address

This indicates the role of the NI in the context of the Solar network. It is not manually entered as it is derived automatically when the NI is allocated to a role by the TM during the TM configuration process.

The prefix 'CEN' indicates that the mode is "Central" and the prefix 'STN' indicates the mode is "Station". The suffix indicates the operating number that this unit has been assigned; for Central the number is in the range of 1 to 16, for Stations 1 to 32.

2.3.2 Name

This is a user defined text label to aid identification of the NI. The name will be displayed in some of the TM ET windows to assist the user by confirming that the NI being viewed or altered is the correct one. The process to enter text for the name is detailed in **Section 5.2.3.1 – Name**.

2.3.3 Channel

This shows the current channel assignment of the NI in the multi-channel versions of TM. For single channel versions this will always be 1.

2.3.4 Iso I/P and Iso O/P

The application of an input condition to an 'Iso I/P' (Isolated Input) or activation of an 'Iso O/P' (Isolated Output) will be shown by the associated indicator being lit **Yellow**. Each input and output can be named by the user to aid identification of the role assigned to each function.

For further information on the setup options for these inputs and outputs, see **Section 5.2.2.4 – Isolated Inputs and Section 5.2.2.5 – Isolated Outputs** respectively. Any Isolated I/P may be assigned to "Alarm" status – see **Section 12 – Alarms**.

2.4 NI STATUS PAGE – LOWER AREA

The information in the Network and PLL areas rotate to show the full set of details; the Network area taking two rotations and the PLL area three rotations as shown below in **Figure 12**.

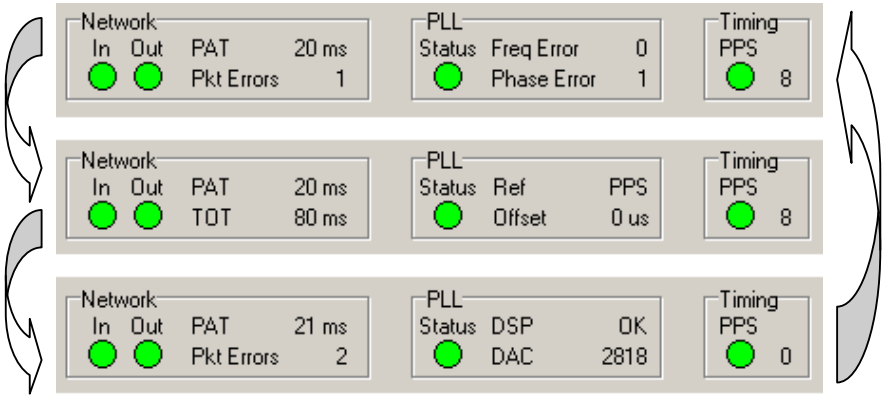

Figure 12. NI Status Page – Lower Area.

2.4.1 Network

2.4.1.1 In/Out

The 'Network' 'In/Out' indications are designed to show if data flow fails in either direction, with the indications turning **Red** if data flow is lost. However, the way in which IP networks operate mean that one way data flow is an unlikely condition. Clearly, the NI will be aware when the incoming data fails, however, knowledge that packets are being received by the TM is made evident to the NI by information in the packets sent from the TM.

Moving the mouse pointer over the 'In' indicator will show information about packet errors – see **Section 2.4.1.4** below.

A network failure may be assigned to 'Alarm' status – see **Section 12 – Alarms**. There will be a delay of several seconds between the moment of network failure and the failed indication appearing, in order to prevent short drop-outs from raising the alarm.

2.4.1.2 PAT

The Packet Arrival Time ('PAT') is the time, in milliseconds, taken for packet zero to arrive at the NI. The value is rounded up to the nearest millisecond and is used as an indication of network transit time. It is updated every second and is also presented on the 'Sync Timing' screen of the TM ET (see **Section 5.3.1 – Sync Timing**).

This value should largely remain static unless a network re-route is experienced. A figure that is not stable may indicate a network problem as long as the NI is receiving a valid timing signal. If the 'PLL' is indicating a frequency error, the PAT report cannot be trusted.

2.4.1.3 TOT

This is the setting of the Total Output Time (TOT) as configured in the TM. See **Section 7 – Solar (Sync) Timing** for detailed information.

2.4.1.4 Pkt Errors

This is an incrementing count updated in real time that shows the number of packets that arrive too late for processing at the NI (this includes any that do not arrive at all). The value shown is that which has occurred since the ET was first connected and this may be set to zero by clicking on the count value.

A total count of packet errors is maintained in the NI itself and this value, together with the ET value of packet errors, will be displayed in a "hints window" for a short time if the mouse pointer is positioned over the Network 'In' indicator. The NI total count value will be reset by a power off/on cycle of the NI.

In both cases, the values will roll back to zero after reaching 65,535. A count that is gradually incrementing indicates that the packets are either being lost or, more likely, arriving close to the limit of the buffer/time settings, with some simply falling past the boundary.

2.4.2 PLL

2.4.2.1 Status and Freq Error/Phase Error

The 'PLL' is the report on the accuracy of the internal clock, which is locked to the 1PPS timing signal in order to synchronise the audio. At power-up, this indication will be **Red** and the 'Freq Error' and 'Phase Error' counts will be zero. Once the PPS timing signal is present, a 'Freq Error' will be shown and this will be brought down to zero over a period of several seconds. This will be followed by a 'Phase Error' count being shown, which again will gradually be brought down towards zero, although this action could take a minute or even longer to achieve. Once the 'Freq Error' count is less than 4 and the 'Phase Error' count is less than 30, the 'Status' indication will turn **Green**.

A large PLL error will be manifest as a wideband phase error on the audio output, however, being a very fine indication, the resultant effect on the audio is such that a 'Phase Error' value as high as 50 is most unlikely to be evident in a signal overlap area. A PLL phase error has no discernable effect for a NI operating in Central mode.

Losing the 1PPS timing signal will cause the frequency and phase error reports to show zero. On resumption of the timing signal and, depending upon the period of time that the timing signal was lost, a 'Freq Error' may be seen, however, a 'Phase Error' is the most likely result together with the 'Status' indication being lit **Red**. Errors will be corrected as described above. If the 1PPS timing signal is lost for a long period, control of the PLL may be taken on by the Traffic Manager – see **Section 2.4.5.2 – Ref**.

A PLL 'Status' failure may be assigned to "Alarm" status – see **Section 12 – Alarms**.

2.4.2.2 Ref

The clock reference for the PLL is normally the 1PPS timing signal as indicated by the text report 'PPS'. Loss of the timing signal will result in a slow drift of the clock and, over an extended period of time, will result in the timing being too inaccurate and packets will be lost, which will ultimately cause the NI to cease operating.

In order to mitigate this situation, the TM can assume control of the PLL and adjust the PLL so that the packet arrival times are maintained. When operating in this mode, the report will show 'TM (+x)' where "***x***" is a number used by the internal process of frame alignment (normally zero unless the power has been interrupted). The 'Freq Error' and 'Phase Error' counts will remain at zero whilst the PLL is being controlled by the TM.

2.4.2.3 Offset

This is the report of the 'Offset delay' that may be applied to each Station NI – see **Section 5.2.1.7 Offset Delay**. Delay offset has no effective meaning or use on a NI operating in Central mode.

2.4.2.4 DSP

This report confirms that the DSP is operating correctly. If a problem occurs the report will show 'Error' and the text in the PLL area will no longer rotate.

2.4.2.5 DAC

This is the reading of the internal control of the PLL. The reading will vary during normal operation.

2.4.3 Timing – PPS

A **Green** PPS indication shows that the selected source of 1PPS timing signal (see **Section 5.2.3.2 – GPS Module**) is present; a **Red** indication shows no input. If the timing signal source is a GPS receiver with NMEA data output, the number shown alongside the indicator is the number of satellites (Space Vehicles) being used to acquire a fix or the number in use once the fix has been obtained. Loss of timing signal input may be assigned to "Alarm" status – see **Section 12 – Alarms**.

2.5 ENVIRONMENT I/O INTERFACE

The 'Environment I/O' interface is an independent sub-module within the Solar 2 unit. It is accessible from and available to any of the main modules that are fitted to the unit. Although the description of the operation of the I/O is presented here under the NI ET it is just the same for the TM ET if the TM module is installed in the unit. Consequently, any action or setting applied through one module is visible to and open to change through another module.

2.5.1 Environment Status

The status of each of the sixteen connection points that comprise the 'Environment I/O' are displayed on the Environment page shown in **Figure 13** overleaf. To open this page, select the 'Environment' tab.

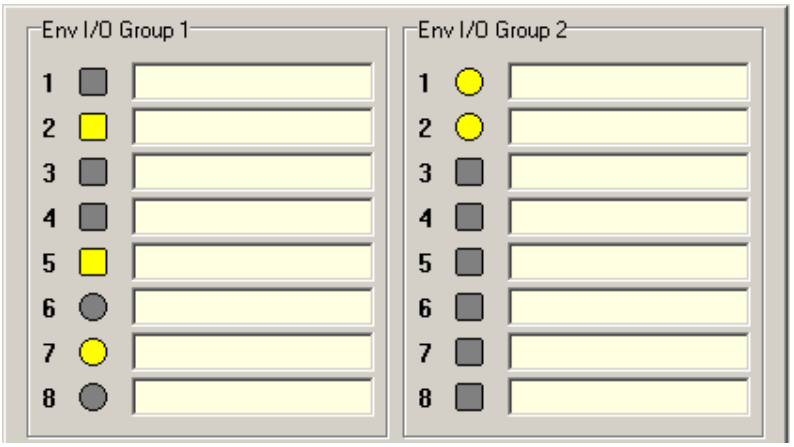

Figure 13. Environment I/O.

2.5.2 Indicators

Each connection point is able to operate as an input or an output, which is defined by the configuration mode for each connection (see **Section 5.2.4 – Environment**). Inputs are denoted by a circular indicator and outputs by a square indicator. An active input or output is shown by the corresponding indicator being lit **Yellow** as seen in **Figure 13** above. Each connection has provision for a user entered text label alongside the indicator (see **Section 5.2.4.1 – Status**).

2.6 NI Button Area

An overview of the functions of each button on the NI ET main page is provided in the sections below. Full details of the operation of each will be covered under **Section 5 Solar Commissioning.**

Figure 14. NI ET Buttons.

2.6.1 Network

The 'Network' button opens the window where the IP address of the NI is entered – see **Section 4.2 – Setting the NI IP Address** for full details. This facility is only available to the NI ET.

2.6.2 Eng (Engineering)

Selecting the 'Eng' button opens a new window that has four pages of information: 'Main Audio', 'Signalling', 'Facilities' and 'Environment'. Each page is accessed by selecting the corresponding tab – see **Section 5.2 – NI Engineering** for details of each. The results are identical to those obtained on the TM ET view of the NI.

2.6.3 DSP

The 'DSP' button is used if new firmware is to be loaded into the DSP – see **Section 11.2.5 – NI DSP Firmware Up-issue** for full details. This facility is only available to the NI ET.

2.6.4 GPS

If the 1PPS timing signal is being supplied from a GPS receiver that also has NMEA data output; e.g. Dalman 60742, the 'GPS' button opens a window where information about the satellites and the received signal levels is displayed. If no NMEA data is available then the window will be devoid of information.

As the TM also needs a timing signal, the identical facility is available to the TM ET (although not for a remote view of the NI). Therefore, details of the GPS window and the indicators for both ETs are given in **Section 9.1 – GPS**.

3 TRAFFIC MANAGER ET

3.1 INTRODUCTION

The main operating entry level window to the Solar TM ET application software is shown below in **Figure 15**. It provides a reflection of the Solar network status. The Station NI panels will be blank until assigned an IP address of the respective NI and enabled whereupon additional indicators and a control become visible.

3.2 MAIN WINDOW

The main window divides into two areas:

- The upper area is fixed and shows the status of all the Station NI.
- The lower area varies according to the selection made.

The example in **Figure 22** below shows a TM that has only been setup for a single station. The number of channel ('Chn:') tabs is likely to be different to this example.

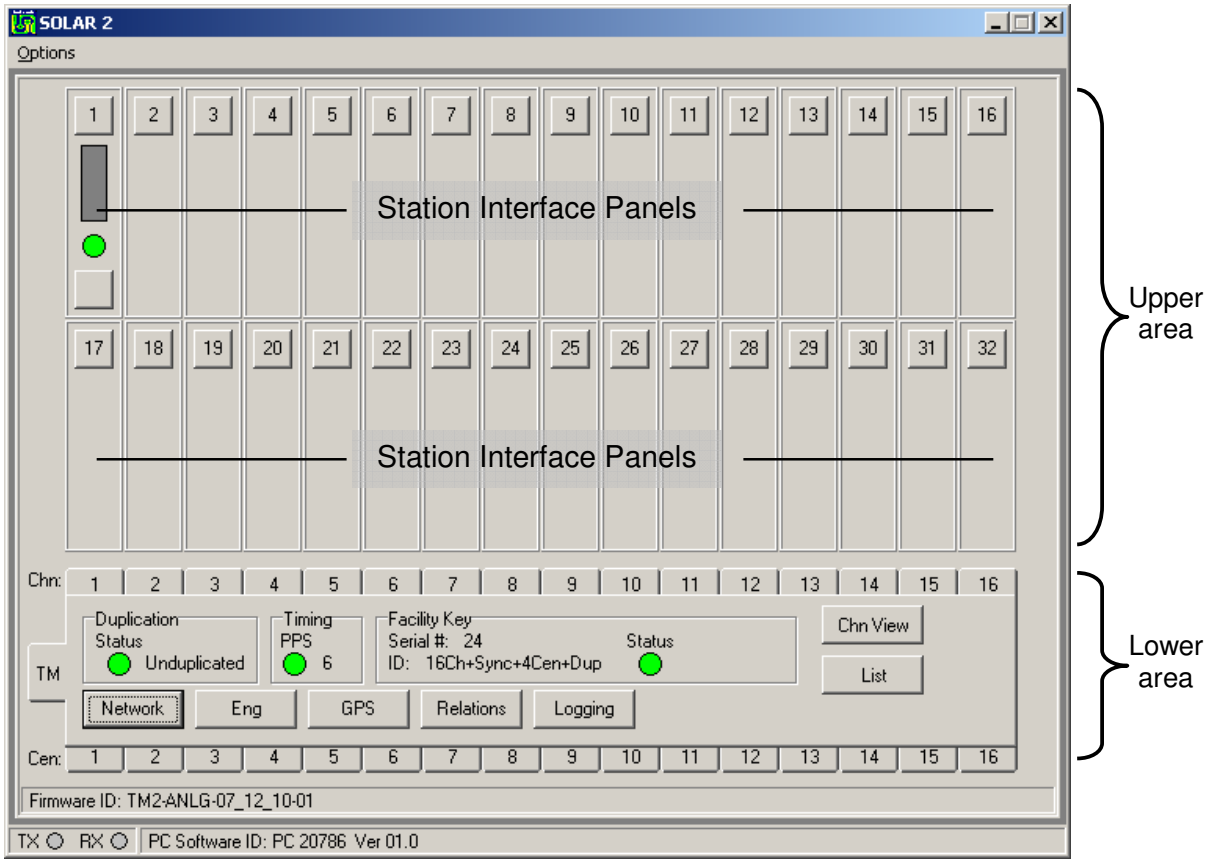

Figure 15. TM Main window.

In **Figure 15**, the Upper Area shows the status of all Stations for all channels through "Station Interface Panels". The details in the Lower Area will change to reflect the status of the item selected.

The following sub-sections and paragraphs outline the meaning of the indications on the main window and panel areas. Separate sections in this manual deal with the actions and subsequent pages associated with the buttons.

3.3 UPPER AREA

3.3.1 Station NI Panels

As a minimum, each panel in the upper area of the TM ET will have a numbered button displayed. This button is the route to the IP address assignment facility as shown in **Section 4.4.3 – Allocating a Station NI**. A second button, a bar and a round coloured indicator will appear once the panel has been allocated to an NI, i.e. given the IP address of an NI and "Enabled" (see **Figure 16** below).

The panel border highlight is designed to show extra detail about the Station NI and will not appear until the panel has been allocated.

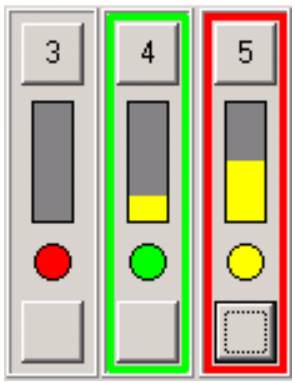

Figure 16. Station NI panels.

The functions of each indicator are as follows:

- Vertical Bar:
  - RSSI level, indicated by the height of the **Yellow** bar.
  - Voter override, indicated by a **Blue** bar (see **Section 5.4.2.2 – Voter Override**).
- Round Status indicator:
  - **Green** – Normal condition during no signal/idle period.
  - **Yellow** – Site selected by "voter".
  - **Red** steady – No network comms.
  - **Red** flashing – NI inhibit invoked or no timing signal input.
- The panel border highlight colours:
  - No highlight – this station is not in the currently selected channel.
  - **Green** – this station is a member of the selected channel.
  - **Red** flashing – an alarm is present or has not been acknowledged.
  - **Yellow** flashing – an alarm is present and has been acknowledged.
- Bottom button (no legend):
  - Access to the remote view of a Station NI for engineering purposes.

3.4 LOWER AREA

3.4.1 TM Status Panel

The TM Status panel is selected by selecting the 'TM' tab (indicated in **Figure 17** below). The example shown below in **Figure 17** is of a TM with the maximum number of channels enabled; a typical TM configuration is likely to have many fewer channels. When used with a Solar 2 P25 system, a maximum of four channels can be enabled (see **Figure 18**).

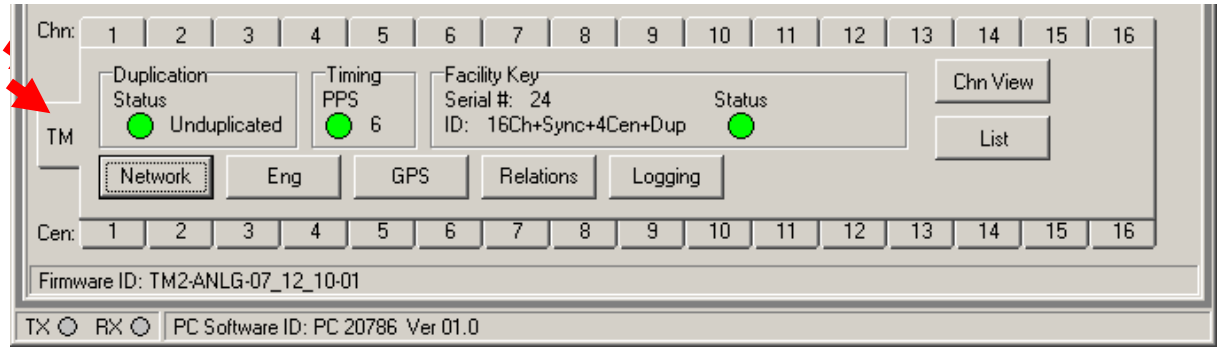

Figure 17. TM Status Panel.

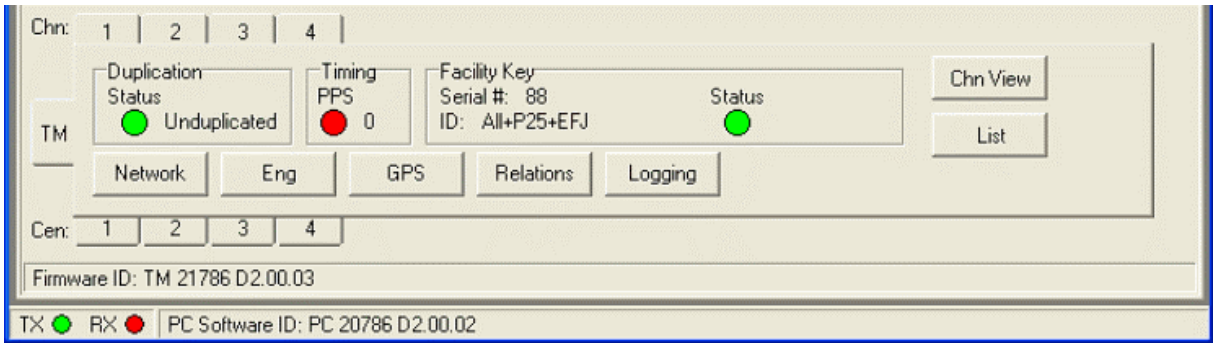

Figure 18. TM Status Panel for P25 system.

The status indications presented on this panel and the configurable settings accessed through the buttons on this panel are global for the TM, i.e. they are common to all Channels and all NI. Summary details of each item in this panel are provided in the following sections although the user may be directed to other sections in this manual for more comprehensive information.

3.4.1.1 Duplication

A normal operating state is indicated by a **Green** status indicator, an abnormal state by a **Red** indicator. See **Section 8.2.4 – Duplication Status** for full details.

3.4.1.2 Timing

A normal operating state is indicated by a **Green** status indicator, an abnormal state by a **Red** indicator. If the timing signal source is a GPS receiver with NMEA data output, the number shown alongside the indicator is the number of satellites (Space Vehicles) being used to acquire a fix or the number in use once the fix has been acquired.

Whilst the TM is designed to operate with a global timing signal, it is able to continue operation without it, since the TM clock timing is not critical to delivering synchronised audio. Under this situation, the TM will adjust its clock to maintain consistent PAT timing reports from NIs that have the global timing signal. This is indicated by the text 'NI' replacing that of the 'SV' number alongside the indicator which will remain lit **Red**.

Loss of the timing signal may be assigned to "Alarm" status – see **Section 12 – Alarms**.

3.4.1.3 Facility Key

A normal operating state is indicated by the status indicator being lit **Green**, an abnormal state by a status indicator being lit **Red**. See **Section 9.2 – Facility Key** for full details.

3.4.1.4 Network

See **Section 4.3 – Setting the TM IP Address** for full details.

3.4.1.5 Eng

See **Section 5.3 – TM Engineering** for full details.

3.4.1.6 GPS

See **Section 9.1 – GPS** for full details.

3.4.1.7 Relations

See **Section 6 – Solar Channels (Relations)** for full details.

3.4.1.8 Logging

See **Section 13 – TM Logging** for full details.

3.4.1.9 List

The 'List' feature is an aid for the user as opposed to a commissioning tool. It presents the user with a window giving a list of 'System Names', i.e. those given to every NI and channel on the TM. Whist this is available as a discrete function from the 'List' button, it is most useful when the 'Relations' function is used and can be accessed directly from that page. It is therefore described in greater detail in **Section 6 – Solar Channels (Relations)**.

3.4.1.10 Chan View

See **Section 6.3 – Channel View Facility** for full details.

3.4.2 Channel Status Panel

To select the status window for Channel #N (where N is the number of the required channel), click 'Chn:' N tab (indicated in **Figure 19** below). The tab will gain a **Green** highlight when selected as does the Station Interface panels of all member sites of this Channel (see **Section 3.3.1 – Station NI Panels**). If a Central NI has been assigned to operate this Channel, the tab for that unit will also gain the **Green** highlight. The example in **Figure 19** shows Channel #1 selected, which is operated by Central NI #1.

Functions and facilities accessed using the 'Setup' button are covered in **Section 5.4 – Channel Setup**.

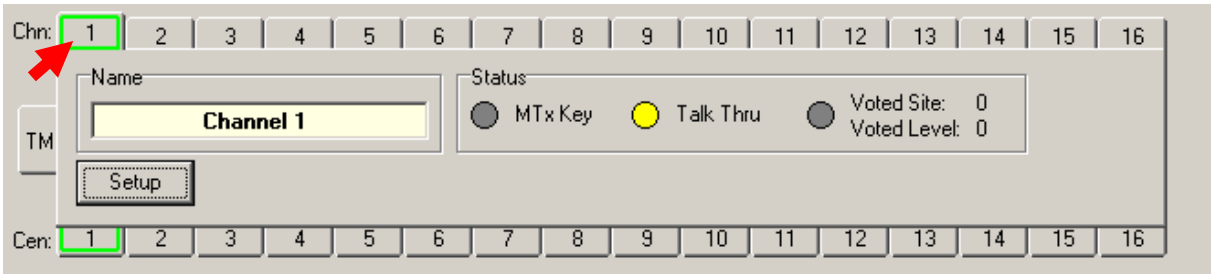

Figure 19. Channel #1 Status Panel.

3.4.2.1 Name

A simple text label that can be entered by the user through 'Setup' to identify one channel from another (see **Section 5.4.1 – Name**).

3.4.2.2 Status

(a). '**MTx Key**' – lit **Yellow** when the channel is keyed either by a control PTT from a Central NI or as a result of a voted signal being present while T/T is on.

(b). '**Talk Thru**' – lit **Yellow** when the channel has T/T switched on either by an input signal to a Central NI or a setting of the TM Setup.

(c). '**Voted Site**' – the number of the site currently selected as offering the best incoming signal is displayed. The number is that of the station panel for that site.

(d). '**Voted Level**' – the Solar RSSI level that is being presented by the site currently selected.

3.4.3 Central NI Status Panel

The status window for Central NI #N (where N is the number of the NI) is selected by clicking on the 'Cen:' N tab (highlighted in **Figure 20** below).

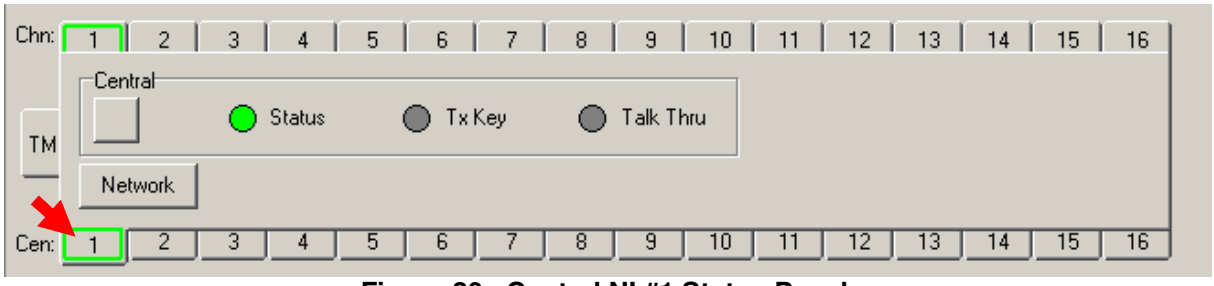

Figure 20. Central NI #1 Status Panel.

The Central NI Status Panel tab gains a **Green** highlight when selected as does the Channel 'Chn:' #N tab to which the Central NI has been assigned. All the Station Interface Panels that are members of the Channel will also gain the **Green** highlight. The example in **Figure 20** shows Central NI #1 selected, which operates Channel #1.

The facility accessed using the Network button is covered in **Section 4.4.4 – Allocating a Central NI**. The button (no legend) in the 'Central' area provides access to the remote view of the Central NI for engineering purposes.

3.4.3.1 Central Indicators

(a). '**Status**' – lit **Green** when network communications with the Central NI is established and **Red** if it fails. This may be assigned 'Alarm' status – see **Section 12 – Alarms**.

(b). '**Tx Key**' – lit **Yellow** when the Central NI has a PTT applied from a control or console input.

(c). '**Talk Thru**' – lit **Yellow** when the Central NI has the T/T input signal applied. The indicator and text will be disabled (greyed out) if the Central NI is not configured for control of T/T – see **Figure 28** as an example and **Section 5.2.2.4 – Isolated Inputs** for details on configuring Isolated Inputs.

3.5 REMOTE VIEW OF A NI

The facility to remotely examine the status and adjust the engineering settings of a NI from a connection to the TM is enormously beneficial especially if the host network permits this to be achieved from anywhere on the network. The view of any NI when accessed in this way is essentially the same as for a local NI ET connection, the main difference being the number and designation of the buttons across the lower area.

There are two examples of a NI accessed through the TM ET shown overleaf in **Figure 21**; a Central NI on the top and a Station NI on the bottom (again the outer frame of the ET screen has been removed for clarity).

The TM ET only shows the 'Eng', 'Alarms' and 'Close' buttons. With the exception of "Alarm" related items which are only available to the TM ET as alarm functions, the 'NI Engineering' facilities accessed through the 'Eng' button are identical to that of a locally connected NI ET – refer to those sections in the handbook as necessary. The 'Close' button closes the view of the NI as does the standard Windows™ close icon ☒ in the top right corner.

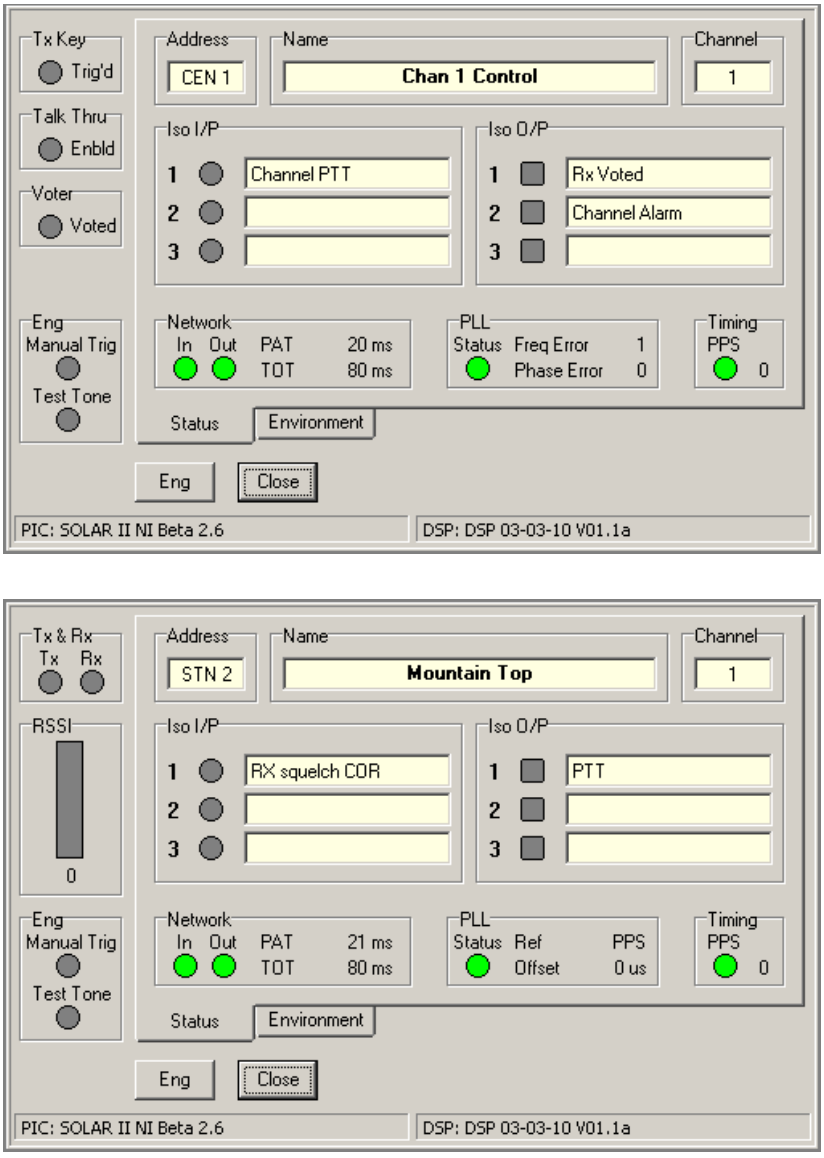

Figure 21. Views of NI with a TM ET.

