SRM9000X8 800MHz Mobile Radio Transceiver

Revision 2 Hardware

SERVICE MANUAL

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SRM9000X8 800MHz Mobile Radio Transceiver Rev 2 Hardware TNM-M-E-0022 Iss. 1.0

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Declaration

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

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Errors and Omissions

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Document History

Issue	Date	Comments
1	January 2008	Initial issue

List of Associated Publications

Document No.	Description	Issue
TNM-I-E-0005	SRM9000 Series Installation Instructions	6
TNM-P-E-004	Selcall Product Manual	2.56
TNM-U-E-0055	SRM9022 P25 Operating Instructions	2
TNM-U-E-0074	SRM9030 P25 Operating Instructions	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 1.6

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 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).

1. INTRODUCTION

1.1 GENERAL

The SRM9000X8 800MHz mobile transceiver is designed for PMR operation in analog systems or P25 in digital systems.

The SRM9000X8 transceiver can be used with either the SRM9022 Graphics Display Handset or the SRM9030 System Level Remote Control Head with Alpha capability.

1.2 SCOPE

This manual provides technical specifications, description and servicing details for the SRM9000 mobile radio transceiver.

1.3 DESCRIPTION

The design concept utilises wide band techniques for RF transmit and receive circuitry with digital signal processing of analog 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 12.5kHz or 25kHz FM signals or P25 digital modulation 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 basic 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.

1.4 PRODUCT VARIANTS AND FACILITIES

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

Table 1-1 Features for Control Variants

Feature:	**Model:**	**9022**	**9030**
Control		Controller Microphone	Control Unit with Microphone
Display		8x14 char LCD Graphics 102x64 pixels	8x14 char LCD Graphics 102x64 pixels
Adjustable Display Illumination		Yes	Yes
Buttons and Keys		Vol Up/Down 6 Function 12 Keypad Send/End Menu + Scroll	6 Function 12 Keypad Send/End Menu + Scroll
Speaker		Yes	Yes
Channel Spacing		12.5kHz/ 25kHz	
Menu driven		Yes	Yes
Customisable Menus		Yes	Yes

Table 1-2 Conventional-PMR Variants

Feature:	Model:	9022	9030
Channels		1000	1000
Signalling		CTCSS/DCS Selcall	CTCSS/DCS Selcall
Attack Operation		Yes	Yes
DTMF Encode		Yes	Yes
PTT Limit Timer with warning beeps		Yes	Yes
Busy Channel Lockout		Yes	Yes
PTT Inhibit on Busy		Yes	Yes
Scanning		124 groups of up to 16 channels per group, 4 user defined scan groups.	
Voting		Up to 200 groups consisting of up to 16 channels per group.	
Priority Scanning		Yes	Yes
Nuisance Delete		Yes	Yes
Phonebook		250 entries	250 entries
Multiax		Yes	Yes
Ignition Sense Input		Yes	Yes
VOX Handsfree		Yes	Option
600 Ohm Interface		Option	
SIB		Option	
ASIG		Option	
P25		Option	

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 analog PMR, Trunking and Alignment.

The 9022 Controller Mic/Handsets has one SW file for its PIC and the 9030 Control Head has two SW files for its Flash and EEPROM.

1.4.1 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. **9etm533.bin**

9ep_533.bin

9es_533.bin

9ecf101.hex

9ece101.hex

1.4.2 Application Code

This identifies the application the SW was initially designed for:

9e	Standard SRM9000 Rev 9 Software
ae	SRM9000 Rev 9 Software applicable for SRP9022

1.4.3 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
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
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 and DMAP codes. The Bootloader, PLA Backup and PLA codes show release dates only.

1.4.4 Version Number

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

e.g. 103 = Version 1.03

1.4.5 Exclusions

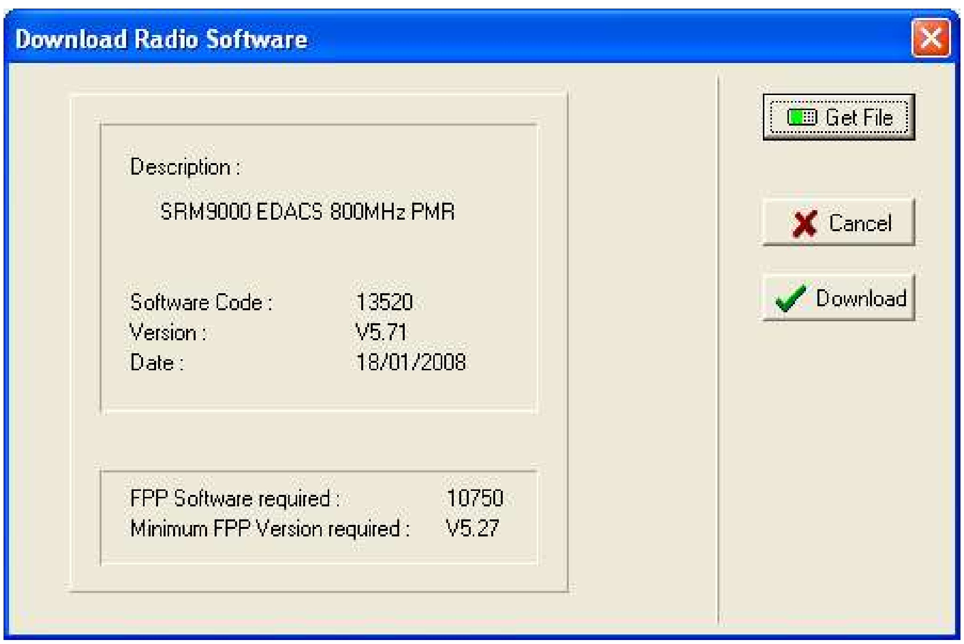
The Programmer SW does not follow the above rules as it is a PC based Program and its version number can be easily identified by starting the SW. Later releases of SW will be backward compatible, unless deliberately not so, in which case a different directory structure/path may be implemented.

1.4.6 Displaying Software Versions

Each Transceiver SW code file (e.g. 9etm533.bin, etc.) contains version information about itself and possible compatibility with Programming SW.

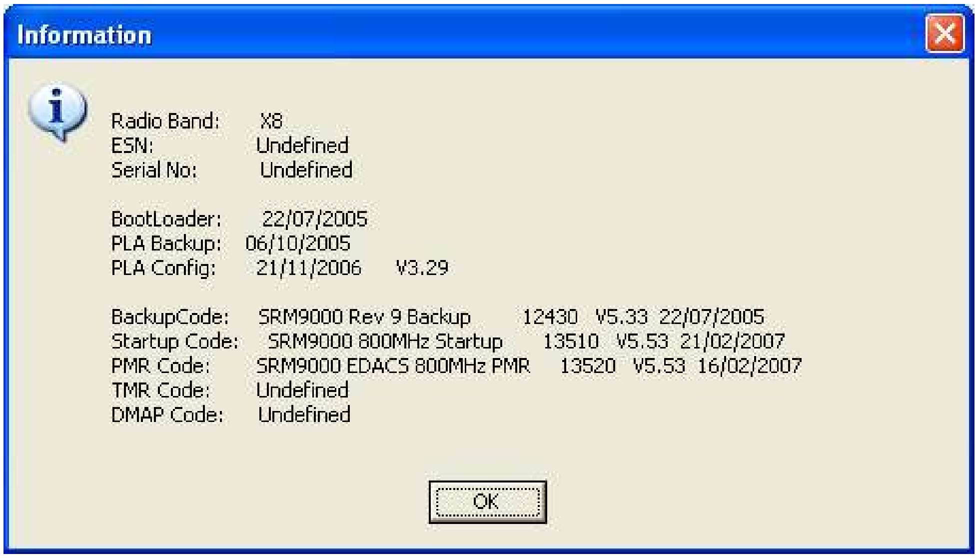
For **Radio SW saved on Disk**, this information can be displayed via the Programmer function:

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



SRM9030 Control Head SW can be displayed on the Control Head by holding the '3' button down when the radio is switched on. **SRM9022 Handset SW** can be displayed by pressing the top side button when the radio is switched on.

1.4.7 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 code.

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

1.4.8 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

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 PMR 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 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".
- 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.)

1.4.9 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 = *9es_xxx.bin*) and Mainline PMR (9ep_xxx.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.

1.5 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 outside the chassis provided that a temporary heatsink is fitted under the transmitter PA module for transmitter servicing and that the receiver audio output be kept below 100mW for receiver servicing. Radio performance is only slightly 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.

1.6 CHASSIS ASSEMBLY

Important Note!

1.6.1 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.

1.6.2 Thermal Compound Application

Just enough thermal compound should be applied to the PA tray to provide good thermal contact with the chassis.

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

1.6.3 Assembly

The Inner extrusion should initially be nested together with the PCB and then the assembly slid into place within the outer extrusion.

Positioning 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.

Whilst 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.

1.7 SPECIFICATION

1.7.1 General

Operation

Single frequency simplex or two-frequency simplex (half-duplex).

Modulation

Frequency modulation (phase) F3E and F1E.

Operational Temperature Range

-30°C to +60°C

Storage Temperature Range

-40°C to +80°C

Supply Voltage Requirements

10.8V to 16.32V DC negative earth (13.8V nom.)

Current Consumption

	Mobile With 9022 Control Mic	**Mobile With 9030 Alpha Head**
Radio off	≤ 5mA	≤ 5mA
Standby (squelched):	≤ 200mA	≤ 210mA*
Rx Audio O/P:		
300mW	≤ 450mA	≤ 500mA *
4.0W	≤ 1200mA	≤ 1250mA*
Transmit:		
25W	≤ 7.0A	
6W	≤ 3.0A	

*Add 100mA to current consumption for the 9030 Control Head with backlight on.

Frequency Band	**Frequency Range**	
X8	Transmit	Receiver
2 Frequency Simplex	806-825MHz	851-870MHz
Turnaround	851-870MHz	851-870MHz
Channel Spacing	12.5kHz/ 25kHz	

Frequency Stability (-30°C to 60°C)	Less than ±1.5ppm

Dimensions (mm)	**Height**	**Width**	**Depth**
Transceiver	56	170	165
9022 Controller Microphone	145*	68	30
9030 Alpha Control Head	300	120	130
	* Does not include cable or strain relief		

Weight	
Transceiver	1.8kg

Regulatory Approvals	FCC ID: STZSRM9000X8 IC: 7068A-M9000X8

1.7.2 Transmitter

Power Output	Any two levels are programmable: High Power: 25W Adjustable down to 1W Low Power: 1W Adjustable up to 25W
Carrier Attack Time	Less than 50 ms
Duty Cycle	1 minute transmit: 4 minutes receive
Spurious Emissions	< -20dBm
FM Hum & Noise	25kHz Channel Spacing: >40dB
Audio Frequency Distortion	< 5%.
Audio Frequency Response	300 to 3000Hz +1dB to -3dB of a 6dB/octave pre-emphasis curve.
Audio Sensitivity (1kHz) **(User programmable via FPP)**	RJ8 Connector: 40mV±2dB from 470Ω source impedance. Option Audio: 40mV±2dB.

1.7.3 Receiver

Sensitivity Analog C4FM	 < -117.5dBm for 12dB SINAD < -116dBm for 5% BER
Adjacent Channel Rejection Analog 25kHz C4FM	 >70dB >60dB
Offset Channel Rejection (NPSPAC)	>20dB
Intermodulation Rejection	>70dB
Spurious Response Rejection	>70dB
Blocking	>90dB
Conducted Spurious Emissions	<-57dBm
FM Hum & Noise (Analog 25kHz)	>40dB
Mute Range	Typically 6dB to 25dB SINAD Typical preset level 10dB ±2dB SINAD
Receiver Attack Time	<150mS
Receiver Closing Time	<90mS
Audio Distortion	4W into 4Ω at <5% distortion
Audio Frequency Response	300 to 3000Hz: +2dB to -8dB of a 6dB/octave de-emphasis curve
Deviation Sensitivity (for rated audio at 1kHz)	20% to 40% PSD

1.7.4 Signalling

1.7.4.1 CTCSS

38 standard CTCSS Tones and 13 non-standard tones are supported as per the table below:

Standard Frequencies	Standard Frequencies	Standard Frequencies	Non-Standard Frequencies
67.0	107.2	167.9	69.3
71.9	110.9	173.8	150.0
74.4	114.8	179.9	159.8
77.0	118.8	186.2	165.5
79.7	123.0	192.8	171.3
82.5	127.3	203.5	177.3
85.4	131.8	210.7	183.5
88.5	136.5	218.1	189.9
91.5	141.3	225.7	196.6
94.8	146.2	233.6	199.5
97.4	151.4	241.8	206.5
100	156.7	250.3	229.1
103.5	162.2		254.1

CTCSS Encoder

Tone Deviation:

25kHz channel spacing:	500 to 750Hz
NPSPAC:	400 to 600Hz

Tone Distortion:	Less than 5.0%
Tone Frequency Error:	Less than ±0.3%

CTCSS Decoder

Bandwidth	Complies with TIA-603 part 3.4.6
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 1 false decode per 30 minutes (no carrier input).
Blocking	For no dropouts in one minute, interfering tone at 90% of system deviation (CTCSS tone at 10% of system deviation) as follows:
	Full quieting signal: 310Hz to 3000Hz
	20dB SINAD RF signal: 320Hz to 3000Hz
	12dB SINAD RF signal: 350Hz to 3000Hz
Attack Time	Less than 250ms (tone frequency >100Hz)
	Less than 350ms (tone frequency <100Hz)
Closing Time	Less than 250ms
Squelch Tail Elimination	Less than 50ms

1.7.4.2 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

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

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

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

1.7.4.3 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

1.7.4.4 DCS

Data rate	134 bits per second, frequency modulated 7.46ms/bit 171.6ms per codeword continuously repeating
Deviation	500 to 1000Hz for 25kHz channel spacing 400 to 800Hz (NPSPAC)
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	

1.7.4.5 C4FM

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

1.7.5 Environmental

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

Operational Temperature -30°C to +60°C MIL-STD-810F Methods 501.4 and 502.4, Proc II	
Storage Temperature -40°C to +80°C MIL-STD-810F Methods 501.4 and 502.4 Proc I	
Vibration Stability MIL-STD-810F Method 514.5C-1, Proc I, Cat 4 and USFS Vibration Standard	
Cold MIL-STD-810F Method 502.4, Proc II	
High Temperature MIL-STD-810F Method 501.4, Proc II	
Humidity MIL-STD-810F Method 507.4-1	
Low Pressure	
Storage	MIL-STD-810F Method 500.4, Proc I
Operational	MIL-STD-810F Method 500.4, Proc II
Sand and Dust MIL-STD-810F Method 510.4, Procedures I and II	
Shock MIL-STD-810F Method 516.5, Proc I	
Product Sealing MIL-STD-810F Method 505.4, Proc III (Equivalent to IEC529 rating IP54)	

2. SERVICE PHILOSOPHY

2.1 SERVICE CONCEPT

The SRM9000 series has been designed to provide low cost analog 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.

2.3 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.

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 T/R switch. With the mobile in receive mode, diodes D580, D582 and D583 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.

The signal is then fed through SAW bandpass filter (Z400) to the input of the RF amplifier (Q404). The SAW filter bandpass covers 851MHz to 870MHz. The RF amplifier stage comprises a low noise transistor amplifier (Q404) 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 approximately 9dB.The RF amplifier has constant current bias controlled by Q402. The output of the RF amplifier is coupled through a varactor-tuned bandpass filter comprising of two ceramic resonators (Z430 and Z431). The varactors have individual PWM tuning voltages, TUNE 1 and TUNE 2, that are derived from PLA (U300). The tuning voltages values for the filter varactors are controlled by the alignment data stored in the radio. The DSP processes these data to optimise the filter tuning for each of the programmed channel frequencies.

A negative bias supply originates from the DSP/PLA as a PWM signal for the two filter tuning voltages for the specific channel frequency selected. The PWM signal, which is dependent on channel frequency and tuning, passes through level shifting transistors Q451 to Q454, where it is converted to a negative voltage in the range -0.5V to -11.5V. The -12.0V rail for the level translators is generated by U904E/F, with D903 to D906 providing the required voltage multiplication.

3.1.2 First Mixer and IF Section

The output of the ceramic resonator pair is then fed into U441, a high performance passive mixer that converts the RF signal to a IF of 45MHz. The first local oscillator injection level is typically +8dBm with high side injection.

Following the mixer is a IF amplifier (Q461) 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 Z471A/Z471B.

The crystal filters provide part the total 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 U481, which is a dedicated IF AGC Amplifier and Quadrature Demodulator. The AGC voltage for U481 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 U481. The 90MHz second local oscillator signal for U481 is generated by VCO Q730, which is phase locked by the PLL CPIF output of U721, via feedback signal FINIF.

