

Eclipse Series

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R220 Receiver **Operation and Maintenance Manual**

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WARNING

Changes or modifications not expressly approved by RF Technology could void your authority to operate this equipment. Specifications may vary from those given in this document in accordance with requirements of local authorities. RF Technology equipment is subject to continual improvement and RF Technology reserves the right to change performance and specification without further notice.

1 Operating Instructions

1.1 Front Panel Controls and Indicators

1.1.1 Mon. Volume

The Mon. Volume control is used to adjust the volume of the internal loudspeaker and any external speaker connected to the test socket. It does not effect the level of the 600 Ω line or direct audio output.

1.1.2 Mon. SQ.

The Mon. SQ. switch allows all squelch functions controlling the monitor output to be disabled. When the switch is in the Mon. SQ. position the audio at the monitor speaker is controlled by the noise detector. The CTCSS, carrier and external squelch functions are disabled. This can be useful when you are trying to trace the source of on-channel interference or when setting the noise squelch threshold. the audio from the 600 Ω line and direct outputs is not effected by the switch position.

1.1.3 N.SQ

The N.SQ trimpot is used to set the noise squelch sensitivity. Use the following procedure to set the noise squelch to maximum sensitivity.

1. Set the toggle switch to the Mon. Sq. position and set the Mon. Volume control to 9 o'clock.

2. Turn the N. SQ. adjustment counter clockwise until the squelch opens and noise is heard from the speaker. Adjust the VOLUME to a comfortable listening level.
3. In the absence of any on channel signal, turn the N.SQ. screw clockwise until the noise in the speaker is muted. Then turn the screw two additional turns in the clockwise direction.

1.1.4 C.SQ

The C.SQ trimpot is used to set the carrier squelch sensitivity. Carrier squelch is useful at higher signal levels than those at which noise squelch and can be used typically from 1-200 μ V input.

It is provided mainly for use in fixed link applications where a high minimum signal to noise ratio is required or where very fast squelch operation is required for data transmission. The carrier squelch will open and close in less than 2 mSec.

In most base station applications carrier squelch is disabled by turning the adjustment counter clockwise until the screw clicks.

The carrier squelch may be set to a predetermined level with the Techelp/Service Monitor 2000 software or by using the following procedure:

1. First turn the adjustment fully counter-clockwise. Then set the noise squelch as above.
2. Connect a source of an on channel signal with the desired threshold level to the receiver's RF input.
3. Turn the screw clockwise until the SQ LED goes OFF. Then turn the screw back until the LED just comes ON.

1.1.5 LINE

The LINE trimpot is used to set the line and direct audio output level. It is normally set to give 0dBm (775mV) to line with a standard input signal equal to 60% of maximum deviation at 1 KHz. The level can be measured between test socket pins 6 and 1 and set as desired.

1.1.6 PWR LED

The PWR LED shows that the dc supply is connected to the receiver.

1.1.7 SQ LED

The SQ LED comes on when the audio to the line and direct outputs is un-squelched. The LED and squelch function are controlled by noise, carrier and tone squelch circuits.

1.1.8 ALARM LED

The ALARM LED can indicate the detection of several different fault conditions by the self test circuits. The alarm indicator shows the highest priority fault present. Receivers using software issue 5 and higher use the cadence of the LED flash sequence to indicate the alarm condition. Refer to table 1.

LED Flash Cadence	Fault Condition
5 flashes, pause	Synthesizer unlocked
4 flashes, pause	Tuning voltage outside limits
3 flashes, pause	Signal level below preset threshold (fixed link)
1 flash, pause	dc supply voltage low or high
LED ON continuously	External squelch is active

Table 1: Interpretations of LED flash cadence

Receivers using software issue 4 and lower use the LED flash rate to indicate the alarm condition. Refer to table 2.

Indication	Fault condition
Flashing, 8 per second	Synthesizer unlocked
Flashing, 4 per second	Tuning voltage outside 2-7 Vdc
Flashing, 2 per second	Signal level below preset threshold (fixed links)
Continuous	dc supply voltage low or high

Table 2: Interpretations of LED flash speed, for early models.

2 Receiver Internal Jumper Options

In the following subsections an asterisk (*) signifies the standard (Ex-Factory) configuration of a jumper.

2.1 JP1: 240 Hz Notch Filter

JP1 allows the 240Hz notch filter in the normal audio path to be bypassed.