4 SOLAR CONFIGURATION

4.1 IP ADDRESSES

For efficient and effective user interaction with the ET, it is essential that the user has knowledge of the topography of the system.

Before anything else can happen the IP addresses of the equipment must be assigned and set. The assigned IP address for an individual unit on any monolithic network must be unique, i.e. there must not be more than one equipment unit with a given IP address. This rule covers all equipment units on the network and there may be units that have no relationship with the Solar equipment. Generally, the IP addresses will be assigned by a network administrator – possibly in agreement with the Solar commissioning technician. A pre-defined plan of IP addresses is likely to make the task more straightforward and reduce the possibility of errors.

For an overview discussion about IP addresses, Subnet masks, Primary and Secondary gateways see the paper published on the Team Simoco web site http://www.teamsimoco.com/downloads.

4.2 SETTING THE NI IP ADDRESS (NI ET ONLY)

Connect the NI ET to an NI whereupon the ET main window will show as one of three variants: unconfigured (**Figure 8**); Station mode; or Central mode (**Figure 9**). It is not necessary for the NI to be connected to the network at this stage.

In the example shown below in **Figure 22**, the blank 'Address' window and the blank panel on the left indicate that this NI has not been in communication with a TM. Even if these are not blank, the action of changing the IP address will cause that information to be cleared and will remain in that state until communications with a TM is established.

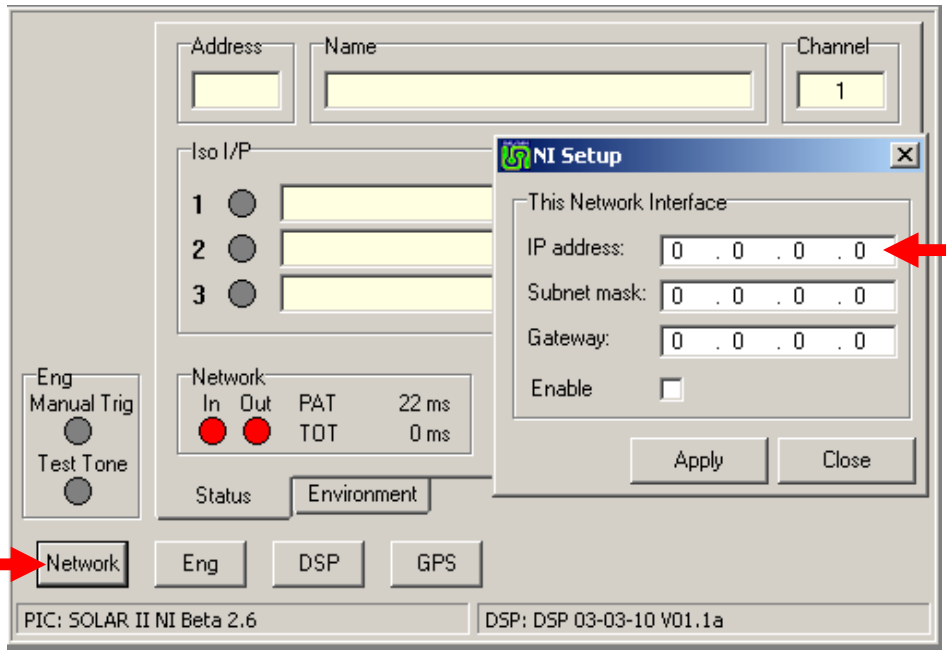

Figure 22. Setting the NI IP Address.

To set the IP address of an NI, proceed as follows:

1. On the NI window, select the 'Network' button (indicated) and the NI IP 'Setup' window will be displayed.

2. On the NI IP 'Setup' window, carry out the following:

2.1. Enter the IP address and subnet mask.

Note.

The subnet mask and gateway address are not required by a NI but this facility has been provided for possible future upgrades.

2.2. Check the 'Enable' box.

2.3. Select 'Apply' and then 'Close'.

3. Repeat Paras 1 to 2.3 above for every NI in the system.

It may prove helpful if the IP address is noted on the NI case to save having to reconnect the NI ET later just to find that detail (it is not visible to the TM ET).

4.3 SETTING THE TM IP ADDRESS (TM ET ONLY)

The next stage is to set the IP address of the TM and this requires that the TM ET is connected locally (front panel USB connection).

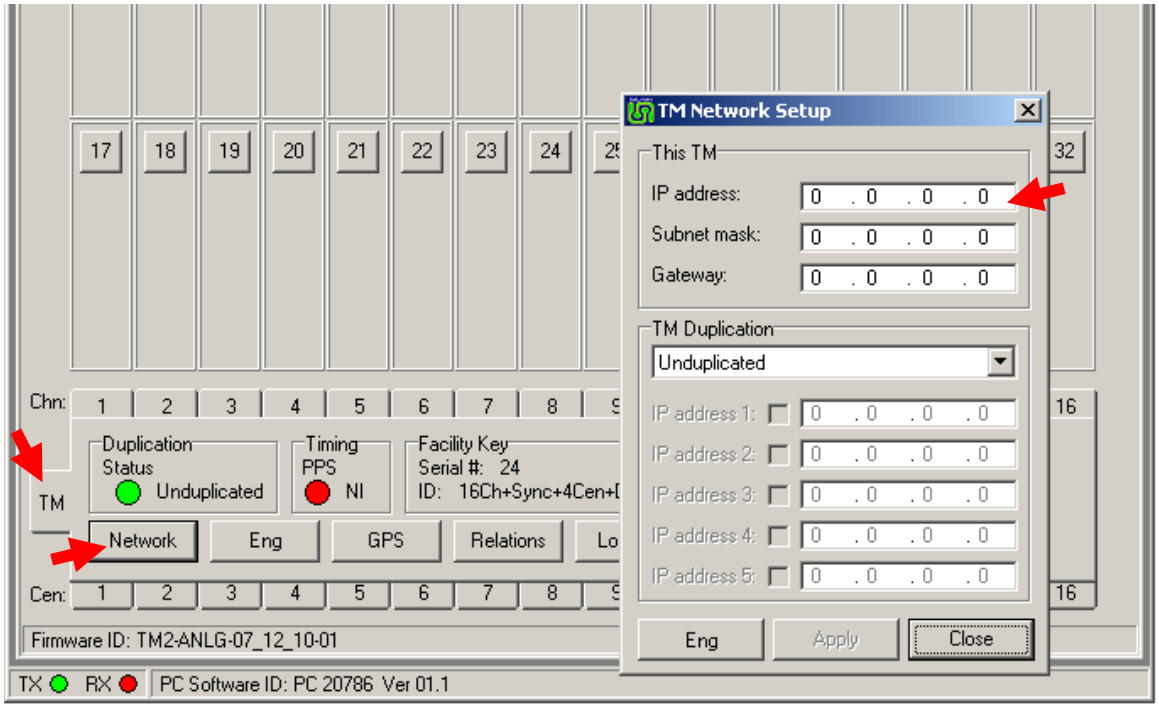

Figure 23. Setting the TM IP Address.

To set the IP address of a TM, proceed as follows:

1. On the TM ET window, select the 'TM' tab (indicated in **Figure 23**) to open the view of the TM status panel.

2. On the TM Status Panel, select the 'Network' button to open the 'TM Network Setup' page.

3. On the 'TM Network Setup' window, carry out the following:

3.1. Select the 'Eng' button and enter the 'IP address', 'Subnet mask' and 'Gateway' address.

3.2. From the drop-down list, set the 'Traffic Manager Duplication' option to 'Unduplicated'. (If the duplication option has not been purchased then 'Unduplicated' will be the only available item in the drop-down list).

Note.

Even if the final system configuration is to use the 'Traffic Manager Duplication' option, at this stage it should be set as "Unduplicated". This option can be changed later as detailed in Section 8 – TM Duplication.

3.3. Select 'Apply' then 'Close'.

4.3.1 Network Connected ET

Once the TM has been given an IP address, it is then possible to continue configuration of the TM using a network connected ET if this is more convenient.

Note.

A change to the PC IP address may be required in order to put it in the same subnet at the TM, as the TM does not allocate the address, i.e. it does not provide a Dynamic Host Configuration Protocol (DHCP) service.

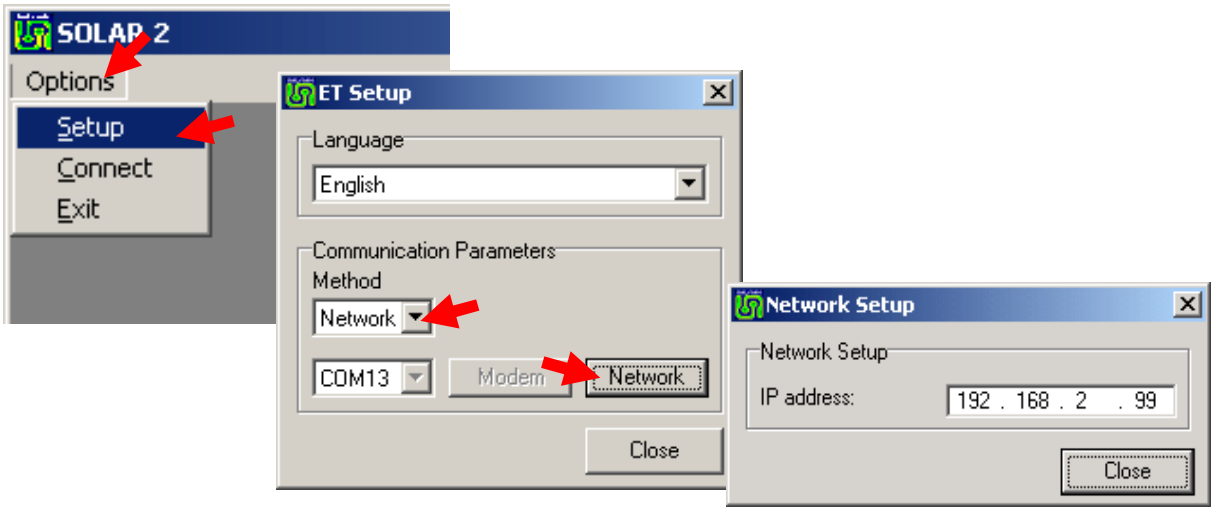

Figure 24. Changing to a Network Connected TM ET.

To change from a local ET to a network connection ET, proceed as follows:

1. Close the existing connection and the 'Disconnected' sub-window as per **Section 1.4.1**.
2. On the TM ET window, on the menu bar, select 'Options' > 'Setup'.
3. On the 'ET Setup' page, carry out the following:
   3.1. From the drop-down list, set the 'Method:' to 'Network'. The 'Network' button will now become active.
   3.2. Select the 'Network' button and the 'Network Setup' page will be displayed.
4. On the 'Network Setup' page, enter the 'IP address' of the TM and select 'Close'.
5. On the 'ET Setup' page, select 'Close'.
6. On the TM ET window, on the menu bar, select 'Options' > 'Connect'.

Configuration can now continue as for a local connection. However, it will not be possible to change any of the IP parameters of the TM itself whilst connected in this way but this information will be displayed when the TM 'Network' button is clicked.

4.4 TM ADDRESS INVENTORY

The next stage is to inform the TM of all the NIs that will operate within the Solar network. Therefore, the IP address of every NI must be known, if not actually programmed into the NI units although that is preferable.

4.4.1 TM Capacity

A Solar network can be populated by a maximum of 32 NIs operating in Station mode. Depending upon the configuration options purchased, the Solar P25 network may comprise of multiple channels up to a maximum of 4 and a maximum of 4 NIs operating in Central mode. One channel may support the maximum of 32 Station NIs and may be permitted to have more than one Central NI per channel (this is a factory configured option).

If the PMR system is only required to work in T/T (repeat) mode, a Central NI it is not necessary (there being no Console or Control Room). Every NI will be assigned a unique system 'Address': Central NIs will range from CEN1 to CEN4; and Stations from STN1 to STN32 – these numbers are crucial for the multi-channel option.

4.4.2 Allocating NI

It is important to understand that the action of entering the IP address for each and every NI into the TM's system address inventory defines the mode of operation of each NI unit within the system. Furthermore, the settings stored in the TM for the NI relate to the system address and not to the individual unit's IP address. It is the system address that is used to allocate stations and centrals to channels in the multi-channel version.

Whilst the same IP address should not be entered in more than one place in the system, this is not an illegal action. However, an attempt to 'Enable' a second use of the same IP address on the system will be rejected.

4.4.3 Allocating a Station NI

The upper area of the TM ET main window shows 32 blank station panels, which relate to the 32 possible Station NI (radio base stations) in the Solar network. These will show the status of each Station NI member as they are connected.

This process would logically start at #1 and increment in order, however, this is not mandatory, as any Station NI may be assigned to any station panel. For a multi-channel system, there is merit in arranging the stations in groups with unassigned panels between them, which makes the channel separation more obvious.

Figure 25 overleaf shows a NI being allocated to Station #1 (station panel #1).

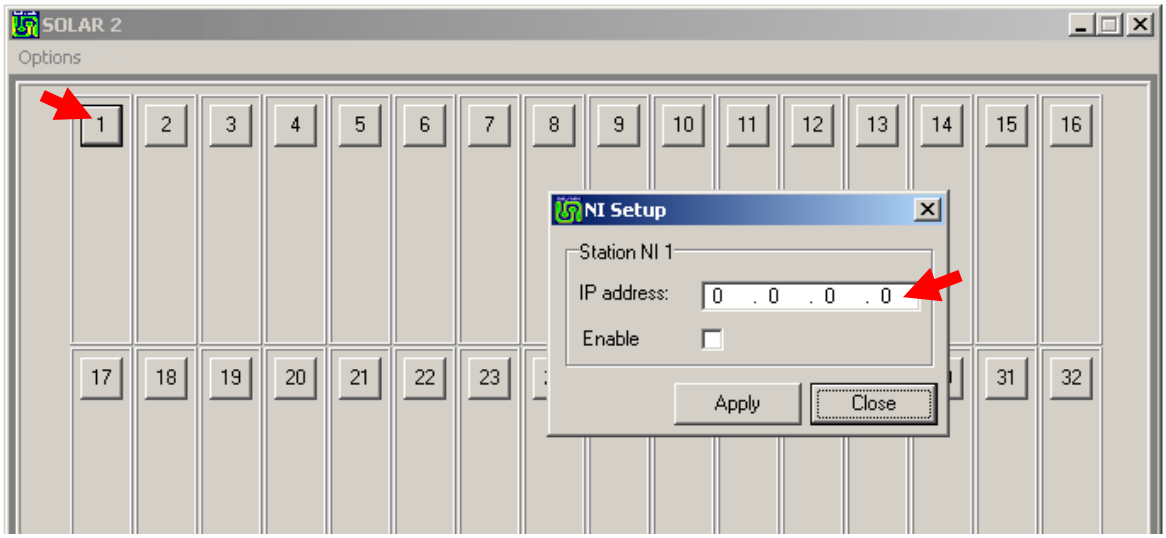

Figure 25. Allocating a Station NI.

The allocation process is as follows:

1. On the TM ET window, on the relevant station panel, click the “identity” button to gain access to the ‘NI Setup’ page.

2. On the ‘NI Setup’ page, carry out the following:

   2.1. Enter the ‘IP address’ of the NI that is to be used as the Station Interface for that number.

   2.2. Check the ‘Enable’ check box.

   2.3. Select ‘Apply’ > ‘Close’.

3. Repeat Paras 1 to 2.3 for each Station NI on the system.

If the NI is connected to the network, communication should be established immediately so that the NI adopts a Station mode of operation with the station panel number displayed as the system ‘Address’ on the NI main window. The station panels will also confirm communication is active by displaying a **Green** status indication at the bottom of the panel (see **Figure 26** below).

Figure 26. Station #1 allocated and operating.

Note.

If an IP address is entered that is the same as one already actively in use anywhere on the TM this will be cleared back to the previous setting when 'Apply' is clicked.

4.4.4 Allocating a Central NI

The process and rules for the allocation of a NI as a Central unit are much the same as for a Station.

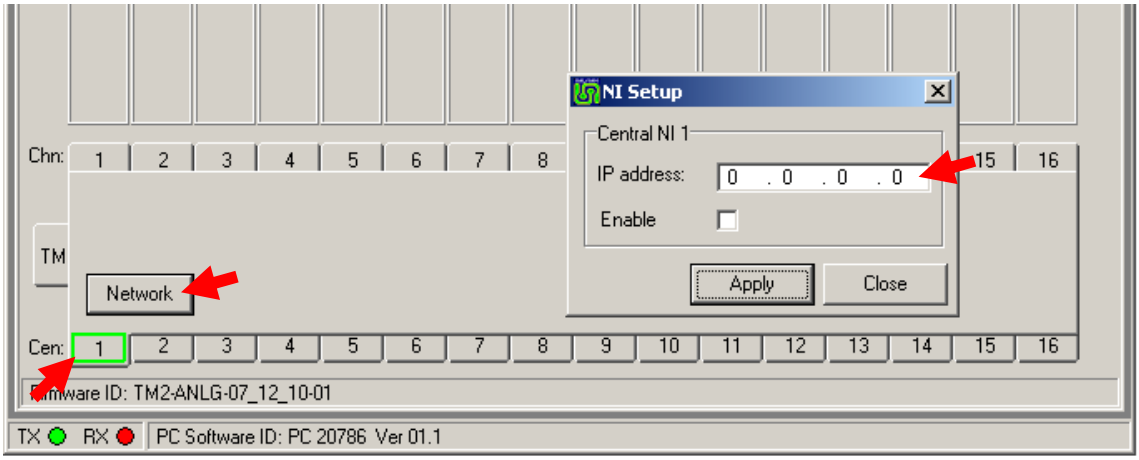

Figure 27. Allocating a Central NI.

The allocation process is as follows:

1. On the TM ET window, open the Central Interface status panel #N by clicking on 'Cen:' #N tab (indicated in **Figure 27**).

2. On the #N Central Interface status panel, select the 'Network' button to open the 'NI Setup' page.

3. On the 'NI Setup' page, carry out the following:

   3.1. Enter the 'IP address' of the NI that is to be used as the Central Interface for that number.

   3.2. Check the 'Enable' check box.

   3.3. Select 'Apply' > 'Close'.

4. Repeat Paras 1 to 3.3 for each Central NI on the system.

If the corresponding NI is connected to the network, communication should be established immediately so the NI will adopt a Central mode of operation and the system Address on the NI main window will show 'CEN #N'. The TM central status panel will also confirm communication is active by displaying a **Green** status indication (see **Figure 28** overleaf).

Note.

If an IP address is entered that is the same as one already actively in use anywhere on the TM this will be cleared back to the previous setting when 'Apply' is clicked.

Figure 28. Central #1 allocated and operating.

4.4.5 Channel Designation (Multi-channel TM Option)

At this stage, every Station NI will be assigned to operate on Channel 1 – this is the default setting. This does not affect the commissioning process, although it is likely that the task will be conducted on a channel by channel basis.

Therefore, the user may prefer to go directly to **Section 6 – Solar Channels (Relations)**, which details the procedures for assigning Station and Central NIs to channels, before proceeding to **Section 5 – Solar Commissioning**.

5 SOLAR COMMISSIONING

5.1 COMMISSIONING OVERVIEW

Solar commissioning falls into two stages:

(a). Configuring the analogue interface of each NI to suit the requirements of the connected equipment.

(b). Configuring the system parameters to meet the operational requirements.

Stages (a) lies entirely with the NI and comes under 'Engineering' settings, which can be set using the TM ET as well as the NI ET. Stage (b) lies entirely with the TM and can therefore only be set using the TM ET.

After the basic commissioning is complete there is likely to be a period of optimisation when the Solar network is "fine tuned" to the IP bearer network. Ultimately, the user may like to consider ways to enhance the Solar network with the addition of specific features such as Alarms, SNMP or TM redundancy (the latter two features are special options). These particular topics are dealt with in their own sections.

5.2 NI ENGINEERING

All "Engineering" settings and adjustments that are accessed under the 'NI Engineering' window are available to both the NI ET and TM ET. The settings are stored in the TM, which continually sends this information as part of the Solar supervisory system. The settings are also held in the non-volatile memory of each NI, so that the NI can continue to operate in a fall back mode if isolated from the TM as well as recovering quickly from a loss of power.

These settings are referenced by the NI 'Address' as designated in the TM and not the IP address, although, naturally, the IP address for each NI must match that held in the TM for correct operation. This means that replacement of an NI is made much more straightforward as the 'Engineering' settings will be automatically uploaded when contact with the TM is established.

For example, replacing the NI in Site #4 will result in the original settings for that site being passed in a few seconds to the replacement unit, which must match the IP address of the original unit (text labels will take a lot longer as these are given lowest priority).

The 'NI Engineering' window is accessed by clicking on the 'Eng' button on the NI main window – see **Section 2.6 – NI Button Area**. This action opens a new window that has four pages of information: 'Main Audio', 'Signalling', 'Facilities' and 'Environment'. Each page is accessed by clicking on the tab for that page.

The 'NI Engineering' window also has an 'Eng' button that must be clicked "IN" before a change can be made, whereupon the 'Apply' button will become active. Any changes in settings will not become active until the 'Apply' button is selected. The 'NI Engineering' window is closed by clicking on the 'Close' button or the close icon ☒ in the top right hand corner. Any changes made but not applied will be lost when the window is closed.

If these pages are viewed through the TM ET there will be an 'Alarm' button on the lower area of the page and extra tabs on the 'Signalling' and 'Environment' pages – see **Section 12 – Alarms** for full details of these functions.

5.2.1 Main Audio

The audio input and output levels and other associated functions are set through this page of the 'NI Engineering' facility. The 'Main Audio' page of the NI Engineering facility for an Analogue system is shown overleaf in **Figure 29**.

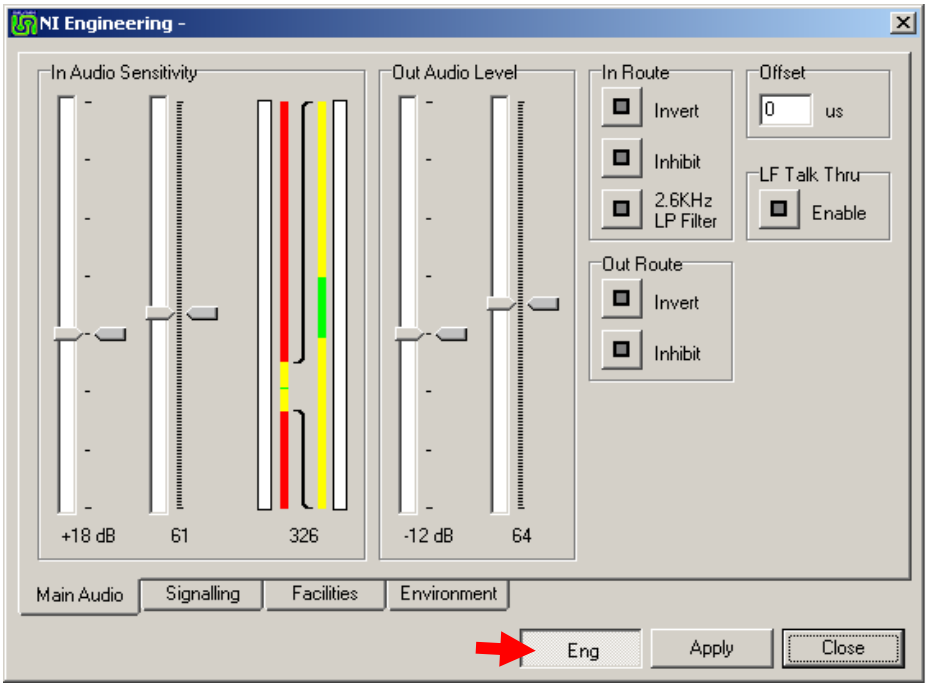

Figure 29. NI Engineering – Main Audio (Analogue).

The 'Main Audio' page of the NI Engineering facility for a P25 system is shown below in **Figure 30**.

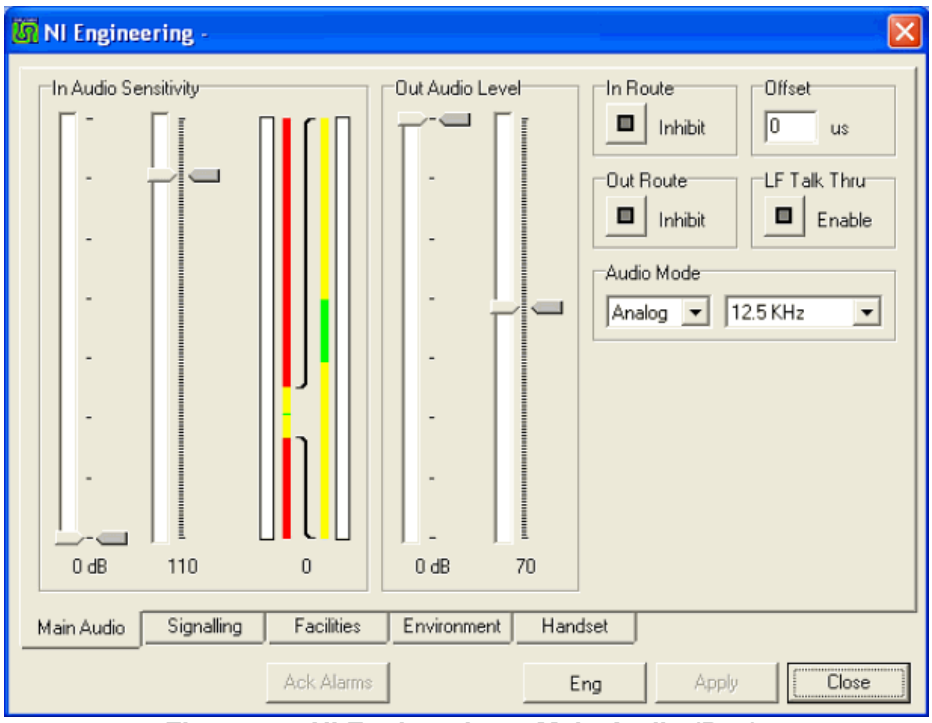

Figure 30. NI Engineering – Main Audio (P25).

5.2.1.1 In Audio Sensitivity

The input sensitivity is determined by adjustment of a coarse gain setting (left slider) and a fine gain setting (right slider) (see **Figure 31**). The gauge on the right is an expanded view of the left hand gauge to provide greater accuracy of setting. The current settings are shown by the marker to the right of the slider and the numerical value at the bottom.

When a level change is applied, the marker alongside the slider will turn **Blue** until the change is confirmed, whereupon the position of the marker will match that of the slider control pointer and turn **Grey** again.

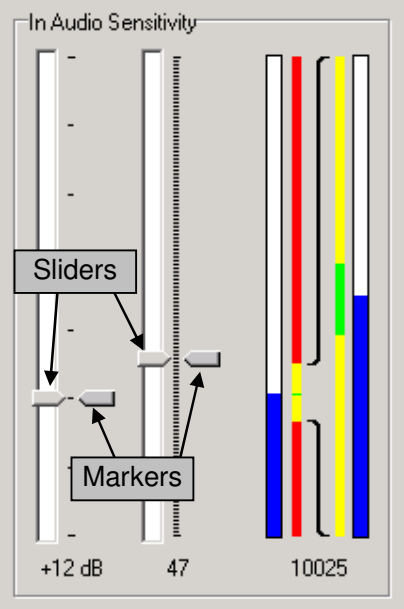

Figure 31. Audio I/P Level adjustment.

5.2.1.2 Audio Input Setup Process

The following process is used to setup the audio input sensitivity:

1. Apply a test tone (see note) to the input at the required Peak System Level (PSL).

Note.

Due to the digitisation sampling rate, the gauge and reading will not be stable at a test tone frequency of 1 kHz or multiples thereof (an aliasing effect). However, even a small change (a few Hertz) will greatly stabilise the readings. A change of at least ±20 Hz is recommended to give a fully stable result.

2. Adjust the input gain control and fine slider so that the top of the blue "gauge" is aligned to the centre of the green datum mark. (Adjusting the coarse gain control may cause a momentary effect on the PLL status).

3. The reading at the foot of the gauge is the Solar internal PSL and a reading of 10,000 (±50) is the target value.

4. The coarse gain setting steps are 0 db, +6 dB, +12 dB, +18 dB, +20 dB, +26 dB and +32 dB.

5. As a guide, each "click" on the fine slider nominally corresponds to change of 0.05 dB and changes the internal input level reading by approximately 50 points.

Note.

A change in the coarse gain setting will cause the PLL to show an error and possibly an alarm for a short duration.

5.2.1.3 Out Audio Level

The audio output level is set using a coarse level control (left slider) and fine level control (right slider) (see **Figure 32**). The current settings are shown by the marker to the right of the slider and the value at the bottom.

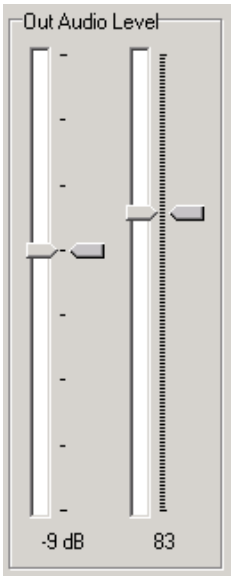

Figure 32. Audio Output Level adjustment.

When a level change is applied, the marker alongside the slider will turn **Blue** until the change is confirmed, whereupon the position of the marker will match that of the slider control pointer and turn **Grey** again.

5.2.1.4 Audio Output Setup Process

The audio output level is set using the Test Tone facility, which is described in more detail in **Section 5.2.3.3 – Test Tone**.

