

SRM 9000 Series FM VHF/UHF Mobile Radio Transceiver

Revision 9 Hardware

SERVICE MANUAL

TNM-M-E-0002

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SRM9000 Series Mobile Radio Transceiver Rev 9 Hardware TNM-M-E-0002 ~ Iss 1.0

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APPENDIX A ~ GLOSSARY

APPENDIX B ~ TRANSCEIVER CONNECTIONS

APPENDIX C ~ SRM9010 MICROPHONE

APPENDIX D ~ SRM9020 MICROPHONE

APPENDIX E ~ SRM9022 MICROPHONE

APPENDIX F ~ SRM9030 CONTROL HEAD

APPENDIX G ~ ANCILLARIES

Declaration

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1	January 2006	Initial issue

List of Associated Publications

Document No.	Description	Issue
TNM-I-E-0005	SRM9000 Series Installation Instructions	5
TNM-P-E-004	Selcall Product Manual	2.56
TNM-U-E-0012	SRM9020 Trunk Operating Instructions	2
TNM-U-E-0013	SRM9020 PMR Operating Instructions	2
TNM-U-E-0063	SRM9022 PMR Operating Instructions	1
TNM-U-E-0014	SRM9025 PMR Operating Instructions	2
TNM-U-E-0015	SRM9025 Trunk Operating Instructions	2
TNM-U-E-0003	SRM9030 PMR Operating Instructions	2
TNM-U-E-0004	SRM9030 Trunk Operating Instructions	2
TNM-U-E-0020	SRM9030 Brief User Guide	2
TNM-U-E-0042	SRM9010 Brief User Guide	2
TNM-U-E-0043	SRM9020 Brief User Guide	2
TNM-U-E-0044	SRM9025 Brief User Guide	2

Warnings and Cautions

WARNING

Compliance with RF Energy Exposure Standards: To minimise exposure to RF fields during equipment service and repair, the antenna terminal of the SRM9000 radio should be connected to a suitable non-radiating RF load when the transmitter is in use.

WARNING

SRM9000 radio equipment is to be connected *only* to 12-volt negative earth systems. In vehicles with a 24-volt supply, an approved 24V/12V converter must be used. The supply must not be taken from a 12V tap on the battery.

WARNING

To avoid RF injury, do not touch the Antenna when the Transmitter is in use.

WARNING

Double-fused 12V Supply Leads, Antenna cables and Speaker wiring is to be routed as far away as possible from gas or fuel lines or any electronic control device. The radio transceiver and antenna are to be mounted as far away as possible from these devices and their cabling.

Equipment is to be installed, by a competent person, in accordance with the requirements of local radio communications authorities and/or Health and Safety regulations.

Post installation checks should be performed to ensure that there is no effect on the operation of the vehicle's electronics.

WARNING

Do not operate your radio, without a handsfree kit, whilst driving a vehicle.

WARNING

Do not operate your radio in an explosive atmosphere. Obey the "Turn Off Two-way Radios" signs where these are posted, e.g. on a petrol station forecourt.

Caution

During disassembly and assembly, refer to Torque Settings in Section 1.7

Caution

Customer configuration files should be saved prior to any alignment adjustments.

Preparing the radio for alignment will erase from the radio all customer PMR and Trunking configuration data (channel, signalling information etc). The only data retained by the Alignment Tool is the factory alignment data for the radio (DAC settings for Tx power, front-end

1. INTRODUCTION

1.1 GENERAL

The SRM9000 series of FM mobile radio transceivers is designed for PMR and Trunked operation in VHF and UHF radio systems.

The system is available in a number of functional variants. Each variant uses the standard SRM9000 mobile transceiver, which is software configured for different control ancillaries. The software configuration together with the type of controller (Basic or Enhanced microphone, Handset, or Alphanumeric Control Head) determines the radio features for the different variants as follows.

	PMR/Trunked
Basic Telemetry Transceiver No Display or Control Head.	SRM9005
Low Range Version with Basic Fist Microphone.	SRM9010
Mid Range Version with Enhanced Alphanumeric Fist Microphone.	SRM9020
High-end Version with Graphics Display Handset.	SRM9022
High-end Version with Alpha Display Handset.	SRM9025
System Level Remote Control Head with Alpha capability and Handset / Fist Microphone / Desk Microphone options.	SRM9030

1.2 SCOPE

This manual provides technical specifications, description and servicing details for the SRM9000 series of mobile radio transceivers together with the related microphones and control heads.

Unless specifically stated otherwise, the text and illustrations refer to all versions in the series.

1.3 DESCRIPTION

The design concept utilises wide band analogue techniques for RF transmit and receive circuitry with digital signal processing of analogue or digital modulation and demodulation. Electronic tuning is used throughout the mobile to eliminate manual tuning and level adjustment.

A Digital Signal Processor (DSP) and a Programmable Gate Array (PLA) are used with other dedicated devices in the SRM9000 to perform the following functions under software control:

- Frequency Synthesis of all operating frequencies.
- Modulation and demodulation of 10/12.5/20/25kHz FM signals on a per channel basis.
- Modem functionality for specified data modulation schemes.
- Filtering, pre-emphasis, de-emphasis, limiting, compression, muting, CTCSS, Selcall or any other frequency or level dependent signal modification.
- Serial communications with the Control Ancillaries and Alignment Tool.
- Tuning Control data for Tx and Rx.

The SRM9000 Transceiver comprises a rugged extruded aluminium sleeve, which houses a single printed circuit board assembly and provides all heatsink requirements. The sleeve housing is closed at each end by high-impact plastic end caps; all cable ports and mechanical interfaces are sealed against moisture and dust ingress.

The PCB assembly comprises a single, multi-layer PCB containing all the RF and control circuitry. The PCB seats on an extruded aluminium tray that slides into the outer aluminium sleeve where it is secured with screws accessed from the outside of the case. Provision is made under the main PCB tray assembly for additional hardware options as well as optional accessories plugged directly into the main PCB.

There are two installation methods available for the SRM9000. The outer aluminium extrusion has side flanges that allow the mobile to be bolted directly to any flat surface in the vehicle. A quick release cradle is also available.

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1.4 PRODUCT VARIANTS AND FACILITIES

Product variants and facilities are detailed in Table 1-1, Table 1-2 and Table 1-3.

Table 0-1 Common Features for All Variants

Feature:	Model:	9005	9010	9020	9022	9025	9030
Control		None or Serial or Parallel if Option Board	Display Microphone	Display Microphone	Controller Microphone	Display Handset	Control Unit with Microphone
Display		-	1 digit LED	6 char LCD	8x14 char LCD Graphics 102x64 pixels	2x12 char LCD	8x14 char LCD Graphics 102x64 pixels
Adjustable Display Illumination		-	-	Yes	Yes	Yes	Yes
Buttons and Keys		-	Vol Up/Down Select 1 Function	Vol Up/Down 4 Function Scroll Up/Down	Vol Up/Down 6 Function 12 Keypad Send/End Menu + Scroll	Vol Up/Down 6 Function 12 Keypad Send/End Menu + Scroll	6 Function 12 Keypad Send/End Menu + Scroll
Speaker		-	Yes	Yes	Yes*	Yes*	Yes
Frequency Bands		66-88MHz, 136-174MHz, 174-208MHz, 208-245MHz, 335-375MHz, 400-480MHz, 440-520MHz					
Channel Spacing		10/12.5/20/25kHz					
Menu driven		-	-	Yes	Yes	Yes	Yes
Customisable Menus		-	-	Yes	Yes	Yes	Yes

* Note: Handsets have a built-in earpiece, therefore an external speaker is optional.

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Table 0-2 Conventional-PMR Variants

Feature:	Model:	9005	9010	9020	9022	9025	9030
Channels		1000	10	100 +	1000	1000	1000
Signalling		CTCSS/DCS	CTCSS/DCS ANI	CTCSS/DCS Selcall	CTCSS/DCS Selcall	CTCSS/DCS Selcall	CTCSS/DCS Selcall
Attack Operation		-	Yes	Yes	Yes	Yes	Yes
DTMF Encode		-	2 Fixed Seq	2 Fixed Seq	Yes	Yes	Yes
MPT1327 Trunking		Yes	Program-mable	User selectable	User selectable	User selectable	User selectable
PTT Limit Timer with warning beeps		Yes					
Busy Channel Lockout		Yes					
PTT Inhibit on Busy		Yes					
Scanning		Yes	10 groups of up to 16 channels per group.	10 groups of up to 16 channels per group, 4 user defined scan groups.	124 groups of up to 16 channels per group, 4 user defined scan groups.		
Voting		Yes	10 fixed groups consisting of up to 16 channels per group.	Up to 200 groups consisting of up to 16 channels per group.			
Priority Scanning		Yes					
Nuisance Delete		-	-	Yes	Yes	Yes	Yes
Phonebook		-	-	250 entries	250 entries	250 entries	250 entries
Multiax		Yes					
Mod/Demod Function		Option	-	-	-	-	-
Ignition Sense Input		Yes					
VOX Handsfree		Option	Option	Option	Option	Yes	Option
600 Ohm Interface		Option					
SIB							
DMAP		Option					
ASI Standard		Option					
ASI with GPS		Option					
Direct GPS		Option					
RSM with GPS		Option					
P25		Option					
Audio Discriminator		Option					

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Table 0-3 Trunked Variants

Feature:	Model:	9005	9010	9020	9022	9025	9030
Channels	1024 channels in 50 sub-bands						
Frequency Bands	Specifically: 136-174MHz, 400-450MHz (and possible in all other bands)						
Background Hunt and Vote-Now	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MPT1343 dial strings	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ANN Numbering	-	-	-	Yes	Yes	Yes	Yes
Phonebook Memories	250	10	100+	250	250	250	250
User Phonebook	Recall entries configured by FPP only	Recall entries configured by FPP only.	Recall entries configured by FPP only	Recall and edit.	Recall and edit.	Recall and edit.	Recall and edit.
Alpha Status List	-	-	Yes	Yes	Yes	Yes	Yes
SDM/EDMs	Yes	-	-	Yes	Yes	Yes	Yes
NPDs	Yes	-	-	TBA	TBA	TBA	TBA
Mod/Demod Function	Option	-	-	-	-	-	-
Attack Operation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ignition Sense Input	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VOX Handsfree	Option	Option	Option	Yes*	Yes*	Yes*	Yes*
General External IO	Option	Option	Option	Option	Option	Option	Option
600 Ohm Interface	Option	Option	Option	Option	Option	Option	Option

* Note: Requires external microphone for optimum performance.

1.5 SOFTWARE VERSIONS AND NAMING

There are various associated items of Software (SW) required for the SRM9000 radio and programmer to operate. This section simply defines the naming rules of the SW files to allow identification and conformity.

This allows different versions of SW to be distributed and co-exist without confusion.

The SRM9000 Transceiver has three items of SW for digital and analogue PMR, Trunking and Alignment.

The 9022/9025 Controller Mic/Handsets have one SW file for their PIC's and 9030 Control Head has two SW files for its Flash and EEPROM.

1.5.1 Filename Structure

Basically the Filename Structure is defined as follows:

- 2 character Application code
- 2 or 3 character SW Type code
- 3 character version number
- File Extension as required.

eg. **99tm533.bin**

99p_533.bin

99s_533.bin

99cf101.hex

99ce101.hex

1.5.2 Application Code

This identifies the application the SW was initially designed for:

9k	Standard SRM9000 Pre-Rev 9 Software
99	Standard SRM9000 Rev 9 Software
ak	SRM9000 Pre-Rev 9 Software applicable for SRP9022
a9	SRM9000 Rev 9 Software applicable for SRP9022
rw	Specific SW for Raywood Taxi Applications

1.5.3 Software Type Code

This identifies different types of SW within an application.

s_	Startup
p_	Standard PMR. DMAP or No option board
p_s	PMR with Scrambler/Discriminator option board
p_g	PMR with Direct GPS
p_a	PMR with ASI Map27option board
p_u	PMR with ASI SUP option board
p_q	PMR with ASI-G Map27option board
a__	9022 Standard PMR. DMAP or No option board
a_s	9022 PMR with Scrambler/Discriminator option board
a_g	9022 PMR with Direct GPS

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a_a	9022 PMR with ASI Map27option board
a_u	9022 PMR with ASI SUP option board
a_q	9022 PMR with ASI-G Map27option board
tm	Standard MPT1343 Trunking. DMAP or No option board
ta	Standard ANN Trunking. DMAP or No option board
tb	Basic (9010/9020) MPT1343 Trunking. DMAP or No option board
tmg	Standard MPT1343 Trunking. Direct GPS option board
tag	Standard ANN Trunking. Direct GPS option board
tbg	Basic (9010/9020) MPT1343 Trunking. Direct GPS option board
tma	Standard MPT1343 Trunking. ASI Map27 option board
taa	Standard ANN Trunking. ASI Map27 option board
tba	Basic (9010/9020) MPT1343 Trunking. ASI Map27 option board
tmu	Standard MPT1343 Trunking. ASI SUP option board
tau	Standard ANN Trunking. ASI SUP option board
tbu	Basic (9010/9020) MPT1343 Trunking. ASI SUP option board
tmq	Standard MPT1343 Trunking. ASI-G option board
taq	Standard ANN Trunking. ASI-G option board
tbq	Basic (9010/9020) MPT1343 Trunking. ASI-G option board
TBD	9022 Trunking
bo	Transceiver Boot-code
bc	Transceiver Boot-Backup-code
bf	Transceiver PLA-code
ba	Transceiver PLA-Backup-code

Note. The above file names are not stored within the code. As a consequence, when the radio is read by the FPP, the FPP will display version numbers and release dates for the Backup, Startup, PMR, TMR and DMAP codes. The Bootloader, PLA Backup and PLA codes show release dates only.

1.5.4 Version Number

This is a 3-digit number allocated by Engineering to identify the SW version.

e.g. 103 = Version 1.03

1.5.5 Exclusions

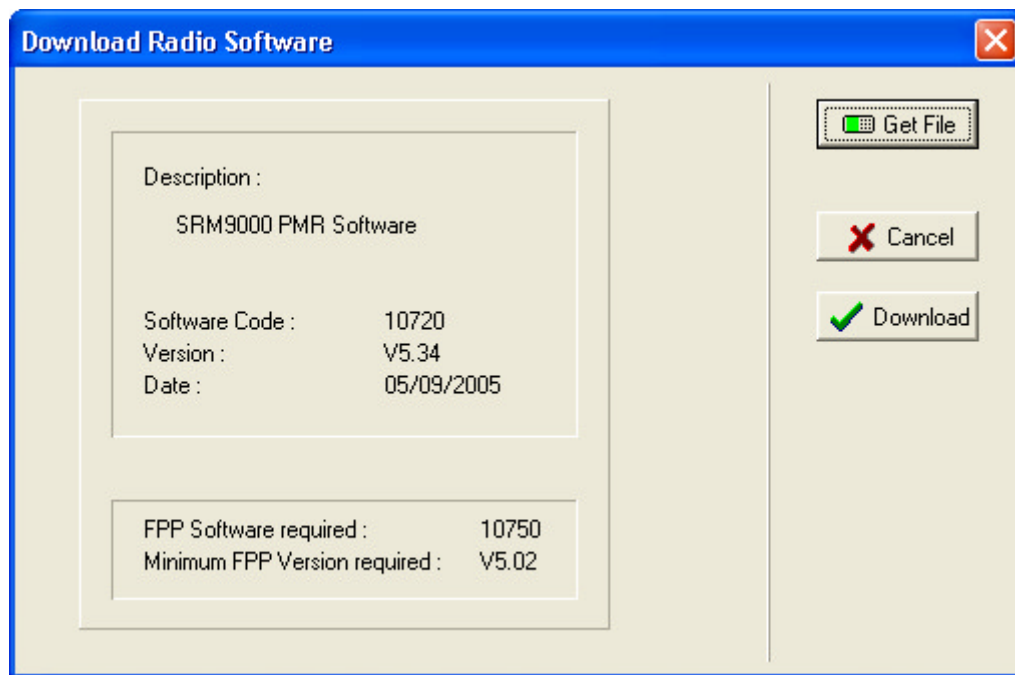
The Programmer SW does not follow the above rules as it is a PC based Program and its version number can be easily identified by starting the SW. Later releases of SW will be backward compatible, unless deliberately not so, in which case a different directory structure/path may be implemented.

1.5.6 Displaying Software Versions

Each Transceiver SW code file (e.g. 99tm533.bin, etc.) contains version information about itself and possibly compatible Programming SW.