Condition	Position
Notch Filter In	1-2 *
Notch Filter Out	2-3

2.2 JP2: Audio Response

Condition	Position
750 uSec. de-emphasis	1-2 *
Flat response	2-3

2.3 JP3: Audio Filter In/Out

JP3 bypasses the 300Hz high-pass filter and 240Hz notch filter if necessary.

Condition	Position
Hi-pass, Notch In	2-3 *
Flat response	1-2

2.4 JP4: 600h Line dc Loop COS

JP4 allows the dc return path through the output audio transformer to be broken, to permit dc signaling via the audio pair or wires.

Condition	Position
dc Loop Configured by JP7, JP8, JP9	1-2 *
dc Loop Not used	2-3

2.5 JP6: COS Polarity

Condition	Position
Active on Signal	2-3 *
Active on No Signal	1-2

2.6 JP7, JP8, JP9: dc Loop COS Configuration (JP4 1-2)

These settings are relevant when the Carrier Operated Switch (COS) signal is to be used across the same wires as the audio. Refer to setting of JP4, in section 2.4. They control the levels and connection into the audio balanced line circuitry.

Condition	JP7	JP8	JP9
Source +12 Vdc Loop	2-3	ON	1-2 *
Free Switch Output	1-2	ON	2-3

2.7 JP7, JP8, JP9: Direct Output COS (JP4 2-3)

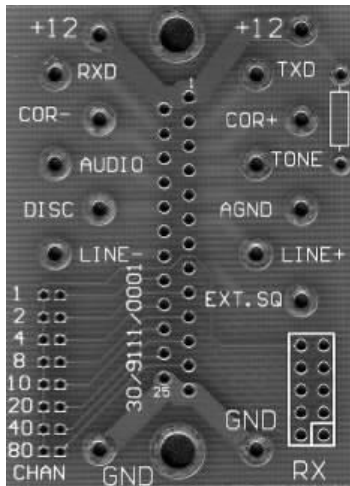
In this arrangement, the COS signal is taken via the separate COS+ and COS- outputs, either with free (floating) output or with +12Vdc pull-up.

Condition	JP7	JP8	JP9
+12 Vdc Direct Output	2-3	OFF	OFF
Free Switch Output	1-2	OFF	OFF

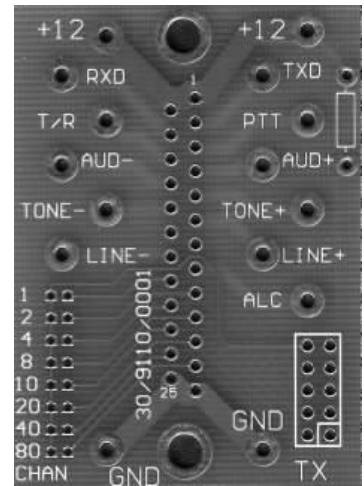
2.8 JP11 EPROM Type

Condition	Position
27C256	2-3 *
27C64	1-2

* = Standard Ex-Factory Configuration



RX PCB



TX PCB

The Receiver and Transmitter modules plug into the back plane DB25/F connectors

Miniature spade connectors (2.1 x 0.6 x 7mm) are captive/ soldered at the labelled points.

To configure: Solder wire connections between appropriate points.

Receiver DB25/F	RX PCB	DESCRIPTION		TX PCB	Transmitter DB25/F
1, 14	+12V	+12V DC SUPPLY		+12V	1, 14
2	TXD	TX Data		TXD	2
15	RXD	RX Data		RXD	15
3	COR+	Carrier Operate Sw+	PressToTalk input	PTT	3
16	COR-	Carrier Operate Sw-	Tx/Rx output	T/R	16
4	TONE	Subtone output	Hi Z audio input+	AUD+	4
17	AUDIO	Audio output	Hi Z audio input-	AUD-	17
5	AGND	Audio Ground	Ext tone input+	TONE+	5
18	DISC	Discriminator output	Ext tone input-	TONE-	18
6	LINE+	Line output+	Line input+	LINE+	6
20	LINE-	Line output-	Line input-	LINE-	20
8	EXT SQ	Ext Squelch input	Auto Level Control	ALC	8
13, 25	GND	Ground, 0V		GND	13, 25
21	BCD 1	Channel select 1's digit		BCD 1	21
9	BCD 2	Channel select 1's digit		BCD 2	9
22	BCD 4	Channel select 1's digit		BCD 4	22
10	BCD 8	Channel select 1's digit		BCD 8	10
23	BCD 10	Channel select 10's digit		BCD 10	23
11	BCD 20	Channel select 10's digit		BCD 20	11
24	BCD 40	Channel select 10's digit		BCD 40	24
12	BCD 80	Channel select 10's digit		BCD 80	12

3 Receiver I/O Connections

3.1 25 Pin Connector

The D-shell 25 pin connector is the main interface to the receiver. The pin connections are described in table 3.