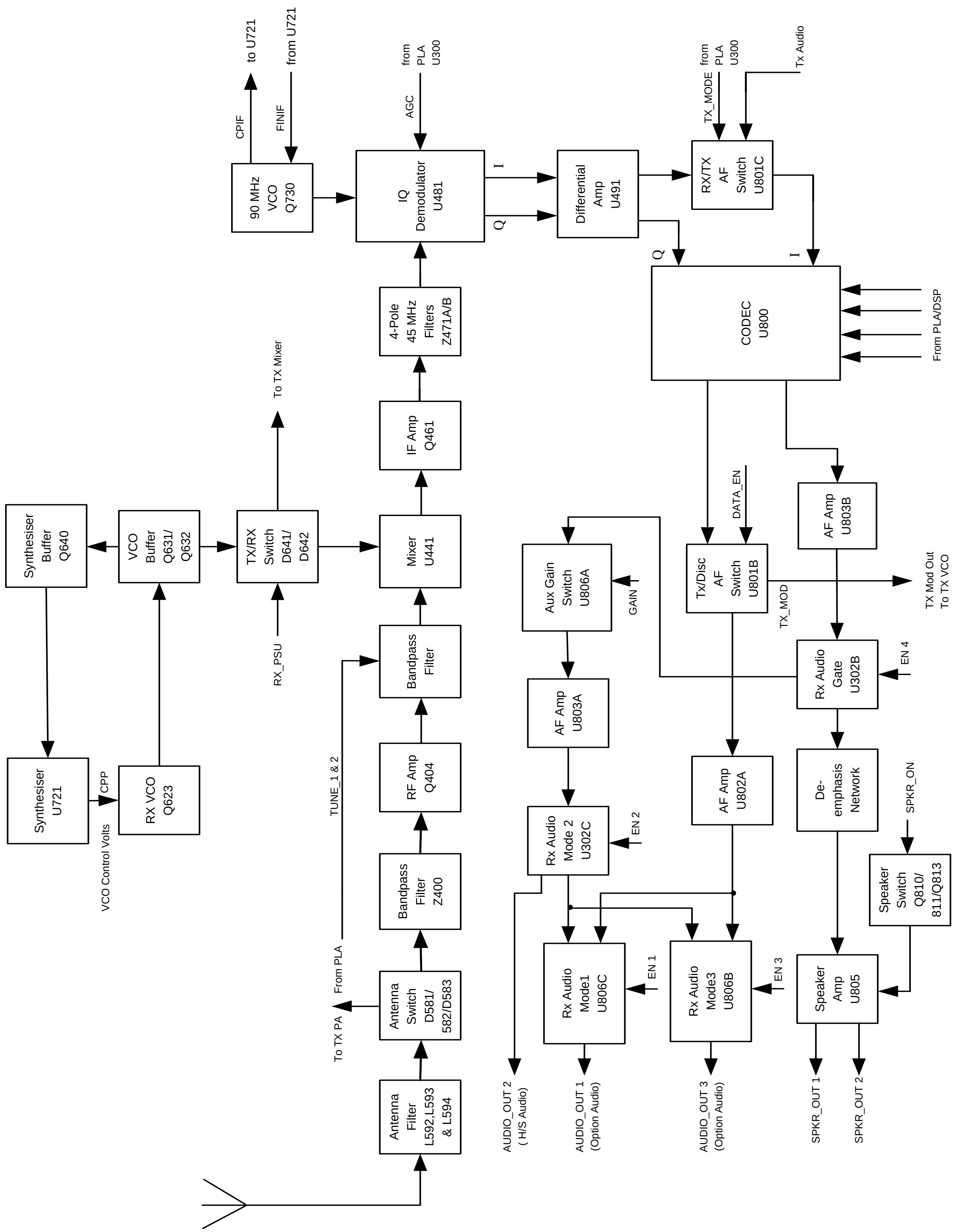


Figure 3-1 Receiver Block Diagram

3.1.4 Receiver Audio Processing

The baseband audio from the IQ Demodulator is applied to a differential amplifier (U941A/ U941B) that converts the balanced demodulator I and 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 analog baseband signals are converted to digital signals by the CODEC ADC before being applied to a series of digital filters that provide the final stages of adjacent channel filtering, high pass and low pass audio filtering, mute noise processing, and volume control level for narrow and wideband operation. The fully processed signal is then converted to an analog audio signal by the CODEC DAC and then applied to conventional audio amplifiers (U803A/B) and the loudspeaker amplifier (U805).

In addition, Discriminator Audio is derived from the second 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; this high power option is enabled by adding 0 ohm resistor, R859. The carrier and signalling mute functions are performed by Q810/Q811/Q813 under DSP control. De-emphasis to the audio PA (U805) is performed by R861 and capacitor C872. Flat audio is provided to connector S1-6 via amplifier U803A.

3.2 TRANSMITTER

Refer to Figure 3-2.

3.2.1 Drivers and PA Stages

The carrier frequency for the transmitter is generated by combining the receiver first LO with the receiver second LO in TX mixer (U650).

The output of the mixer (U650) is fed into a broadband amplifier (U670) via a tuned filter comprising of varactors D660 and D661, to reduce the unwanted mixer products. The tuning voltage for the filter varactors, TUNE 1N, is derived from level translators Q451 and Q452. U670 amplifies signals from 806MHz to 825MHz for two frequency simplex applications and 851MHz to 870MHz for turnaround operation. The output of U670 connects to a diode switch arrangement consisting of D681 to D684; this switch is used to select pairs of SAW filters on either the 806 to 825MHz band with Z681 and Z683, or the 851 to 870MHz band with Z682 and Z684. The diode switch is controlled by transistors Q681 and Q682.

The carrier signal level at the output of the SAW filters is approximately –7dBm. This signal is then further amplified in subsequent broadband stages Q691 to approximately +2dBm, Q501 to +15dBm, Q521 to +17dBm and Q531a to +20dBm. Each of these stages has a resistive attenuator network to provide isolation from the affects of transient load impedance changes. The output of final driver (Q531a) is fed through a resistive network consisting of R536, R537 and R538, to the input of the broadband power amplifier module (U561) at a level of approximately +16dBm.

The PA module (U561) contains three MOSFET stages to achieve the required maximum RF output power level of +44.4dBm (27.5 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 limit should be monitored at all times and preset to as low as required. The radio has some additional inbuilt safeguards, but these should not be relied on.

Final power output settings are derived from alignment data stored in flash memory during the initial factory alignment. The DSP processes these data to optimise the power output level relative to the selected programmed channel frequencies.

PA current is monitored via comparator U551B, the output of which is passed via a temperature compensation network R552, R553 and NTC R554, to the ADC, U301C. U301C samples the applied voltage and then passes it to the PLA, after which it is processed by the DSP. The PA current limit value is calibrated as part of the alignment procedure.

3.2.2 Power Control

The final output power is stabilised by a power control feedback loop. A printed circuit transmission line, L561, resistor R560, diodes D561A and D561B, and other associated components, form the power detector. Comparator U551A and associated components provide the power setting and power 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 calibration voltage originates from the PLA as a PWM signal and is integrated for application to the comparator.

The PA module output level variation due to variations of supply voltage, output load or temperature, is detected and applied to the comparator. The comparator proportionally adjusts the PA module bias supply and the bias supply for the PA driver (Q531A) and thus the PA drive level. High temperature protection is provided by thermistor R557, 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 D581, D582 and D583, is switched by transistors Q571, Q572 and Q573 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 C585. The short circuit at the receiver input is transformed to an effective open circuit at D581, by a lumped transmission line (L591), 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 reject, low pass filter comprises L592, L593, L594 and associated capacitors.

3.2.4 Transmitter Audio Processing

The microphone audio input signal is applied to the radio microphone input (AUDIO_IN1) and is derived from an external microphone and pre-amplifier that provides a typical speech signal 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.

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).

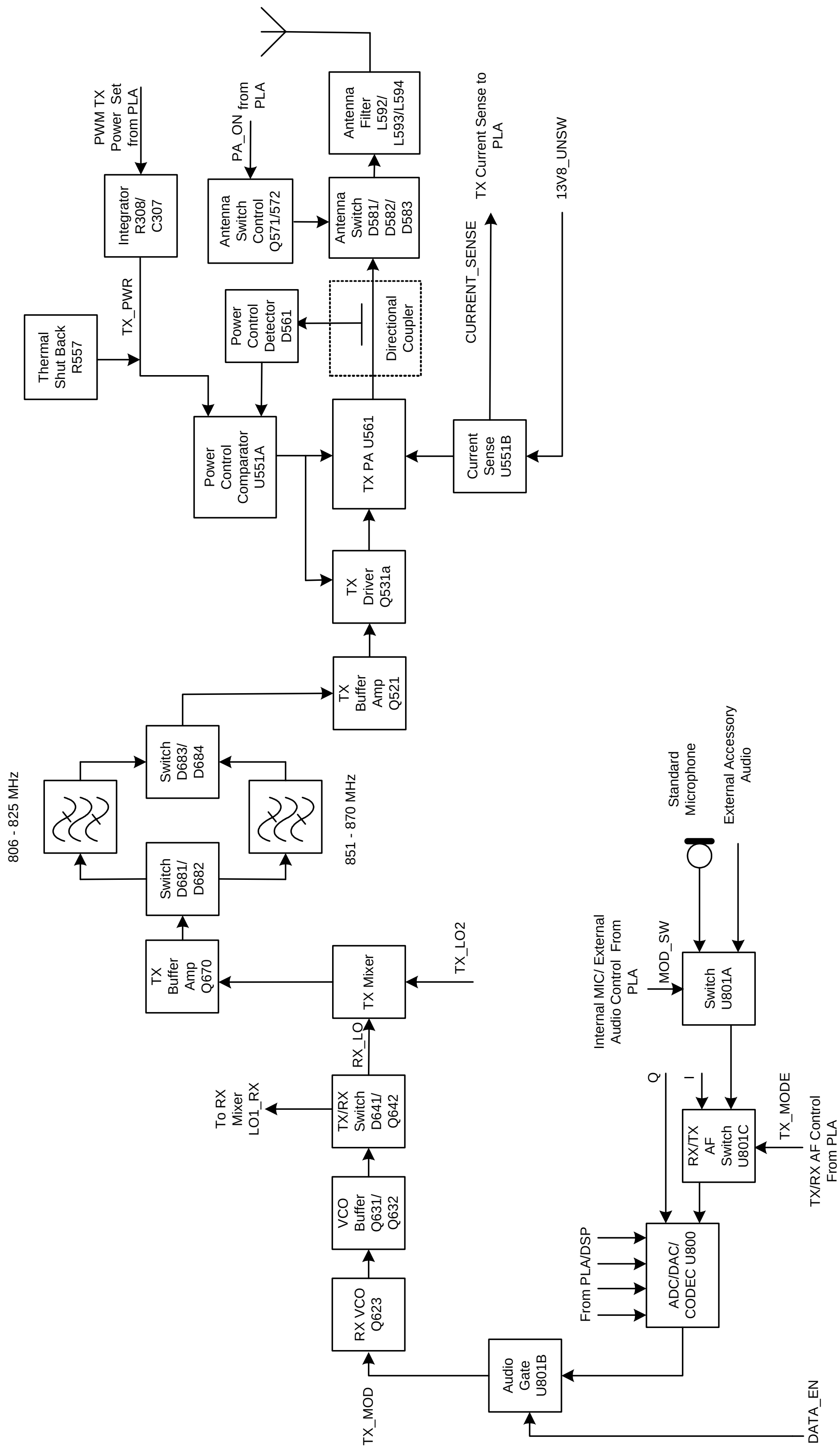


Figure 3-2 Transmitter Block Diagram

3.3 Frequency Synthesiser

3.3.1 General

Refer to Figure 3-3.

The frequency synthesiser consists of the RX VCO, the second local oscillator VCO (90MHz), loop filters, varactor positive bias generator, reference oscillator, external divider and an integrated fractional N phase locked loop IC (U721).

3.3.2 PLL

The PLL is a high performance delta-sigma fractional-N device with an auxiliary integer-N PLL (U721).

The PLL contains two prescalers, programmable dividers and phase comparators, to provide a main and an auxiliary PLL. The main PLL of U721 controls the frequency of the RX VCO via CPRF at pin 1 and VCO feedback to FINRF at pin 4. The auxiliary PLL is used to control the receiver 90MHz second LO VCO via CPIF at pin 16 and VCO feedback to FINIF at pin 13. The PLL operation involves the external frequency divider (U760) dividing the 15.36MHz reference oscillator by 32 to produce a PLL input reference of 480kHz; this reference is used directly by the RF PLL phase detector. The RX VCO frequency is sampled and divided down and compared to the reference frequency. 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 LD pin 12 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.

For the IF PLL, the input reference is divided by 4 to produce a 120kHz phase comparator reference, which is a sub-multiple of the 90MHz second LO VCO.

3.3.3 VCOs

The main RX VCO uses a low noise bipolar transistor (Q623) and associated parts to generate signal frequencies from 896MHz to 960MHz. Electronic tuning is provided by varactor diode (D610) with its control voltage derived from the Loop Filter, PLL and +16 volt Bias Generator. VCO buffer (Q631 and Q632) isolates the VCO from any load variations from its following circuits. The active power supply filter (Q622) minimises any supply related noise. A PLL feedback signal is returned from the VCO buffer output via amplifier Q640.

The 90MHz receiver second LO VCO comprises Q730 and associated parts. Automatic tuning is achieved by applying a control voltage to D730 and D731, via Loop Filter R718, R719, R720, C732, C733 and C734.

3.3.4 Positive Bias Generator and Loop Filter

A positive bias voltage for varactor D610, has been used to achieve the required broadband tuning range of the VCO. PLL device, U721, is programmed to deliver a nominal +1.65V output from phase detector/charge pump CPRF, for any channel frequency selected. The CPRF voltage is filtered by the Loop Filter comprising C605, C607, C607a, C609a, R609 and R612; the loop filter removes any synthesiser noise or reference products. The resulting low noise control voltage is applied to the anode side of VCO varactor. The cathode voltage of D610 is controlled by the output of voltage level translator Q780, Q781, Q782 and Q783. The level translator supply voltage is +16V, which is provided by U904E/F. The level translator output voltage is accurately controlled by the PLA/DSP from values stored during VCO alignment. This voltage is varied versus frequency to maintain a typical CPRF value of +1.65V.

3.3.5 Phase Modulator

The modulation path for audio, data and higher frequency CTCSS signals is via varactor D610 and associated components. The reference input to the PLL (REFIN) provides the low frequency modulation path via a phase modulator.

The phase modulator comprises the following sections:

- Integrator U761A is a low pass filter providing 6dB per octave attenuation to frequencies above approximately 10Hz.
- Divider U760 divides the 15.36MHz reference frequency down to 480kHz.
- Ramp generator Q771 and Q772 provides a sawtooth 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 sawtooth ramp.

The divided reference signal is differentiated and discharges C778 via Q771, after which Q771 is turned off allowing C778 to recharge via constant current source Q772.
The Schmitt Trigger comprising Q774, Q775 and Q776, converts the modulation combined with the sawtooth ramp, to a square wave output, the duty cycle of which is controlled by the ramp slope and modulation.

The Modulation Balance adjustment is carried out using a CODEC-generated 100Hz square wave applied to the TX_MOD input and set to give an optimum demodulated square wave output.

3.3.6 Reference Oscillators

Two TCXOs are used as optional reference frequencies for carrier frequency generation and also to provide the DSP clock. U711 is the principal TCXO and operates at 15.36MHz and U712 is the alternate TCXO and operates at approximately 15.359767MHz. The alternate TCXO (U712) is frequency shifted to avoid specific receiver interference products. U711 and U712 are selected by the REF_SHIFT line, which controls the complementary switch (Q711 and Q712). The outputs of U711 and U712 are connected to the PLL reference divider (U760) and to the input of U701, a high frequency PLL, the output of which provides the DSP clock signal.

The carrier frequency adjustments for U711 and U712 are achieved by setting the ADJ voltage by using the Alignment Tool. In addition, the ADJ input is used in a frequency control loop with the receiver I and Q signals, to provide receiver AFC. The TCXOs are specified at ±1.5ppm frequency stability over the temperature range -30° to +75°C.

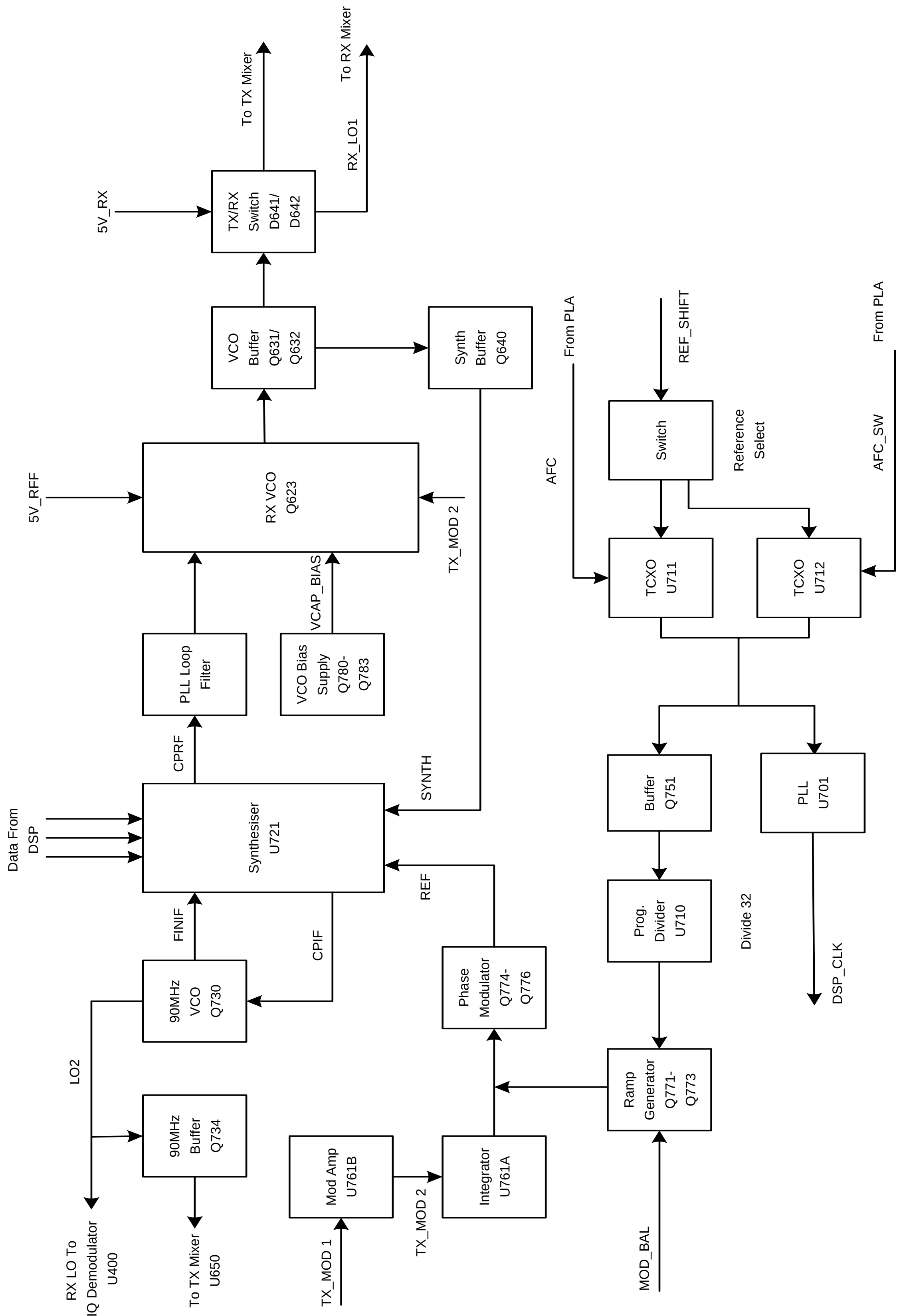


Figure 3-3 Synthesiser, Block Diagram

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
- Receiver muting control
- TCXO/ Alternate TCXO select
- 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 PLA PWM

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

The front-end tune signals (TUNE1 and TUNE2) originate from the PLA in the form of PWM signals. The values for these signals are stored in flash memory from radio alignment and are selected depending on the channel that the radio is currently tuned to. The PWM signals are integrated by RC networks to provide the analog tuning voltages for the varicap tuning diodes.

