TB9100 base station

Installation and Operation Manual

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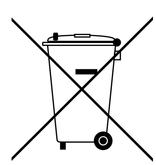

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Contents

Preface

Scope of Manual

Welcome to the TB9100 base station Installation and Operation Manual. This manual is intended for use by experienced technicians familiar with installing and operating base station equipment. It includes a technical description of the base station, maintenance and troubleshooting information.

Document Conventions

"File > Open" means "click File on the menu bar, then click Open on the list of commands that pops up". "Monitor > Module Details > Reciter" means "click the Monitor icon on the toolbar, then in the navigation pane find the Module Details group, and select Reciter from it".

Within this manual, four types of alerts are given to the reader: Warning, Caution, Important and Note. The following paragraphs illustrate each type of alert and its associated symbol.

Warning!! **This alert is used when there is a potential risk of death or serious injury.**

Caution **This alert is used when there is a risk of minor or moderate injury to people.**

Important This alert is used to warn about the risk of equipment damage or malfunction.

Note This alert is used to highlight information that is required to ensure procedures are performed correctly.

Associated Documentation

TB9100 Reciter Service Manual (MBA-00017-xx).

TB9100 Specifications Manual (MBA-00014-xx).

TB9100 Customer Service Software User's Manual (MBA-00003-xx) and online Help.

TB9100 Calibration Software User's Manual (MBA-00004-xx) and online Help.

TBA0STU/TBA0STP Calibration and Test Unit Operation Manual (MBA-00013-xx).

TaitNet P25 Network Installation Guide (MBA-00018-xx).

Technical notes are published from time to time to describe applications for Tait products, to provide technical details not included in manuals, and to offer solutions for any problems that arise.

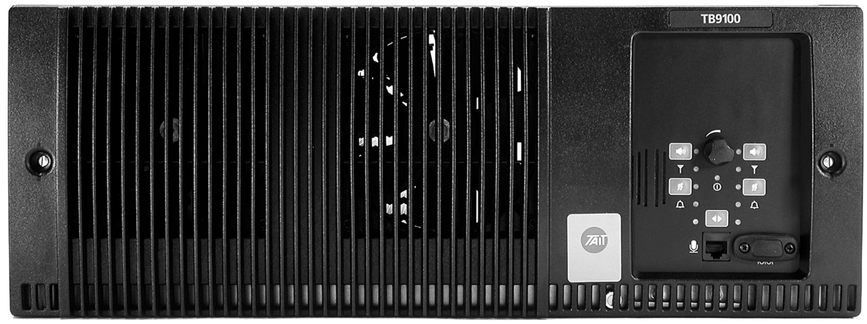
All available TB9100 product documentation is provided on the CD supplied with the base station[1]. Updates may also be published on the Tait support website.

Publication Record

Issue	Publication Date	Description
1	July 2004	First release
2	January 2005	General updates; new photographs; Appendix C added
3	March 2005	General updates; Appendix D added
4	August 2005	General updates for version 1.2 release; Appendix D removed
5	May 2006	General updates for version 2.1 release

1. Technical notes are only available in PDF format from the Tait support website. Consult your nearest Tait Dealer or Customer Service Organization for more information.

1 Description



The Tait TB9100 base station/repeater is a robust state-of-the-art digital fixed station that combines Tait's proven strengths in reliability, high performance and modular design with software-based configurability and operation, digital signal processing and voice-over-IP technology. The TB9100 is designed for operation in a conventional Project 25 radio network and can be configured as a repeater or as a line-connected base station.

The ability to interoperate in both analog FM and digital P25 modes, to link stations using standard Internet Protocol communications, and to add features such as encryption through software options ensures that P25 systems designed with the TB9100 are scalable in both size and functionality.

The TB9100 combines industry-leading digital voice quality with rugged design specifications and intuitive user interfaces. This product has been designed to meet the demanding needs of the public safety and public service sectors.

The TB9100 RF interface is dual-mode analog/digital, allowing users of APCO P25 or analog radios to communicate via the network.

Its digital line provides built-in network connectivity, allowing the TB9100 to join with other TB9100s to form a TaitNet P25 network. This network supports voice over IP and remote management of all TB9100s.

Its analog line allows the direct connection of third party dispatch systems.

1.1 Features

The following are some of the features of the TB9100 base station:

- Fully compliant with the Project 25 Common Air Interface. Can therefore interoperate with any similarly compliant radios.
- Dual mode. Comprehensive analog and digital features ensure

interoperability with analog or digital technology. The TB9100 can switch seamlessly between analog FM and digital P25 communications on a per-call basis.

- Integrated built-in voting facility. In a TaitNet P25 network, TB9100 base stations use distributed voting to compare the received signals, selecting the best quality signal for transmission through the system. No external voter is needed.
- Can be completely managed remotely from a PC running the Tait Customer Service Software: configuration, alarm monitoring, fault diagnosis, feature and firmware upgrades.
- Rugged construction with generous heatsinks and fan-forced cooling for continuous operation from −30°C to +60°C (–22°F to +140°F).

1.2 Modules

The TB9100 base station consists of several modules in a subrack: a power management unit (PMU) to supply and manage power to the subrack, a reciter (receiver and exciter), a power amplifier (PA), a front panel with fans, and a control panel. The modules are interconnected at the front of the subrack. External connections to the modules are located at the rear.

Modules come in different variants depending for example on the RF band or the supply voltage. Many of them are common to the TB8100. Applications such as a receive-only base station do not need them all.

Each module is inserted into the TB9100 4U subrack from the front and is secured at the front with a metal clamp. Both clamp and module are easily removed for rapid module replacement. The modules are secured laterally with plastic guides that clip into the top and bottom of the subrack. These guides can be easily repositioned to change the configuration of a subrack. The heavier modules are also secured laterally by metal tabs at the rear of the subrack.

The following provides a brief description of the available modules.

Reciter

The reciter module comprises the receiver, exciter and digital control circuitry. It also incorporates the network board, which provides the connection to the digital and analog lines and to the general purpose digital inputs and outputs.

Power Amplifier

The power amplifier amplifies the RF output from the reciter and is available in 5 W, 50 W and 100 W models.

The 5 W and 50 W models mount vertically in the subrack, while the 100 W model mounts horizontally as it has a wider heatsink. The 100 W PA is also fitted with an airflow duct.

5/50W PA

100W PA

All three models are designed to operate on the 28 VDC output provided by the TB9100 power management unit. In addition, variants of the 5 W and 50 W models are available for operation on 12 VDC. These two 12 V PAs are fitted with an internal boost regulator board, which converts the 12 V nominal DC input to a 28 VDC output to power the PA circuit boards. The boost regulator board also provides a 12 VDC output to power the reciter.

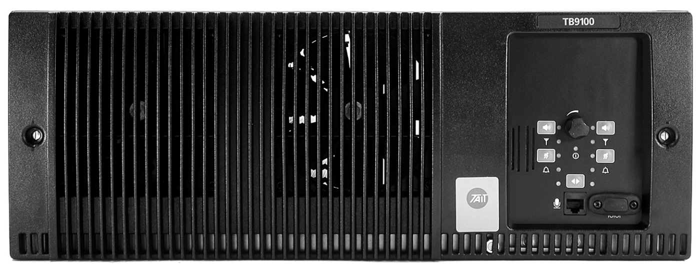
Power Management Unit

The PMU provides the 28 VDC power supply for the modules in the TB9100. The input voltage can be AC, DC or both AC and DC, depending on the model. An auxiliary DC output is also available when the optional power supply board is fitted. This board is available with an output of 13.65 VDC, 27.3 VDC, or 54.6 VDC.

AC and DC PMU shown

Front Panel

The TB9100 front panel is mounted onto the subrack with two quick-release fasteners. It incorporates the cooling fans for the PA and PMU.

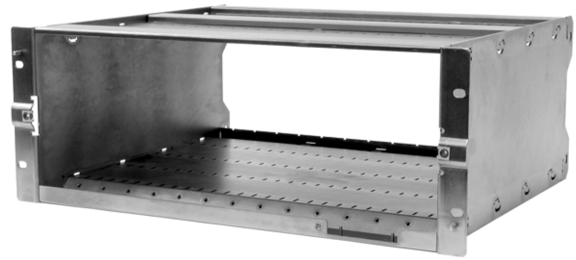


Control Panel

The TB9100 control panel is mounted onto the subrack and is accessible through an opening in the front panel. The control panel provides the user with hardware controls for direct control of the base station.

Subrack

The TB9100 4U subrack is made of passivated steel and is designed to fit into a standard 19 inch rack or cabinet.



1.3 Frequency Bands and Sub-bands

Much of the circuitry in the TB9100 base station is common to both frequency bands, and is therefore covered by a single description in this manual. Where the circuitry differs between VHF and UHF, separate descriptions are provided for each frequency band. In some cases the descriptions refer to specific VHF or UHF bands or sub-bands, and these are identified with the letters listed in the following table.

	Frequency Identification	**Frequency Band and Sub-band**
VHF	B band	B1 = 136MHz to 174MHz B2 = 136MHz to 156MHz B3 = 148MHz to 174MHz
UHF	H band	H0 = 400MHz to 520MHz H1 = 400MHz to 440MHz H2 = 440MHz to 480MHz H3 = 470MHz to 520MHz
UHF	K band	K4 = 762MHz to 870MHz[a]

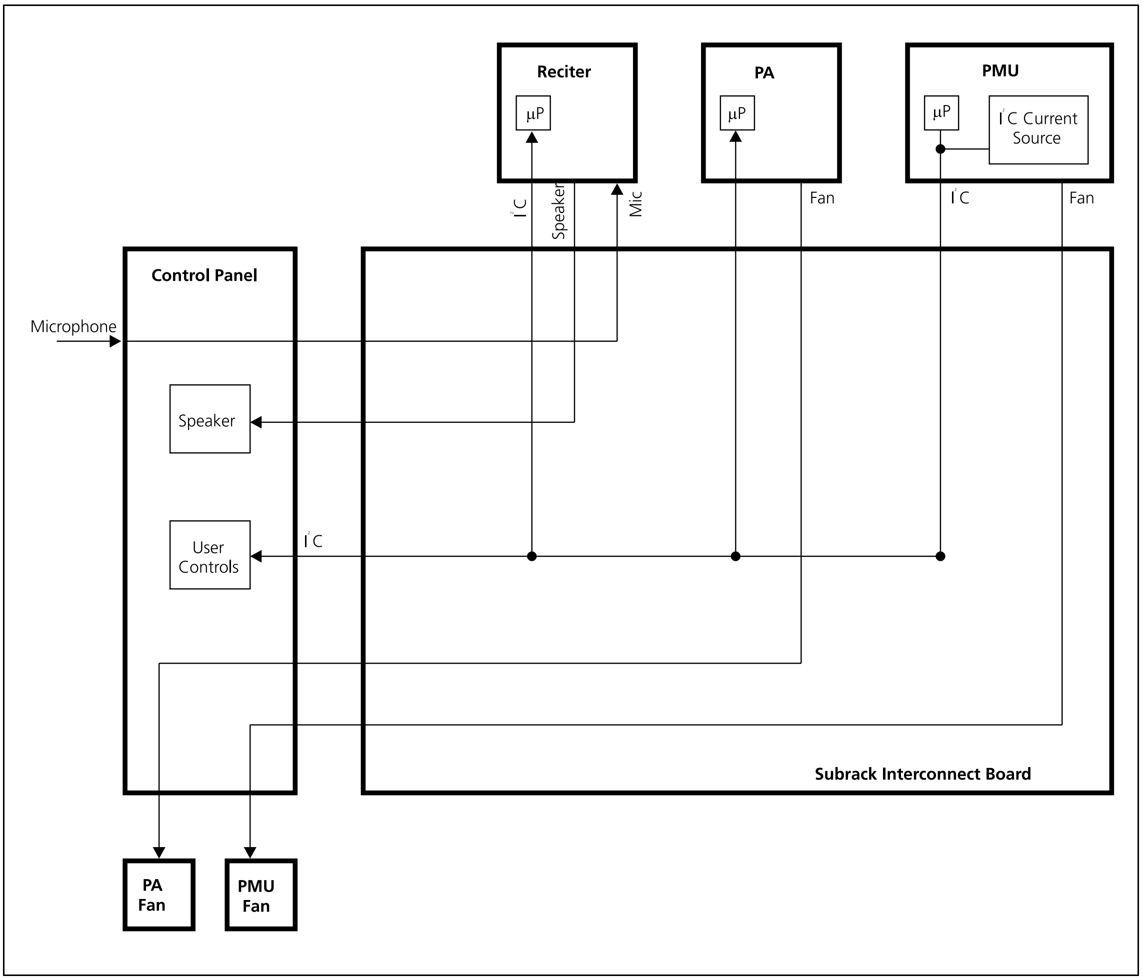
a. The actual frequency coverage in this band is:
Transmit: 762MHz to 776MHz, and 850MHz to 870MHz
Receive: 792MHz to 824MHz

1.4 Theory of Operation

Typical Base Station System

A typical TB9100 base station (shown in Figure 1.1) has a PMU that supplies power to the modules in the subrack.

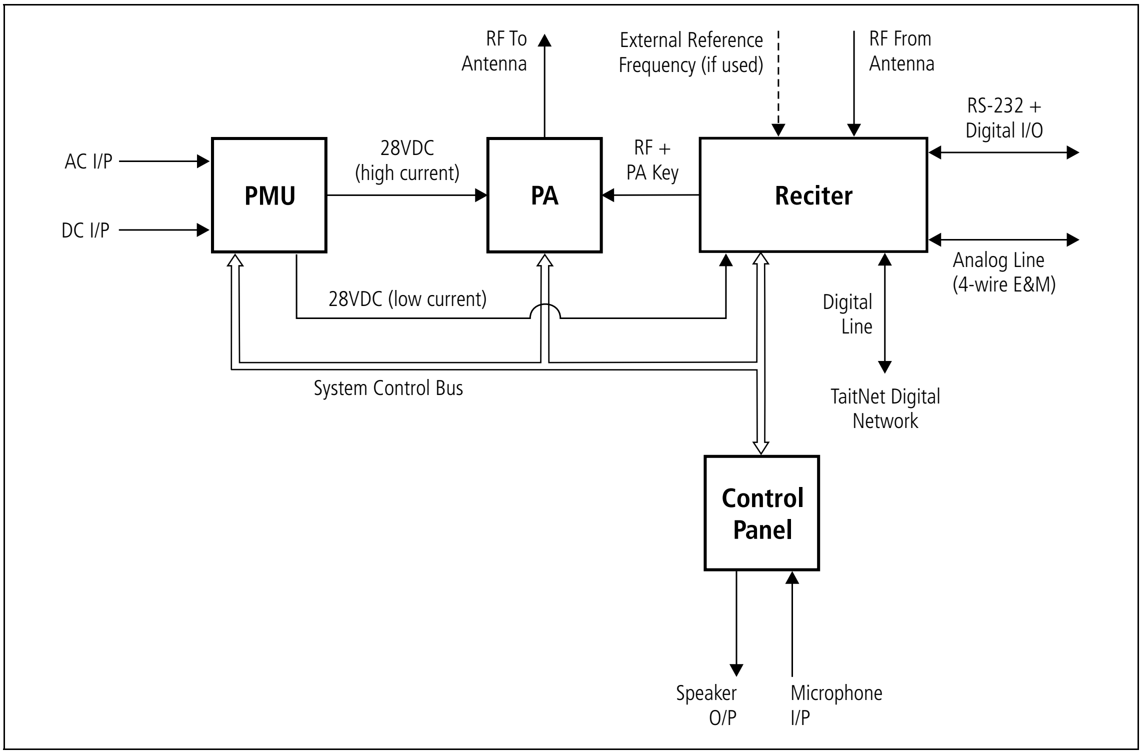
Figure 1.1 Base station system communication paths



A system control bus interconnects the modules and carries alarm and control signaling between the reciter and the other modules (shown in Figure 1.2). The reciter receives RF signals from its RF input and sends RF from its RF output to the PA, along with a PA key signal. The reciter also receives signals from and sends signals to the analog line, the digital line, and the control panel.

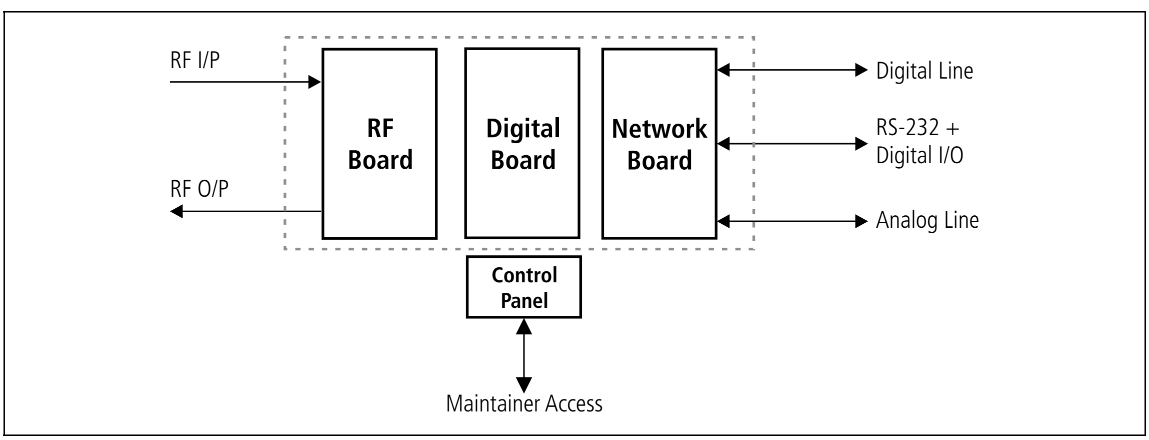
The control panel speaker and microphone enable the base station maintainer to communicate with the dispatcher or with subscriber unit radios. As well as voice over IP, the digital line carries communications between the CSS and the base station.

Figure 1.2 Base station high-level diagram



The signal processing and the overall base station control is carried out by the reciter, which comprises an RF, a digital, and a network board, as shown in Figure 1.3.

Figure 1.3 Reciter boards



The RF board contains the receiver and exciter circuitry.

The digital board is responsible for the digital conversion of analog information and for controlling the maintainer's access via the control panel. It performs the air interface signal processing for both analog FM and digital P25 modes.

The network board acts as the link between the digital circuitry and the TaitNet digital network, and gives the base station an identity as a network element. It also provides the physical connections for the digital, analog and RS-232 serial interfaces.

For more detailed information, see "Technical Description" on page 91.

12V PA Base Station System

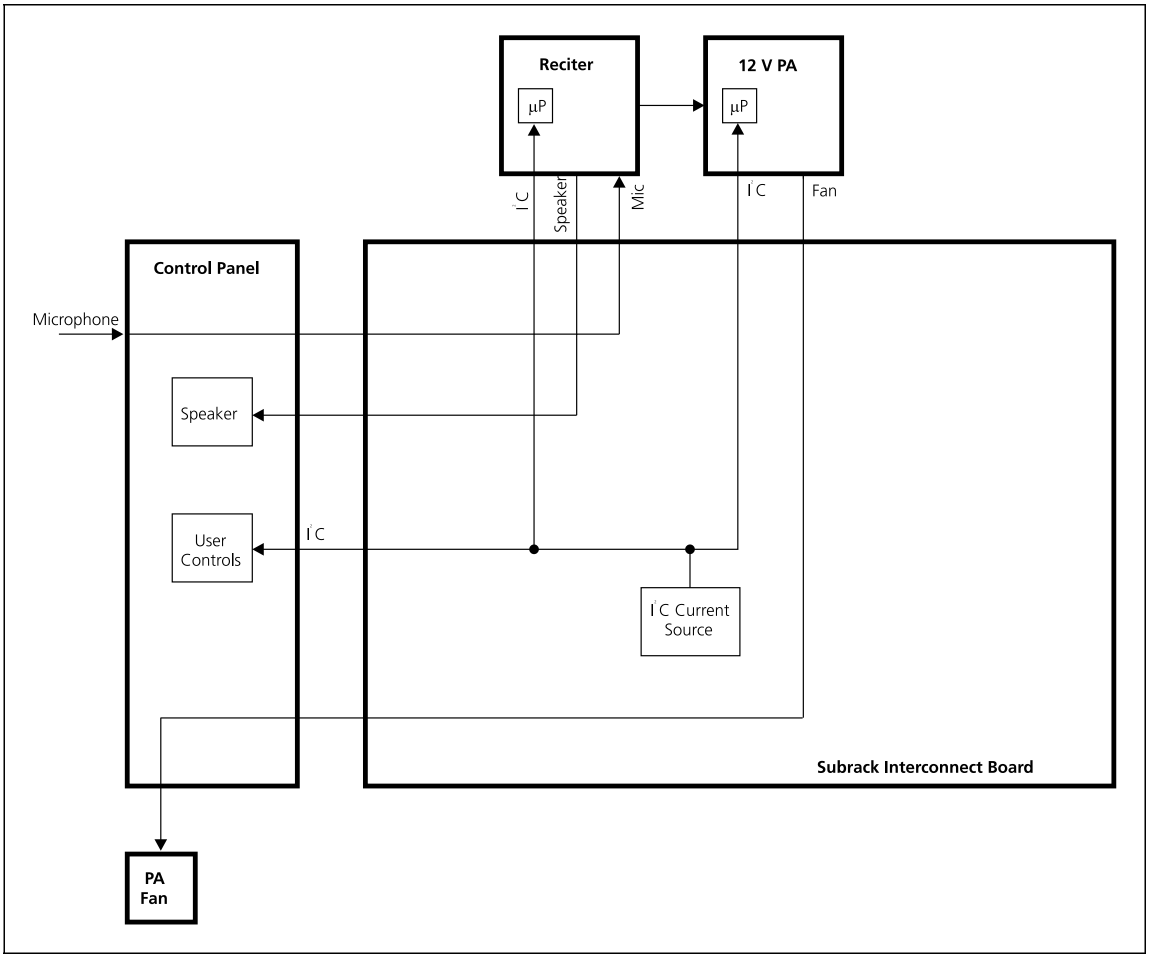
The TB9100 platform also supports the operation of a 12V PA base station. Figure 1.4 shows the main communication paths in a 12V PA base station system. The 12V PA base station system does not require a PMU, as the DC input is connected directly to the 12V PA. An internal boost regulator board converts the 12V nominal DC input to a 28VDC output to power the PA circuit boards. The boost regulator board also provides a 12VDC output to power the reciter.

12V PA base stations use a different subrack interconnect board from base stations with a PMU, which provides the I^2C current source normally provided by the PMU.

Note The 12V PA base station subrack interconnect board has a set of switches which must be set according to the base station configuration. Refer to "Replacing the Subrack Interconnect Board" on page 86 for details of the switch settings.

Because there is no PMU, it is recommended that the "No PMU detected" alarm be disabled for 12V PA base stations.

Figure 1.4 12 V PA base station system communication paths



Power Management

TB9100 base stations with a PMU manage the supply of power to ensure uninterrupted operation of the base station. A range of parameters is monitored and can trigger alarms that are sent via the reciter to the CSS and a syslog collector.

AC to DC Changeover

When the PMU has an AC and a DC module, the TB9100 can be powered by either the AC (mains) or the DC (battery) supply. The base station will default to the AC supply if both supplies are provided. If the AC supply becomes unavailable, a seamless changeover from the AC to DC supply takes place, providing that the battery voltage is above the configured minimum. You can use the CSS to monitor whether the base station is running on battery or mains power.

DC Operation

When the base station is running off the DC supply and the battery voltage falls below the configured minimum, the base station will enter PMU Shutdown mode to protect the battery and base station equipment. A standby power supply card is required to maintain the power to the PMU microprocessor, while the rest of the PMU is shut down.

When the battery voltage rises to the configured startup setting, power is resumed to the DC supply.

Auxiliary Power Control

If the PMU is fitted with an auxiliary power supply unit, its output can be used to power other site equipment or to recharge the DC battery supply when the base station is running off the AC supply. You will need to configure it to suit your requirements.

Power Distribution

This section details how the input power feed is distributed throughout the base station system to power its various sub-systems. The high level block diagrams in Figure 1.5 on page 19 show the power distribution paths in base station systems.

The TB9100 can receive input power from either the AC or DC input. Internal seamless switching between the AC or DC input ensures there are no power interruptions should a changeover occur between the two inputs. The base station will default to the AC input if both AC and DC inputs are provided.

The AC converter has a series switch which isolates the mains input from the converter. The DC input, however, has much higher current ratings, and supports an on/off switch on the converter only.

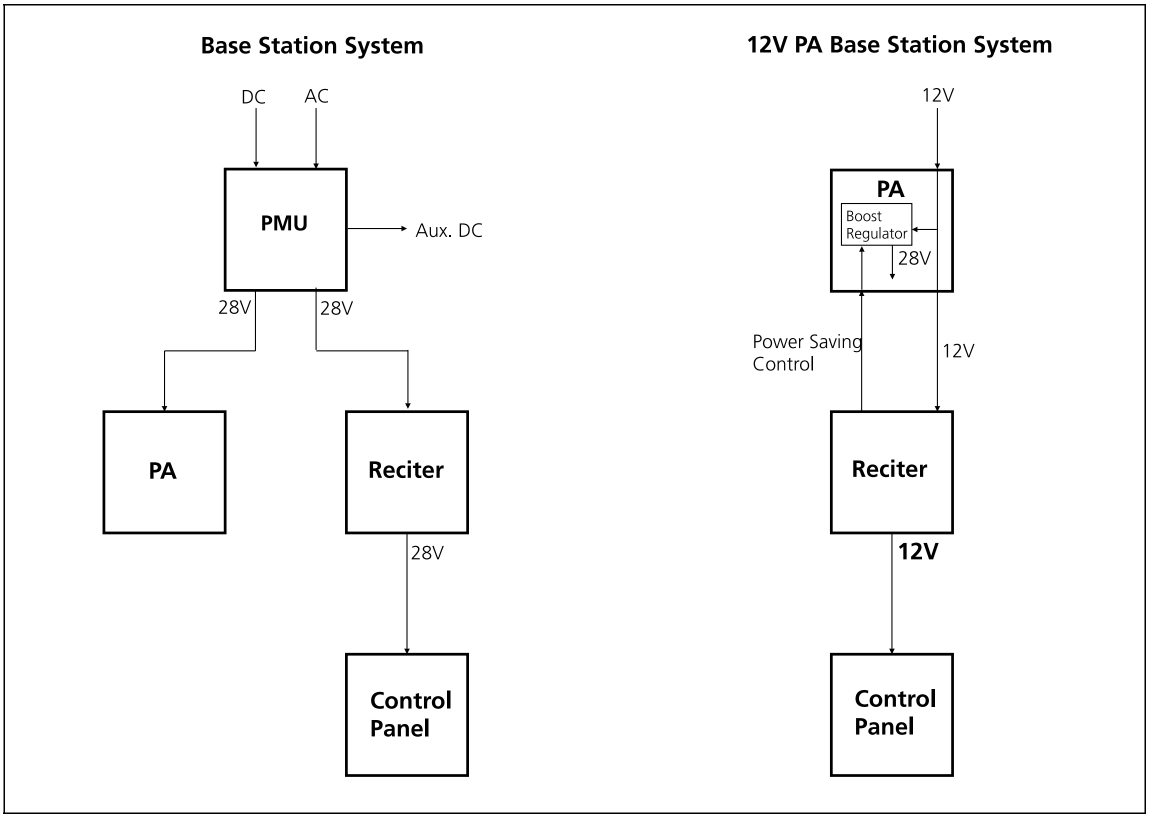
The outputs from both the AC and DC high power converters are added together and fed to the PA via the PA1 and PA2 outputs. The auxiliary output is also tapped off this summed output.

Base stations fitted with a 12V PA do not require a PMU. In this case the DC input is connected directly to the PA, where it is fed to the internal boost regulator board. This board provides a 12VDC output for the reciter and a 28VDC output for the PA circuit boards.

The reciter input power feed is distributed to all internal reciter boards. Local regulation ensures that noise and common mode interface signals are kept to a minimum between sub-assemblies. Various power supplies in the reciter further power and isolate critical sub-sections.

The reciter also powers the control panel, via a backpower protection diode. The system control bus is used to route power from the reciter to the control panel. When a reciter is powered and plugged into the control bus, if a control panel is connected there will always be a reciter present to drive the control bus functions.

Figure 1.5 TB9100 power distribution high level block diagram



Front Panel Fan Operation

The TB9100 base station is equipped with three fans. One fan is for the PMU, one fan is for the PA, and the third fan is for the reciter. This section deals with the PMU and PA fans. For information on reciter fan operation, refer to "Reciter Fan Operation" on page 95.

The PMU and PA cooling fans are located in the front panel of the base station. The fans do not operate continuously but are switched on and off as needed by the reciter firmware.

When the base station powers up, the fans turn on: the PMU fan runs first, followed by the PA fan (the reciter fan will also power up, after the PA fan). Each fan will run for about 5 seconds before switching off.

Fans used in the TB9100 must have the correct wiring: power and ground (2-wire fans), or power, ground, and rotation detect (3-wire fans). Both fans in the subrack must be of the same type. If 3-wire fans are fitted, the reciter can monitor whether the fans are rotating and generate an alarm if the fan fails.

Configuring Fan Control

The operation of the PA fan is configurable via the CSS: you can specify the threshold temperature at which the fan will be turned on, and set the fan to operate only when the PA is transmitting.

The PMU fan has fixed on/off thresholds and a defined set of duty cycles based on the PMU temperature, as follows:

PMU Temperature	Duty Cycle
<149°F (65°C)	Increases with increasing current draw
149-167°F (65-75°C)	On two minutes, off one minute
>167°F (75°C)	Always on

Run and Standby Modes

The TB9100 normally operates in Run mode, but you can use the CSS to put it in Standby mode.

Run mode

In Run mode, the base station performs its normal functions.

Standby mode

When you program the base station or run invasive diagnostic tests, the base station must be in Standby mode. This takes the base station out of service. However, the control panel is still effective; you can use it to send and receive over the air and across the analog line and to receive from the digital line.

Dual Mode

The TB9100 base station can handle analog FM calls as well as digital P25 calls. It is a dual-mode base station. However, it can be configured to always operate in one mode. For example, if only digital P25 radios use the base station, the base station can ignore analog FM calls. Note that at any one time, the base station can only handle one call, either analog FM or digital P25. It cannot receive in one mode and simultaneously transmit in the other.

Analog FM mode

In Analog FM mode, the base station can receive and transmit over the RF interface using analog FM modulation. Analog FM speech is sent and received on the digital line using the G.711 format.

Digital P25 mode

In digital P25 mode, the base station can receive and transmit over the RF interface using digital P25 modulation. Digital speech is in the IMBE (Improved Multi-Band Excitation) format.

Dual mode configuration

Dual mode is configured not for the base station as a whole, but for the inputs at a particular interface. The mode of outputs is not configurable; it can always be either analog FM or digital P25, depending on the input. When the base station receives an input on an interface, it operates in the mode of that input.

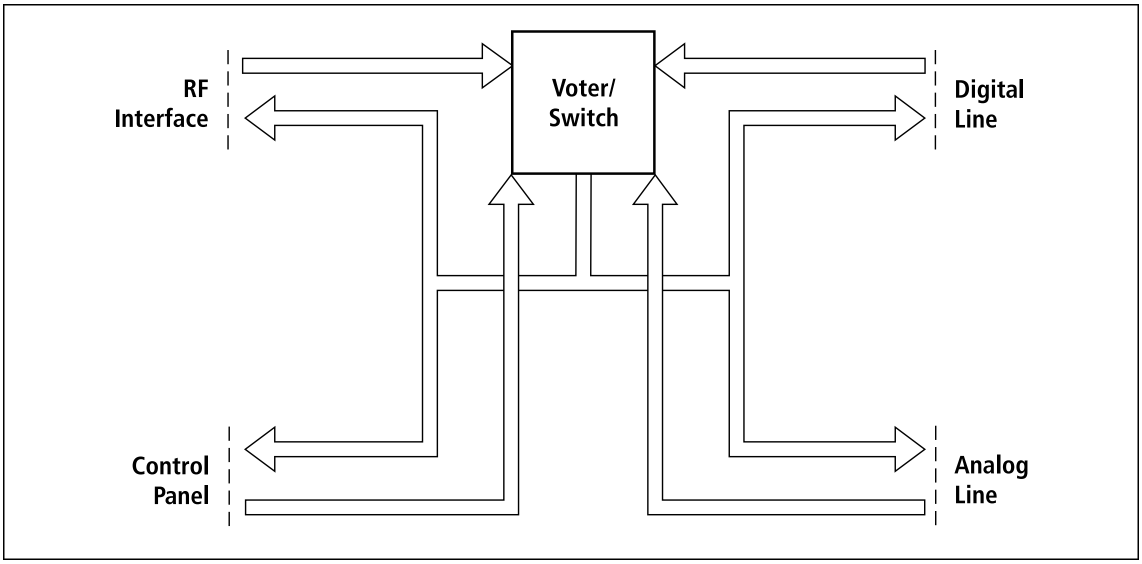
Dual mode is configured or selected at the different inputs in the following way:

Input interface	Description
RF	The RF interface can be configured in channel profiles to receive analog speech, digital speech or both (dual mode). In dual mode, the receiver listens for digital P25 signals. If they are detected, the base station operates in digital P25 mode, otherwise in analog FM mode.
Analog Line	The analog line receives analog speech signals from the dispatch console. The current calling profile defines whether the signal is to be handled as digital P25 or analog FM. Different calling profiles can select different modes.
Digital Line	The digital line receives speech signals whose mode has already been defined by another base station in the network. They are in the format of IMBE speech packets (digital P25 calls) or G.711 speech packets (analog FM calls). The digital line is always capable of receiving calls in either mode.
Control Panel	The control panel receives speech from the connected microphone. The user selects digital P25 or analog FM mode using the microphone channel button. Refer to "Microphone Operation" on page 68 for further details. The destination of the signal is configured by the CSS.