The following process is used to setup the audio output level:

1. Connect an audio level measuring device to the output port ensuring that a 600 Ω termination is applied.

2. Invoke the internal 'Test Tone' to 'External' route ensuring that the test tone level is set to maximum (0 dB).

3. Adjust the output gain control and fine slider to achieve PSL. (Adjusting the coarse gain control may cause a momentary effect on the PLL status.)

4. The coarse gain settings are in 3 dB steps from 0 dB down to –24 dB

5. The fine slider gives a 6 dB range of control and each "click" nominally corresponds to a change of 0.05 dB.

Whilst the preferred method is to set peak levels, it is possible to set the audio output for levels less than peak as long as the Test Tone output level is set to match. For example, to set a 60% system level of –10 dBm, set the Test Tone output level to –4.4 dB (60% of peak) and adjust the output level controls to give –10 dBm.

Note.

A change in the coarse gain setting will cause the PLL to show an error and possibly an alarm for a short duration.

5.2.1.5 In Route

The 'In Route' functions available for an Analogue system are shown below in **Figure 33**. For a P25 system, only the inhibit function is available. Details of the functions are:

(a). **Invert**. When the 'Invert' option is selected, the phase of the audio input signal will be inverted (phase reversal). Whilst this function is not normally required, it does provide a useful facility in the advent that the audio wiring between NI and base station is suspected as being reversed.

(b). **Inhibit**. When the 'Inhibit' option is selected, the audio signal fed in will be inhibited in the NI, which will cause a flashing **Red** warning indication on the front panel LED Status indicators. Depending upon the operational mode and setup configuration of the NI, these inhibits will also result in the Tx key or voting functions being inhibited, i.e. all associated input signalling will also be inhibited.

(c). **2.6KHz LP Filter**. When this option is selected, the incoming audio will be low-pass filtered to 2.6 kHz to prevent signalling tones such as tone RSSI or transmit keytone from passing through Solar.

Figure 33. In Route functions.

5.2.1.6 Out Route

The 'Out Route' functions available for an Analogue system are shown below in **Figure 34**. Again, for a P25 system, only the inhibit function is available. Details of the functions are:

(a). **Invert**. When the 'Invert' option is selected, the phase of the audio output signal will be inverted (phase reversal). Whilst this function is not normally required, it does provide a useful facility in the advent that the audio wiring between NI and base station is suspected as being reversed.

(b). **Inhibit**. When the 'Inhibit' option is selected, the audio and any associated signalling that is output from the NI will be inhibited and a flashing **Red** warning indication will be visible on the front panel LED Status Indicators.

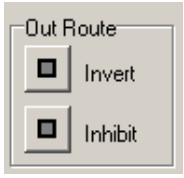

Figure 34. Out Route functions.

5.2.1.7 Offset

The 'Offset' facility (see **Figure 35** below) is provided in order to adjust the relative delay of the audio output if there is a need to artificially compensate for signal overlap areas that are not equidistant from sites. The range of delay available is from 0 µs to 255 µs and the required value is entered directly. An entry that exceeds the maximum will automatically be changed to 255 µs when applied.

The delay setting is also applied to the CTCSS output if that is used.

Whilst an offset delay may be set on a Central NI it has no effective meaning.

Figure 35. Offset facility.

5.2.1.8 LF Talk Thru

In the event that network communications (line fail) with the TM are lost, setting this facility will "Enable" Local Station T/T (repeat mode).

Although 'LF Talk Thru' may be enabled on a Central NI, it has no meaning.

Figure 36. LF Talk Thru facility.

5.2.1.9 Audio Mode (P25 only)

The 'Audio Mode' is only available on a P25 system and can be set to 'Remote', 'Analogue', 'P25' or 'Auto'. When set to 'Remote', the Station NI follows the Audio Mode of the channel it is assigned to. The Analogue modes are 12.5 kHz and 25 kHz to match the SB2025 bandwidth setting.

Note.

On a working site, setting the Audio Mode to anything other than 'Remote' can end up with this station being at odds with others on the channel, which can cause a degradation in overall transmitted signal quality in overlap areas,

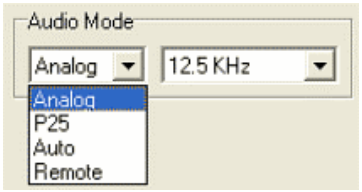

Figure 37. Audio Mode facility (P25 only).

5.2.2 Signalling

The input and output signalling, which may be dry contact, tone or a mixture of both, is configured on the 'NI Engineering' 'Signalling' page. If this page is viewed through the TM ET there will be a tab 'Alarms' for the 'Isolated Inputs' that is not shown on the NI ET – see **Section 12 – Alarms** for full details of this function.

The 'Signalling' page of the NI Engineering facility is shown overleaf in **Figure 38**.

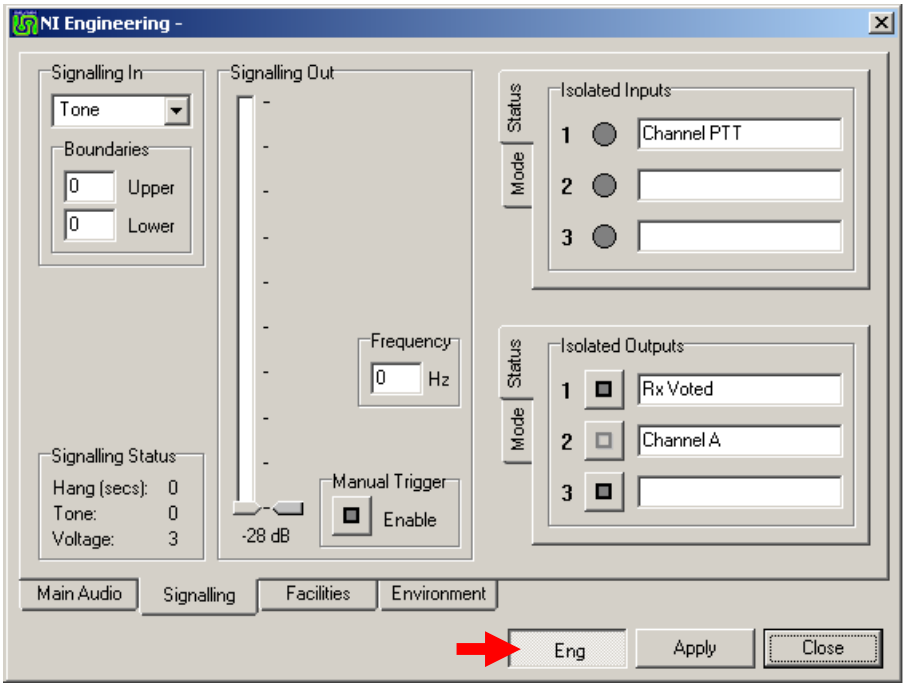

Figure 38. NI Engineering – Signalling page.

5.2.2.1 Signalling In

The signalling input may take the form of a variable voltage or tone. The NI will automatically determine the meaning of this input according to the mode of operation, i.e. Central or Station, although setting to 'Voltage' has no meaning for an NI operating in Central mode. The type of signalling required is selected from the drop-down list as shown in **Figure 39**.

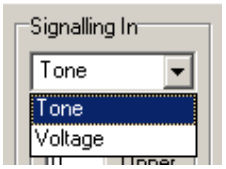

Figure 39. Signalling In – Menu Options.

If a voltage input is used, it must be wired to the dedicated input on the NI Facilities connector (see **Table 7**). A signalling tone must be applied to the composite audio input.

Note.

> ***On a P25 system, the Signalling tab of the NI Engineering window differs only in that the 'Signalling In' box is always set to 'Voltage' mode because there is no tone RSSI available from the SB2025 in P25 mode.***

5.2.2.1.1 Voltage

Voltage I/P used as RSSI in Station Mode.

The voltage input range is from 0 V to +5 V and this is measured and reported as a value from 0 to 1023 respectively. The 'Boundaries' boxes (see **Figure 40** overleaf) define the maximum and minimum values, and an input level between these limits will be translated into one of the 14 Solar internal RSSI levels. An input below the minimum value will be regarded as no signal, whereas an input greater than the maximum value will continue to be regarded as the top RSSI level. Setting a minimum value of zero disables the function.

The setup process for the RSSI input levels is as follows:

1. Apply a signal level to the Rx of minimum RSSI, typically a mute threshold level.

2. Subtract 10 (see note) from the 'Signalling Status' measured value of voltage and enter this into the minimum Boundary box.

Note.

The subtract figure above is a suggested value to help ensure that the NI does not cut off low level signals when the receiver squelch may still be open (squelch hysteresis).

3. Apply a signal of maximum RSSI.

4. Enter the 'Signalling Status' measured value of voltage into the maximum Boundary box.

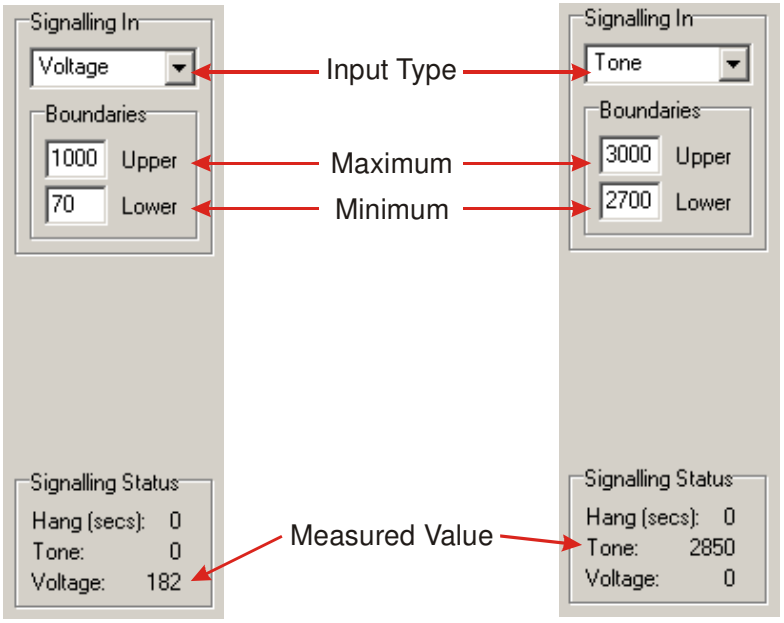

Figure 40. Signalling In Configurations.

5.2.2.1.2 Signalling Status

The report of the incoming signal is displayed in this area. Also shown is the 'Hang' time in seconds. This is the time that the transmitters will remain keyed after the channel PTT instruction has been removed as defined in the TM channel configuration – see **Section 5.4.3.1**.

5.2.2.2 Signalling Out

This facilitates the use of a signalling tone output. The signalling tone is enabled by setting a valid frequency (0 Hz = Off). When enabled, the tone is switched on:

- for Station NI mode when Tx PTT is active;
- for Central NI mode when a voted signal is present.

Both level and frequency can be set as required (see **Figure 41** overleaf).

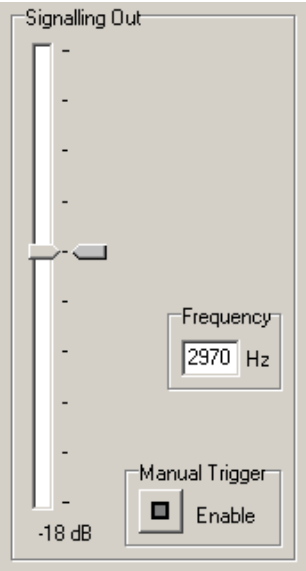

Figure 41. Signalling Tone Output.

The frequency range is 2.5 kHz to 3.5 kHz and, consequently, values entered outside this range will be changed to the closest limit when the 'Apply' button is selected. The tone level setting is in 2 dB steps covering the range of –10 dB to –28 dB relative to the peak system audio level, i.e. it is not an absolute level. The current level setting is shown at the foot of the slider.

When a level change is applied the marker alongside the slider will turn **Blue** until the change is confirmed whereupon the position of the marker will match that of the slider control pointer and turn **Grey** again.

Note.

For FW Config builds other than 0x7FFF, the operation of this facility may be different. See Section 15 – Firmware Extensions for more information.

5.2.2.3 Manual Trigger

For a Station NI this facility provides a simple means to apply a Tx PTT "ON" condition for test purposes. For a Central NI this becomes the "Rx Voted" output (if used). Whether it is a relay, a tone or both that is activated depends on what has been configured for the function.

If this facility is used and then the network connection to the Station NI fails, rather than leaving the Tx keyed indefinitely, under this situation the function will cancel automatically otherwise it must be cancelled manually. However, activating the facility is indicated on the NI mode panel of the status page on the ET as a warning – see **Section 3.2**.

5.2.2.4 Isolated Inputs

The state of the Isolated Inputs is presented on the 'Status' page (this is the default view) and configured on the 'Mode' page. The Isolated Inputs 'Status' page and 'Mode' page are shown overleaf in **Figure 42**.

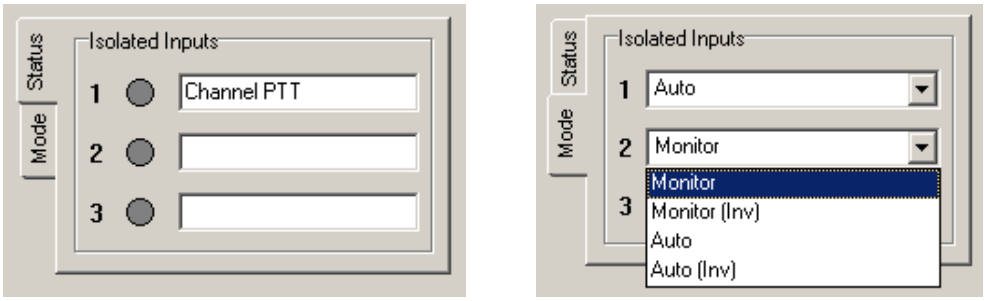

Figure 42. Isolated Input Options.

Each input is assigned to either a 'Monitor' mode, which provides a visual indication of the status of an input, or an 'Auto' mode, which pre-defines the duty of each input as shown overleaf in **Table 1**.

The '(Inv)' option of each setting inverts the "ON" state of the input; i.e. in non-inverted mode the indicator and any associated function is "ON" when the input is taken low, in the inverted mode the indicator and function is "ON" when the input is taken high or left open circuit.

To change the mode of an input, carry out the following:

1. On the 'NI Engineering' window, select the 'Eng' button (IN).

2. On the 'Signalling' page, select the 'Isolated Inputs – Mode' tab to access the 'Mode' page.

3. On the 'Mode' page, for the input in question, using the drop-down list, select the mode required.

Note.

On the Isolated Inputs Status page, there is provision for the user to enter a text label of choice against each input as a reminder of the role assigned to the input.

4. On the 'Signalling' page, select the 'Isolated Inputs – Status' tab to access the 'Status' page.

5. On the 'Status' page, for the input in question, click in the text box and enter or amend the text as required.

6. On the 'NI Engineering' window, select the 'Apply' button.

More than one item may be changed at a time but the action must be completed by selecting 'Apply'. At this point, any new setting or text will turn **Blue** until full confirmation is received from the opposing end of the system. For text labels this will take several minutes as text is given lowest priority in the supervisory process.

Table 1. Isolated I/P Functions.

Input	Central NI	Station NI
#1	Channel Tx Key (PTT)	Rx squelch open (COR)
#2	Controlled T/T	No function assigned
#3	No function assigned	SB2000 Alarm state

The use of Input #1 at a Station NI to indicate receiver squelch status is not mandatory as the 'Signalling In' facility can be setup to provide this function (see **Section 5.2.2.1**).

Note.

For FW Config builds other than the standard 0x7FFF, the Auto modes may produce a different operation to that shown in Table 1. See Section 15 – Firmware Extensions for more information.

5.2.2.5 Isolated Outputs

Control of the isolated outputs (relays) and their current state is presented on the 'Status' page (this is the default view) and configured on the 'Mode' page. The Isolated Outputs 'Status' page and 'Mode' page are shown below in **Figure 43**.

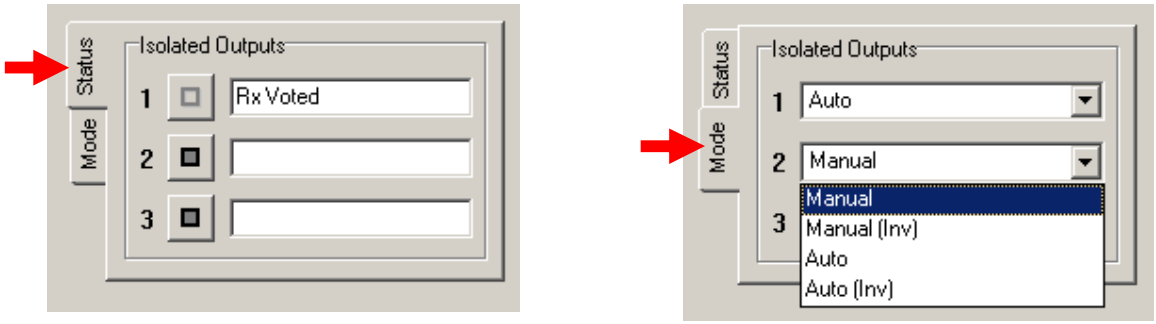

Figure 43. Isolated Output Options.

Each output is assigned to either a 'Manual' mode, which allows manual control of the output relay or an 'Auto' mode, which pre-defines the duty of the output relay as shown overleaf in **Table 2**. Once assigned to either of the two auto modes, the button to manually activate the output becomes unavailable (greyed out).

The '(Inv)' option of each setting inverts the "ON" state of the output with respect to the button state; i.e. in non-inverted mode the output is "ON" when the button is 'IN', in the inverted mode the output is "ON" when the button is 'OUT'.

To change the mode of an output, carry out the following:

1. On the 'NI Engineering' window, select the 'Eng' button (IN).

2. On the 'Signalling' page, select the 'Isolated Outputs – Mode' tab to access the 'Mode' page.

3. On the 'Mode' page, for the output in question, using the drop-down list, select the mode required.

Note.

On the Isolated Outputs Status page, there is provision for the user to enter a text label of choice against each output as a reminder of the role assigned to the output.

4. On the 'Signalling' page, select the 'Isolated Outputs – Status' tab to access the 'Status' page.

5. On the 'Status' page, for the Output in question, click in the text box and enter or amend the text as required.

6. On the 'NI Engineering' window, select the 'Apply' button.

More than one item may be changed at a time but the action must be completed by clicking 'Apply'. At this point any new setting or text will turn **Blue** until full confirmation is received from the opposing end of the system. For text labels this will take several minutes as text is given lowest priority in the supervisory process.

Table 2. Isolated O/P Functions in 'Auto' mode.

Relay O/P	Central NI	Station NI
#1	Voted signal present	Tx Key (PTT)
#2	System/Channel Alarm ON	No function assigned
#3	No function assigned	No function assigned

Note.

For FW Config builds other than the standard 0x7FFFF, the Auto modes may produce a different operation to that shown in Table 2. See Section 15 – Firmware Extensions for more information.

5.2.3 Facilities

The 'NI Engineering – Facilities' page provides access to: the NI text label 'Name'; the selection of the signals presented to the GPS module; the setting of the 'Test Tone' frequency and level; and the 'CTCSS Tone' level.

The 'Facilities' page of the NI Engineering facility is shown below in **Figure 44**.

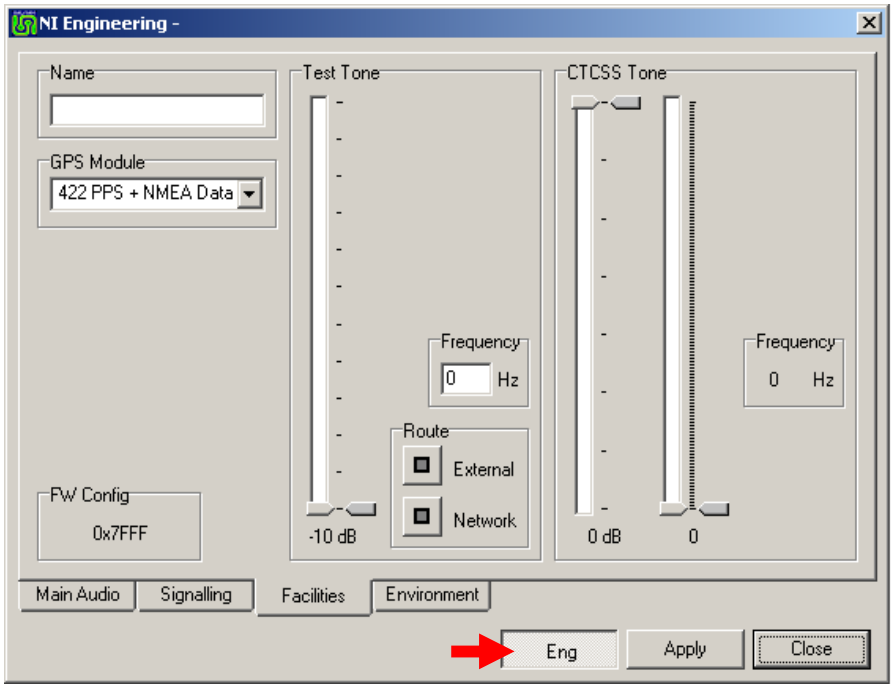

Figure 44. NI Engineering – Facilities page.

When viewing this page through the NI ET (as in **Figure 44** above), there is facility for setting NI alarms that is not visible; this is only presented on the TM ET – see **Section 12 – Alarms** for full details of this function.

5.2.3.1 Name

This is a user defined text label to aid identification of the NI. The name will be displayed in some of the TM ET windows to assist the user by confirming that the NI being viewed or altered is the correct one. To enter or change the text select the 'Eng' button (IN), click in the 'Name' text box and amend the text as required (the limit is 19 characters). As for all settings, a change must be completed by using 'Apply'.

At this point the text will turn **Blue** until full confirmation is received from the opposing end of the system, which will take several minutes as text is given lowest priority in the supervisory process.

5.2.3.2 GPS Module

The passage of audio through a NI is dependant upon packet timing, which, in turn, is governed by the 1PPS timing signal. Therefore, it is important that the configuration and connections match the type of timing signal to be used, as well as the signal being present and correct before full commissioning is attempted.

As the GPS/1PPS timing signal connects to a separate and independent sub-module, these settings will be accessible to other main module(s) that may be fitted to the Solar 2 unit.

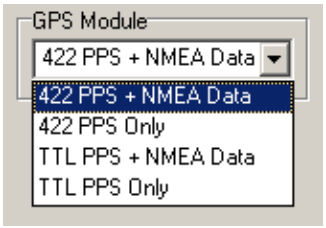

Figure 45. GPS Module Timing Source Menu Options.

The timing signal may be one of two signal voltage types each with or without NMEA data; the latter must be at RS422 voltage levels. The default setting is '422 PPS + NMEA Data' and changing to either of the TTL 1PPS options will necessitate that the TTL input is used on the GPS connector (see **Part 1, Section 4.1.2.1 – GPS (1PPS Timing Signal Input**). When NMEA data is in the selected option, loss of that data will cause a PPS fail indication even if the 1PPS signal is still present and correct.

Table 3. NI Timing Signal Options.

1PPS Signal	NMEA Data	Selection Option	Notes
RS422	RS422	422 PPS + NMEA Data	Setting for use with GPS Ae/Rx
RS422	None	422 PPS Only	
TTL	RS422	TTL PPS + NMEA Data	The TTL I/P connection must be used if one of these two options is selected
TTL	None	TTL PPS Only	

5.2.3.3 Test Tone

5.2.3.3.1 Level

The test tone level has 11 fixed values and is calibrated relative to the peak audio output level (see **Section 5.3.2.4**). It has a range of 0 dB (peak) to –10 dB (below peak) in 1 db steps plus a step of -4.4 dB which equates to 60% of PSL.

5.2.3.3.2 Frequency

The test tone frequency range is 300 Hz to 2500 Hz and the required frequency is entered in the box in Hz. Entering a value outside this range other than zero will cause the setting to change to the nearest limit when the setting is applied.

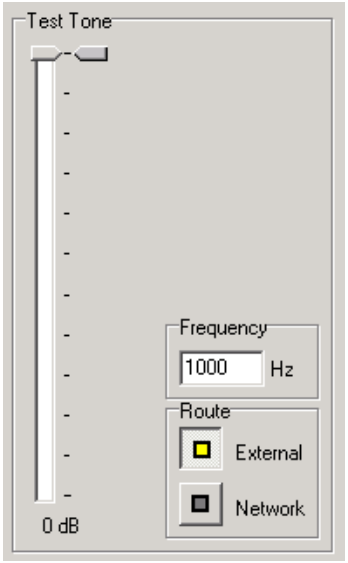

Figure 46. Test Tone Facility.

5.2.3.3.3 Route

The test tone may be sent to either the 'External' (the analogue output), 'Network' towards the TM or both by setting that route to "ON". It is the selection of the 'Route' that activates the test tone. Selecting the 'Network' route at a Station NI will need to be accompanied by a valid RSSI level (and mute open condition if so configured) for the test tone to pass through the TM and be output from the Central NI. The tone will be re-broadcast if channel T/T is selected.

Selecting the 'Network' route will result in the 'In Audio Sensitivity' gauge displaying a level in sympathy with the test tone level while the network is connected. When a 'Route' is selected the indication on the front status page (see **Section 2.2.1.2**) will be present to warn the user that it is active and that normal operation is suspended.

When a level change is applied the marker alongside the slider will turn **Blue** until the change is confirmed whereupon the position of the marker will match that of the slider control pointer and turn **Grey** again.

Note.

> ***If a frequency of 0 Hz is entered and a 'Route' selection is made, no tone will be output and the normal audio path in the 'Route' direction will be suspended.***

5.2.3.4 CTCSS Tone

The CTCSS Tone Level is set to meet the required output using the coarse level (left slider) and fine level (right slider) controls (see **Figure 47** overleaf). The coarse gain steps are 3 dB and the fine slider gives a 6 dB range of control. The current settings are shown by the marker to the right of the slider and the value at the bottom.

When a level change is applied the marker alongside the slider will turn Blue until the change is confirmed whereupon the position of the marker will match that of the slider control pointer and turn Grey again.

Whilst the CTCSS Tone frequency can only be set centrally at the TM to ensure all sites within a channel generate the same CTCSS frequency (see **Section 5.4.3.2**), the frequency setting is reported here for convenience.

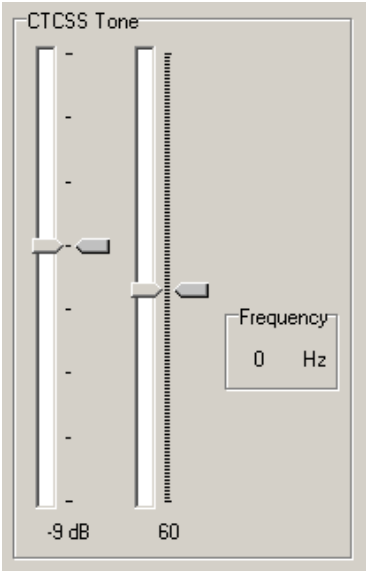

Figure 47. CTCSS Tone level.

5.2.4 Environment

The 'Environment I/O' interface is an independent sub-module within the Solar 2 unit. It is accessible from and available to any of the main modules that are fitted to the unit. Consequently, any action or setting applied through one module is visible to and open to change through another module. If this page is viewed through the TM ET there will be tabs for 'Alarms' that are not shown on the NI ET – see **Section 12 – Alarms** for full details of this function.

The 'Environment' page of the 'NI Engineering' facility is shown below in **Figure 48**.

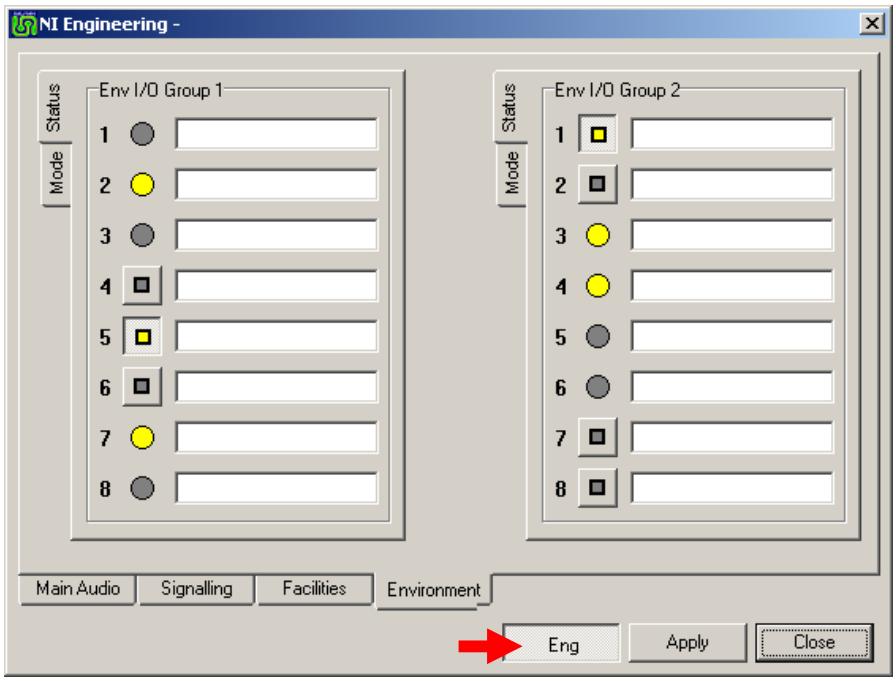

Figure 48. NI Engineering – Environment page.

These connections are arranged in two groups of eight, which reflects the fact that each point in the group is electrically connected to the same physical device (integrated circuit). This has no significance as far as operation is concerned but will limit the total load current that can be switched by all the outputs in a group – see **Part 1, Section 3.2**. The following information applies equally to both groups.

5.2.4.1 Status

The state of the inputs and control of the outputs is presented on the 'Status' page for each group, which is the default view. To change the state of an output, select the 'Eng' button (IN), select the button of the required output(s) then select 'Apply' to invoke the change. The inner square of the button will turn **Blue** until the change is confirmed whereupon it will turn **Grey** again.

Each item has a text label available that is designed to help the user confirm that the individual input/output that is being examined or controlled is the correct one; the text plays no part in the operation of the unit and can be omitted. The text entered via this page will be presented on the main status page of the NI and on some of the TM ET windows.