Other analog PWM derived signals used are transmitter power (TX_PWR), PLL varicap bias (VCAP_ADJ), receiver IF gain (IF_GAIN), Automatic Frequency Control (AFC), AFC Switched (AFC_SW), VCO automatic level control (VCO_ALC) and modulation balance (MOD_BAL).

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

Analog voltages to be monitored such as PLL Loop Voltage (LOOP_VOLTS), battery voltage (BAT_SENSE), transmitter current (CURRENT_SENSE) and external sense (EXT_SENSE) are connected to the inverting inputs. The analog 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 at which 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 RAMs 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 Alignment Tool. DSP SW comprises Start-up code that is also loaded by the factory. High-level software comprising Operational Code and Customer Configuration are loaded at distribution centres and are loaded via the FPP Programmer.

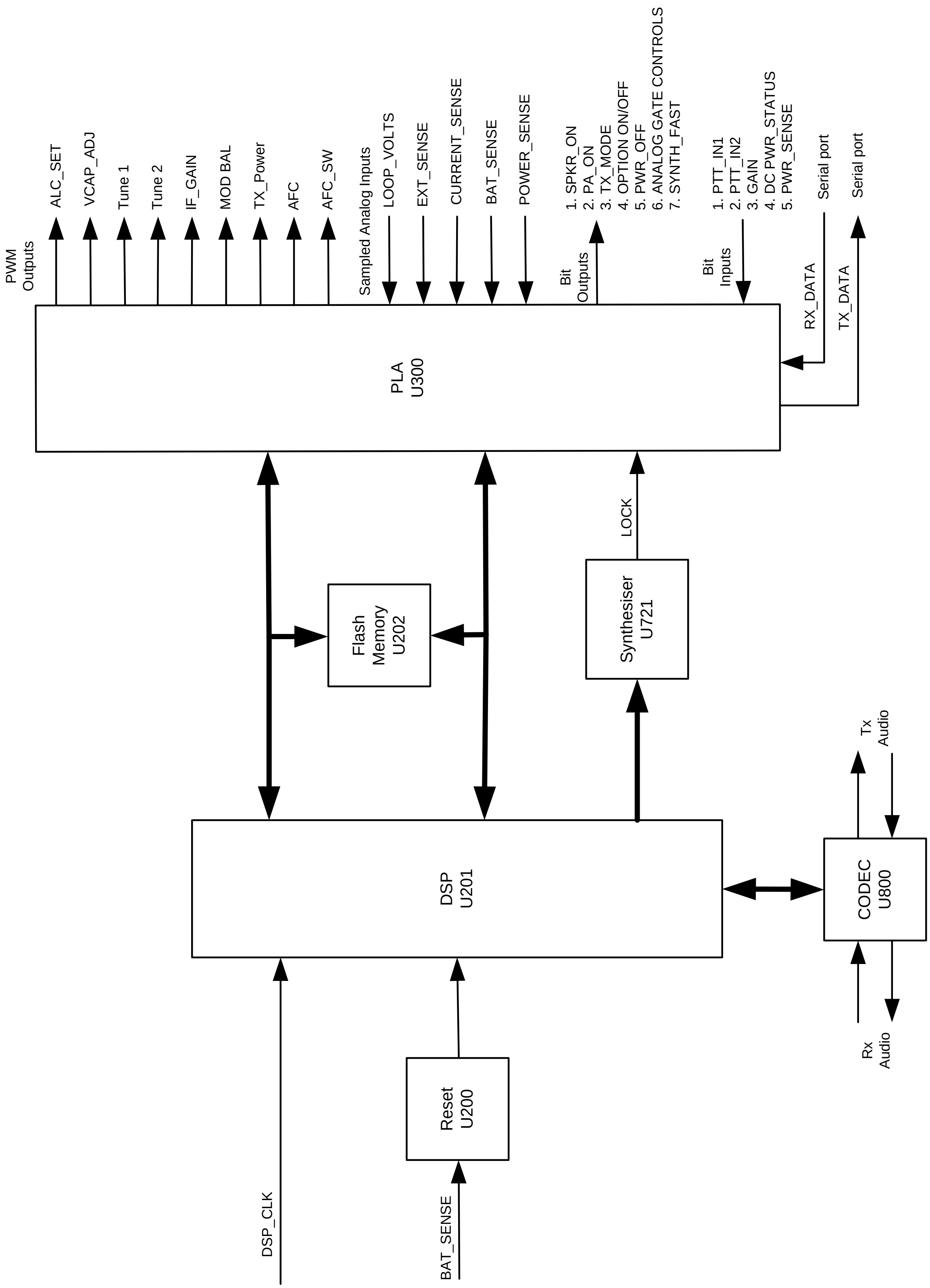


Figure 3-4 Controller Block Diagram

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 and positive voltage generators. 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 (Q900) 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 (8V RF)

- Tx buffers Q521, Q531a
- VCOs and VCO buffers via active filter Q622

Regulated 8.0V switched supply (5V RX)

- Rx front end
- IF Amplifier
- Various switching functions

3.6.2.2 5V Regulator U901

Regulated 5.0V supply (5V A, 5V D, 5V RF and 5V RFF)

- Synthesizer buffer Q640
- VCO varactor positive supply Q780 to Q783
- TCXOs U711 and U712
- TCXO divider U760
- Rx audio amplifiers U802/U803
- Rx mute switch Q810 to Q813

Regulated 5.0V switched supply (5V TX and Tx PSU+)

- Tx power control U551
- Tx buffers Q501 to Q531a
- 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)

- Analog supply for CODEC U800

Regulated 3.3V supply (3Q3)

- I/Q demodulator U481

Regulated 3.3V supply (3P3)

- Digital supply for PLL U701

Unregulated 13.8V (13V8_UNSW)

- Tx PA module U500
- Antenna changeover switch Q571/572/573

3.6.2.4 2.5V Regulator U903

Regulated 2.5V supply (2V5)

- DSP core U201
- PLA core U300

3.6.2.5 Negative and Positive High Voltage 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)

- Rx audio power amplifier U805
- Rx mute switch Q811

4. ALIGNMENT (LEVEL 3 SERVICE ONLY)

4.1 GENERAL

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 the 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.

Each transceiver will need to be individually tested and to have the resultant calibration data stored within it. This data cannot be modified by the user or by the normal customisation (eg. channel frequency, selcall ID etc.) process. It is set during the manufacturing process and may be modified for maintenance purposes by use of the Alignment Tool.
For customer channels between each pair of test frequencies, an interpolation is automatically carried out to determine the correct DAC values at the relevant frequency for the above calibration parameters.

For all of the following alignment procedures it is assumed that the radio is connected to a Comms. Analyser or equivalent collection of test equipment. The alignment is performed at room temperature, with a 50Ω termination on the antenna connector and with a power supply set to give 13.2V at the radio connector.

Warning

The RF power output from the transmitter during these tests can cause burns and can be dangerous to some discrete items of test equipment, hence power attenuators may be needed. Also the heat generated inside the radio after a long period of transmission can be hazardous.

Calibration sequence

On a set that has not previously been calibrated or in which the calibration has been corrupted, preset parameters should be initially loaded into the radio for optimum alignment, after which the calibration steps must be carried out in the following order. These preset parameters may be obtained by reading a previously aligned radio or by loading predetermined default values.

A number of aspects of the radio need to have calibration data determined and stored during manufacture and subsequently used by the S/W during normal operation. These must be aligned in the following order:

- Tx and Rx VCO
- TCXO's
- Tx power
- VCO ALC
- Tx modulation (deviation and then mod balance)
- Rx and Tx filter tuning
- Rx mute
- RSSI
- Tx Current Limit

4.1.1 Test Equipment

1	Radio transceiver test set	CMS-50 Comms. Analyser 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 7.5 amps.
3	Oscilloscope	20 MHz bandwidth minimum
4	SRM9000 Programming & Alignment Lead	P/N MAR-PROGLEAD
5	SRM9000 Radio Test Interface Unit	P/N TBD
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
9	SRM9000 Battery Cable	
10	RF coax double shielded – N Type male to TNC male.	

4.1.2 Alignment Frequencies

Channel	0	1	2	3
	Low_RP	High_RP	Low_TA	High_TA
Rx	851.075	869.975	N/A	N/A
Tx	806.025	824.925	851.025	869.925

4.1.3 Preset Parameters

The table below defines the preset alignment settings for the radio DAC's. These will be programmed into the radio prior to performing an initial alignment. The **Fixed** values are not altered by the alignment adjustments whereas the **Adjustable** values are used as starting points for alignment where the radio has not been calibrated previously, or where the calibration has been corrupted.

Variable Name	DAC Value	
	Alignment Adjustable	Alignment Fixed
Synth_DAC_TX_Low_RP	193	
Synth_DAC_TX_High RP	158	
Synth_DAC_TX_Low_TA	106	
Synth_DAC_TX_High_TA	66	
Synth_DAC_RX_Low	193 (note 1)	
Synth_DAC_RX_High	158 (note 1)	
Front_End_Tune1_Low	110	
Front_End_Tune2_Low	110	
Front_End_Tune1_High	185	
Front_End_Tune2_High	185	
Tx_Filter_Low_RP	60	
Tx_Filter_High_RP	90	
Tx_Filter_Low_TA	130	
Tx_Filter_High_TA	170	
Tx_Low_Power_Low_RP	55	
Tx_Mid_Power_Low_RP	95	
Tx_High_Power_Low_RP	210	
Tx_Low_Power_High_RP	55	
Tx_Mid_Power_High_RP	95	
Tx_High_Power_High_RP	210	
Tx_Low_Power_Low_TA	55	
Tx_Mid_Power_Low_TA	95	
Tx_High_Power_Low_TA	210	
Tx_Low_Power_High_TA	55	
Tx_Mid_Power_High_TA	95	
Tx_High_Power_High_TA	210	

Variable Name	DAC Value	
	Alignment Adjustable	Alignment Fixed
VCO_Mod_Limit_Low_RP	14000	
VCO_Mod_Limit_High_RP	16500	
VCO_Mod_Limit_Low_TA	18300	
VCO_Mod_Limit_High_TA	19000	
Modulation_Bal_Low_RP	40	
Modulation_Bal_High_RP	80	
Modulation_Bal_Low_TA	105	
Modulation_Bal_High_TA	125	
VCO_ALC_Low_RP	75	
VCO_ALC_High_RP	80	
VCO_ALC_Low_TA	95	
VCO_ALC_High_TA	100	
Sq_Upper_Threshold	2600	
Sq_Lower_Threshold	1000	
TCXO	14800	
Alternate TCXO	6000	
CGF_Current		15
CPG_Current		5
CPT_Timer		6.666
PA_On_Timer		8
CPT2_Timer		255
CPG2_Current		0
Tx_Current_Limit		44 (typ)
Power_Ramp_High_Power_Up_0		0
Power_Ramp_High_Power_Up_1		67
Power_Ramp_High_Power_Up_2		67
Power_Ramp_High_Power_Up_3		215
Power_Ramp_High_Power_Up_4		215
Power_Ramp_High_Power_Up_5		215
Power_Ramp_High_Power_Up_6		215
Power_Ramp_High_Power_Up_7		215

Variable Name	DAC Value	
	Alignment Adjustable	Alignment Fixed
Power_Ramp_High_Power_Up_8		215
Power_Ramp_High_Power_Up_9		215
Power_Ramp_High_Power_Down_0		215
Power_Ramp_High_Power_Down_1		158
Power_Ramp_High_Power_Down_2		96
Power_Ramp_High_Power_Down_3		46(abs)
Power_Ramp_High_Power_Down_4		0
Power_Ramp_High_Power_Down_5		0
Power_Ramp_High_Power_Down_6		0
Power_Ramp_High_Power_Down_7		0
Power_Ramp_High_Power_Down_8		0
Power_Ramp_High_Power_Down_9		0
Power_Ramp_Low_Power_Up_0		10(abs)
Power_Ramp_Low_Power_Up_1		56
Power_Ramp_Low_Power_Up_2		56
Power_Ramp_Low_Power_Up_3		56
Power_Ramp_Low_Power_Up_4		56
Power_Ramp_Low_Power_Up_5		56
Power_Ramp_Low_Power_Up_6		56
Power_Ramp_Low_Power_Up_7		56
Power_Ramp_Low_Power_Up_8		56
Power_Ramp_Low_Power_Up_9		56
Power_Ramp_Low_Power_Down_0		56
Power_Ramp_Low_Power_Down_1		26(abs)
Power_Ramp_Low_Power_Down_2		0
Power_Ramp_Low_Power_Down_3		0
Power_Ramp_Low_Power_Down_4		0
Power_Ramp_Low_Power_Down_5		0
Power_Ramp_Low_Power_Down_6		0
Power_Ramp_Low_Power_Down_7		0
Power_Ramp_Low_Power_Down_8		0
Power_Ramp_Low_Power_Down_9		0

Note 1. These values are automatically set and should equal Synth_DAC_TX_Low_RP and Synth_DAC_TX_High_RP values respectively.

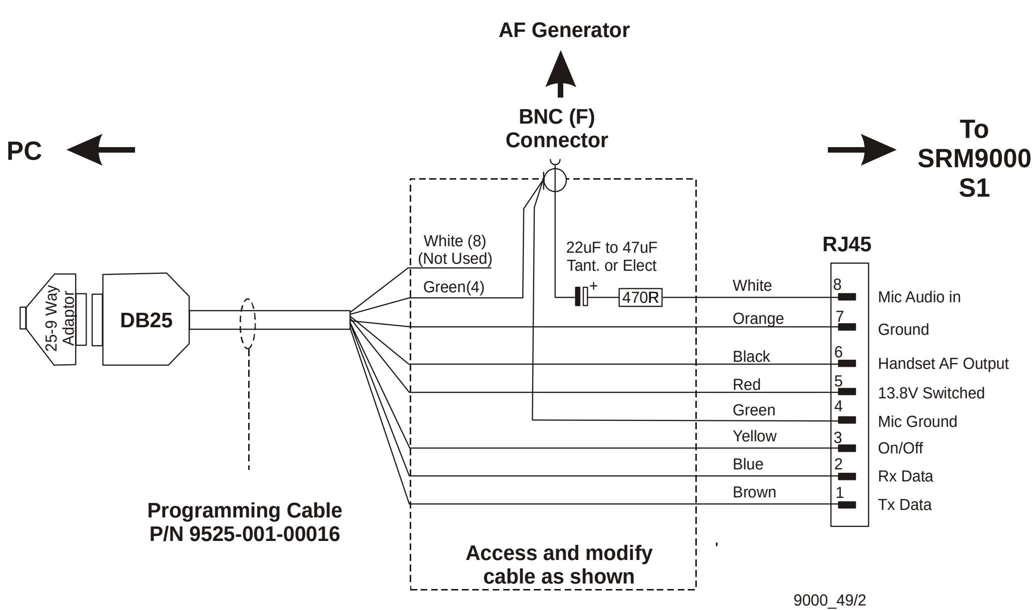
4.1.4 Alignment Limits

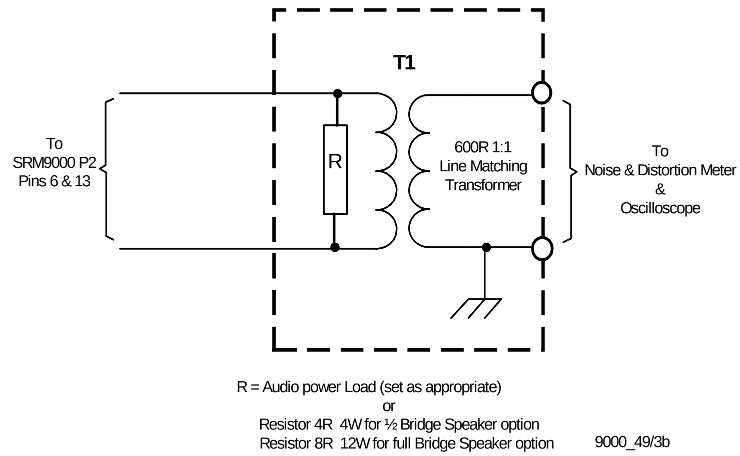
TEST NAME	HIGH LIMIT	LOW LIMIT	UNIT
TCXO Alignment	+50	-50	Hz
TX POWER 1.0W	1.06	0.94	W
TX POWER 5W	5.20	4.80	W
TX POWER 27.5W	28.0	27.0	W
VCO MOD LIMIT (Max peak)	2300	2250	Hz
MOD BALANCE	+5%	-5%	Flatness
RX FILTER 1,2	Auto aligned	Auto aligned	
TX FILTER 1,2,3,4	Preset	Preset	
RSSI CAL @ -90dBm	2000	500	
SQUELCH OPEN	11.5	8.5	dBS
SQUELCH CLOSED	7.0	3.0	dBS