Signal Voting and Switching

The TB9100 base station receives signals at its four interfaces: RF, analog line, digital line and control panel microphone. The signals travel along a path and are presented at the internal voter, as shown in Figure 1.6. Often, the paths for analog FM and for digital P25 signals diverge.

Figure 1.6 TB9100 signal paths



When more than one signal is present, the voter selects the most appropriate one. Calls made from the control panel microphone are given priority, followed by signals received at the analog line. Signals received at the RF and digital interfaces are voted between on the basis of signal quality. Note that P25 digital signals take priority over analog signals.

When the base station is part of a channel group, the voters in the other base stations act in concert, selecting the same signal. The switching system then sends the winning signal to the intended interfaces for transmission.

The channel group can operate in simplex or duplex modes. This mode is distinct from (but related to) the RF simplex/duplex mode.

Simplex mode

The simplex channel group has a single voter at each channel group member, which selects one stream from all possible sources, and sends it to all output interfaces. The vote winner could be a terminal speaker, or a line interface speaker (dispatcher).

Duplex mode

The duplex channel group allows two directions of speech flow simultaneously. Channel group members vote incoming RF streams and select one vote winner. The channel group members send this inbound stream to all line interfaces and control panel speakers (if so enabled). At the same time, in each channel group member, a separate voter selects one voice stream from the line interfaces (and control panels), and the outbound stream is sent to all RF interfaces. Like the simplex voter, there are duplex voters at each channel group member.

Both simplex and duplex channel groups can repeat the RF, or not.

For full details about the audio paths and signal processing, refer to "Signal Paths" on page 97.

1.5 Base Station Options

The modular design of the TB9100 base station means that it is available in many variations. A range of features that can be enabled in software adds another level of configurability. Here are some of the different kinds of TB9100 base station that result from different module combinations.

Base Station/Repeater

The standard TB9100 combination of modules is suitable for use as a line-connected base station and as a repeater. This is the typical base station configuration described in "Theory of Operation" on page 14.

Base Station/Repeater for External Power Supply

The TB9100 base station can be provided without a PMU for those who prefer to use an external third party power supply. This option must use a variant of the PA that works off a 12V power supply and includes a boost regulator board that takes the 12V input and outputs a regulated 24V supply to the rest of the PA. Customers must provide their own power supply. Without a PMU, the base station cannot carry out its power management functions.

Receive-only Base Station

The TB9100 base station can be provided as a receive-only variant in systems that need sites to enhance the receive coverage. This consists of a single reciter in a subrack, with or without power management. The exciter is present but not licensed to transmit.

Analog Gateway

A reciter in a subrack can provide a gateway between an analog dispatch system and a TaitNet P25 network of TB9100 base stations. Its analog line connects to the dispatch system and its digital line connects to the TaitNet P25 network. This is particularly valuable in networks that use encryption; it brings the encryption and decryption point close to the dispatch equipment. This option is effectively the same as the receive-only base station; in addition, the receiver is disabled.

Encryption

The TB9100 supports end-to-end encryption between radios. The repeated voice quality is indistinguishable from non-encrypted voice. If the control panel speaker is turned on, it plays continuous noise throughout the transmission (silence into the transmitting radio sounds the same as voice), unless the base station has a basic encryption license, in which case encrypted calls cannot be heard at all through the front panel speaker. Support is also available for encryption and decryption at the base station analog line interface or at an analog gateway. An additional AES encryption license is available in addition to the basic (DES) encryption license.

1.6 Base Station Applications

TB9100 base stations can be used as repeaters, as base stations, and they can be connected together to form a wide-area repeater or wide-area base station. For more information, see the white paper *TaitNet P25 Networks*.

Repeater

TheTB9100 base station can function as a standalone repeater. The analog line is not used and the digital line is only used for CSS access. Software licenses for these lines are not needed.

Line-Connected Base Station

A TB9100 base station can function as a line-connected base station. A dispatch console is connected to the analog line. If the repeat function is enabled, the base station repeats what it receives unless the microphone or analog line input is being used. If the repeat function is disabled, the base station puts the received signal on the analog line but does not transmit it. A software license for the analog line is needed.

TaitNet P25 Network

TB9100 base stations can be interconnected over an IP-based linking infrastructure to form a TaitNet P25 network. Each base station in the network belongs to a channel group. A channel group is a set of one or more base stations. Any base station in the channel group can have a dispatch console connected via its analog line (analog line license required). Base stations in a channel group all require a digital line license.

The base stations in a channel group act as one. This is made possible by distributed voting. A channel group can operate in simplex or duplex modes, which means that each base station has either one voter that applies the same voting rules to the same signals in simplex mode, or two voters in duplex mode that allow two directions of speech flow simultaneously. For example, in simplex mode, when the console operator presses PTT, all base stations in the channel group transmit, not just the base station connected to the dispatch console. If the base stations receive more than one signal, they vote on the best one and then repeat it and/or pass it to the dispatch console.

If the base stations in a channel group have the repeat function enabled, that channel group acts as a wide-area repeater (however, dispatcher calls and control panel calls are given priority over radio calls).

If the repeat function is disabled, the channel group acts as a wide-area line-connected base station. Calls received by any base station are sent to the dispatcher and calls from the dispatcher are transmitted via all the base stations.

2 General Safety and Regulatory Information

This chapter provides general information on safety precautions for operating the TB9100 base station.

2.1 General Safety

Personal Safety

Lethal Voltages

Warning!! **The PMU contains voltages that may be lethal. Refer to the ratings label on the rear of the module.**

The TB9100 base station must be installed so that the rear of the PMU is located in a service access area. The PMU must be connected to the mains supply source by trained personnel in accordance with local and national regulations.

Disconnect the mains IEC connector and wait for five minutes for the internal voltages to self-discharge before dismantling. The AC power on/off switch does not isolate the PMU from the mains. It breaks only the phase circuit, not the neutral.

The PMU should be serviced only by qualified technicians. There are no user-replaceable parts inside. If the PMU is damaged and does not function properly, stop the module safely and contact your nearest Tait Dealer or Customer Service Organization immediately.

All servicing should be carried out only when the PMU is powered through a mains isolating transformer of sufficient rating. We **strongly recommend** that the mains power to the whole of the repair and test area is supplied via an earth leakage circuit breaker.

Explosive Environments

> **Warning!!** **Do not operate TB9100 equipment near electrical blasting caps or in an explosive atmosphere. Operating the equipment in these environments is a definite safety hazard.**

Proximity to RF Transmissions

Do not operate the transmitter when someone is standing within 3 ft. (90 cm) of the antenna. Do not operate the transmitter unless you have checked that all RF connectors are secure.

High Temperatures

Take care when handling a PMU or PA which has been operating recently. Under extreme operating conditions (+140°F [+60°C] ambient air temperature) or high duty cycles, the external surfaces of the PMU and PA can reach temperatures of up to +176°F (+80°C).

Equipment Safety

Installation and Servicing Personnel

The TB9100 should be installed and serviced only by qualified personnel.

Antenna Load

> ***Important*** The PA may be damaged if the load is removed or switched while the PA is transmitting.

To protect the PA output stage from load transients (i.e. switching or removing the load), we recommend that you fit an isolator between the PA and the load. Fit the isolator as close as possible to the RF output connector on the PA. Do not connect any switching or combining equipment between the isolator and the PA.

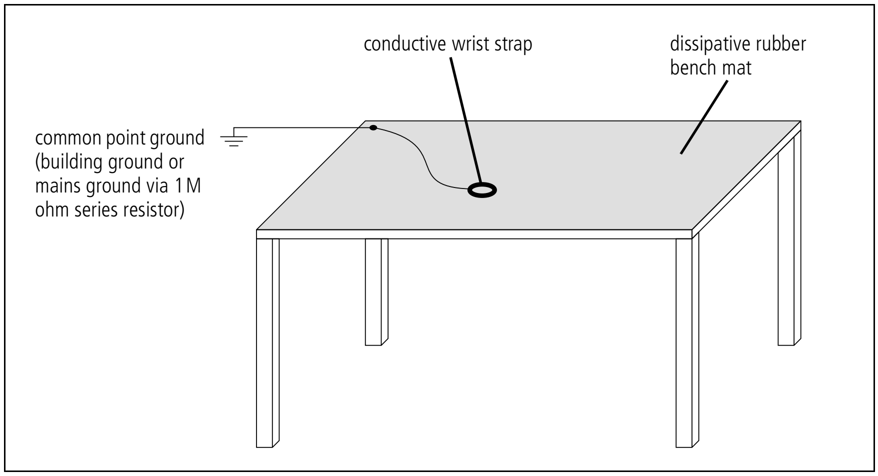
ESD Precautions

> ***Important*** This equipment contains devices which are susceptible to damage from static charges. You must handle these devices carefully and according to the procedures described in the manufacturers' data books.

We recommend you purchase an antistatic bench kit from a reputable manufacturer and install and test it according to the manufacturer's instructions. Figure 2.1 shows a typical antistatic bench set-up.

You can obtain further information on antistatic precautions and the dangers of electrostatic discharge (ESD) from standards such as ANSI/ESD S20.20-1999 or BS EN 100015-4 1994.

Figure 2.1 Typical antistatic bench set-up



Anti-tampering Devices

All network elements should be physically secured, where possible. This includes the use of locked cabinets and the use of seals on connectors.

All network and audio connectors should be sealed with the stick on type of seal. The purpose of the seals is to detect unauthorized tampering. The seal should reveal if any of the connectors have been unplugged or if any unauthorized equipment has been plugged in.

The seals must be difficult to remove without breaking, and must bridge between the cable and equipment side (plug and socket) of the connection.

Seals must cover any unused network or audio sockets. This includes the Ethernet connector on the front panel, any spare switch ports, and the console port on the router and switch.

The seals must be difficult to reproduce. A sticker initialed or signed by the technician should satisfy this.

Seals must be replaced if they need to be disturbed during maintenance.

Environmental Conditions

Operating Temperature Range

The operating temperature range of the TB9100 is −22°F to +140°F (−30°C to +60°C) ambient temperature. Ambient temperature is defined as the temperature of the air at the intake to the cooling fans.

Humidity

The humidity should not exceed 95% relative humidity through the specified operating temperature range.

Dust and Dirt For uncontrolled environments, the level of airborne particulates must not exceed 100μg/m^3.

2.2 Regulatory Information

Distress Frequencies

The 406 to 406.1MHz frequency range is reserved worldwide for use by Distress Beacons. Do **not** program transmitters to operate in this frequency range.

FCC Compliance

This equipment complies with:

- Part 15 Class B of 47CFR: Radiated and conducted emissions, and electromagnetic susceptibility specifications of the Federal Communications Commission (FCC) rules for the United States.

  Operation is subject to the following two conditions:

  a. This device may not cause harmful interference, and

  b. This device must not accept any interference received, including interference that may cause undesired operation.

- Part 68 of 47CFR: (Connection of terminal equipment to the telephone network) of the FCC rules and the requirements adopted by ACTA.

  This equipment's FCC certification number (US: 6FPOTNANTBA1PA0) is displayed on the label to be found towards the rear of the left-hand (RF) side of the reciter. If requested, you must provide this number to the telephone company. (This approval applies solely to the *TPA1PA0 Network Board* in the Reciter.)

  TTE Information
  USOC Jacks: RIJCX (where required)
  Service Order Code: 7.0Y
  Facility Interface Code: 04N02, TL31E

Warnings: If the *TPA1PA0 Network Board* in the Reciter causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. But if advance notice isn't practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations or procedures that could affect the operation of the equipment. If this happens the telephone company will provide advance notice in order for you to make necessary modifications to maintain uninterrupted service.

Connection to party line service is subject to state tariffs. Contact the state public utility commission, public service commission or corporation commission for information.

If trouble is experienced with the *TPA1PA0 Network Board* in the Reciter, for repair or warranty information, please contact:

Tait North America Inc
Building 1, Suite 450
15740 Park Row
Houston, Texas 77084

E-mail: usa@taitworld.com
Web: www.taitworld.com

Only approved Tait Dealer or Customer Service Organizations equipped with the necessary facilities should perform any servicing. Repairs attempted with incorrect equipment or untrained personnel may result in permanent damage. If the equipment, *TPA1PA0 Network Board* in the Reciter, is causing harm to the telephone network, the telephone company may request that you disconnect the equipment until the problem is solved.

Unauthorized Modifications

Any modifications you make to this equipment which are not authorised by Tait Electronics Ltd may invalidate your compliance authority's approval to operate the equipment.

Health, Safety and Electromagnetic Compatibility in Europe

In the European Community, radio and telecommunications equipment is regulated by Directive 1999/5/EC, also known as Radio and Telecommunications Terminal Equipment (R&TTE) directive. The requirements of this directive include protection of health and safety of users, as well as electromagnetic compatibility.

Intended Purpose of Product

This product is an FM radio transceiver. Its intended purpose is for radio communication in Private Mobile Radio (PMR) services or Public Access Mobile Radio (PAMR) services.

Important This product can be programmed for frequencies or emissions that may make its use illegal. A license must be obtained before this product is used. All license requirements must be observed. Limitations may apply to transmitter power, operating frequency, channel spacing and emission.

Declaration of Conformity

You can download the formal Declaration of Conformity from http://eudocs.taitworld.com/. You can also obtain a signed and dated paper copy of the Declaration of Conformity from Tait Europe Ltd.

3 Maintenance

The TB9100 is designed to be very reliable and should require little maintenance. However, performing regular checks will prolong the life of the equipment and prevent problems from happening.

It is beyond the scope of this manual to list every check that you should perform on your base station. The type and frequency of maintenance checks will depend on the location and type of your system. The checks and procedures listed below can be used as a starting point for your maintenance schedule.

Performance Checks

We suggest you monitor the following operational parameters using the CSS:

- VSWR
- DC input voltage, especially on transmit
- receiver sensitivity
- the setting of the receiver gate opening
- any temperature alarms.

These basic checks will provide an overview of how well your base station is operating.

Reciter

There are no special maintenance requirements for the reciter. You may choose to recalibrate the TCXO frequency periodically. Refer to the Calibration Software documentation for more details.

PA

There are no special maintenance requirements for the PA.

PMU

There are no special maintenance requirements for the PMU. However, if you are using battery back-up, you should check the batteries regularly in accordance with the manufacturer's recommendations.

Ventilation

The TB9100 base station has been designed to have a front-to-back cooling airflow. We strongly recommend that you periodically check and maintain the ventilation requirements described in "Equipment Ventilation" on page 36 to ensure a long life and trouble-free operation for your base station.

Cooling Fans

The cooling fans have a long service life and have no special maintenance requirements. You can use the CSS to configure the base station to generate an alarm if either of the cooling fans fail. Refer to the CSS documentation for more details.

4 Installation

This chapter provides information on the site requirements for your TB9100 equipment and also describes how to install the base station in a standard 19 inch rack or cabinet.

If this is your first time installing a TB9100 base station, we recommend that you read the entire chapter before beginning the actual installation.

4.1 Before You Begin

Equipment Security

The security of your base station equipment is a high priority. If the site is not fully secure, the base station should at least be locked in a secure cabinet to prevent unauthorized access.

The base station control panel provides access to the speaker, microphone input and alarm status display. It is important that control panel access is restricted to authorized maintainers only in order to ensure the confidentiality of voice communications and alarm status information.

Grounding and Lightning Protection

Electrical Ground

The TB9100 base station modules are grounded by physical contact between the module case and the subrack. To ensure a good ground connection you must tighten each module retaining clamp securely (refer to "Final Reassembly" on page 88 for the correct torque).

A threaded grounding connector is provided on the rear of the subrack for connection to the site ground point (refer to "Connecting Up the Base Station" on page 52 for more details).

Lightning Ground

It is extremely important for the security of the site and its equipment that you take adequate precautions against lightning strike. Because it is outside the scope of this manual to provide comprehensive information on this subject, we recommend that you conform to your country's standards organization or regulatory body.

Equipment Ventilation

Always ensure there is adequate ventilation around the TB9100 base station.

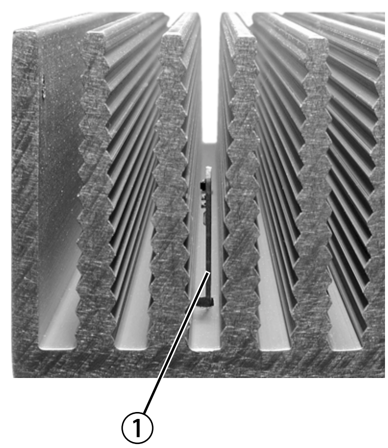
Warning!! **Do not operate it in a sealed cabinet. You must keep the ambient temperature within the specified range, and we strongly recommended that you ensure that the cooling airflow is not restricted.**

Important The cooling fans are mounted on the front panel and will only operate when the panel is fitted correctly to the front of the subrack. To ensure adequate airflow through the base station, do not operate it for more than a few minutes with the front panel removed (e.g. for servicing purposes).

Ambient Air Temperature Sensor

The ambient air temperature reading for the TB9100 base station is provided by the ambient air temperature sensor board ① fitted to the PA control board.

The sensor board is inserted through slots in the control board and heatsink to be positioned between the heatsink fins.



Important If the sensor board is to provide accurate ambient temperature readings, it must have forced airflow and must not come into contact with the metal of the heatsink fins. **Do not stack PAs with the fins together.** It is possible for the fins on one heatsink to slide between the fins on the other heatsink. This can damage the sensor board, and possibly result in the heatsink fins becoming locked together.

Cabinet and Rack Ventilation

The cooling airflow for the TB9100 base station enters through the front panel and exits at the rear of the subrack. For optimum thermal performance, the heated air that has passed through a base station must not be allowed to re-enter the air intakes on the front panel. Any space at the front of the cabinet not occupied by equipment should be covered by a blanking panel. Refer to Figure 4.1 on page 38.

To allow enough cooling airflow through a cabinet-mounted base station, we recommend the following:

- an area of at least 23 in^2 (150 cm^2) of unrestricted ventilation slots or holes in front of the air intakes for the fans for each subrack; for example, thirty 0.25 x 3.3 in (6 x 85 mm) slots will allow the recommended airflow
- a vent in the top of the cabinet with an area of approximately 23 in^2 (150 cm^2) per subrack, or a similar area of ventilation per subrack at the rear of the cabinet behind each subrack
- a 2U gap at the top of the cabinet.

Note The ventilation opening must be unrestricted. If the slots or holes are covered with a filter, mesh or grille, the open area must be increased to allow the same airflow as an unrestricted opening.

The maximum ambient temperature entering the cabinet must not exceed +140°F (+60°C).

If the TB9100 base station is installed in a rack or cabinet with other equipment with different ventilation requirements, we recommend that the TB9100 be positioned below this equipment.

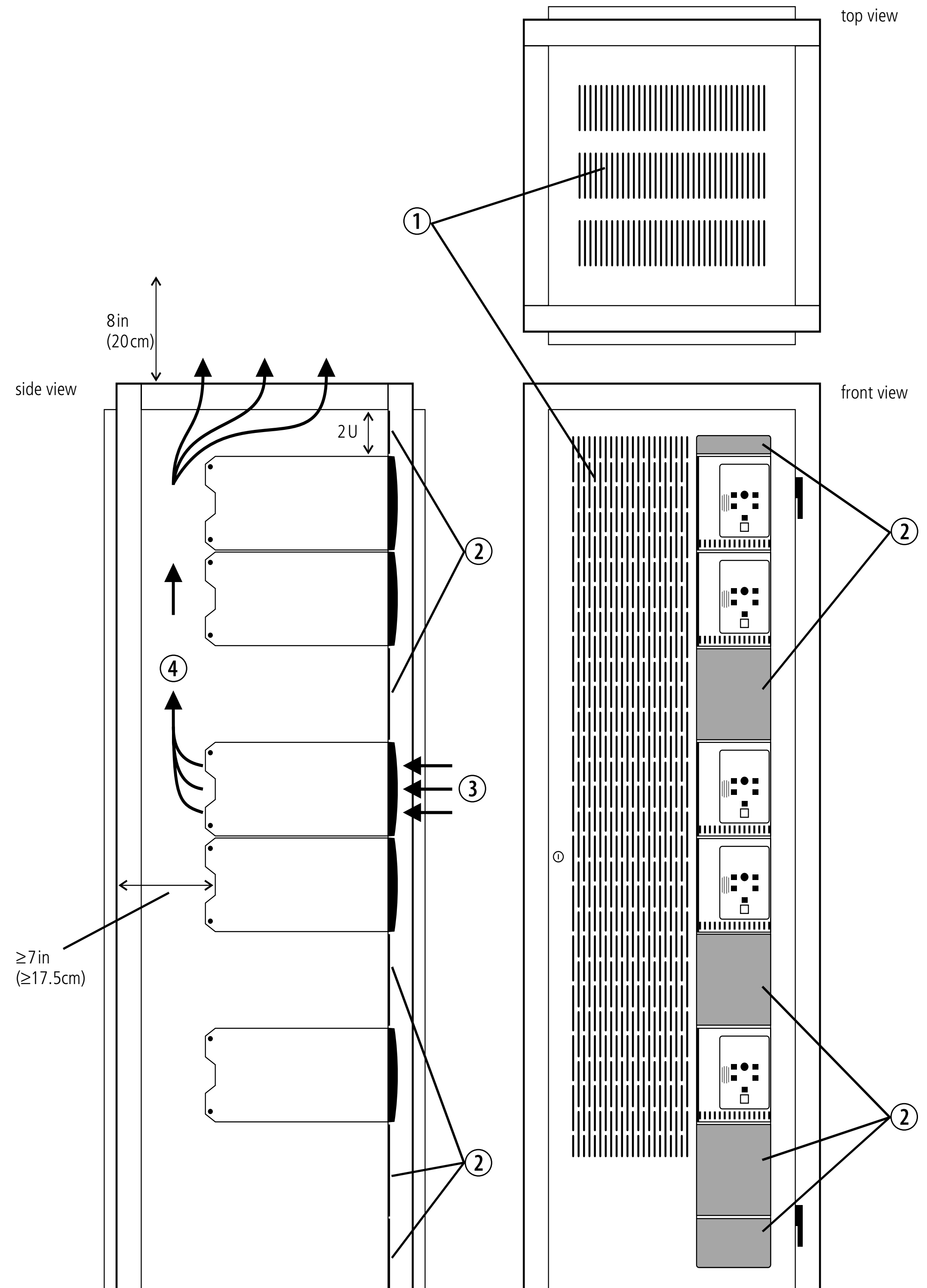
Auxiliary Extractor Fans

The TB9100 base station does not require auxiliary extractor fans mounted in the top of the cabinet. If your cabinet is already fitted with fans, the following procedures apply:

- if there are six or more 4.75 in (12 cm) fans, each capable of extracting 94.2 ft^3 per minute (160 m^3 per hour), they must run continuously
- if there are fewer than six fans, you must remove them and ensure the vent in the top of the cabinet has an area of approximately 23 in^2 (150 cm^2) per subrack.

If you have any other configuration, the performance of your system will depend on how closely you comply with the TB9100 base station airflow requirements described above.

Figure 4.1 Typical cabinet ventilation requirements



① ventilation slots
② blanking panels
③ airflow entry
④ airflow exit

4.2 Installing and Setting up the CSS

To monitor and configure the base station, and to carry diagnostic tests on it, you need the CSS. Follow the instructions on the TB9100 CSS CD and install the CSS on a PC.

To install the CSS, you need a registration key. You can obtain a key from Tait. Please contact your technical support representative. If you have previously installed a CSS, you can use the same key.

You also need to set up the PC so that it can handle network communications with base stations. When the base station is on the bench and connected via a hub, the PC can use any IP address and no special routing configuration is needed.

If the PC has a fixed location, refer to the *Customer Service Software User's Manual* for information on how to connect to a base station.

If the PC is a laptop that can be taken on-site, it can be set up so that it can access any base station on the subnet. Maintenance staff use the CSS on their laptops during visits to base stations so that they can adjust the configuration of the base stations they are working on. So that technicians do not need to change the IP address of their laptop every time they visit a different site, a laptop subnet is allocated.

This subnet exists on all site LANs in the network but cannot be routed across the WAN. All routers (unless there are multiple routers on a site LAN) have the same address in the laptop subnet. This will be a secondary address on the routers LAN connection.

Each laptop can be set up with an address in the laptop subnet and their default gateway equal to the router address in that subnet.

Each router will redirect traffic originating on its local LAN and addressed to the laptop network back to the LAN. New base stations and spare base stations will also be allocated addresses in this subnet to facilitate their setup.

You need to tell the CSS which base stations it can connect to. This is done by editing the host information file. Open conncfg.dat in a text editor or select "Tools > Connections" and add names and IP addresses for each base station.

Setting up CSS Access Codes

The CSS has three different privilege levels: Guest, Maintainer, and Administrator. Access codes can be defined for the Maintainer and Administrator privileges. This is done during the CSS installation process.

When you use the CSS, you automatically have the Guest privilege. If you try to carry out an operation requiring the Maintainer or the Administrator privilege, you are asked for the corresponding access code, if one has been defined.

Minimum PC Hardware Requirements for Running CSS

1. Pentium 450 MHz
2. SVGA Monitor (1024 * 768 minimum)
3. Available Serial Port
4. 128 Mb RAM
5. 100 Mb of free HD Space
6. Windows 2000/XP

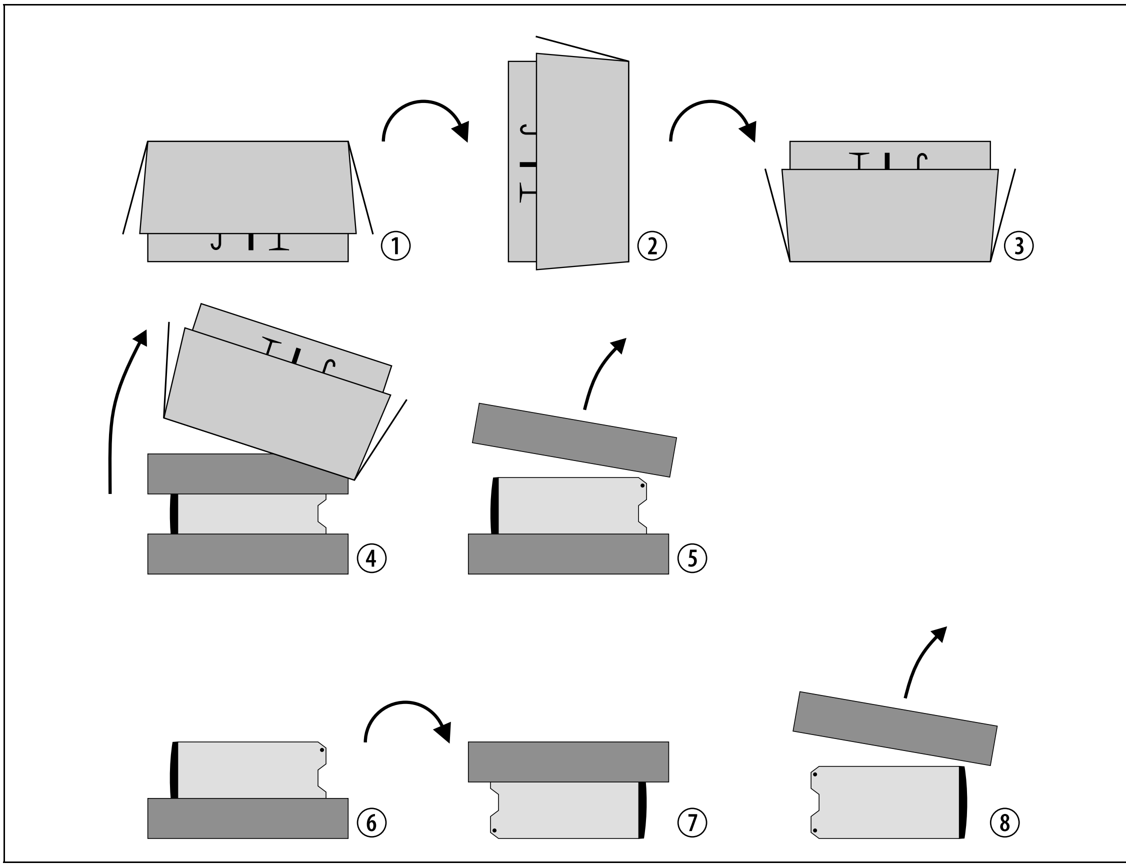
4.3 Unpacking the Base Station

The TB9100 base station is packed in a strong corrugated cardboard carton with top and bottom foam cushions. To prevent personal injury and damage to the equipment, we recommend that two people unpack the base station.

To remove the base station from the carton, follow the procedure illustrated in Figure 4.2 on page 41.

Caution **A TB9100 subrack complete with modules can weigh up to 62lb (28kg), or up to 66lb (30kg) complete with packaging. We recommend that, once the equipment is out of the carton, you remove the modules from the subrack before moving the equipment again. In all cases follow safe lifting practices.**

Figure 4.2 Unpacking the TB9100 base station



1. Cut the tape securing the flaps at the top of the carton and fold them flat against the sides ①.
2. Rotate the carton carefully onto its side ② and then onto its top ③, ensuring that none of the flaps is trapped underneath.
3. Slide the carton upwards over the foam cushions and lift it away ④. Remove the cushion from the bottom of the base station ⑤.
4. Rotate the base station and cushion carefully over the rear of the base station ⑥ so that it is the right way up with the cushion on top ⑦. Remove the cushion from the top of the base station ⑧.

Disposal of Packaging

If you do not need to keep the packaging, we recommend that you recycle it according to your local recycling methods. The foam cushions are CFC- and HCFC-free and may be burnt in a suitable waste-to-energy combustion facility, or compacted in landfill.

4.4 Setting Up on the Bench

Before installing the base station in the on-site cabinets or racks, you need to set it up on the bench. You can then verify that it is operating correctly, and tune it if necessary. You can also customize its configuration for the installation it is destined for and verify that the configuration is correct. An important aspect of that configuration is the base station's IP address. The base station comes with a default IP address but needs to be given the IP address required for its position in the TaitNet digital network.

Important Make sure that the RF output is connected to a suitable attenuator or dummy load.

Confirming Operation

To ensure that the TB9100 is working correctly before site installation, you may want to apply power to check for proper operation.

Applying Power

1. Before turning the TB9100 base station on, carry out the following tasks:
   - check that the PMU is turned off – ensure that the AC and DC module power switches are both set to 'Off' (refer to Figure 5.5 on page 66)
   - **12V PA only:** check that the battery supply lead is disconnected (refer to "Replacing the Power Amplifier" on page 80)
   - remove the front panel (refer to "Preliminary Disassembly" on page 75)
   - check that all looms and cables at the front and rear of the base station are fitted correctly
   - check that all connectors are secure
   - refit the front panel – ensure that it is fitted correctly so that the fans will operate if needed (refer to "Final Reassembly" on page 88)
2. Apply power by turning on the PMU, or by connecting the battery supply lead to the 12V PA.
3. Check that the base station powers up correctly:
   - check that the cooling fans in the front panel turn on in the correct order after power-up: the PMU fan will run first, followed by the PA fan and then the reciter fan; each fan will run for about five seconds and then switch off (note that the PMU fan is not fitted to a 12V PA base station)
   - check that the LEDs on the control panel come on after about five seconds, and then go off (refer to "Control Panel" on page 61)
   - at this point you can safely press the speaker and microphone channel button and check that they are operating correctly

Making Test Transmissions

You can verify that the TB9100 is operating correctly by making some test transmissions.