To enter or change the text, select the 'Eng' button, click in the text box for the required input/output and enter or amend the text as required (the limit is 20 characters). As for all settings, a change must be completed by using 'Apply'. At this point the text will turn **Blue** until full confirmation is received from the opposing end of the system, which will take several minutes as text is given lowest priority in the supervisory process.

5.2.4.2 Mode

Each connection point is able to operate as an input or an output, which is defined by the option selected from the drop-down list. The setting of 'Monitor' or 'Monitor (Inv)' dictates that the point will be an input; any other setting dictates the point will be an output.

The 'Monitor (Inv)' option inverts the "ON" state of the input; i.e. in non-inverted mode the indicator and any associated function is "ON" when the input is taken low, in the inverted mode the indicator and function is "ON" when the input is taken high or left open circuit.

The 'Manual (Inv)' option inverts the "ON" state of the output with respect to the button state; i.e. in non-inverted mode the output is "ON" when the button is "IN", in the inverted mode the output is "ON" when the button is "OUT".

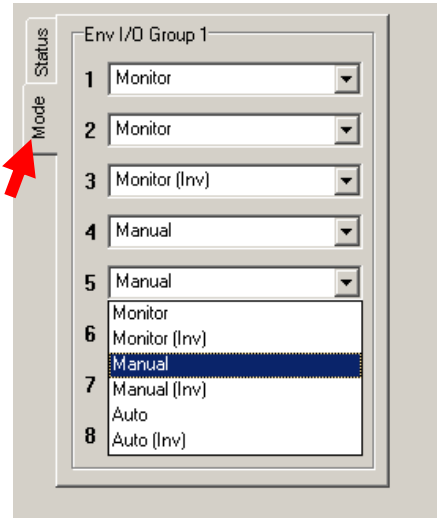

Figure 49. Environment Mode settings.

Note.

For FW Config builds other than the standard 0x7FFF, whilst the indicator will function as described above, when 'Auto' or 'Auto (Inv)' mode is selected, either setting may invoke a different or additional action. See Section 15 – Firmware Extensions for more information.

5.3 TM ENGINEERING (TM ET ONLY)

'TM Engineering' is accessed by clicking on the 'Eng' button on the TM Status panel. The settings accessed in the following pages are stored in the TM, some being sent to the NI for configuration purposes as part of the Solar supervisory system, others are sent for information purposes only.

The 'TM Engineering' window also has an 'Eng' button that must be selected (IN) before a change can be made, whereupon the 'Apply' button will become active. Changes in settings will not become active until the 'Apply' button is selected. The 'TM Engineering' window is closed by selecting the 'Close' button or by using the close icon ☒ in the top right hand corner. Any changes made but not applied will be lost when the window is closed.

Also visible on the 'TM Engineering' window is an 'Ack Alarms' button, which will be unavailable (greyed out). See **Section 12 – Alarms** for full details of this function.

5.3.1 Sync Timing

The purpose of 'Sync Timing' is to facilitate setting the size of the Solar packet buffers that are crucial to the correct operation of a Solar simulcast radio network. Due to the detailed nature of the subject, the information is presented in full detail in **Section 7 – Solar (Sync) Timing** of this manual. The user is well advised to study this section carefully prior to system optimisation.

At the initial commissioning stage "nominal" values will be used to get the system operating.

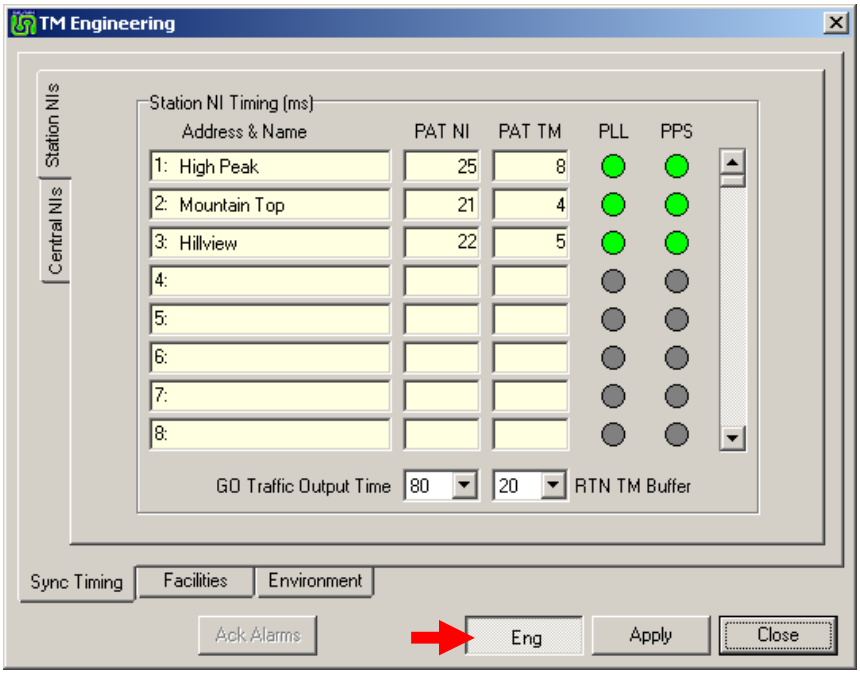

Figure 50. TM Engineering – Sync Timing (Station NIs).

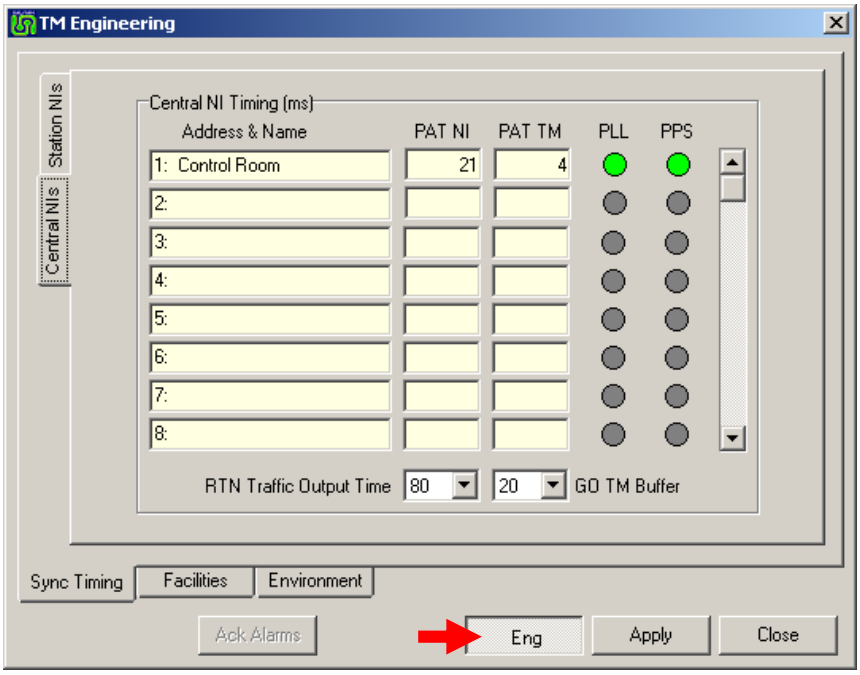

Figure 51. TM Engineering – Sync Timing (Central NIs).

There are two 'Sync Timing' pages; one for the Station NI and one for the Central NI, each being selected by the corresponding tabs as seen in **Figures 50 and 51** above. If the number of the NI in use exceeds the capacity of the display area, the slider to the right of each table allows the display area to be moved up and down to view every report.

Each page has two buffer settings where values are taken from the drop-down lists. As the buffer settings are inter-dependant, the Central NI page must be used to complete the set-up process even on a system that has no Central NI.

5.3.1.1 PAT Reports

A brief explanation of the terminology used on the 'Sync Timing' pages is given here for completeness.

The 'PAT' values are calculated by every unit receiving packets. For each NI, that information is passed back to the TM for display on this page, together with the figures calculated by the arrival time of packets at the TM itself. The measurements and reports take place once a second.

'PAT NI' is the average time taken for packet zero to arrive at a NI (rounded up to the nearest millisecond).

'PAT TM' is the average time taken for packet zero to arrive at the TM (rounded up to the nearest millisecond).

The 'PLL' indication confirms the health of the phase locked loop within the NI and the 'PPS' indication confirms the health of the 1PPS timing signal within the NI.

Note.

> ***The PAT value reported from a NI that is indicating loss of PPS may not be correct. Similarly, the 'PAT TM' report depends on the TM PPS signal being present.***

5.3.1.2 Initial Values

The principle is to start with nominal values and assume that these settings will require adjustment to values better suited to the IP network. This is especially true if the network has a means of alternate routing or fallback as the configuration offering 'worst case' values must be considered.

Note.

These buffer parameter values are global and apply to all channels on a multi-channel system.

It is necessary to depress the 'Eng' button before any setting may be selected from the drop-down lists (there is no direct entry of values). Any changes must be saved by selecting 'Apply'.

The suggested settings that are likely to be satisfactory for the majority of networks so that the initial commissioning may be instigated are:

(a). 'GO TM Buffer' and 'RTN TM Buffer' set to 60 ms.

(b). 'GO Traffic Output Time' and 'RTN Traffic Output Time' set to 120 ms.

If network latency is believed to be significant, increasing all settings by a further 40 ms may be necessary. All times are in 20 ms steps.

5.3.2 Facilities

The item of primary importance on the 'Facilities' page is that of selecting the right format of signal input for the 'GPS Module'. If the Solar 2 unit also supports an NI, the setting of the 'GPS Module' may have already been undertaken through that route. Apart from being able to allocate a 'Name' to the TM, the other areas on this page are covered in the 'Alarms' and 'SNMP' sections of this manual.

The 'Facilities' page of the 'TM Engineering' facility is shown below in **Figure 52**.

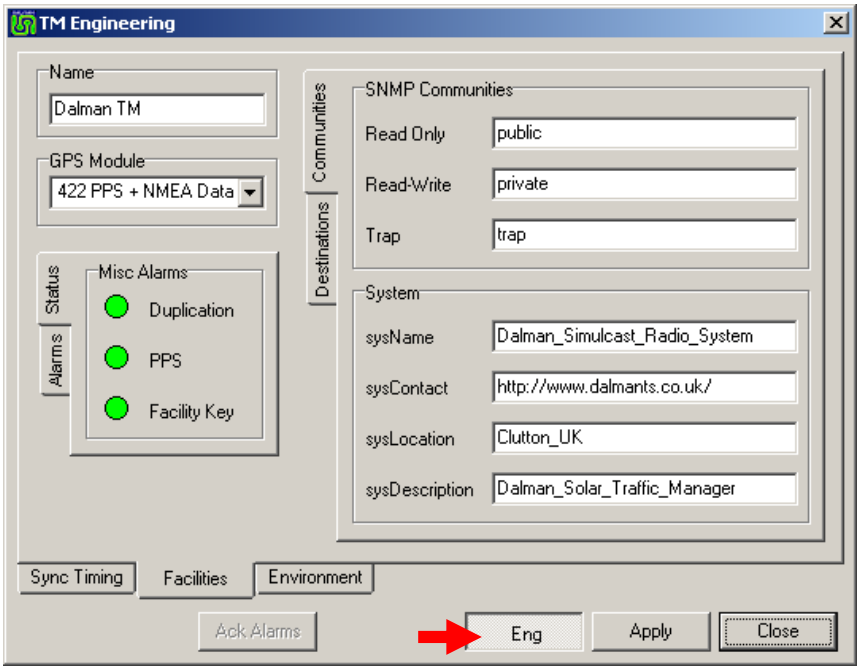

Figure 52. TM Engineering – Facilities page.

5.3.2.1 Name

To enter or change the 'Name' text, select the 'Eng' button, click in the 'Name' text box and enter or amend the text as required (the limit is 20 characters). As for all settings, a change must be completed by using 'Apply', which will take immediate effect as the information remains with the TM; i.e. it is not transmitted through the Solar supervisory system.

5.3.2.2 GPS Module

The GPS/timing interface is an independent sub-module within the Solar 2 unit. It is accessible from and available to any of the main modules that are fitted to the unit. Consequently, any action or setting applied through one module is visible to and open to change through another module.

Therefore, refer to **Section 5.2.3.2** on the NI for all the necessary information on the GPS module options and settings.

5.3.2.3 Misc Alarms

The indicators shown on the 'Status' page are a repeat of those presented on the TM Status panel. The "Alarm' page is covered under **Section 12 – Alarms**.

5.3.2.4 SNMP

This feature is an option that is controlled by the 'Facility Key' and may not be present on all versions of the TM. The feature is covered under **Section 14 – SNMP**.

5.3.3 Environment

The 'Environment I/O' interface is an independent sub-module within the Solar 2 unit. It is accessible from and available to any of the main modules that are fitted to the unit. Consequently, any action or setting applied through one module is visible to and open to change through another module.

Apart from the additional pages for 'Alarms' (see **Figure 53** below), the options and settings are identical to those available to an NI. Therefore, refer to **Section 5.2.3** for all the necessary information. For full details on the 'Alarms' pages see **Section 12 – Alarms**.

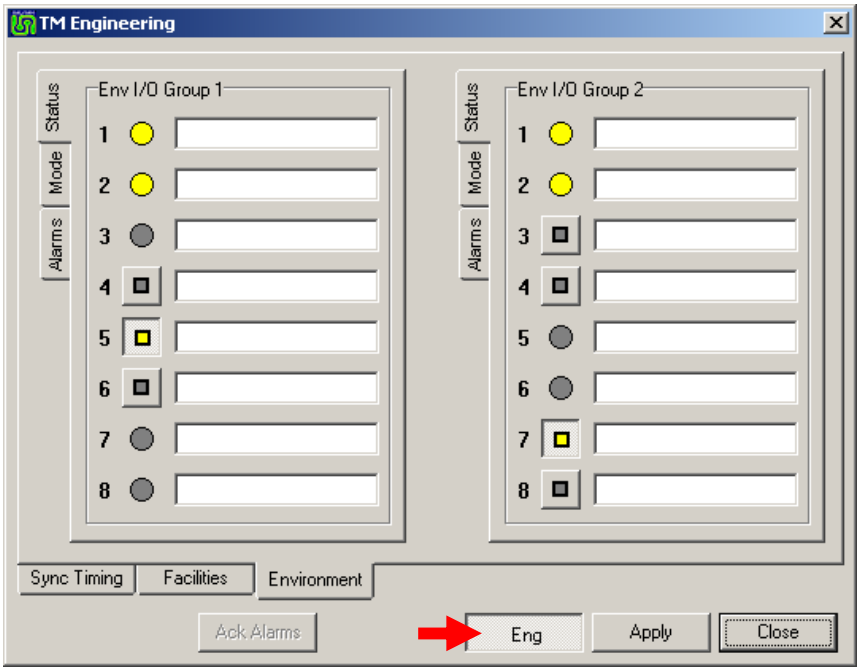

Figure 53. TM Engineering – Environment page.

5.4 CHANNEL SETUP

The 'Channel Setup' page for an Analogue system, shown below in **Figure 54**, is accessed via the 'Setup' button on the Channel Status Panel of the TM ET main window as shown in **Section 3.4.2 – Channel Status Panel**.

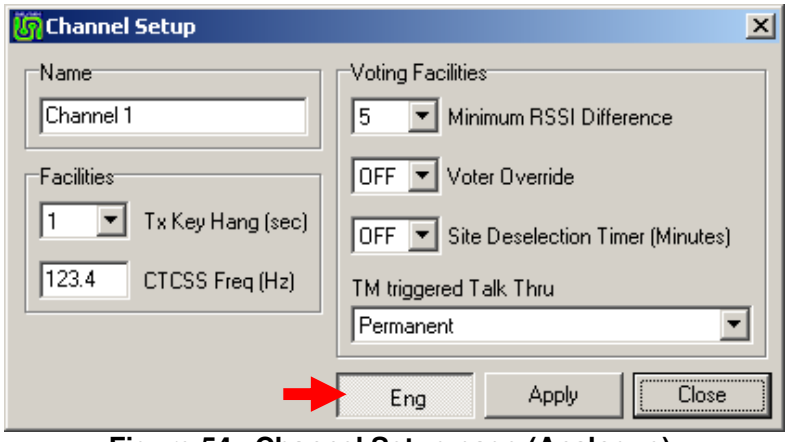

Figure 54. Channel Setup page (Analogue).

Of the parameters that are accessed from this page, those that relate to the operation of receiver voting are probably the ones that are most likely to have the greater impact upon the successful operation of the Solar channel. That being the case, whilst there are brief details of each parameter in the following sections, to complete the information a more in depth description of the receiver voting function of Solar is given in **Section 10 – Receiver Voting**.

The 'Eng' button must be selected to enable changes to be made and the 'Apply' must be selected to complete the changes.

5.4.1 Name

This facility is used to identify each channel to ensure that settings, tests or simply observations are being applied to or made on the correct channel when operating in a multiple channel environment.

The 'Name' is entered or edited by selecting the 'Eng' button then clicking in the 'Name' text box, which allows direct entry of characters into the text box, the limit is 20 characters. The change is confirmed by selecting the 'Apply' button.

5.4.2 Voting Facilities

5.4.2.1 Minimum RSSI Difference

This sets the minimum difference between RSSI levels before the Voter makes a new selection (sometimes referred to as level hysteresis). The RSSI level size is determined by the values entered for the NI boundary levels and input signal type (see **Section 5.2.2.1 – Signalling In**).

5.4.2.2 Voter Override

This facilitates the testing of RTN paths. When "ON", the Voter is forced to select this site and pass on any speech traffic or test tones from that Station NI. When activated, the 'Voted Level' text shows 'OVR' and the Station panel displays a **Yellow** voted indication with a full RSSI level shown as a **Blue** bar. The "OFF" state returns the channel to normal operation.

5.4.2.3 Site Deselection Timer (Minutes)

If an in-service base station Rx squelch is open for longer than this value, that station will be removed from the Voter list until that squelch is closed continuously for a short time (typically 10 seconds). If invoked, the Station panel will still indicate a received RSSI level but not a voted indication.

5.4.2.4 TM triggered Talk Through

T/T or repeat mode is implemented in the digital domain within the TM, no matter how the function is controlled or initiated. The following options refer to the manner in which T/T may be enabled, in addition to the external application of console/control switched facility through the Central NI. If no Central NI is in use, the setting 'Permanent' will need to be used.

(a). **'None'**. T/T operation is not enabled.

Note.

T/T is still available as a controlled function via the Central NI if enabled for operation – see Section 5.2.2.4.

(b). **'On Central NI Fail'**. Loss of communications between the corresponding Central NI and the TM will cause T/T to be enabled.

(c). **'Permanent'**. T/T is permanently enabled.

Note.

When the Control Tx Key function is active, T/T will be suspended, i.e. Control Tx Key has precedence but will not switch off the T/T function.

5.4.3 Facilities

5.4.3.1 Tx Key Hang

The 'Tx Key Hang (sec)' is the time that the Tx PTT is maintained after the Tx Key command has been removed either as a direct input to the Central NI or after cessation of a received signal when the channel is operating on T/T. This setting is maintained by a Station NI that is operating in fall back (Line Fail) T/T.

The range is from OFF (no delay) to 5 seconds (in 1 second increments).

5.4.3.2 CTCSS

A phase coherent CTCSS tone is available from a dedicated output on the Facilities connector of a Station NI. The tone is generated at the NI from a value that is passed from the TM. The CTCSS frequency is entered in Hertz in the range of 50 Hz to 300 Hz inclusive (in 0.1 Hz increments). A value entered outside of this range will be corrected to the closest limit. Entering 0 Hz indicates that no CTCSS tone is to be generated.

This setting is maintained by a Station NI that is operating in fall back (Line Fail) T/T.

5.5 CHANNEL SETUP P25

For a P25 system, the 'Channel Setup' page is slightly different and is shown overleaf in **Figure 55**. It is still accessed in the same way via the 'Setup' button on the Channel Status Panel of the TM ET main window as shown in **Section 3.4.2 – Channel Status Panel**.

The significant difference is that the page now contains 'Main' and 'P25' tabs, with the P25 features/parameters accessed via the P25 tab. The Main tab simply contains all the parameters for an Analogue system, which are detailed in **Section 5.4** above.

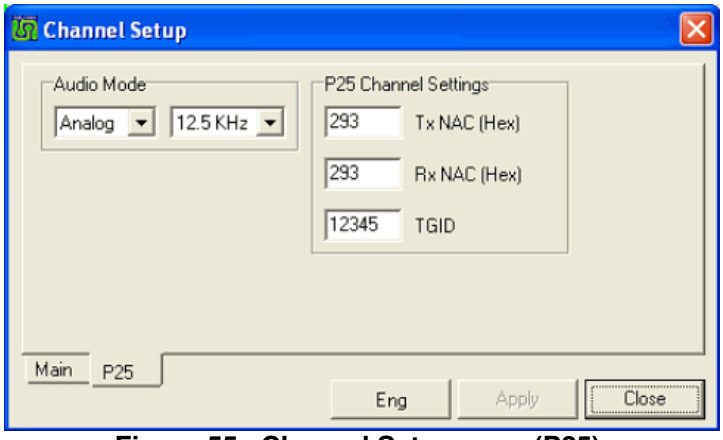

Figure 55. Channel Setup page (P25).

The 'Eng' button must be selected to enable changes to be made and the 'Apply' must be selected to complete the changes.

5.5.1 Audio Mode

The channel's Audio Mode is set here. This mode will be adopted by all NIs assigned to this channel as long as they have their individual Audio Mode set to Remote. (See **Section 5.2.1 - Main Audio**). In Analogue or Auto mode, the channel bandwidth must be set to either 12.5 kHz or 25 kHz to match the setting in the SB2025 base stations and all the base stations must be set the same.

5.5.2 P25 Channel Settings

The 'P25 Channel Settings' area is where the Tx and Rx Network Access Codes (NAC) are set.

The 'Tx NAC' and 'TGID' settings will be transmitted for all P25 calls originated by the dispatcher and for all P25 T/T calls unless the Rx NAC is set to 0xF7F, in which case, the received NAC and Talk Group Identification (TGID) will be transmitted.

If the 'Rx NAC' is set to 0xF7E or 0xF7F, the channel will respond to any P25 transmissions irrespective of their own Tx NAC, however, if set to anything else, the received NAC must match or the call will be ignored.

6 SOLAR CHANNELS (RELATIONS)

6.1 MULTI-CHANNEL OVERVIEW

The 'Facility Key' controlled Multi-channel option of the TM allows a collection of Station NI (sites) to be grouped together and operate as an independent sub-system of the parent Solar network. These groupings will be referred to as a "Solar Channel" and, although it is anticipated that all base stations or repeaters on a Solar Channel would be operating on the same radio frequency, it is not mandatory.

The maximum capacity of a Solar TM is 32 Station NI (sites) and every TM is able to support the maximum irrespective of any options. A TM can also support up to 16 Channels but will be programmed for the number according to the option fitted. The Station NI can be distributed across these channels in any mix of quantities; for example eight channels of four sites each or four channels with eight sites each and so on. The introduction of Solar 2 has seen the feature added to have more than one Central NI per channel in order to provide multiple presentations to Control/Console systems. However, the maximum number of Central NIs per system remains at 16 no matter these are allocated to channels. A channel need not have a Central NI if no Control/Console connection is required.

6.2 RELATIONS FUNCTION

6.2.1 NI to Channel Association

The facility to define which Station(s) belong to which channel and to define which Central NI, if any, will operate a channel is accessed by clicking the 'Relations' button on the TM Status panel (see **Section 3.4.1**).

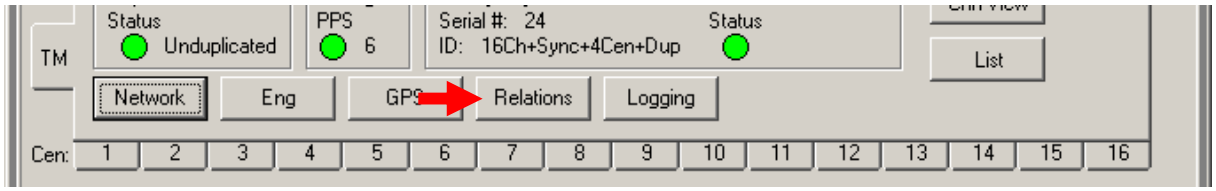

Figure 56. Route to Relations page.

This will open a window that has three rows of numbered squares: Station NIs across the top; Channels in the middle; and Central NIs across the bottom. Station squares and Central squares will only become active when allocated to an NI. Channel squares will be active to the number authorised on the system.

The example 'Relations' page, shown overleaf in **Figure 57**, shows a TM with the 16 channel option that has six Station NIs and three Central NIs enabled. The 'Relations' page is available on a single channel TM but it serves no purpose in the configuration process.

A Station NI square will be active when the corresponding Station NI panel is enabled and a Central NI square will be active when the corresponding Central NI panel is enabled. The channel squares that are active will correspond to the number of channels that have been enabled by the Facility Key.

At the initial configuration stage, all Station NIs will be associated to channel #1 and the Central NI will be related to channels on a one to one basis. Once all the NIs that form the Solar network have been allocated to a Station or Central role and are online, the redefining of relationships between channels and NI can be undertaken. These relationships are shown by the lines that link the squares. It is not possible to delete a relationship only to change it.

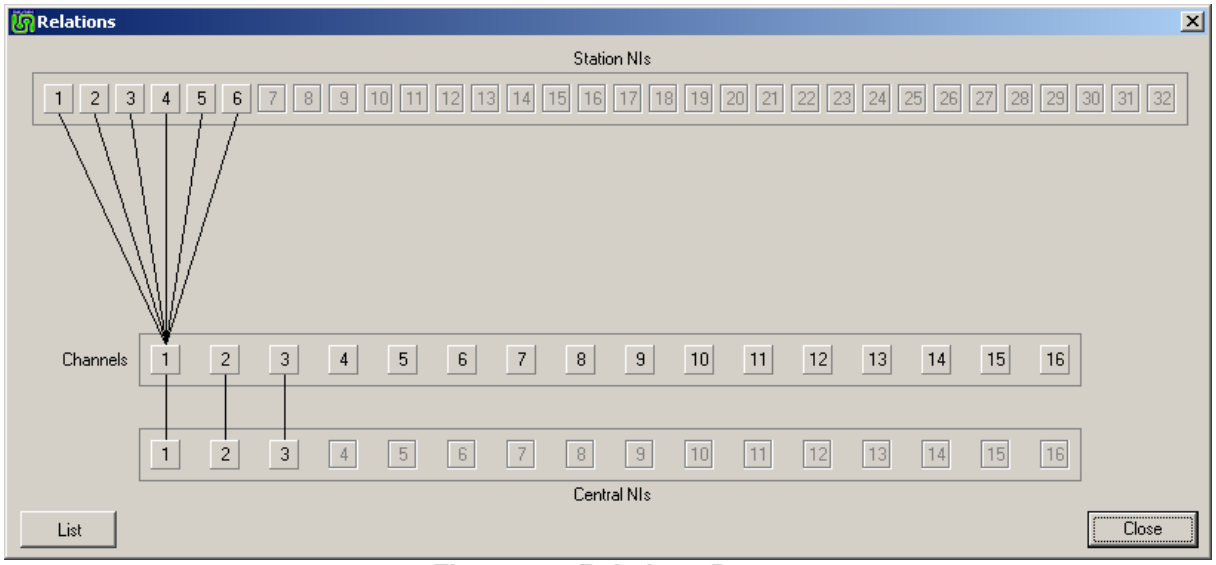

Figure 57. Relations Page.

6.2.2 Moving a Station to a Different Channel

The following procedure is an example of how to move Station NI #1 from Channel #1 to Channel #2. The process is also shown in **Figure 58** below.

1. Move the mouse pointer over Station NI#1 square, click and hold the left mouse button.
2. A square with a **Green** highlight and the number 1 in it will appear under the pointer. Drag this to the Channel #2 square, which will also gain a **Green** highlight.
3. Release the mouse button.
4. The line linking Station NI #1 to Channel #1 will move across to Channel #2.
5. The action is complete.

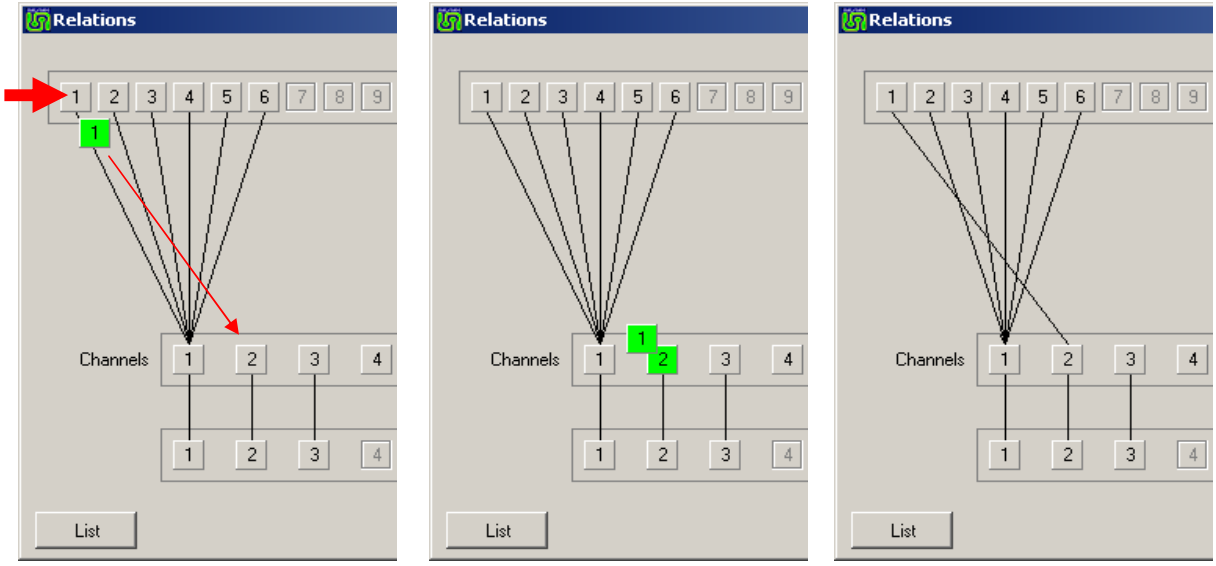

Figure 58. Moving a Station NI between Channels.

6.2.3 Moving a Central NI to a Different Channel

The following procedure is an example of moving the Central NI #1 from Channel #1 to Channel #2. The process is very much the same as moving a Station NI and is shown below in **Figure 59**.