For **Radio SW saved on Disk**, this information can be displayed via the Programmer function:

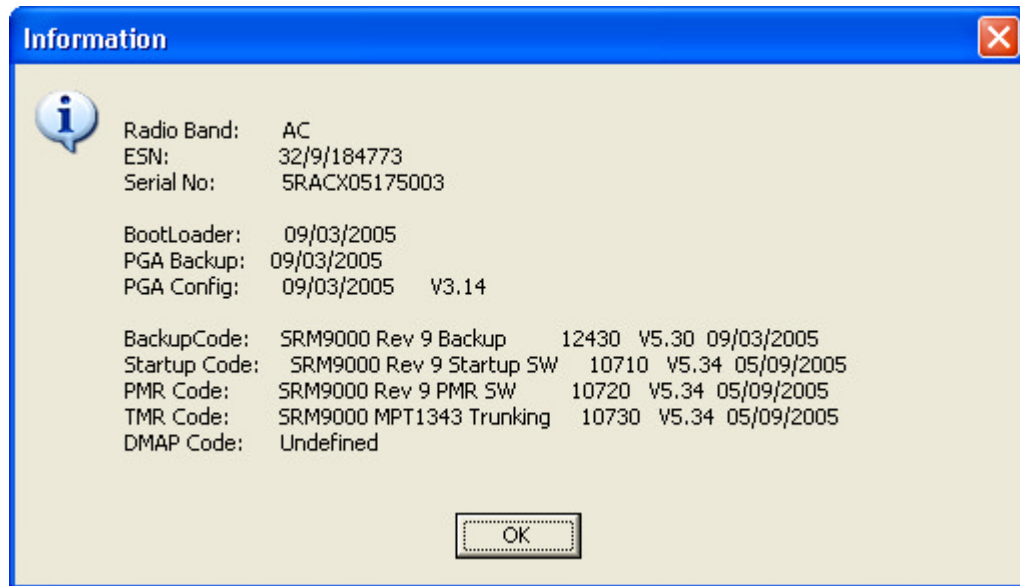
Options : Upgrade_Software : Get_File



For **Software loaded in the radio**, information can be read from the Transceiver and displayed via the Programmer function:

Options : Radio_Information

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SRM9030 Control Head SW can be displayed on the Control Head by holding the '3' button down when the radio is switched on. This is only implemented in CH V1.06 SW (Oct/2000) and later.

SRM9025 Handset SW has a similar method of Version identification.

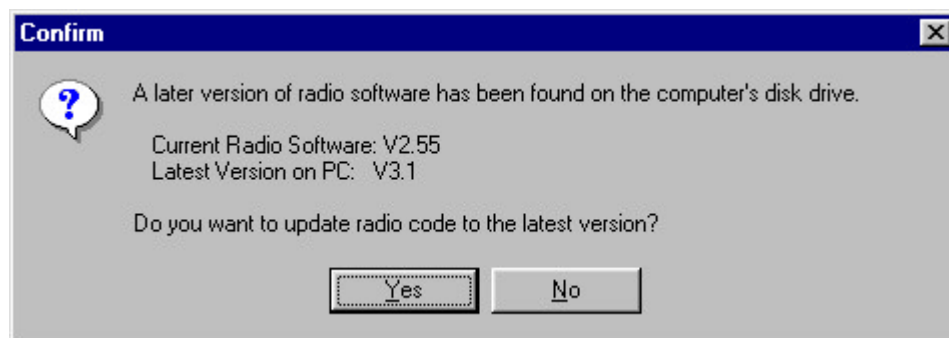
SRM9020 Microphone SW has a similar method of Version identification.

SRM9022 Handset SW can be displayed by pressing the top side button when the radio is switched on.

SRM9010 Microphone does not have any method of determining loaded SW. There is only one version of this SW in the field.

1.5.7 Automatic Version Upgrade Prompting

When a configuration is downloaded to the Transceiver, the Programmer performs a brief check on the SW currently installed in the radio. If a later version of SW exists (on PC hard-disk) then the Programmer will prompt the user with the following message:



NOTE. As early versions of FPP cannot recognise a more recent revision of the radio, it is important that the latest FPP version is downloaded from <http://www.tmcradio.com>.

If **YES** is selected, the Transceiver Radio code is updated before the new configuration is downloaded.

If **NO** is selected, only the configuration is downloaded.

This process also updates the Startup code to ensure it is compatible with the loaded PMR or Trunk code.

Note : If the ...\\SRM9000\\FPP\\RadioSW folder contains no files, then the above check will not be performed.

1.5.8 Transceiver SW Description, Start-up and Backup-Software

The SRM9000 Transceiver software is split into the following separate modules:

- Bootloader and Backup Software
- Start-Up Software
- PLA and PLA-Backup Software
- Mainline PMR Software
- Mainline Trunk Software

When the Transceiver starts, it basically performs the following steps:

- Initial execution starts with the Bootloader code, which attempts to load the Start-Up Software (if Start-Up checksum is bad, then the Backup Software is loaded.)
- Start-Up Software then downloads the PLA code (or PLA-Backup code if PLA checksum is bad) to the PLA device. If both PLA and PLA-Backup checksums are bad then the radio is not operational and serial communication is not possible.
- Start-Up Software then reads the On/Off switch plus Ignition-Sense lines and compares these with saved parameters to determine if the radio should be continue to power-up or switch itself off again.
- Start-Up software then attempts to load either PMR or Trunk Mainline Software (dependent on saved parameter) and switches execution to complete the power-up process and start normal operation.

If the Mainline Software cannot be loaded, or a Job file configuration has not been loaded (e.g. non-existent or checksum fail) then execution switches to Backup Software until the error is corrected (e.g. by FPPing the radio).

There are three states that the radio can configure after switch-on:

- Mainline Trunk Software or Mainline PMR Software (normal power-up)
If the radio does not have a valid Job file configuration loaded, then it will display a “No PMR Cfg” or “No TMR Cfg” message.
- Start-Up Software (characterised by “Alignment Mode” shown on the display). This is also the code that is running when the radio is being aligned using the Alignment Tool.
- Backup Software (via various paths from above.)

1.5.9 Wailing Siren (Boot-up Software Corrupted)

A “WAILING SIREN” sound is emitted from the Loudspeaker while the radio is running in Boot Backup Software. In this mode the FPP can be used to re-load a Jobfile, or re-load Start-Up or Mainline Operating Software.

Simply writing a Jobfile to the radio should allow the FPP to determine and update the offending software – however there may be instances where the FPP cannot determine this and the Start-Up and Mainline Software should be updated manually. This can be done using the *FPP : Upgrade_Software : Get_File ...* then *Download*. Both Start-Up Software (filename = 99s_xxx.bin) and Mainline PMR (99p_xxx.bin) or Trunk (99txxxx.bin) should be loaded if the FPP cannot automatically fix the problem. The wailing siren should stop once the problem is fixed.

Note: Should these steps fail to restore the set and the Wailing Siren cease, the radio will need to be returned to a Level 3 Service Centre for FLASH replacement.

1.6 ADJUSTMENT AND ALIGNMENT

There are no manual internal adjustments in the SRM9000. Re-programming and alignment is done using software tools with the PCB installed in its chassis. For servicing, the radio PCB can be operated as a stand alone unit provided a temporary heatsink is fitted under the transmitter PA module for transmitter

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servicing and that the receiver audio output be kept below 100mW for receiver servicing. Radio performance is not adversely affected by operating without the outer sleeve but there will be some change to performance when the metal cans are removed from the RF sections of the board.

On re-assembly, the PA module should be checked for a thin layer of heat-conducting paste. If this is missing or dried-out, it should be replaced prior to re-assembly.

1.7 CHASSIS ASSEMBLY

Important - Take Note!

1.7.1 Torque Settings

Assembly of 'Chassis' (Inner Extrusion) to 'Outer Extrusion' 1.4 Nm (PA x 2), 1.25Nm (Others x 3)

Assembly of 'Front' and 'Rear' end-caps to 'Outer Extrusion' 1.4 Nm.

1.7.2 Thermal Compound Application

For radios using a PA tray without full bottom surface with no cut-out, no thermal compound is necessary.

However, on later radios that have a tray containing a cut-out section in the bottom, just enough thermal compound should be applied to provide good thermal contact with the chassis.

Note. If thermal compound is old and difficult to spread, it should be discarded.

1.7.3 Assembly

The Inner extrusion should initially be fitted to the PCB and the assembly then slid into place within the chassis.

Then by holding the inner extrusion upwards by hand, it is then important to insert all screws by hand and ensure they have been fully inserted through the PCB, thereby locating the assembly correctly.

Still holding the inner extrusion upwards to ensure the assembly does not twist, lightly torque up the centre screw of the row of three followed by the PA module mounting screw towards the middle of the chassis.

The remaining screws can then be screwed up to full torque followed by re-torque of the first two screws again.

1.8 SPECIFICATION

1.8.1 General

Operation

Single or two frequency simplex (half-duplex).

Modulation

Frequency modulation (phase) F3E, F1D, F1E.

Operational Temperature Range

-30°C to 60°C

Supply Voltage Requirements

10.8V to 16.3V DC negative earth (13.8V nom.)

Current Consumption

	Mobile With Control Mic	Mobile With Alpha Mic	Mobile With Alpha Head
Radio off	≤ 5mA	≤ 5mA	≤ 5mA
Standby (squelched):	≤ 200mA	≤ 210mA	≤ 210mA*

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Rx Audio O/P:

300mW (not bridged)	≤ 450mA	≤ 470mA	≤ 500mA *
4.0W	≤ 1200mA	≤ 1220mA	≤ 1250mA*
Transmit:	VHF	UHF	
25W	≤ 6.5A	≤ 6.5A	
1W	≤ 1.5A	≤ 1.5A	

*Add 250mA to current consumption for Control Head with backlight on.

Frequency Bands	Frequency Range	Band	Frequency Range
E0	66 - 88 MHz	R1	335 - 375MHz
AC	136 - 174MHz	TU	400 - 480MHz
K1	174 - 208MHz	UW	440 - 520MHz
KM	208 -245MHz		

Switching Bandwidth

Radio covers the complete band without retuning

Channel Spacing

10/ 12.5 / 20 / 25kHz

Frequency Stability (-30°C to 60°C)

Less than ±2.0ppm

Dimensions (mm)	Height	Width	Depth
Transceiver	56	170	165
9010/30 Microphone	91*	62	38
9020 Alpha Display Microphone	96*	70	42
9022 Graphics Display Controller	145*	68	30
Mic	165*	52	30
9025 Alpha Display Handset	65	188	46
9030 Graphics Display Control	300	120	130
Head	200	50	40
9030 Desk Microphone			
9030 Handset			

* Does not include cable or strain relief

Weight

Transceiver 1.8kg

Conformance Approvals

ETS	EN 300 086 *
	EN 300 113 *
	EN 300 489 *
	EN 300 219 *
Australia	AS4295 *
USA	FCC (AC, UW)

* Pending in some cases

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1.8.2 Transmitter

Power Output

Any two levels programmable from
High Power: 25W Adjustable down to 1W
Low Power: 1W Adjustable up to 25W

Transmitter Rise Time

Less than 40 ms

Duty Cycle

1 minute transmit: 4 minutes receive

Spurious Emissions

< 0.25uW (9kHz to 1GHz)

< 1.0uW (1GHz to 4GHz)

Residual Noise

60% deviation. CCITT Weighted

25kHz Channel Spacing >45dB

12.5kHz Channel Spacing >40dB

Audio Frequency Distortion

≤ 3% (at 60% deviation)

Audio Frequency Response

300 to 3000Hz* +1dB -3dB

Figures apply for a flat audio response or a 6dB/octave pre-emphasis curve

(*2550Hz for 12.5kHz channel spacing)

Audio Sensitivity (1kHz)

RJ8 Connector: 40mV±2dB

(User programmable via FPP)

Option Audio: 40mV±2dB

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1.8.3 Receiver

ETS

AS4295

Sensitivity	≤0.5μV PD (-113dBm) for 20dB SINAD	≤0.3μV PD (-117.5dBm) for 12dB SINAD ≤0.5μV PD (-113dBm) for 20 dB Quieting.
Adjacent Channel Selectivity	25kHz Channel Spacing: >73dB 12.5kHz Channel Spacing: >60dB	25kHz Channel Spacing: >73dB 12.5kHz Channel Spacing: >65dB
Intermodulation Rejection	>65dB	>70dB
Spurious Response Rejection	>70dB	>73dB
Blocking	>95dB	>95dB
Conducted Spurious Emissions	<2nW (-57dBm) - 9kHz to 1GHz <20nW (-47dBm) - 1GHz to 4GHz	<20nW (-47dBm) - 9kHz to 4GHz

GENERAL

FM Residual Noise (CCITT weighted)	25kHz Channel Spacing: >45dB 12.5kHz Channel Spacing: >40dB
Mute Range	Typically 6dB to 25dB SINAD Typical setting 10dB to 12dB SINAD
Mute Response Time	<30mS (no CTCSS) Add 200mS for CTCSS
Voting Response Time	Searches at 50ms/channel
Audio Distortion	4W into 4Ω at <5% distortion
Audio Frequency Response	300 to 3000Hz*: +1dB to -3dB Figures apply for a flat audio response or a 6dB/octave de-emphasis curve (*2550Hz for 12.5kHz channel spacing)
Deviation Sensitivity (for rated audio at 1kHz)	Speaker: 20% MSD±3dB
Option Audio Output at 60% MSD (P1-23)	Standard build: Flat Unsquelched Audio: 200mV±1dB RMS-O/C (R871=NF, R872=0R, R82=NF on Rev 9C or 0R/1k on Rev 9B), Flat Squelched Audio: 450mV±2dB RMS-O/C at Rated Speaker Audio (R871=1k or 0R, R872=NF, R82=NF).
Option Audio Output at 60% MSD (P2-15)	Standard build: Flat Unsquelched Audio: 160mV±1dB RMS (600 ohms) R871=1k, R82=1k, C857=NF: Flat Squelched Audio: 88mV±2dB RMS (600 ohms) at Rated Speaker Audio.
Handset Audio (S1-6)	230mV±2dB RMS (600 ohms) at Rated Speaker Audio.

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1.8.4 Signalling

1.8.4.1 CTCSS

All 38 standard CTCSS Tones are supported as per the table below.

Identifier	Frequency	Identifier	Frequency	Identifier	Frequency
Q	67.0	C	107.2	0	167.9
R	71.9	L	110.9	1	173.8
S	74.4	D	114.8	2	179.9
T	77.0	M	118.8	3	186.2
U	79.7	E	123.0	4	192.8
I	82.5	N	127.3	5	203.5
V	85.4	F	131.8	6	210.7
A	88.5	O	136.5	7	218.1
W	91.5	G	141.3	8	223.6
J	94.8	P	146.2	9	229.1
=	97.4	H	151.4	*	241.8
B	100	X	156.7	#	250.3
K	103.5	Y	162.2	' '	NONE

Encoder

Tone Deviation:

25kHz channel spacing	500 to 750Hz
20kHz channel spacing	400 to 600Hz
12.5kHz channel spacing	250 to 375Hz
Tone Distortion	Less than 5.0%
Frequency Error	Less than $\pm 0.5\%$

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Decoder

Bandwidth	Not greater than $\pm 3.0\%$
Deviation Sensitivity	Less than 6.0% of system deviation (for decode with full RF quieting)
Noise Immunity	Less than 500ms dropout per minute at 10dB SINAD (CTCSS tone deviation 10% of system deviation. RF deviation 60% at 1000Hz).
False Decode Rate	Less than 5 false decodes per minute (no carrier input)
Talk-off	For no dropouts in one minute, interfering tone at 90% of system deviation (CTCSS tone at 10% of system deviation). Full quieting signal: 310Hz to 3000Hz 20dB SINAD RF signal: 320Hz to 3000Hz 12dB SINAD RF signal: 350Hz to 3000Hz
Response Time	Less than 250ms (full quieting/tone >100Hz) Less than 350ms (full quieting/tone <100Hz)
De-Response Time	Less than 250ms
Reverse Tone Burst	none

1.8.4.2 FFSK

1200 Baud : 1200 / 1800 Hz MPT1317 based

2400 Baud : 1200 / 2400 Hz MPT1317 based

1.8.4.3 Selcall

The following tone sets are supported as per tables below:

- ST-500: CCIR, EEA, ZVEI, DZVEI, EIA
- ST500/CML: ZVEI_3, DZVEI
- CML: CCIR, EEA, ZVEI
- SIGTEC: CCIR, CCIRH, EEA, ZVEI_1, XVEI_2, ZVEI_3, NATEL, EIA
- SEPAC: CCIR, EEA, ZVEI_1, ZVEI_2, ZVEI_3, EIA

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Selcall Tone Frequency Table