1. Ensure that the base station is correctly connected to an appropriate load and that all RF connectors are secure.

2. Plug the Tait TMAA02-01 microphone supplied with the TB9100 into the RJ-45 socket on the control panel (for a list of the microphone pin allocations refer to "Microphone Connection" on page 125).

3. Use the left microphone channel button to select the speech mode for the transmission. Check that the corresponding microphone channel LED behaves correctly. Refer to "Microphone Operation" on page 68.

4. Turn on the speaker audio by pressing the speaker button.

5. Press the PTT switch on the microphone and make your transmission. Check that:
   - the red transmit LED turns on
   - there are no alarms generated
   - the audio quality on the receiving radio is good

6. When the other radio answers your transmission, check that:
   - the green receive LED turns on
   - the audio quality from the speaker in the control panel is good (adjust the speaker volume as required)

Tuning

Before the TB9100 is installed on site, you may need to tune the reciter. You can use the Calibration Software to carry out the following:

- adjust the switching range of the reciter
- flatten the response across the base station's switching range

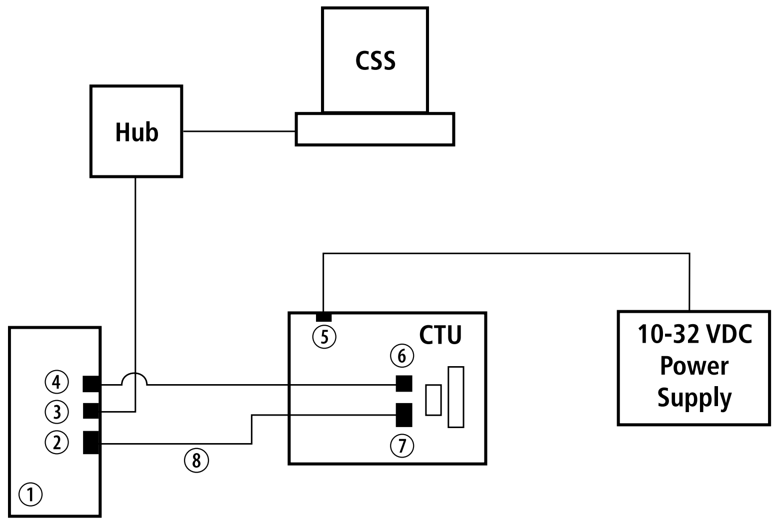
The switching range is the range of frequencies that the base station receiver or transmitter is calibrated to operate on. To adjust this range, the reciter will need to be removed from the subrack to gain access to the tuning holes.

For full details on how to carry out the tuning procedures, refer to the Calibration Software documentation.

Connecting to a Calibration and Test Unit

If you have a TB9100 Calibration and Test Unit (CTU), connect it to the base station as follows for testing base station operation:

Figure 4.3 TB9100 to CTU connections



① Reciter rear
② 9-way digital I/O / serial connector
③ Ethernet RJ-45
④ Analog RJ-45 (audio)
⑤ DC input connector
⑥ RJ-45
⑦ 9-way port (male)
⑧ 3-wire cable (TXD,RXD,GRND)

Note Refer to the Calibration Software online Help or User's Manual and to the Calibration and Test Unit Operation Manual for detailed information about connecting and operating the CTU.

With this set up, you can carry out the following tasks to exercise the base station.

Task	Instructions
Listen to the analog line output	Turn the switch to 'BALANCED' and adjust the speaker volume.
Monitor the analog line output	Connect test equipment to the LINE OUTPUT.
Provide test inputs on the analog line	Connect test equipment to the LINE INPUT.
Key the transmitter via the E-line	Turn the TX KEY switch to ON. Alternatively, connect a cable to the TX KEY and GNT banana sockets and short the cable. (The E-line must be configured to key the transmitter using the CSS).
Check the status of the M-line	View the RX GATE LED. When it is lit, the M-line is low (active).
Monitor the digital output	Connect test equipment to the RSSI.
Turn digital inputs on and off	Switch the DIGITAL INPUTS* 1-4 between OFF and ON. If you have set up Task Manager actions with the digital input value as the input, you can check that the base station responds as expected. * **NB** The TB9100 digital inputs 0-3 are numbered 1-4 on the CTU, and for the TB9100 digital input 4, short the TX RELAY to GND.
Test receiver operation in analog mode	Connect NOISE to the reciter's RF input. Turn the NOISE switch to ON. Alternatively, connect RF test equipment and use it.

Note The CTU is common to TB8100 and TB9100 base stations: some of its connectors and controls are not used with a TB9100.

Setting the Base Station IP Address

Before the base station is installed on site, you need to provide it with a name and its proper IP address. Make sure that you do not lose this address. You must also add the same name and IP address to the CSS connections list, so that you can select the base station when you want to re-connect to it.

1. Run the CSS.
2. You are asked to enter the base station password. Don't enter anything; just click OK. (New base stations have a null password.)
3. Connect to the base station by selecting from the connection list the default entry with the IP address 192.168.1.2.

4. Read the base station's configuration.
5. Select "Configure > Digital Line > Network Identity".
6. Enter the subnet and the IP address specified for this base station by the IP addressing plan for the network. Also enter a suitable name for the base station.

Important Be careful to enter the correct address and subnet, and to keep a written record of them. If you give the base station an unknown IP address or subnet, the CSS will be unable to connect to it.

7. Click **OK** to confirm your entry and exit the configuration form.
8. Click "Tools > Connections" and add an entry to the connections list, consisting of the name and IP address you have entered.
9. Make any other configuration changes that are required, and click Save to save them to file.
10. On the toolbar, click Program to program the information into the base station.
11. Click **Overwrite** to confirm that you really do want to change the IP address.
12. Reset the base station so that the new IP address and name take effect. This disconnects the CSS.
13. Wait for the base station to power up, then on the toolbar, click the Connect icon.
14. Select the entry you added to the connection list and click **Connect**.
15. In the status bar, verify that you are actually connected to the base station

Finding a Lost or Forgotten IP Address

Use the following procedure if an IP address has been lost or forgotten.

1. Connect your PC to the 9-pin serial connector on the back of the reciter.
2. Run a program such as HyperTerminal, Teraterm or minicom.
3. Select the following port settings: 57600 baud, 8 bits, no parity, 1 stop bit, no flow control.
4. Press the 'Enter' key. A login prompt will appear displaying the base station's IP address.

Customizing the Configuration

While the base station is still on the bench, you can configure the settings it requires. The CTU can help you test its operation. The following steps provide an overview of the process. For detailed information and assistance, refer to the CSS online Help or manual.

1. Run the CSS software.
2. Check that the CSS PC is connected to the base station via an Ethernet cable and a hub.
3. On the toolbar, click **Connect**. The Connections dialog box appears.
4. Click on the appropriate entry in the base station list, and then click **Connect**.
5. On the toolbar, click **Read** to read in the configuration settings on the connected base station.
6. On the toolbar, click **Configure**. The navigation tree now gives you access to the available configuration screens.
7. Make the changes needed.
8. Click "File > Save" to save your changes, and then click Program on the toolbar to program these changes into the base station.

Important Make sure that you save the configuration to a file. This provides a backup in case the configuration information becomes lost or corrupted.

4.5 Installing the Base Station on Site

Equipment Required

It is beyond the scope of this manual to list every piece of equipment that an installation technician should carry. However, the following tools are specifically required for installing the TB9100 base station:

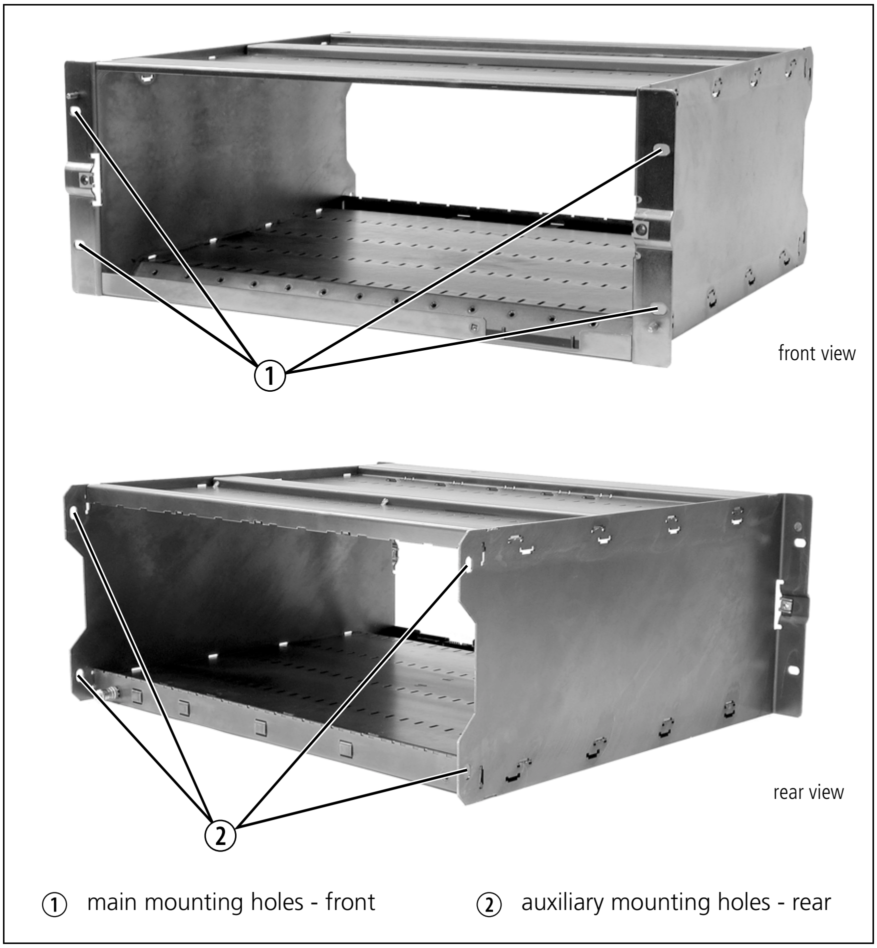
- Pozidriv PZ3 screwdriver for the M6 screws used in the DC input terminals on the PMU; M6 (0.25 in) screws are also used to secure the subrack to the cabinet in Tait factory-assembled systems
- Pozidriv PZ2 screwdriver for the M4 screws used to secure the module retaining clamps
- 0.25 in or 6 mm flat blade screwdriver for the fasteners used to secure the front panel to the subrack
- 8 mm AF spanner for the SMA connectors.

You can also obtain the TBA0ST2 tool kit from your nearest Tait Dealer or Customer Service Organization. It contains the basic tools needed to install, tune, and service the TB9100 base station.

Mounting the Subrack

Caution **We recommend that you remove the modules from the subrack before lifting it (refer to "Replacing Modules" on page 75), or have another person help you with the lifting.**

Figure 4.4 Subrack mounting points



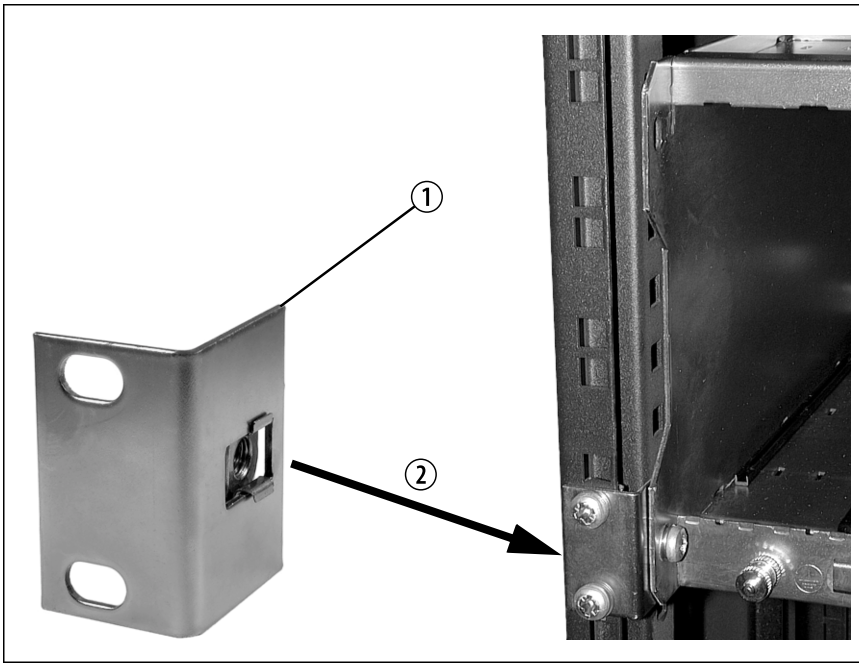
1. Remove the front panel, as described in "Preliminary Disassembly" on page 75.
2. Fit the subrack into the cabinet or rack and secure it firmly with an M6 (0.25 in) screw, flat and spring washer in each of the four main mounting holes ①, as shown in Figure 4.4.

Note If you need extra mounting security, additional mounting holes ② are provided at the rear of the subrack for auxiliary support brackets.

Auxiliary Support Bracket

TBA2140 auxiliary support brackets can be fitted to the rear of the TB9100 subrack to provide additional mounting security. Figure 4.5 shows a standard TBA2140 bracket ① fitted in a typical Tait Electronics cabinet ②. If you are not using a Tait cabinet, you may have to make your own brackets to suit your installation.

Figure 4.5 Auxiliary support bracket



Important You **must** fit the auxiliary support brackets if you intend to transport a cabinet fitted with a fully built-up TB9100 base station.

We also recommend that you fit the brackets under the following conditions:

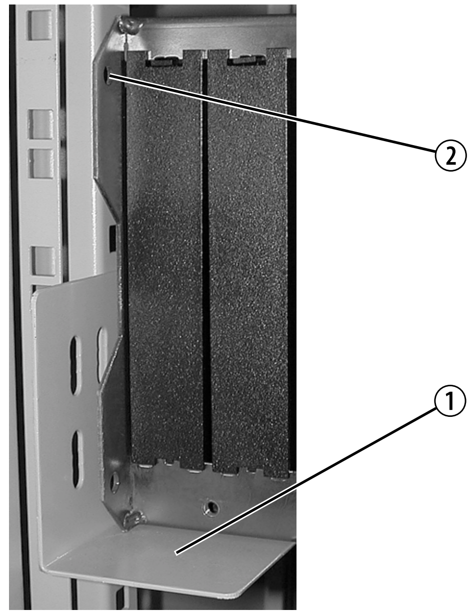
- when the installation is in an area prone to earthquakes
- when third party equipment is installed hard up underneath the TB9100 base station subrack.

Optional Slide Mounting Rails

You can also use TBA2141 slide mounting rails ① when mounting the TB9100 base station in a cabinet, as shown in Figure 4.6 on page 50. These rails will support the base station while you slide it into the cabinet.

However, you must still secure the base station to the cabinet with four M6 (0.25 in) screws through the main mounting holes on the front of the subrack, as shown in Figure 4.4 on page 48.

Figure 4.6 Optional slide mounting rail - rear view



Important The slide mounting rails are not suitable for transporting a cabinet fitted with a fully built-up TB9100 base station. In this case, you must also fit the TBA2140 auxiliary support brackets to the upper set of rear mounting holes ② (support bracket not shown in diagram).

General Cabling

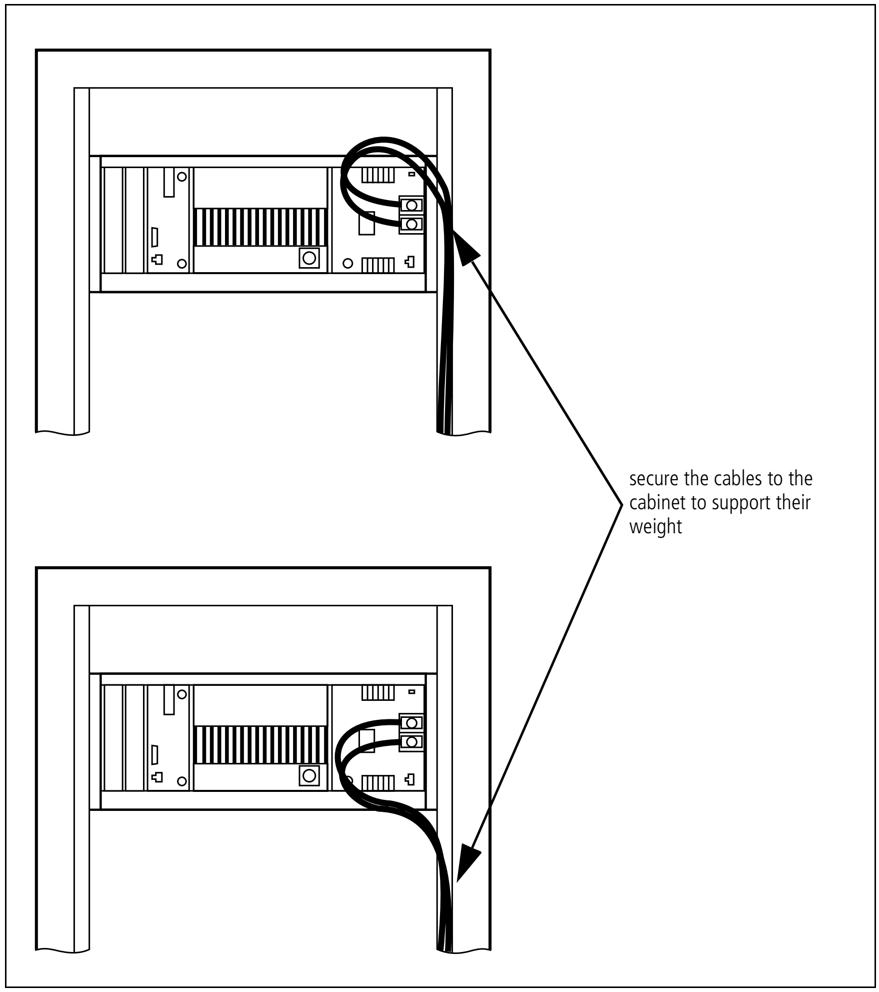
We recommend that you try to route all cables to and from the TB9100 base station along the side of the cabinet so the cooling airflow is not restricted.

DC Power Cabling

DC power cables should be well supported so that the terminals on the PMU and on the ends of the cables do not have to support the full weight of the cables.

Figure 4.7 on page 51 shows two recommended methods of securing these cables to prevent straining either set of terminals.

Figure 4.7 DC power cabling



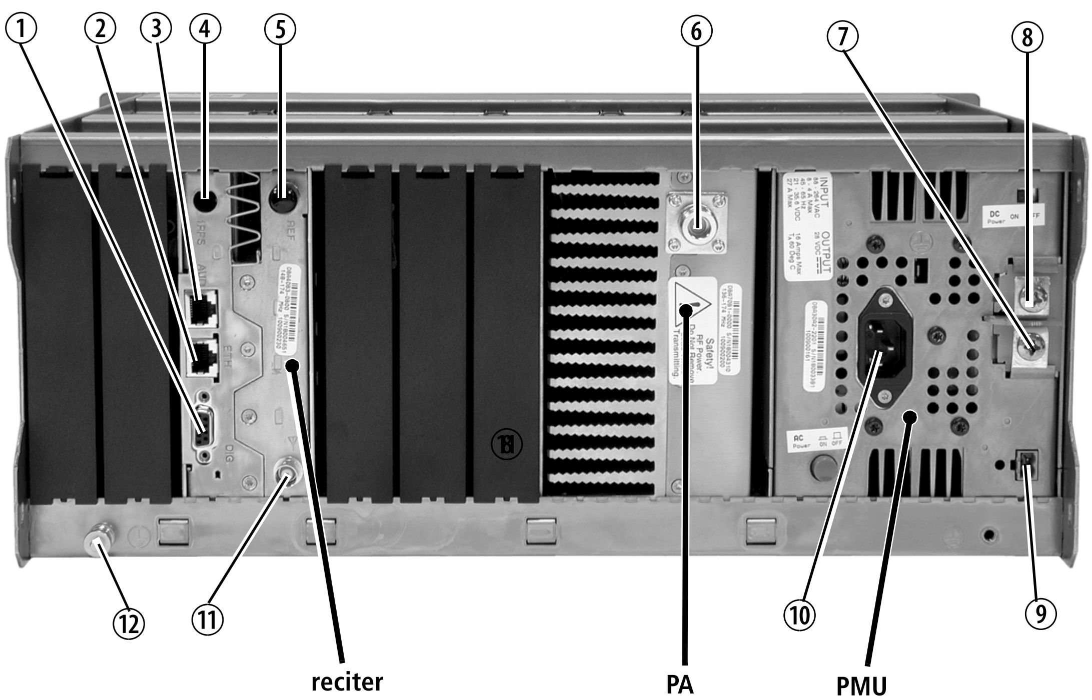
4.6 Connecting Up the Base Station

This section provides information on the inputs and outputs available when connecting up the TB9100 base station.

Base Station Connections

The connections at the rear of a 5 W or 50 W base station are identified in Figure 4.8.

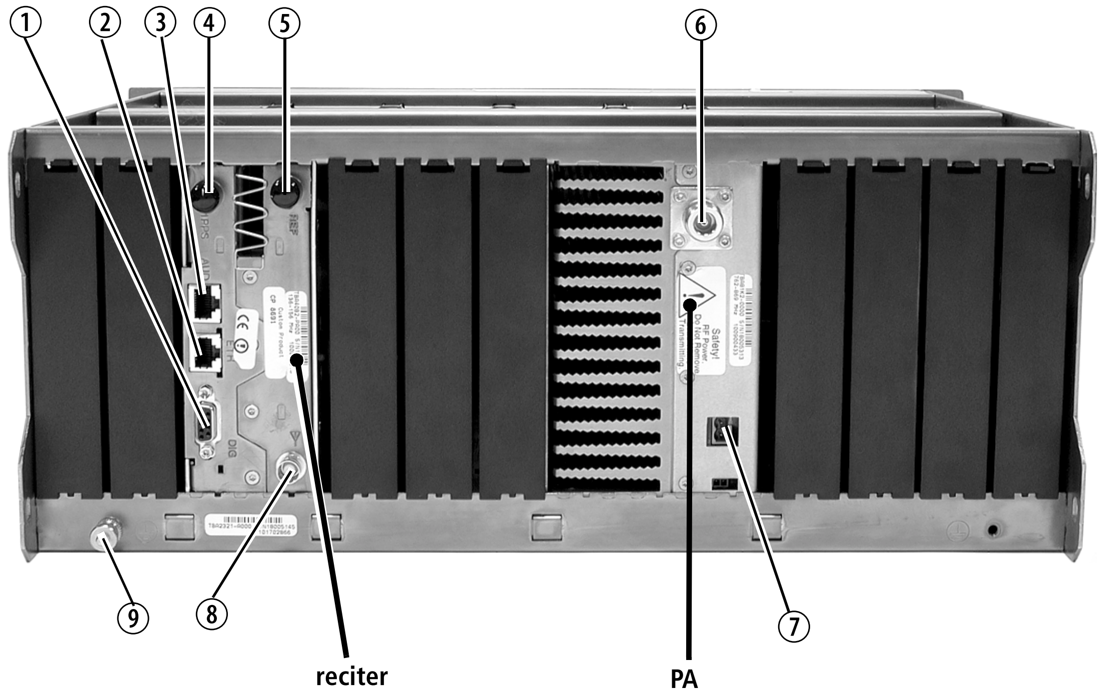
Figure 4.8 5 W or 50 W base station inputs and outputs



① serial RS-232 connector
② digital line connector
③ analog line connector
④ 1 pps input
⑤ external reference frequency input
⑥ RF output
⑦ -VDC input
⑧ +VDC input
⑨ auxiliary 12 VDC output
⑩ AC mains input
⑪ RF input
⑫ subrack ground connector

The connections at the rear of a 5 W or 50 W 12 V PA base station are identified in Figure 4.9.

Figure 4.9 5 W or 50 W 12 V PA base station inputs and outputs



1. serial RS-232 connector
2. digital line connector
3. analog line connector
4. 1 pps input
5. external reference frequency input
6. RF output
7. +12VDC input
8. RF input
9. subrack ground connector

Control Panel Connections

Figure 4.10 Control panel inputs and outputs

① DC outputs for fans mounted on front panel; also used for fan rotation detectors (if fitted)

② microphone connector

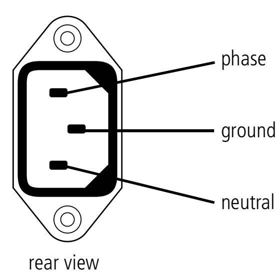
Power Supply Connections

AC Power

The TB9100 PMU is designed to accept a mains input of 88 to 264 VAC at 45 to 65 Hz. We recommend that a 3-wire grounded outlet be used to supply the AC power. The socket-outlet must be installed near the equipment and must be easily accessible. This outlet should be connected to an AC power supply capable of providing at least 600 W. The requirements of two typical AC supplies are given in the following table.

Nominal Supply	Current Requirement	Circuit Breaker/Fuse Rating
115 VAC	8 A	10 A
230 VAC	4 A	6 A

Your TB9100 base station should come supplied with a power supply cord to connect the male IEC connector on the PMU to the local AC supply. The pins of the IEC connector on the PMU are identified at right.



DC Power with PMU

The TB9100 PMU is designed to accept a nominal 12 VDC, 24 VDC or 48 VDC input (depending on the model) with negative or positive ground. There is a minimum DC startup threshold to prevent damaging a battery which has little capacity left.

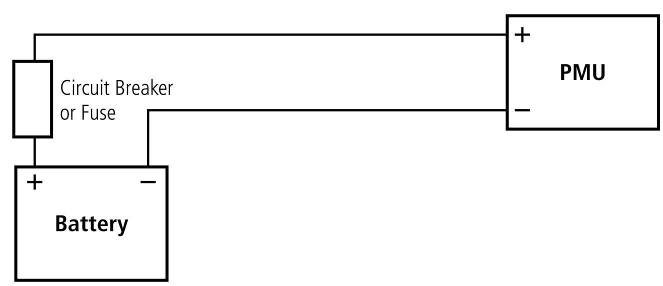
You must connect the DC supply from the battery to the PMU via a fuse or DC-rated circuit breaker with the appropriate rating, as shown in the table below. The DC input leads should be of a suitable gauge to ensure less than 0.2V drop at maximum load over the required length of lead.

Nominal Supply Voltage	Input Voltage Range	Circuit Breaker/ Fuse Rating	Recommended Wire Gauge[a]
12VDC	10VDC to 16.8VDC	60A	2AWG / 35mm^2
24VDC	20VDC to 33.6VDC	30A	5AWG / 16mm^2
48VDC	40VDC to 60VDC	15A	8AWG / 8mm^2

a. For a length of 5ft to 6.5ft (1.5m to 2m) (typical).

Terminate and insulate the DC input leads so they are protected from accidentally shorting to the subrack if the PMU is removed before the leads are disconnected.

Figure 4.11 Recommended DC power connection



DC Power with 12V PA

The TB9100 12V PA is designed to accept a nominal 12VDC input with negative ground. There is a minimum DC startup threshold to prevent damaging a battery which has little capacity left.

You must connect the DC supply from the battery to the PA via a fuse or DC-rated circuit breaker with the appropriate rating, as shown in the table below. The DC input leads should be of a suitable gauge to ensure less than 0.2V drop at maximum load over the required length of lead.

Nominal Supply Voltage	Input Voltage Range	Circuit Breaker/ Fuse Rating	Recommended Wire Gauge[a]
12VDC	10VDC to 16.8VDC	15A to 18A	8AWG / 8mm^2

a. For a length of 5ft to 6.5ft (1.5m to 2m) (typical).

Auxiliary DC Power

PMU Auxiliary DC Output

The PMU can provide an auxiliary DC output when it is fitted with the optional auxiliary power supply board. This board is available with an output of 13.65 VDC, 27.3 VDC, or 54.6 VDC (depending on the model), and is currently limited to 3 A, 1.5 A or 750 mA respectively. This optional power supply is available on the auxiliary output connector on the rear panel.

The auxiliary power supply is configured by the CSS. Refer to the "Customer Service Software User's Manual" for more details.

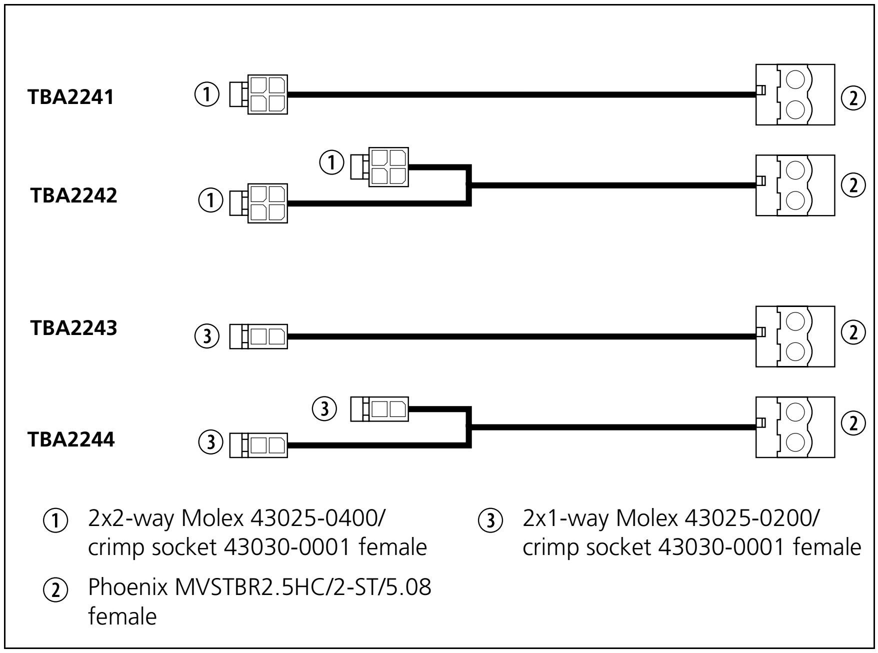
We do not recommend connecting two or more auxiliary power supply boards in parallel to increase the current supply to external equipment. In this situation, the auxiliary board with the highest voltage will try to supply all the current required, until it goes into current limit and the voltage reduces to the level where another board will begin to supply power. Running an auxiliary board continuously in current limit will reduce its life span and reliability. Also, if one auxiliary board fails or is switched off when a base station is powered down for some reason, the remaining auxiliary boards will be unable to supply the required current and will go into current limit, possibly causing the external equipment to shut down.

It is, however, acceptable to connect two or more auxiliary power supply boards in parallel (e.g. for redundancy), as long as the current consumption of the external equipment is less than the rating of one board. This means that, even if only one auxiliary board is functioning, it will still be able to supply the current requirements of the external equipment.

Auxiliary DC Power Supply Connections

Figure 4.12 below shows the standard Tait auxiliary DC power cables available. Details of the individual connector types are also provided in case you want to make up your own cables.

Figure 4.12 Auxiliary DC power cables



Contact your nearest Tait Dealer or Customer Service Organisation for details on the full range of wiring kits available.

RF Connections

Important The PA may be damaged if the load is removed or switched while the PA is transmitting.

The RF input to the TB9100 is via the lower BNC/TNC connector on the rear panel of the reciter. The RF output is via the N-type connector on the rear panel of the PA (refer to Figure 4.8 on page 52).

We recommend that you use dual-screened coaxial cable such as RG223 for the BNC/TNC connections, and RG214 for the N-type connections.

External Reference

For K4 Band, the internal frequency reference accuracy is inadequate, and an external reference (eg. Tait T801-02) **must** be used. The external reference frequency can be 10MHz or 12.8MHz, with an input level of 300mV pp to 5V pp. The stability of this reference should be better than 50 parts per billion.

If an external reference is required, the CSS must be programmed to select 10MHz or 12.8MHz (“Configure > Base Station > Miscellaneous”), and the external reference “Enable” and “Invalid” alarms can be enabled (“Configure > Alarms > Control”).

Coaxial Relay

Important When the base station is used in simplex mode using a single antenna with a coaxial changeover relay, the isolation of this relay **must** be $>$ 40dB. The relay operating time **must** be $<$ 20ms.