Function	Signal	Pins	Specification
DC Power	+12Vdc 0 Vdc	1, 14 13, 25	+11.4 to 16 Vdc
Channel Select	1 2 4 8 10 20 40 80	21 9 22 10 23 11 24 12	BCD Coded 0 = Open Circuit or 0 Vdc 1 = +25 to +16 Vdc
RS232 Data	In Out	15 2	Test and Programming use 9600, 8 data 2 stop bits
600Ω Line	In Out	20 6	Transformer Isolated Balanced 0dBm Output
150Ω / Hybrid		7 19	
Discriminator		18	AC coupled, unscelched
Direct Audio Output		17	Direct AC Coupled Audio
Audio Ground		5	Direct Audio Ground
Sub-Audible Audio Out		4	Unscelched, 1-250 Hz
Carrier Operated Sw	Cos+	3	Opto-coupled Transistor Switch (10mA)
Carrier Operated Sw	Cos-	16	
External Squelch	Input	8	<1 Vdc to Squelch >2 Vdc or open ckt to unscelch

Table 3: Pin connections and explanations for the main, 25-pin, D-shell Connector

4 Frequency Programming

Channel and tone frequency programming is most easily accomplished with RF Technology TechHelp/Service Monitor 2000 software. This software can be run on an IBM compatible/Windows PC and provides a number of additional useful facilities.

TechHelp/Service Monitor 2000 allows setting of the adaptive noise squelch threshold, provides a simple means of calibrating the signal strength output and minimum signal alarm.

TechHelp/Service Monitor 2000 can be supplied by your dealer, distributor or by contacting RF Technology direct.

5 Circuit Description

The following descriptions should be read as an aid to understanding the block and schematic diagrams at the rear of this manual.

5.1 RF Section

A two pole voltage tuned filter (D13, D14, L35-39) is used to limit the RF band width prior to the RF amplifier transistor Q1. The tuning voltage is supplied by the frequency synthesizer through voltage follower U28D. The circuit values are chosen so that the centre frequency tracks the VCO frequency.

RF amplifier transistor Q1 is followed by a second two pole voltage tuned filter (D15, D16, L28-32) which provides additional image and spurious frequency rejection. The filter output is connected to the RF input port of the mixer MX1.

MX1 is a high level double balanced diode ring mixer with excellent intermodulation performance. It has a conversation loss of approximately 6 dB. The gain between the receiver input and the mixer input is approximately 10 dB so that the total gain between the antenna input and the IF input 3-4dB.

Monolithic amplifiers MA1, MA2 and transistor Q5 amplify the VCO output to the necessary LO level for MX1 approximately +13dBm.

The network C8, C9 L1-3 and R6 passes the IF frequency of 45 MHz and terminates the RF and LO components.

5.2 IF Section

The first IF amplifier uses two parallel connected JFET transistors Q2 and Q3 to obtain 8-10 dB gain. The two transistors provide improved dynamic range and input matching over a single transistor.

A two pole 45 MHz crystal filter XF1 is used between the first and second IF amplifiers. The second IF amplifier Q4 provides additional gain of 6-10dB. A two pole crystal filter is used between Q4 and the 2nd oscillator mixer. These two crystal filters provide some adjacent channel rejection and all of the second IF image frequency rejection.

U1 is a monolithic oscillator and mixer IC. It converts the 45 MHz IF signal down to 455 KHz. The second oscillator frequency or 45.455 MHz is controlled by crystal Y1. The 455 KHz output of the second mixer is fed through a ceramic filter CF1 to the second IF amplifier transistor Q27. Q27 provides an additional 15 dB gain ahead of the limiter and discriminator IC U3.

The limiter/discriminator IC U3 further amplifies the signal and passes it through CF2. CF2 does not contribute to the adjacent channel rejection but is used to reduce the wide band noise input to the limiter section of U3.

The limiter section of U3 drives the quadrature detector discriminator. C31 and IF tuned circuit L10 comprise the discriminator phase shift network.

U3 also has a received signal strength indicator output (RSSI). The RSSI voltage connects to the test socket for alignment use. The RSSI voltage is also used by the microprocessor for the adaptive noise squelch, carrier squelch and low signal alarm functions.