4.1.5 Band specific frequency limits

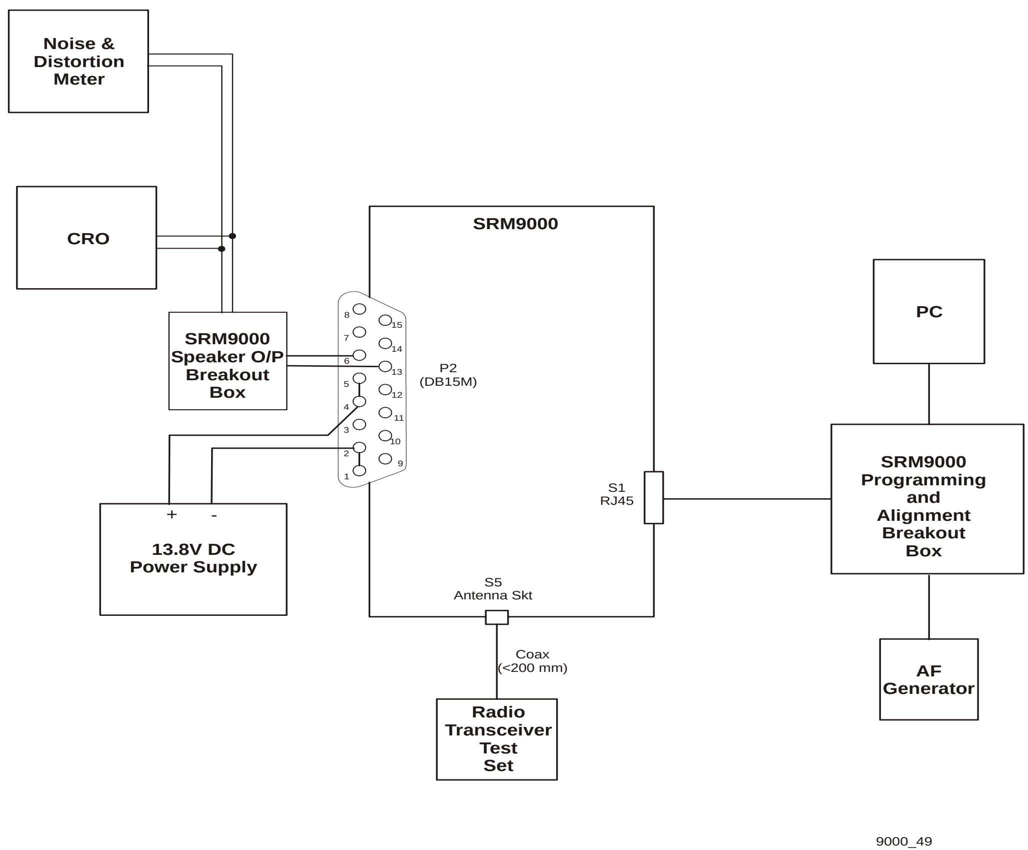
TEST NAME	HIGH LIMIT	LOW LIMIT	UNIT
VCO - Rx	915.000	896.000	MHz
VCO - Tx	960.000	896.000	MHz

4.1.6 SRM9000 Radio Test Interface Unit





4.1.7 Test Setup

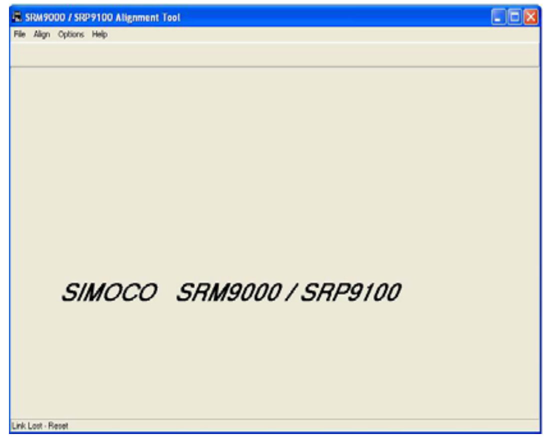


1. Connect the radio to the test equipment as shown above.
2. Switch on the DC Power Supply.

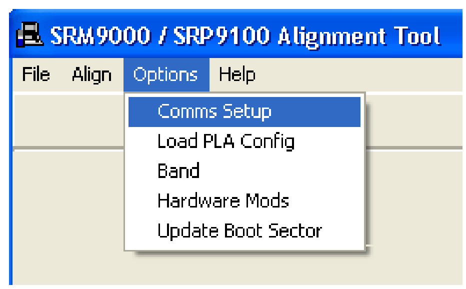
4.1.8 COMMS Setup

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.



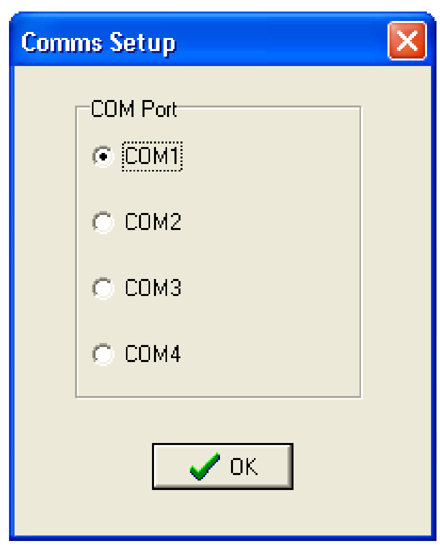
2 Go to the ***Options*** menu and choose ***Comms Setup.***



3 The ***Comms Setup*** dialogue box is displayed.

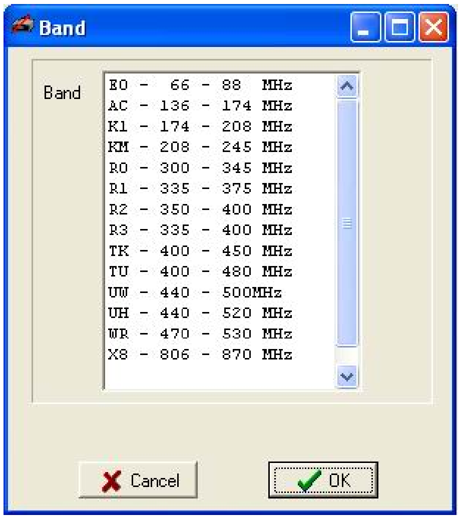
Select the Comms Port setting appropriate to the configuration of your PC and choose ✓**OK**.

(Usually COM1)



4.1.9 Band Preparation

1 Go to the ***Options*** menu and choose ***Band.*** Select appropriate band and choose ✓**OK**.



4.1.10 Hardware Options Select

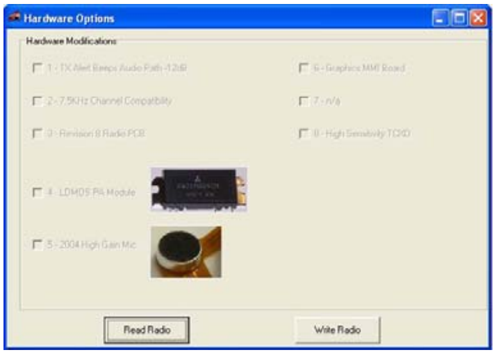
1 ***Options*** menu choose ***Hardware Mods.***

Press **Read Radio.**

Tick ✓ the box according to the revision as desired as in the table below.

Press **Write Radio.**

(Press **Read Radio** again make sure the selected options are still ticked).



4.1.11 Radio Preparation

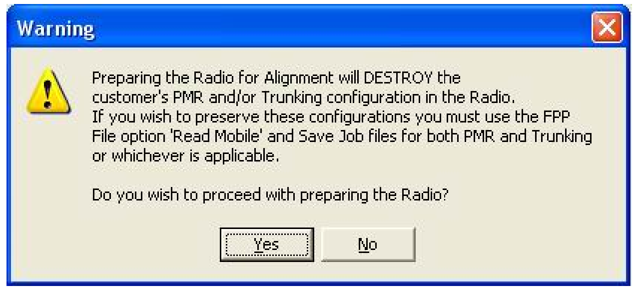
Radio parameters are to be aligned sequentially as detailed in this procedure.

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

2 The ***WARNING*** is displayed.

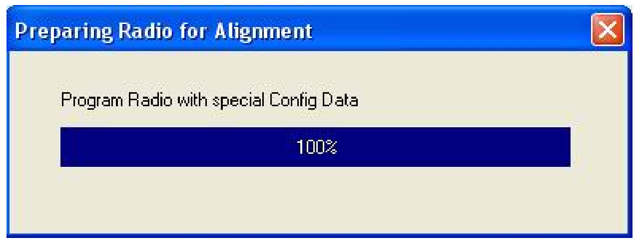
Choose ***No*** if you want to save the configuration and use the FPP software to read and save the data to a file.

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 levels. 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.

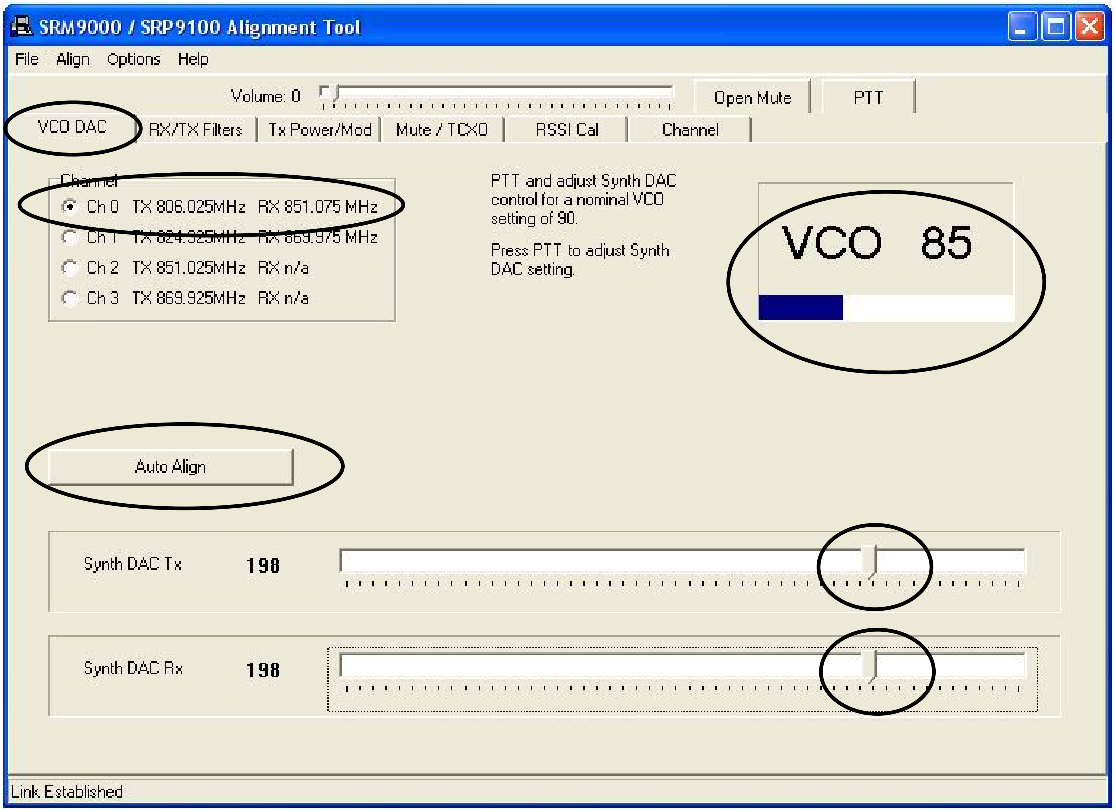
4.1.12 ALIGNMENT PROCEDURE

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

4.1.13 VCO DAC Alignment

The frequencies generated by the Tx and Rx VCO's are determined by the synthesiser loop output for fine control and by a DAC setting for coarse control. The DAC needs calibrating at each of four test frequencies. No calibration is necessary for the receiver 2nd LO.

During this procedure, the alignment program puts the radio into a special mode in which it ignores the 'out of lock' signal from the synthesiser.



Calibration procedure

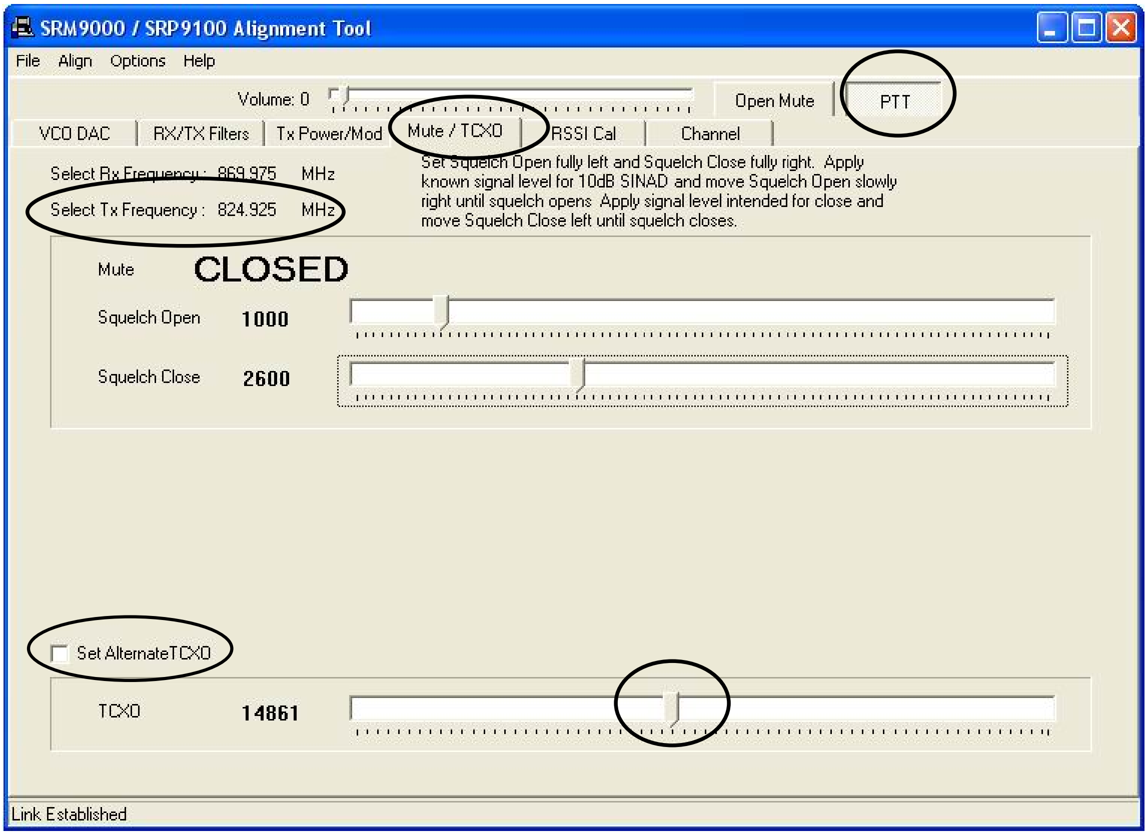
1. Select the ***VCO DAC*** page.
2. Select ***PTT*** with no modulation.
3. Select ***Auto Align.*** The ***Synth DAC Tx*** slider will automatically adjust its value for each transmitter alignment frequency to set the VCO loop filter value between 87 and 93.
4. The ***Synth DAC Rx*** slider must be set to the same Tx value for Channels 0 and 1 only.

   This is automatically set when ***Auto Align*** is selected.

4.1.14 TCXO DAC Alignment

General

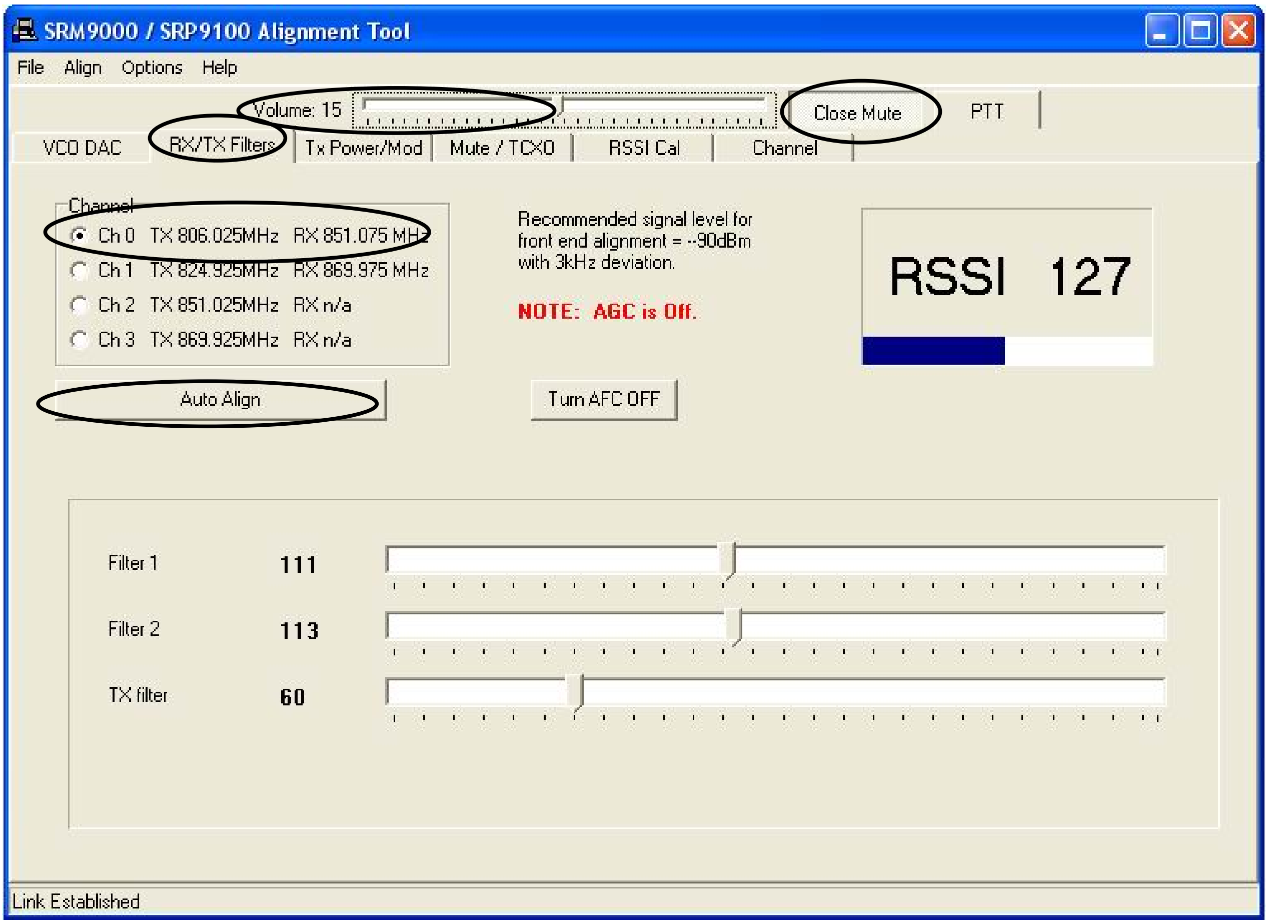
The optimum radio case temperature for TCXO alignment is around 25°C although a temperature between 20°C and 30°C is permissible. If the radio has been allowed to exceed this range during previous transmit cycles, it should be allowed to cool until it is within the permissible range.