To prevent damage to the base station, the relay must not switch whilst the base station is transmitting, and the tranmsitter must not operate whilst the relay is switched to the receiver.

System Interface

The reciter is fitted with industry-standard sockets which provide the connections for the digital and analog lines, and the serial communication link. Figure 4.8 on page 52 shows the position of the sockets on the rear of the reciter. Each socket visible from the reciter will be clearly labeled to ensure proper connection.

Digital Line

The RJ-45 socket labeled ETH provides the Ethernet connection to the other devices in the network. The 10BASE-T ethernet uses Cat-5 cable and RJ-45 sockets to connect the base station to the network via a hub or router.

Refer to “Digital Interface Connection” on page 124 for a list of ethernet connection pin allocations.

Analog Line

The RJ-45 socket labeled AUD provides the direct audio connection to a local or remote dispatcher. This also provides a basic E&M signaling interface. Refer to “Analog Interface Connection” on page 123 for a list of the analog connection pin allocations.

Important The analog RJ-45 socket is keyed to ensure that the correct cable (one with a keyed plug) is connected. If the analog cable were to be connected to the digital RJ-45 socket, the potentially high voltages on the E&M lines would damage the ethernet interface.

Before connecting up any E & M or 4-wire audio circuit, consult the Network Installation Guide for information on circuit design and interface protection. On the E & M circuit, the DC current flow must not exceed 150 mA under any conditions. There must also be sufficient suppression to absorb any inductive spikes. If DC is applied to the 4 wire audio lines, it should also be limited to 150 mA. The nominal voltage should not exceed 48 V and the peak voltage must never exceed 58 V.

Note Refer to the CSS documentation for information on setting the analog line level.

Serial Port

The 9-way D-range socket provides the serial RS-232 connection to external devices. This socket is compatible with IBM PC serial cables.

This socket can be used to connect the reciter to the 9-way male connector on the Calibration and Test Unit when tuning and calibration is required. Refer to "Connecting to a Calibration and Test Unit" on page 44 for further details.

The serial interface is shared with the programmable digital inputs and outputs. These are configured via the CSS and may be used for local reciter control or for alarm inputs and outputs. Refer to the CSS documentation for further information.

The assignment of the serial interface pins does not interfere with the functions of the digital inputs and outputs. Refer to "Serial Interface Connection" on page 123 for a description of the pin allocations.

5 Base Station Operation

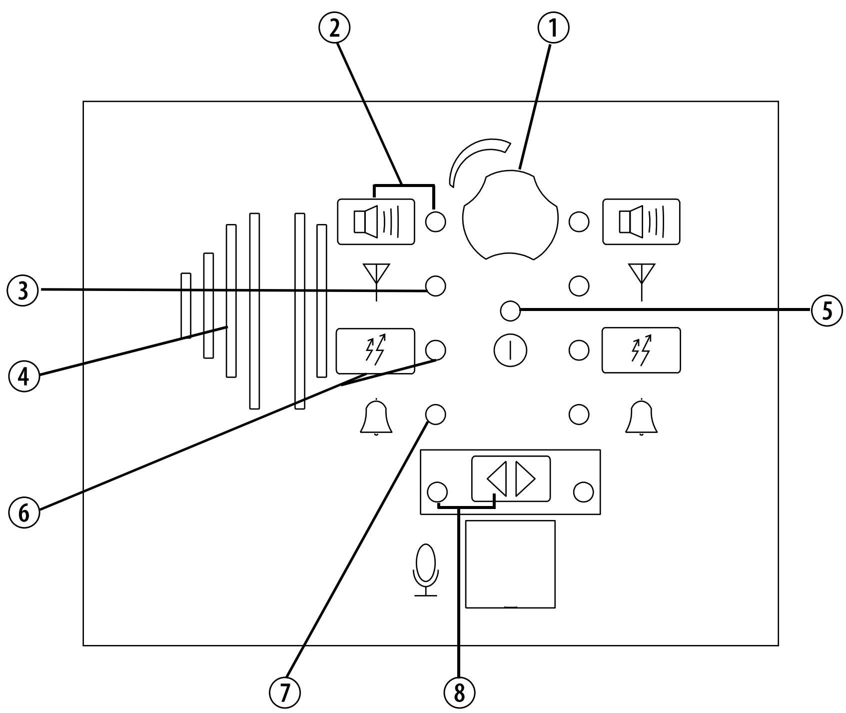
5.1 Operating Controls and LED Indicators

This section describes the hardware controls and LED indicators on the TB9100 control panel, reciter and PMU. The hardware controls allow some manual control of the base station, and the LEDs indicate its operational status.

Control Panel

The operating buttons and indicator LEDs on the left side of the control panel are used to control the TB9100 base station, as shown in Figure 5.1.

Figure 5.1 Operating controls on the control panel



①	speaker volume	⑤	power LED
②	speaker button and LED	⑥	carrier button and transmit LED
③	receive LED	⑦	alarm LED
④	speaker	⑧	microphone channel button and LED

Speaker Button and LED

The speaker button selects the type of speaker output. The green speaker LED indicates the type of speaker output. Refer to “Speaker Operation” on page 67.

Speaker Volume Button

Controls the volume of the speaker mounted behind the control panel. Rotate clockwise to increase the volume, and anticlockwise to decrease the volume.

Receive LED

The green receive LED is on when a valid signal is received on the base station that has won the ‘vote’ (see “Signal Voting and Switching” on page 22).

The receive LED also indicates when the base station has received a valid signal that has lost the ‘vote’, as described in the following table:

LED behaviour	Description
On (steady)	Base station is receiving a valid signal that has won the vote
Flash	Base station is receiving a valid signal that has lost the vote
Off	Base station is deactivated, or is not receiving any signals

Speaker

The control panel is fitted with a 0.5W speaker. Audio from the base station can be connected to this speaker.

Power LED

The green power LED is lit when the PMU is turned on and supplying power to the TB9100 base station.

Carrier Button and Transmit LED

The carrier button is a momentary press switch. When held down, it keys the transmitter while disabling the 600Ω balanced and unbalanced line, and microphone audio. The transmitted signal is unmodulated, i.e. carrier only.

The red transmit LED is lit while the transmitter is transmitting.

Alarm LED

The red alarm LED will flash at a rate of 2 to 5 Hz when an alarm has been generated by any of the TB9100 modules. It will continue to flash until the alarm is canceled, the fault is fixed, or the base station is in standby mode. Note that only those alarms which are enabled using the CSS will cause this LED to flash.

The alarm LED also indicates when the base station is in standby mode, as described in the following table:

LED behaviour	Description
On (steady)	Base station is in standby mode (regardless of the presence of other faults)
Flash	Base station is in run mode, and one or more faults are present
Off	Base station is in run mode, and no faults are present

Microphone Channel Button and LED

The left microphone channel button selects the speech mode for the microphone transmission. The associated microphone channel LED indicates the type of speech mode. Refer to "Microphone Operation" on page 68 for more information.

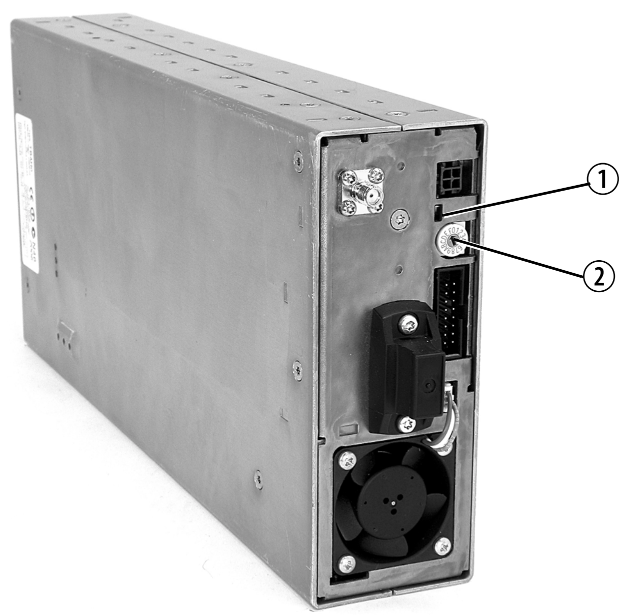
Reciter

The reciter indicator LEDs are located on the front and on the rear.

Front View

The indicator LEDs on the front are visible through a slot in the front panel.

Figure 5.2 Indicator LEDs on the front of the reciter



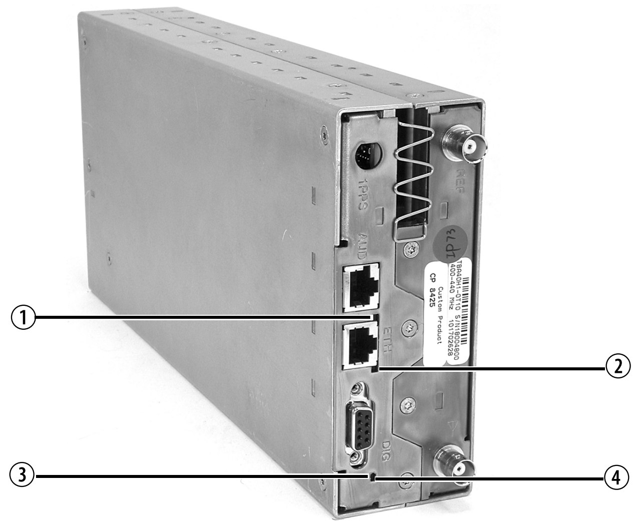
① indicator LEDs   ② hex switch (for future use)

These LEDs provide the following information about the state of the reciter:

- steady green - the reciter is powered up
- flashing red - one or more alarms have been generated; you can use the CSS to find out more details about the alarms.

Rear View The indicator LEDs on the rear are visible through small holes in the rear panel.

Figure 5.3 Indicator LEDs on the rear of the reciter



① network transmit LED ② network activity LED

③ network board PowerPC LED ④ network board DSP LED

Network Transmit LED The amber network transmit LED will flash for 1 second when data is transmitted across the digital line.

Network Activity LED The green network activity LED is lit when the digital line is connected. When network activity is detected, the LED will flash on for 1 second and off for 1 second.

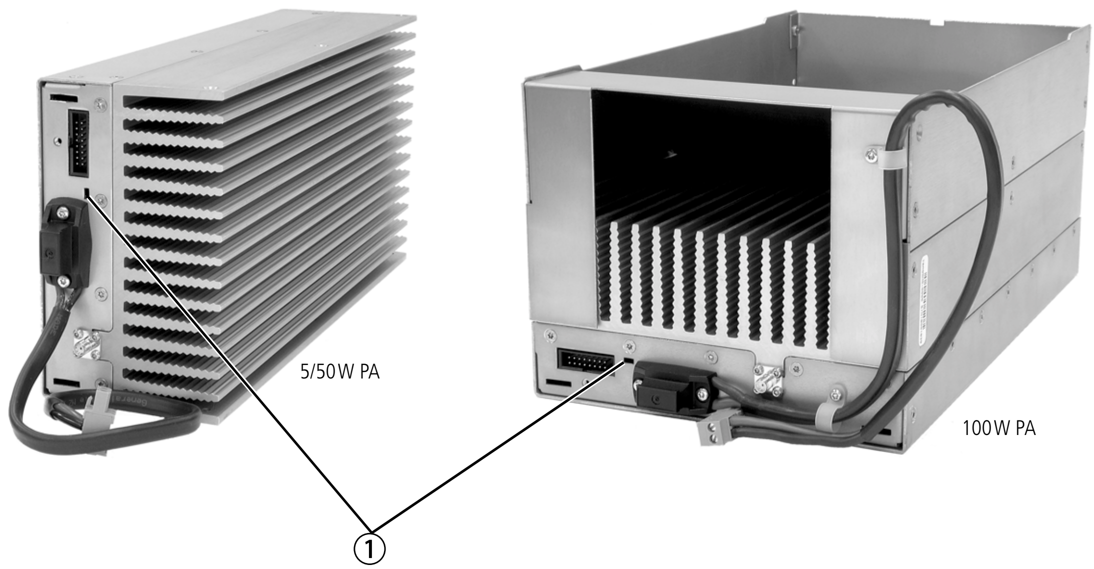
Network Board PowerPC LED The green network board PowerPC LED will flash continuously when the PowerPC is functioning normally.

Network Board DSP LED The amber network board DSP LED will flash continuously when the DSP is functioning normally.

PA

The indicator LEDs on the PA are visible through a slot in the front panel.

Figure 5.4 Indicator LEDs on the PA



① indicator LEDs

Indicator LEDs

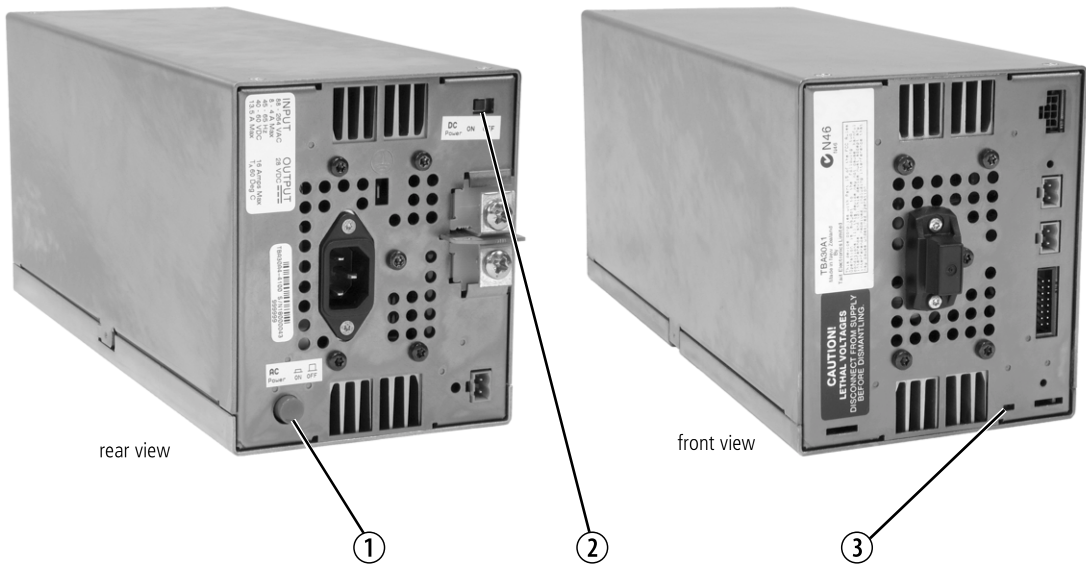
These LEDs provide the following information about the state of the PA:

- steady green - the PA is powered up
- flashing green - the PA has no application firmware loaded; you can use the CSS to download the firmware
- flashing red - one or more alarms have been generated; you can use the CSS to find out more details about the alarms.

PMU

The only controls on the PMU are the on/off switches on the rear panel for the AC and DC modules, and the indicator LEDs visible through a slot in the front panel.

Figure 5.5 Operating controls on the PMU



① AC module on/off switch

② DC module on/off switch

③ indicator LEDs

AC Module On/Off Switch

This switch turns the AC input to the PMU on and off. Note that this switch breaks only the phase circuit, not the neutral.

DC Module On/Off Switch

This switch turns the DC output from the PMU on and off. It is recessed to prevent the DC module being accidentally switched off, thus disabling the battery back-up supply.

Note that this switch disables only the control circuitry – the DC input is still connected to the power circuitry.

Warning!! **These switches do not totally isolate the internal circuitry of the PMU from the AC or DC power supplies. You must disconnect the AC and DC supplies from the PMU before dismantling or carrying out any maintenance. Refer to the service manual for the correct servicing procedures.**

Indicator LEDs

These LEDs provide the following information about the state of the PMU:

- steady green - the PMU is powered up
- flashing green - the PMU has no application firmware loaded; you can use the CSS to download the firmware
- flashing red - one or more alarms have been generated; you can use the CSS to find out more details about the alarms.

5.2 Monitoring the Base Station

You can monitor the performance of your TB9100 remotely with the CSS. Use the Monitor option to view information about the current state of the base station. This option provides details about the PMU, PA and reciter modules. It also displays operational information, such as whether the base station is currently operating in digital P25 or analog FM mode, the status of the network link, and which signal input to the base station has won the vote.

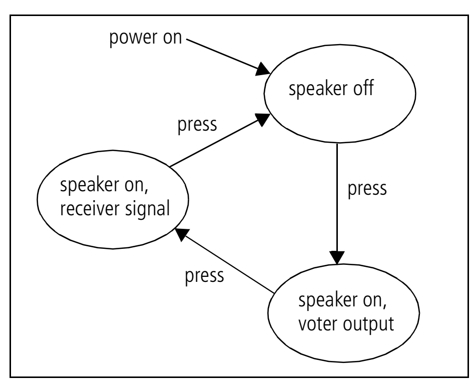
5.3 Control Panel Operation

The TB9100 control panel provides access to the microphone and speaker. It allows the maintainer to:

- monitor voice traffic
- communicate with the dispatcher and other radio users.

Speaker Operation

The speaker can monitor the signal transmitting across the channel group (voter output) or the RF signal received by the base station. The speaker output is controlled using the speaker button.



To set the speaker output:

1. Press the speaker button once to turn the speaker on and play the voter output. The green speaker LED flashes. The speaker produces audible speech for P25 digital and analog FM signals.

2. Press the speaker button a second time to play the receiver input. The green speaker LED is lit.

3. Press the speaker button a third time to turn the speaker off.

Gating and squelch mechanisms are carried out as normal on the voter output.

When the receiver input is monitored, the speaker audio is ungated but the base station still carries out gating and squelch mechanisms on the signal input to the voter. The speaker produces audible speech on P25 signals when the base station successfully detects frame synchronization.

Note If the RF receiver is configured to receive **analog** signals only, the speaker will only play P25 speech if the voter output is selected. If the RF receiver is configured to receive **digital** signals only, the speaker will only play analog speech if the voter output is selected.

To maintain security, the speaker never decrypts encrypted calls. If a call is encrypted, the speaker produces squalks and squeaks. However, if the base station has an encryption license, the speaker remains silent.

Microphone Operation

The control panel microphone allows the maintainer to talk to the dispatcher and to the other radio terminals in the network. This can be done in digital mode or analog mode. This section describes how to set the speech mode for the call. For detailed information about making a control panel call, refer to “Making Test Transmissions” on page 43.

To set the mode for the control panel:

1. Press the left microphone channel button once to set the mode to analog FM. The green microphone LED is lit.

2. Press the microphone channel button a second time to set the mode to digital FM. The green microphone LED flashes.

When the control panel is set to digital mode, the microphone identity is configured by the NAC (network access code) in the signaling profile. The call destination is to all units in the channel group.

When the microphone is set to analog mode, the call properties are configured by sub-audible signaling in the signaling profile. Control panel calls can be made when the base station is in either Standby or Run mode.

Note Making transmissions from the microphone overrides any other calls on the channel. Before using the microphone to make a call, make sure that the channel is clear, otherwise, any calls in progress on the channel, including emergency calls, will be terminated.

5.4 Monitoring Front Panel Fan Operation

You can test that the PA and PMU fans are working by requesting the base station to turn them on. This is done via the CSS Diagnose section and is recommended after fixing a fault or replacing a fan. When you fit a fan, use this test to check that the fan is correctly connected to the appropriate PA or PMU. The CSS will toggle the fan on for a set number of seconds, then the test will end and control of the fan will revert back to the base station.

6 Troubleshooting

Check that all front and rear connectors and cables are in place, and that power switches are on. If problems persist, contact your nearest Tait Dealer or Customer Service Organization.

Symptom	Possible Cause	Action
Alarm LED red and steady (not flashing)	Base station is in standby mode	Use CSS to put base station in Run mode
All reciter LEDs on	Digital board not communicating with Network board	Replace reciter module and send faulty module for servicing
Front panel speaker transmits unintelligible sounds	An encrypted P25 call is being monitored/received	Turn speaker off or take no action - only other radios with encryption decoder can decrypt encrypted calls
Front panel speaker is silent although calls are being transmitted	An encrypted P25 call is being monitored/received	If the base station has an encryption license, the speaker remains silent when encrypted calls are transmitted
Clear warning on transmit	This means that the base station/analog gateway transmitted a clear and not encrypted call	You have a non-encryption system and the clear warning hasn't been turned off in the configuration
		You are transmitting clear when you should be transmitting encryption. This could be because: a) your calling profile specifies an encryption key but you don't have a basic encryption license b) your calling profile specifies an encryption key. That key is filled with AES key information but you don't have an AES encryption license (future releases only).
Mismatch warning on transmit	The base station doesn't transmit/ the analog gateway doesn't pass signal on to the network	The calling profile specifies an encryption key, but that key is not loaded
Mismatch warning on receive	The base station doesn't receive/ the analog gateway doesn't pass signal on to the network	Use the CSS to monitor calls and check that there is no mismatch between the received call and the current calling profile
TX stuck on	TX and RX frequencies are the same	Reconfigure TX and RX with different frequencies
Power LED on control panel is on, but nothing else works	Panel is disabled	Check that the control panel is enabled on the CSS

Symptom	Possible Cause	Action
No power or LEDs on control panel	System control bus not connected to control panel	Check I^2C cable connections
	Pins bent on 15-pin D-range plug on subrack	Replace or repair D-range plug
Can't send microphone audio	Correct buttons have not been pressed on the control panel to select either P25 or Analog mode for the microphone	Check that correct mode is selected
	P25 call being made, but feature not enabled	Check that this feature has been enabled on the CSS
Control panel behaviour is random, as if buttons are being pressed	I^2C cable is not connected to PMU	Check the I^2C cable connection to the PMU - if the I^2C cable is not connected to the PMU, the system control bus is not properly terminated and will account for any strange behaviour
Base station appears to make random transmissions	CWID feature enabled	No action - CWID transmissions are made according to configuration settings
Supplementary services don't work	Features and permissions have not been enabled correctly	Check service profiles. The service profile attached to the channel enables supplementary services on the RF receiver. The service profile attached to the calling profile enables supplementary services on the analog line in.
PA has low power	Channel is configured to low power	Use the CSS to check the power settings
	PA may have suffered partial damage	Replace module and send faulty module for servicing
Digital line not working	Multicast address incorrect	Check the CSS still connects to the base station, and check that the multicast address is correct
	a) keyed connectors were not used b) the analog line was connected by mistake to the digital line c) E & M connection has non-current limiting power supply	Replace module and send faulty module for servicing
Test tones can't be heard	IMBE does not pass on tones higher than 400 HZ	Ensure test tones are less than 400 Hz
Static on analog RX	P25 call is being made on an analog channel	Check configuration on CSS

<table>
<tr><th>Symptom</th><th>Possible Cause</th><th>Action</th></tr>
<tr><td>Base station performs task manager actions unexpectedly when going into run mode</td><td rowspan="2">Digital input cable is not attached, the inputs are active low: thus if no cable is attached the base station reads them as all on.</td><td rowspan="2">1. Check the cable carrying digital inputs

2. Try to avoid Task Manager tasks that trigger when digital inputs float high</td></tr>
<tr><td>Base station performs task manager actions unexpectedly and no longer responds to digital inputs</td></tr>
<tr><td>Lost or forgotten base station IP address</td><td></td><td>1. Connect your PC to the 9-pin serial connector on the back of the reciter.
2. Run a program such as HyperTerminal, Teraterm or minicom.
3. Select the following port settings: 57600 baud, 8 bits, no parity, 1 stop bit, no flow control.
4. Press the ‘Enter’ key. A login prompt will appear displaying the base station’s IP address.</td></tr>
<tr><td>Control panel cannot communicate with the dispatcher</td><td>Repeat mode is disabled. (This is currently an inevitable consequence if the base station has repeat mode disabled. Disabling repeat mode separates the voice stream into two; the inbound voice stream goes to the analog line and the outbound voice stream goes to the transmitter.)</td><td>Enable repeat mode. Use a portable for communications with the dispatcher. A future release will allow the choice of connecting the microphone to the inbound or the outbound voice stream.</td></tr>
</table>

7 Replacing Modules

Caution **The TB9100 PA and PMU weigh between 10.1lb (4.6kg) and 12.8lb (5.8kg) each. Take care when handling these modules to avoid personal injury.**

Important The cooling fans are mounted on the front panel and will only operate when the panel is fitted correctly to the front of the subrack. To ensure adequate airflow through the base station, do not operate it for more than a few minutes with the front panel removed (e.g. for servicing purposes). Both the PMU and PA modules have built-in protection mechanisms to prevent damage from overheating.

7.1 Saving the Base Station's Configuration

Before replacing a module in the TB9100 base station, you should decide whether you need to save its configuration data. If you are unsure whether you have a record of the configuration, use the CSS to read the base station and save the configuration file before removing any modules. Once you have replaced the module, you will be able to restore the original configuration by programming the saved configuration back into the base station.

If one or more of the modules is faulty, you may be unable to read the base station. In this case, you will have to restore the configuration from a back-up file. Refer to the CSS documentation for more information.

7.2 Preliminary Disassembly

Hot-pluggable Modules

The reciter, PA and control panel are hot-pluggable and can be removed from the TB9100 without powering down the whole base station. These modules can also be removed without disrupting the system control bus communications with the other modules in the base station system.

Important The PMU must be connected to the system control bus at all times. The terminating circuitry for the bus is located in the PMU, and if the PMU is disconnected, the state of much of the bus will be undefined. This may cause corrupted data to be present on the bus when the reciter reads the states of the switches on the control panel. This in turn may result in random actuations of microphone PTT, carrier, or speaker key, causing the base station to transmit or the speaker to be actuated incorrectly.

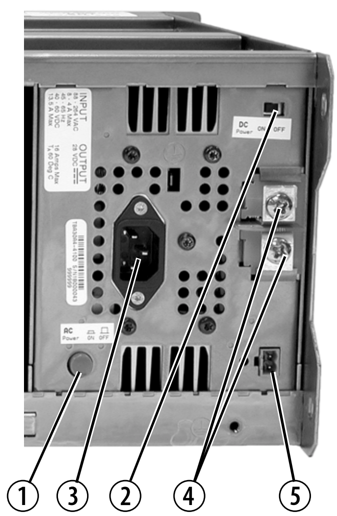
If you want to disconnect the power before working on the TB9100, carry out the instructions in “Disconnect the Power” on page 76.

Important Before removing a PA, disconnect the DC input and RF input first, followed by the RF output (and DC output on the 12V PA). After refitting the PA, reconnect the RF output (and DC output on the 12V PA) first, followed by the RF input, and then the DC input.

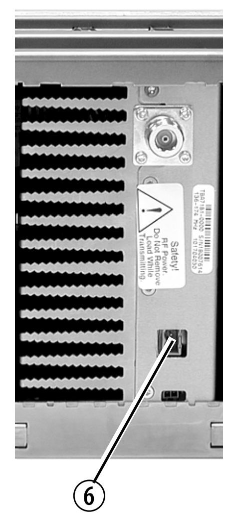
Disconnect the Power

1. Turn off the AC ① and DC ② switches at the rear of the PMU.
2. Also at the rear of the PMU disconnect the mains ③ and battery ④ supply leads, and the auxiliary DC supply lead ⑤ (if fitted).
3. If the base station is using a 12V PA, disconnect the battery supply lead ⑥.

PMU

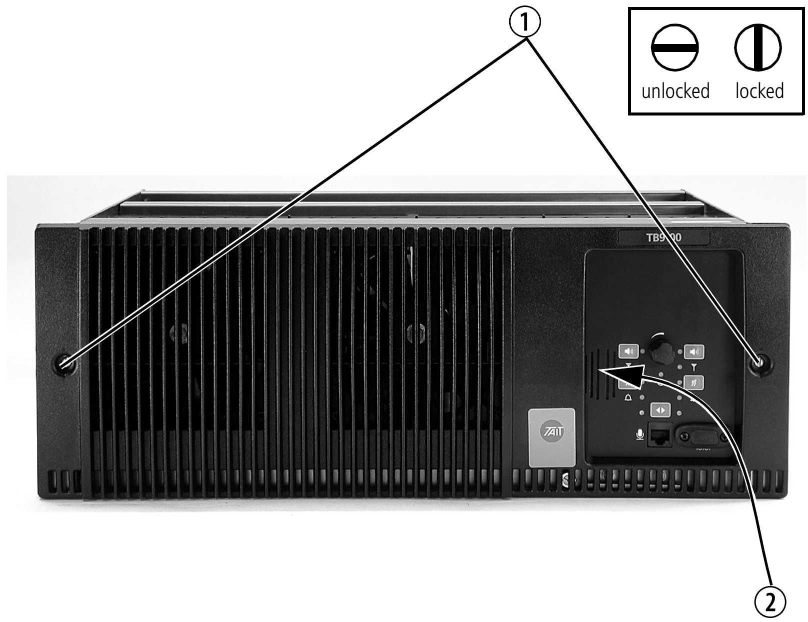


12 V PA



Remove the Front Panel

1. Undo the fastener at each end of the front panel ① with a quarter turn anti-clockwise.



2. While supporting the left end of the front panel, place your fingers in the recess provided on the left side of the control panel opening ② and pull the right end of the front panel away from the subrack. You will need to overcome the resistance of the spring clip securing the front panel to the control panel.

7.3 Replacing the Control Panel

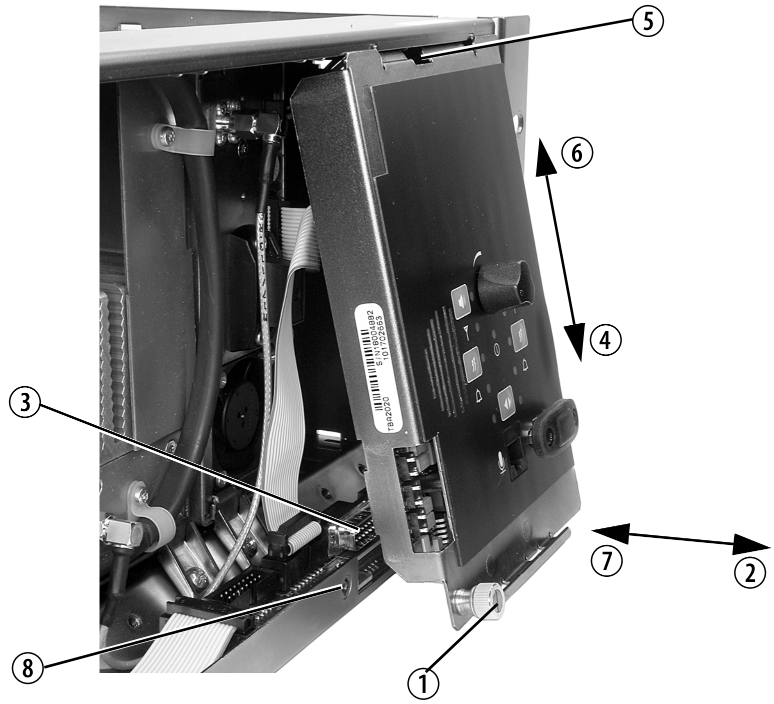
Removal

1. If you have not already done so, carry out the instructions in "Preliminary Disassembly" on page 75.

2. Undo the retaining screw ①. Note that the screw stays attached to the control panel.

3. Pull the bottom of the control panel away from the subrack ② to disconnect the D-range socket on the back of the panel from the plug ③ on the subrack.

4. Pull the control panel down ④ to disengage the center tab ⑤ from the subrack.



Refitting

1. Fit the top of the control panel to the subrack so that the center tab is behind the lip of the subrack and between the two locating tabs formed in the lip. Push the control panel firmly upwards ⑥.

2. Align the D-range socket on the back of the control panel with the plug on the subrack. Gently push the bottom of the panel home against the subrack ⑦ to engage the plug into the socket.

3. Insert the securing screw into the floating nut ⑧ in the subrack and tighten. Note that you may have to push the screw in and down to pick up the floating nut.

4. Carry out the instructions in “Final Reassembly” on page 88.

7.4 Replacing the Reciter

Removal

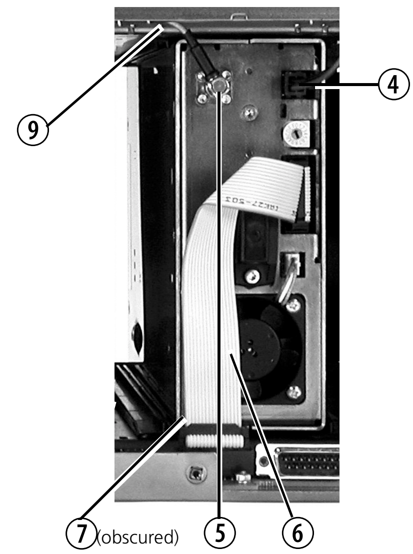
1. If you have not already done so, carry out the instructions in “Preliminary Disassembly” on page 75, and remove the control panel, as described in “Replacing the Control Panel” on page 77.