Tone	CML CCIR	ST500 CCIR	SIGTEC CCIR	SIGTEC CCIRH	SEPAC CCIR	CML EEA	ST500 EEA	SIGTEC EEA
0	1981	1981	1981	1981	1981	1981	1981	1981
1	1124	1124	1124	1124	1124	1124	1124	1124
2	1197	1197	1197	1197	1197	1197	1197	1197
3	1275	1275	1275	1275	1275	1275	1275	1275
4	1358	1358	1358	1358	1358	1358	1358	1358
5	1446	1446	1446	1446	1446	1446	1446	1446
6	1540	1540	1540	1540	1540	1540	1540	1540
7	1640	1640	1640	1640	1640	1640	1640	1640
8	1747	1747	1747	1747	1747	1747	1747	1747
9	1860	1860	1860	1860	1860	1860	1860	1860
A	2400	1055	2110	2400	2400	1055	1055	2110
B	930	....	2400	930	1055	930	....	1055
C	2247	2400	1055	2247	2247	2247	2400	2400
D	991	....	2247	991	991	991	....	2247
E	2110	2110	930	2110	2110	2110	2110	930
F	....	....	991	1055	....	....	....	991

Tone	SEPAC EEA	CML ZVEI	ST500 ZVEI	SIGTEC ZVEI-1	SEPAC ZVEI-1	SIGTEC ZVEI-2	SEPAC ZVEI-2	SIGTEC ZVEI-3
0	1981	2400	2400	2400	2400	2400	2400	2200
1	1124	1060	1060	1060	1060	1060	1060	970
2	1197	1160	1160	1160	1160	1160	1160	1060
3	1275	1270	1270	1270	1270	1270	1270	1160
4	1358	1400	1400	1400	1400	1400	1400	1270
5	1446	1530	1446	1446	1446	1446	1446	1400
6	1540	1670	1670	1670	1670	1670	1670	1530
7	1640	1830	1830	1830	1830	1830	1830	1670
8	1747	2000	2000	2000	2000	2000	2000	1830
9	1860	2200	2200	2200	2200	2200	2200	2000
A	1055	2800	970	2600	2800	970	885	2400
B	970	810	....	2800	970	885	741	885
C	2247	970	2800	741	885	741	2600	741
D	2400	886	970	2600	2600
E	2110	2600	2600	810	2600	2800	970	2800
F	886	600	600

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Tone	SEPAC	ST500/CML		ST500	SIGTEC	SIGTEC	SEPAC	ST500
	ZVEI-3	ZVEI-3	DZVEI	DZVEI	NATEL	EIA	EIA	EIA
0	2200	2400	2200	2200	1633	600	600	600
1	970	1060	970	970	631	741	741	741
2	1060	1160	1060	1060	697	882	882	882
3	1160	1270	1160	1160	770	1023	1023	1023
4	1270	1400	1270	1270	852	1164	1164	1164
5	1400	1530	1400	1400	941	1305	1305	1305
6	1530	1670	1530	1530	1040	1446	1446	1446
7	1670	1830	1670	1670	1209	1587	1587	1587
8	1830	2000	1830	1830	1336	1728	1728	1728
9	2000	2200	2000	2000	1477	1869	1869	1869
A	885	885	2600	825	1805	459	2151	2151
B	741	....	....	....	1995	2151	1091	....
C	2600	810	886	2600	1300	2600	2400	2010
D	....	....	810	....	1700	2010	....	....
E	2400	970	2400	2400	2175	2433	459	459
F	....	....	....	....	2937	2292	....	....

Selcall Tone Periods

The Selcall tone period:

4 preset lengths selectable: 20ms and 30 seconds in 1ms increments.

1.8.4.4 DTMF

DTMF Encode supported via keypad:

TONES	1209Hz	1336Hz	1477Hz
697Hz	1	2	3
770Hz	4	5	6
852Hz	7	8	9
941Hz	*	0	#

Tone Period, programmable: 0 – 2.55s in 10ms steps.

Inter-Tone Period, programmable: 0 – 2.55s in 10ms steps.

Link Establishment Time, programmable: 0 - 10s in 10ms steps.

Tx Hang Time, programmable: 0 – 9.99s in 10ms steps.

Side-Tone in Loudspeaker: selectable via programmer

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1.8.4.5 DCS

Data rate	134 bits per second, frequency modulated 7.46ms/bit 171.6ms per codeword continuously repeating
Deviation	0.5kHz for 12.5kHz systems 1kHz for 25kHz systems
Codeword size	23 bits comprising: 8 bits - DCS code (3 octal digits 000-777) 3 bits - Fixed octal code 4 11 bits - CRC (error detection) code
Available Codes	104 codes from 512 theoretically possible codes – see below
Turn off code	200ms 134Hz tone at PTT release

DCS Codes can be Transmitted “Normal” or “Inverted” (programmable).

The radio can Receive DCS codes in either Transmitted “Normal” or “Inverted” or both (selectable via programmer).

Valid DCS Codes				
023	132	255	413	612
025	134	261	423	624
026	143	263	431	627
031	145	265	432	631
032	152	266	445	632
036	155	271	446	654
043	156	274	452	662
047	162	306	454	664
051	165	311	455	703
053	172	315	462	712
054	174	325	464	723
065	205	331	465	731
071	212	332	466	732
072	223	343	503	734
073	225	346	506	743
074	226	351	516	754
114	243	356	523	
115	244	364	526	
116	245	365	532	
122	246	371	546	
125	251	411	565	
131	252	412	606	

1.8.4.6 C4FM

Digital speech format in accordance with TIA/EIA 102 requirements.

1.8.5 Environmental

Note: Operation of the equipment is possible beyond the limits stated but is not guaranteed.

Operational Temperature

-30°C to +60°C

Storage Temperature

-40°C to +80°C

Vibration Specification

IEC 68-2-6 with additional frequency acceleration from 60 – 150Hz

Check

Cold

IEC 68-2-1 Test 5 hours at -10°C –30°C

Dry Heat

IEC 68-2-2 Test 5 hours at +55°C +60°C

Damp Heat Cycle

IEC 68-2-30 Test 2 cycles at +40°C

Product Sealing

Main Radio Unit: IEC529 rating IP54

Microphones: IEC529 rating IP54

Remote Control Head IEC529 rating IP54

MIL STD810

Low Pressure	500.4 Procedure II
High Temperature Storage	501.4 Procedure I
High Temperature Operation	501.4 Procedure II
Low Temperature Storage	502.4 Procedure I
Low Temperature Operation	502.4 Procedure II
Temperature Shock	503.4 Procedure I
Humidity	507.4 Figure 507.4-1
Sand and Dust	510.4 Procedure I – Blowing Dust
Random Vibration	514.5 Figure 514.5C-1
Transit Drop	516.5 Table 516.5-V1
Functional Shock of severity 25g Acceleration, 6ms pulse duration, 500 shocks in 6 directions.	

2. SERVICE PHILOSOPHY

2.1 SERVICE CONCEPT

The SRM9000 series has been designed to provide low cost trunked, non-trunked analogue and digital speech mobile transceivers, using common core electronics, software and interfacing. It is a requirement that once the customer has purchased equipment, TMC Radio can follow this by providing an ongoing, high level of customer support together with a competitive and professional servicing activity.

There are three levels of service available:

Level	Activity	Recommended Spares	Recommended Test Equipment
1	Replacement of complete transceiver/antenna/fuses Reprogramming	Antennas, Fuses Ancillaries	Multimeter P.C. Radio software Programmer
2	Replacement of PCB or mechanical component replacement, Cosmetic repair	Listed in Level 2 Spares Schedule	As above + service aids and test equipment
3	Repair by PCB or mechanical component replacement, Cosmetic repair. Repair of Radio PCB to component level in CRU.	Listed in Level 2 Spares Schedule Radio PCB components only available to CRU.	As above + service aids and test equipment

2.2 WARRANTY

Initially, the normal 12-month warranty will apply to all radios and ancillaries.

2.2.1 Service Within and Out Of Warranty

The field Service Level for the SRM9000 mobile is LEVEL 2, PCB replacement.

LEVEL 2 Service, PCB (only) and case part replacement, will be carried out in field repair workshops, or the Central Repair Unit (CRU) if required.

LEVEL 3 Service (Radio PCB component level repair) will ONLY be carried out in the Central Repair Unit. For this, the complete radio must be returned to the CRU.

A PCB replacement program may be offered by the CRU in some countries.

2.2.2 Ancillary Items

All ancillary items (except remote alphanumeric control head) are Level 1 service.

These items should be replaced if faulty; they are non-repairable, and non-returnable to the CRU.

2.3 SOFTWARE POLICY

Software provided by TMC Radio shall remain the Company's property, or that of its licensors and the customer recognises the confidential nature of the rights owned by the Company.

The customer is granted a personal, non-exclusive, non-transferable limited right of use of such software in machine-readable form in direct connection with the equipment for which it was supplied only.

In certain circumstances the customer may be required to enter into a separate licence agreement and pay a licence fee, which will be negotiated at the time of the contract.

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The customer undertakes not to disclose any part of the software to third parties without the Company's written consent, nor to copy or modify any software. The Company may, at its discretion, carry out minor modifications to software. Major modifications may be undertaken under a separate agreement, and will be charged separately.

All software is covered by a warranty of 3 months from delivery, and within this warranty period the Company will correct errors or defects, or at its option, arrange free-of-charge replacement against return of defective material.

Other than in the clause above, the Company makes no representations or warranties, expressed or implied such, by way of example, but not of limitation regarding merchantable quality or fitness for any particular purpose, or that the software is error free, the Company does not accept liability with respect to any claims for loss of profits or of contracts, or of any other loss of any kind whatsoever on account of use of software and copies thereof.

3. TECHNICAL DESCRIPTION

3.1 RECEIVER

Refer to Figure 3-1.

3.1.1 Front End Filters and RF Amplifier

The receiver input signal from the antenna passes through the harmonic filter and antenna switch. With the mobile in receive mode, diodes D580, D540a and D541a in the antenna switch are reverse biased allowing the receiver input signal to be coupled through to the receiver front-end with minimal loss. The overall insertion loss of the harmonic filter and switch is approximately 0.8dB.

A noise blanker is also fitted to E0 band radios. The noise blanker samples the received signal and gates the 45MHz signal in the IF stage in the event that high level noise transients are received. Due to inherent time delays in the bandpass filters prior to the blanking gate, gating synchronisation occurs before the transients can adversely affect the following stages.

Varactor-tuned bandpass filters at the input and output of the RF amplifier provide receiver front-end selectivity. Varactor tuning voltages are derived from the alignment data stored in the radio. The DSP processes this data to optimise front end tuning relative to the programmed channel frequencies, which may be changed at any time without re-aligning the radio.

To achieve the required varactor tuning range an arrangement of positive and negative bias power supplies is used to provide a total bias across the varactors of up to 14.0VDC. A fixed 2.5V positive bias derived from the 5.0V supply and voltage divider R425/R426 is applied to the cathodes of the varactor diodes. The negative bias supply originates at the DSP/PLA as a PWM signal (FE TUNE) for the four front-end tuning voltages TUNE1 to 4, for the particular channel frequency selected. The PWM signal is dependent on channel frequency and tuning and passes through level shifting transistors Q404 to Q411 where it is converted to a negative voltage in the range -0.5V to -11.5V. The -12.0V rail of the level translators is generated by U904E/F with D903 to D906 providing the required voltage multiplication.

The RF amplifier stage comprises a low noise transistor amplifier Q400 that is compensated to maintain good linearity and low noise matching. This provides excellent intermodulation and blocking performance across the full operating range. The overall gain of the front-end is typically 14dB for all bands.

3.1.2 First Mixer and IF Section

The output of the last front-end bandpass filter is coupled into single balanced mixer T400/D413 which converts the RF signal to an IF frequency of 45MHz. The local oscillator injection level is typically +8dBm at T400 pin 1 with low side injection used for UHF bands and high side for VHF bands.

Following the mixer is IF amplifier Q401 that provides approximately 15dB of gain and in association with its output circuitry, presents the required load conditions to the 4 pole 45MHz crystal filters Z401A/Z401B.

The crystal filters provide part the required selectivity for adjacent channel operation with the remaining selectivity provided by a DSP bandpass filter algorithm.

3.1.3 Quadrature Demodulator

Additional IF gain of approximately 44dB occurs in U401, which is a dedicated IF AGC amplifier/Quadrature Demodulator. The AGC voltage for U401 is derived from the RSSI function of the DSP. The onset of AGC operation occurs when RF input signal level at the antenna connector exceeds -90dBm and can reduce the gain by approximately 100dB for strong signals.

Conversion of the 45MHz IF signal to I and Q baseband signals is carried out by the demodulator section of U401. The 90MHz local oscillator signal is generated by VCO Q402 which is phase locked by the auxiliary PLL output of U701 via feedback signal AUX_LO2.



3.1.4 Receiver Audio Processing

The base band audio from the IQ Demodulator is applied to a differential amplifier that cancels out DC offsets and converts the balanced demodulator I/Q output signals to unbalanced inputs for the CODEC U800.

All receiver audio processing and filtering functions are performed by the CODEC under the control of the DSP. The receiver I and Q analogue baseband signals are converted to digital signals by the CODEC ADC before being applied to a series of digital filters which provide the final stage of adjacent channel filtering, high pass and low pass filtering, mute noise processing and volume control for narrow and wideband operation. The fully processed signal is then converted to an analogue audio signal by the CODEC DAC and then applied to conventional audio amplifiers U803A/B and the speaker amplifier U805.

In addition, Discriminator Audio is derived from the other CODEC output channel and then amplified by U802A after which it is applied to one of the radio I/O connectors for option purposes. Discriminator Audio is a preset level set by the FPP and is independent of squelch operation.

There are two speaker options available. A half bridged configuration using a speaker across balanced output SPKR OUT1 and 2, which provides an audio output level of up to 4 watts into 4 ohms. The other option is a full bridge configuration using a high power speaker across SPKR OUT1 and 2 and providing an audio output level of up to 10 watts into 8 ohms. The carrier and signalling mute functions are performed by Q810/811/813 under DSP control. De-emphasis to the audio PA U805 is performed by R861 and capacitors C866 to C871. Flat audio is provided to S1-6 via amplifier U803A.

3.2 TRANSMITTER

Refer to Figure 3-2.

3.2.1 Drivers and PA Stages

The RF output level from the VCO T/R switch D611a is typically +5dBm (UHF) and +8dBm (VHF). Tx buffers Q606/Q612 increase this level to provide approximately 10dBm of drive power to the Tx driver Q571. The Tx driver stage provides a maximum of 17dBm of drive to the PA module and provides part of the power control function in conjunction with the first stage of the PA module. The buffer/driver circuits in conjunction with their attenuator circuits also provide a high degree of VCO isolation from the Tx output.

The gains of PA driver Q571 and PA module are controlled by the power control loop to ensure that transmitter output power remains within defined limits.

PA module U500 utilises three MOSFET stages (UHF) and two MOSFET stages (VHF) to achieve the required maximum RF output power level of +44dBm (25 watts).

Note. Care should be taken during servicing since if for any reason the drive power is lost, while the power control voltage is high, the current into the PA may exceed its specification. Therefore, the power supply current should be monitored at all times and preset to as low as required. The radio has additional inbuilt safeguards, but these should not be relied on.

Power output settings are derived from alignment data stored in flash memory during the initial factory alignment. The DSP processes this data to optimise the power output level relative to the programmed channel frequencies that may be changed at any time without retuning the radio.

PA current is monitored via comparator U520B, the output of which is passed via a temperature compensation network R541 to R543 to ADC U301C. U301C samples the applied voltage after which it is passed to the PLA and then processed by the DSP.

3.2.2 Power Control

Output power is stabilised by a power control feedback loop. A printed circuit transmission line, L580, R580, D510 and associated components comprise the power detector. Comparator U520A and associated components provide the power setting and control functions. Forward and reverse power is sampled by the power detector and applied as a DC voltage to the inverting input of the comparator. The TX_PWR set voltage is a DC voltage proportional to the programmed Tx power setting and is applied to the non-inverting input of the comparator.

The TX_PWR voltage originates from the PLA as a PWM signal and is integrated for application to the comparator.

PA module output level changes due to supply voltage, load or temperature variations are detected and applied to the comparator that proportionally adjusts the PA module bias supply and the PA driver (Q571) supply, and therefore the PA drive level. High temperature protection is provided by thermistor R552 that progressively reduces the power level if the PA module temperature becomes excessive.

3.2.3 Antenna Changeover and Harmonic Filter

The antenna changeover circuit consisting of pin diodes D580/D540a/D541a, is switched by Q541/Q542/Q543 and associated circuitry allowing the transmitter output to be coupled to the antenna while providing isolation for the receiver input. With the transmitter switched on, the diodes are forward biased allowing power to be coupled through to the antenna and isolating the receiver by grounding its input at C588. The short circuit at the receiver input is transformed to an effective open circuit at D580 by L583, which minimises transmitter loading. With the transmitter switched off the diodes are reverse biased allowing the receiver input signal to reach the receiver front end with minimal loss. The harmonic rejection low pass filter comprises L582/L584/L585 and associated capacitors.