1. Move the mouse pointer over Central NI #1, click and hold the left mouse button.

2. A square with a **Green** highlight and the number 1 in it will appear under the pointer. Drag this to the Channel #2 square, which will also gain a **Green** highlight.

3. Release the mouse button.

4. The line linking Central NI #1 to Channel #1 will move across to Channel #2 as shown in **Figure 59** below.

5. The action is complete.

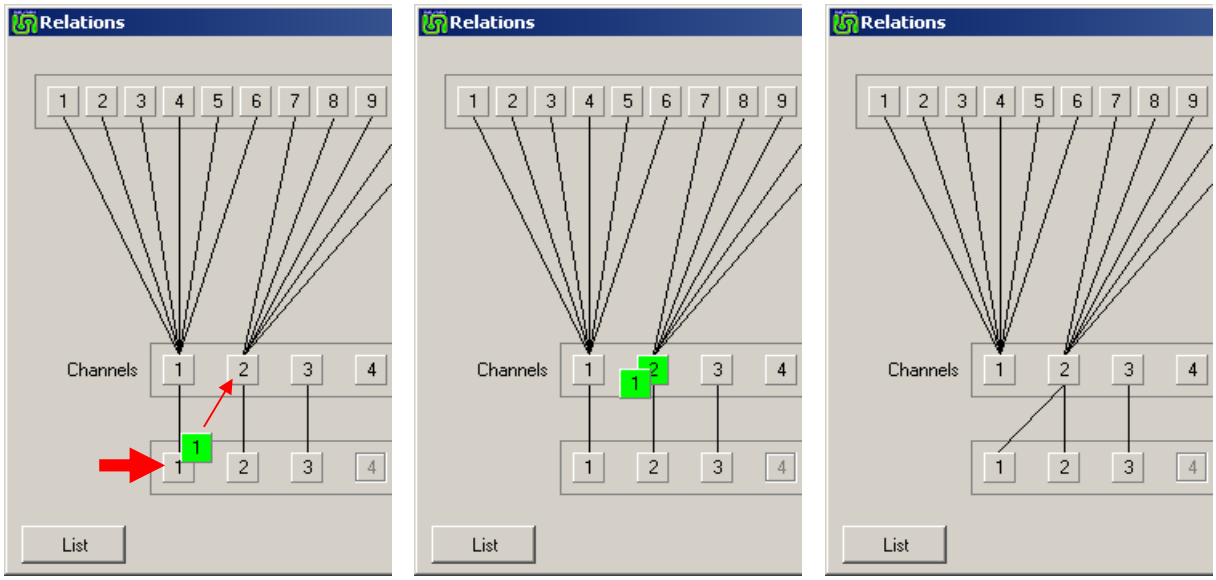

Figure 59. Moving a Central NI between Channels.

6.2.4 Disabling and Re-enabling a NI

If a Station or Central NI is disabled this will cause the relationship between that NI and the channel to cease and the connecting line to disappear. When the NI is re-enabled, the original relationship will be restored.

A new Central NI added to the system will normally relate to the corresponding Channel number; i.e. Central NI #3 will connect to Channel #3, Central NI #4 to Channel #4 as so forth.

The example in **Figure 60** shows the effect of disabling Station NI #4.

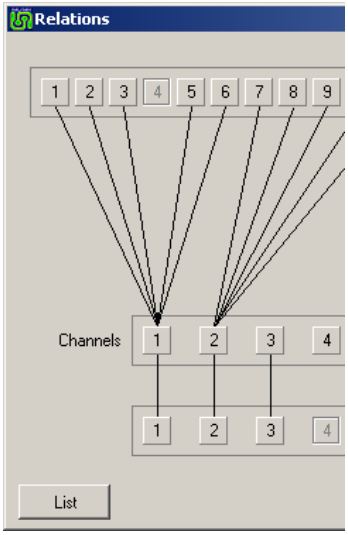

Figure 60. Examples of disabled NI.

6.3 LIST

The function of 'List' is to present all the NI and Channels that are on the system in a single window for ease of identification. 'List' may be activated directly from the TM Status panel or via the 'Relations' window.

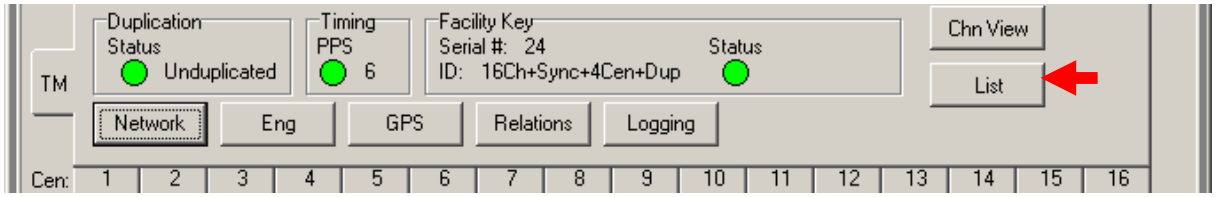

Figure 61. Route to List facility.

There are three lists in the window; one for Stations, one for Channels and one for Centrals. Each list is on its own page and accessed with the corresponding tab. Each member in the list will be displayed with its 'Name', i.e. the text label attributed to the NI or Channel.

If an NI is currently offline, the name will still be visible but will be greyed out to indicate its offline status as shown for Station # 4 in **Figure 62** overleaf. An NI that has been "seen" by the TM at some stage, perhaps during the system staging process, will be retained until over-written by another; i.e. there is no facility to delete unwanted entries.

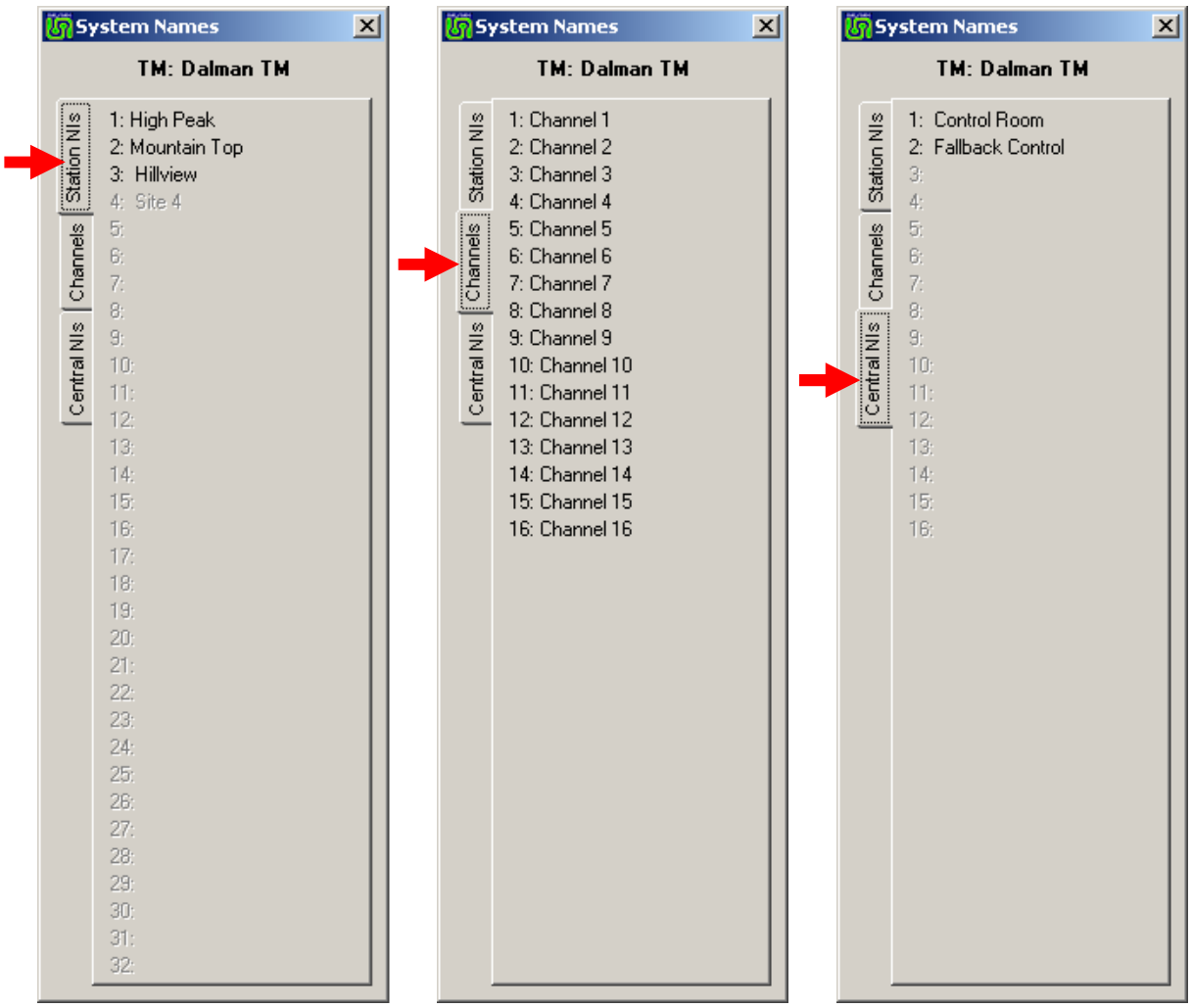

Figure 62. Pages in the 'List' window.

7 SOLAR (SYNC) TIMING

7.1 GENERAL

The purpose of this section is to give the user an understanding of the way in which Solar operates in the context of packet timing and buffering, which is core to the task of delivering consistent and reliable audio over an IP network. There is more information on the specific subject of IP network changes and the effects on Solar operation in **Section 11 – Troubleshooting & Maintenance**.

7.1.1 Synchronising Signals

The first and fundamental issue to be appreciated is that to synchronise multiple signals, which each pass over different bearer circuits, means that each signal must be delayed by an amount such that its total end-to-end delay is the same as that of the signal that passes over the route of longest delay. In other words, hold back the quicker signals until they are each as slow as the slowest, since it is not possible to make the slower signals travel faster. This is a core principle and is just the same for Solar as it is for a conventional analogue borne simulcast system.

7.1.2 Network Jitter

There is an additional aspect about the use of IP that is different to conventional bearers and that is "Network Jitter". On a stable and robust IP network, IP packets are likely to arrive at a fairly consistent rate. However, even on good, reliable networks there will be times when packets get delayed slightly longer than the average, for a variety of reasons. To cater for this situation, it is necessary to hold packets received at the destination unit in a store or buffer for a short (variable) time, then output the data at precise intervals to iron out these variations and produce a steady contiguous audio stream. Larger variations in the packet delivery times require larger buffers, however, it would be poor practice to use large buffers as a means to overcome a poor quality or unstable IP network. The user must be satisfied that the IP network is working correctly at the outset before attempting to optimise Solar 'Sync Timing'.

7.2 SOLAR INTERNAL TIMING

The 1PPS timing signal is used to generate very accurate timing frames of 20 ms duration and it is to these frames that Solar is synchronised – this is the function of the PLL in the NI. Therefore, each 1 second period will contain 50 such frames, which are numbered 0 to 49 with frame 0 (zero) starting on the rising edge of the 1PPS signal. Since all internal timing events are linked to the frame clock, Solar's timing parameters are in 20 ms steps.

7.2.1 Determining the Timing Values

In order to operate correctly, the timing settings must be sufficient to provide buffer periods that can cater for the longest delay exhibited on the system. It should be recognised that the longest network delay may not occur during normal operation but under network fault conditions if a network re-route is applied (see **Section 11.1 – Network Latency and Faults** for further information on this topic).

The initial approach for commissioning is to set timing periods that will probably prove to be significantly longer than the network delays. However, these settings will need to be optimised, as it is likely to result in the end-to-end delay on the audio signal being longer than necessary, which may be noticeable especially for T/T operation.

7.2.2 PAT Reports

To be able to select the optimum timing values, the average time taken for data packets to arrive at each unit are calculated and displayed on the TM Sync Timing page. These times are labelled 'PAT' and are calculated once a second, based upon the time taken for the packet originating in frame 0 to arrive at the destination unit. The 'PAT TM' figure indicates the time of packet arrival at the TM, the 'PAT' NI figure indicates the time of packet arrival at an NI. Both figures are rounded up to the nearest 1 ms.

The data flow in a Solar network may be divided into four discrete parts:

- Central NI to TM.
- TM to Station NI.
- Station NI to TM.
- TM to Central NI.

'Sync Timing' which is part of the TM Engineering as shown in **Figures 50 and 51** and described briefly in **Section 5.3.1 – Sync Timing**, has been arranged to reflect this separation of data flow. One page is concerned with the data flow between Central NI and TM and the other page with the data flow between TM and Station NI. Each one of these pages is then divided into two further parts by considering the "GO" traffic and "RTN" traffic separately.

Individual Sync Timing values need to be entered for each direction of traffic flow for the entire Solar network. Even though significant time differences should not be observed between the two directions, this facility does cater for unusual network situations, e.g. asymmetric network speeds. It is the alignment of the audio signal timing to a common and consistent overall figure at every NI that ensures true signal phase coherence; this value is the Total Output Time or 'TOT'. Part of the 'TOT' is allocated to be the TM input buffer time, 'GO TM Buffer' and 'RTN TM Buffer', the remainder becomes the NI input buffer time, which has no specific name. Therefore, it can be seen that the 'GO TM Buffer' and 'RTN TM Buffer' cannot be greater than their respective 'TOT' times and that increasing a TM input buffer size is likely to mean that the 'TOT' for that direction will need to be increased accordingly.

7.2.3 Solar Buffer Size

The input buffers on Solar are capable of holding 50 packets, which means that the maximum delay that Solar can accommodate is 1 second. As this amount of delay on a PMR system would be totally unacceptable, this is limited in the software to 500 ms even though this figure should far exceed the packet delays experienced in practice.

7.3 Parameter Checking Tool

As an aid to setting the timing values, checking their validity and to assist with timing optimisation, a checking tool using Excel™ is available from the Team Simoco web site. This is designed to replicate the TM 'Sync Timing' page and requires entry of the four main timing values, which must be entered first, and the PAT reports for every NI. As the spreadsheet makes extensive use of macros, these must be enabled for the tool to function.

Using this tool, it is possible to see the effect of a progressive increase in network delay (every NI is deemed to be affected in the same way), which helps to give an indication of whether the timing values in use have a reasonable margin or are close to the limit.

7.4 Loss of 1PPS Timing

Whilst the TM expects to be connected to a timing signal (1PPS), operation can continue if the timing signal is lost. Whilst 1PPS timing is present, the TM builds and maintains a table of the PAT values from every NI. If 1PPS is subsequently lost, the TM will adjust its own clock timing based upon the average PAT value from the first NI in the table that has a valid 1PPS signal, usually Central NI #1. If Central NI #1 is also suffering from loss of 1PPS (it may be co-sited with the TM and share the same 1PPS signal) or simply doesn't exist, the TM will look to take timing from the next NI in the table and so on down the table until an NI with a valid timing signal is found.

This method of timing will not give the degree of accuracy that a 1PPS signal produces. However, it is more than sufficient to ensure that the packets arrive at all the NIs at a time that still allows full

packet buffering, therefore maintaining approximate synchronisation. This fallback mode of timing is indicated by the text 'NI' where the 'SV' number is shown alongside the 1PPS status indication (now showing **Red** failed) on the TM status panel.

7.5 TIMING DIAGRAMS

If the user wishes to gain a deeper understanding of the Solar timing process and the selection of the correct timing values, some timing diagrams have been produced. The diagrams show the sequential events that occur when a 20 ms sample of an audio signal presented to the input of a NI. This is processed within Solar then passed through the bearer network and ultimately re-constituted into the original audio signal at the destination NI.

For the purposes of clarity, the Solar network shown has been restricted to a single Central NI and two Station NIs. Neither do the diagrams show any network devices that will be interfacing between each Solar unit and the network itself. Therefore, it may appear that Solar is being connected at different network data rates whereas, in practice, it will only ever connect at 10/100 Mbs (the NI is always 10 Mbs) but the data will be transported at the rate determined by the local network speed.

7.5.1 Dynamic Diagrams

A fully dynamic copy of the core timing diagram has been produced using Microsoft™ Visio™ and is available on the Team Simoco website. This diagram allows variables about the network characteristics to be entered and the resultant effects on Solar timing can be examined. Two versions of the file are available: one in Visio 2005 format; and one in the earlier Visio 2002 format.

For those who do not have a copy of Visio, a Visio viewer is available from the Microsoft™ web site. This will allow the diagrams to be displayed but may not allow access to the dynamic aspect of the timing diagrams, which is the feature that is most useful.

7.5.2 Operating the Visio Diagrams

The Visio diagram has two pages: one for the "Go" path; and one for the "Return" path. Each page operates independently from the other but they both basically function in the same manner. The results of the parameters entered are summarised in the reports box, which is also fully dynamic.

To change the parameters for each section of the network, right click on the text box displaying the network information to open the menu list. The first menu item shown is for the NI parameters; select that to open a data entry window, where a data rate may be selected and a delay value entered. A network delay limit of 60 ms has been applied and, whilst it is possible to enter a higher value, this will not be used and a notice of 'Invalid Delay' will be displayed. A range of network connection speeds has been provided and the packet size changes according to the data rate, which naturally impacts upon the network delay figure.

To make changes to the Solar setup parameters, right click on the background to open the page menu. The first item in the menu list is 'Solar Parameters'; select this to open the data entry window. All entries for 'Solar Parameters' are from pull down lists, therefore, it is not possible to enter an invalid value.

All shapes within the diagram have been protected to prevent the inadvertent movement of a shape. If a shape is moved it will lose the relationship to the other shapes and the diagram will no longer function correctly. If this situation should arise, since 'Undo' will not recover the severed link, the best course of action is to delete the diagram and reload the file from the web site.

8 TM DUPLICATION

8.1 DUPLICATION OVERVIEW

The TM lies at the heart of a Solar network and loss of the TM whether due to a unit fault or network failure will have a severe impact upon the operational capability of the system. To mitigate the risk there is a “Facility Key” enabled option to have a second TM acting as a hot standby unit.

This additional or Secondary TM is able to automatically takeover operation of the Solar network should the first or Primary TM become unavailable. Once the Primary TM becomes available again, the Secondary TM will stand down and the Solar network will return to normal mode of operation from the Primary TM.

Apart from a possible network traffic load change in parts of the network, there is no operational or performance difference in operating the Solar network from a Secondary TM, since it is an identical unit to the Primary TM. To maintain correct operation, it is very important that the same firmware release is installed in both TM. Any firmware upgrade must be applied to both units (see **Section 11.2.3 – Traffic Manager** for more information).

Solar 2 has introduced an extension to the original 1+1 configuration option in that up to five Primary TM can now be supported by a single Secondary TM. The duplication process involving more than one Primary TM remains fundamentally the same as for a 1+1 configuration.

Knowledge of the network design is important when considering a duplicated configuration either at the initial installation or if an existing Solar network is upgraded to duplicated TM operation. The reasons for this are discussed briefly below.

8.1.1 TM Resilience

To obtain the maximum benefit from employing a duplicated TM configuration, the Primary and Secondary TM equipment should be placed at different physical locations. This approach provides better resilience compared to placing both TMs at the same location where single points of failure can occur. However, diverse locations can produce unwanted effects when the change in traffic flow through the network is taken into account. These effects are discussed in detail in **Section 11 – Troubleshooting & Maintenance** and in particular **Section 11.1.3 – TM Duplication**.

8.1.2 Duplication Operation

The Primary TM sends a summary of the system configuration file to the Secondary TM every second, which the Secondary TM acknowledges. This serves to check if any configuration changes have been made as well as confirming to each TM that the other is operating normally. If configuration changes have been made in any of the Primary TMs, the Secondary TM will recognise that situation and, in order to bring itself up to date, will request the full configuration file from the Primary TM in question. The configuration update process is completed in a few seconds as the file is very compact. Therefore, the Secondary TM will hold and maintain as many configurations as there are Primary TMs on the network (to a maximum of five).

Other than entering the IP address information of the Secondary TM and those of the Primary TM to be supported, no further configuration of a Secondary TM is necessary. If a change is made to a setting on the Secondary TM that is online and acting for a Primary TM, i.e. a Primary TM has become unavailable, that change will be overwritten by the Primary TM when it comes back online since it has precedence.

As stated earlier, up to five Primary TM units can be supported by one Secondary TM but this means that the Secondary TM can only take over from one Primary TM at a time. To cater for the situation where more than one Primary TM becomes unavailable, rather than applying a “first come, first served” rule, which could easily lead to an arbitrary result, the IP addresses for the Primary TMs that are entered into the table in the Secondary TM also reflect the order of priority.

For example, if the Secondary TM has taken over the duties of the Primary TM in position two in the table, then loss of the Primary TM in position three will not result in any change in the function of the Secondary TM and the Solar channel(s) operated by Primary TM number three will be unavailable. However, if at this time Primary TM number two is brought back into service (online), the Secondary TM will relinquish the duties of Primary TM number two and take over for Primary TM number three. If, in this example situation, Primary TM number one (first position in the table) is lost, the Secondary TM will cease the duties for any other Primary TM and take over for Primary TM number one since it has highest priority.

8.1.3 Changeover Operation

Loss of the data exchange between one of the Primary TMs and the Secondary TM will cause the Secondary TM to assume that that particular Primary TM is unavailable; consequently, the Secondary TM will start sending data packets to every NI under the jurisdiction of the failed Primary TM. Since every NI sends its data packets to the IP address that is taken from the source of the incoming data packets, the changeover to a Secondary TM results in NIs 'connecting' to the active TM simply by changing the destination address of their outgoing packets.

In this way, control of the system will changeover to the Secondary TM and this usually occurs within 5 seconds. However, this time may be extended according to the network design and the nature of the failure. The status quo will continue indefinitely until the data exchange between Primary and Secondary resumes, at which point, the Secondary TM will cease to send data packets to the NIs and thereby relinquishes control back to the Primary TM. The NIs will now receive data packets from the Primary TM, which will change the destination address back to that of the Primary TM and normal operation will return.

8.2 CONFIGURING FOR DUPLICATION

Attempting to select a duplicated option on a TM that does not have the facility enabled in the 'Facility Key' will fail. The three duplication options for a TM unit are detailed below.

8.2.1 Unduplicated

This option is the default stand alone mode of operation of the TM. In this configuration the TM is effectively operating as a Primary TM but not configured for the presence of a Secondary TM.

8.2.2 Duplicated (Primary)

This option specifies that this TM will be operating in a duplicated environment and that it is designated as a Primary TM.

To configure a TM to operate as a Primary, carry out the following:

1. Open the TM Status panel and select the 'Network' button (see **Section 4.3 – Setting the TM IP Address**). The 'TM Network Setup' page shown in part in **Figure 63** overleaf will open.

2. On the 'TM Network Setup' page, carry out the following:

    2.1. Select the 'Eng' button.

    2.2. Using the drop-down list, set the TM Duplication to 'Duplicated (Primary)'.

    2.3. Tick the 'IP Address 1' box, which is now active.

    2.4. Enter the IP address of the Secondary TM.

    2.5. Select the 'Apply' and then the 'Close' buttons.

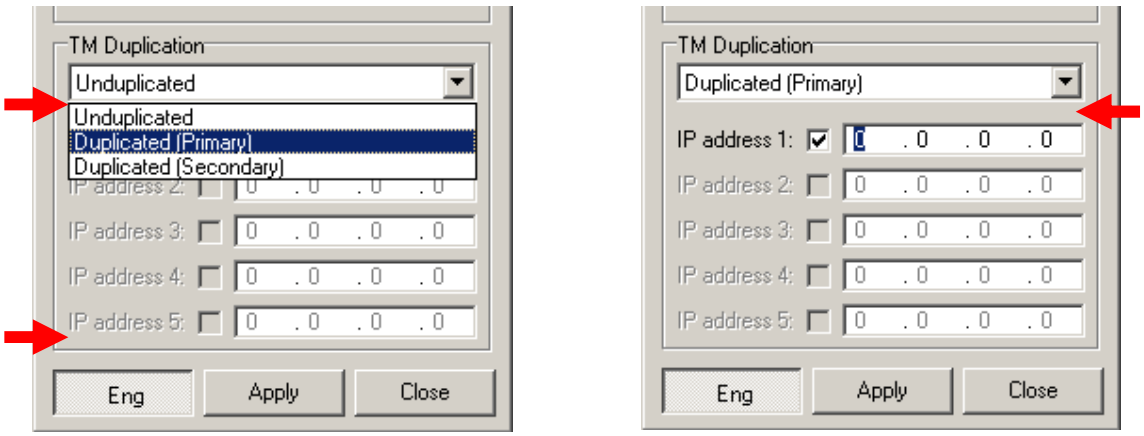

Figure 63. Setting for Duplicated (Primary).

Note.

If an IP address is entered that is the same as one already actively in use anywhere on the TM this will be cleared back to 0.0.0.0 when 'Apply' is clicked.

The 'Duplication Status' text will now change to reflect the duplication setting and the colour of the indicator will show the status – see **Section 8.2.4** below.

8.2.3 Duplicated (Secondary)

This option specifies that this TM will be operating in a duplicated environment and that it is designated as a Secondary TM.

To configure a TM to operate as a Primary, carry out the following:

1. Open the TM Status panel and select the 'Network' button (see **Section 4.3 – Setting the TM IP Address**). The 'TM Network Setup' page shown below in part in **Figure 64** will open.

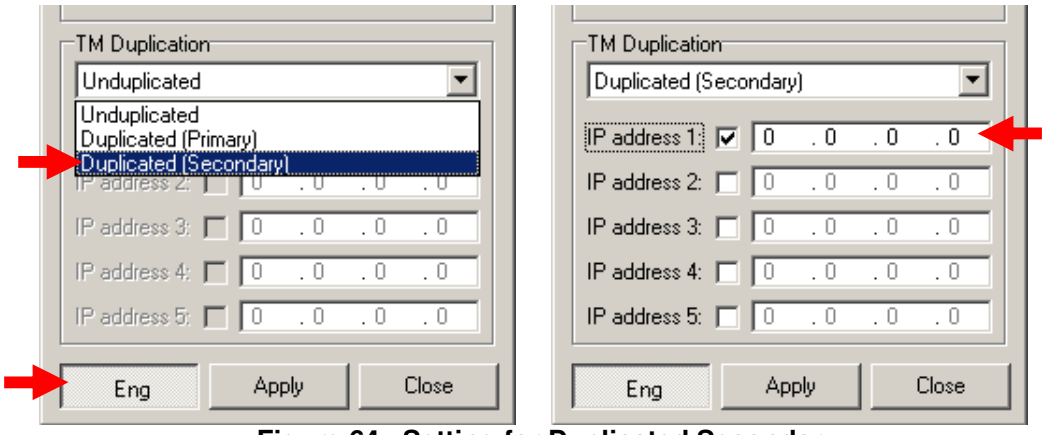

Figure 64. Setting for Duplicated Secondary.

2. On the 'TM Network Setup' page, carry out the following:

   2.1. Select the 'Eng' button.

   2.2. Using the drop-down list, set the TM Duplication to 'Duplicated (Secondary)'.

   2.3. Tick the 'IP Address 1' box, which is now active.

   2.4. Enter the IP address of the first Primary TM.

2.5. Repeat Paras 2.3 and 2.4 for any further Primary TMs but ticking 'IP Address' box 2, 3 etc in order of their priority.

2.6. Select the 'Apply' and then the 'Close' buttons.

Note.

The IP address table also reflects the priority order in which the Secondary TM will take over from the Primary TM (highest priority is position 1, lowest priority is position 5).

The 'Duplication Status' text will now change to reflect the duplication setting and the colour of the indicator will show the status – see **Section 8.2.4** below. Once the Secondary TM is configured and connected to the network it will quickly gain the configuration(s) from the Primary TM(s) and be ready to operate as hot standby.

8.2.4 Duplication Status

The text alongside the Status indication on the TM Status panel will show 'Primary' or 'Secondary' according to the duplication configuration.

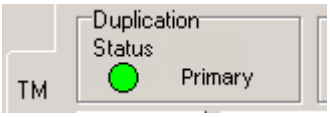

Figure 65. Duplication Status Indication.

Confirmation that Primary and Secondary units are operating and in communications with each other is shown by the 'Duplication Status' indicator going **Green**; loss of communications will cause the indicator to turn **Red** on both units. A **Red** Status indication does not necessarily mean that the other TM has failed but that there is no information exchange between units. This may result from unit failure or a network problem. However, in the case where the Secondary TM has taken over from another Primary TM since it no longer is able to offer support to those of a lower priority, the Secondary TM will cease communications with those units causing a **Red** Status indication to be displayed on each.

The Status indicator may be assigned 'Alarm' status although an unduplicated TM will never show a **Red** Status indication; see **Section 12 – Alarms**.

9 DIAGNOSTICS AND OTHER INFORMATION

9.1 GPS

If a GPS Rx is used to provide the 1PPS timing signal, it is likely that NMEA data will also be supplied. Information is taken from the NMEA data stream about the GPS Rx and displayed on the satellite signal report page. The 'GPS' button on the NI ET and the TM ET provides access to this page, which is designed to assist in the installation and any subsequent diagnostics of the GPS Rx. The page is identical in look and operation for both types of ET. Whilst part of the equipment configuration is to define whether or not NMEA data is present (see **Section 5.3.2.2 – GPS Module**), the information will always be displayed when NMEA data is connected, i.e. irrespective of the setup configuration.