Calibration procedure

1. Select the ***Mute/TCXO*** page.
2. Select ***PTT***.
3. Adjust the ***TCXO*** slider to ensure that the transmit frequency error is within 50Hz of 824.925000MHz.
4. Select “***Set Alternate TCXO***”.
5. Adjust the ***TCXO*** slider to ensure that the transmit frequency error is within 50Hz of 824.912500MHz.
6. Deselect “***Set Alternate TCXO”.***
7. Deselect ***PTT***.

4.1.15 Rx Front End DAC Alignment



Calibration procedure

1 Ensure that the TCX0 Alignment has been done before proceeding with this section.

2 Select the ***Rx/Tx Filter*** 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 Select ***Channel 0***

6 Set the Signal Generator to the Channel 0 carrier frequency, with a 1000Hz modulation signal, a deviation of ±3 kHz and a RF level of -90dBm.

The RSSI bar-chart display should now be (typically) well above a reading of 20.

7 Select ***Auto Align***.

The front end will be tuned automatically and finish with an RSSI reading of typically around 150..

8 Change deviation to 1.5kHz.

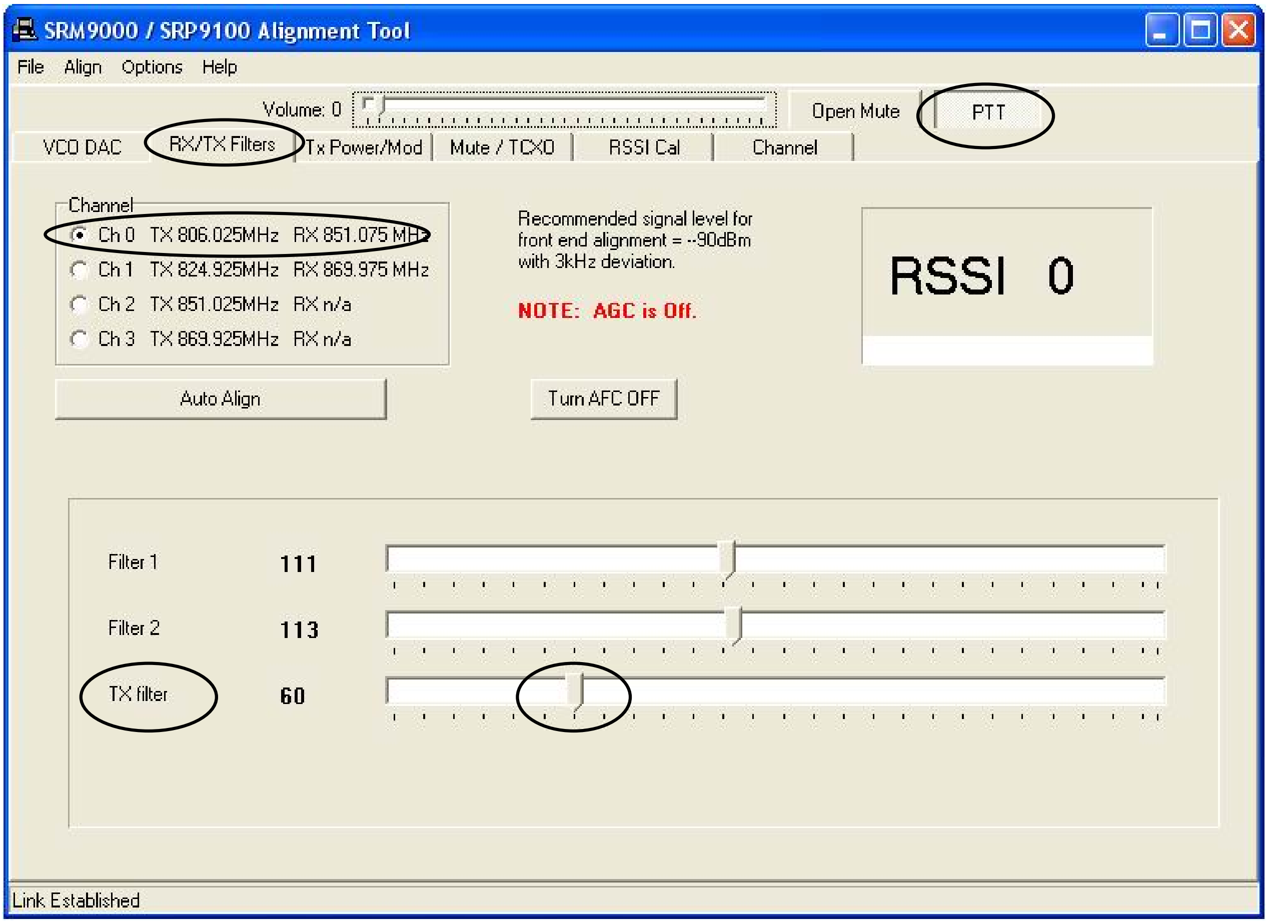
9 Verify that the receiver sensitivity is better than -117.5dBm for 12dB SINAD. (Sensitivity is typically -120dBm).

10 Repeat Steps 7 to 9 for Channel 1.

4.1.16 Tx Filter DAC Alignment

General

This filter should be set so that the Tx spurious emission at 180MHz above the carrier frequency is adequately notched.

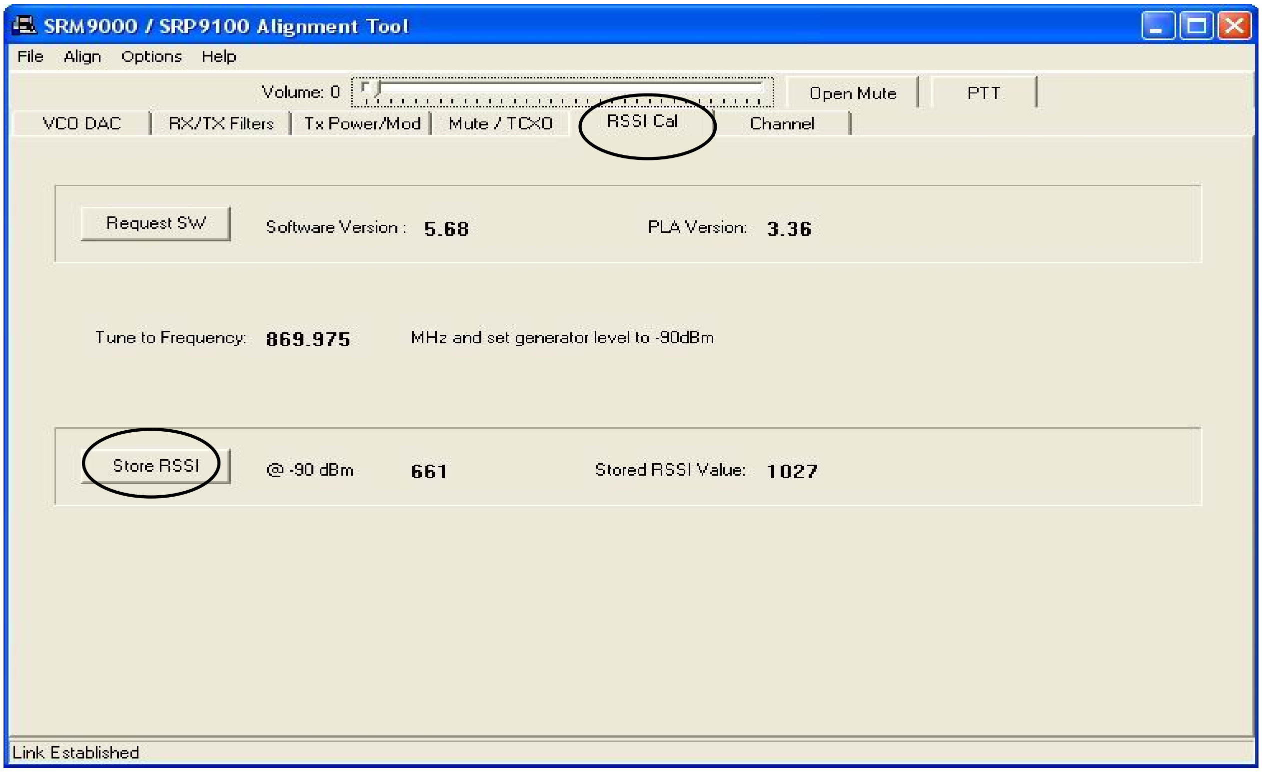


Calibration procedure

Note. This step is only required if Tx Filter DAC values have been corrupted.

1. Select the ***Rx/Tx Filter*** Page
2. Select ***Channel 0***
3. Set DAC to preset value as per Section 2.13.
4. Repeat for the next three channels 1, 2 and 3.

4.1.17 RSSI Calibration

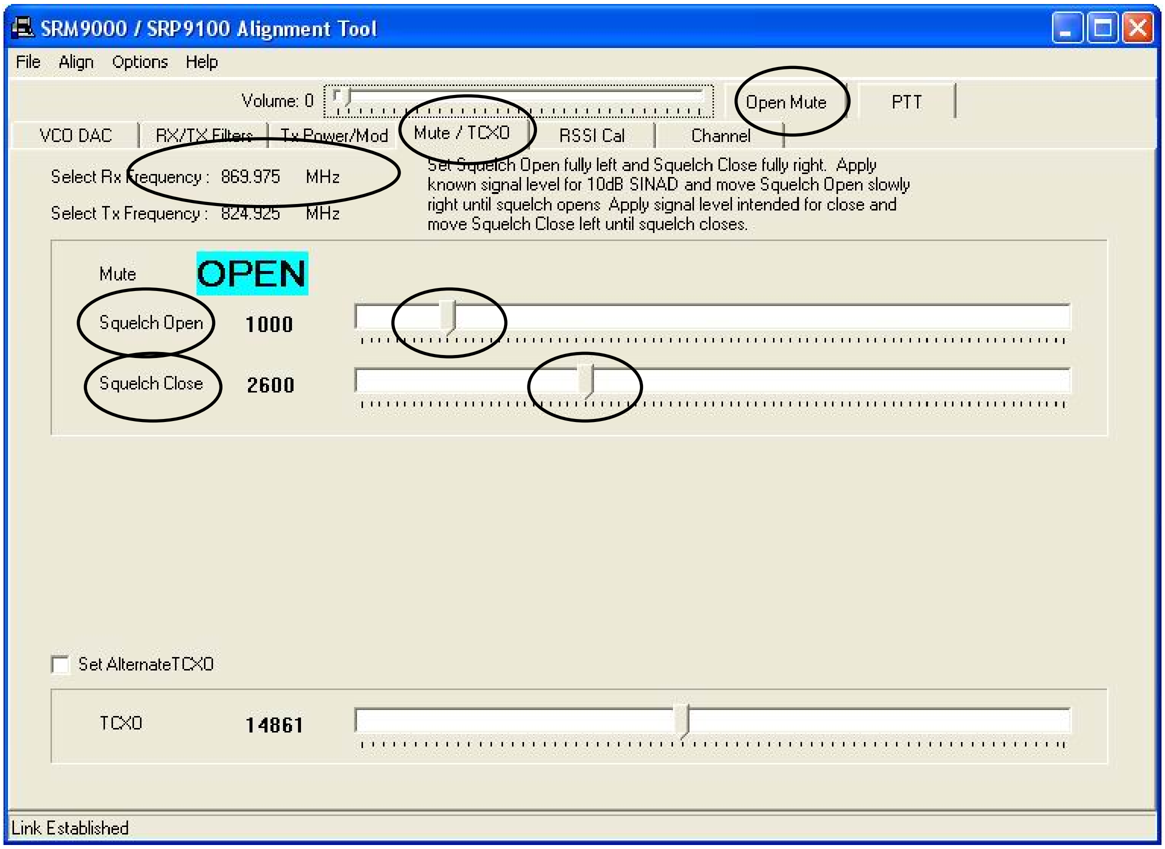


Calibration procedure

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

   The receiver RSSI threshold setting is calibrated.

4.1.18 Mute DAC Adjustment



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

Calibration procedure

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.

4.1.19 Tx Power DAC Alignment

General

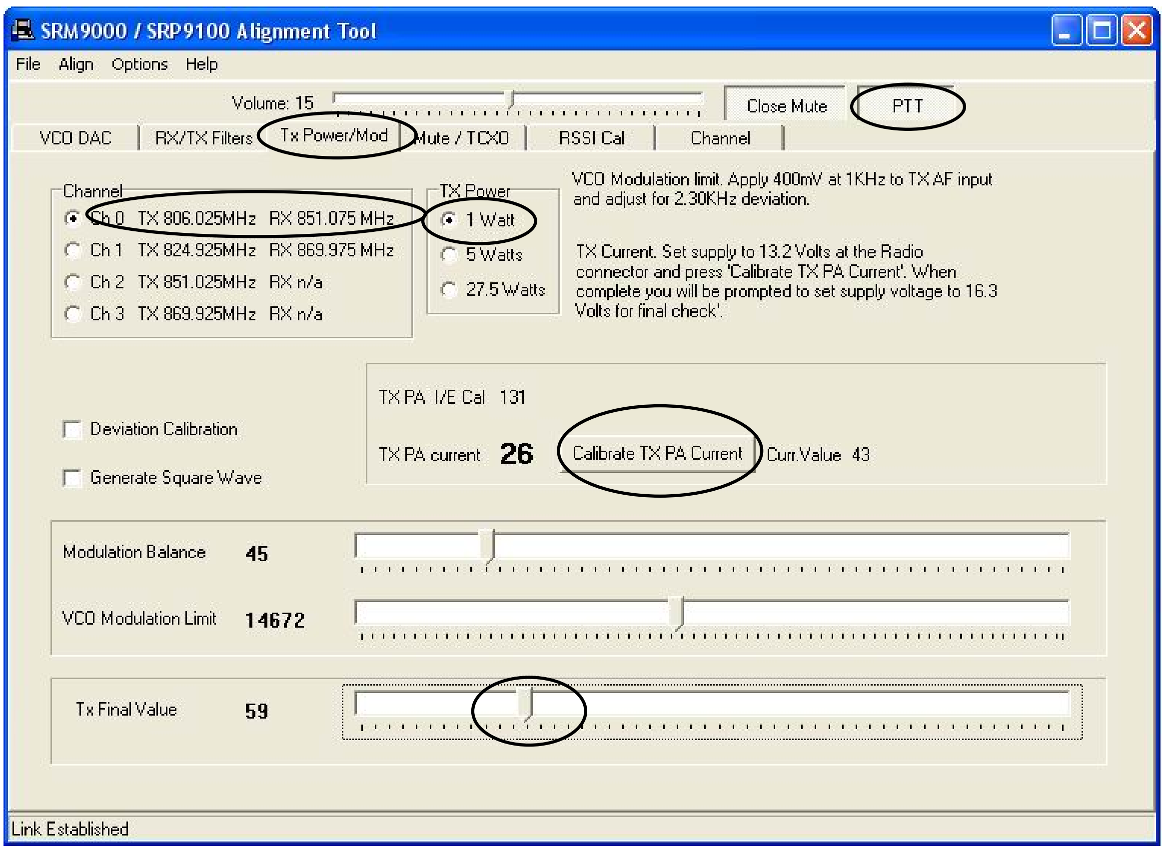
The transmitter output power can be programmed to three power ranges: 1W, 5W and 27.5W by the appropriate setting.

Note 1: Care should be taken not to set the output power and hence supply current to excessive levels, ie. above 30W or 7.5A, since the higher heat dissipation involved may effect component reliability.

Note 2: Also, the antenna connector should be terminated directly into the Comms. Analyser for this test to minimise VSWR effects that could affect settings.

Note 2: Repeat the following steps as quickly as possible to avoid excessive heating the radio, which may affect calibration.

Note 3: The Tx Current Limit setting provides a maximum current limit into the RF PA module to protect it in the event of high dissipation as a result of inadequate drive power being applied relative to the Power DAC setting or high VSWR's



Calibration procedure

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 ***27.5W*** power level.

11 Adjust the ***Tx Final Value*** slider for a power output of 27.5W.

Note that the supply current is less than 7.5A.