2. At the rear of the reciter, unplug the RF input cable ①, any system cables ② and the external reference cable ③ (if fitted).

3. At the front of the reciter, unplug the DC input cable ④ and the RF output cable ⑤, and move both cables to one side. Unplug both ends of the system control bus loom ⑥ and remove it.

4. Loosen the screw securing the retaining clamp ⑦ and rotate the clamp through 90° to clear the module.

5. Slide the reciter out of the subrack, taking care not to damage any of the cables.



Refitting

1. Slide the replacement reciter into the subrack and secure it with the retaining clamp.

2. Reconnect all the front and rear panel cables previously disconnected. Ensure the front panel cables are retained by the cable retaining clips ⑨ in the top of the subrack.

Important **Do not** force the system control bus behind the reciter handle as this may damage the ribbon cable.

Note If you need to remove any front panel cables, simply pull the front of the cable retaining clip down and then slide it out from the subrack until it reaches the end of its travel.

3. Tighten the nut on the SMA connector to a torque of 8lbf·in (0.9N·m).

4. Refit the control panel, as described in "Replacing the Control Panel" on page 77.

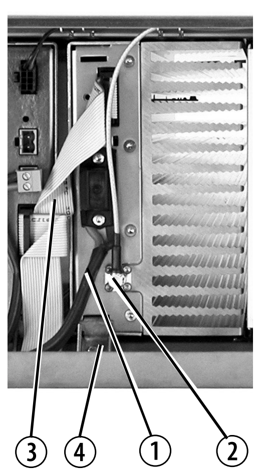
5. Carry out the instructions in "Final Reassembly" on page 88.

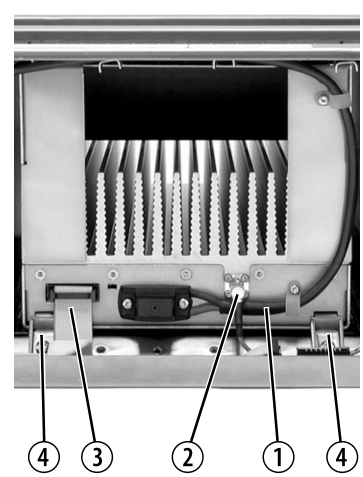
7.5 Replacing the Power Amplifier

Important Before removing a PA, disconnect the DC input and RF input first, followed by the RF output (and DC output on the 12V PA). After refitting the PA, reconnect the RF output (and DC output on the 12V PA) first, followed by the RF input, and then the DC input.

Removal

1. If you have not already done so, carry out the instructions in "Preliminary Disassembly" on page 75. If necessary, remove the control panel, as described in "Replacing the Control Panel" on page 77.
2. At the front of the PA, unplug the DC input cable (DC output cable on the 12V PA) ① and the RF input cable ②, and move both cables to one side. Unplug both ends of the system control bus loom ③ and remove it.
3. At the rear of the PA, unplug the RF output cable. **12V PA only:** also unplug the battery supply lead.
4. Loosen the screw securing the retaining clamp(s) ④ and rotate the clamp(s) through 90° to clear the module.
5. Slide the PA out of the subrack, taking care not to damage any of the cables.





Refitting

1. Slide the replacement PA into the subrack and secure it with the retaining clamp(s).
2. At the rear of the PA, connect the RF output cable. **12V PA only:** also connect the battery supply lead.
3. At the front of the PA, connect the RF input cable, followed by the DC input cable (DC output cable on the 12V PA).

4. Reconnect all the other front and rear panel cables previously disconnected. Ensure the front panel cables are retained by the cable retaining clips in the top of the subrack.

Note If you need to remove any front panel cables, simply pull the front of the cable retaining clip down and then slide it out from the subrack until it reaches the end of its travel.

5. Tighten the nut on the SMA connector to a torque of 8lbf·in (0.9N·m).

6. If necessary, refit the control panel, as described in "Replacing the Control Panel" on page 77.

7. Carry out the instructions in "Final Reassembly" on page 88.

7.6 Replacing the Power Management Unit

Important You must disconnect the AC and DC power cables before removing the PMU from the subrack.

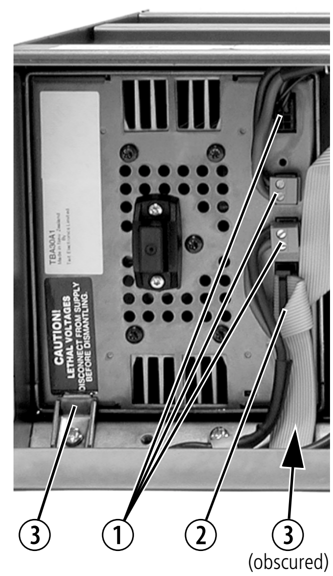
Removal

1. If you have not already done so, carry out the instructions in "Preliminary Disassembly" on page 75.

2. At the front of the PMU, unplug the output power cable(s) ① and system control bus loom ②, and move them to one side.

3. Loosen the screw securing the retaining clamps ③ and rotate the clamps through 90° to clear the module.

4. Slide the PMU out of the subrack, taking care not to damage any of the cables.



Refitting

1. Slide the replacement PMU into the subrack and secure it with the retaining clamps.

2. Reconnect all the front and rear panel cables previously disconnected. Connect the DC power cables on the rear panel as shown in Figure 4.7 on page 51. Ensure the front panel cables are retained by the cable retaining clips in the top of the subrack.

Note If you need to remove any front panel cables, simply pull the front of the cable retaining clip down and then slide it out from the subrack until it reaches the end of its travel.

3. Carry out the instructions in "Final Reassembly" on page 88.

7.7 Replacing the Front Panel Fans

Unless otherwise indicated, the following instructions refer to Figure 7.1 on page 84.

Removal

1. If you have not already done so, carry out the instructions in "Preliminary Disassembly" on page 75.
2. PA Fan
   a. Remove the four screws labeled ① and remove the duct and fan assembly from the front panel.
   b. Unplug the fan from the fan contact board ②.
   c. Remove the fours screws holding the fan into the duct ③ and remove the fan.
3. PMU Fan
   a. Remove the PA fan/duct assembly as described above.
   b. Remove the two screws labeled ④ and remove the PMU fan/duct assembly.
   c. Unplug the fan from the fan contact board ⑤.
   d. Remove the fours screws holding the fan into the duct ⑥ and remove the fan.

Refitting

1. Fit the replacement fan into the duct with the power wires located in the slot in the side of the duct ⑦.
2. Refit the four screws securing the fan into the duct. **Do not** overtighten these screws or you will distort the fan body.
3. PMU Fan
   a. Refit the PMU fan/duct assembly onto its mounting bosses. Note that the two inner mounting tabs ⑧ fit over the bosses.
   b. Plug the fan into the fan contact board ⑤ and route the wires around the PA fan opening ⑨.
   c. Refit the two screws labeled ④.
   d. Refit the PA fan as described below.
4. PA Fan
   a. Plug the power wires into the fan contact board ② and route the wires around the PA fan opening ⑨.
   b. Refit the PA fan/duct assembly onto its mounting bosses. Note

that the two inner mounting tabs ⑩ fit over the inner tabs of the PMU fan. Ensure that all the power wires are secured under the retaining hooks ⑪ and are not crimped.

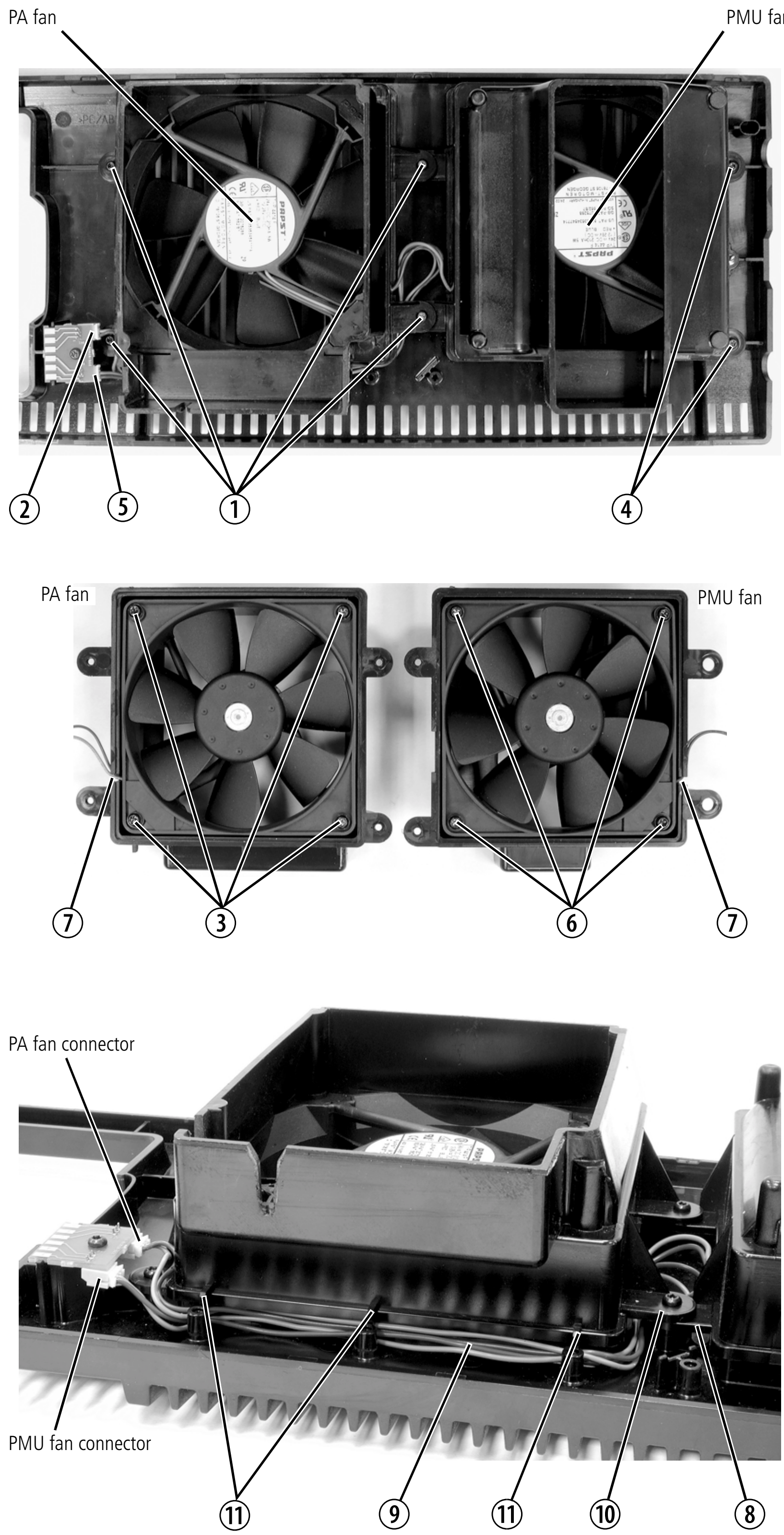
c. Refit the fours screws labeled ①.

5. Carry out the instructions in “Final Reassembly” on page 88.

Important You must connect the fans to the correct sockets on the fan contact board. If the fan connections are reversed, the wrong fan will be activated when a module needs cooling. The module may then fold back and shut down. When you power-up the TB9100, check that the PMU fan runs first, followed by the PA fan. Each fan will run for about five seconds.

Important You must refit the correct duct to the PA fan. There are several small but important differences between the duct for a 5 W or 50 W PA and the duct for a 100 W PA. Refer to Figure 7.3 on page 89 for more details.

Figure 7.1 Replacing the front panel fans



100W base station front panel shown

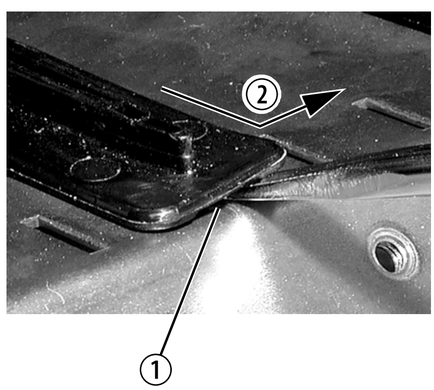
7.8 Replacing the Module Guide Rails

The module guide rails are held in place by four hooks that fit through the slots in the top and bottom of the subrack. There is also a locking tab which prevents the guide rails from working loose.

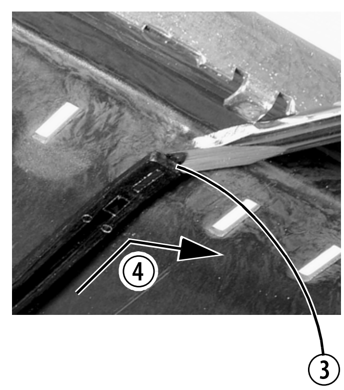
Removal

1. Bottom Guide Rails
   a. Insert a small flat-blade screwdriver under the front end of the guide rail and lift it slightly ①. This will ensure the small locking tab is clear of the slot in the subrack.
   b. Whilst holding the front end of the guide rail up, pull the guide rail towards the front of the subrack ② and lift it clear of the slots.
2. Top Rails
   a. Insert a small flat-blade screwdriver under the rear end of the guide rail and lift it slightly ③. This will ensure the small locking tab is clear of the slot in the subrack.
   b. Whilst holding the rear end of the guide rail up, pull the guide rail towards the rear of the subrack ④ and lift it clear of the slots.

bottom guide rail



top guide rail



Refitting

1. Bottom Guide Rails
   a. With the locating hooks pointing towards the rear of the subrack, insert the hooks into the slots in the subrack.
   b. Push the guide rail towards the rear of the subrack until you hear the locking tab “click” into place.
2. Top Guide Rails
   a. With the locating hooks pointing towards the front of the subrack, insert the hooks into the slots in the subrack.
   b. Push the guide rail towards the front of the subrack until you hear the locking tab “click” into place.

7.9 Replacing the Subrack Interconnect Board

There are two types of subrack interconnect board available, as follows:

- for base stations with PMU
- for base stations with 12V PA

Figure 7.2 on page 87 shows the two types of board, and "Switch settings" on page 87 explains the settings for the switches on the 12V PA interconnect board.

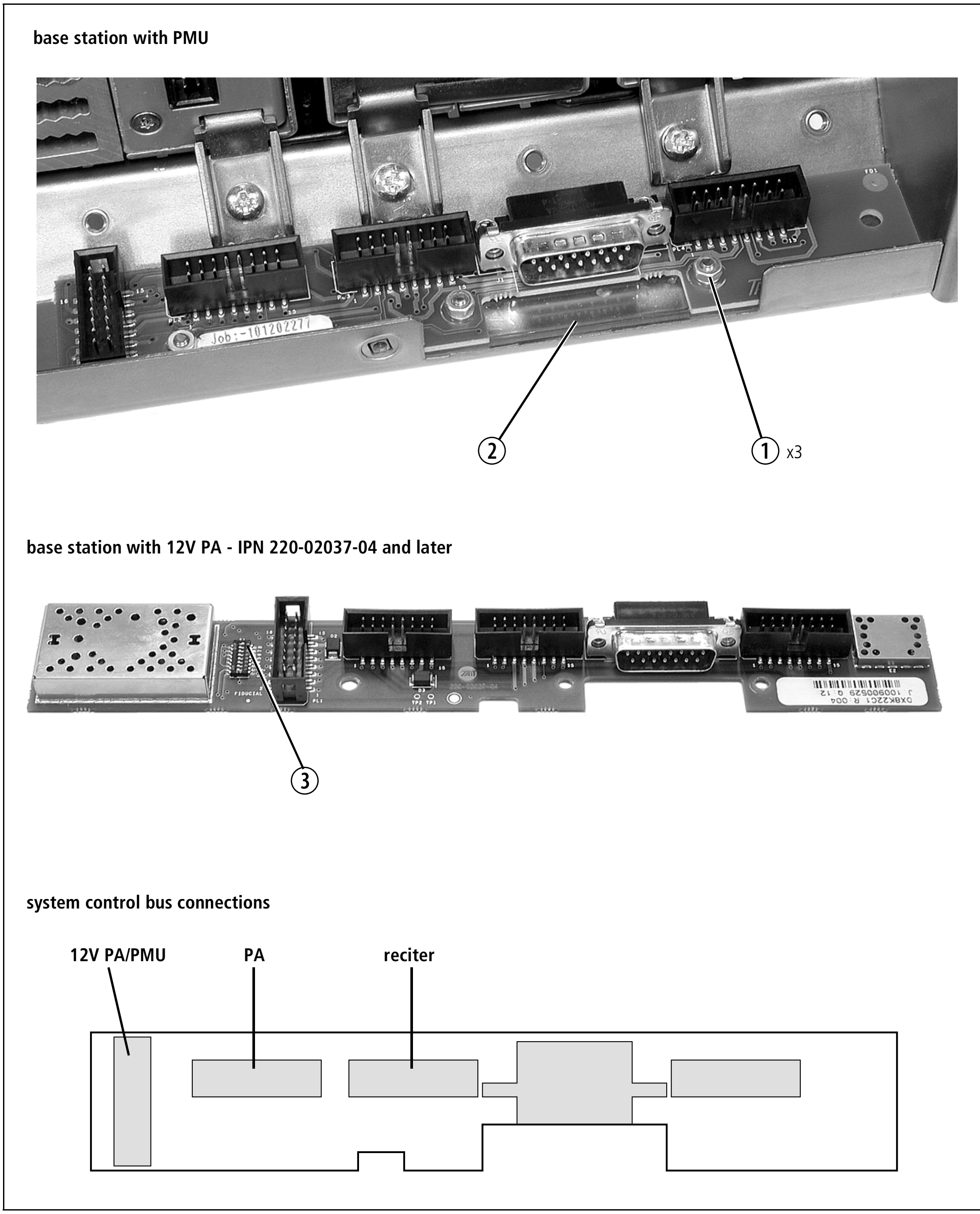
Removal

1. If you have not already done so, carry out the instructions in "Preliminary Disassembly" on page 75, and remove the control panel, as described in "Replacing the Control Panel" on page 77.
2. Disconnect any system control bus cables.
3. Remove the M3 nuts and spring washers ① securing the interconnect board to the subrack, as shown in Figure 7.2.
4. Remove the board. If you are changing the type of board, also remove the insulator ②.

Refitting

1. If previously removed, replace the insulator. If you are changing the type of board, you must fit the matching insulator.
2. Refit the board and secure with the M3 nuts and spring washers.
3. If you have fitted a 12V PA interconnect board, set the switches of S1 ③ as described in "Switch settings" on page 87.
4. Reconnect the system control bus cables as shown in Figure 7.2.

Figure 7.2 Replacing the subrack interconnect board



Switch settings

You must set the switches on the 12V PA interconnect board correctly. Table 7.1 gives the switch settings for newer boards with the part number 220-02037-04 and later. These boards are used with 12V PA base stations.

Table 7.1 Switch S1 settings - IPN 220-02037-04 and later

Switch	Function	Base Station with 12 V PA
		State
1	CH1 select button active	off
2	CH2 select button active	off
3	independent CH1 and CH2 channels	Tait use only - leave on
4	channel 1 I^2C_CLK pullup	on
5	channel 1 I^2C_DATA pullup	on
6	channel 2 I^2C_CLK pullup	on
7	channel 2 I^2C_DATA pullup	on
8	connected CH1 and CH2 channels	Tait use only - leave off

7.10 Final Reassembly

Important You must refit the correct type of front panel to your TB9100 base station. There are several small but important differences between the front panel for a 5W or 50W base station and the front panel for a 100W base station. These differences are in the duct for the PA fan and are described in the following paragraphs.

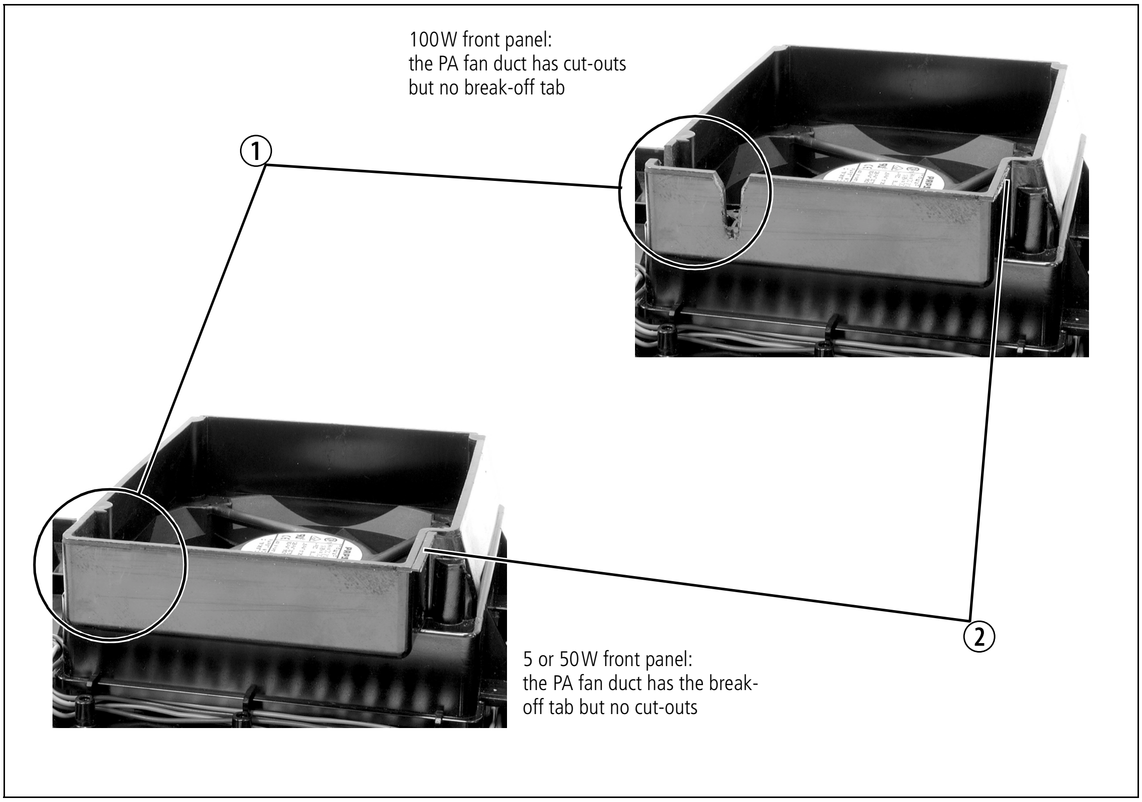
5W or 50W Front Panel

The PA fan duct does not have the cut-outs ① required for the 100W PA RF and DC cables. The break-off tab ② will also still be present and will jam on the system control bus. Do not try to fit this front panel to a 100W base station or you will damage these cables and possibly the front panel itself.

100W Front Panel

Do not fit this front panel to a 5W or 50W base station. The presence of the cut-outs and absence of the break-off tab will allow air to escape and reduce the velocity of air directed through the heatsink.

Figure 7.3 Identifying the correct front panel

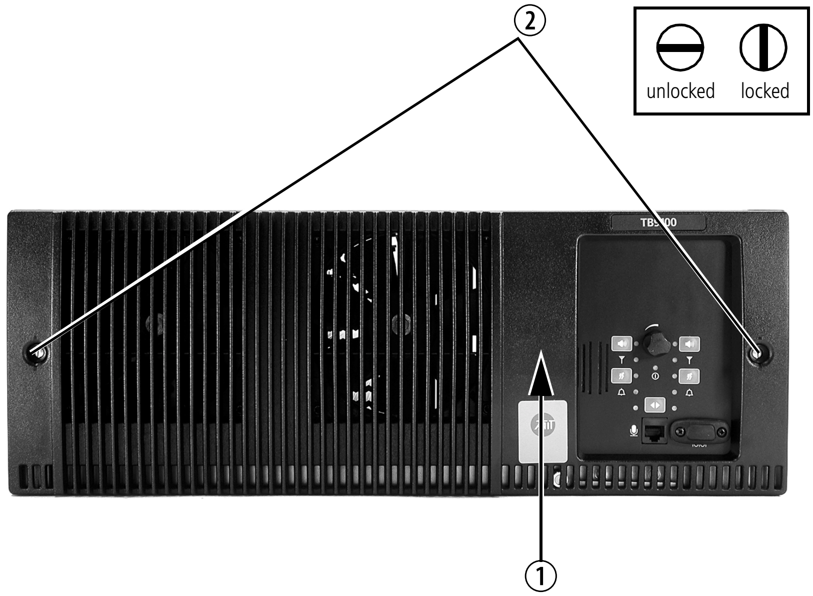


1. Before fitting the front panel, ensure that all cables are secured and positioned correctly so they are clear of the fan ducts (refer to Figure 4.8 on page 52 and "Appendix B – Inter-Module Connections" on page 127). Otherwise the panel may not fit properly, or you may damage the cables.

2. Refit the Front Panel

   a. Fit the front panel onto the locating pegs on the subrack. Fit the left end first, followed by the right end, pressing the panel in the center as shown ① to secure the spring clip behind the control panel.

   b. Secure the fastener at each end ② with a quarter turn clockwise. Align the slot horizontally, then press the fastener in and turn to lock.



3. Before powering up the base station, check that all power, RF and system cables are connected correctly and securely at the rear of the base station.

Important When refitting modules, make sure they are fitted correctly into the subrack and all retaining clamps are securely tightened. The recommended torque for the retaining clamp screws is 17 lbf·in (1.9 N·m). As well as holding the modules in place, the retaining clamps push the modules hard against the rear rail of the subrack to ensure a good ground connection between the modules and subrack.

8 Technical Description

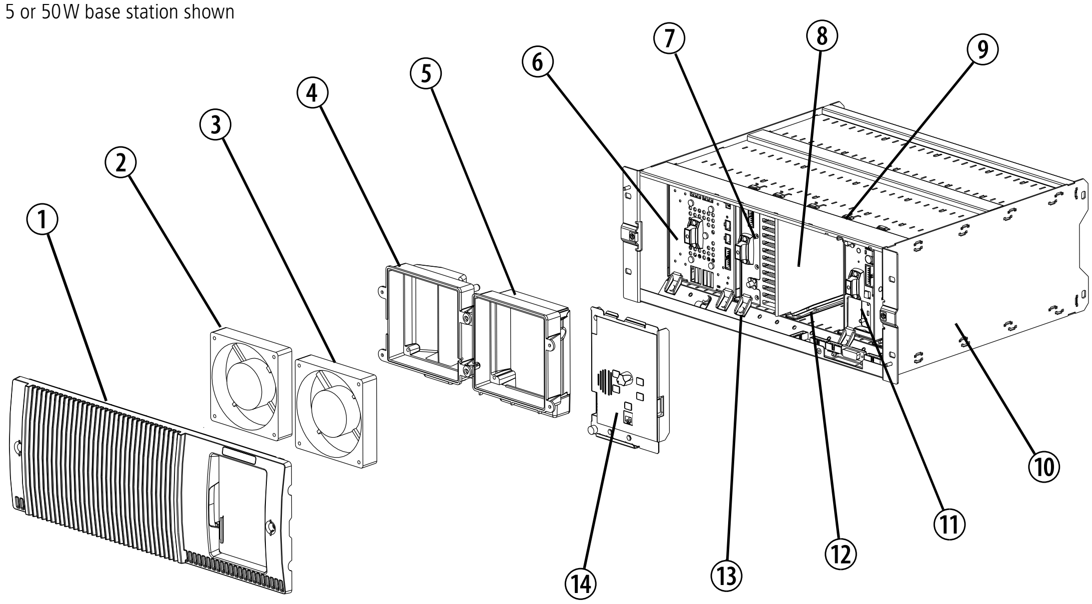
8.1 Mechanical Assembly

This section illustrates the main mechanical components that comprise the TB9100 base station. Figure 8.1 below shows the configuration for a typical 5 W or 50 W base station.

Note Figure 8.1 shows the cooling fans and their ducts detached from the front panel only for the clarity of the illustration. The cooling fans and ducts are normally screwed to the rear of the front panel.

Figure 8.1 Mechanical assembly - front panel, fans and control panel

5 or 50 W base station shown



1	front panel	8	airflow separator
2	PMU fan	9	cable retaining clip
3	PA fan	10	subrack
4	PMU fan duct	11	reciter
5	PA fan duct	12	plastic guide rail
6	PMU	13	module retaining clamp
7	PA	14	control panel

The front panel can be easily removed from the subrack by undoing two quick-release fasteners. Once the front panel is removed, the control panel can also be removed from the subrack by undoing a single screw. Refer to "Replacing Modules" on page 75 for more details.

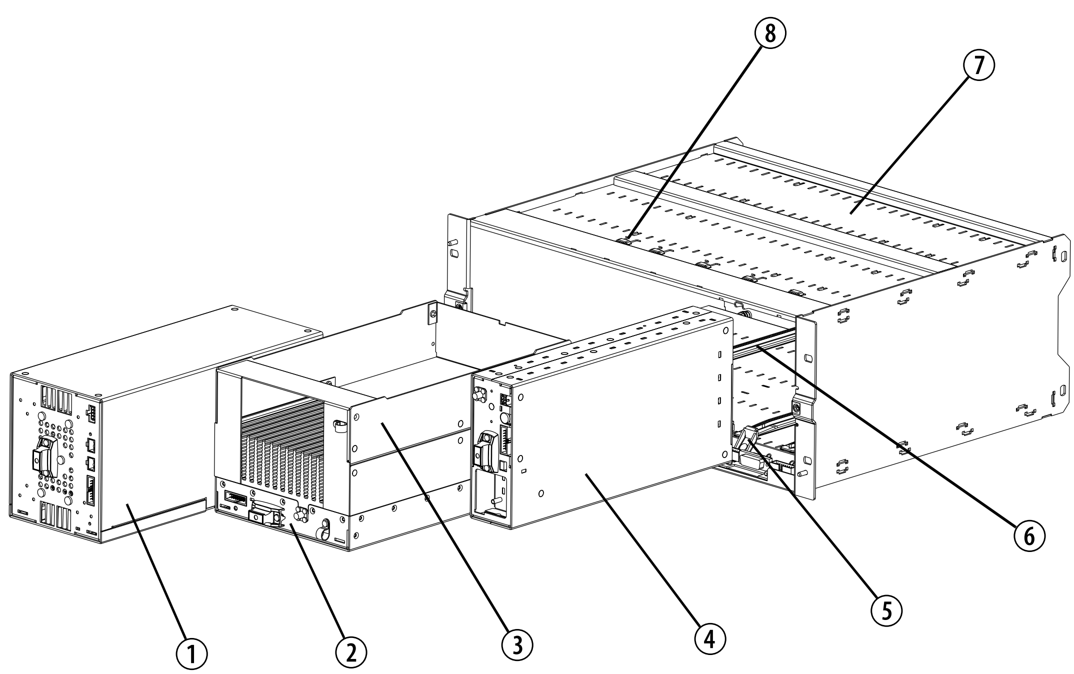
The PMU occupies the slot at the left end of the subrack, with the PA directly beside it. The reciter normally occupies the second slot from the right of the subrack.

The PA is mounted vertically with the heatsink facing the center of the subrack. This positions the cooling fins directly behind the PA fan. The airflow separator is fitted directly beside the PA to help direct the cooling airflow through the heatsink.

Note The configuration for 12V base stations is the same as shown in Figure 8.1, but the PMU and its cooling fan are not fitted.

Figure 8.2 below shows the configuration for a typical 100 W base station.

Figure 8.2 Mechanical assembly - front of a 100W base station



① PMU
② PA
③ airflow duct
④ reciter
⑤ module retaining clamp
⑥ plastic guide rail
⑦ subrack
⑧ cable retaining clip

The PMU occupies its normal slot at the left end of the subrack, with the PA directly beside it. The reciter occupies the slot immediately to the right of the PA. Unlike the 5W and 50W PAs, the 100W PA is mounted horizontally with the heatsink facing upwards. It is also fitted with an airflow duct to channel the airflow from the cooling fan through the heatsink fins.

8.2 Reciter Module Operation

The TB9100 reciter consists of an RF, a digital and a network board. Figure 8.3 on page 96 shows the configuration of the main circuit blocks, and the main inputs and outputs of the reciter.