3.2.4 Transmitter Audio Processing

The microphone audio input signal is applied to the microphone input (AUDIO_IN1) and is derived from an external microphone unit with an applied nominal level of 40mV RMS. U801A is a control gate that switches between AUDIO_IN1 and OPTION_AUDIO1 to provide external audio options and data input.

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U801C provides CODEC input switching which selects either the receiver I signal or transmitter audio/data signals depending on the Tx/Rx mode. All pre-emphasis, filtering, compression and limiting processes for narrow and wideband operation are carried out in the DSP after A-D conversion by CODEC U800. The processed transmitter audio/data from the CODEC output at VOUTR is applied to the VCO as a modulation signal with a level of approximately 200mV P/P via AF Switch U801B.

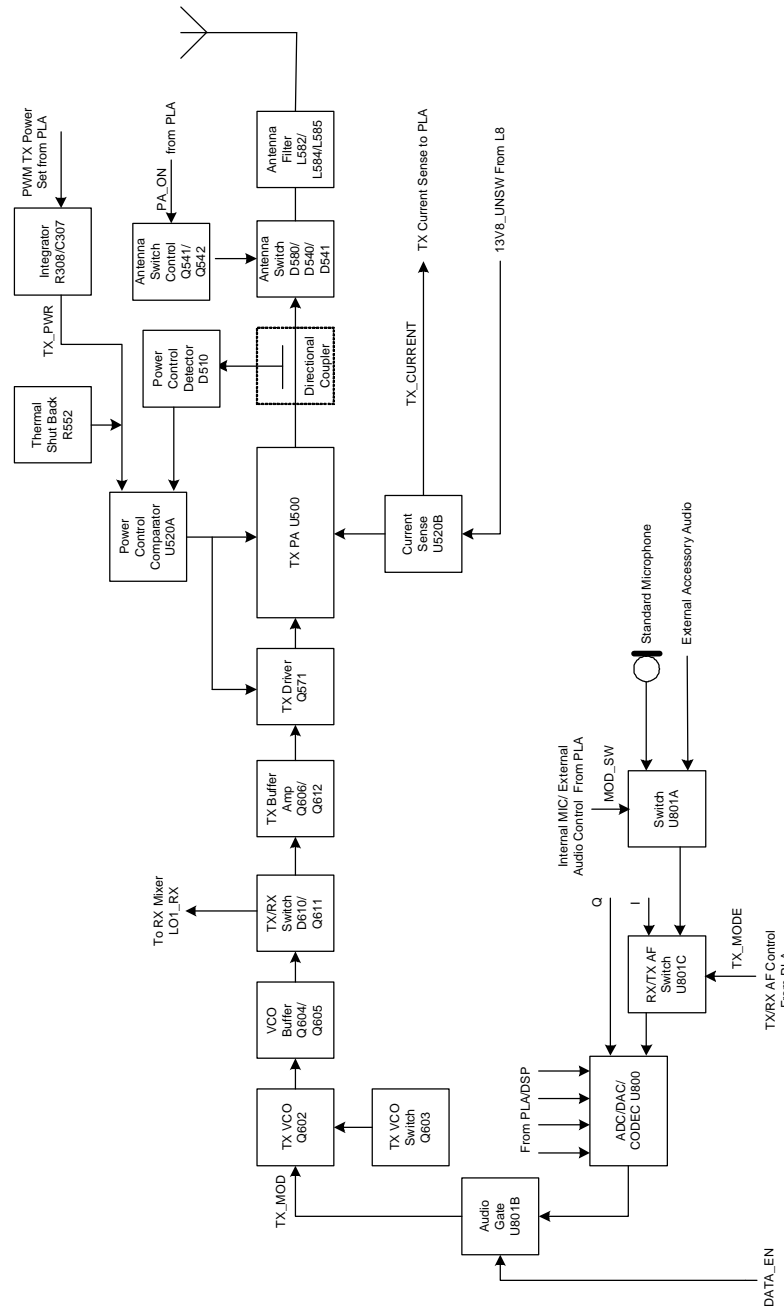


Figure 3-2 VHF/UHF Transmitter Block Diagram

3.3 FREQUENCY SYNTHESISER

3.3.1 General

Refer to Figure 3-3.

The frequency synthesiser consists of one transmitter and two receiver voltage controlled oscillators, loop filters, varactor negative bias generator, reference oscillator and an integrated dual phase locked loop device U701.

3.3.2 PLL

The PLL device contains two prescalers, programmable dividers and phase comparators to provide a main and auxiliary PLL. The main PLL of U701 controls the frequency of the Tx/Rx VCOs via Control Voltage outputs at pins 2 and 3 and VCO feedback to pin 6. The auxiliary PLL is used to control the receiver 90MHz second local oscillator via the Control Voltage output at pin 17 and VCO feedback to pin 15. The PLL operation involves the division of the 14.4MHz reference oscillator frequency to 225kHz (VHF) or 450kHz (UHF) by divider U710. It is then divided by the internal divider of U701 down to a low frequency that corresponds to a sub-multiple of the radio channel spacing, ie. 6.25kHz for 12.5/25kHz channel spacing, 5kHz for 10/20kHz channel spacing or 7.5kHz if required. The VCO frequency is sampled and divided down to the same frequency after which it is phase compared to the reference. Any error produces an offset to the Control Voltage output that is used to correct the VCO frequency. A valid lock detect output is derived from pin 20 and is sampled by the PLA. During transmit, if an unlocked signal is detected the radio will switch back to receive mode. An unlocked signal in receive mode will cause the radio to beep.

3.3.3 VCO's

The transmitter and receiver VCO's use low noise JFET transistors Q600 (Rx), Q602 (Tx) and associated parts to generate the signals for the required band coverage. Electronic tuning is provided by varactor diodes D600 to D608 with their control voltages derived from the Loop Filter, PLL and Negative Bias Generator. VCO selection and timing is controlled by the DSP/PLA via the Rx and Tx power supplies and applied through switches Q601 (Rx) and Q603 (Tx). VCO buffer Q604/Q605 isolates the VCO from load variations in following circuits and active power supply filter Q615 minimises supply related noise. A PLL feedback signal is sampled from the VCO buffer output via buffer Q607.

The 90MHz receiver VCO comprises Q402 and associated parts. Automatic tuning is achieved by applying a control voltage to D414/D415 via Loop Filter R445, R446, R701, C486, C701 and C702.

3.3.4 Negative Bias Generator and Loop Filter

A positive and negative varactor bias supply similar to the front-end varactor arrangement has been used to achieve the required broadband tuning range of the VCO's. PLL device U701 is programmed to deliver a nominal +2.5V output from phase detector/charge pump CPPF or CPP regardless of the channel frequency selected. This voltage is filtered to remove synthesiser noise and reference products by the Loop Filter comprising C671 to C681 and R653/R654/R655. The resulting low noise voltage is applied to the cathode side of the VCO varactor tuning diodes as a positive bias voltage. The negative bias supply originates as a positive DC voltage (0.1V to 3.0V) at the DAC output of U701 (DOUT) with a level relative to the programmed state of the radio (eg. channel frequency and Tx/Rx state). The voltage is translated to a negative voltage between 0V and -16V by the circuit comprising Q700 to Q703. The -16V rail of this supply is generated by U904E/F with D903 to D906 providing the voltage multiplying effect needed to achieve -16V. The output of the negative supply is applied directly to the VCO varactor anodes as the negative tuning voltage VCAP BIAS.

3.3.5 Phase Modulator

The modulation path for audio, data and higher frequency CTCSS signals is via varactor D609 and its associated components in the Tx VCO. The reference input to the PLL (REF) provides the low frequency modulation path via the Phase Modulator.

The phase modulator comprises the following sections:

- Integrator U711A is a low pass filter providing 6dB per octave attenuation to frequencies above approximately 10Hz.
- Divider U710 divides the 14.4MHz reference frequency down to 225kHz (VHF) or 450kHz (UHF).
- Ramp generator Q711/Q712 provides a saw tooth output, the slope of which is adjustable via the MOD_BAL line. This adjustment is set via a DAC output controlled from the Alignment Tool. Adjustment of the ramp slope effectively changes the Phase Modulator gain by modification of the Schmitt Trigger switching points after modulation from the Integrator is combined to the saw tooth ramp.

- Schmitt Trigger comprising Q714 to Q716 converts the modulation combined with the saw tooth ramp to a square wave output, the duty cycle of which is controlled by the ramp slope and modulation.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 84

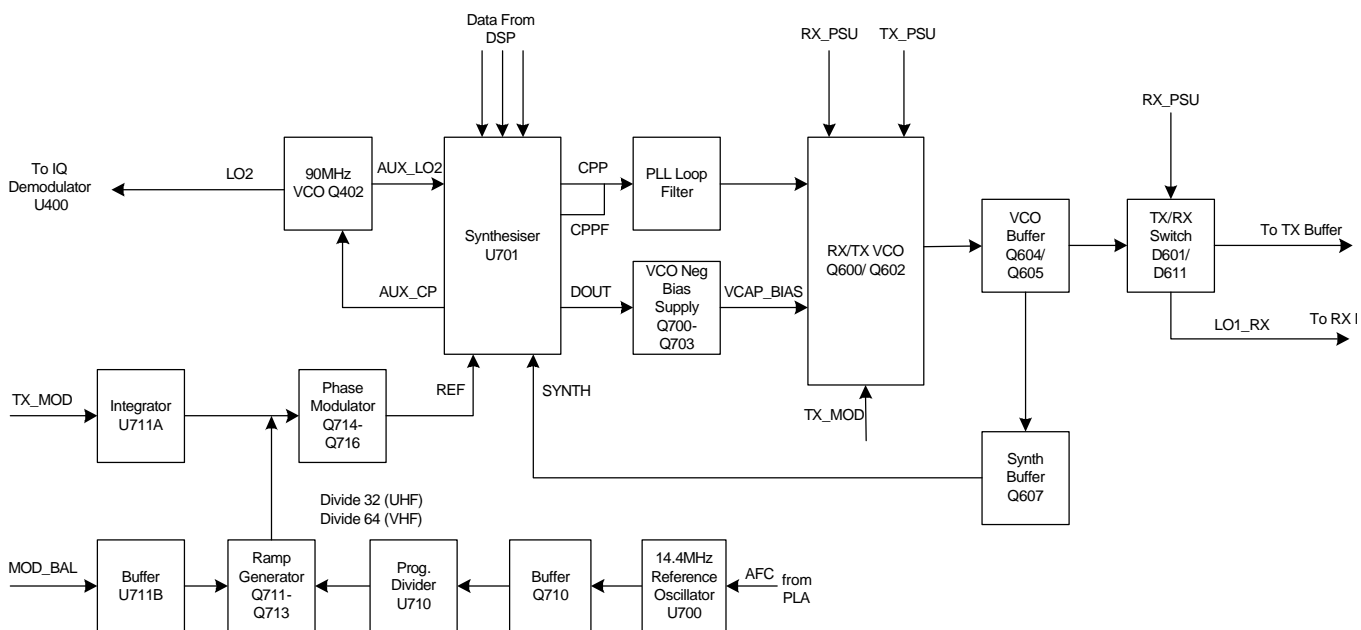


Figure 3-3 VHF/UHF Synthesiser, Block Diagram

3.4 CONTROL

Refer to Figure 3-4.

3.4.1 DSP and PLA

The SRM9000 transceiver operates under the control of a DSP (U201) and PLA (U300) combination that together with a number of other dedicated devices perform all the operational and processing functions required by the radio. The PLA is configured by the DSP under software control to provide the following functions:

- Channel set-up of all operating frequencies
- Modulation processing and filtering
- De-modulation processing and filtering
- Tx power output reference

- Modulation Balance adjustment
- Receiver front-end tuning
- Serial communications with alignment tool, microphone and control head
- Modem functionality for data modulation
- All signalling / CTCSS generation and decoding
- DSP Crystal Oscillator control
- Receiver muting control
- RSSI / AGC control
- AFC
- Tx / Rx switching and PTT control
- PLL lock detect
- Audio switching
- Power On/Off control
- Interface functionality with Option Boards and External Devices
- Battery voltage and Tx current monitor

3.4.2 DSP Clock Oscillator

The DSP is clocked by a 15.360MHz oscillator that consists of crystal X200 and an internal DSP oscillator. Q200 forms a crystal switching circuit with C205 which, when activated by a command from the PLA, steers the oscillator away from potential interfering frequencies.

3.4.3 PLA PWM

The PLA must supply several analogue signals to control radio tuning. It does this with several Pulse Width Modulated (PWM) outputs.

The front-end tune signals (TUNE1-TUNE4) originate from the PLA in the form of PWM signals. The values for these signals are stored in flash memory from radio alignment and selected depending on the channel that the radio is currently tuned to. These signals are integrated by RC networks to provide the analogue tuning voltages that are then applied to the tuning varicap diodes.

Other analogue PWM derived signals used are transmitter power (TX_PWR), receiver AGC voltage (AGC), LED's (RED/GREEN) and modulation balance (MOD_BAL).

Analogue inputs are monitored by four comparators comprising U301A-D and a ramp generator, the ramp being derived from a PWM signal from the PLA.

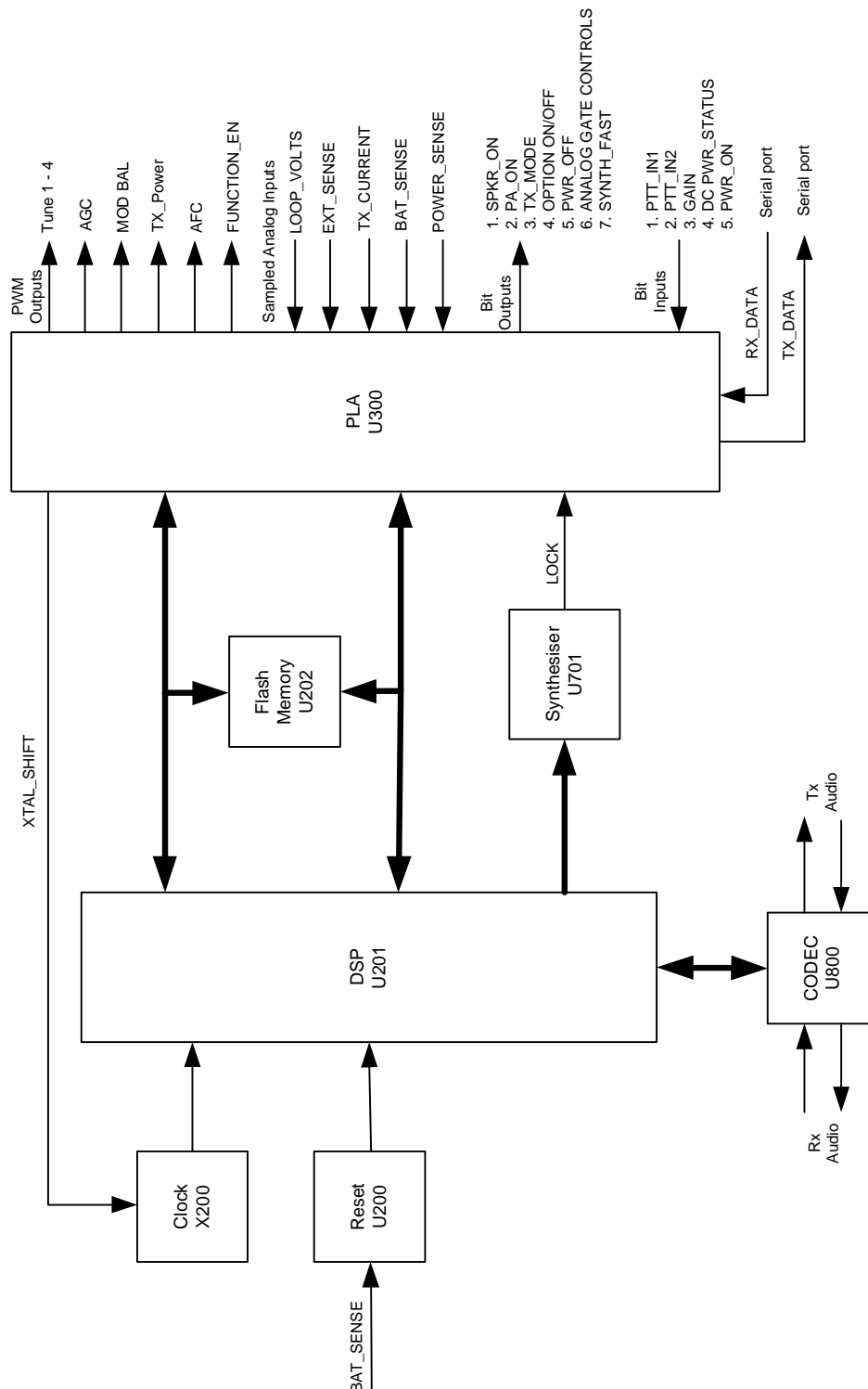
Analogue voltages to be monitored such as PLL Loop Voltage (LOOP_VOLTS), key detect (KEY_DET), battery voltage (BAT SENSE), transmitter current (TX_CURRENT), volume level (VOLUME) and external sense (EXT_SENSE) are connected to the inverting inputs. The analogue voltages are compared with the ramp voltage as they increase and the comparator switches at the point where the input voltage exceeds the ramp. The PLA compares the time that this occurs with the PWM signal and converts it to a binary value.