12 Repeat step 11 for the remaining 3 Channels (1, 2, & 3).

13 Press ***Calibrate TX PA Current*** button and follow the prompt to automatically set the maximum current limit.

14 The ***PTT*** will automatically dekey after this procedure.

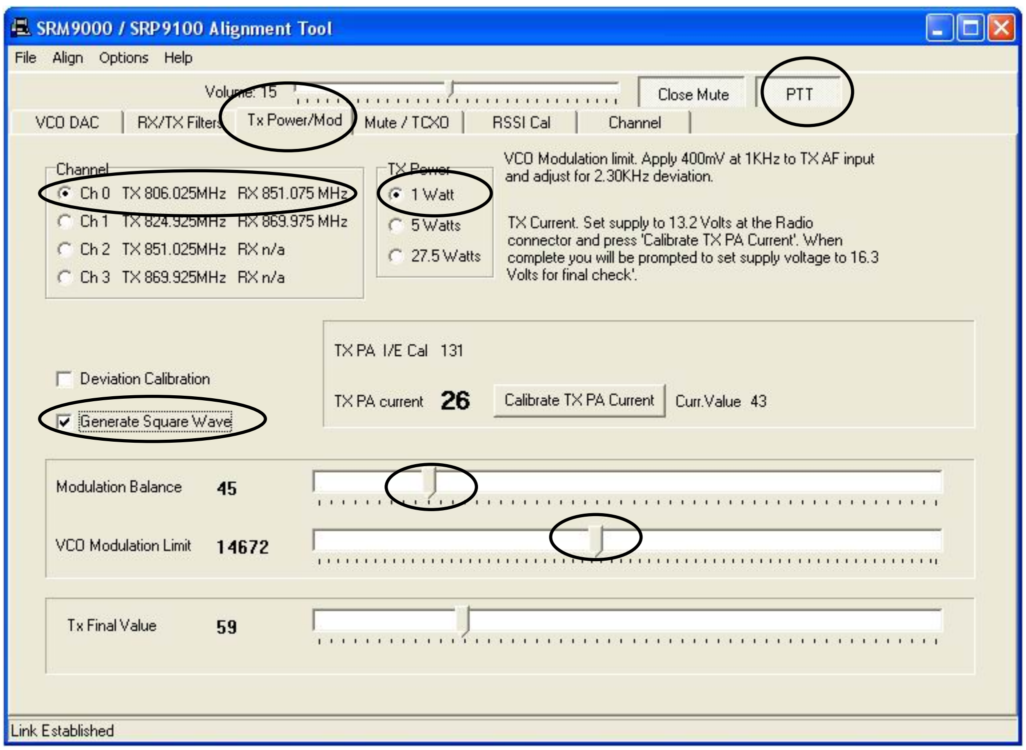
4.1.18 Tx Modulation DAC Alignment

All microphone levels are referenced to the audio level output displayed on the Comms. Analyser and based on <10Ω source impedance.

NOTE: This audio signal is fed to the radio input via a series 470Ω resistor and 47uF capacitor in the Audio/ Serial Interface Adaptor.

General
Dual point modulation is used and there are two settings that need adjusting to meet deviation requirements. The modulation alignment is set up for 12.5kHz channel spacing. For customer configurations of other channel spacings, the modulation alignment is automatically adjusted for those settings.

Note that when measuring deviation at 60% MSD the average of the + and – readings should be used. When measuring maximum deviation, the higher of the + and – readings should be used.



Calibration procedure

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 Select ***PTT*** and adjust the ***VCO Modulation Limit*** DAC to give a maximum peak deviation of 2.30kHz.

6 Reduce the microphone input level to 40mV RMS and check that the deviation is within the range ±1.25 kHz to ±1.75 kHz.

7 Repeat steps 5 to 6 inclusive for the remaining three Channels (1, 2, & 3).

8 Remove the microphone audio input signal

9 Select the ***Generate Square Wave*** function.

10 While viewing the de-modulated signal on the transceiver test set oscilloscope, set to DC coupling, adjust the ***Modulation Balance*** slider for the best square wave symmetry.

Refer to Note below

11 Repeat steps 9 to 10 inclusive for the remaining three Channels (2, 1 & 0).

12 Release the ***PTT*** button.

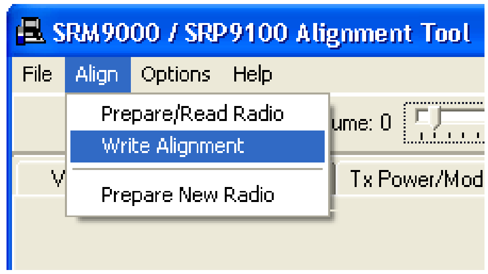
Note: The FM demodulator on the measuring equipment also requires DC coupling for this test to provide correct results. If an HP8920A is used, the top and bottom of the square wave must be set with a 16.6% negative slope.

ie. For a waveform of 4 divisions p-p (neglecting overshoot) the slope should be adjusted to 0.3 divisions.

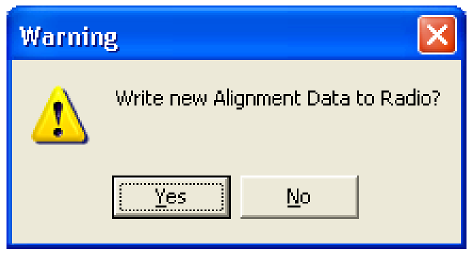
4.1.20 PROGRAMMING ALIGNMENT DATA

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

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

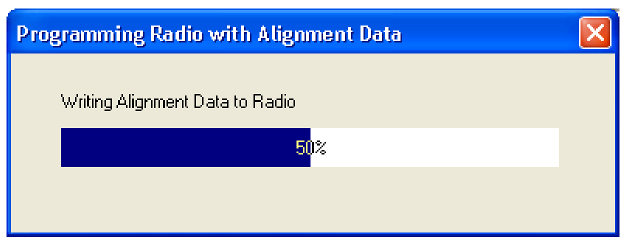


2 A warning message is displayed.



3 Choose ***Yes***.

New alignment data is written to the radio.



4.1.21 CUSTOMER RADIO PERSONALITY DATA

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

5. REPLACEABLE PARTS

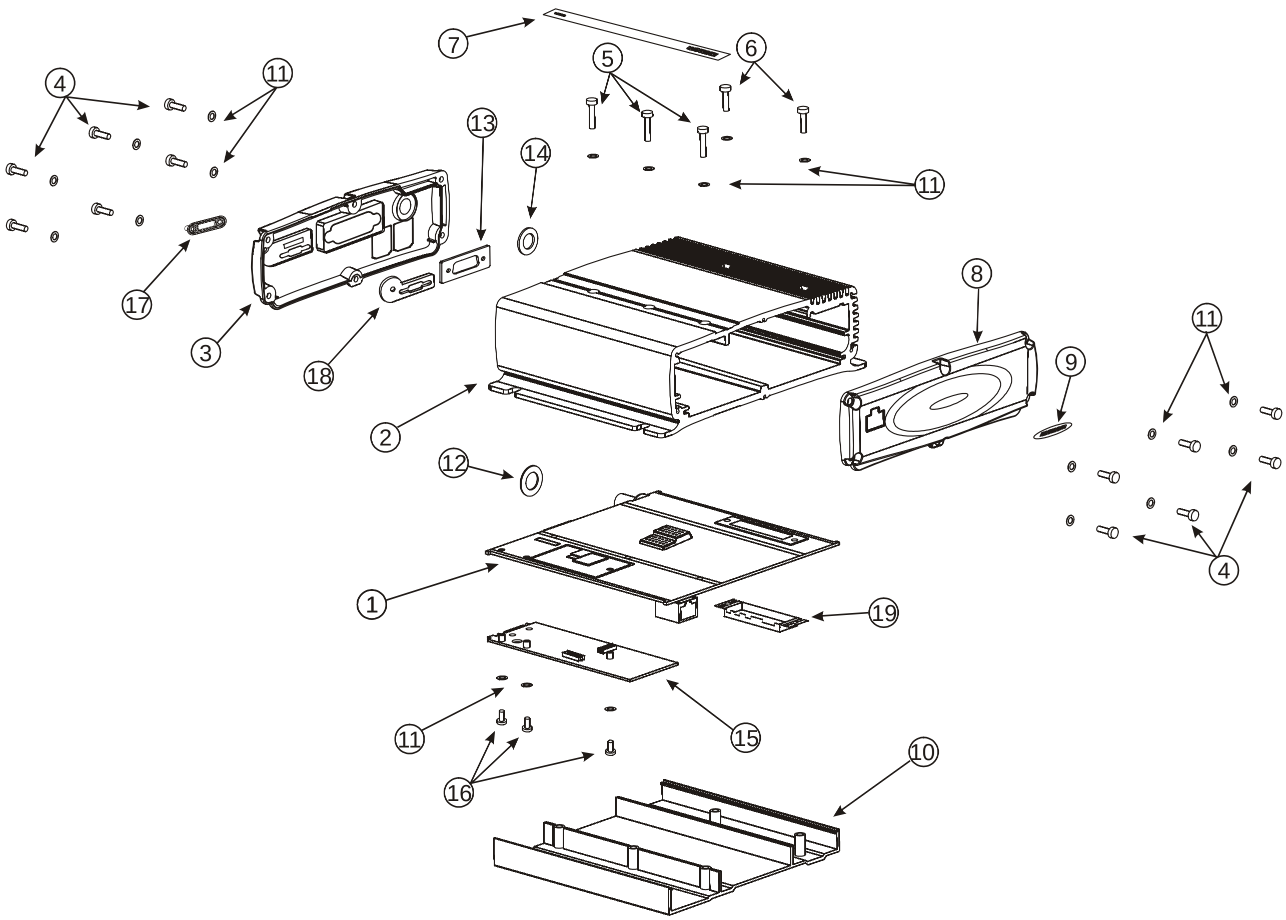


Figure 5-1 Replaceable Parts

5.1 REPLACEABLE PARTS

Ident	Description	Quantity per Assembly	Part Number
1	Radio Board Assembly X8 Band	1	6102 359 6232
2	Extrusion Main Body Macom	1	6102 310 01452
3	End Cap, Rear, P25 Option	1	6102 310 00532
4	Screw End Cap	12	3513 993 85009
5	Screw Tray Retention M3 x 16 Zinc	3	3513 993 57117
6	Screw Tray Retention M3 x 12 Black	2	6102 700 00081
7	Label Transceiver Top Macom	1	6102 303 00242
8	End Cap, Front	1	3513 903 91072
9	Label End Cap, Front Macom	1	6102 303 00251
10	Inner Tray	1	3513 901 70083
11	Washer Fibre	20	3513 907 30241
12	Washer Seal Antenna Connector	1	3513 907 3255A

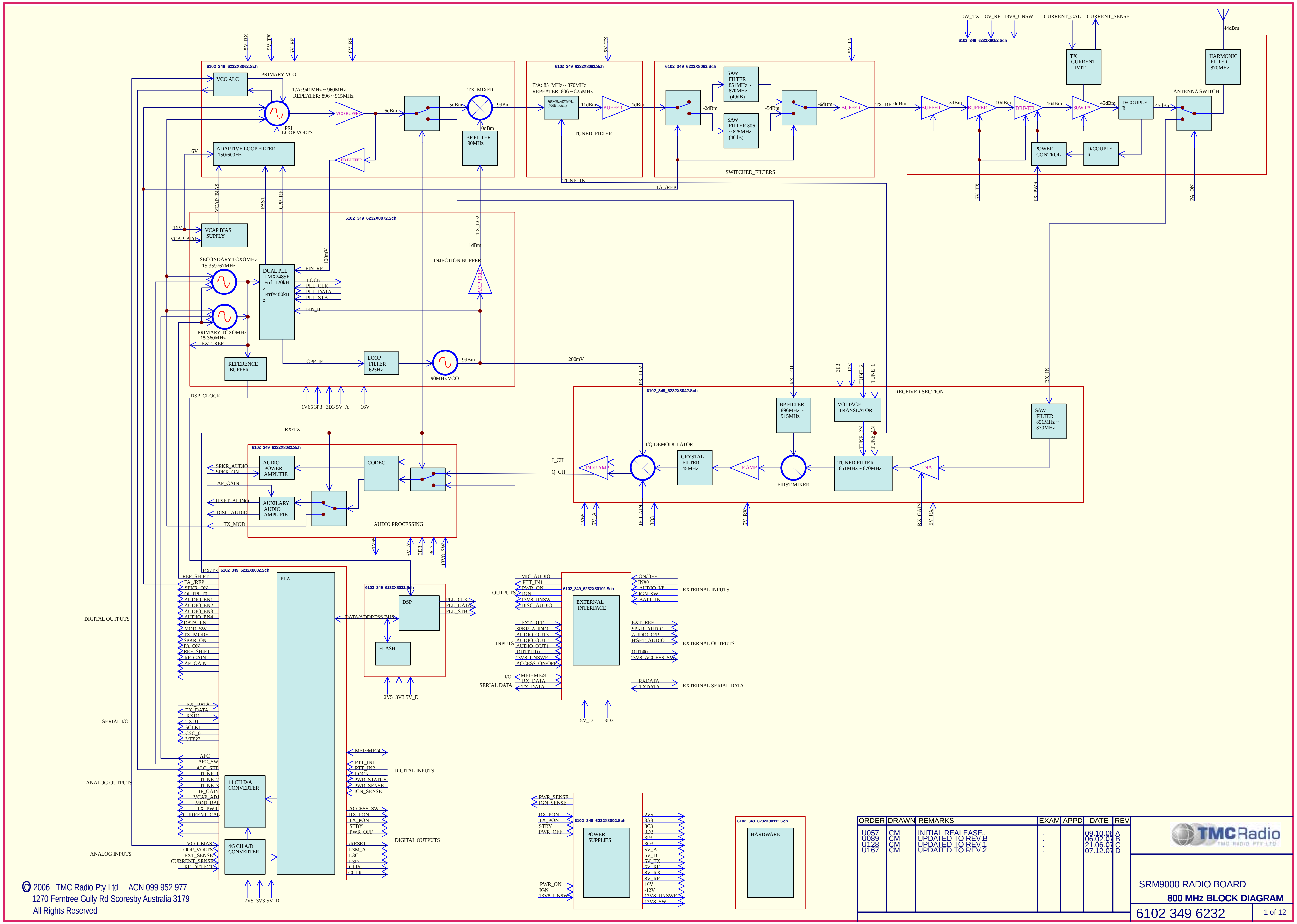
Ident	Description	Quantity per Assembly	Part Number
13	Gasket D Connector	1	3513 902 1082A
14	Gasket Antenna Connector	1	3513 902 10651
15	MAB-2 Option Board- Programmed	1	6102 359 6213
16	Screw Option Board M3 x 6	3	6102 700 00071
17	Dust Cap P25 Option Connector	1	6102 310 01222
18	Gasket P25	1	6102 310 00812
19	Tx PA Shield cover	1	6102 310 01201
	DC Power Cable Macom	1	6102 350 13591
	RJ45 Connector, S1	1	6102 621 00121
	DB15 Connector, P2	1	3513 993 02063
	Antenna TNC connector, S501	1	6102 310 01431
	Audio PA Module U805	1	3513 999 52036
	Voltage Regulator U900, U901, U912	1	6102 822 00121
	Voltage Regulator U903	1	6102 822 00161
	Temperature Controlled Crystal Oscillator, U711 & U712	1	6102 922 00011
	Transient Suppressor Diode, D900	1	6102 012 00031
	Transmit Receive Switch, Q541	1	3513 999 00006
	ON/OFF FET Q7, Q900	1	6102 062 00051
	Tx PA Module RA45H8087M-101, U561	1	6102 861 00153

6. SCHEMATICS

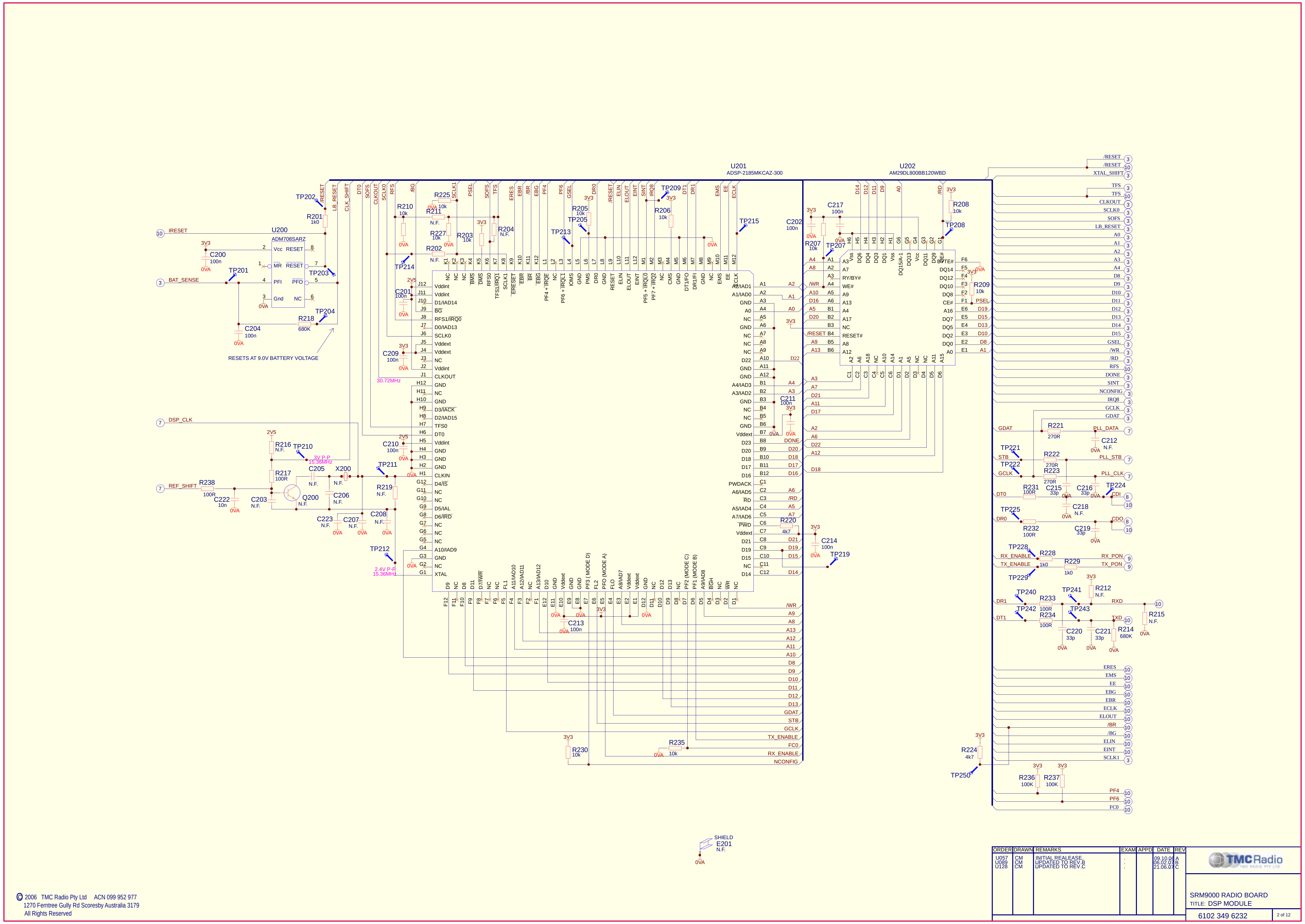
6.1 SRM9000 800MHz RADIO BOARD SCHEMATICS:

Sheet No.	Description
1	Transceiver Block Diagram
2	DSP/Flash
3	PLA
4	Receiver
5	Transmitter
6	VCO
7	Synthesizer
8	Tx/Rx Audio
9	Power Supply
10	I/O Connections
	Top Overlay of PCB
	Bottom Overlay of PCB

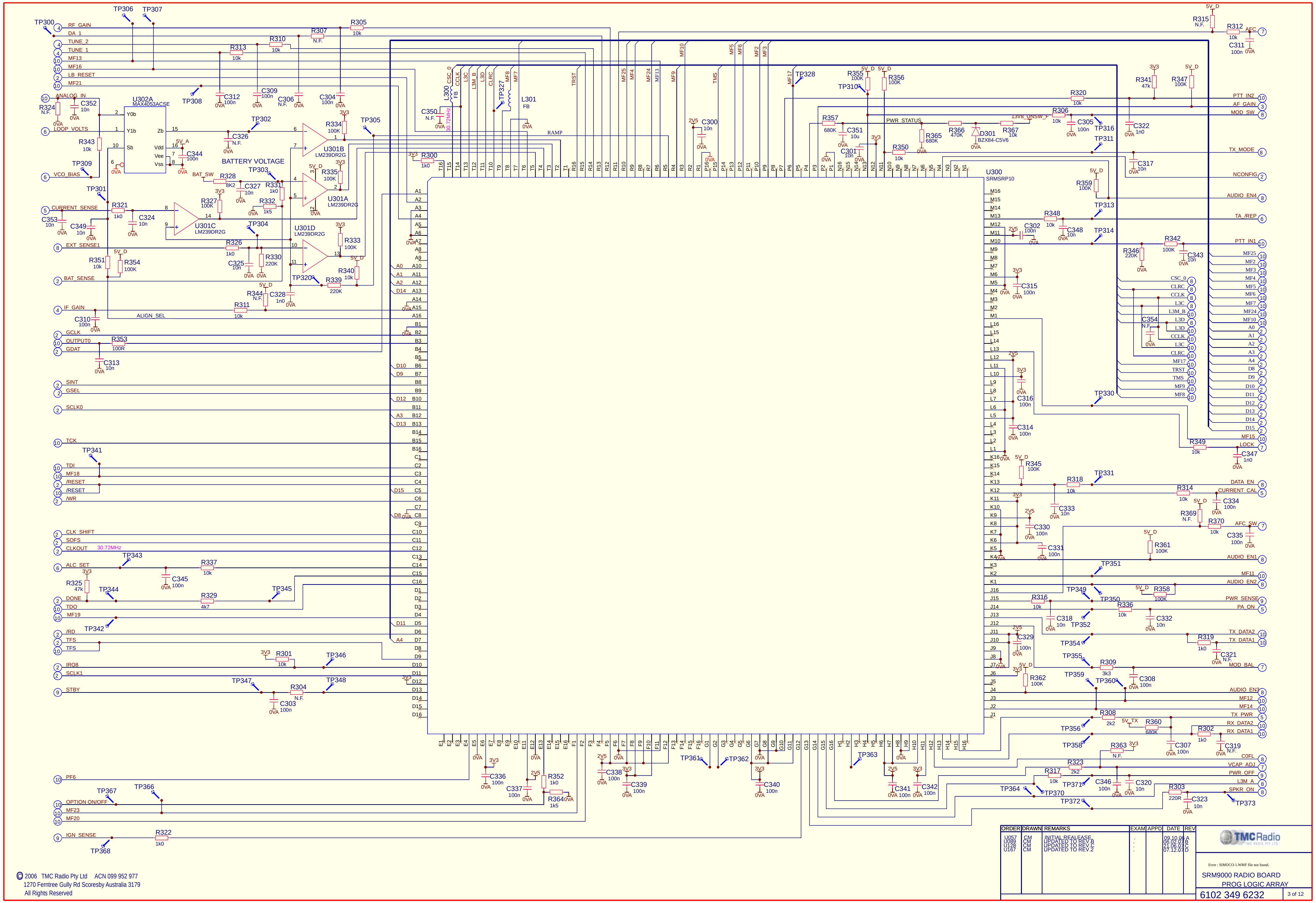
Sheet 1: Transceiver Block Diagram



Sheet 2: DSP/ Flash



Sheet 3: PLA


U300
SRMSRP10
U302A
MAX4053ACSE
U301A
LM239DR2G
U301B
LM239DR2G
U301C
LM239DR2G
U301D
LM239DR2G
BATTERY VOLTAGE
30.72MHz
D301
BZX84-C5V6
ORDER DRAWN REMARKS EXAM APPD DATE REV
U057 CM INITIAL REALEASE 09.10.06 A
U098 CM UPDATED TO REV B 06.02.07 B
U128 CM UPDATED TO REV C 07.06.07 C
U167 CM UPDATED TO REV 2 07.12.07 D
TMC Radio
SRM9000 RADIO BOARD
PROG LOGIC ARRAY
6102 349 6232
3 of 12
© 2006 TMC Radio Pty Ltd ACN 099 952 977
1270 Ferntree Gully Rd Scoresby Australia 3179
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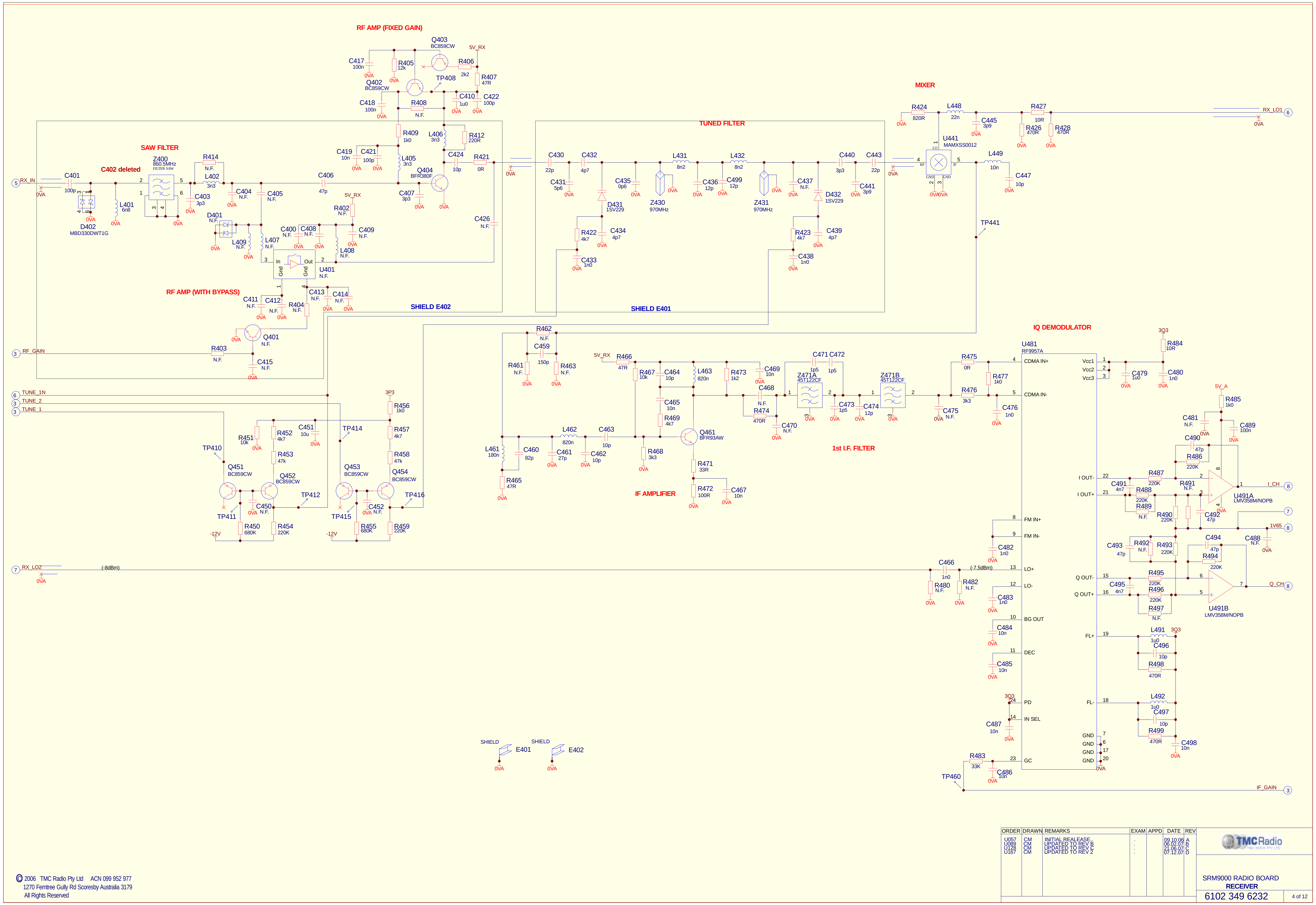
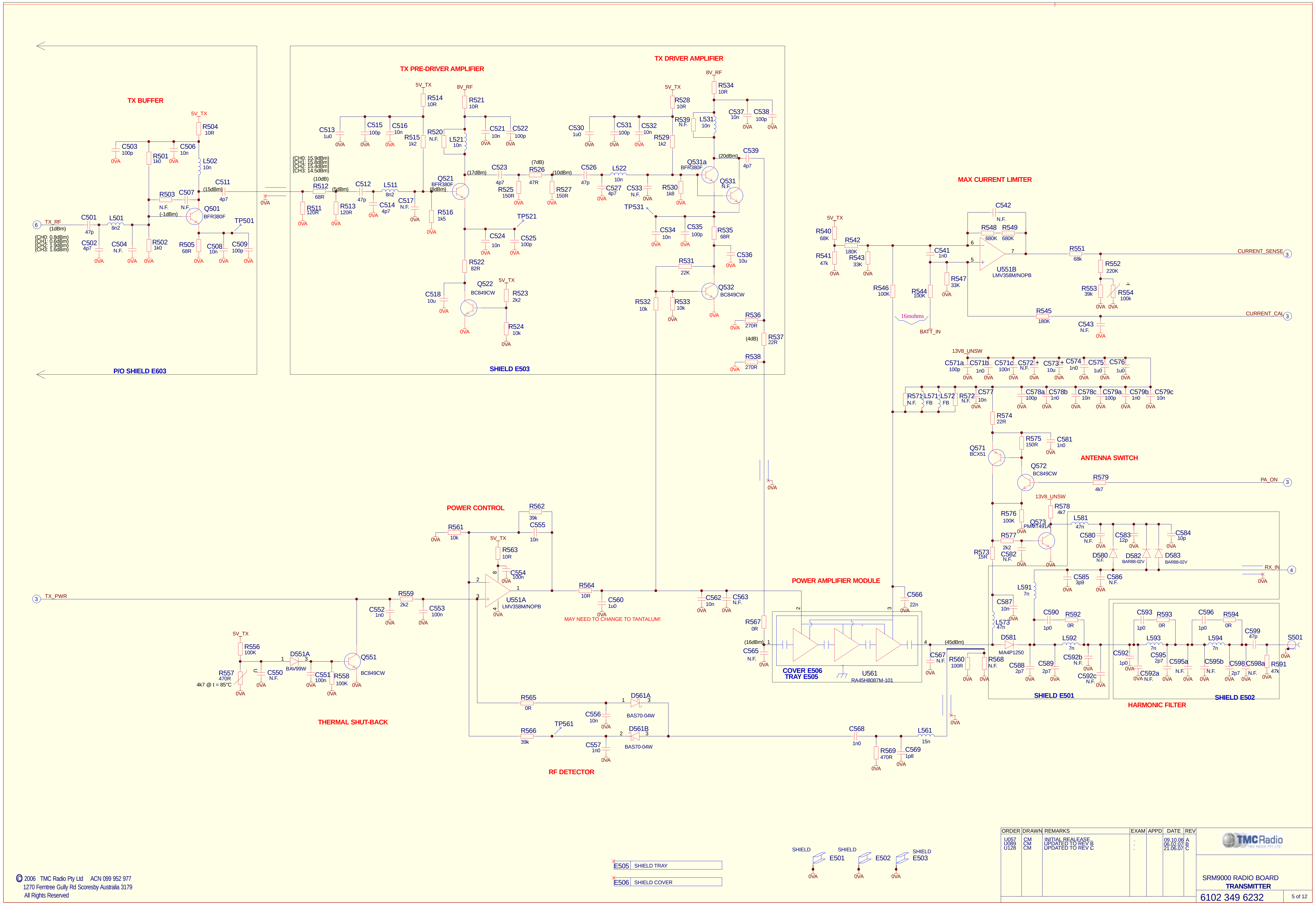
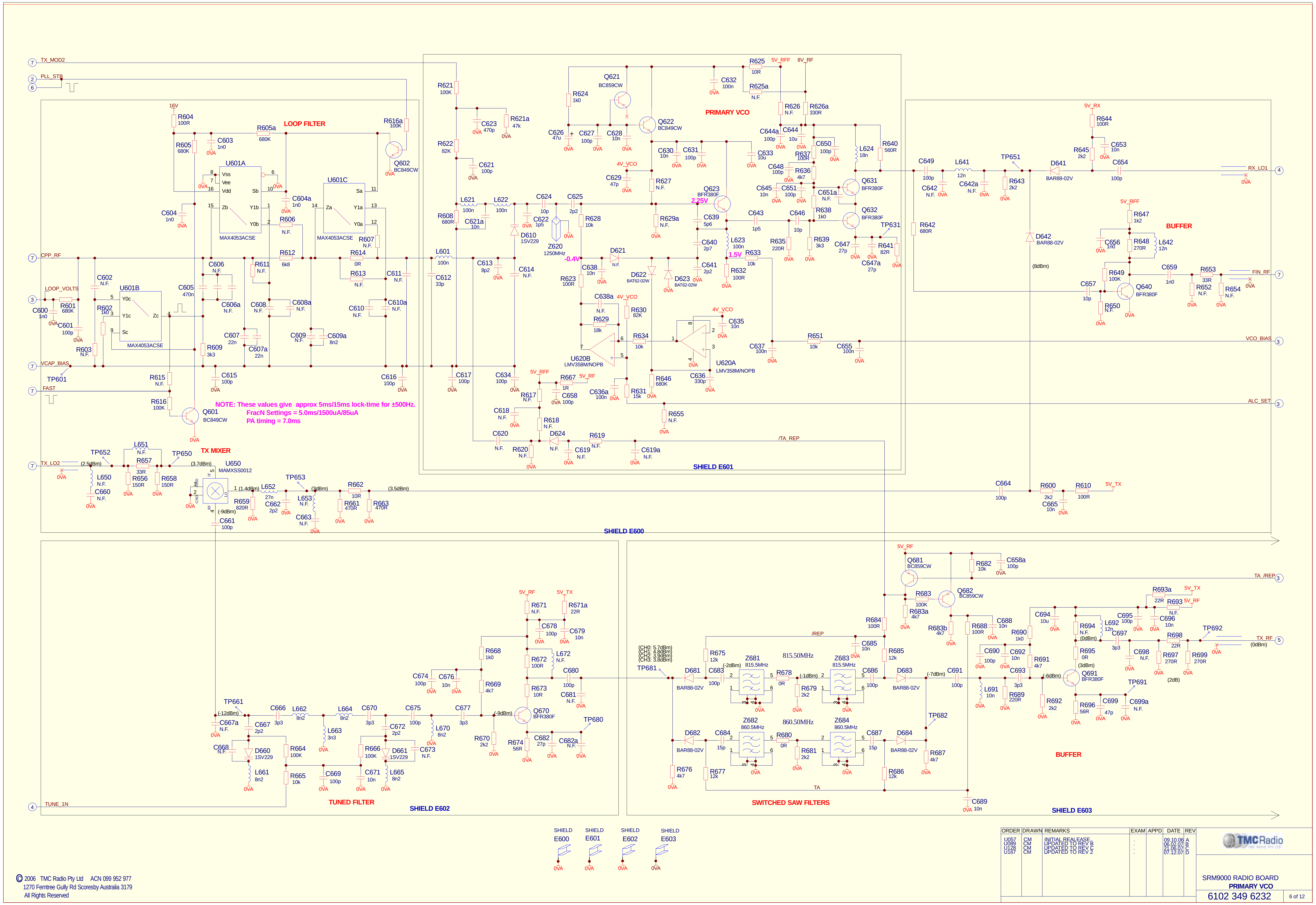
Sheet 4: Receiver