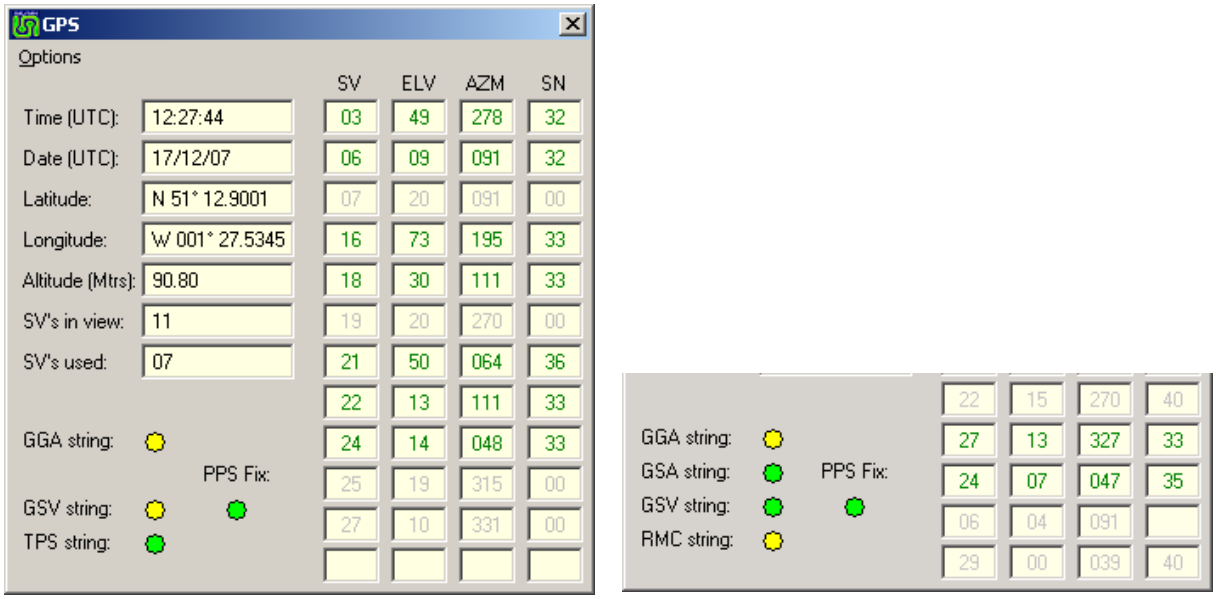

Figure 66. Satellite Signal Report.

With the exception of the 'PPS Fix' indication, the indicators will flash **Green**/**Yellow** to confirm correct operation. If all indications remain **Grey** then no data is being received and further investigation will be required.

The "string" information may differ with early models of GPS Rxs:

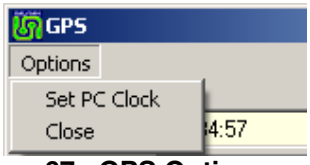

Figure 67. GPS Options menu.

Through the 'Options' menu it is possible to use Universal Time Coordinated (UTC) time from the GPS Rx to 'Set PC Clock' of the PC running the ET application. This automatically takes into account the world time zone setting of the PC. The other option is to 'Close' the GPS page.

9.2 FACILITY KEY

The 'Facility Key' is a hardware element of the TM programmed and fitted in the factory that determines the options available. Correct operation of the 'Facility Key' is indicated in the area of the TM Status panel (part shown below).

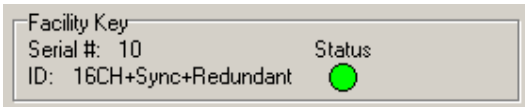

Figure 68. Facility Key information.

There are three aspects of information displayed about the Key:

(a). '**Serial #**'. This is the unique number for the 'Facility Key' and ties it to the original supply.

(b). '**ID**'. This is a short text string that outlines the facilities enabled by the Key.

(c). '**Status**'. This indicates the status of the 'Facility Key' and will show **Green** when working correctly or turn **Red** under a fault condition. This will be accompanied by the text:

(i). **Failed**. The 'Facility Key' is now not working correctly having previously been working.

(ii). **Not Found**. The 'Facility Key' has not been detected at start-up.

The 'Facility Key' Status may be assigned "Alarm" status, see **Section 12 – Alarms**.

9.3 CHANNEL VIEW FACILITY

Although this facility is closely linked to the 'Relations' aspect of a multi-channel TM, it probably becomes of most benefit during system monitoring or maintenance work.

9.3.1 Normal View

To identify which stations are on which channel, the borders around the Station panels that are members of the channel group and the corresponding 'Chn' tab turn **Green** when the channel status panel is selected. If the channel has an associated Central NI, the Central NI tab for that channel group will also gain the **Green** border. Similarly, selection of the Central NI panel will produce the same indications for the channel group to which that Central belongs. Every Station panel, whether enabled or not, will be visible at all times.

9.3.2 Channel View

When a TM is operating a multi-channel environment, unless the TM configuration has segregated the stations on a channel by channel basis, it may not be readily apparent which stations belong to which channel. This situation becomes most noticeable if the user is trying to monitor the activity of just one channel and stations on other channels are also active, which serves as a distraction.

9.3.3 Selecting Channel View

To enable channel view mode, on the TM Status panel, select the 'Chn View' button (see **Section 3.4.1 – TM Status Panel**). Once this mode is enabled, selection of any channel related item results in only the NI (Stations and Centrals) that are members of that channel group remaining visible. Normal operation of those NIs no longer visible continues, i.e. this mode does not affect operation in any respect, it just changes the view presented on the TM ET.

Examples of Channel view mode are shown overleaf in **Figure 69**.

9.3.4 Returning to Normal View

Reselecting the TM Status view will cause all station panels to become visible as no channel specific item is selected. To return fully to this view, release the 'Chn View' button on the TM Status panel.

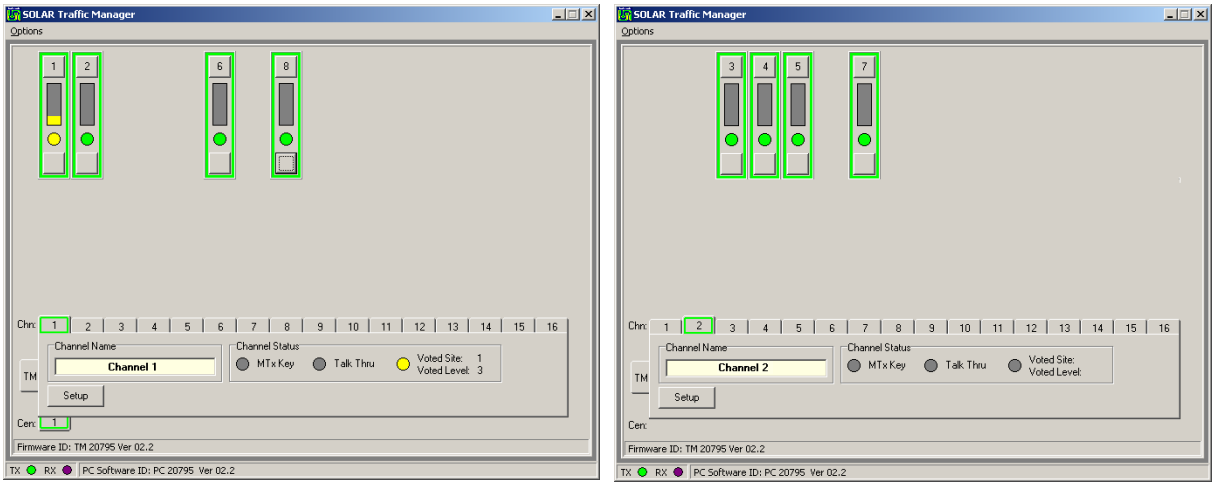

Figure 69. Examples of Channel View Mode.

10 RECEIVER VOTING

10.1 VOTING OVERVIEW

The process of selecting the best signal from a collection of signals that are being returned from several Station NIs at remote radio sites is commonly referred to as “Voting”. This terminology will be used throughout this section.

The voting process takes place in the TM unit at a digital level. In order that the TM can make a selection of the best incoming signal, information needs to be available on which the voting process can operate. That information is produced by the Station NI and, upon receipt of that information, the TM will make a comparison of the value that is being returned from every active site and, subject to criteria, select the site delivering the highest value.

10.2 SIGNAL QUALITY INFORMATION

Each and every Station NI will produce a value representative of the quality of any signal originating from the co-sited base station Rx.

The source of this signal can be in one of two formats:

- Signal strength reading as an analogue voltage (RSSI).
- Variable tone representing the RSSI (either continuously variable or stepped).

The analogue voltage RSSI is taken to a dedicated input on the facilities connector, whereas the variable tone is taken from the audio input that is being produced from the base station Rx.

Whatever the signal source selected (a user configurable feature), it is turned into a number that is compared to preset boundary values (also configurable parameters), which define the minimum threshold of operation and govern the range and resolution of the reported signal quality level. A hard-wired signal indicating receiver mute open (COR) may also be used. The configuration values of these parameters are likely to be the same at every radio site and that is a good way to achieve initial setup. Subsequently, these may well be varied to suit individual site conditions, e.g. sites with high background noise levels.

A value representing the signal quality is added to the packet of data containing the radio traffic itself and passed back to the TM every 20 ms. This information is treated as a high priority part of the Solar supervisory and signalling data subset information within the IP data packet.

10.3 VOTING PROCESS

For each NI, the RTN traffic audio packets are assigned to slots in a queue (a buffer) according to the packet number. This action ensures that the packet order is correct, so that when the Voter process compares the RSSI of packets at the head of the queue they will all have the same time of origin (the input from main Rx to Station NI). As this is done for every NI at the same time, synchronisation of the RTN audio is achieved.

The Voting process consists of looking for the mute open status within each packet and extracting the RSSI value if appropriate. The RSSI values for each active site are then compared and the packet from the site offering the highest value is passed to the Central NI for decoding. Once a site is selected, a site offering a higher RSSI value must exceed the current RSSI value of that from the selected site by the ‘Voter Level Difference’ parameter before a change in selection will occur.

As this process is undertaken for every packet, the voting response time is 20 ms. Since the IP data packet contains both the RSSI information, the digitised audio and simultaneously conveys the fact that a signal is present, no audio will be lost at the start of an incoming signal due to the delay whilst the voter makes a signal assessment. The latter situation is common with conventional analogue voting systems as the audio is already being presented before the voter has made a selection.

10.4 VOTER CONFIGURATION

The Firmware configuration table contains variable parameters that control the action of the Voting process based on the Signal Quality information. These parameters have a range of movement which may include the OFF state; they can be adjusted to give optimum performance to suit the operational conditions.

10.4.1 Voting Parameters

The configuration table state is non-volatile and is accessed indirectly via the ET.

Table 4. Voter Adjustable Parameters.

Function	Range
Level of difference in RSSI necessary before a selection change is made.	1 to 13 in unity steps.
Deselect and ignore a site that has had mute open for x (time). Return the site to voter availability when it's mute closes for a minimum of 10 seconds (not configurable).	Range OFF or x = 5 min to 30 min in 5 min steps.
Voter Override – a means to force the selection of site x irrespective of the incoming RSSI.	Range OFF or x = 1 to 32 – only enabled slots may be selected.

10.5 BEST SIGNAL SELECTION – PARAMETERS

This relates to the measurement units used by the integrated Voting algorithm of the NI.

10.5.1 RSSI

An output is required from the base station Rx in the form of a varying voltage or a variable tone that is input to the Station NI.

Table 5. RSSI Requirements.

Function	Range
Voltage RSSI:	
Voltage Input Range	>0 V and <5 V DC
Conversion Resolution	14 steps
Conversion Settings	The minimum and maximum values of RSSI input are entered as boundary values. A minimum value of zero will disable the function. A value exceeding the maximum will not increase the RSSI further.
Tone RSSI:	
Tone Input Range	2.6 kHz to 3.5 kHz – user definable.
Conversion Resolution	14 steps – equally spaced in tone range

10.6 SQUELCH INPUT (COR)

This is an optional input condition, since the RSSI input itself can be used to determine that the receiver is active once the input signal has reached the minimum boundary value. However, use of this input is strongly recommended to prevent false voting states if an RSSI voltage is used. This condition can often occur, as the RSSI voltage output is likely to rise when invalid signals are received (incorrect or no CTCSS) or from high level close frequency signals such as adjacent channel interference.

To use this input for the “Squelch” or “COR” state requires that ‘Isolated Input #1’ be assigned to ‘Auto’ in the Setup configuration of the NI (see **Section 5.2.2.4 – Isolated Inputs**). It is activated by the application of a ground (0 V) to the input and when the RSSI signal from the receiver is equal to or exceeds the minimum defined level the voting encode process will commence; i.e. Rx squelch **AND** the minimum RSSI level are both required.

11 ET TROUBLESHOOTING AND MAINTENANCE

11.1 NETWORK LATENCY AND FAULTS

The crucial parameters in the successful operation of Solar are the buffer times, which are set in the 'Sync Timing' page of the TM ET (see **Section 7 – Solar (Sync) Timing** for details). Making the buffers unnecessarily large will undoubtedly mean the Solar network will function but will introduce noticeable end-to-end audio delay especially for T/T operation. It is far better to optimise the settings to match the characteristics of the network. In order to do that requires an understanding of the effects that can result from network issues; these are examined in the following sub-sections.

11.1.1 Packets Arriving Late

Data packets that arrive outside of the allocated time window will be discarded. If this situation occurs infrequently, the effect is highly unlikely to be noticed. However, if the packet loss rate increases to a significant number, the glitches in recovered audio signal will become apparent, necessitating an increase in the overall time allocation or a examination of the network quality or both. If a problem occurs that causes every packet to arrive outside of the time window, the NI will not function, i.e. neither the audio nor the signalling will be output. The NI reports lost packets on the Setup Info page (see **Section 2.4.1.4 – Pkt Errors**).

11.1.2 Network Re-routing

One of the biggest advantages of using IP networks is the possibility to quickly re-route 'traffic' around a fault condition. Traditionally, this is not something that a conventional simulcast system could easily manage, due to the change in audio characteristics that inevitably results from changing a bearer circuit. As Solar is transported entirely at IP level, then, subject to its operating limits, Solar is able to make good use of the network re-route feature and provide a level of resilience not available to conventional simulcast systems.

It is quite reasonable to assume that, when a network route change occurs, the network latency or packet delivery times to one or more NI will also change. If this results in an increase in time, the buffer time(s) allocated could prove to be insufficient. This could easily be manifest as performance degradation on a Solar network that has been operating perfectly up until the point when a network re-route occurs.

Consequently, it is most important that all potential re-route conditions are carefully examined at the commissioning stage and the effect on packet delivery times are noted, which will probably require manually forcing a re-route to occur and analysing the effect. Once the "worst case" situation has been identified, i.e. the one that reports the longest network delivery times, these figures should be used to set the 'Sync Timing' parameters on the TM.

11.1.3 TM Duplication

If a duplicated TM configuration is to be used, then, as discussed briefly in **Section 8.1.1**, there is a clear benefit in not locating both Primary and Secondary units together. If this approach is adopted, there are two situations that must be considered:

(a). The network latency time between any given NI and each TM could be quite different.

(b). A network fault could result in loss of communications between the TM even though each TM is operating normally.

11.1.3.1 Delay from NI to each TM

The Solar network settings are held in the Primary TM and passed, in their entirety, to the Secondary TM, i.e. there is no provision to "customise" the Secondary TM in any way. Depending upon the network "distance" between the two TMs, it is quite reasonable to expect that some NIs will be 'closer' to the Primary than the Secondary and vice-versa.

If buffer settings are used that are simply taken from the results obtained from the Primary TM, albeit that this is the best way to get the system operating at the initial commissioning stage, when TM changeover occurs, it may be found that system performance degrades. Therefore, it would be very easy to conclude that there is some sort of malfunction with the Secondary TM when in fact the real reason is more subtle.

Therefore, when it comes to optimising the Solar buffer times on a duplicated configuration, the packet delivery times must be examined when each TM is operating and the "worst case" values used. If a duplicated configuration is used together with network re-routing, the permutations of configurations will probably become considerable. However, unless the network architecture is very complex, it should prove relatively easy to identify what is likely to be the worst case situation and study that in detail in order to arrive at the optimum buffer settings.

11.1.3.2 Network Fault causing TM Changeover

Similar to the situation with a network re-route, a network failure could result in loss of communications between the Primary and Secondary TM while both units are working normally. This will result in the Secondary TM sending data packets to every NI while the Primary TM is still active. Since we are assuming a fault condition that is preventing inter-TM traffic flow, it would not be possible for any single NI to "see" both the Primary TM and the Secondary TM at the same time, i.e. the NI would only receive packets from one TM. This would cause a "split" of the NIs between the two TM.

The network design and the location of the fault determine which NI would be associated to which TM. This could range from the Central NI for the channel being on one TM and all the Station NIs being on the other TM to just one Station NI being "lost" to the Secondary. In the first scenario, the setting 'TM triggered Talk Thru' 'On Central NI Fail' (see **Section 5.4.2.4**) would be recommended so that the channel could still provide a fallback service when running on the Secondary TM. This setting would of course have to be applied at the Primary TM even though the facility may not seem appropriate when operating in that mode.

The results of network problems when using a duplicated TM configuration may be very varied but should be entirely predictable if each fault scenario is carefully considered, even though there may be little or nothing that can be done about the resultant effects.

11.2 FIRMWARE UP-ISSUES

11.2.1 Availability

The latest Firmware version is posted on the Team Simoco web site; users who are on a list of interested parties will be notified when a new version becomes available.

11.2.2 Loader – General

To up-issue the TM Firmware and NI PIC Firmware requires the use of the ET or 'Loader' software applications. The Loader software is available from the Team Simoco website and, like the ET, is an executable file, which uses the front panel USB port – it is possible to change firmware remotely with the ET, however, the Loader application needs a direct USB connection.

Note.

The ET cannot be used at the same time as the Loader software as they use the same com port on the equipment.

Run the Loader application and "Connect" to the equipment in exactly the same way as for the ET. Follow the help guidelines for using the ET in **Section 1.3**. The current Firmware version will be reported once the connection is established.

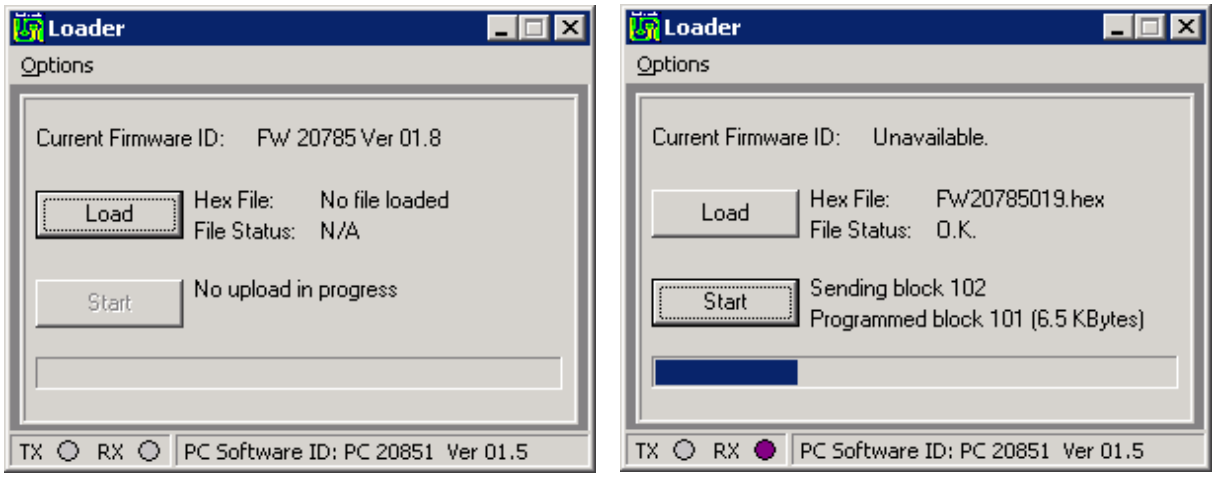

Figure 70. Loader Application.

On the Loader application window, select the 'Load' button and an Open file window will be displayed from which the folder and file may be selected; only filenames with the 'hex' extension will be displayed. Navigate to and select the correct file and, on the Open file window, select the 'Open' button to prime the file loading. On the Loader application window, select the 'Start' button to commence loading the selected file. The progress bar indicates the time to completion.

11.2.3 Traffic Manager

The TM will continue to operate normally during an up-issue. When the firmware upload is complete the TM will restart automatically and will be running the new software within a few seconds. Occasionally, adding new features will necessitate changing the format of the stored configuration data, therefore, the existing stored data may not match the requirement of the new firmware and, consequently, may need to be re-entered using the ET application. If this is going to be necessary, suitable notification will be given in the Engineering Bulletin that accompanies all software releases.

If operating a Solar network with duplicated TMs, it is essential that both TMs are upgraded to the same software version. During the upgrade process it would be prudent to ensure that only one of the TMs is operating at a time. This will prevent the situation arising when both TMs try to run the network, which might occur after the first TM is upgraded and before the second TM is brought up to the same version of software. Again, suitable advise of the potential for this situation arising will be provided in the associated Engineering Bulletin.

11.2.3.1 Invalid TM firmware

When a new firmware file is offered to a TM, the TM will check the file to ensure that it is valid TM firmware and a file that fails this check will be rejected. This check is very comprehensive so it would be extremely unlikely that an invalid file would be loaded. Once the file check test has been passed, the loading process will commence and each byte is checked against a checksum and again once the whole file is loaded. Only at this stage would the file be used to replace the existing firmware.

If circumstances should somehow arise that results in the firmware file being corrupted, although the TM will not operate normally, it will run a special fall back program to allow the 'Loader' to be connected so that replacement firmware can be loaded.

11.2.4 Network Interface

The NI will suspend normal operation during an upgrade. There are two Firmware programmes in the NI:

(a). **PIC Firmware**. This is the main unit operating process and is changed using the Loader application as detailed above.

(b). **DSP Firmware**. Digital Signals Processor (DSP) Firmware is changed using a function integral to the NI ET.

11.2.5 NI DSP Firmware Up-issue

A DSP Firmware up-issue is executed by selecting the 'DSP' button of the NI ET (see **Section 2.6**). This runs the Loader application from within the ET, which is used in exactly the same way as for the NI PIC Firmware itself.

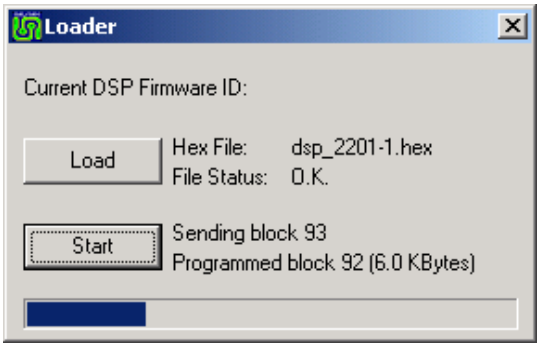

Figure 71. NI DSP Upgrade.

On the 'Loader' application window, select the 'Load' button to open a standard Open file window. On the Open file window, locate the appropriate DSP 'hex' file and select the 'Open' button to prime the file for loading. On the Loader application window, select the 'Start' button to instigate the upload process. The progress bar indicates the time to completion.

The NI will automatically restart following a DSP upgrade and the new firmware version will be reported in the DSP loader sub-window and on the bottom bar of the ET main window. Close the DSP loader sub-window with the ☒ (close) icon (top right).

12 ALARMS

12.1 ALARMS OVERVIEW

The alarms facility of Solar is a useful feature especially for the smaller systems. It is designed to alert the user by means of an alerter device connected to a Central NI to a situation designated as requiring attention. Configuration of the alarms facility and any subsequent analysis into the nature of an alarm requires use the TM ET and, therefore, is not recommended for use by non-engineering staff. Whilst alarms may originate from a NI, the NI does not generate the alarm condition. It is the report of a state change (an event) from a NI to the TM, as part of the normal supervisory process, which will cause the TM to raise an alarm if that event has been so designated, i.e. the alarm process lies entirely within the TM domain.

On larger systems or for more comprehensive system monitoring, the use of SNMP is strongly recommended. SNMP will provide control of many aspects of a Solar network as well as being able to take/accept user definable fault conditions. Full information on SNMP is provided in **Section 14 – SNMP**.

12.2 ALARM FUNCTIONALITY

There are a number of designated events in a NI and a TM that may be selected to operate as alarm initiation events. When an event is selected and that event is active, a flashing **Red** indication will be displayed on the ET to alert the user to the presence and source of the alarm.

An external indication of an alarm being active can be obtained from the 'Isolated Output #2' on a Central NI when it is set to operate in the 'Auto' mode. The alarm condition will then operate that relay in the Central NI for the channel that is exhibiting the alarm. If the alarm is from the TM itself making it channel independent, 'Isolated Output #2' will be activated on every Central NI configured for an alarm output.

12.3 ALARM SETUP (TM ET ONLY)

Although the majority of alarms are likely to originate from NI, there is no facility to alter or examine the alarm settings from the NI ET, as the alarm settings are managed and maintained by the TM from the status information passed to the TM through the supervisory sub-system. The events that may be selected to generate the alarm condition are set on a unit by unit basis through the engineering facility.

Events that can be configured to generate an alarm condition are selected by opening the 'Alarms' page (the 'Alarms' tab) of the item and selecting the event(s) as required from the following:

(a). Environment Inputs – 'Environment' page.

(b). Isolated Inputs (NI only) – 'Signalling' page.

(c). Network Status, 1PPS Status and PLL Status – these comprise the 'Misc Alarms' on the 'Facilities' page of the NI.

(d). Duplication Status, 1PPS Status and Facility Key Status – these comprise the 'Misc Alarms' on the 'Facilities' page of the TM.

Before any change or selection can be made, the 'Eng' button must be selected and the 'Apply' button used to confirm the selection.

12.3.1 Environment Inputs

Each of the environment inputs may be selected to generate an alarm whenever that input is taken to an active state. As each on the sixteen connection points may be defined as an input or an output, only those defined as inputs are available to assign to an alarm; those defined as outputs do not support the alarm facility as shown by the button being unavailable.

As an example, **Figure 72** below shows that points 4, 5 and 6 in Group 1 and 3, 4, 7 and 8 in Group 2 have been defined as outputs making them unavailable to be assigned to the alarm state. The remaining points have been defined as inputs and, of these, 2 and 7 in Group 1 and 1 and 6 in Group 2 have been assigned to alarm status.

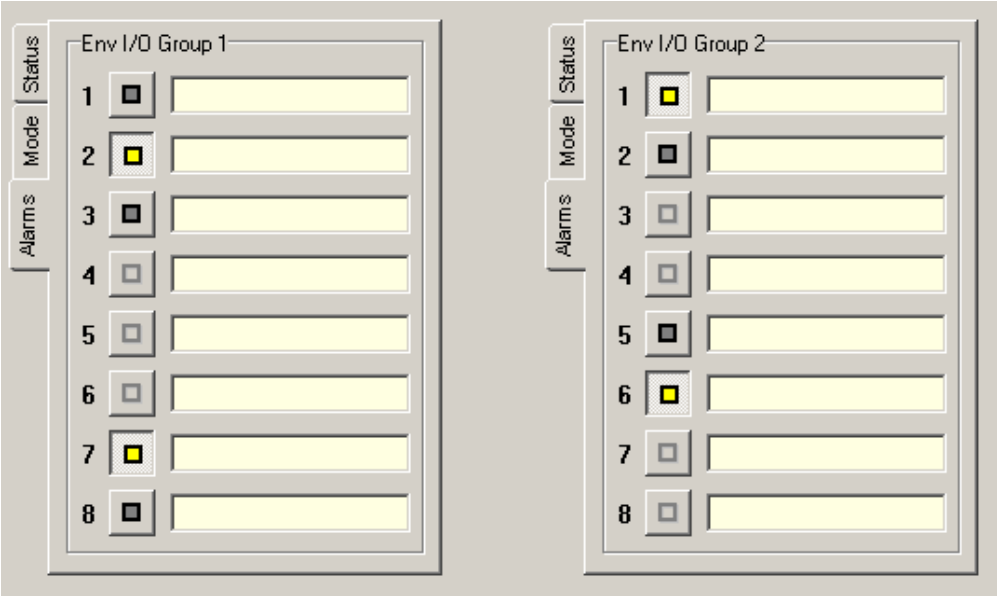

Figure 72. Setting Alarms for Environment Inputs on a NI.

12.3.2 Isolated Inputs

As an example, **Figure 73** below shows that 'Isolated Input' #3 has been assigned to alarm status.

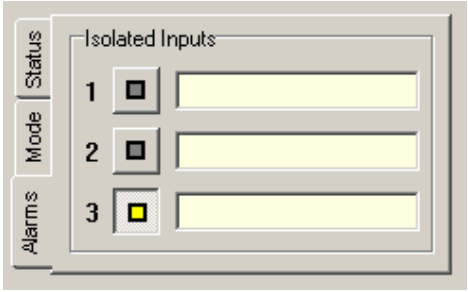

Figure 73. Setting Alarms for Isolated Inputs on a NI.

12.3.3 NI Misc Alarms

As an example, **Figure 74** overleaf shows that 'Network' and 'PPS' have been assigned to alarm status.

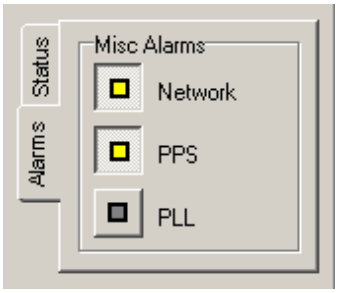

Figure 74. Setting Misc Alarms for a NI.

12.3.4 TM Misc Alarms

As an example, **Figure 75** below shows that 'Duplication' and 'PPS' have been assigned to alarm status.

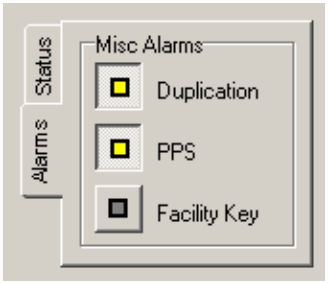

Figure 75. Alarms Setup for a TM.

12.4 ALARM INDICATIONS

12.4.1 Alarm Active

The presence of an alarm condition will be indicated by one or more flashing **Red** borders on the area(s) of the TM ET main window to indicate the source of the alarm(s). For a Station NI, this is the Station panel; for a Central NI, this is the 'Cen #N' tab; and for the TM itself, this in the 'TM' tab. If the origin of the alarm is an NI which will has a channel relationship, then the tab of the channel group containing the NI with the alarm will also gain a flashing **Red** border. If a panel or tab was previously selected so that it had a **Green** border prior to the alarm state, then the border will now flash alternately **Red** and **Green**.

In **Figure 76** overleaf there are two alarms active as indicated by the flashing **Red** borders or highlights; one is on the TM itself and the other is on Station NI#1. The Station NI#1 alarm is causing the alarm indication on the Chan #1 tab to appear since it is a member of the Chan #1 group. To determine the exact cause of the alarm, the status view of the unit with the alarm indication must be examined. For a NI this means clicking the button to open the remote view window; for the TM this is shown on the TM Status panel.