Dual op-amp U2 is used to amplify and buffer the discriminator audio and RSSI outputs.

5.3 VCO Section

The Voltage Controlled Oscillator uses a junction FET Q6 which oscillates at the required mixer injection frequency. Varactor diode D4 is used by the PLL circuit to keep the oscillator on the desired frequency. Transistor Q7 is used as a filter to reduce the noise on the oscillator supply voltage.

5.4 PLL Section

The synthesizer frequency reference is supplied by a temperature compensated crystal oscillator (XO1). The frequency stability of the oscillator is better than 1 ppm.

The 12.0/12.8 MHz output of Q25 or XO1 is amplified by Q8 to drive the reference input of the PLL synthesizer IC U4. This IC is a single chip synthesizer which includes a

1.1 GHz pre-scaler, programmable divider, reference divider and phase/frequency detector. The frequency data is entered a serial data link from the microprocessor.

The phase detector output signals of U4 are used to control two switched current sources. The output of the positive and negative sources' Q10 and Q16, produce the tuning voltage which is smoothed by the loop filter components to bias the VCO varactor diode D4.

5.5 Audio Signal Processing

A 4 KHz low pass filter (U27b) is used to remove high frequency noise from the signal. A 300 Hz high pass filter (U26a,b) then removes the sub-audible tones. A 240 Hz notch filter (U26c,d) is used to improve the rejection of tones above 200 Hz. The high pass and notch filters can be bypassed by internal jumpers JP1 and JP3.

The audio frequency response can be set for either 750 uS de-emphasis or a flat characteristic by JP2. JP2 selects the feedback network of amplifier U27c.

After de-emphasis and filtering, the audio signal is applied to the inputs of two analog switches (U17a,b). These switches are controlled by the micro-controller and squelch or mute the audio to the line and monitor output circuits. The monitor output can be set for noise squelch only operation by S1.

The audio from U17a is adjusted by the volume control before connecting to the monitor output amplifier U5. U5 drives the internal speaker and can also supply 3-5 watts to an external loudspeaker.

The audio from U17b is adjusted by RV3 before connecting to the line output IC (U22a,b). U22 is a dual amplifier connected in a bridge configuration to drive the 600Ω line output transformer T1.

5.6 Noise Filter, Amplifier and Detector

The unfiltered audio from the discriminator is fed to trimpot RV4 which is used to set the noise squelch threshold. From RV4 the audio goes to the noise filter (U27a). This is a 10 KHz high pass filter and is used to eliminate voice frequency components.

The noise signal is then amplified by U27d and fed to the noise detector. The noise detector consists of D6, Q17 and U26c. D6 and Q17 are a charge pump detector and pull the input to U26c low as the noise increases. U26c has positive feedback and acts like a schmitt trigger. The output of U26c goes high when noise is detected. It connects to the micro-controller and to analog switch U17d. U17d varies the gain of the noise amplifier to provide approximately 2dB hysteresis.

5.7 Sub-Tone Filter and CTCSS

The discriminator audio is fed through cascaded low pass filters U28a and U28b to filter out the voice frequency components. The filtered sub-tone audio is supplied to the CTCSS hybrid and the rear panel system connector. The filtered output can be used for re-transmission of CTCSS or DCS.

The CTCSS decoder module is a micro-controller base hybrid module. Under control of the main microprocessor U15 it can decode all 38 EIA tones and 12 additional commonly used tones. The decode bandwidth is set to 1% but may be changed to 2% by a jumper on the printed circuit board.

5.8 External Squelch

The audio output can be muted through pin 8 of the receiver system connector P1. When pin 8 is pulled to less than 1 volt above ground, the micro-controller U15 will mute the audio output.

This facility can be used to mute the audio during transmission, as is required in single frequency systems, by simply connecting pin 8 of the receiver to the transmitter T/R relay driver output (pin 16 on Eclipse transmitters).

5.9 Microprocessor Controller

The microprocessor controller circuit uses an advanced eight bit processor and several support chips. The processor U15 includes EE memory for channel frequencies, tones, and other information. It also has an asynchronous serial port and an analog to digital converter.

The program is stored in U12, a CMOS EPROM. U13 is an address latch for the low order address bits. U11 is used to read the channel select lines onto the data bus. U7 is an address decoder for U11 and U12. U14 is a supervisory chip which keeps the processor reset unless the +5 Volt supply is within operating limits. U16 translates the asynchronous serial port data to standard RS232 levels.