Receiver RF - VHF Reciter

The incoming RF signal is fed through a low pass filter, then through a band pass "doublet" filter, and finally through a high pass filter. The signal is then amplified and passed through another band pass "doublet" filter before being passed to the mixer, where it is converted down to the 16.9MHz IF (intermediate frequency). A VCO (voltage controlled oscillator) provides a +17dBm input to the mixer, and a diplexer terminates the mixer IF port in 50Ω. The signal from the mixer is fed through a 2-pole crystal filter to the IF amplifier which provides enough gain to drive the digital receiver. Note that there are two 2-pole crystal filters, one for narrow bandwidth and one for wide bandwidth. The appropriate filter is selected by software-controlled PIN switches, according to the bandwidth selected in the CSS. The signal is finally passed to the ADC (analog-to-digital converter) in the digital receiver via an anti-alias filter.

Receiver RF - UHF Reciter

The incoming RF signal is fed through a band-pass filter, followed by a simple low-pass network. It then passes through further stages of filtering, amplification and AGC[1] (automatic gain control) before being fed to the mixer where it is converted down to the 70.1MHz IF (intermediate frequency). A VCO (voltage controlled oscillator) provides a +17dBm input to the mixer, and a diplexer terminates the mixer IF port in 50Ω. The signal from the mixer is fed through a 4-pole crystal filter to the IF amplifier which provides enough gain to drive the digital receiver. The signal is finally passed to the ADC (analog-to-digital converter) in the digital receiver via an anti-alias filter.

Exciter Circuitry

P25 digital or analog FM audio signals from the network, analog line or microphone are fed to the exciter RF circuitry via the digital board DSP (digital signal processor) and CODECs (encoder/decoder). These modulating signals are applied to the exciter at two points (dual point modulation): low frequency modulation is via the FCL (frequency control loop), which modulates the exciter synthesizer's frequency reference, and speech band modulation is supplied directly to the VCO.

1. AGC is available in H-band reciters only. It can be disabled using the CSS.

The VCO is phase-locked to the frequency reference via the synthesizer. The output from the VCO passes through the VCO buffer to the exciter amplifier, which increases the RF signal to +20 dBm. This signal is then attenuated through a pad to +11 dBm. An 8 VDC PA Key signal is mixed in with the RF signal which is then fed to the PA.

Digital Board

The IF from the receiver RF circuitry is passed through an ADC and DDC (digital down-converter) to the digital board DSP. Incoming audio from the network, analog line or microphone is passed to the exciter RF circuitry via the DSP and CODECs.

The main control elements on the digital board are the RISC processor and the DSP. Communication between the two takes place via a host port interface.

The digital board RISC is responsible for the following:

- initializing and supervising the digital board DSP
- controlling the Tx key, Rx gate and PA key
- monitoring the maintainer's access via the control panel microphone.

The digital board DSP operates under the control of the RISC to provide a number of functions, including:

- demodulating incoming FM signal and identifying whether it is P25 digital or analog FM
- modulating an RF signal from a P25 digital or analog FM signal received from the network, analog line or microphone
- implementing the control panel interface: transmitting and receiving speech samples to and from the network board DSP
- generating NAC, CTCSS and DCS
- generating the signal quality information RSSI and SINAD.

Network Board

The network board provides the links between the digital circuitry and the TaitNet digital network. This board is securely mounted to the reciter's chassis and is connected to the digital board by a 40-way flexible connector and a PCB connector. The network board provides the base station with an identity as a network element.

The network board has a DSP and a RISC processor. The RISC provides the main control functions of the board. It communicates with the DSP via a host port interface.

The network DSP provides a number of functions, including:

- performing forward error correction (FEC) encode/decode on P25 signal to/from the RF interface
- encoding P25 digital signals into IMBE speech packets
- encoding analog FM signals into G.711 speech packets

- carrying out the switching to send signals to the RF, analog and control panel interfaces, based on the voting output.

The network RISC is responsible for the following:

- inserting header information into P25 signals originating from the control panel and analog line
- performing the signal voting and switching
- inserting RTP (Real-time Transport Protocol) frame information into IMBE and G.711 speech packets
- transmitting and receiving RTP frames over the IP network.

Power Supply

The reciter operates off a +28 VDC supply. The supply is fed to two separate power supplies, one on the RF board and a second on the digital board. The power supply on the RF board also powers some of the circuitry on the network board.

The power supply on the RF board provides 5.3 V and 8.5 V regulated supplies. This 5.3 V supply is boosted to 23 V and also provides a 3.3 V regulated supply. The power supply on the digital board provides 3.3 V and 5.3 V regulated supplies. It is also fed through to provide a 2.5 V supply.

The network board requires the internal supply voltages of +6 V, +3.3 V, +1.8 V and +1.6 V. These are all derived from the main +28 V supply rail:

- the +3.3 V and +1.8 V supplies are acquired from the +28 V supply using a dual-phase switching converter
- the +1.6 V supply is acquired from the +3.3 V supply using an adjustable output switching regulator
- the +6 V low current auxiliary supply is acquired from the +28 V supply using a linear regulator.

Reciter Fan Operation

The reciter fan has a temperature sensor that reads the temperature on the component side of the digital board.

The reciter fan will operate briefly at start up, after the PMU and PA fans. This provides a simple diagnostic capability, and the ability to raise or clear faults.

No configuration is necessary for the reciter fan, it has fixed on/off thresholds:

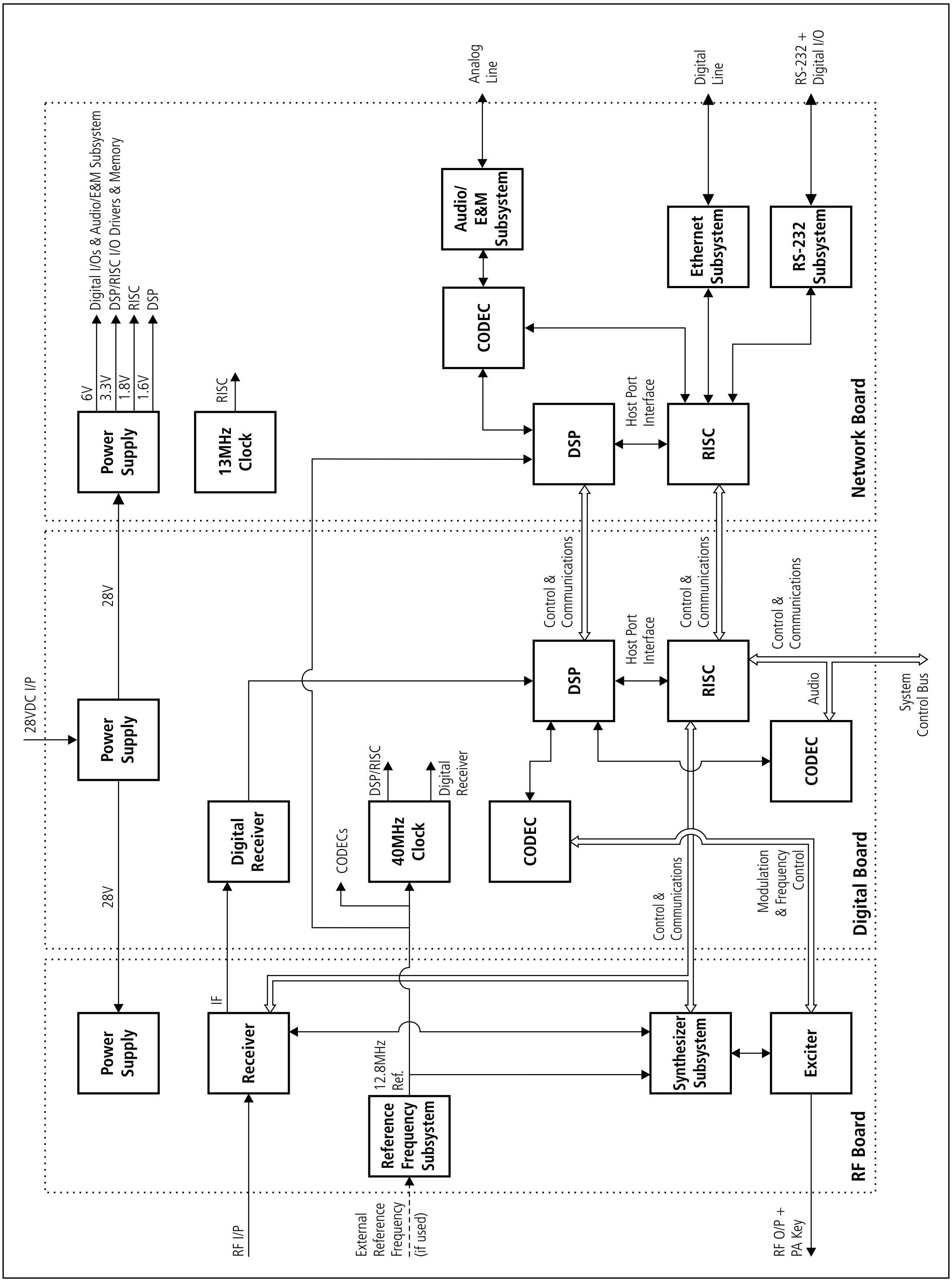
- Fan on threshold: 57°C
- Fan off threshold: 46°C

A ‘fan failed’ alarm is raised when the reciter reaches a temperature of 72.5°C.

For monitoring purposes, the following information is displayed on the CSS Monitor Reciter screen:

- Reciter temperature
- Fan on/off state
- Fan rotation state (the fan must have a 3-wire connection to detect rotation, as well as power and ground)

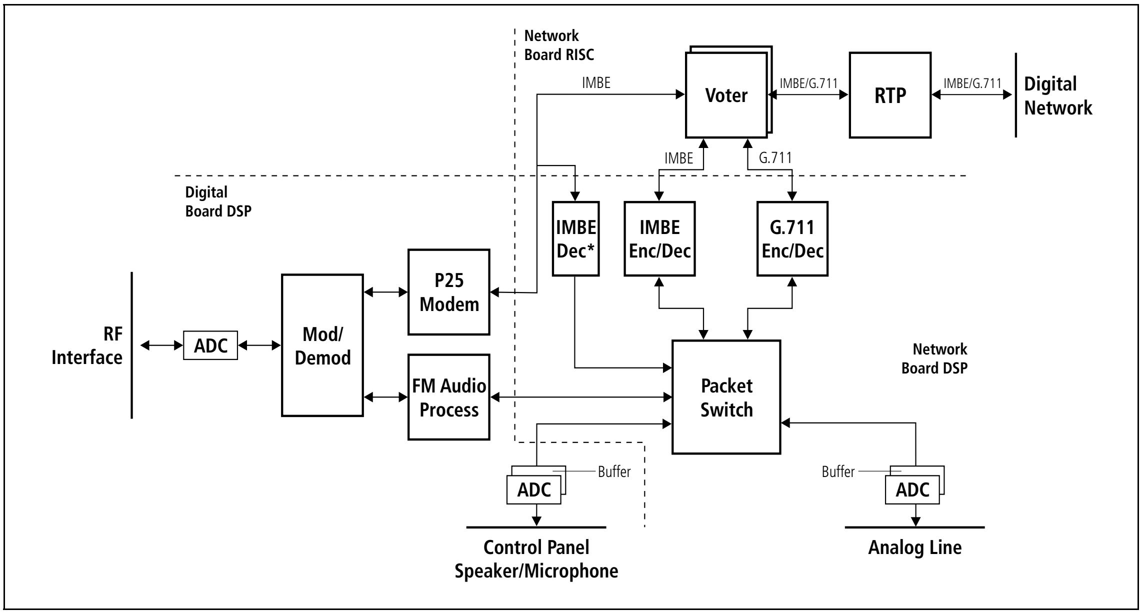
Figure 8.3 Reciter high-level diagram



Signal Paths

The digital board's DSP and RISC, and the network board's DSP and RISC carry out signal processing and provide audio paths from the four external inputs to the voter(s) and from the voter(s) to the four external outputs. Figure 8.4 shows the main circuit blocks involved.

Figure 8.4 Reciter block diagram



Speech signals received at the base station interfaces are either already in packet form, or will be converted into packet form before reaching the voter. The packets have a different format depending on the base station's mode. When the base station is in digital P25 mode, speech is encoded as IMBE packets. When the base station is in analog FM mode, speech is encoded according to the G.711 standard.

The voter selects the winning speech packets and routes them according to the destination ID stored in their header data.

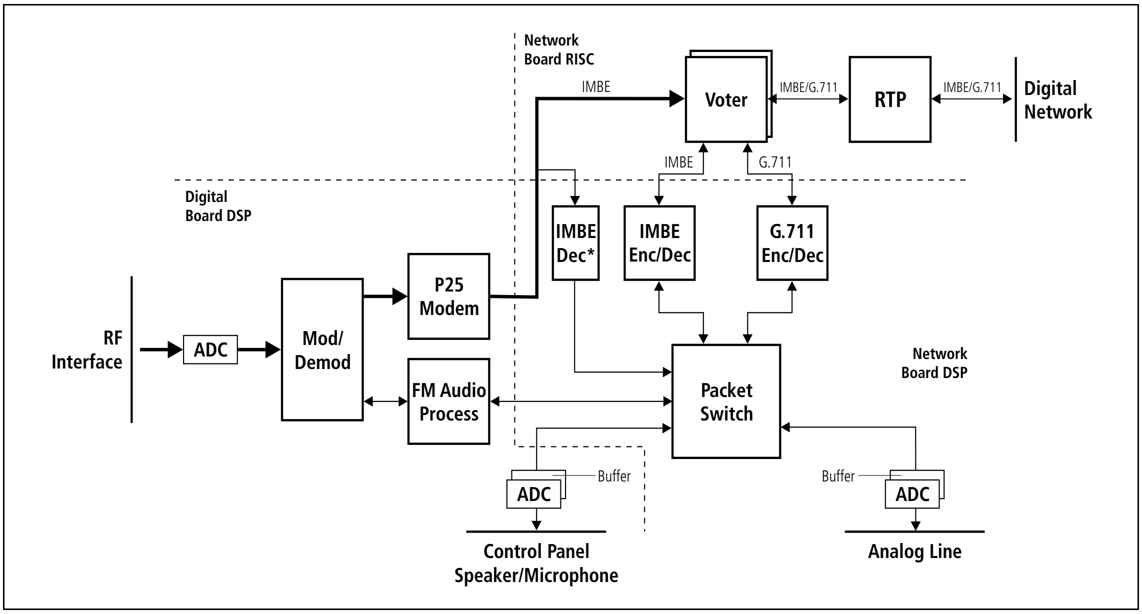
Input Signal Paths

The following section describes the signal processing that takes place on the signal path between each reciter interface and the voter.

From the RF interface (Digital P25)

Figure 8.5 shows the signal path from the RF interface to the voter(s) for a digital P25 call.

Figure 8.5 Path from receiver to voter (digital P25 mode)



1. The RF signal is processed by the receiver circuitry on the RF board and is passed to the ADC (analog-to-digital converter) in the digital receiver.

2. The Modulator/Demodulator circuitry demodulates the RF signal.

3. The digital board DSP detects that the signal is digital P25 and passes it on to the P25 modem.

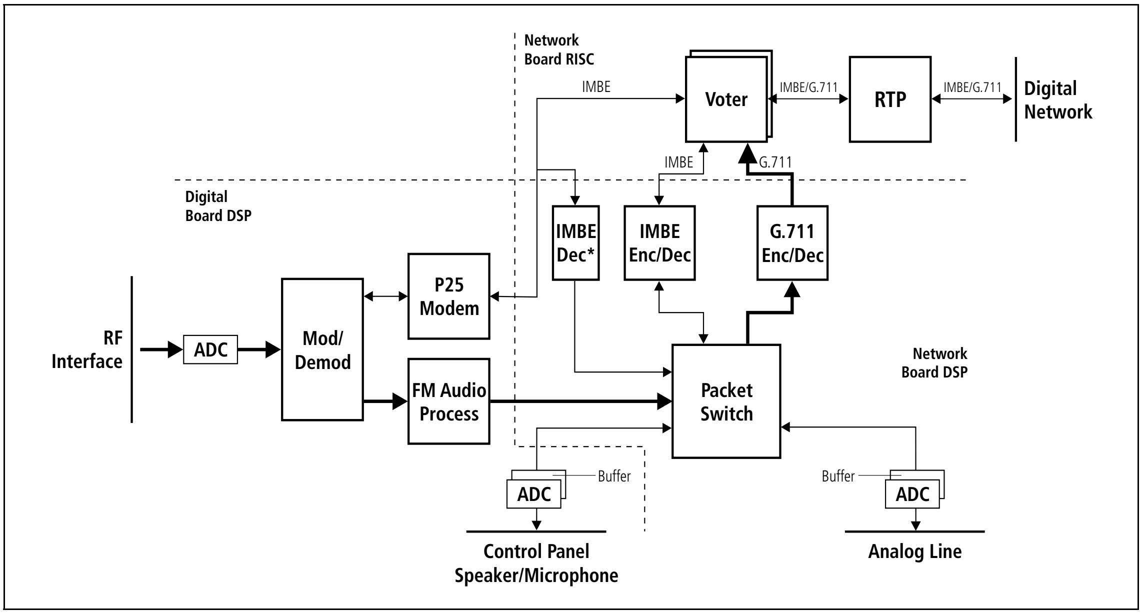
4. The P25 modem extracts the digital bits from the received signal.

5. Error correction is carried out and the IMBE packets are passed directly to the voter.

From the RF Interface (Analog FM)

Figure 8.6 shows the signal path from the RF interface to the voter(s) for an analog FM call.

Figure 8.6 Path from receiver to voter (analog FM mode)



An FM RF signal is processed as follows:

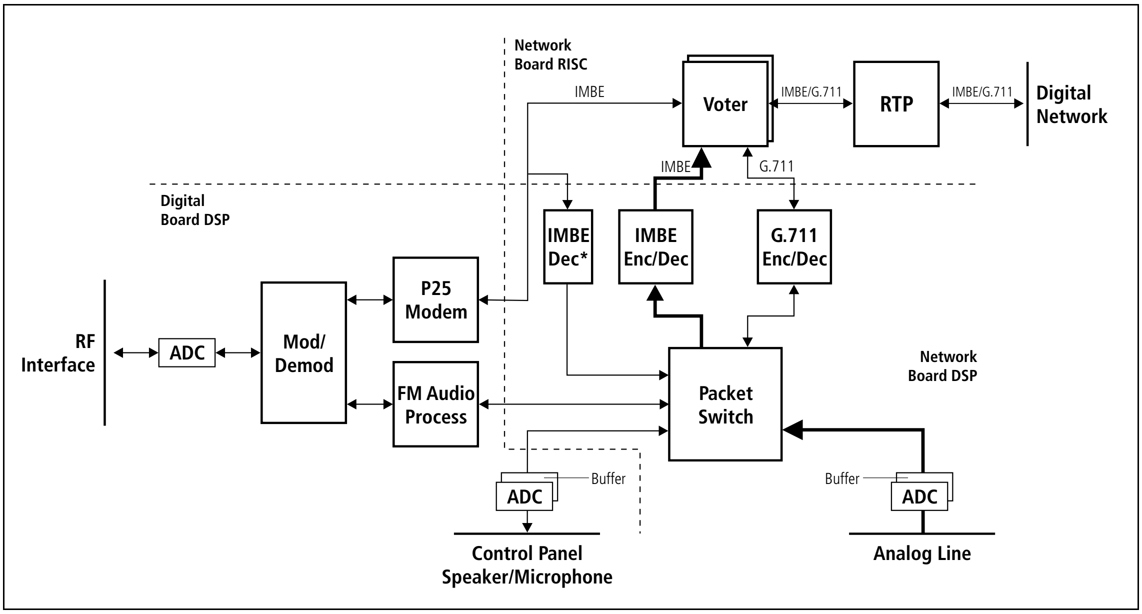
1. The RF signal is processed by the receiver circuitry on the RF board and is passed to the ADC (analog-to-digital converter) in the digital receiver via an anti-alias filter.
2. The Modulator/Demodulator circuitry demodulates the RF signal.
3. The digital board DSP does not detect any digital P25 RF signals and so passes voice stream on to the audio circuitry for analog FM calls.
4. The Audio circuitry carries out the decoding of subaudible signals (e.g. DCS, CTCSS).
5. The Audio circuitry adds header data to the signals and passes them to the packet switch.
6. The packet switch switches the signals to the G.711 encoder.
7. The G.711 encoder turns the signals into G.711 speech packets and passes them on to the voter.

From the Analog Line

The analog line can be used to make a call in digital P25 or in analog FM mode. The current calling profile determines which type of call is made.

Figure 8.7 shows a call being received on the analog line when the calling profile specifies digital P25 mode.

Figure 8.7 Path from analog line to voter (digital P25 mode)



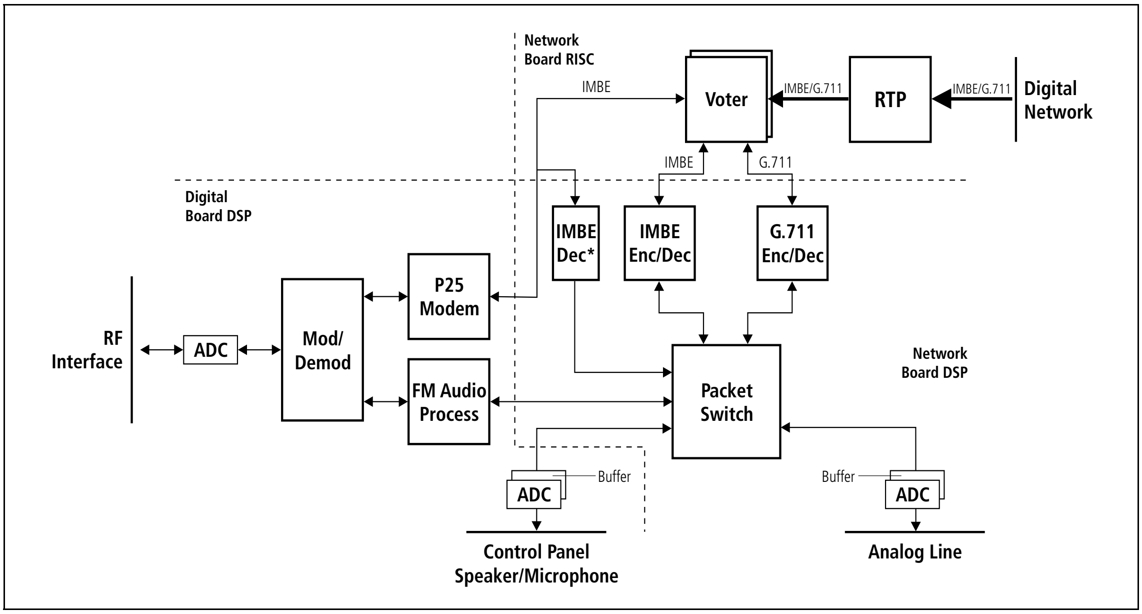
1. Audio speech from the dispatcher arrives at the analog interface.
2. The ADC converts the analog audio to a digital voice stream.
3. A buffer adjacent to the ADC collects the individual samples into packets. Header data is added to the packets.
4. The packet switch routes the packets to the appropriate encoder; the IMBE encoder for digital P25 packets or the G.711 encoder for analog FM packets.
5. The encoder passes the packets to the voter.

From the Digital Line

The digital line can receive calls that were made in digital P25 or analog FM mode. Digital P25 calls arrive in IMBE format. Analog FM calls arrive in G.711 format.

Figure 8.8 shows a call being received on the digital line.

Figure 8.8 Path from digital line to voter



1. Speech packets arrive from the network in either IMBE or G.711 format.
2. The RTP frame information is extracted and the speech packets are passed directly to the voter.

From the Control Panel Microphone

The control panel microphone can be used to make a call in either P25 digital or analog FM mode. Refer to "Microphone Operation" on page 68 for details of how to set the mode for a control panel transmission. Calls made from the control panel participate in the base station voting.

The signal path (not illustrated) is similar to the path for the analog line.

1. The ADC at the control panel interface converts audio speech samples to digital samples. A buffer adjacent to the ADC collects the individual digital samples into packets. Header data is added.
2. The packet switch routes the packets to the appropriate encoder; the IMBE encoder for digital P25 packets or the G.711 encoder for analog FM packets.
3. The encoder passes the packets to the voter.

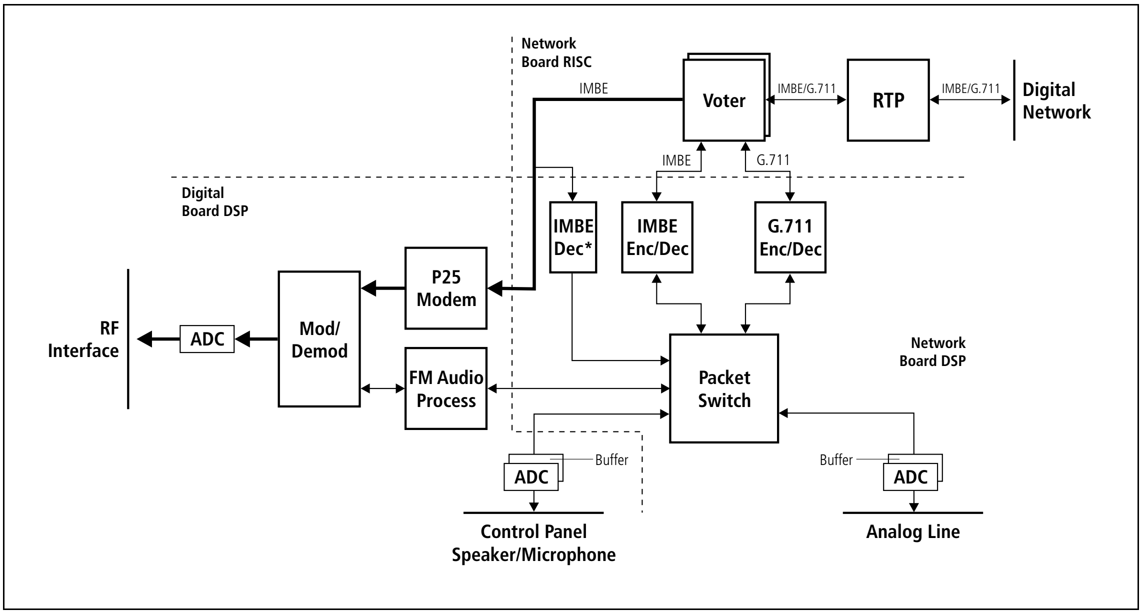
Output Paths

The following sections describe how the output paths from the voter to the four reciter interfaces process their signals.

To the Transmitter (Digital P25)

Figure 8.9 shows the signal path from the voter to the RF interface for a digital P25 call.

Figure 8.9 Path from voter to transmitter (digital P25 mode)



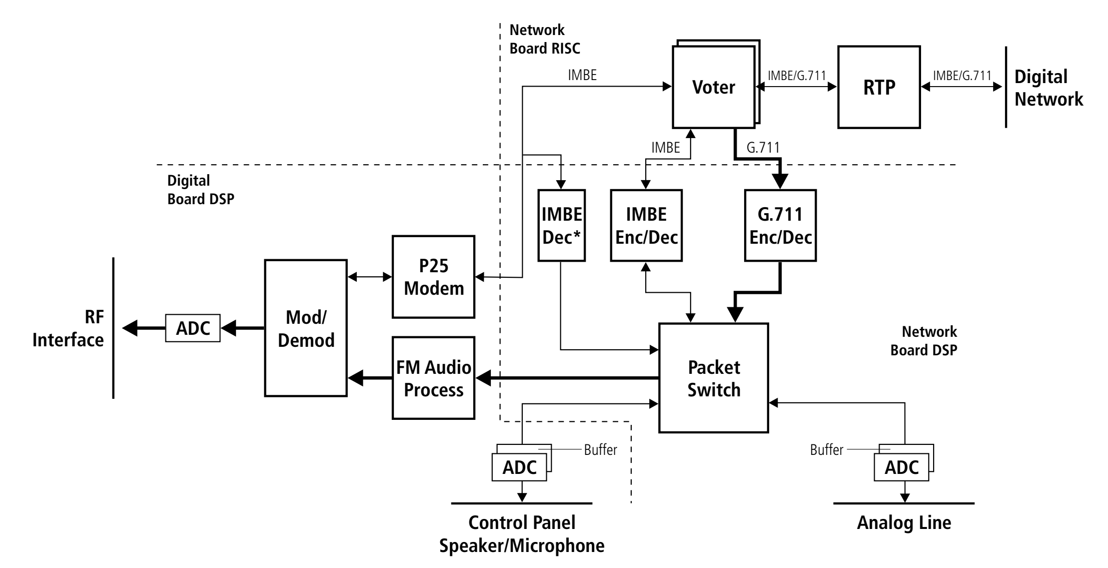
The winning signal is processed as follows.

1. The voter switches the signal to the P25 modem.
2. The P25 modem adds forward error correction to the IMBE packets.
3. The Modulator/Demodulator circuitry converts the audio frequency to the required RF frequency (VHF or UHF).

To the Transmitter (Analog FM)

Figure 8.10 shows the signal path from the voter to the RF interface for an analog FM call.

Figure 8.10 Path from voter to transmitter (analog FM mode)



The winning signal is processed as follows.

1. The voter passes the signal to the G.711 encoder/decoder, which decodes the G.711 packets and passes them to the packet switch.

2. The packet switch switches the signals to the audio circuitry for analog FM calls, which encodes any subaudible signaling (e.g. DCS, CTCSS).

3. The Modulator/Demodulator circuitry converts the audio frequency to the required RF frequency (VHF or UHF).

4. The ADC turns the sampled bitstream into the analog signal that is sent to the exciter.

To the Analog Line

The signal processing on the audio path from the voter to the analog line (not illustrated) is as follows:

1. The voter switches the winning packets to the appropriate decoder (IMBE encoder for digital P25 packets or the G.711 encoder for analog FM packets).

2. The packet switch routes the resultant digital voice stream to the ADC for the analog line.

3. The ADC converts the digital voice stream to analog audio, which is put on the analog line.

To the Digital Line

The signal processing on the audio path from the voter to the digital line (not illustrated) is as follows:

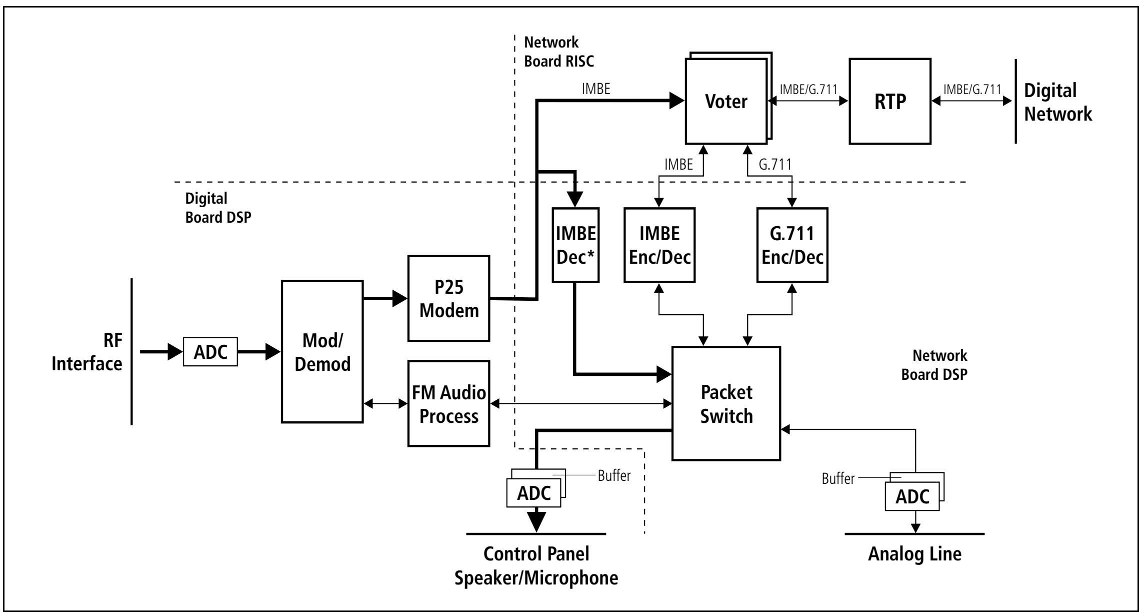
1. The voter switches the winning packets to the RTP processing circuitry.