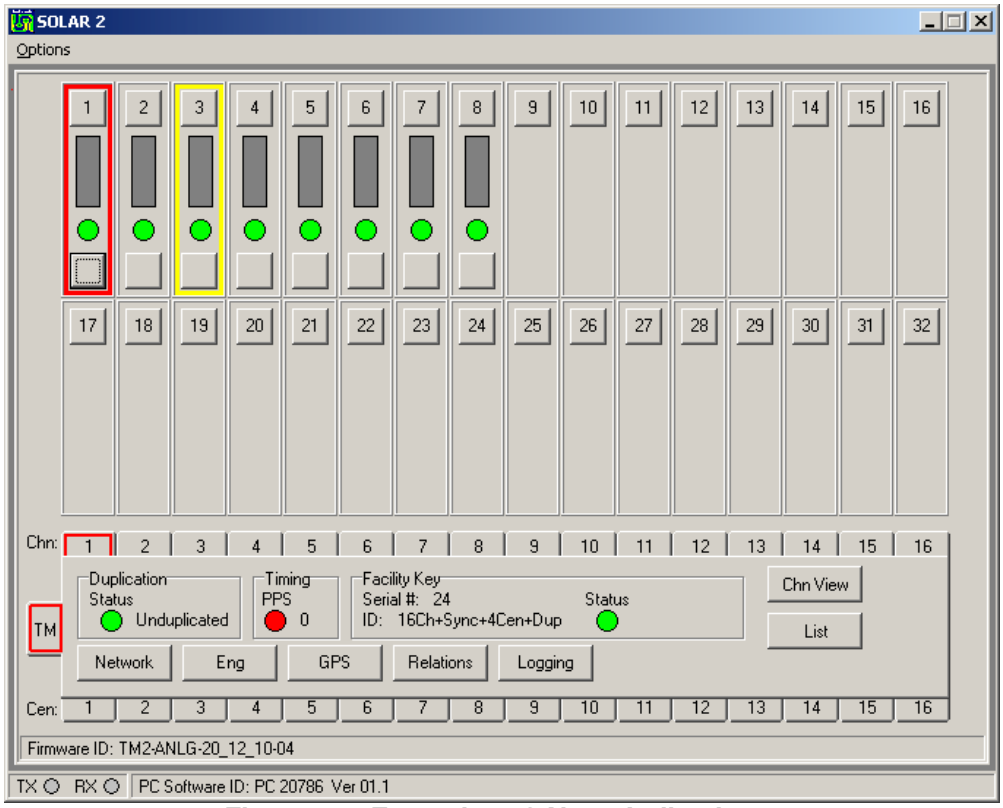

Figure 76. Examples of Alarm Indications.

12.4.2 Alarm Acknowledge

As an alarm indication will continue to be displayed even if the original event is no longer active, the alarm may be acknowledged so that the external alarm output, 'Isolated Output #2' on the Central NI, is deactivated. This also serves as a means of recognising if a subsequent alarm condition occurs before the first has been cleared.

When an alarm is acknowledged, the alarm indication will change to a flashing **Yellow** border if no other alarms are present on the unit. Once an alarm is acknowledged, the flashing **Yellow** indication will cease immediately if the original alarm event is no longer active or will continue until that alarm event becomes inactive. Individual status indicators will also adopt the flashing **Yellow** state for the alarm acknowledged condition. In **Figure 76**, Station NI#3 has an acknowledged alarm and the following figures will show the process of other alarms being acknowledged.

Alarms are acknowledged through the 'Engineering' facility for the unit concerned using the 'Ack Alarms' button, which will only become active if an alarm is present on the page in view. If alarms exist on more than one page, then each page must be acknowledged individually. Only when all alarms have been acknowledged will the common alarm indication for the unit enter the acknowledged state.

If alarms are originating from different units, each unit will have to be acknowledged individually. If multiple alarms are present on a channel, only when all alarms on the channel have been acknowledged will the external alarm output cease.

The alarm example in **Figure 77** overleaf shows that the TM alarm is due to the 'PPS' Status indicator on the 'Misc Alarms' page. The 'Ack Alarms' button is enabled and when it is selected, the alarm indication changes to the acknowledged state and the 'Ack Alarms' button becomes disabled. If a second alarm had been present on the same page, that too would have been acknowledged.

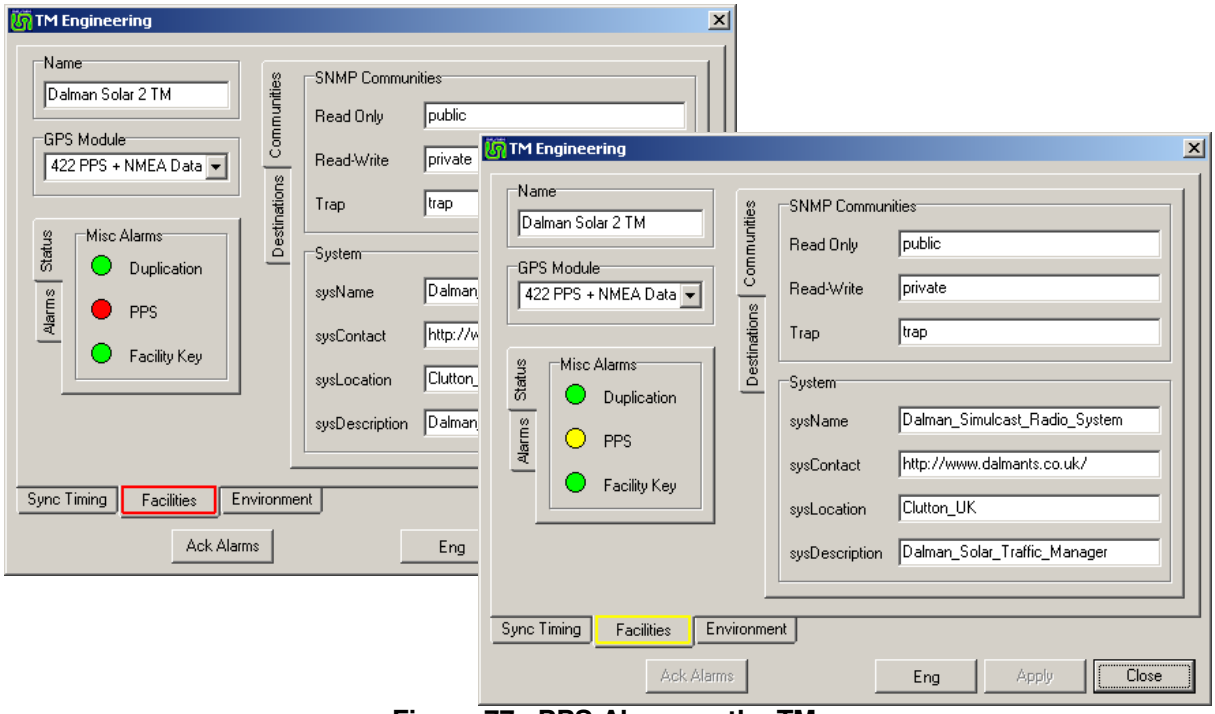

Figure 77. PPS Alarm on the TM.

The alarm example in **Figure 78** below shows that alarms are present on the NI 'Signalling' and 'Environment' pages. The 'Signalling' alarm is due to 'Isolated Input #3' and acknowledging that changes the flashing border on the 'Signalling' tab and the input indicator to flashing **Yellow** whereupon the 'Ack Alarms' button becomes disabled. The alarm on the 'Environment' page must be acknowledged separately as shown overleaf in **Figure 79**.

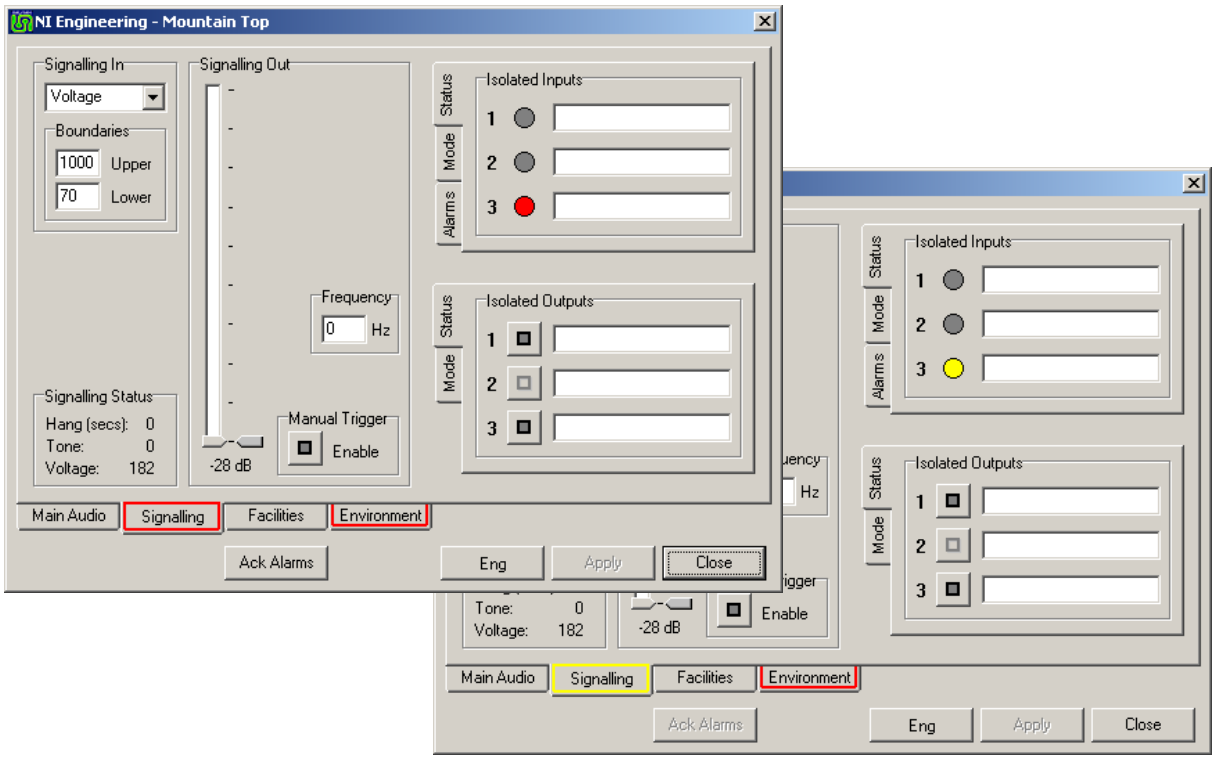

Figure 78. Alarm on the NI Signalling page.

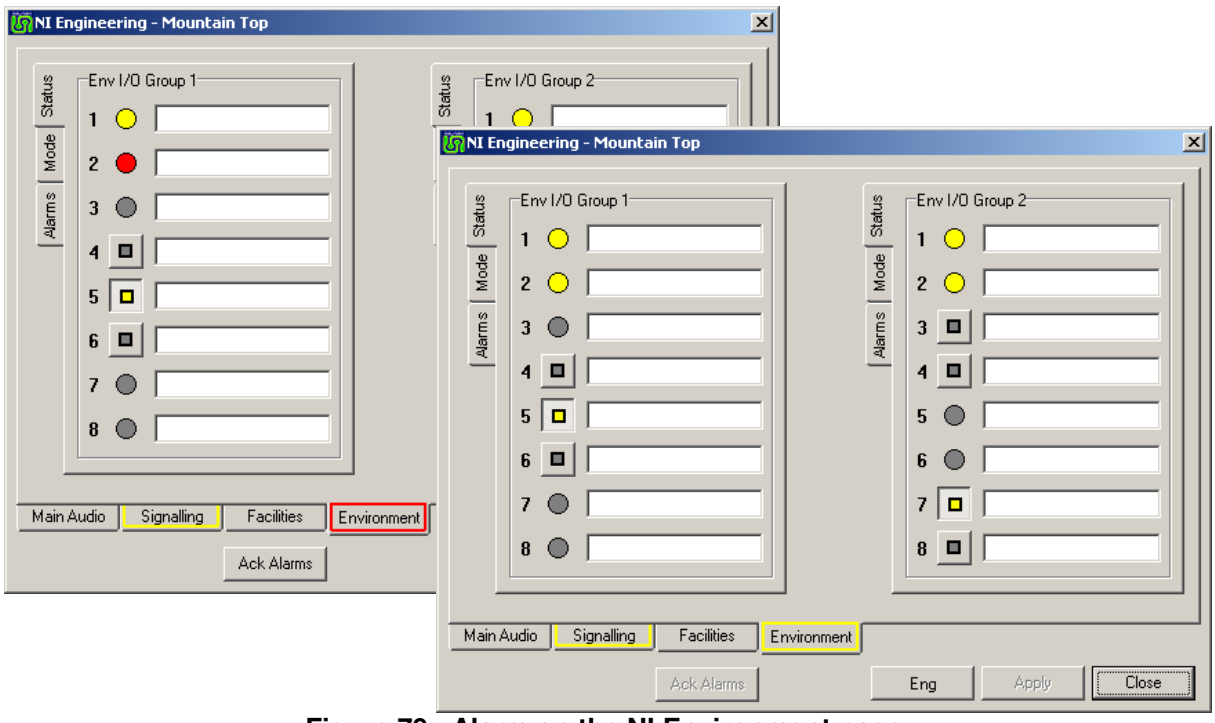

Figure 79. Alarm on the NI Environment page.

12.5 TM DUPLICATION ALARMS

12.5.1 Alarms on a Secondary TM

Just as for the other parameters in the Secondary TM, the definition of alarm events will be taken from the Primary TM; they cannot be different to the Primary TM or defined at the Secondary TM. However, alarm events must be acknowledged at each TM independently.

When the Primary TM has been configured to generate alarms, if the Secondary TM subsequently experiences an alarm event whilst offline, it will not have control of the Central NI and, therefore, is unable to generate the external alarm function to indicate a problem. Similarly, monitoring for alarms will be conducted through the Primary TM, consequently, an alarm on the Secondary TM will again go unnoticed.

12.5.2 Indicating an Alarm from an Offline TM

The problem of not knowing of an alarm on an offline Secondary TM is handled by the Secondary TM ceasing to communicate with the Primary TM. This will cause the 'Duplication' fail indication on the Primary TM to be activated, therefore, it is imperative to ensure that the 'Duplication' alarm is enabled so that the external alarm indication will operate.

If this situation arises, the first action will be to acknowledge the 'Duplication' alarm on the Primary TM and then attempt to access the Secondary TM to examine and acknowledge the alarm. If remote access to the Secondary TM fails, this will indicate either a total failure of the Secondary TM unit or a network fault. If access into the Secondary TM is successful, the alarm can be acknowledged as described earlier and any appropriate action taken.

12.5.3 Secondary TM Alarm Acknowledged

On acknowledging the Secondary TM alarm, the Secondary TM will resume communications with the Primary TM resulting in the acknowledged 'Duplication' alarm on the Primary TM ceasing. From that point on, it will not be automatically apparent, that the original alarm on the Secondary TM has cleared. For example, if the original problem at the Secondary TM was loss of GPS signal ('PPS' fail), once this alarm is acknowledged, the return of the GPS signal will not be notified, i.e. it will be necessary to log back into to the Secondary TM at intervals to check if the problem is still present or has cleared. Once the original alarm has been acknowledged on the Secondary TM, the occurrence of any other alarm or re-occurrence of the same alarm will be notified as described above.

13 TM LOGGING

13.1 OVERVIEW

This section describes the TM Logging facility that is an inherent feature of the TM and independent of all other options.

Information is automatically gathered by the TM; the only setup required is that of setting system time. The data is stored in four log files, one covering each event subject. These are generated on a daily basis and are retained for 28 days. Through the TM ET, the information held in any log file (current or historic) may be viewed by selecting the date and the log subject. The log file view on the ET also allows the results to be filtered to focus on the specific subjects such as channel, equipment and type if a specific issue is being analysed.

The SB2025NT has the option to use a compact flash card instead of the usual hard disk drive and to reduce wear and prevent premature failure the amount of logging is reduced when the CF is fitted.

Once a log file is transferred to the ET (opened) it may then be saved to a file in “comma separated values” (csv) format for archiving. This format makes it ideal for transfer to a spreadsheet if a more detailed examination outside of the ET application is required. The original log files are not accessible to the user.

13.2 EVENT SUBJECTS

The log files are separated into the four event subjects: Alarms; System; Voter; and ET. A new log file is created when the first event for that log occurs for that day. If the first event is the TM being switched on, every log file will start with that entry showing the time the log file was created and the fact that the TM was started. Subsequent TM restarts or reboots are logged in each file but the full start-up information is only in the system log.

13.2.1 Alarms Log

For an event to be logged in the Alarm log, that event must be configured to alarm status. Full information on configuring alarms and their action can be found in **Section 12 – Alarms**. The occurrence of every alarm event is logged with the information that uniquely identifies the source and nature of the alarm. The action of acknowledging an alarm is also logged and this action may or may not have occurred before the status of the alarm item in question has returned to normal.

If the item had returned to normal status before the alarm is acknowledged, the alarm log will show the alarm cleared immediately after the alarm was acknowledged. If the acknowledge occurs while the item is still at alarm status, the alarm cleared message will be logged at the point at which the status returned to normal, i.e. in real time.

13.2.2 System Log

The system log is focussed on recording events and conditions that might impact upon the operation of the wider Solar network. Events that directly or indirectly involve the TM are logged even though these might have occurred at a remote Station NI. For example, a record will be kept of the ‘PPS’ and ‘PLL’ status for every NI, as problems with either item will result in inaccurate measurement of the PATs, which impact upon the TM. The log will also record the error counts of frequency and phase for a NI PLL. These are displayed in the style of ‘0Xnn’ for each value, where “nn” is the error value in hexadecimal notation.

The event field of a system log will have many entries immediately after a TM is restarted. There will be more than 20 log entries for the TM itself and also one per NI as each unit is enabled and brought online.

The majority of entries in the system log are likely to be due to automatic functions although an event might be due to manual action elsewhere on the system.

13.2.3 Voter Log

When a voter change occurs such as happens at the start of an incoming call or a change in voted site selection or at the end of a call, an entry is generated in the voter log. The information included with each entry is the RSSI signal level for every site within the channel. This information is presented as a sub-list in the format of a series of numbers separated by commas such that:

- A value greater than zero represents a site with a valid signal.
- A value of zero represents a site with no incoming signal.
- A null value represents a site that is either not present on that channel or not enabled on the system.

The full TM capacity of 32 stations is always output in the data field irrespective of the number of stations on the Solar network. Therefore, it will not be unusual to see a long row of commas running from Site 1 to Site 32. This approach ensures that opening a log file in a spreadsheet causes each site to fall into the correct column for each station to ease station identification and traffic analysis.

13.2.4 ET Log

Connection and disconnection of the TM ET in either serial or network mode will result in an entry in the ET Log. Actions taken through the ET are also logged but the details of the changes made will vary according to the nature of the change.

Configuration changes to the TM are logged in full detail as are system configuration changes, e.g. enabling or disabling an NI, moving a station from one channel to another, changes to an IP address and changing the alarm configuration of any item. However, engineering changes to an NI are not logged in detail due to the almost infinite number of variations to audio and tone levels alone that could occur; these are simply recorded as “Change to Engineering settings”.

13.3 Access To The TM Logs

To gain access to any log related aspect, select the ‘Logging’ button on the TM Status panel to open the main logging window (still a sub-window on the TM ET).

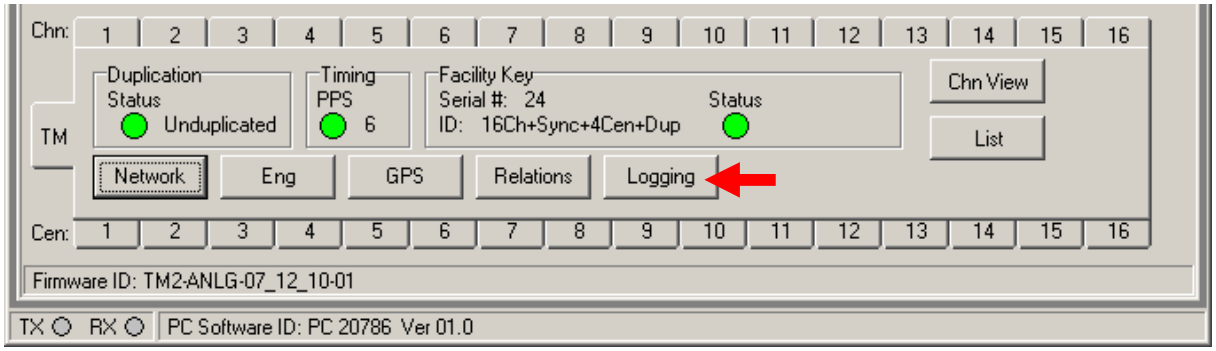

Figure 80. Route to TM Logging.

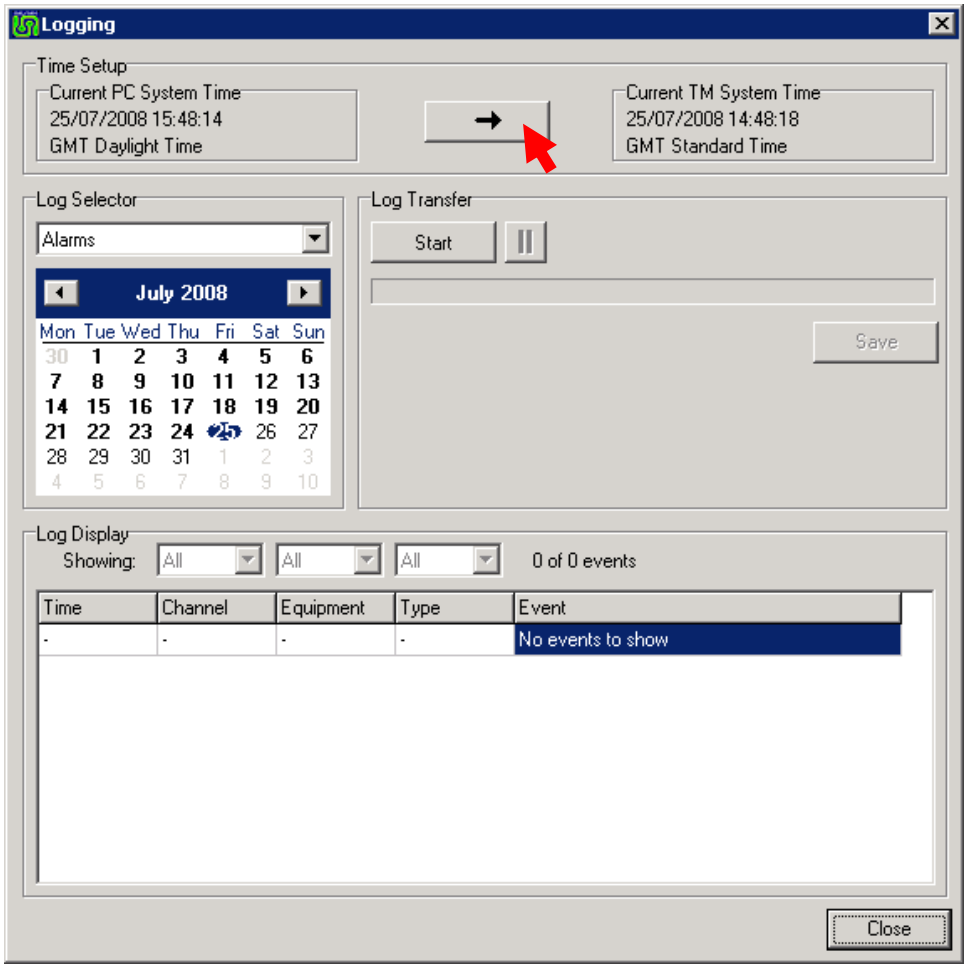

Figure 81. The TM Logging window.

13.4 TM System Time

TM system time is taken from the TM real-time clock, which will initially need to be configured to operate in the correct time zone. This information is gathered from the PC hosting the ET application and the clock will remain aligned to GPS UTC time when this is available with the appropriate time zone offset. If GPS is not directly connected to the TM, the internal clock may need to be reset again in the future. The time used in the logs will always be local standard time, i.e. it is not adjusted for 'daylight time' variations.

The four log files created will each normally encompass a 24 hour period of operation of the TM from 00:00 to 23:59 but will cover a lesser period if the TM is only operating for part of that time.

13.4.1 Setting TM System Time

The TM system clock is automatically synchronised with UTC time from GPS at a "Time Update" event. However, for a system that does not have a GPS directly connected and therefore UTC is not available, the TM system clock may be set to that of the PC. To set the TM system time to that of the PC, select the "Arrow" button in the 'Time Setup' panel (see **Figure 81** above).

This time change may be made even if the TM is receiving UTC information, however, the TM system time will eventually be over-written using UTC when the Time Update event occurs. The action of setting system time, whether manual or automatic, is itself logged in the system event log together with the amount of adjustment made.

13.5 LOG SELECTION

Selection of the date of the log to be transferred to the ET is made by clicking on the date required on the calendar, which will gain the blue highlight; the default selection being the current date. There is no need to re-select the date if the correct date is already highlighted. The log event subject is selected from the pull-down list visible above the calendar.

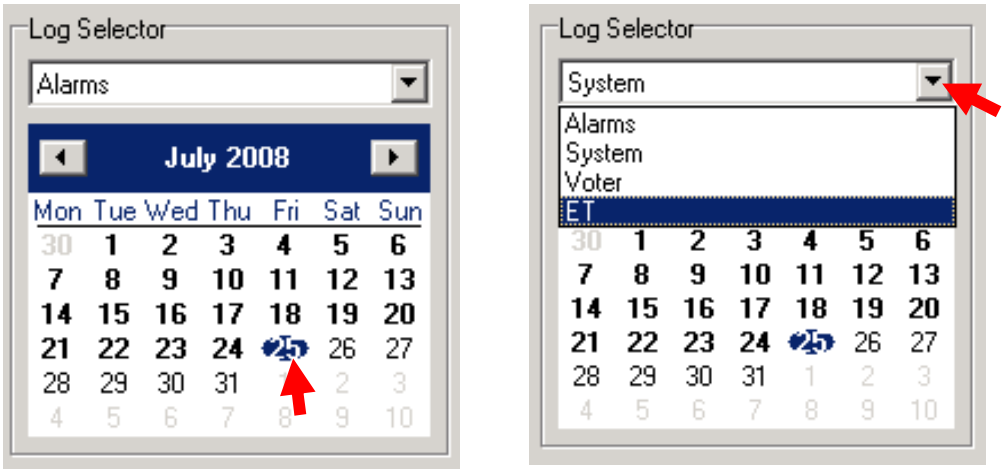

Figure 82. Selecting an Alarm Log.

Dates that fall in the 28 day date range are indicated on the calendar by figures in bold text and this is most likely to cross the monthly boundary. To select another month, click on one of the arrow buttons positioned on either side of the name of the month; the button with the left pointing arrow will move to the previous month and the button with the right pointing arrow will move to the next month. It is not possible to select a month that would move beyond the twenty-eight day range.

The fact that a date is shown in bold does not indicate that a log file is available for that date just that the date lies within the last twenty-eight days. If no activity occurs under a particular event for that date, no log file will have been created and an attempt to access the log file for that event on that day will fail as shown by the text 'No events to show'. This action will itself result in an entry being logged in today's system log to show that the log file for that date was not found.

13.6 TRANSFERRING THE LOG

Once the date and log event have been selected, select the 'Start' button to transfer the log to the ET. The transfer may be cancelled with the 'Cancel' button or paused at any time using the pause button, which only becomes active during the transfer process. Depending upon the size of the log file and the speed of the ET connection (i.e. network or serial), the progress bar will indicate the rate of transfer. A short log file will be transferred very quickly on a network connected ET therefore the progress bar may only appear to blink.

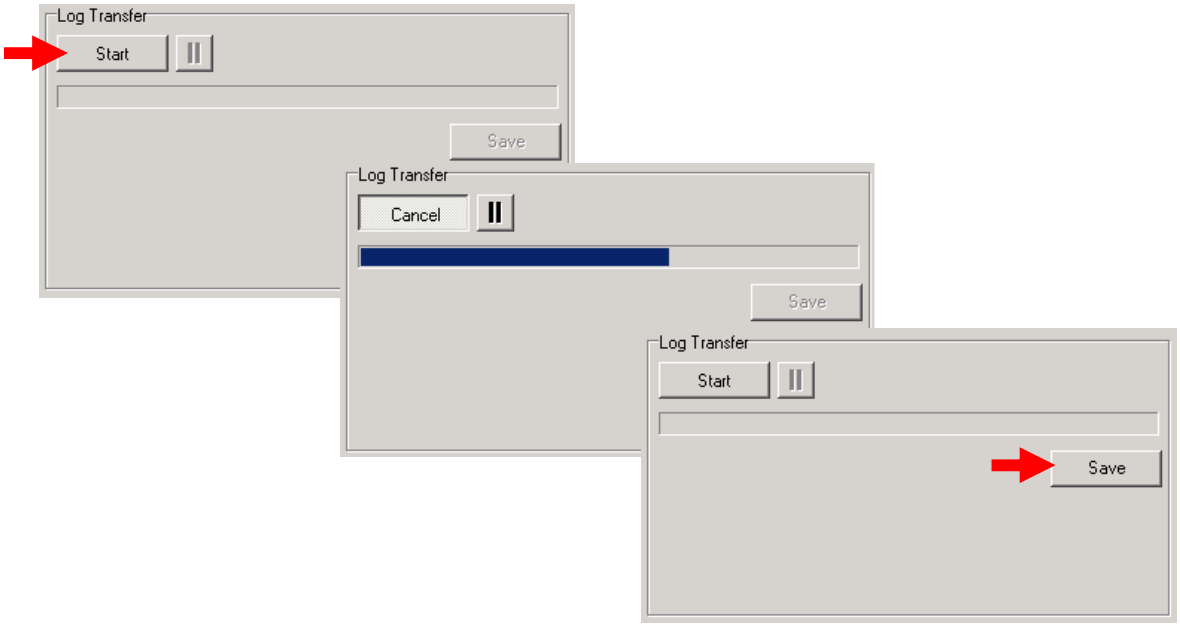

Figure 83. Transferring a Log File to the ET.

13.6.1 Saving the Log

When the log transfer process is complete, the 'Save' button will become active and remain active while the file is present in the 'Log Display' area. When the 'Save' button is selected, the 'Save Log' file page will open allowing the selection of folder and naming of the log file. The default filename indicates the type of event log and the date (day), this may be changed as desired although the file type is always 'csv'. The file name suggested is not that of the internal log file, which is not accessible to the user.