3.5 MEMORY

Memory consists of the internal DSP memory and an external 8MB non-volatile Flash Memory U202. When power is off, all program SW and data are retained in Flash Memory. At power-on, a boot program downloads the DSP and PLA SW from Flash Memory to their internal RAM's for faster program execution and access to data. PLA SW is loaded by the factory into the Flash Memory and can be updated via the

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Alignment Tool. DSP SW comprises Start-up code that is also loaded by the factory. High-level SW comprising Operational Code and Customer Configuration are loaded at distribution centres and are loaded via the FPP Programmer.



UPDATE Figure 3-4 Controller Block Diagram

3.6 POWER SUPPLIES

3.6.1 Power On Function

The unregulated 13.8V DC input (13V8_UNSW_F) is routed directly to all high current devices and is then switched via FET Q900 to provide BAT_SW supply for all other circuits. The output from Q900 feeds three low dropout series regulators and switched battery voltage. These regulated supplies power auxiliary supplies as well as the negative voltage generator. The radio ON/OFF function is achieved through Q902, Q908 and Q909. A low voltage pulse from the control unit or microphone handset PWR ON or PWR OFF momentarily turns on Q900/Q908 for approximately 1 sec. In this time, the radio DSP samples the PWR_SENSE line and determines the state of the on-off switch. If the on-off switch is on, the DSP raises the PWR_OFF line and latches the main FET on, which then maintains power to the radio circuitry.

The Power-off operation requires the On-Off switch to be turned off for more than 2 seconds. If the On-Off switch is sensed going low by the DSP via the PWR_SENSE line, the DSP will save radio settings and then lower the PWR_OFF line, thereby turning Q900 off.

3.6.2 Power Supplies

The following is a list of the SRM9000 power supplies and some of the devices and circuits they supply.

3.6.2.1 8V Regulator U900

Regulated 8.0V supply (8V0 and +8V)

- Tx buffers Q571, Q612
- VCO's and VCO buffers via active filter Q615
- Rx second local oscillator via Q403

Regulated 8.0V switched supply (Rx PSU)

- Rx front end
- IF Amplifier
- Various switching functions

3.6.2.2 5V Regulator U901

Regulated 5.0V supply (5V0 and +5V)

- Rx front end varactor positive bias
- Synthesizer buffer Q607
- VCO varactor negative supply Q700 to Q703
- TCXO U700
- TCXO divider U710
- Rx audio amplifiers U802/U803
- Rx mute switch Q810 to Q813
- FE TUNE level translators, Q404 to Q411
- Analogue supply for U701

Regulated 5.0V switched supply (Tx PSU and Tx PSU+)

- Tx power control U520
- Tx buffer Q606
- Various switching functions

3.6.2.3 3.3V Regulator U912

Regulated 3.3V supply (3V3)

- Reset U200
- PLA U300
- DSP U201
- Flash U202
- Digital supply for CODEC U800

Regulated 3.3V supply (3C3)

- Analogue supply for CODEC U800

Regulated 3.3V supply (3Q3)

- I/Q demodulator U401

Regulated 3.3V supply (3P3)

- Digital supply for PLL U701

Unregulated 13.8V (13V8_UNSW_F)

- Tx PA module U500
- Antenna changeover switch Q541/542/543
- Rx mute switch Q811
- Rx audio power amplifier U805

3.6.2.4 2.5V Regulator U903

Regulated 2.5V supply (2V5)

- DSP core U201
- PLA core U300

3.6.2.5 Negative Power Supply U904E/F

- -16V output (-16V) for VCO Varicap tuning drivers
- -12V Output (-12V) for Front end Varicap tuning drivers

3.6.2.6 Unswitched Battery (13V8_UNSW_F)

- Transmit Power Amplifier
- Speaker Amplifier

4. ALIGNMENT (LEVEL 3 SERVICE ONLY)

This procedure is applicable to all versions of **SRM9000** mobile transceivers.

Caution

Preparing the radio for alignment will erase from the radio all customer PMR and Trunking configuration data (channel, signalling information etc). The only data retained by the Alignment Tool is the factory alignment data for the radio (DAC settings for Tx power, front-end tuning, etc).

Using the Alignment Tool will allow changes to the original factory alignment and will invalidate all warranties and guarantees unless performed by an authorised level 3 service centre.

If the radio contains customer configuration data that must be retained, you **must first** use the SRM/SRP Personality Programmer (FPP) software to read all radio configuration files and save them on to alternative media **before** commencing the alignment procedure.

When the Alignment is completed, use the FPP software to retrieve this stored data and write it back to the radio.

It is preferred that the radio remain installed in its aluminium extruded case throughout this alignment procedure. If the radio is to be aligned when removed from the case, a temporary heat sink must be fitted under the Transmitter PA module and the receiver output must be kept below 100mW.

Note. Final Tx power adjustments must be performed with the radio board installed in the chassis.

4.1 TEST EQUIPMENT

- | | |
|---|---|
| 1. Radio transceiver test set | CMT, 52/82 or similar.

Note. For alternative equipment, the Mod Balance test requires internal DC coupling between the demodulated signal and demodulation output connector. |
| 2. Variable DC power supply | 10.8V to 16.3V current limited to 7 amps |
| 3. Oscilloscope | 20 MHz bandwidth minimum |
| 4. SRM9000 Programming & Alignment Breakout Box | As detailed in Figure 4-1 |
| 5. SRM9000 Speaker O/P Breakout Box | As detailed in Figure 4-2 |
| 6. Personal Computer | 486 DX 66 or better.

Operating system Windows 95 or later.
Minimum RAM - 16MB.
5MB free hard disk space.
Floppy drive - 1.44MB.
Mouse and serial port required |
| 7. SRM/SRP Alignment Tool | Computer Software file |
| 8. SRM/SRP Field Personality Programmer (FPP) | Computer Software file |

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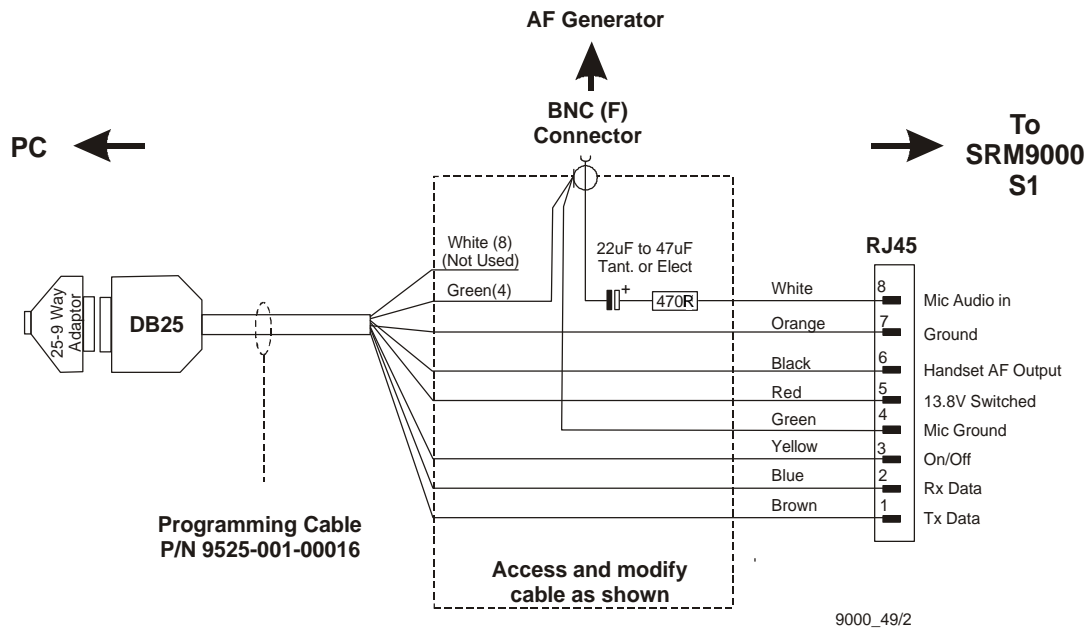


Figure 4-1 SRM9000 Programming & Alignment Breakout Box

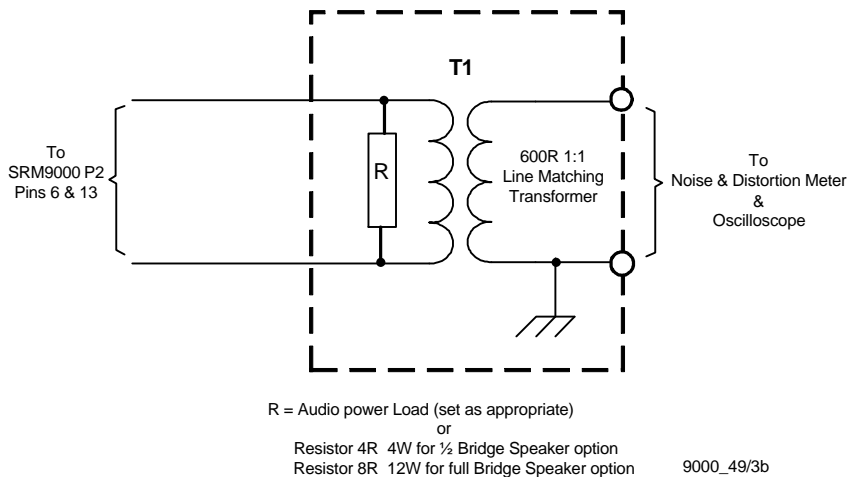
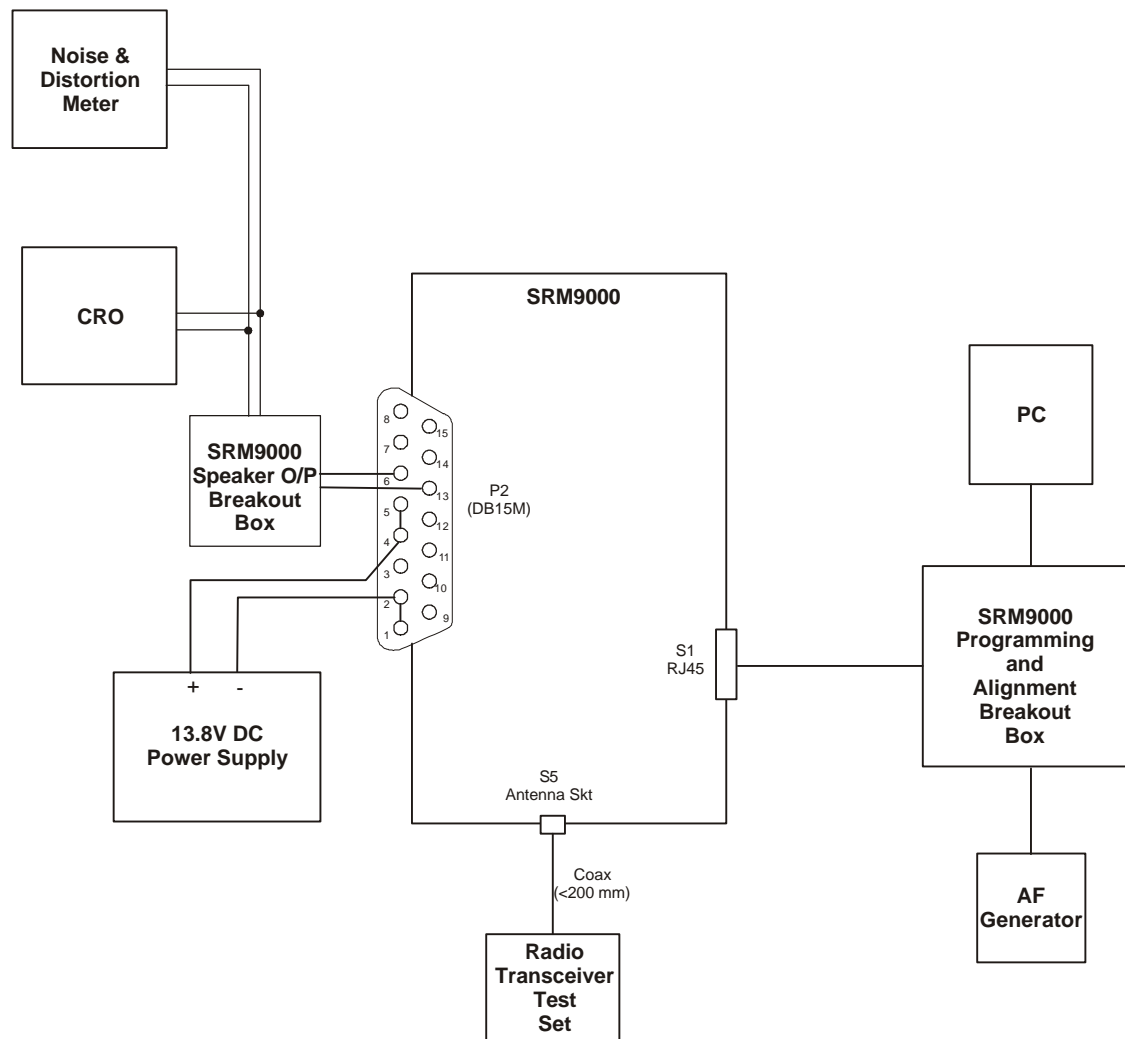


Figure 4-2 SRM9000 Speaker Output Breakout Box

4.2 TEST SET-UP



9000_49

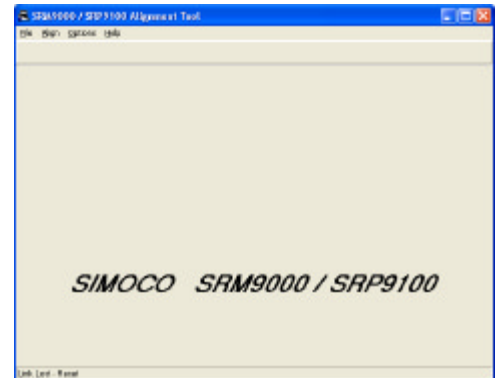
Figure 4-3 Test Set-up

1. Connect the radio to the test equipment as shown in
- 2.
- 3.
4. Figure 4-3.
5. Switch on the DC Power Supply.

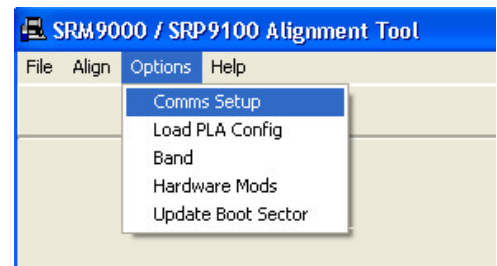
4.2.1 COMMS Set up

1. Copy the SRM9000 Alignment Tool Computer Software file to the PC hard drive and run the program

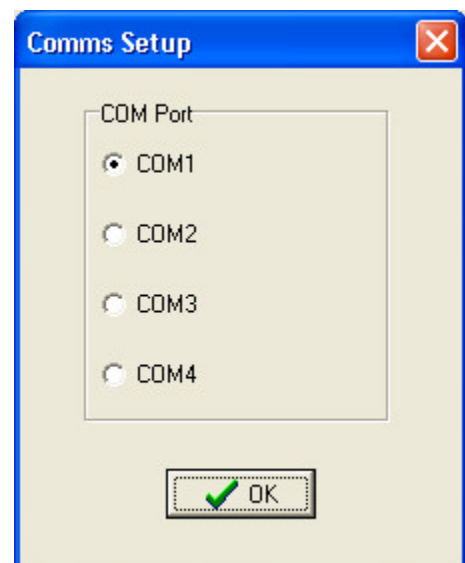
The Alignment Tool Opening Menu is displayed.