Sheet 5: Transmitter



Sheet 6: VCO


LOOP FILTER
PRIMARY VCO
BUFFER
TX MIXER
TUNED FILTER
SWITCHED SAW FILTERS
SHIELD E600
SHIELD E601
SHIELD E602
SHIELD E603
NOTE: These values give approx 5ms/15ms lock-time for ±500Hz.
FracN Settings = 5.0ms/1500uA/85uA
PA timing = 7.0ms
TX_MOD2
PLL_STB
CPP_RF
LOOP_VOLTS
VCAP_BIAS
FAST
TX_LO2
TUNE_1N
RX_LO1
FIN_RF
VCO_BIAS
ALC_SET
TA_/REP
TX_RF
SRM9000 RADIO BOARD
PRIMARY VCO
6102 349 6232
6 of 12
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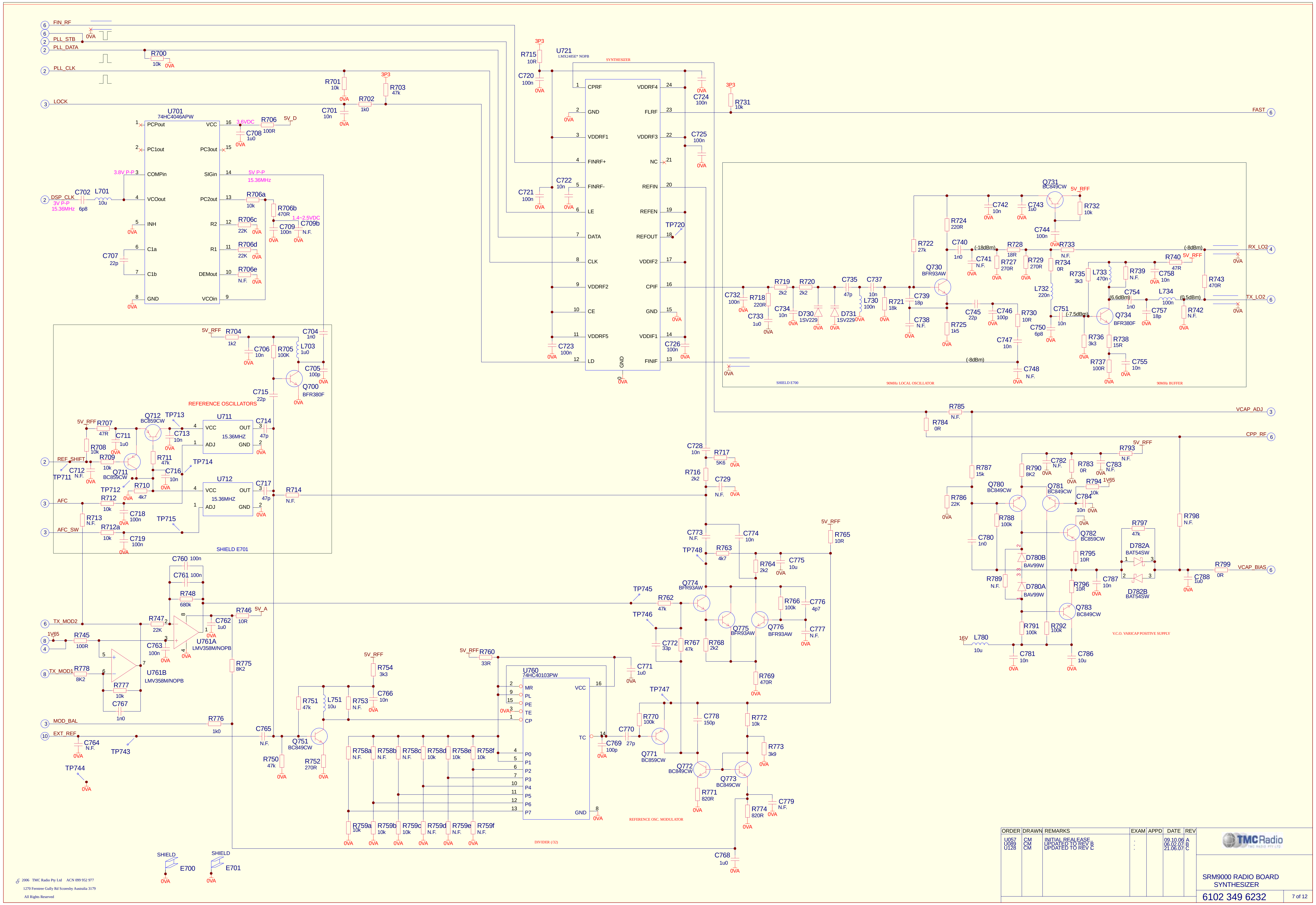
Sheet 7: Synthesiser



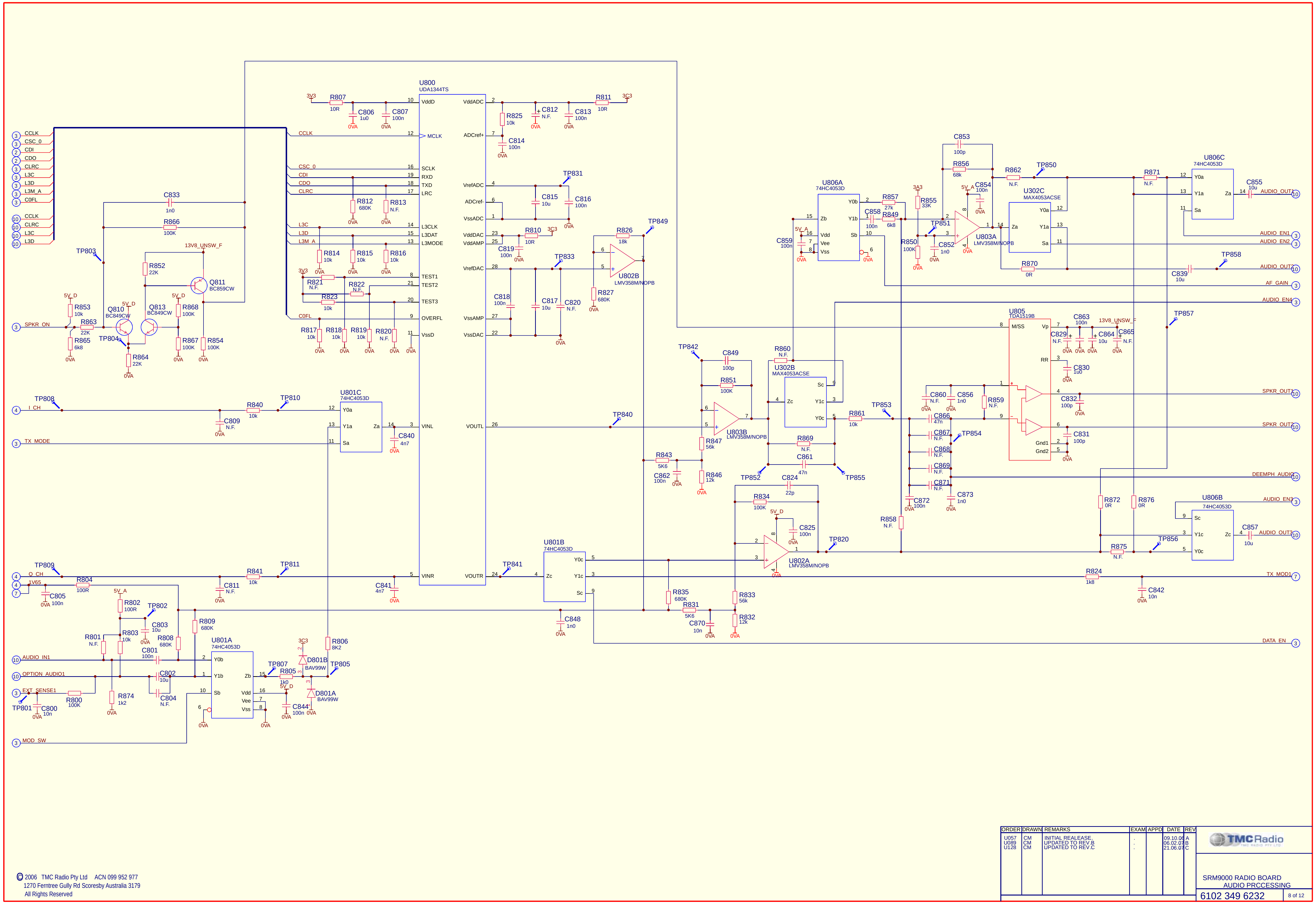
ORDER	DRAWN	REMARKS	EXAM	APPD	DATE	REV
U057	CM	INITIAL REALEASE	.		09.10.06	A
U089	CM	UPDATED TO REV B	.		06.02.07	B
U128	CM	UPDATED TO REV C	.		21.06.07	C

TMC Radio

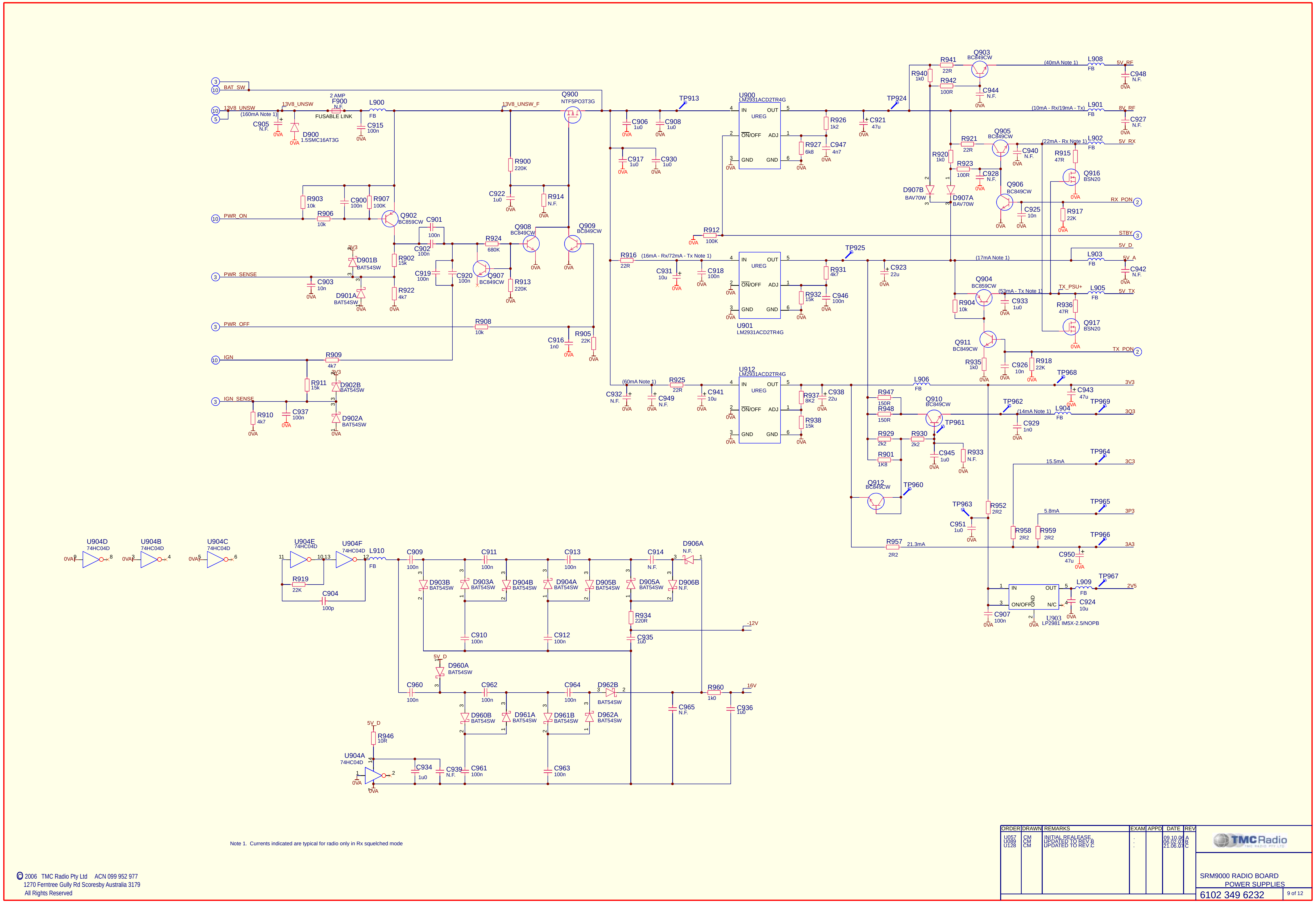
SRM9000 RADIO BOARD
SYNTHESIZER

6102 349 6232 — 7 of 12

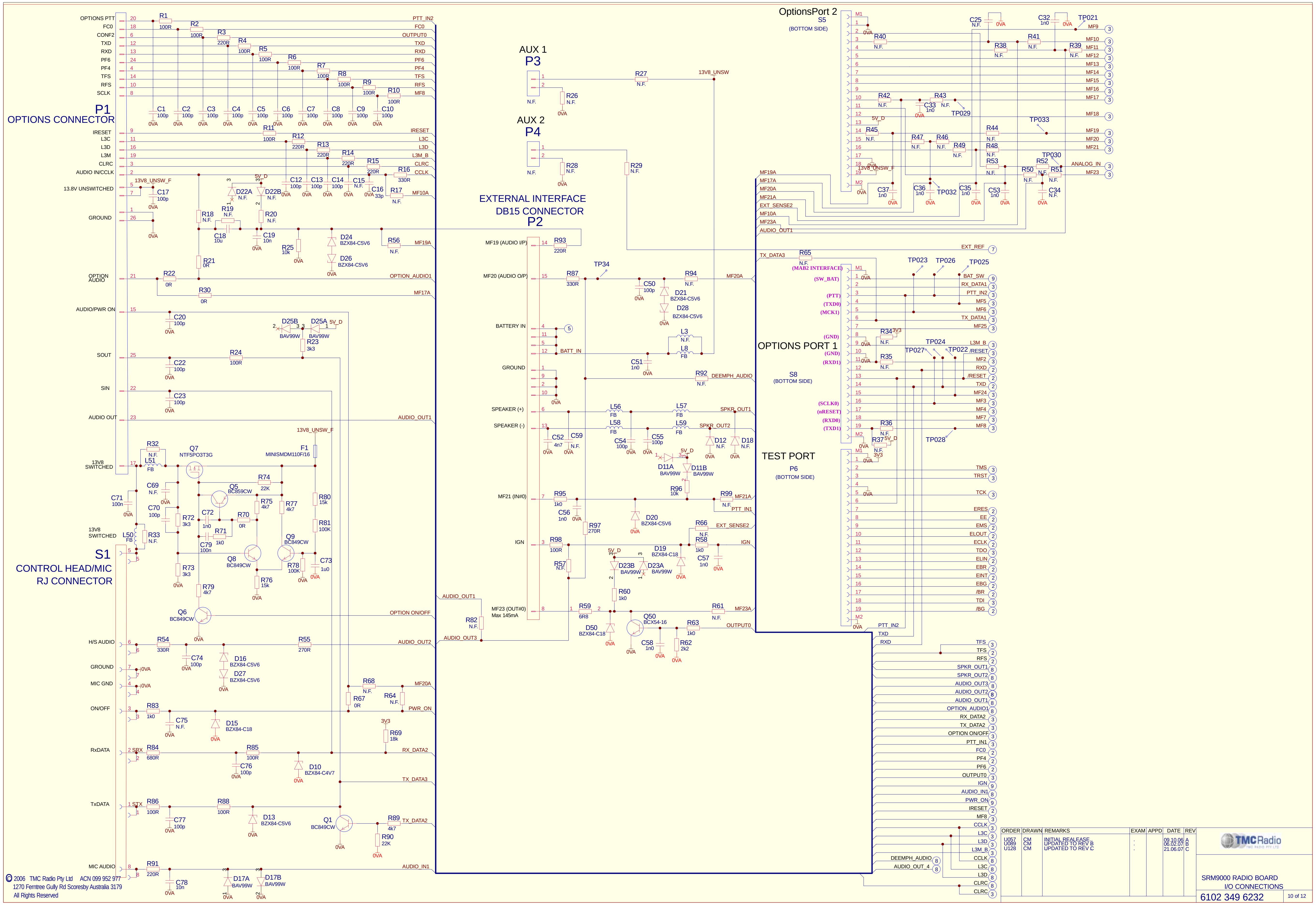
Sheet 8: TX/ RX Audio



Sheet 9: Power Supply



Sheet 10: I/O Connections



Top Overlay

6102 309 6232	2	800MHz RADIO BOARD	
TOP COMPONENT OVERLAY	114 - 301	U167	CJM

Bottom Overlay

6102 309 6232	2	800MHz RADIO BOARD		
BOTTOM COMPONENT OVERLAY		114 - 302	U167	CJM

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.

ADC Analog to Digital Converter.

AFC Automatic Frequency Control.

AGC Automatic Gain Control.

Alarm A Selcall sequence sent from subscriber equipment to indicate an Emergency situation.

When activated the radio will enter a repeating sequence consisting of an Alarm Live Transmit Time and an Alarm Dead Receive Time.

Certain special conditions for the radio may also occur during the alarm.

A dedicated SFM (trunked system) that is sent by pressing the Alarm Key.

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.

Busy The state of a channel such that:

- 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.

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.

C4FM Compatible 4-Level Frequency Modulation.

Call Back A request, sent by the dispatcher, to a unit requesting that the unit calls the dispatcher back.

Channel Spacing The distance (in kHz) between the defined frequency channels.

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 (Analog to Digital Converter) / DECode (Digital to Analog 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.

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 Analog 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 that have been instructed to recognise the same DCS sequence are able to open their squelch and receive the associated speech transmissions. This 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.

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.

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.

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.
PLA	Programmable Logic Array.
FPP	Field Personality Programmer.
Hash (#) digits	These digits are used for two purposes: • 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.
Identity	Name given to a sequence of tones which is used in sequential tone signalling. See Valid Selcall Digits.
Idle State	The state of the radio when it is not in a call.
Inaccessible	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.
Link Establishment Time	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.
Locked	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.
Null Id	A Selcall identity that is not defined and whose tones' field is displayed as a blank.
Open	A state where transmit and receive are allowed. The channel is no longer open when reset. Contrast with Closed. Normally an Open channel would not have Selcall Mute and PTT Inhibit would be disabled.
PABX	Private Automatic Branch Exchange.
Password	An optional password system available on the radio. This feature is only available if the radio 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.
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.

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.

Repeat Tone A selcall tone that is used to replace repeated tones. Fixed at tone E.

Example: An identity entered as '12333' would be sent by the radio as '123E3'.

Reset 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:

- 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
- 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.

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.

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>Sel</u>ective <u>Call</u>ing, uses a tone sequence at the start, and end, of a call to control which members of a fleet react to the transmission.

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 Digits known as Status or Message digits. These digits are used for three purposes:

- 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 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: Encode Identities: Status digits within the identity are used to transmit the current situation of the radio's user (e.g. "Out To Lunch"). Decode Identities: Status digits are looked up in a table (Status Menu) for possible messages to display.
SW	Software.
TCXO	Temperature Compensated Crystal Oscillator.
Three Tone Reset	This is a system whereby a call to a user automatically reset all other users in a group. 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.
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.
Tx Inhibit	A facility which prevents the user from transmitting,(other than alarms), while the channel is Busy.
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.