2. This circuitry adds RTP frame information to the speech packets and then puts them on the digital line.

To the Speaker (Monitoring the Receiver)

The control panel speaker can be used to monitor the received RF signal (see "Speaker Operation" on page 67), bypassing the voter. If the call is analog FM, the packet switch routes the incoming signal directly to the speaker. If the call is digital P25 (see Figure 8.11), the P25 modem output is passed through an IMBE decoder (shown with a *).

Figure 8.11 Path when monitoring receiver (digital P25 mode)



To the Speaker (Vote Winner Mode)

The control panel speaker can be used to monitor the voter output (see "Speaker Operation" on page 67). In this case, the signal path (not illustrated) is as follows:

1. The voter sends the output to the appropriate decoder.

2. The decoder sends its output via the packet switch to the control panel speaker.

Voting

The base stations and gateways in one channel group act in concert to transmit the same conversation. The channel group participants vote amongst incoming streams to select the best outgoing stream. Thus, the channel group participants select which terminal, line interface or control panel microphone shall be sent to the channel group.

The channel group can operate in simplex or duplex modes. This mode is distinct from (but related to) the RF simplex/duplex mode.

Simplex mode

The simplex channel group has a single voter at each channel group member, which selects one stream from all possible sources, and sends it to all output interfaces. The vote winner could be a terminal speaker, or a line interface speaker (dispatcher).

Duplex mode

The duplex channel group allows two directions of speech flow simultaneously. Channel group members vote incoming RF streams and select one vote winner. The channel group members send this inbound stream to all line interfaces and control panel speakers (if so enabled). At the same time, in each channel group member, a separate voter selects one voice stream from the line interfaces (and control panels), and the outbound stream is sent to all RF interfaces. Like the simplex voter, there are duplex voters at each channel group member.

Both simplex and duplex channel groups can repeat the RF, or not.

- All of the channel group voters act in unison, and reach the same decision
- The voters choose the stream based on a set of priorities: originating interface, arrival order, flow type (analog or digital), signal quality, and network location
- If the base stations share the same receiver frequency, the channel group members periodically re-vote, to give preference to the best quality (RF) frequency
- If the channel group base stations have their repeaters enabled, the base stations in the channel group act as a wide area repeater
- The channel group supports line interfaces at more than one base station: voice streams from different line interfaces are prioritized by IP address
- Control of channel group mode is by means of configuration, or tone remote/task manager

Switching and Voting Priorities

Run mode Run mode switching is defined by the following table.

Table 8.1 Base station voice switching and voting priority order: run mode

Input	Source[1]	Direction (duplex)[2]	RF Tx[3]	Speaker[4]	Analog Line	IP[5]
Microphone	Network - lower IP address	outbound	Yes	Simplex[6]	Simplex	No
Microphone	Local	outbound	Yes	No	Simplex	Yes
Microphone	Network - higher IP address	outbound	Yes	Simplex	Simplex	No
Analog line	Network - lower IP address	outbound	Yes	Simplex	Simplex	No
Analog line	Local	outbound	Yes	Simplex	No	Yes
Analog line	Network - higher IP address	outbound	Yes	Simplex	Simplex	No
P25 terminal	Network - higher quality	inbound	Repeat[7]	Yes	Yes	No
P25 terminal	Local	inbound	Repeat	Yes	Yes	Yes
P25 terminal	Network - lower quality	inbound	Repeat	Yes	Yes	No
Analog terminal	Network - higher quality	inbound	Repeat	Yes	Yes	No
Analog terminal	Local	inbound	Repeat	Yes	Yes	Yes
Analog terminal	Network - lower quality	inbound	Repeat	Yes	Yes	No

The switching rules are explained as follows:

1. Higher priority streams are listed earlier in the table. Higher priority streams will be voted in preference to lower priority streams.
2. If the channel group mode is duplex, the base station selects a single inbound source, and a single outbound source, and sends them to the interfaces as defined in the table.
   - Outbound streams are sent to the local RF interface
   - Outbound streams are also sent to the local speaker in simplex mode
   - Inbound streams are sent to the analog line and speaker
   - Inbound streams are also sent to the RF if RF repeat is enabled
3. RF transmitter operation depends on whether repeater transmission is enabled or disabled.
4. Maintainers may put the speaker into RF monitor mode using the control panel. The behavior of the microphone is independent of the speaker monitor setting.
5. Only streams that originate locally are sent to the channel group (IP network)
6. "Simplex" in the table means that this switching path will occur only if the channel group is set to simplex. Simplex channel group mode selects the highest priority (earliest in table) stream, and sends it to all the local interfaces.
7. "Repeat" in the table means that this switching path will occur only if RF repeat is enabled. This may be via configuration or task manager.

Standby mode

In standby mode, the IP network is ignored. The microphone and speaker operate as in run mode, but terminals and dispatchers cannot talk.

The following table is interpreted in the same way as Table 8.1.

Table 8.2 Base station voice switching and voting priority order: standby mode

Input	Source	Direction (duplex)	RF Tx	Speaker	Analog Line	IP[1]
Microphone	Network - lower IP address	outbound	No	No	No	No
Microphone	Local	outbound	Yes[2]	No	Simplex[3]	No
Microphone	Network - higher IP address	outbound	No	No	No	No
Analog line	Network - lower IP address	outbound	No[4]	No	No	No
Analog line	Local	outbound	No[4]	Simplex	No	No
Analog line	Network - higher IP address	outbound	No[4]	No	No	No
P25 terminal	Network - higher quality	inbound	No	Yes	No	No
P25 terminal	Local	inbound	No	Yes	No	No
P25 terminal	Network - lower quality	inbound	No	Yes	No	No
Analog terminal	Network - higher quality	inbound	No	Yes	No	No
Analog terminal	Local	inbound	No	Yes	No	No
Analog terminal	Network - lower quality	inbound	No	Yes	No	No

The switching rules are explained as follows:

1. No streams are sent to the channel group (IP network), or received from the channel group.
2. The microphone and speaker can talk to the RF interface in channel group simplex and duplex modes.
3. The microphone and speaker can talk to the analog line interface in channel group simplex mode.
4. The analog line and RF interfaces cannot talk or listen to each other.

Signaling messages

Signaling messages are switched in sequence with voice streams. That is, if a signaling message precedes an FM or P25 transmission, the sequence of transmission is preserved at all interfaces.

The voting rules for switching messages are the same as the switching rules for a P25 terminal or line originated stream.

Re-voting

If base stations are configured for a common input frequency, multiple base stations can receive the same terminal stream. If the receiver fades at the vote winner, another base station may have a better signal, and should take over.

With a common frequency, multiple base stations will often start calls at approximately the same time, however, the normal voting rules will select the best stream.

Re-voting takes place every 180 ms, when all base stations select the best stream available, and transmit it until the next re-vote. If the winning receiver loses its signal entirely, it sends a fade message instead of the header at the next re-vote. The fade message is an announcement that the base station has lost the vote. All base stations receiving RF signal immediately re-vote when they receive a fade message.

When voting, the voter sequences the packets from the voted streams so that proper packet ordering is preserved. In particular, re-voting is transparent to encryption.

Re-voting will not work if the cross-network delay is greater than 180 ms. It is no longer possible to guarantee that all base stations are voting the same signal.

Shared receiver frequency operation and repeater disable both increase the network bandwidth requirements. With shared frequency, for the jitter buffer to work properly, it needs to be set to the network delay plus the network jitter allowance.

8.3 PA Module Operation

The TB9100 PA is a modular design with the circuitry divided among separate boards which are assembled in different configurations in different models. Interconnect boards are used in certain models to connect boards that are physically separated on the heatsink. The 5, 50 and 100 W PAs are available for operation on 28 VDC, while the 5 and 50 W PAs are also available for operation on 12 VDC.

Figure 8.12 on page 111 shows the configurations of a 100W 28V PA and a 50W 12V PA, along with the main inputs and outputs for power, RF and control signals.

RF Circuitry

The RF output from the reciter is fed first to the 6 W driver board. In the 100 W model the output from the 6 W driver board is fed into a −3 dB hybrid coupler on a separate splitter board and then to two 60 W final boards in quadrature. The outputs from these two boards are then combined by another −3 dB hybrid coupler on a separate combiner board before being fed to the low-pass filter (LPF)/directional coupler board.

In the 50 W model, the output from the 6 W driver board is fed to one 60 W final board and then to the LPF/directional coupler board. In the 5 W model, the output from the 6 W driver board is fed directly to the LPF/ directional coupler board.

Control Circuitry

The microprocessor located on the control board monitors and controls the operation of the PA. There are no manual adjustments in the PA because all the calibration voltages and currents required to control and protect the PA are monitored by the microprocessor. The software also automatically detects the PA configuration and controls the PA accordingly.

If any of the monitored conditions exceeds its normal range of values, the microprocessor will generate an alarm and reduce the output power to a preset level (foldback). If the measured values do not return within the normal range after foldback, the PA will be shut down.

The alarms and diagnostic functions are accessed through I^2C bus messages on the system control bus via the reciter, control panel and CSS. Some measurements are logged by the microprocessor and this information can also be accessed through the system control bus.

The operation of the cooling fan mounted on the front panel is determined by the temperature limits set in the PA software.

Power Supply

The 100 W PA operates off a 28 VDC external power supply only, while the 5 and 50 W PAs can operate off a 28 VDC or 12 VDC external power supply, depending on the model. The 12 V PAs are fitted with an internal boost regulator board (refer to "Boost Regulator" below).

The PA also has four internal power supplies located on the control board which produce −3, +2.5, +5 and +10 VDC.

Boost Regulator

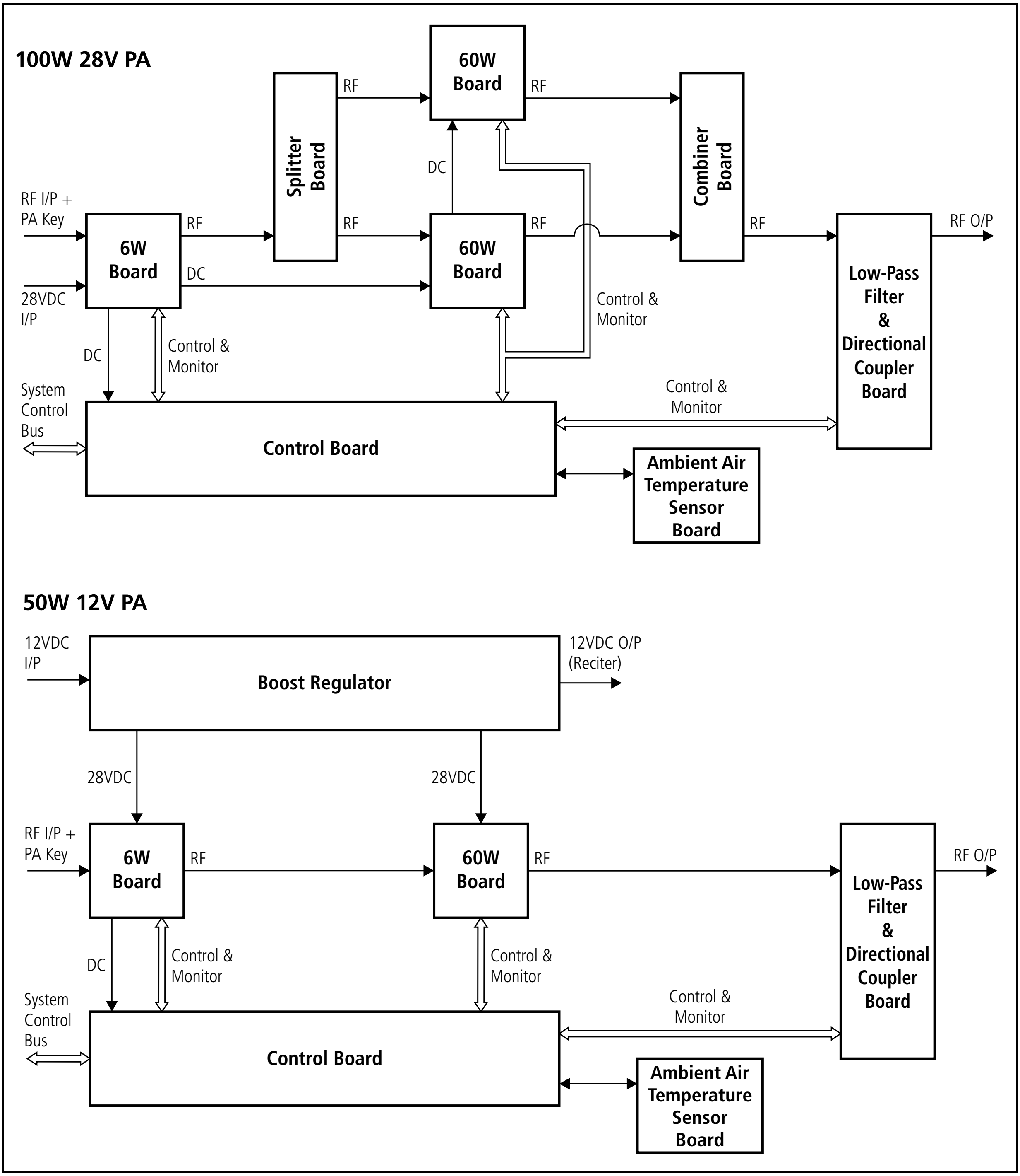
5 and 50 W 12 V PAs are fitted with a boost regulator board. Figure 8.12 on page 111 shows the configuration for a 50 W 12 V PA, along with the main inputs and outputs for power, RF and control signals. Note that the 60 W board is only fitted to the 50 W PA.

The boost regulator board accepts an input of 12 VDC nominal. The input is firstly fed through the DC input filter, and then through an output filter and switch which is controlled by a battery control circuit. This output is fed to the reciter, which operates from 12 VDC instead of the standard 28 VDC provided when a PMU is used. The output from the DC input filter is also fed to the power stage where the voltage is boosted to 28 VDC, and is then fed through an output filter to provide the 28 VDC output for the PA circuit boards.

The battery control circuitry monitors the DC input voltage from the battery. Protection is provided against the wrong input voltage being supplied. Reverse polarity protection is provided by a diode between positive and ground, and requires a user-provided fuse or circuit breaker in series with the DC input line. The fuse or circuit breaker should be rated at 15 A to 18 A at 30 VDC.

The startup voltage is 12 VDC or higher. Once started, the boost regulator will operate down to 10.25 VDC ±0.25 V before it shuts down to prevent deep discharge of the battery.

Figure 8.12 PA high-level block diagrams



8.4 PMU Module Operation

The PMU is available in three main configurations:

- AC PMU (AC input only)
- DC PMU (DC input only)
- AC and DC PMU (both AC and DC converters are fitted to allow both AC and DC inputs).

Figure 8.13 shows the configurations for an AC and DC PMU, along with the main inputs and outputs for power and control signals.

AC Module

The AC module accepts an input of 115/230 VAC 50/60 Hz nominal. The input is fed via the PFC (power factor control) input stage to the HVDC (high voltage DC) stage on the AC converter board. The HVDC circuitry generates the final 28 VDC outputs and provides galvanic isolation between the mains input and DC output. The output stage on the AC converter board provides a common output filter and current monitoring circuit which is used by both AC and DC modules.

Each power stage is controlled by its own plug-in control card. The microprocessor is also located on the HVDC control card. The microprocessor is used by both the AC and DC modules and is fitted to all PMU models.

The leaded high-power components are situated on the AC converter board, while the plug-in cards have only SMD control components.

DC Module

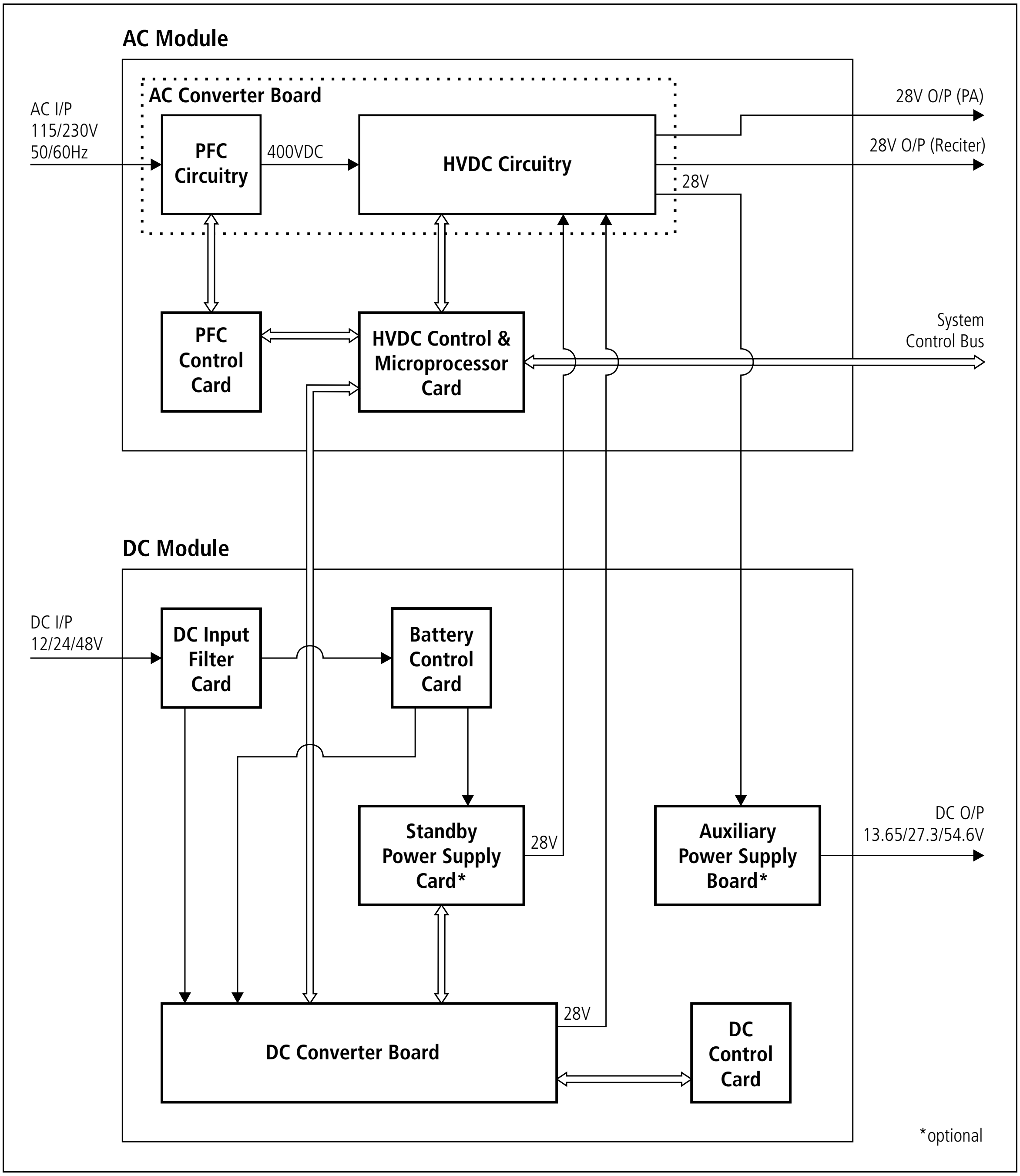
The DC module accepts an input of 12, 24 or 48 VDC nominal. The input is fed through the DC input filter to the input of the power stage on the DC converter board. This circuitry provides PWM (pulse width modulation) conversion to produce the final DC output. It also provides galvanic isolation, allowing the DC input to be positive or negative ground. The final DC output is fed back to the output stage on the AC convertor board.

The battery control card monitors the DC input voltage and prevents the PMU from starting if an incorrect input voltage is applied. It also operates as a fail-safe to prevent deep discharge of the battery, and provides information to the microprocessor to allow the CSS to display information about the battery.

The DC control card controls the power stage of the DC converter. It also provides protection from overload and short circuit conditions.

The leaded high-power components are situated on the DC converter board, while the plug-in cards have only SMD control components.

Figure 8.13 PMU high-level diagram



Standby Power Supply

This optional power supply card plugs into the DC converter board and provides power to the reciter output. This allows the main DC unit to be switched off to reduce current consumption in low-power situations, e.g. when the PA is not transmitting.

Also, when battery capacity is low, it will maintain the power supply to the microprocessor and shut down the rest of the PMU. Refer to "Power Management" on page 17 for further details.

Auxiliary Power Supply

This optional power supply board is mounted on the DC module. The input power is provided from the PA output of the HVDC circuitry on the AC converter board. It provides a high quality 13.65 VDC, 27.3 VDC or 54.6 VDC output (depending on the model) to power external accessory equipment, or can be used to trickle-charge batteries. It can be configured using the CSS to operate whenever mains voltage is available, or whenever the PA output is available.

Note While the auxiliary power output can be used for more than one purpose at once, this is generally not recommended. It can result in a short-circuit and equipment damage. The output is floating. If it is connected to a negatively earthed battery and to positively earthed auxiliary equipment, it will short-circuit.

Microprocessor

The microprocessor on the HVDC control card monitors and controls the operation of the PMU. There are no manual adjustments in the PMU because all the calibration voltages and currents required to control and protect the PMU are monitored by the microprocessor. The software also automatically detects the PMU configuration and controls the PMU accordingly.

If any of the monitored conditions exceeds its normal range of values, the microprocessor will generate an alarm and take appropriate action, depending on the configuration of the PMU.

The alarms and diagnostic functions are accessed through I^2C bus messages on the system control bus via the reciter, control panel and CSS.

The operation of the cooling fan mounted on the front panel is determined by the temperature limits set in the PMU software.

Important In base station systems that use a PMU, the PMU must be connected to the system control bus at all times. The I^2C current source is located in the PMU, and if the PMU is disconnected, the state of much of the bus will be undefined. This may cause corrupted data to be present on the bus when the reciter reads the states of the switches on the control panel. This in turn may result in random actuations of microphone PTT, and carrier or speaker key, causing the base station to transmit, or the speaker to be actuated, incorrectly.

Indicator LEDs

The indicator LEDs on the front panel are used to indicate the state of the PMU and its microprocessor. There are two LEDs, one red and one green. Each LED can be on, off, or flashing at two rates (fast or slow). The state of these LEDs can indicate a number of operating modes or fault conditions, as described in Table 8.3 on page 115.

Table 8.3 PMU 1ndicator LED states

Green	Red	PMU condition
off	off	power off (input above or below safe operating range)
flashing (3 Hz)	off	no application firmware loaded; use the CSS to download the firmware
on	off	the microprocessor is operating; no alarm detected
on	flashing (3 Hz)	one or more alarm conditions indicated: ■ output is overvoltage ■ output is undervoltage ■ output is current-limiting ■ overtemperature ■ mains failure ■ battery voltage is low ■ battery voltage is high ■ shutdown is imminent ■ DC converter is faulty ■ battery is faulty, or DC converter is switched off ■ auxiliary power supply is faulty ■ PMU is not calibrated ■ self-test has failed ■ PMU is not configured
flashing (on 300ms, off 2700ms)	flashing (on 300ms, off 2700ms)	PMU is in battery protection mode
flashing (on 300ms, off 4700ms)	flashing (on 300ms, off 4700ms)	PMU is in Deep Sleep mode
flashing (3 Hz)	flashing (3 Hz)	CSS LED test - LEDs flash alternately

PMU Operation on DC Input

The operation of the PMU on DC input is controlled by three sets of parameters:

- user-programmable alarms
- user-programmable startup and shutdown limits
- battery protection limits

The voltage range for each of these parameters is provided in Table 8.4 on page 117. Figure 8.14 on page 116 illustrates how these parameters interact, and how they control the operation of the PMU over a range of DC input voltages.

Alarms

User-programmable alarms can be set for low or high battery voltage. The alarms will be triggered when the set voltage levels are reached.

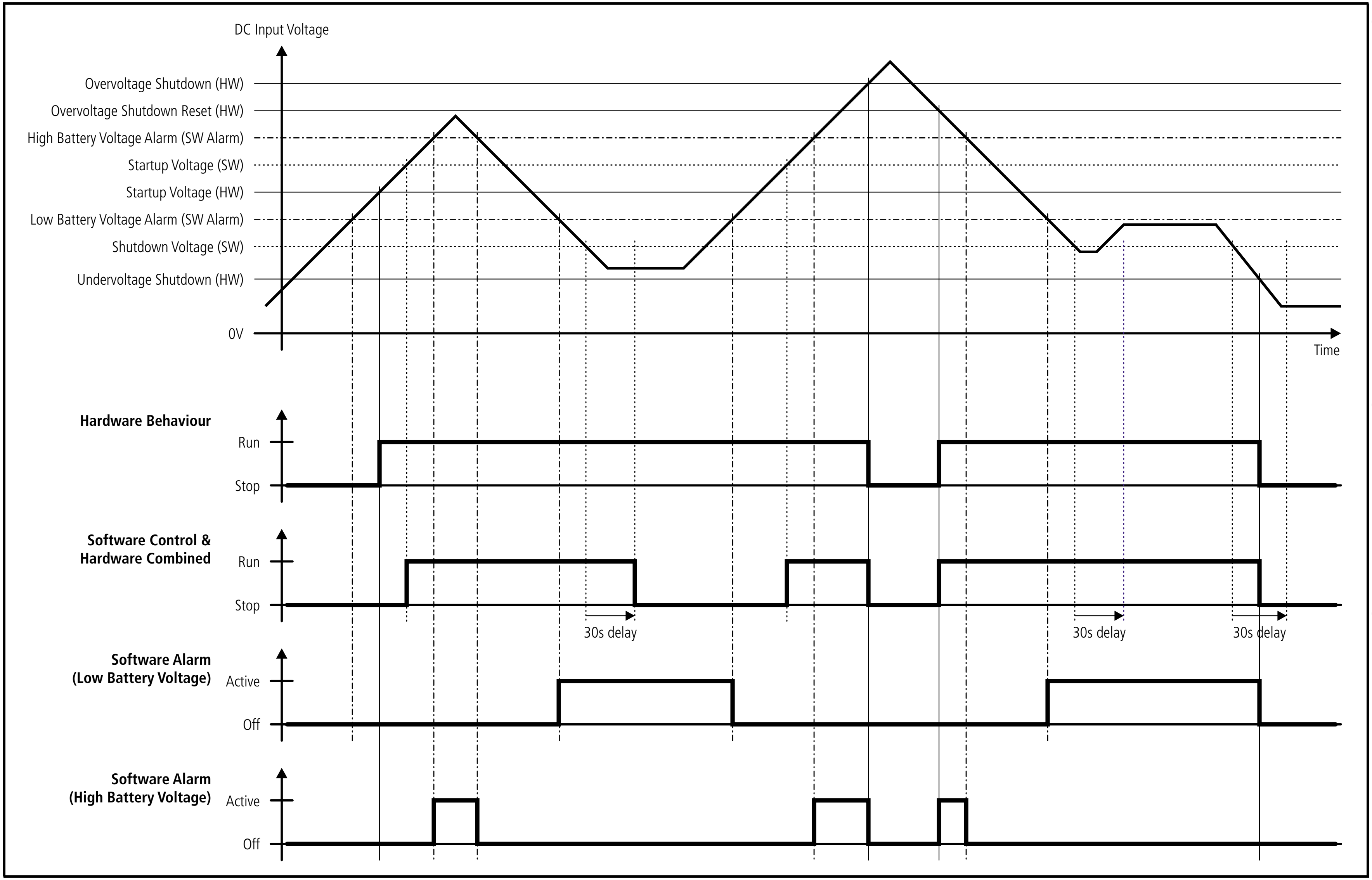


Figure 8.14 PMU alarm thresholds and voltage limits when operating on DC

Startup and Shutdown Limits

The user-programmable startup and shutdown limits allow for adjustable startup and shutdown voltages. These limits can be adjusted for different numbers of battery cells, or for the particular requirements of the base station operation. Once the limits are reached, the PMU will shut down.

Battery Protection Limits

The battery protection limits are set in hardware at the factory, and cannot be adjusted by the user. These limits will not be reached under normal operation conditions, but are provided as "fail-safe" measures to protect the battery from deep discharge. They also remove the need for low-voltage disconnect modules.

Table 8.4 PMU DC voltage limits[a]

Parameter	Voltage Range		
	12V PMU	**24V PMU**	**48V PMU**
User-programmable Alarms[b]			
Low Battery Voltage	10V to 14V	20V to 28V	40V to 56V
High Battery Voltage	14V to 17.5V	28V to 35V	56V to 70V
User-programmable Limits[bc]			
Startup Voltage (after shutdown)	12V to 15V	23.9V to 30V	47.8V to 60V
Shutdown Voltage	10V to 13.5V	20V to 27V	40V to 54V
Battery Protection (Fail-safe) Limits			
Startup Voltage	11.7V ±0.3V	23.4V ±0.5V	46.8V ±1V
Undervoltage Shutdown	9.5V ±0.3V	19V ±0.5V	38V ±1V
Overvoltage Shutdown	18.1V ±0.3V	36.2V ±0.5V	72.4V ±1V
Overvoltage Shutdown Reset	17.1V ±0.3V	34.2V ±0.5V	68.4V ±1V

a. The information in this table is extracted from the TB9100 Specifications Manual. Refer to the latest issue of this manual (MBA-00014-xx) for the most up-to-date and complete PMU specifications.

b. Using the CSS

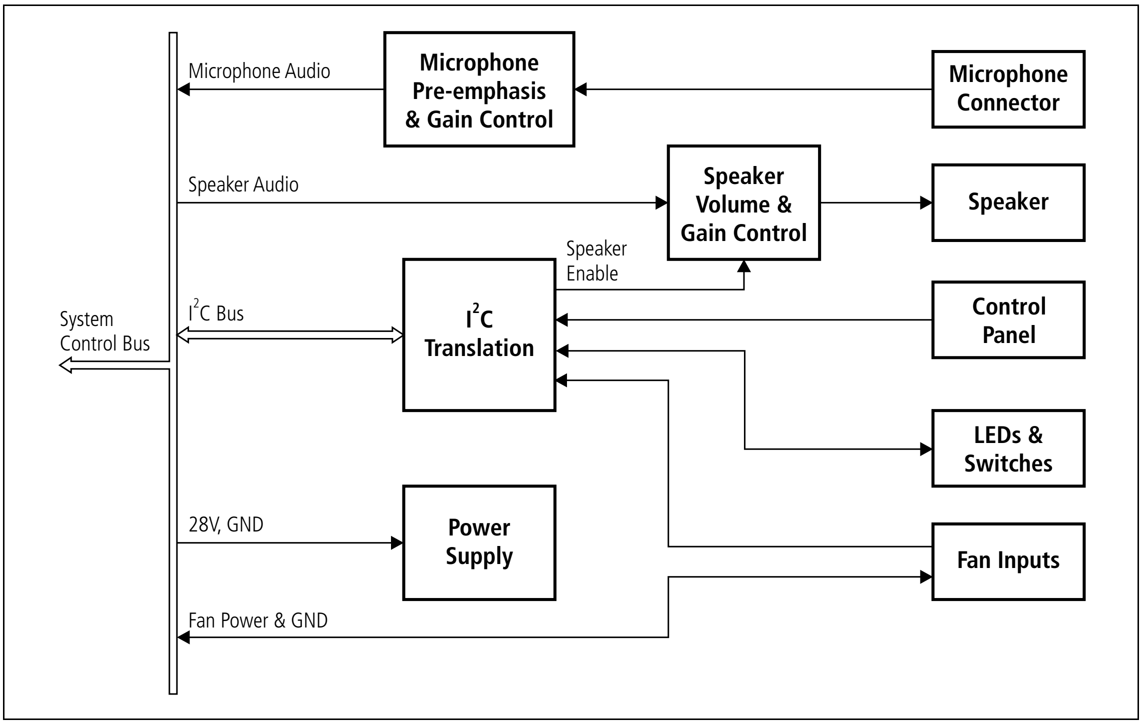
c. Only available if the standby power supply card is fitted.

8.5 Control Panel

The control panel is designed to be the link between the user and the TB9100 base station. The circuitry for the operation of the control panel is located on a board mounted behind its front face. All communication between the base station and the control panel is via the system control bus.

Figure 8.15 shows the configuration of the main circuit blocks, and the main inputs and outputs for power, audio and control signals.

Figure 8.15 Control panel high-level diagram



Control Circuitry

The control panel board translates:

- I^2C messages from the reciter into an appropriate response on the LEDs
- control panel key inputs and fan rotation inputs from both fans into appropriate I^2C messages.

Audio Circuitry

The control panel provides a volume knob to control the volume of the speaker. In addition, the control panel circuitry performs gain control so that the power output into a 16 Ω speaker is ≥0.5 W at the maximum position of the knob, with an input of 167 mV pp.