2. Go to the **Options** menu and choose **Comms Setup**.



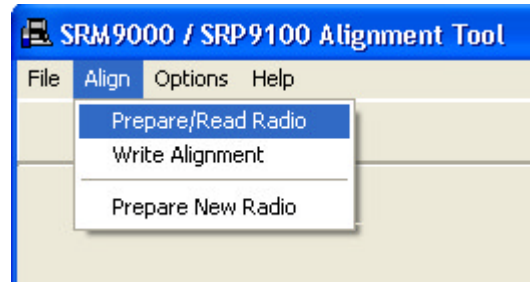
3. The **Comms Setup** dialogue box is displayed.
Select the Comms Port setting appropriate to the configuration of your PC and choose ✓OK.
(Usually COM1)



4.2.2 Radio Preparation

Radio parameters are to be aligned sequentially as detailed in this procedure.

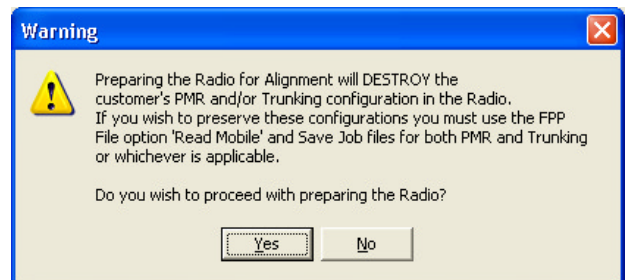
1. At the Opening Menu, select the **Align Menu** and choose **Prepare/Read Radio**.



2. The **WARNING** is displayed.

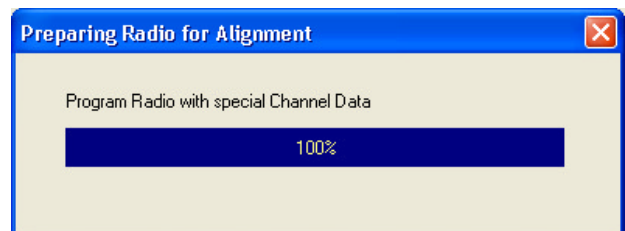
Choose **No** if you want to save the configuration and use the FPP software to read and save the data to a file.

Choose **Yes** if you want to proceed and go to step 3.



3. The radio alignment data is read (indicated by percentage bar) and stored.

The test alignment data is downloaded into the radio.

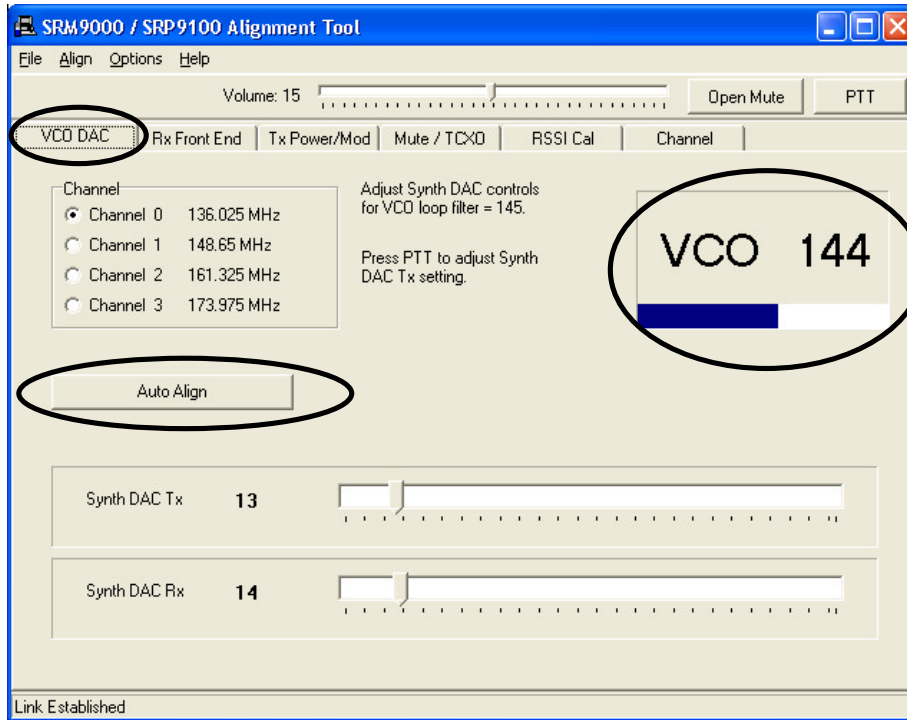


Note: *In test alignment mode the radio is configured only for 12.5 kHz channel spacing, therefore all alignment is carried out at 12.5 kHz settings unless otherwise specified. When the radio is configured with the FPP for other channel spacings, the deviation related levels are calculated on a per channel basis by the radio software.*

4.2.3 Alignment Procedure

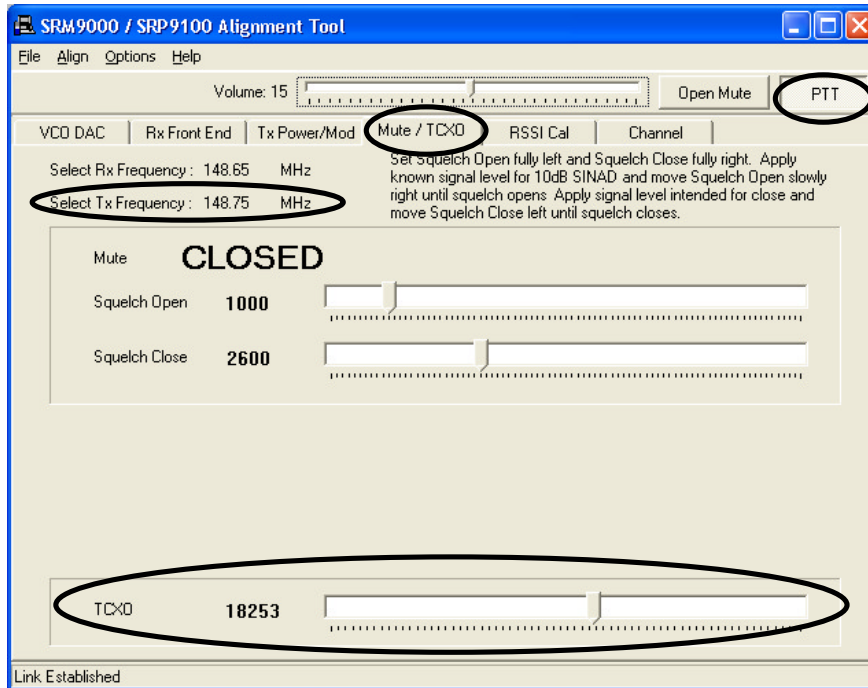
Radio alignment must be done in the sequence detailed in the following paragraphs. This alignment assumes that the radio is functioning normally.

4.2.3.1 VCO DAC Alignment



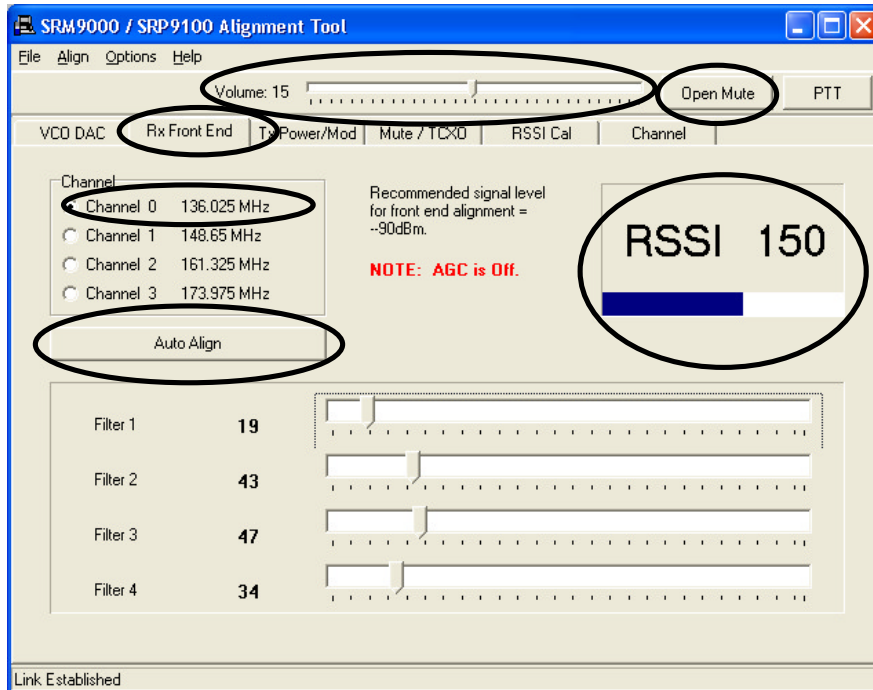
1. Select the **VCO DAC** page.
2. Select **Auto Align**. The Synth DAC Rx slider will automatically adjust its value for each receiver alignment frequency to set the VCO loop filter value between 140 and 150.
3. Select **PTT** and then select **Auto Align**. The Synth DAC Tx slider will automatically adjust its value for each transmitter alignment frequency to set the VCO loop filter value between 140 and 150.

4.2.3.2 TCXO (Radio Netting Adjustment)



1. Select the **Mute/TCXO** page.
2. Select **PTT**.
3. Adjust the **TCXO** slider to ensure that the transmit frequency error is within 50Hz for the selected channel (to be measured on the RF Test Set frequency counter).

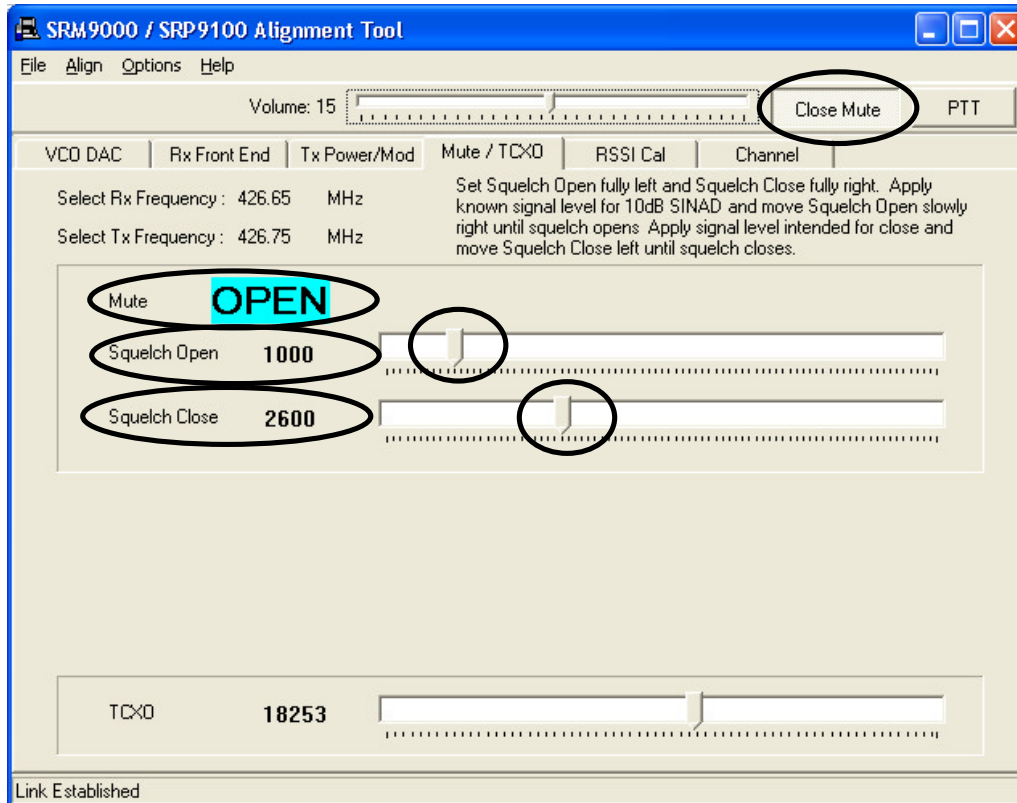
4.2.3.3 Rx Front End



1. Ensure that the TCX0 Alignment has been done before proceeding with this section.
2. Select the **Rx Front End** Page.
3. Select **Open Mute**.
4. Set the **Volume** slider to 15.
Speaker audio should now be visible on the Scope. If required readjust the **Volume** slider to a suitable level.
5. Set the Signal Generator to the Channel 0 carrier frequency, with a 1000Hz modulation signal, a deviation of ± 2 kHz and an RF level of -90dBm.
6. Select **Channel 0**.
7. Select **Auto Align**.
The front end will be tuned automatically and finish with an RSSI reading of typically around 150.
8. Repeat Steps 7 to 8 for the remaining 3 Channels (1, 2, & 3).
9. Change deviation to 1.5kHz.
10. Verify that the receiver sensitivity is better than -117.5dBm for 12dB sinad on all channels.
(Sensitivity is typically -120dBm).

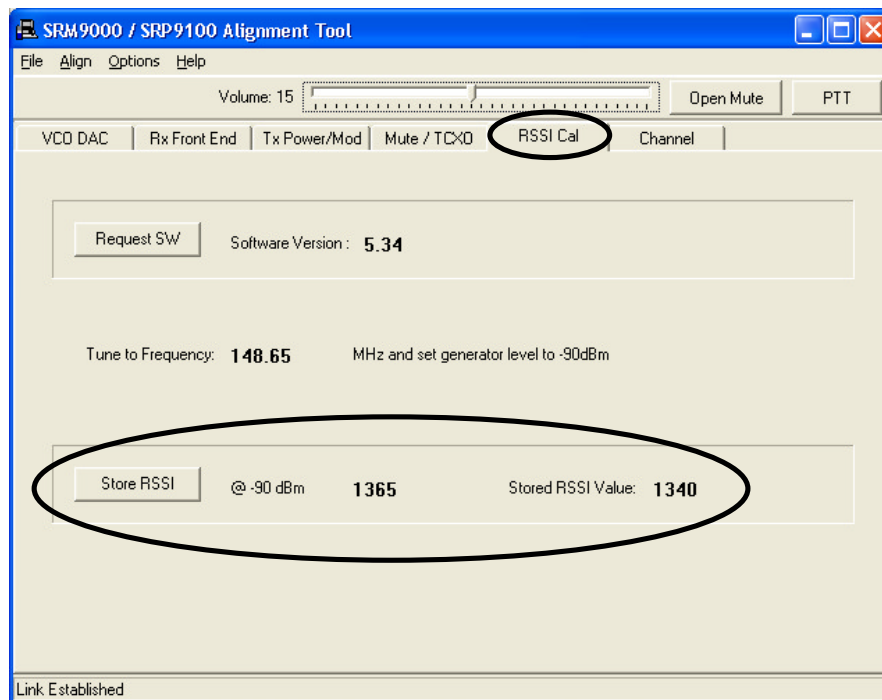
4.2.3.4 Mute Adjustment

Note. This adjustment has default setting of 1000/2600 and should not need changing except for specific requirements.



1. Select the **Mute/TCXO** page and select **Open Mute**.
2. Set the RF signal generator to the receiver alignment frequency, and adjust the RF level such that the desired mute opening SINAD (typically 10dB SINAD) is achieved.
3. Select **Close Mute** and remove the RF input from the radio.
4. Set the **Squelch Open** and **Squelch Close** sliders to the fully left position. This ensures the receiver will be muted.
5. Set the **Squelch Close** slider to the fully right position.
6. Reconnect the RF input to the radio.
7. Adjust the **Squelch Open** slider to the right until the mute opens.
8. Reduce the Signal Generator output level by approximately 2dB (or by an amount equal to the desired mute hysteresis level).
9. Adjust the **Squelch Close** slider to the left until the mute closes.
10. The mute should now open and close at the desired RF levels.
15. Note. On revision 9 radios and higher, an additional **Tx Audio Balance** DAC is also provided. For these radios, the **Tx Audio Balance** DAC is defaulted to zero for normal setting. However, for a more accurate setting, the DC voltage at TP745 needs to be noted during Rx and adjusted by the **Tx Audio Balance** DAC to give the same reading (to within 10mV).