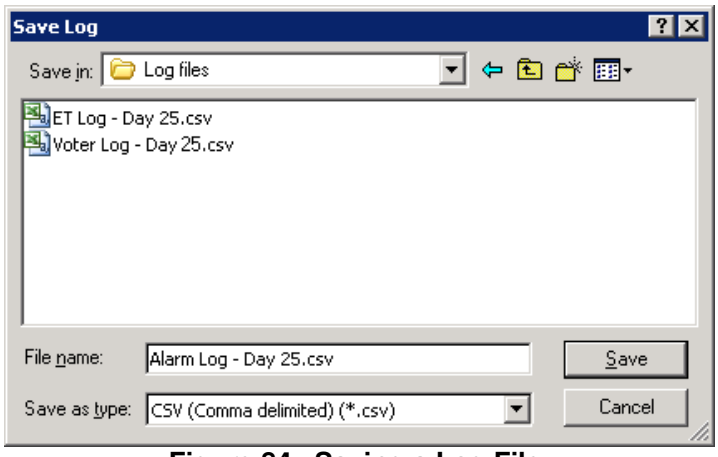

Figure 84. Saving a Log File.

If a complete record of system operation is to be kept then saving the log files on a regular basis is necessary as each internal log file will be deleted after twenty-eight days.

13.6.2 Log Display

Once a log file has been transferred to the ET the information will be shown in the log display area. Each event occupies a separate line and the details of the event are separated into five data fields, which are shown in columns. The data fields are:

(a). '**Time**'. The time stamp for the event taken from the TM system clock.

(b). '**Channel**'. The channel number encompassing the event is displayed when appropriate. On single channel versions this will only be "Chn 01".

(c). '**Equipment**'. The equipment or hardware unit that experienced the event. Typical data is "TM", "Cen 01" and "Stn 02" etc.

(d). '**Type**'. The area of the equipment in which the event occurred. Typical data is "File", "Key" and "NI", etc.

(e). '**Event**'. The details of the event itself. This varies widely according to both the event itself and the log subject.

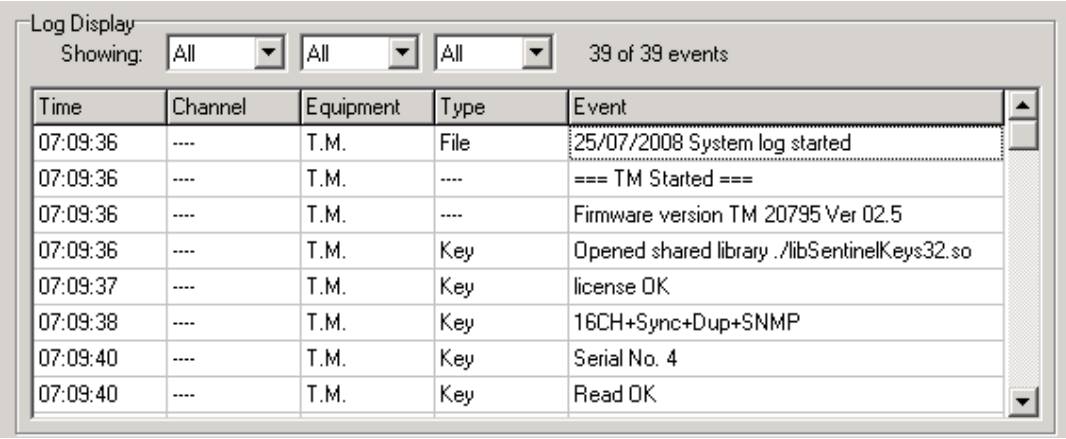

Figure 85. Example of a System Log.

A log entry that does not have information that relates to a data field will be displayed as '----' in that column. In the above system log file display, every entry is an example of the latter situation as these are all concerned with the TM itself, which has no channel association and so the Channel data fields are shown as '----'. Similarly the entries for TM start-up and firmware have no 'Type' data.

13.6.3 Filtering the Log Display

The 'Channel', 'Equipment' and 'Type' columns may be filtered to allow closer examination of specific details and this feature operates in a very similar way to that available in spreadsheet applications. Once a filter is applied, the list will be reduced and the number of events that match that filter setting will be shown in the display header area.

The example overleaf has been constructed for handbook purposes as it is not possible to operate all three pull down lists simultaneously even though all three columns may be filtered together.

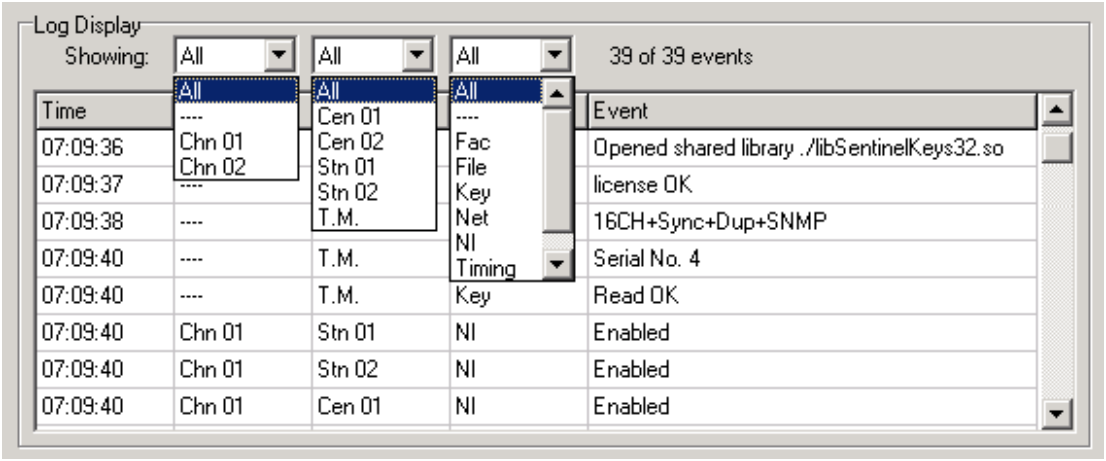

Figure 86. Applying a Display Filter.

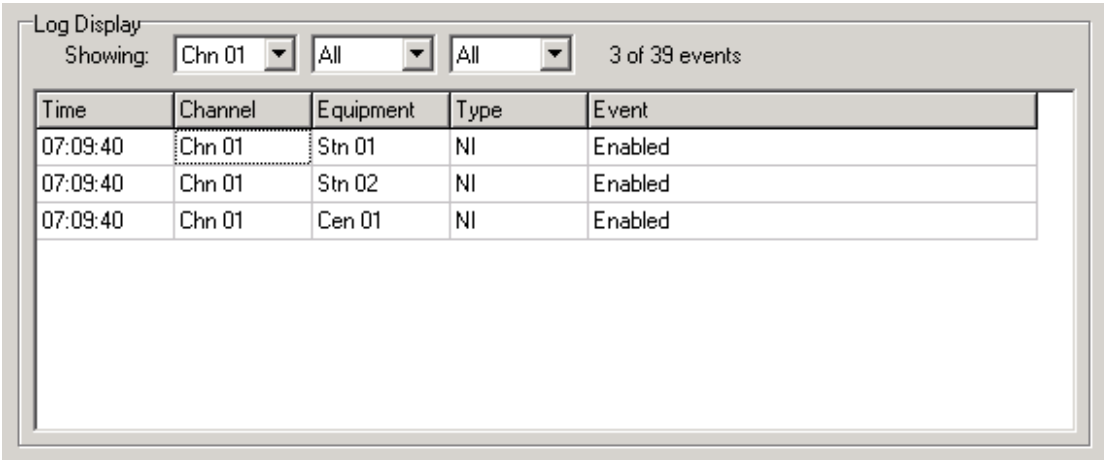

Figure 87. Filtering the Log Display on 'Channel'.

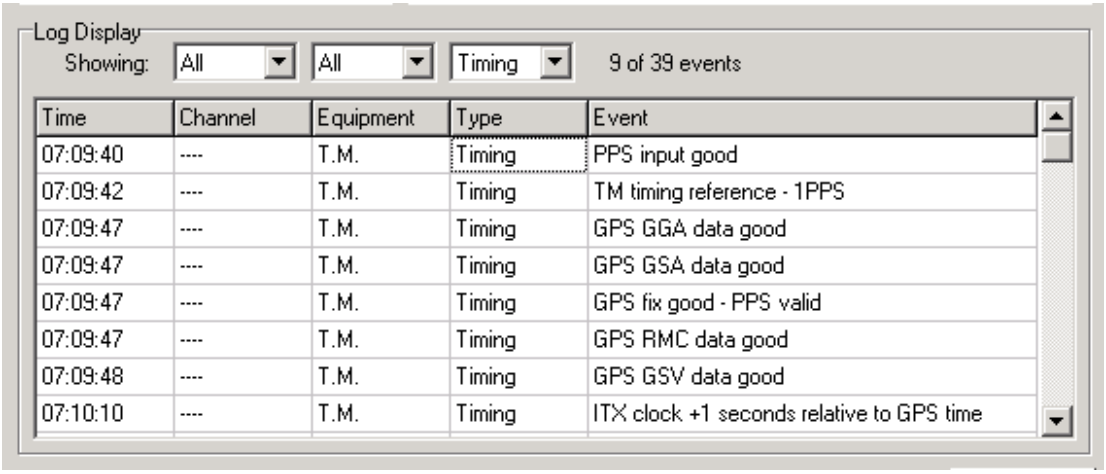

Figure 88. Filtering the Log Display on 'Type'.

More than one column may be filtered at the same time. To remove a filter select 'All' from the drop-down list. A filter must be removed before selection of a different filter item can be made in order to show the full list of selectable items.

The complete log file will be saved when the file save function is used even if one or more filters are currently being applied.

13.7 EVENTS ACROSS MULTIPLE LOGS

There will be events that cause a log entry to occur in more than one event log. An example of such a situation is the loss of the PPS signal at a NI. This could be logged as an alarm (if so configured) but would also be logged as a system event as the TM would remove the entry for that NI from the timing table.

This highlights the fact that it might prove necessary to take information from more than one log file to interpret the full details of an event, if a detailed investigation into the circumstances surrounding an event is required.

14 SNMP

14.1 OVERVIEW OF SNMP IN SOLAR

This section details the setting up necessary to implement the SNMP facility and the functions that are available through it. However, it does not go into any detail of SNMP operation, as it is assumed the user will already have knowledge of and be familiar with SNMP. This feature is a 'Facility Key' enabled option which requires the Solar 2 ET and MIB file 'DALMAN-SOLAR-MIB-011.txt' or higher.

SNMP is a defined standard for the data transfer between networks to be monitored and network management systems. The use of SNMP will allow the user to monitor and control a Solar network as well as providing indications of the operational status of the Solar network all in a manner that suits the particular needs of the user.

To make use of the SNMP facility, the user is required to provide a NMS. There are many commercially available NMS software packages to choose from or perhaps the user has an existing NMS, therefore, it might be preferable to simply add the Solar SNMP to the existing NMS.

The SNMP implementation in the TM is SNMPv2 and a MIB is provided to define the data and data structure of the information that is necessary for the NMS to operate into Solar. Certain objects have Object Identifiers (OIDs) defined in the standard mib-2; these include the "sysDescription", "sysContact", "sysName", "sysLocation" strings and "sysUpTime". Also defined in mib-2 are the "Coldstart" and "Warmstart" traps sent when the TM starts up.

The SNMP facility does not replace the requirement for using the ET, since the basic configuration of a Solar network must be undertaken using the ET before the SNMP facility itself can be realised. Thereafter, although some of the parameters of the Solar network equipment can be accessed and altered through SNMP, the majority can only be accessed using the ET.

14.2 CONFIGURING SNMP IN THE TM

As long as the 'Facility Key' has the SNMP feature enabled, the 'SNMP' table of entries will be enabled on the 'Facility' page of 'TM Engineering'.

The SNMP setup information is presented under two pages: 'Communities' and 'Destinations'. The default text settings in 'SNMP Communities' and 'System' must all be changed to suit and the appropriate IP addresses entered in 'Destinations'.

14.2.1 SNMP Communities and System

All these entries are simple text strings but, as the purpose of those in the 'Communities' area is similar to that of password access, the default settings for 'Read Only', 'Read-Write' and 'Trap' should be changed to protect the Solar network from unauthorised access. The 'System' values are used to provide information about the monitored network. These can also be changed as required, perhaps to make this network more readily identifiable as a Solar network if the NMS is monitoring several networks.

To change any of the text strings, depress the 'Eng' button then select the item to be changed and edit the existing string or enter a new text string as appropriate. To complete the change, the 'Apply' button must be selected which will automatically release the 'Eng' button.

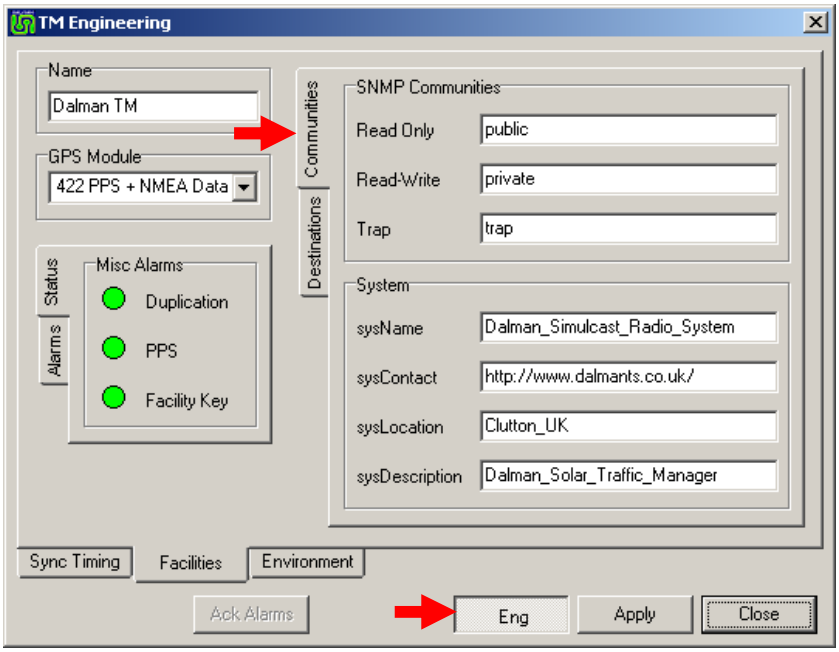

Figure 89. SNMP Text Label/Data Entry.

14.2.2 Trap Destinations

The IP addresses entered into any of these fields (to a maximum of six) will be the locations to which any trap event notification is sent. To enter or change an IP address, depress the 'Eng' button and position the mouse pointer on the entry to be changed or added and click the mouse button to activate the edit cursor (caret).

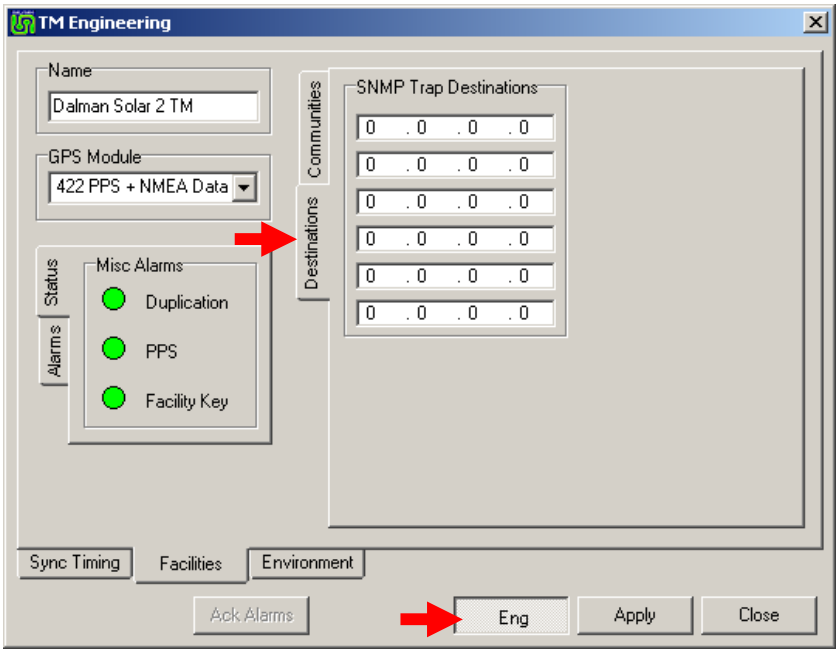

Figure 90. SNMP Trap Address Entry.

The keyboard "Tab" key will move the cursor from left to right and then down to the next address line highlighting each item (octet value) in turn. Once the changes have been made, select the 'Apply' button, which will save the changes and automatically release the 'Eng' button.

The "Default Gateway" address entered in the main TM 'Network' setup will be used in conjunction with the trap destination addresses.

14.3 DATA ORGANISATION

The data and meaning of the information that can be monitored by the SNMP NMS is detailed in a MIB file. This file is provided by Simoco and contains all the necessary references, plain text translations and value limitations that are applicable to every item of data that is accessible with the NMS using SNMP.

14.3.1 Data Format

A summary of the data is set out in the following tables and the meaning of each column headings is:

(a). **Data Item**. A short text description of the item in question.

(b). **Type**. 'Single' means that there is only one such item in the network; 'Multiple' means the entity in question has to be uniquely addressed as many of them exist in the network. In "Traps" the source of the event may be from multiple items.

(c). **Access**. Data may be read from the item or written to the item or both.

(d). **Data type**. The nature of the data stored for the item.

(e). **Notes**. Any supplementary information about the data item.

14.3.2 Network Interfaces (Centrals and Stations)

Table 6. SNMP Data Format for NI Info.

Data Item	Type	Access	Data Type	Notes
Maximum Number	Single	Read	Integer	0 to 16 for Centrals : 1 to 32 for Stations
IP Address	Multiple	Read	IP Address	
Enabled	Multiple	Read	Integer	0 or 1
Name	Multiple	Read	Text String	
Environment	Multiple	Read	Integer	Bit representation of I/Ps and O/Ps
Alarms	Multiple	Read	Integer	Bit representation of alarms and acknowledges
Alarm Acknowledge	Multiple	Read/Write	Integer	Acknowledges active alarms

14.3.3 Channels

Table 7. SNMP Data Format for Channel Info.

Data Item	Type	Access	Data Type	Notes
Maximum Number	Single	Read	Integer	1 to 16
Name	Multiple	Read/Write	Text String	
Tx Key Hang Time	Multiple	Read/Write	Integer	0 to 5 (seconds)
CTCSS Freq.	Multiple	Read/Write	Integer	500 to 3000 (x 0.1 Hz)
RSSI Threshold	Multiple	Read/Write	Integer	0 or 14
Voter Override	Multiple	Read/Write	Integer	0 to 32 (Stn No : 0 = off)
Site Deselect Time	Multiple	Read/Write	Integer	0 to 6 (5 mins : 0 = off)
TM triggered T/T	Multiple	Read/Write	Integer	0 to 2
Channel Status	Multiple	Read	Integer	Bit representation of voted site and RSSI level

14.3.4 Traffic Manager

Table 8. SNMP Data Format for TM Info.

Data Item	Type	Access	Data Type	Notes
Uptime	Single	Read	Integer	Seconds since program start
Facility Key Status	Single	Read	Integer	0 to 2
Key Serial Number	Single	Read	Integer	Unique serial number
Key Text	Single	Read	Text String	
Duplication Status	Single	Read	Integer	Bit representation of setting and status
Alarms	Single	Read	Integer	Bit representation of alarms and acknowledges
Alarm Acknowledge	Single	Read/Write	Integer	Acknowledges active alarms

14.3.5 Traps

Table 9. SNMP Data Format for Trap Info.

Data Item	Type	Data Type	Notes
TM Alarms	Single	Integer	Bit representation of active alarms
Station NI Alarms	Multiple	Integer	Bit representation of active alarms
Central NI Alarms	Multiple	Integer	Bit representation of active alarms

15 FIRMWARE EXTENSIONS

15.1 FIRMWARE EXTENSIONS – OVERVIEW

The firmware installed in a NI is the same for all users. However, extension modules are supported in the firmware, which will be created to perform specific and dedicated functions. These extension modules will be activated according to the setting of the FW Config Byte, which is displayed on the 'Facilities' page of 'NI Engineering' (see **Section 8.2.3 – Facilities**).

The 'FW Config' setting is displayed as a hexadecimal byte value and value 0x7FFF is the default or base setting that does not implement any extension facility. This setting is only programmable in the factory and, therefore, the user cannot elect to use a particular feature set. The NI will perform only those duties that the equipment has been built to fulfil, although, when an extension is enabled, individual items of that feature set may be enabled or not as desired; if none are enabled the unit will operate as standard.

The configurations available from the NI are listed in order of the 'FW Config' byte value in **Table 10**. As more variants evolve they will be added to this document.

Table 10. Configuration Byte Usage.

Date	Config Byte	Function/Facility	Section
Original	0x7FFF	Standard build, no extension features available	N/A

APPENDIX A

SOLAR CONFIGURABLE SETTINGS

The intention here is to list the user configurable settings of a Solar network in alphabetical order and to indicate which ET has access to which. The precursor to any change is likely to need selection of an engineering mode and the conclusion being that the change needs to be applied (see the relevant section in the handbook for full details).

Many of the settings are accessible from either the TM ET or the NI ET and this is indicated by the text 'Both ET' in the 'ET' column. As a Solar 2 unit may have either a TM or an NI or both fitted as main modules and that the GPS and the Environment I/O sub-modules may be accessed through the ET appropriate to the unit build, then these settings are shown as 'Either'. A setting that is available to only one of the ETs is indicated by the text 'TM ET' or 'NI ET' as appropriate. Any further information is noted where applicable.

The 'Type' column indicates the nature of the setting by using the following notation:

- 'Button' – click in or out to enable/disable or set on/set off etc.
- 'Check' – check the box to enable, un-check the box to disable.
- 'Click' – single (momentary) action to instigate function.
- 'Drag/drop' – the selection is made using a 'Drag and drop' operation.
- 'Enter' – the user must enter a value (usually validated) or character string (not usually validated).
- 'Select' – select the option from a pull-down list (fixed choice).
- 'Slider' – the setting is adjusted by dragging a slider to the required position/level.

Table A1. List of ET Settings.

Topic	Description	Options/Notes	Type	Location (ET page)	ET
Alarms	Configuration and acknowledgement of alarm events	Enable/Disable alarm events & acknowledge alarms	Button	Alarms (alarms button, TM Tab)	TM ET
Audio In	Set audio I/P – fine level	Approx 6 dB range	Slider	NI Engineering (Main audio tab)	Both ET
Audio In	Set audio I/P – coarse level	0 to –18 dB, then –20 to –32 dB (6 dB steps)	Slider	NI Engineering (Main audio tab)	Both ET
Audio In	In route	Normal/Inverted	Button	NI Engineering (Main audio tab)	Both ET
Audio In	Enable 2.6 kHz LPF	On/Off	Check	Setup (Misc tab)	Both ET
Audio Out	Set audio O/P – fine level	Approx 6 dB range	Slider	NI Engineering (Main audio tab)	Both ET
Audio Out	Set audio O/P – coarse level	0 dB to –21 dB (3 dB steps)	Slider	NI Engineering (Main audio tab)	Both ET
Audio Out	Out route	Normal/Inverted	Button	NI Engineering (Main audio tab)	Both ET
Channel Allocation	Relations: allocate each NI to a channel	Associate any to any	Drag/drop	Relations (Relations button, TM tab)	TM ET
Channel Facilities	Channel Name: identify channel	Up to 20 characters text	Enter	Channel Setup (Setup button, channel tab)	TM ET

Topic	Description	Options/Notes	Type	Location (ET page)	ET
Channel Facilities	TX Key Hang	0 secs – 5 secs	Select	Channel Setup (Setup button, channel tab)	TM ET
Channel Facilities	TM Triggered T/T	None/Perm/Central NI fail	Select	Channel Setup (Setup button, channel tab)	TM ET
CTCSS	CTCSS frequency	50 Hz to 300 Hz (to 0.1 Hz)	Enter	Channel Setup (Setup button, channel tab)	TM ET
CTCSS	CTCSS out route	Feature not in use	Button	NI Engineering (CTCSS tab)	Both ET
CTCSS	CTCSS tone O/P – fine level	Approx 3 dB range	Slider	NI Engineering (CTCSS tab)	Both ET
CTCSS	CTCSS tone O/P – coarse level	0 dB to –21 dB (3 dB steps)	Slider	NI Engineering (CTCSS tab)	Both ET
DSP Firmware	Read in FW file	Load file into ET	Button	DSP button (Loader)	NI ET
DSP Firmware	Upload FW to NI	Start upload process	Button	DSP button (Loader)	NI ET
Environment	Set I/O text tables	Max 20 characters	Enter	Setup (Labels tab)	Either
Environment	Configure the environment I/Ps	Monitor/Auto with invert options	Select	Setup (Misc tab)	Either
Environment	Configure the environment O/Ps	Manual/Auto	Select	Setup (Misc tab)	Either
Environment	Environment O/P control	O/Ps 1 to 8: On/Off	Button	NI Engineering (Facilities tab)	Either
GPS	View GPS signals	No action		GPS (GPS button)	Either
GPS	Set PC Clock		Select	GPS > Options menu (GPS button)	Either
Isolated I/Ps	Configure isolated I/Ps	Monitor/Auto	Select	Setup (Misc tab)	Both ET
Isolated O/Ps	Configure isolated O/Ps (relays)	Manual/Auto	Select	Setup (Misc tab)	Both ET
NI Facilities	Inhibit controls: I/P and/or O/P	On/Off	Button	NI Engineering (Facilities tab)	Both ET
NI Facilities	Isolated (relay) O/P controls	Relay 1 to 3: On/Off	Button	NI Engineering (Facilities tab)	Both ET
NI Facilities	Line fail T/T	On/Off	Button	NI Engineering (Station tab)	Both ET
NI Name	Set Station/Central NI name	Max 20 characters	Enter	Setup (Labels tab)	Both ET
NI Network	Set IP address	Set to suit network addressing scheme	Enter	NI Setup (Network button)	NI ET
NI Network	Set Subnet mask	Feature not in use	Enter	NI Setup (Network button)	NI ET
NI Network	Set default gateway	Feature not in use	N/A	NI Setup (Network button)	NI ET
NI Network	Enable NI	Enable/Disable	Check	NI Setup (Network button)	NI ET
Signalling In	I/P signal type	Tone/Voltage	Select	Setup (Signalling tab)	Both ET
Signalling In	Boundaries: min & max	Tone: 2.6 – 3.5 kHz V'age: 1 – 1023	Enter	Setup (Signalling tab)	Both ET
Signalling Out	O/P tone frequency	2.5 kHz – 3.6 kHz	Select	Setup (Signalling tab)	Both ET
Signalling Out	O/P tone level	–10 dB to –28 dB (2 dB steps)	Slider	Setup (Signalling tab)	Both ET
SNMP	Setup 'Communities' parameters (3 entries)	Plain text (password)	Enter	SNMP (SNMP button, TM tab)	TM ET
SNMP	Setup 'System' parameters (4 entries)	Plain text (info)	Enter	SNMP (SNMP button, TM tab)	TM ET

Topic	Description	Options/Notes	Type	Location (ET page)	ET
SNMP	Setup 'Trap' destinations (up to 6)	One IP address per destination	Enter	SNMP (SNMP button, TM tab)	TM ET
Solar Event Log	Set System Time	Action as required	Click	Logging (Logging button, TM tab)	TM ET
Solar Event Log	Read Log File	Select Type & Date	Select	Logging (Logging button, TM tab)	TM ET
Solar Event Log	Transfer Log File	Start transfer	Click	Logging (Logging button, TM tab)	TM ET
Solar Event Log	Filter Log File	Action as required	Select	Logging (Logging button, TM tab)	TM ET
Solar Event Log	Save Log File	Action if required	Click	Logging (Logging button, TM tab)	TM ET
Solar Timing	GO Traffic O/P Time (Station NI)	40 ms – 200 ms (20 ms steps)	Select	Sync Timing (Sync button, TM tab)	TM ET
Solar Timing	RTN Traffic O/P Time (Central NI)	40 ms – 200 ms (20 ms steps)	Select	Sync Timing (Sync button, TM tab)	TM ET
Solar Timing	GO TM Buffer (Central NI)	20 ms – 140 ms (20 ms steps)	Select	Sync Timing (Sync button, TM tab)	TM ET
Solar Timing	RTN TM Buffer (Station NI)	20 ms – 140 ms (20 ms steps)	Select	Sync Timing (Sync button, TM tab)	TM ET
Test Tone	Test tone route	External/Network/Off	Button	NI Engineering (Facilities tab)	Both ET
Test Tone	Test tone frequency	300 Hz – 2500 Hz	Enter	NI Engineering (Facilities tab)	Both ET
Test Tone	Test tone level	0 dB to –10 dB (1 dB steps & –4.4 dB)	Slider	NI Engineering (Facilities tab)	Both ET
Timing Source (NI)	Select 1PPS and NMEA data source	RS422/TTL: with/ without NMEA data	Select	Setup (Misc tab)	Either
Timing Source (TM)	Select 1PPS and NMEA data source	RS422/TTL: with/ without NMEA data	Select	Sync Timing (Setup button, TM tab)	Either
TM Duplication	Duplication mode	Unduplicated Dupl.(Pri), Dupl.(Sec)	Select	TM Setup (Network button, TM tab)	TM ET
TM Duplication	IP address	Set to address of "other" TM	Enter	TM Setup (Network button, TM tab)	TM ET
TM Network	TM IP address	Set to suit network addressing scheme	Enter	TM Setup (Network button, TM tab)	TM ET
TM Network	Set subnet mask	Set to suit network addressing scheme	Enter	TM Setup (Network button, TM tab)	TM ET
TM Network	Default gateway	Set to suit network addressing scheme	Enter	TM Setup (Network button, TM tab)	TM ET
TM Setup – Central NI	IP Address	Set to IP address of required Central NI	Enter	Network button on Central panel	TM ET
TM Setup – Central NI	Enable/Disable each Central NI	Enable/Disable	Check	Network button on Central panel	TM ET
TM Setup – Station NI	IP Address	Set to IP address of required Station NI	Enter	Numbered button on Station panels	TM ET
TM Setup – Station NI	Enable/Disable each Station NI	Enable/Disable	Check	Numbered button on Station panels	TM ET
Voting (Chan) Facilities	Minimum RSSI Difference	Select from 1 – 13	Select	Channel Setup (Setup button, channel tab)	TM ET
Voting (Chan) Facilities	Site Deselection Timer	0 min – 30 min (5 min steps)	Select	Channel Setup (Setup button, channel tab)	TM ET
Voting (Chan) Facilities	Voter Override	Off/any enabled NI	Select	Channel Setup (Setup button, channel tab)	TM ET

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