Power Supply

The control panel operates off a 28 V (nominal) power supply provided by the reciter. The power supply for the cooling fans mounted on the front panel is fed through the control panel.

8.6 System Control Bus

The system control bus provides the following physical paths:

- I^2C communications between modules
- RS-232 communications between the reciter and Calibration Software
- fan power from the PA and PMU
- speaker and microphone signals to and from the control panel
- power connections for the control panel.

The system control bus has been designed so that, if a major fault occurs on the bus, the basic operation of the base station is unaffected, but some features will not operate correctly. For example, if the PA is disconnected from the bus:

- the 'PA not detected' alarm is generated in the reciter; however, transmission still takes place because the transmit RF and key signals are transmitted from the reciter to the PA via the interconnecting coaxial cable
- the PA is unable to turn on its fan. Depending on the ambient temperature at the site and the transmit duty cycle, this could allow the PA to heat up to the point where it reaches the upper temperature threshold. At this point it will begin power foldback, protecting the equipment from damage.

The PMU behaves in a similar way to the PA.

The system control bus has been designed to operate only within the TB9100 subrack. It has not been designed for use outside the subrack or to interconnect two subracks.

I^2C Signals

The TB9100 base station uses the I^2C bus and a proprietary software protocol to provide communications between any modules connected to the bus. Typically this involves the reciter assuming 'server' status, and PA and PMU 'client' status. The reciter co-ordinates the entire subrack operation, reading from and writing to all modules, including the control panel. The I^2C bus allows the reciter to perform the following functions:

- monitoring (e.g. operating status, module details, operating temperatures etc.)
- diagnostics (execution of tests to confirm correct operation)
- firmware upgrades
- configuration (of operational parameters).

The I^2C current source is located in the PMU so that the TB9100 base station can operate with the control panel removed. However, the PMU must be powered up to enable the I^2C communications to operate. Base stations which use the 12V PA do not require a PMU, and in this case the I^2C current source is located on the base station subrack interconnect board.

RS-232 Signals

Calibration Software serial communications occur directly between the connected computer (or modem) and the reciter over the RS-232 serial lines. When the connected computer needs to communicate with the PA, PMU or control panel, the reciter routes the RS-232 data stream to the I^2C bus. Only reciters use the RS-232 interface.

Because RS-232 is a peer-to-peer physical interface, the control panel converts RS-232 to open collector logic. Open collector logic allows the control panel to communicate with the reciter. This same logic level conversion is also performed in the Calibration Test Unit when the control bus interface is connected directly to the reciter.

Fan Signals

The power and ground signals for the PA and PMU fans are routed from the modules to the front panel (via the control panel) along the system control bus. These signals are electrically isolated from all other system signals to ensure fan noise is not transferred to other sensitive system components.

Although the PA and PMU modules provide the power and ground for their respective fans, the fan rotation detection is performed in the control panel. The result is then read and processed by the reciter via the I^2C interface. The PA and PMU do not know if their fan has been correctly enabled, however, if there is a fault in the fan circuitry, each module is protected from overheating by its internal foldback circuitry.

Speaker Signal

Received audio can be sent from the reciter to the control panel. This function is controlled by the speaker button on the control panel. The audio signal is then amplified and passed to the control panel speaker for monitoring purposes. The audio output impedance of the reciter is fixed at approximately $2k\Omega$.

Microphone Signal

When you press the microphone PTT button, the reciter enables the transmitter and connects the audio signal from the microphone input to the modulator. The microphone PTT signal is read via the control panel using the I^2C bus and this then enables the transmitter. Note that the PTT response times are slower than the response times for the Channel Seize input from the analog interface.

Power and Ground

The PMU provides power to the control panel via the reciter. The reciter has a series diode to ‘diode OR’ the power to the control panel, but not to backpower a reciter that does not have a power cable connected.

Pin Allocations

The subrack interconnect board at the front of the TB9100 subrack provides a parallel interconnection between all connectors on the board.

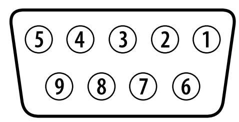
The following table gives the pin allocations for the IDC connectors to the reciter, PA and PMU, and for the D-range connector to the control panel.

Signal	Reciter, PA & PMU IDC Pin	Control Panel D-range Pin
I^2C interrupt (not used)	1	8
I^2C data	2	15
ground (I^2C)	3	no connection
I^2C clock	4	7
+28V (control panel power)	5	14
RS-232 Tx data	6	6
ground (control panel power)	7	13
RS-232 Rx data	8	5
ground (analog)	9	12
control panel speaker	10	4
control panel microphone	11	11
PSU back-up (not used)	12	3
+24V switched (PA fan)	13	2
ground (PA fan)	14	10
+24V switched (PMU fan)	15	9
ground (PMU fan)	16	1

Appendix A – Interface Pin Assignments

Serial Interface Connection

The pin allocations for the serial interface connection are given in the following table.

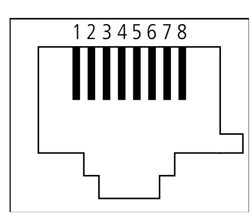


front view

Pin	Description
1	general purpose output/ digital input 4/ antenna relay
2	transmit data output
3	receive data input
4	digital input 0
5	ground
6	digital input 1
7	digital input 2
8	digital input 3
9	digital output/ RSSI[a]

a. The function of Pin 9 of the DB9 connector of the network board is configurable between programmable digital output 0 and RSSI output (selected by configuration). If RSSI output, the range of received signal is configurable between -130 dBm and -60 dBm. The DC output characteristic lies between the fixed points of 0.5 V and 4.5 V.

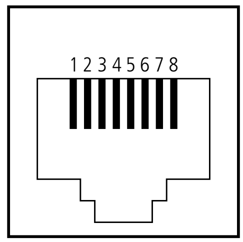
Analog Interface Connection



front view

Pin	Description
1	E & M signaling input
2	E & M signaling input
3	audio output
4	audio output
5	audio input
6	audio input
7	E & M signaling output
8	E & M signaling output

Digital Interface Connection

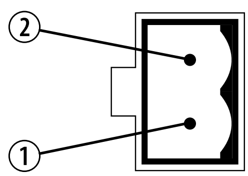


front view

Pin	Description
1	transmit output
2	transmit output
3	receive input
4	not connected
5	not connected
6	receive input
7	not connected
8	not connected

PMU Auxiliary DC Output

The pin allocations for the auxiliary DC output on the PMU are given in the following table.

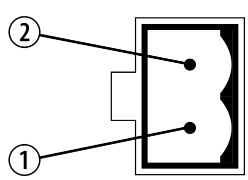


2-pin connector - rear view

Pin	Description
1	+V output
2	ground

DC Input to 12 V PA

The pin allocations for the 2-way DC input connector are shown below.

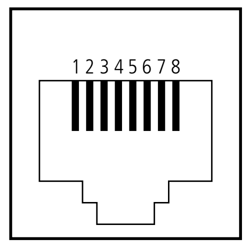


2-pin connector - rear view

Pin	Description
1	+V output
2	ground

Microphone Connection

The pin allocations for the microphone socket are given in the following table.



front view

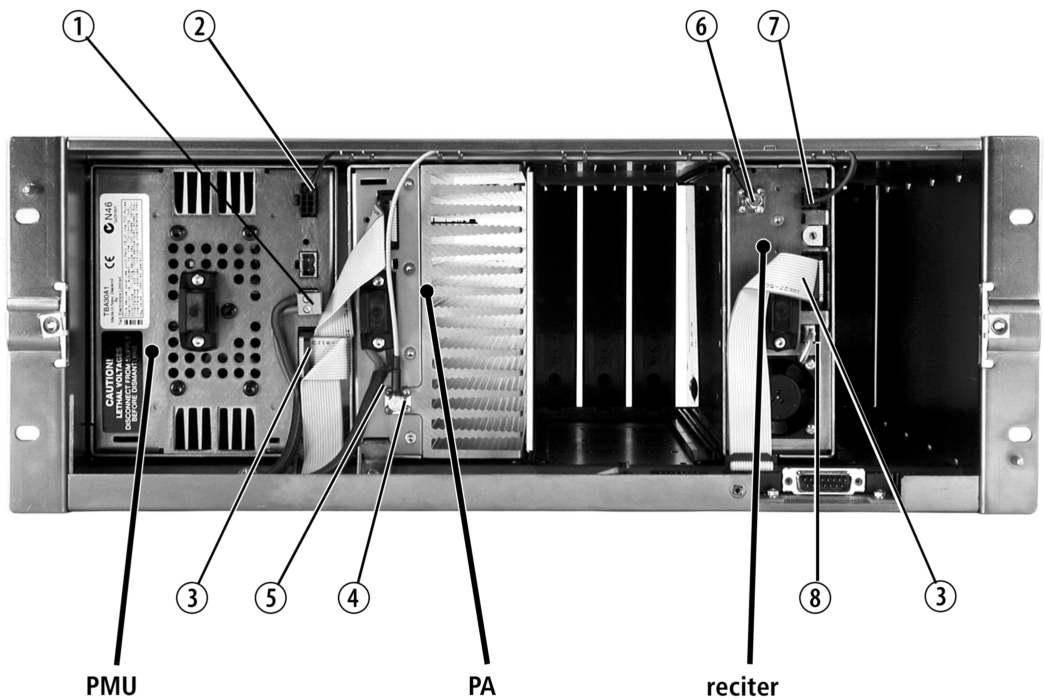
Pin	Description
1	not connected
2	not connected
3	not connected
4	PTT
5	voice band (microphone) input
6	microphone ground
7	not connected
8	not connected

Appendix B – Inter-Module Connections

5 or 50 W Base Station

The connections between modules at the front of a 5 or 50 W base station are shown below.

5 or 50 W base station internal connections



① 28 VDC high current output for PA

② 28 VDC low current output for reciter

③ system control bus

④ RF input from reciter

⑤ 28 VDC high current input cable from PMU

⑥ RF output to PA

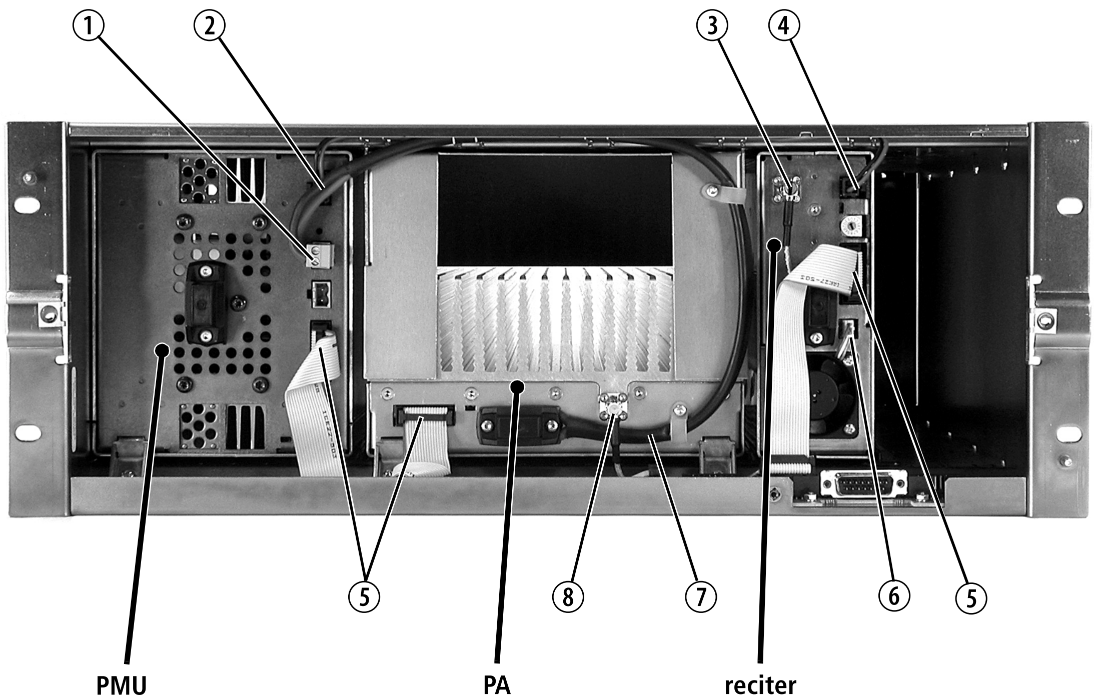
⑦ 28 VDC low current input from PMU

⑧ DC output for reciter fan

100 W Base Station

The connections between modules at the front of a 100 W base station are shown below.

100 W base station internal connections



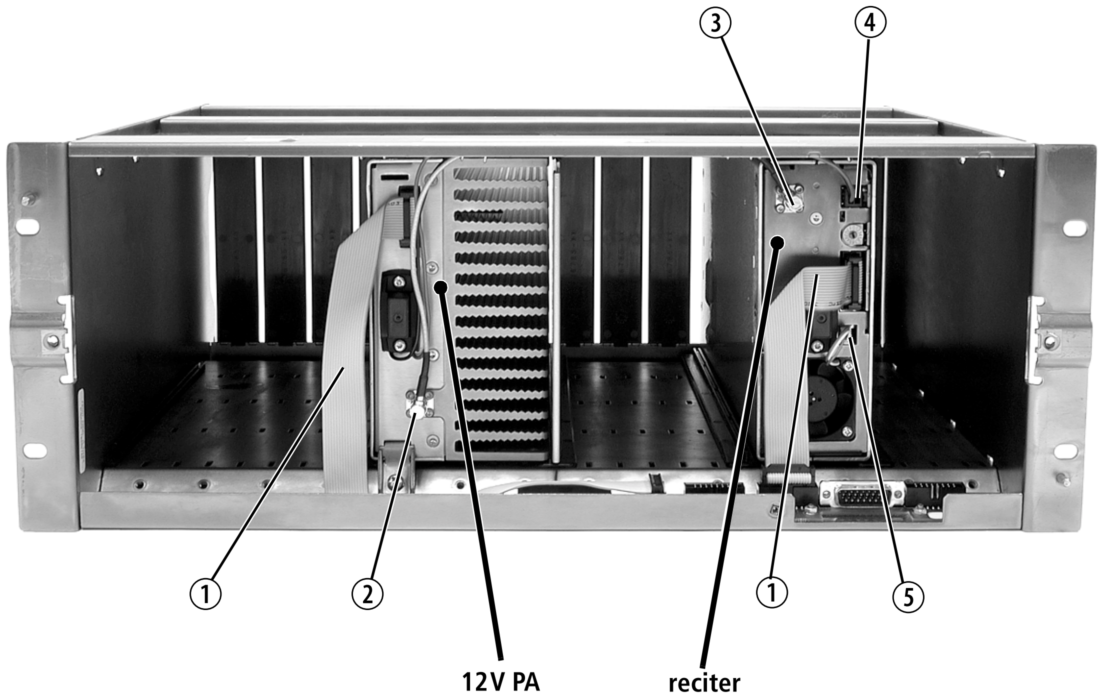
1. 28 VDC high current output for PA
2. 28 VDC low current output for reciter (obscured)
3. RF output to PA
4. 28 VDC low current input from PMU
5. system control bus
6. DC output for reciter fan
7. 28 VDC high current input cable from PMU
8. RF input from reciter

Important The PMU must be connected to the system control bus at all times. The terminating circuitry for the bus is located in the PMU, and if the PMU is disconnected, the state of much of the bus will be undefined. This may cause corrupted data to be present on the bus when the reciter reads the states of the switches on the control panel. This in turn may result in random actuations of microphone PTT, carrier, or speaker key, causing the base station to transmit or the speaker to be actuated incorrectly.

12 V PA Base Station

The connections between modules at the front of a 12V PA base station are shown below.

12 V PA base station internal connections



① system control bus

② RF input from reciter

③ RF output to PA

④ 12 VDC input from PA

⑤ DC output for reciter fan

Glossary

This glossary contains an alphabetical list of terms and abbreviations related to the TB9100 base station.

A

administrator A special type of access to CSS functions, used for activities such as changing passwords.

ADC Analog-to-Digital Converter. A device for converting an analog signal to a digital signal that represents the same information.

AGC Automatic Gain Control. A device that optimizes signal level.

Alarm Center Alarm Center is the Tait name for a utility that receives, stores, and displays syslog messages from elements in the TaitNet P25 network.

analog FM mode A mode of operation in which the RF interface transmits and receives analog FM signal. The digital line sends and receives the analog signal as G. 711 speech packets.

analog valid Analog valid is a signal that indicates that the base station is presenting a valid output on the analog line. This output can originate from an analog FM or from a digital P25 call. The M-line carries the analog valid signal.

ANI Automatic Number Identification. A service that provides the receiver of a call the number of the caller.

APCO The Association of Public Safety Communications Officials in the United States. The APCO Project 25 standards committee defined a digital radio standard. The standard is often referred to as APCO or P25.

B

Base station

In general, a radio receiver and transmitter that is located in a specific place (at a site) that allows portable and mobile radio terminals to communicate over a larger range. Specifically, Tait TB9100 equipment in a subrack.

BCD

BCD (binary coded decimal) is a code in which a string of four binary digits represents a decimal number.

BER

Bit Error Rate. A measure of the quality of digital transmission, expressed as a percentage. The BER indicates the proportion of errors in a transmission.

C

C4FM

Compatible Four-level Frequency Modulation. A modulation scheme defined in the CAI standard for 12.5 kHz bandwidth.

CAI

Common Air Interface. The over-the-air data formats and protocols defined by the APCO P25 committee.

Calibration Software

The TB9100 Calibration Software is a utility for defining the switching ranges of the receiver and the exciter and for flattening the receiver response across its switching range. It can also be used to calibrate TB9100 modules.

call

A complete exchange of information between two or more parties. A call requires a receive signal path and a transmit signal path. In trunked systems, a call is a conversation, made up of a number of overs, but in conventional systems, a call is an over.

calling profile

A group of configuration settings that defines the properties of the TB9100 analog line, which can be regarded as equivalent to a radio on the network.

channel

A channel is:
1. A path through which signals can flow.
2. In the RF domain, a frequency pair (or just a single frequency in a simplex system).
3. A set of configuration information that defines the frequency pair and other related settings (a channel configuration). Generally, ‘channel’ has this meaning in the CSS.

channel group A channel group is a single logical channel consisting of a set of base stations. The base stations are linked by an IP network and share a common multicast IP address.

channel profile A channel profile is a named group of configuration settings that help to define the properties of a channel. Each channel in the channel table must have a channel profile assigned to it.

channel seize Channel seize is a signal received at the analog line interface, requesting the base station to accept the analog signal as an input into the channel group. The base station can be configured to acknowledge an asserted E-line, LLGT, or LLGT following MDC1200 signaling as a channel seize signal.

channel spacing Channel spacing is the bandwidth that a channel nominally occupies. If a base station has a channel spacing of 12.5 kHz, there must be a separation of at least 12.5 kHz between its operating frequencies and those of any other equipment.

channel table The channel table is the base station's database of channel configurations.

circuit domain The part of the base station processing functionality that processes speech signal as a continuous stream of bits – a digital circuit. The opposite of packet domain.

CODEC An IC which combines analog-to-digital conversion (coding) and digital-to-analog conversion (decoding).

configuration file A configuration file consists of all the configuration settings needed for a base station, stored as a file in the configurations folder. Configuration files have the extension *.apc.

connection list A connection list contains the names and IP addresses of base stations that the CSS can connect to.

control bus The control bus is used for communications between base station modules in a subrack. It is an I^2C bus, a bi-directional two-wire serial bus which is used to connect integrated circuits (ICs). I^2C is a multi-server bus, which means that multiple chips can be connected to the same bus, and each one can act as a server by initiating a data transfer.

control panel

The control panel is an area at the front of the base station with buttons, LEDs and other controls that let you interact with the base station.

CRTP

Compressed RTP.

CSS

Customer Service Software. Tait PC-based software for monitoring, configuring, and diagnosing a Tait TB9100 base station.

CTCSS

CTCSS (continuous tone controlled squelch system), also known as PL (private line) is a type of signaling that uses subaudible tones to segregate groups of users.

custom action

A custom action is a user-defined Task Manager action that consists of more than one pre-defined action.

custom input

A custom input is a user-defined Task Manager input that consists of a set of pre-defined inputs that are combined using Boolean logic.

CWID

CWID (**C**ontinuous **W**ave **ID**entification) is a method of automatically identifying the base station using a Morse code. Continuous wave means transmission of a signal with a single frequency that is either on or off, as opposed to a modulated carrier.

D

DAC

Digital-to-Analog Converter. A device for converting a digital signal to an analog signal that represents the same information.

DCS

DCS (digital coded squelch), also known as DPL (digital private line), is a type of subaudible signaling used for segregating groups of users. DCS codes are identified by a three-digit octal number, which forms part of the continuously repeating codeword. When assigning DCS signaling for a channel, you specify the three-digit code.

de-emphasis

De-emphasis is a process in the receiver that restores pre-emphasized audio to its original relative proportions.

digital input value — A value that the base station computes from the state of a configured number of digital inputs. The digital input value is an input into Task Manager.

digital P25 mode — A mode of operation in which the RF interface transmits and receives digital signal as defined by the APCO P25 CAI. The digital line sends and receives IMBE speech packets.

dispatcher — A dispatcher is a person who gives official instructions by radio to a fleet.

dotted quad — A method for writing IPv4 addresses. The form is DDD.DDD.DDD.DDD where DDD is an 8-bit decimal number.

DSP — Digital Signal Processor.

dual mode — The ability to operate as a transceiver in two different ways: analog FM and P25 digital. Dual mode equipment can be configured to support either mode or to switch between modes from one over to another.

duplex channel group — The duplex channel group has two voters at each channel group member, which allows for two directions of speech flow simultaneously. The selected inbound stream can be sent to all line interfaces and control speakers at the same time as an outbound stream is selected and sent to all RF interfaces (see inbound and outbound).

duty cycle — Duty cycle is used in relation to the PA. It is the proportion of time (expressed as a percentage) during which the PA is operated.

E

EIA — Electronic Industries Alliance. Accredited by the American National Standards Institute (ANSI) and responsible for developing telecommunications and electronics standards in the USA.

EMC — Electromagnetic Compatibility. The ability of equipment to operate in its electromagnetic environment without creating interference with other devices.

ETSI European Telecommunications Standards Institute. The non-profit organization responsible for producing European telecommunications standards.

F

FCC Federal Communications Commission. The FCC is an independent United States government agency that regulates interstate and international radio communications.

Feature Code Code that identifies a feature license that can be enabled or disabled using the Software Feature Enabler.

Feature Code Sequence Number Number that indicates how many times a feature license has been enabled or disabled.

Feature license key A set of digits purchased from Tait that is required to enable a feature license.

FEC Forward Error Correction.

FFSK Fast Frequency Shift Keying. A modem encoding scheme for carrying data on FM radios.

flag A flag is a programming term for a "yes/no" indicator used to represent the current status of something. The base station has a set of flags that Task Manager can set and clear.

FLASH Electrically block erasable and programmable read-only memory.

FM Frequency Modulation. Often used as an adjective to denote analog radio transmission.

frequency band The range of frequencies that the equipment is capable of operating on.

front panel The cover over the front of the base station containing fans for the PA and PMU.

G

G. 711

The name of the ITU standard that defines how speech is digitally encoded (64 kbit, A-law or u-law). When the base station is in analog mode, G. 711 speech is sent and received on the digital line interface.

gating

Gating is the process of opening and closing the receiver gate. When a valid signal is received, the receiver gate opens.

group call

A group call is a call that involves more than two radios simultaneously.

H

hiccup mode

Many power supplies switch off in the event of a short-circuit and try to start again after a short time (usually after a few seconds). This "hiccup"-type of switching off and on is repeated until the problem is eliminated.

hub

A unit for connecting hosts together. It sends all incoming ethernet packets to all the other hosts.

hysteresis

Hysteresis is the difference between the upper and lower trigger points. For example, the receiver unmutes when the upper trigger point is reached, but will mute again until the level falls to the lower trigger point. An adequate hysteresis prevents the receiver gate from repeatedly muting and unmuting when the level varies around the trigger point.

I

IMBE

Improved Multiband Excitation. A voice compression technology patented by Digital Voice Systems, Inc and used in the vocoders of P25 radios.

inbound

Inbound describes the direction of a signal: from a subscriber unit over the air interface to the fixed station.

inhibit

A control command that can be sent across the CAI to inhibit a radio. An inhibited radio appears to the user as if it is powered off.

IP Internet Protocol. IP is a protocol for sending data packets between hosts.

isolator An isolator is a passive two-port device which transmits power in one direction, and absorbs power in the other direction. It is used in a PA to prevent damage to the RF circuitry from high reverse power.

L

LAN Local Area Network

LED Light Emitting Diode. Also the screen representation of a physical LED.

LLGT Low level guard tone. One of a set of tones used to remotely control base stations.

Lockout U.S. term for Inhibit (see inhibit).

M

MDC1200 MDC1200 is a proprietary signaling protocol developed by Motorola and used to enhance basic communications in analog PMR.

monitor The Monitor function unmutes the receiver, so that the user can hear all traffic on a channel.

multicast group The group of hosts associated with a specific IP multicast address.

multicast IP address An IP address that addresses a group of hosts rather than a single host.

mute A mute controls the circumstances under which a received signal is passed to the radio's speaker. When a mute is active, the radio's speaker only unmutes under certain conditions, determined by the type of signaling operating on a channel and the squelch threshold.

N

NAC

Network Access Code. The 12 most significant bits of the network identifier information that precedes every packet sent on the CAI. The NAC identifies which network the data belongs to, allowing base stations and mobiles to ignore packets belonging to interfering networks.

navigation pane

The navigation pane is the left-hand pane of the CSS application window. It displays a hierarchical list of items. When you click an item, the main pane displays the corresponding form.

normal squelch

A type of squelch operation in which the receiver unmutes on any signal with the correct NAC (digital P25) or subaudible signaling (analog FM).

O

octet

A set of 8 bits.

operating range

Operating range is another term for switching range.

outbound

Outbound describes the direction of a signal: from a fixed station over the air interface to a subscriber unit.

over

A single transmission, which begins when a user presses PTT and ends when the user stops pressing.

P

P25

Project 25. A suite of standards and requirements intended for digital public safety radio communications systems.

PA

The PA (power amplifier) is a base station module that boosts the exciter output to transmit level.

packet domain

The speech processing area that deals with speech data that has been collected up into a packet. IP networks convey packets. The opposite of circuit domain.

PCB

Printed Circuit Board

PMU The PMU (power management unit) is a module that provides power to the base station.

pre-emphasis Pre-emphasis is a process in the transmitter that boosts higher audio frequencies.

program The act of sending a configuration data set from the CSS to the base station.

Project 25 A project set up by APCO (the Association of Public Safety Communications Officials International), together with other US governmental organizations, to develop standards for interoperable digital radios to meet the needs of public safety users.

PSTN Public Switched Telephone Network: The public telephone network.

PTT Push To Talk. The button on a radio terminal that keys the transmitter.

Q

QoS Quality Of Service.

R

reciter The reciter is a module of a TB9100 base station that acts as receiver and exciter.

repeater talkaround Repeater talkaround allows the radio user to bypass repeater operation and so communicate directly with other radios. While repeater talkaround is active, all transmissions are made on the receive frequency programmed for the channel.

reverse tone burst Reverse tone bursts can be used with CTCSS. When reverse tone bursts are enabled, the phase of the generated tones is reversed for a number of cycles just before transmission ceases. If the receiver is configured for reverse tone burst, it responds by closing its gate.

RISC Reduced instruction set chip. The name used for the control processors in the reciter's digital board and network board.

RS-232 A serial communications protocol.

RSSI RSSI (Received Signal Strength Indicator) is a level that indicates the strength of the received signal.

RTP RTP (Real Time Protocol) is an Internet protocol that supports the real-time transmission of voice and data.

Run mode Run mode is the normal operating mode of the base station.

Rx Receiver.

S

selective squelch A type of squelch operation in which the receiver unmutes only on signals that are explicitly addressed to that receiver. This can be done through a talk group ID or unit ID (digital P25) or through MDC1200 signaling (analog FM).

sensitivity The sensitivity of a radio receiver is the minimum input signal strength required to provide a useable signal.

signaling profile A signaling profile is a named set of configuration items related to signaling that can be applied to any channel. Items include subaudible signaling and transmit timers.

simplex channel group The simplex channel group has a single voter at each channel group member, which selects one stream from all the possible sources, and sends it to all the output interfaces.

SINAD SINAD (Signal plus Noise and Distortion) is a measure of signal quality. It is the ratio of (signal + noise + distortion) to (noise + distortion). A SINAD of 12 dB corresponds to a signal to noise ratio of 4:1. The TB9100 can provide an approximate SINAD value while in service by comparing the in-band audio against out-of-band noise. This value should not be relied upon to make calibrated measurements.

site 1. The base station electronics at a particular location. This includes power supplies, transmitters, receivers, network interfaces and controllers. 2. The location of that electronic equipment.

SMR Specialized Mobile Radio. A communications system used by police, ambulances, taxis, trucks and other delivery vehicles.

squelch Squelch is a feature of radio equipment. It ensures that the speaker only unmutes when a valid signal is received. To be valid, it must, for example, exceed a certain signal strength.

Standby mode Standby mode is a mode of base station operation in which active service is suspended so that special operations can be carried out, such as programming a new configuration into the base station.

subaudible signaling Subaudible signaling is signaling that is at the bottom end of the range of audible frequencies. The TB9100 base station supports CTCSS and DCS subaudible signaling.

subtone A subtone (subaudible signaling tone) is a CTCSS tone or a DCS code.

supplementary service A term used in the P25 standards. It refers to a group of services that is additional to the basic service that a telecommunications network provides. Examples include encryption and radio unit monitoring.

switching range The switching range is the range of frequencies (about 10 MHz) that the equipment is tuned to operate on. This is a subset of the equipment's frequency band.

syslog protocol syslog is a standard protocol used for the transmission of event notification messages across IP networks. Base stations can send messages such as alarms to an IP address on the TaitNet P25 network. The base station's logs store messages in the syslog format.

T

TaitNet Brand name for any PMR network designed and manufactured by Tait Electronics Limited.

TaitNet P25 network A set of Tait base stations interconnected by an IP network that can carry voice and data traffic.

TB9100 Base Station A Tait TB9100 base station consists of the equipment necessary to receive and transmit on one channel. Generally, this means a reciter, a PA, and a PMU. Often abbreviated to TB9100 or base station.

Task action A task action is the second part of a Task Manager task. It specifies what the base station must do when the first part (the input) becomes true.

Task input A task input is the first part of a Task Manager task. It specifies what the must become true before the base station carries out the second part.

Task Manager Task Manager is a part of the TB9100 base station firmware that carries out tasks in response to inputs. These tasks are formulated using the CSS.

TCP Transmission Control Protocol. A complex protocol on top of IP for sending reliable streams of data with flow control.

TELCO Telephone company.

TIA Telecommunications Industry Association

toggle The term toggle is used to describe the switching between two states. If something is on, toggling it turns it off. If it is off, toggling it turns it on.

tone A tone is a sound wave of a particular frequency.

Tx Transmitter.

U

uninhibit A control command that can be sent across the CAI to restore and inhibited radio to normal functioning.

UDP User Datagram Protocol. A simple protocol on top of IP for sending streams of data.

UTC Coordinated Universal Time (word order from French). An international time standard that has replaced Greenwich Mean Time.

V

valid signal A valid signal is a signal that the receiver responds to by unmuting the receiver. A signal is valid, for example, when it is stronger than a minimum level and when it has the specified NAC.

vocoder Voice encoder/decoder. A processing element that compresses/decompresses the digital voice signal.

VoIP Voice over IP. The name for the technology that puts speech signals in packets and then routes them over an IP backbone network.

voting Voting is the systematic sampling of a group of channels for the channel with the greatest signal strength. Voting provides wide-area coverage and ensures that as the user moves throughout the coverage area the strongest channel is always available for a call. The TB9100 has an internal voter, which decides which base station input is passed to the switch for distribution to the configured and enabled outputs.

VSWR Voltage Standing Wave Ratio (VSWR) is the ratio of the maximum peak voltage anywhere on the line to the minimum value anywhere on the line. A perfectly matched line has a VSWR of 1:1. A high ratio indicates that the antenna subsystem is poorly matched.

W

watchdog A watchdog circuit checks that the system is still responding. If the system does not respond (because the firmware has locked up), the circuit resets the system.