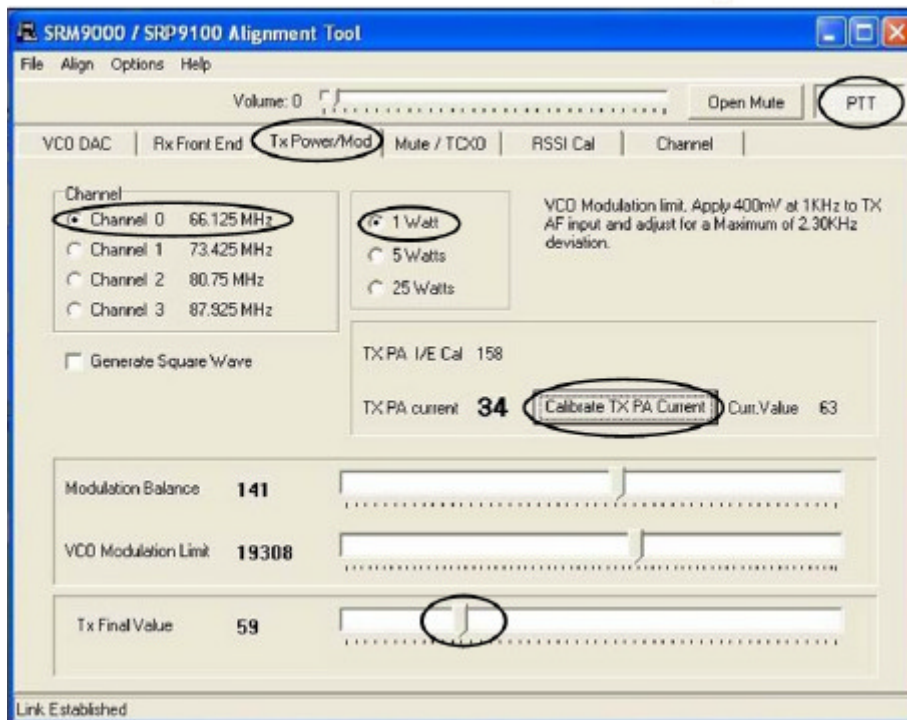
4.2.3.5 RSSI



1. Select the **RSSI Cal** page.
2. Set the Signal Generator for a RF output level of -90dBm and 2kHz deviation at the specified frequency.
3. Activate the **Store RSSI** button.

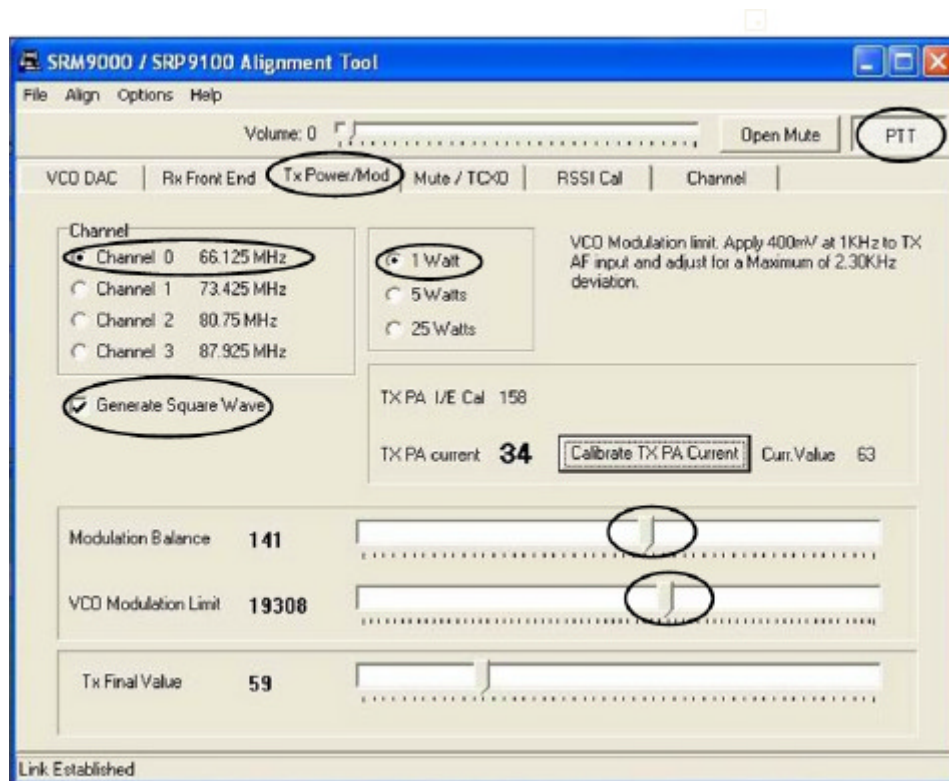
The receiver RSSI threshold setting is calibrated.

4.2.3.6 Tx Power



1. Select **Tx Power/Mod** page.
2. Select **Channel 0**.
3. Select the **1W** power level.
4. Press the **PTT** button.
5. Adjust the **Tx Final Value** slider for a power output of 1W.
6. Repeat step 5 for the remaining 3 Channels (1, 2, & 3).
7. Select the **5W** power level.
8. Adjust the **Tx Final Value** slider for a power output of 5W.
9. Repeat step 8 for the remaining 3 Channels (2, 1 & 0).
10. Select the **25W** power level.
11. Adjust the **Tx Final Value** slider for a power output of 25W.
Note that the supply current is less than 6.5A.
12. Repeat step 11 for the remaining 3 Channels (1, 2, & 3).
13. Rev 9C+ only, press "Calibrate TX PA Current" button to automatically set the maximum current limit.
Note: This feature is not available on earlier radios and therefore will not be displayed.
14. Release the **PTT** button.

4.2.3.7 Modulation

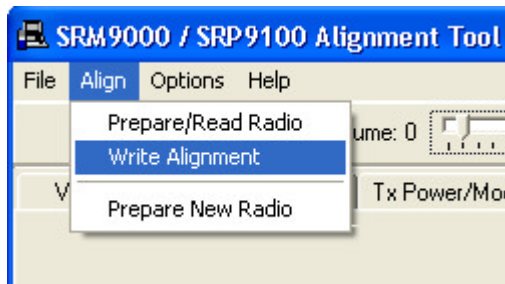


1. Select **Tx Power/Mod** page.
2. Select **Channel 0**.
3. Select the **1W** power level.
4. Set the microphone input signal from the Audio Generator to 1000Hz at 400 mV RMS.
5. Adjust the **VCO Modulation Limit** slider for a maximum peak deviation of $\pm 2.3\text{kHz}$
6. Reduce the microphone input level to 40mV RMS and check that the deviation is within the range $\pm 1.25\text{ kHz}$ to $\pm 1.75\text{ kHz}$.
7. Repeat steps 2 to 7 inclusive for the remaining 3 Channels (1, 2, & 3).
8. Remove the microphone audio input signal.
9. Select the **Generate Square Wave** function.
10. Select **PTT** and, while viewing the de-modulated signal on the transceiver test set oscilloscope, adjust the **Modulation Balance** slider for the best square wave symmetry.
Note. DC coupling is required on the scope for optimum setting accuracy.
11. Repeat steps 8 to 11 inclusive for the remaining 3 Channels (1, 2, & 3).

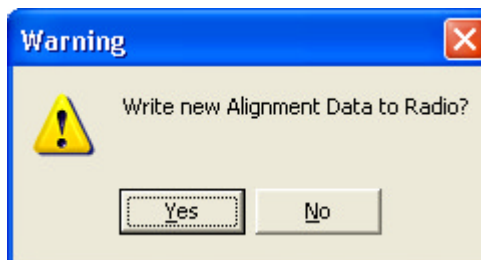
4.2.3.8 Programming

When all channels have been aligned the radio is programmed with the new alignment data:

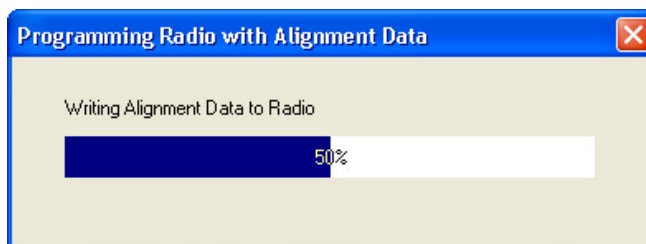
1. Select **Align** and choose **Write Alignment**.



2. A warning message is displayed.



3. Choose **Yes**.
New alignment data is written to the radio.



4.2.3.9 Customers Radio Personality Data

If the Customers Radio Personality Data was saved as a separate file, use the FPP Programmer to write this data to the radio.

5. REPLACEABLE PARTS

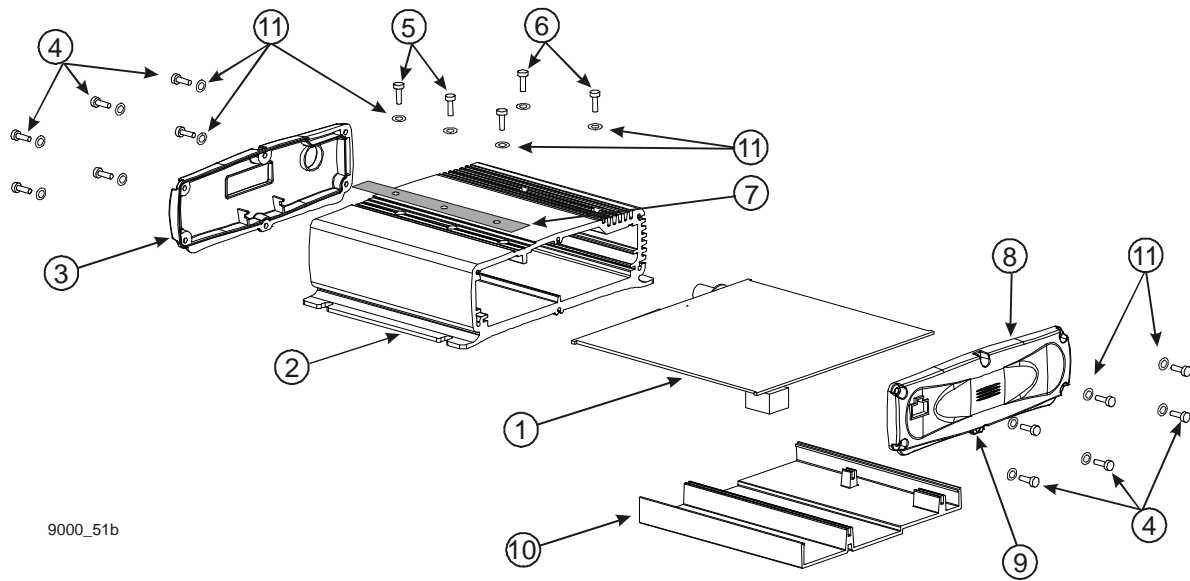


Figure 5-1 Replaceable Parts

5.1 COMMON PARTS

| Ident | Description | Quantity per Assembly | Part Number |
|-------|--|-----------------------|------------------|
| 2 | Case | 1 | 3513 901 70071 |
| 3 | End Cap, Rear | 1 | 6102 310 00212 |
| 4 | Screw End Cap | 12 | 3513 993 85009 |
| 5 | Screw Tray Retention M3 x 16 | 3 | 3513 993 57117 |
| 6 | Screw Tray Retention M3 x 12 | 2 | 3513 993 57116 |
| 7 | Label Transceiver Top | 1 | 6102 303 00101-0 |
| 8 | End Cap, Front | 1 | 3513 903 91072 |
| 9 | Label Front End Cap | 1 | 6102 303 00041-0 |
| 10 | Inner Tray | 1 | 3513 901 70083 |
| 11 | Washer Fibre | 17 | 3513 907 30241 |
| | Washer Seal BNC | 1 | 3513 907 3255A |
| | Gasket D Connector | 1 | 3513 902 1082A |
| | Gasket BNC | 1 | 3513 902 10651 |
| | DC power installation kit | 1 | MA-DCPOWER |
| | Tx PA Shield cover | 1 | 3502 310 63223 |
| | RJ45 Connector S1 | 1 | 6102 621 00121-0 |
| | DB15 Connector P2 | 1 | 3513 993 02063 |
| | Antenna BNC connector S500 | 1 | 3513 505 05991 |
| | Audio PA Module U805 | 1 | 3513 999 52036 |
| | Voltage Regulator U900, U901, U912 | 1 | 6102 822 00121-0 |
| | Voltage Regulator U903 | 1 | 6102 822 00011 |
| | Temperature Controlled Crystal Oscillator U700 | 1 | 6102 982 00011-0 |

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| Ident | Description | Quantity per Assembly | Part Number |
|-------|---------------------------------|-----------------------|------------------|
| | Transient Suppressor Diode D900 | 1 | 6102 012 00031-0 |
| | Transmit Receive Switch Q541 | 1 | 3513 999 00006 |
| | ON/OFF FET Q7, Q900 | 1 | 6102 062 00051-0 |

5.2 BAND-SPECIFIC PARTS

| Ident | Description | Quantity per Assembly | Part Number |
|-------|----------------------------------|-----------------------|------------------|
| | Tx PA Module U500 (E0 Band) | 1 | 6102 861 00112-0 |
| | Tx PA Module U500 (AC Band) | 1 | 6102 861 00012-1 |
| | Tx PA Module U500 (TU Band) | 1 | 6102 861 00052-0 |
| | Tx PA Module U500 (R1 & R2 Band) | 1 | 6102 861 00022-0 |
| | Tx PA Module U500 (UW Band) | 1 | 6102 861 00042-0 |
| | Tx PA Module U500 (K1 Band) | 1 | 6102 861 00122-0 |
| | Tx PA Module U500 (KM Band) | 1 | 6102 861 00132-0 |
| | | | |

6. CIRCUIT DIAGRAMS

Issue 9 Circuit Diagrams are contained in this Section. Previous releases of circuit diagrams are contained in separate Service Manual Supplements. See the table below for details:

| Supplement Number | Description |
|-------------------|--------------------------|
| TNM-S-E-0001 | Issue 9 Circuit Diagrams |

6.1 ISSUE 9 CIRCUIT DIAGRAMS

| Figure | Description |
|--------|-----------------------|
| 6.1 | Top Overlay of PCB |
| 6.2 | Bottom Overlay of PCB |
| 6.3 | DSP/Flash |
| 6.4 | PLA |
| 6.5 | Tx/Rx Audio |
| 6.6 | Power Supply |
| 6.7 | I/O Connections |
| 6.8 | E0 Band Receiver |
| 6.9 | E0 Band Transmitter |
| 6.10 | E0 Band VCO's |

| Figure | Description |
|--------|---------------------|
| 6.20 | E0 Band Synthesizer |
| 6.21 | AC Band Receiver |
| 6.22 | AC Band Transmitter |
| 6.23 | AC Band VCO's |
| 6.24 | AC Band Synthesizer |
| 6.25 | K1 Band Receiver |
| 6.26 | K1 Band Transmitter |
| 6.27 | K1 Band VCO's |
| 6.28 | K1 Band Synthesizer |
| 6.29 | KM Band Receiver |

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| | |
|------|---------------------|
| 6.11 | KM Band Transmitter |
| 6.12 | KM Band VCO's |
| 6.13 | KM Band Synthesizer |
| 6.14 | R1 Band Receiver |
| 6.15 | R1 Band Transmitter |
| 6.16 | R1 Band VCO's |
| 6.17 | R1 Band Synthesizer |
| 6.18 | R2 Band Receiver |
| 6.19 | R2 Band Transmitter |

| | |
|------|---------------------|
| 6.30 | R2 Band VCO's |
| 6.31 | R2 Band Synthesizer |
| 6.32 | TU Band Receiver |
| 6.33 | TU Band Transmitter |
| 6.34 | TU Band VCO's |
| 6.35 | TU Band Synthesizer |
| 6.36 | UW Band Receiver |
| 6.37 | UW Band Transmitter |
| 6.38 | UW Band VCO's |
| 6.39 | UW Band Synthesizer |

APPENDIX A - GLOSSARY OF TERMS

A summary of common radio terms and some other terms used in this document, and their meanings, are given below.

| | |
|---------------------------|--|
| 3RP | Trunking Signalling Specification relating to trunked networks for shared use. Used primarily for networks in France. |
| ADC | Analogue to Digital Converter. |
| AFC | Automatic Frequency Control. |
| AGC | Automatic Gain Control. |
| Alarm | <p>A Selcall sequence sent from subscriber equipment to indicate an Emergency situation.</p> <p>When activated the radio will enter a repeating sequence consisting of an Alarm Live Transmit Time and an Alarm Dead Receive Time.</p> <p>Certain special conditions for the radio may also occur during the alarm.</p> <p>A dedicated SFM (trunked system) that is sent by pressing the Alarm Key.</p> |
| ANN | Abbreviation for Algorithmic Network Numbering. This is the numbering system where the numbers presented to the radio user can be mapped directly to the MPT1327 PFI/IDENTs and vice versa by use of a fixed algorithm in combination with some other customisation parameters. See also FPP and MEP. |
| ANI | Automatic Number Identification. |
| Auto Interrogate | An Acknowledge identity sent as a response to an individual reset call. |
| Automatic Power | Feature whereby the transmit power is automatically set to a level determined by the level of the received signal. This is used to extend the battery life and/or reduce radiated emissions. |
| Automatic Volume | Feature whereby the background audio level is monitored and if this is found to be noisy then the volume level is increased to compensate, allowing the user to hear better. |
| Background Hunting | The searching for an alternative and 'better' control channel whilst already on a valid control channel. |
| BCAST | MPT1327 broadcast message. Used to transmit information about the trunked radio system to radio units. |
| Busy | <p>The state of a channel such that:</p> <ul style="list-style-type: none">• For a non-signalling channel - if Busy this means that the carrier is above squelch.• For a channel with CTCSS/DCS - if Busy this means a signal is being received with either no CTCSS tone / DCS code or the correct CTCSS tone /DCS code.• For a channel with Selcall - if Busy this means a closed channel where the signal is above squelch. <p>A feature that equates to 'Do Not Disturb' such that the radio will reject all non-emergency calls. This feature can be activated using the Busy key (if assigned) or from a menu; it is reset to disabled at switch on.</p> |
| C4FM | Compatible 4-Level Frequency Modulation. |

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| | |
|------------------------------|--|
| Call Back | A request, sent by the dispatcher, to a unit requesting that the unit calls the dispatcher back. |
| CCSC | Control Channel System Codeword. |
| Channel Spacing | The distance (in Hz) between the defined frequency channels. |
| CHEKKER | System Interface Specification for Trunked Networks in Germany. |
| CLIM | Call Limit Time; time limit on calls made. Normally this is defined by the Call Time Limit parameter but can be overridden by the TSC depending upon the setting of TSCLIM. |
| CLIME | Emergency Call Limit Timer. |
| Clipboard | A temporary storage area in Windows used to store data in cut, copy and paste operations. |
| Closed | A state where transmit and receive are not allowed until a Selcall message to open the channel has been received. A Closed Channel is one which defaults (when selected or after timed reset) to its closed state. Contrast with Open. Normally a Closed channel would have Selcall Mute and PTT Inhibit would be enabled. |
| CODEC | CODE (Analogue to Digital Converter) / DECODE (Digital to Analogue Converter). |
| Community Repeater | A communications set-up whereby different groups of radios can operate by using only one base station. This is achieved by the use of CTCSS tone signalling such that each group has a different CTCSS tone (encode and decode) and radios can only communicate with other radios in their group. Only one group of radios can use the base station at any one time. |
| Continuous | A continuous control channel is one that is only used by one site. There are no breaks in the transmission of signalling. Emergency Call Time Limit |
| Control Channel | A channel used for the transmission of messages that enables the TSC to control radios. Control channels may either Continuous or Timed Shared. |
| Control Channel Burst | A feature that enables control channel burst transmissions on systems using time-shared control channels. It is unavailable if the control channel acquisition type is not 'Time Shared'. To make available: go to Control Channel Acquisition Type and set to Time-shared. |
| CRU | Central Repair Unit |
| CTCSS | CTCSS stands for Continuous Tone Controlled Signalling System. A continuous tone (lower than the audio range of the receiver) is modulated onto the carrier as well as other signalling or voice traffic. Compare with DCS. Only receivers that have been instructed to recognise the same CTCSS tone are able to receive the transmissions, since the squelch of receivers looking for different CTCSS tones prevents the audio from being heard. This provides a simple method of sending messages to selected receivers only and allows several different networks to use the same frequencies. CTCSS is also known as Tone Lock or Tone Squelch. |
| DAC | Digital to Analogue Converter. |
| Dash (-) digits | Digits known as 'No Tone' digits used in Selcall Identities. |
| DCS | Digital Coded Squelch system is based on sending a continuous stream of binary code words using, low deviation, direct frequency shift keying. Only receivers which have been instructed to recognise the same DCS sequence are able to open their squelch and receive the associated speech transmissions. This |

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provides a simple method of sending messages to selected receivers only and allows several different networks to use the same frequencies.

| | |
|----------------------------|--|
| Decode | Reception of signalling. Either Selcall where encoded tone frequencies are decoded and identified as specific tones digits or CTCSS/DCS where tones are analysed to see if the channel should be opened. |
| Demanded | Demanded Registration; a procedure in which the TSC forces a single radio unit to attempt registration immediately (providing the radio is not already attempting to register). |
| Disabled | The 'False' state of a parameter. That indicates this parameter is not active. Typically this state is represented by an unmarked check box. Compare with Enabled. |
| DSP | Digital Signal Processor. |
| DTMF | Abbreviation of Dual Tone Multi-Frequency signalling. Used to dial into Telephone networks using tone dialling. |
| Dual Watch | A facility that enables the Radio to periodically monitor another channel for a signal above squelch. Typically applications are checking an emergency channel whilst on another channel. |
| Dynamic User Groups | These groups use a temporary user Ident to group a number of units together who would not normally make up a group. These groups are formed by the TSC (contrast with User Defined Groups) sending a special message to units instructing them to add a new group Ident to their list of groups. Up to 8 groups can be defined. These temporary groups are lost at switch off unless 'Save Groups at Switch Off' is enabled. |
| Economiser | A process by which the Receiver is powered down whilst there is no received signal. Periodically the receiver is powered up to check for such a signal. This is used to extend the battery life. |
| Enabled | The 'True' state of a parameter. That indicates this parameter is active. Typically this state is represented by a mark (either a tick or a cross) in a check box. Compare with Disabled. |
| Encode | Transmission of signalling. Either Selcall where Selcall tone digits are encoded into tone frequencies or CTCSS/DCS where tones modulated onto the channel's carrier. |
| ETS | European Technical Standard. |
| External Alert | A facility for switching on various ancillary devices to meet customer's individual requirements (e.g. car horn, flashing lamp etc.) when 'called'.
Only available on a mobile radio. To make available: go to Hardware Components, Terminal Settings and set Product Type to a Mobile type. |
| Fallback | A mode of operation that may be entered when the Network is suffering a malfunction. During this mode certain facilities (e.g. PSTN) may not be available. |
| FFSK | Fast Frequency Shift Keying. This is a signalling system for the transfer of digital information. It works by using one of two audio tones to represent transmit data.. |
| Fleet | A group of units formed such that only a shortened form of dialling (2 or 3 digits) is required between them. These groups are normally assigned contiguous ident's. |
| FOACSU | Full Off Air Call Set Up. A method of call set-up where the calling party has to manually answer the incoming call before the trunking system will allocate a traffic channel to the call. This reduces the loading on traffic channels as it prevents |

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them being allocated to calls when the called party is not present to deal with the call.

PLA

Programmable Logic Array.

FPP

Field Personality Programmer.

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| | |
|--------------------------------|---|
| Hash (#) digits | <p>These digits are used for two purposes:</p> <ul style="list-style-type: none">• For Selcall identities (encode and decode) - known as User Id digits. These digits are replaced by the user id entered at switch on (if enabled)• Use in DTMF dialled strings - their use is network dependent to access special services. |
| IDENT | <p>A 13 bit number used for Identification purposes. Associated with a Prefix (PFX) this forms a 20 bit address which is used for identification purposes in signalling between the radio and the trunking system.</p> |
| Identity | <p>Name given to a sequence of tones which is used in sequential tone signalling. See Valid Selcall Digits.</p> |
| Idle State | <p>The state of the radio when it is not in a call.</p> |
| Inaccessible | <p>A state of a channel such that it is unavailable to the user through normal methods of channel selection. Therefore inaccessible channels will not appear on the channel menu.</p> |
| Include Calls | <p>these types of calls are used to allow a 3rd party to join into an existing call.</p> |
| Link Establishment Time | <p>A delay incorporated into the start of every selective call or DTMF transmission which allows for the finite delay of the radio equipment in responding to any radio signal. This includes both the commencement time of the originating transmitter and the response time of the receiver.</p> |
| Locked | <p>A state of a channel whereby it is not possible to change channels using the normal up/down keys on the channel menu until the OK key is pressed. See Auto Channel Selection Lock.</p> |
| MEP | <p>Miniaturisation Extent Parameter. Used in systems that use ANN numbering.</p> |
| Modifier | <p>Part of a dialled string that modifies the nature of the call made to a number (e.g. dialling "**9" before the number that is to be dialled will modify the call to be an emergency call).</p> |
| MPT1327 | <p>A signalling standard for Trunked Private Land Mobile Radio Systems. Defined for systems in the UK but also used outside the UK. Issued January 1988.</p> |
| MPT1343 | <p>A System Interface Specification for commercial Trunking networks. Defined for systems in the UK but also used outside the UK. Issued January 1988.</p> |
| Noise Blanker | <p>A circuit designed to reduce automotive ignition interference.</p> |
| NDD | <p>Network Dependent Data. This is a field within the CCSC codeword that is used by the trunking system to identify information about the trunking network and, in particular, information specific to the site that is radiating the control channel. It is used by the radio when it is acquiring a control channel to identify valid channels.</p> |
| Null Id | <p>A Selcall identity that is not defined and whose tones' field is displayed as a blank.</p> |
| Open | <p>A state where transmit and receive are allowed. The channel is no longer open when reset. Contrast with Closed.</p> <p>Normally an Open channel would not have Selcall Mute and PTT Inhibit would be disabled.</p> |
| OPID | <p>Network Operator Identity used in Regional Systems. See Roaming.</p> |
| PABX | <p>Private Automatic Branch Exchange.</p> |

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| | |
|----------------------------|---|
| Password | An optional password system available on the radio. This feature is only available if the radio does has a display and a keypad. To make available: go to Hardware Components, Terminal Settings and set Product Type to one which has a display and a keypad. |
| PFIX | The 7 most significant bits of an MPT1327 address number. Normally same fleet units have same prefix. Relates to individual and group address numbers. |
| PLL | Phased Locked Loop. |
| PMR | Private Mobile Radio (not normally trunked). |
| Priority Channel | A channel in a search group that is scanned between every other channel. |
| PSD | Peak System Deviation. |
| PSTN | Public Switched Telephone Network. |
| PTT | Press To Talk. This is the term given to the operator's key normally used to commence transmitting a message. |
| PTT Inhibit | A state whereby transmission using the PTT is not allowed. Also know as Tx Lockout. |
| PWM | Pulse Width Modulation. |
| Queuing | <p>The storing of an Selcall Identity for later transmission.</p> <p>If inhibited from transmitting a selcall sequence because the channel is busy then the radio can queue the Send 1 / Send 2 sequence for later transmission. When a radio unit is in Queuing mode all incoming calls are stored automatically in a queue for later examination. The caller is given an indication that the call has been queued by the called party. The queue will contain the identity of the caller and the status value received (if a status call). Up to 20 calls may be queued. The Queuing mode may be selected using the Modes Menu.</p> <p><i>Note: Connecting a MAP27 device to a radio that is in queuing mode will disable queuing. All incoming calls will then be routed both to the radio user interface and to the MAP27 device connected to the radio. Also known as Logging Mode</i></p> |
| Reference Frequency | Normally this is generated from a high stability crystal oscillator reference and is divided digitally in a frequency synthesiser for comparison with other frequency sources, e.g. a VCO. |
| Registration | Registration is a technique used to ensure that the trunking system knows the location of radio units that are using the system. This allows the system to setup calls quickly without having to search the whole system for the called radio. |
| Repeat Tone | <p>A selcall tone that is used to replace repeated tones. Fixed at tone E.</p> <p>Example: An identity entered as '12333' would be sent by the radio as '123E3'.</p> |
| Reset | <p>Resetting is caused by Three Tone Reset, a Remote Reset, an Individual reset or a Group reset (Call Types in Decode Identity). When a radio is reset the effect on the radio will be as follows:</p> <ul style="list-style-type: none">• Any Call Alerts will be stopped• The Call LED flashing will stop• If the channel is in Open mode then the channel is closed• The PTT is optionally inhibited see PTT Inhibit After Reset Sequence.• In searching - if paused on a selcall channel then searching resumes |

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- If the Acknowledge property of a Decode Identity is set to 'Auto Interrogate' or 'Transpond & Auto Interrogate' then the Auto Interrogate encode identity is transmitted.

| | |
|------------------------|--|
| Roaming | This is a process that allows changing between regional trunking systems which have different Operator Identities (OPID 's). Not allowed on MPT1343 Systems. |
| RSSI | Received Signal Strength Indicator. |
| Scanning | Process of switching between the channels in the nominated search group in cyclic sequence, stopping when the search condition (which may be to look for either a free or a busy channel) is satisfied. |
| SDM | Short Data Message. |
| Search Group | A group of channels that are either scanned for a signal above the search threshold or are compared and voted for the strongest signal |
| Selcall | Selective Calling - a system of signalling which allows 'dialling up' of specific mobiles, portables and controllers. Such a system may be used to pass messages as a data message to a specific user or group of users. It can be used to provide remote switching facilities and to provide access control into community repeaters or similar devices. |
| Selcall Mute | A state of the audio gate whereby the loudspeaker is muted (closed). |
| Selcall System | <u>Selective Calling</u> , uses a tone sequence at the start, and end, of a call to control which members of a fleet react to the transmission. |
| SFM | Short Form Memory. |
| Sidetone | Sidetone is the audio which can be (optionally) heard when Selcall, DTMF and toneburst transmissions are made. |
| Simplex | Mode of operation whereby the radio operates as a conventional fixed channel radio outside the Trunking network. |
| Squelch | System used to prevent weak, unintelligible signals and random noise from being heard by a radio operator while still allowing intelligible signals to be received normally. This is accomplished by the use of a threshold below which any received signals are ignored. Only signals whose signal-to-noise ratio is above the squelch level cause the audio circuits of the radio to be enabled, with the result that only satisfactory signals are received. The squelch level is specified in SINAD. |
| Star (*) digits | <p>Digits known as Status or Message digits. These digits are used for three purposes:</p> <ul style="list-style-type: none">• Status Digits for Selcall Identities• Wildcard digits in Status strings• Use in DTMF dialled strings - their use is network dependent to access special services. |
| Status | <p>A feature whereby a radio's status (or usually the status of the radio's user) can be transmitted and a status message from other radios can be displayed. This operates through status digits in Selcall identities. Either in Encode Identities or Decode Identities as follows:</p> <p>Encode Identities: Status digits within the identity are used to transmit the current situation of the radio's user (e.g. "Out To Lunch").</p> <p>Decode Identities: Status digits are looked up in a table (Status Menu) for possible messages to display.</p> |

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| | |
|----------------------------|--|
| SW | Software. |
| SYS | System Identity Code part of the CCSC. |
| TCXO | Temperature Compensated Crystal Oscillator. |
| Temporary | Temporary Registration; a process carried out by the Dispatcher due to some system failure that prevents it from carrying out normal registration. The radios will recognise this temporary registration mode but will otherwise use the network in the same way as if they were registered. They may be required to re-register when normal registration mode is resumed. |
| Three Tone Reset | <p>This is a system whereby a call to a user automatically reset all other users in a group.</p> <p>Example: a call to user '12345' would call 12345 and reset all other users on this channel with an identity 123nn where n can be any digit 0-9, A-F.</p> |
| Timed Reset | Facility that causes the Radio, after a certain period of time, to restore current channel to it's initial condition e.g. if it was previously searching it will resume searching. |
| Time Shared | <p>A time-shared control channel is one that is used by more than one site. This allows a wide coverage area to be obtained using only one frequency.</p> <p>The forward channel from the TSC to the radio is divided into timeslots. Each site using the channel is allocated one timeslot in which to transmit and send signalling.</p> <p>Therefore, when on a timeshared channel. the radio may be able to receive bursts of signalling from different sites at different signal strengths and may receive periods when no signalling is received.</p> <p>Depending on the type of system, the radio may be able to perform transactions with any site it can receive from or only with a specific site.</p> |
| TMR | Trunked Mobile Radio. |
| Tone Burst | An audio tone is transmitted at the start of transmission to inform a relay (repeater) station to switch itself on to relay the transmission. |
| Transpond | An Acknowledge identity sent as a response to an individual call. |
| TRAXYS | Air Interface for the PTT Telecom Trunked Radio Network, used in the Netherlands. |
| TSC | Trunking Site Controller. Central control required for the Trunking System to function. Controls base stations. |
| Tx Inhibit | A facility which prevents the user from transmitting,(other than alarms), while the channel is Busy. |
| UMP | User Memory Plug. A special device that contains the customisation data for the radio. If this is removed then this can cause the radio to behave in a number of ways. |
| User Defined Groups | These groups are set up by the user (contrast with Dynamic User Groups) when the user desires to be included, temporarily, in an existing group. Up to 8 groups may be defined (in addition to the Network group Idents defined by Network Group Numbers). This feature is only available if User Defined Groups parameter is enabled. These temporary groups are lost at switch off unless 'Save Groups at Switch Off' is enabled. |

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| | |
|----------------------|---|
| User Identity | This is a sequence of up to four digits entered by the user when the Radio is switched on, if this option is programmed. These digits are then substituted into any transmitted Selcall identity which includes # digits. |
| VCO | Voltage Controlled Oscillator. |
| Vote | Method used to compare the signal strength on a current channel with another specified channel and then to choose the channel having the stronger signal. |
| Voting | Feature used during searching when there is more than one channel that satisfies the required conditions. It involves examining all the channels that satisfy the required conditions, and then selecting the channel with the highest signal strength. |
| VOX | Voice Operated Transmit. |