The analog to digital converter is used to measure the received signal strength, tuning voltage, dc supply voltage and the carrier squelch setting.

5.10 Carrier Operated Switch

The carrier operated switch is an opto-coupled (ISO1) output. Internal jumpers (JP4,7,8,9) can be connected to provide loop source, loop switch, free switch and various other configurations.

The COS can be set to be active (switch closed) on carrier or active in the absence of carrier.

The generic term "Carrier Operated Switch" may be misleading in this case. SINCE, if a sub-audible tone has been programmed for the channel in use, the COS is controlled by carrier and tone detection.

5.11 Voltage Regulator

The dc input voltage is regulated down to 9.4 Vdc by a discrete regulator circuit. The series pass transistor Q20 is driven by error amplifiers Q21 and Q22. Q23 is used to start up the regulator and once the circuit turns on, it plays no further part in the operation.

This circuit is short circuit and overload protected. It provides much better line isolation and lower dropout voltage than can be obtained with current integrated circuit regulators.

6 Alignment Procedure

The following procedures may be used to align the receiver for optimum performance. Normally only RF alignment will be required when changing frequencies. IF alignment should only be necessary after repairs on that part of the circuit.

Reference oscillator or TCXO calibration may be required periodically due to crystal aging. The aging should be less than 1 ppm/year.

6.1 Standard Input Signal

RF Signal Generator
50Ω output impedance Frequency range 215 - 240 MHz FM modulation at 1KHz 1.5KHz peak for 12.5KHz channel spacing

6.2 RF Alignment

Alignment Frequency	
215 - 240 MHz range	221.000 MHz

Step	Input	Measure	Adjust
1	Select alignment frequency channel	dc Volts on test socket pin 9 to pin 1	L34 to read 4.00Vdc
2	Signal generator on centre frequency channel to J1. Modulation off.	dc Volts on test socket pin 7 to pin 1	Generator level to read 1 - 2 Vdc
3	As Above	As Above	L29, 31, 36, 38 for maximum reading. Reduce generator output to keep below 2 Vdc

6.3 IF Alignment

Step	Input	Measure	Adjust
1	Signal generator on center frequency channel to J1. Modulation OFF	dc Volts in test socket pin 7 to pin 1	Generator level to read 1 - 2 Vdc
2	As Above	As Above	L5, L6, L7, L8 for maximum reading. Reduce generator output to keep below 2 Vdc
3	Set generator level to 10 ~V	Frequency U3 pin 9	L9 to read 455 KHz +/- 10Hz
4	Set generator level to 1 millivolt. Modulation ON.	Audio level test socket pin 6 to pin 1	Line level (RV3) to obtain approx. 1 Vrms
5	As Above	As Above	L10 for maximum
6	As Above	Audio level P1 pin 18 to pin 5	RV1 for 0.5 Vrms
7	Set generator level to approx. 25~V	SINAD on test socket pin 6 to pin 1	Reduce generator level to obtain 12 Db SINAD. Carefully adjust L5, L6, L7, L8 to obtain the best SINAD. Reduce generator output to maintain 12 dB SINAD

6.4 Line Level Adjustment

Step	Input	Measure	Adjust
1	Signal generator on centre frequency channel to J1. Modulation ON. Level 1 millivolt	Audio level test socket pin 6 to pin 1	RV3 for 390 mV rms

6.5 Reference Oscillator Calibration

Step	Input	Measure	Adjust
1	None required	Frequency junction of R69 and R26 on the top of the PCB. (LO input to the mixer)	C181 or XO1 for L.O. +/-100 Hz L.O. = Fc+45 MHz

7 Specifications

7.1 General Description

The receiver is a high performance, frequency synthesized, narrow band FM unit which can be used in conjunction with transmitter and power supply modules as a base station or as a stand alone receiver. All necessary control and 600Ω line interface circuitry is included.

7.1.1 Channel Capacity

Although most applications are single channel, it can be programmed for up to 100 channels numbered 0-99. This is to provide the capability of programming all channels into all of the receivers used at a given site.

7.1.2 CTCSS

The CTCSS tone or no tone can also be programmed for each channel. So that each channel number can represent unique RF and tone frequency combination.

7.1.3 Channel Programming

The channelling information is stored in a non-volatile memory chip and can be programmed via the front panel test connector using a PC and RF Technology supplied TechHelp/Service Monitor 2000 software.

7.1.4 Channel Selection

Channel selection is by eight channel select lines. These are available through the rear panel connector.

A BCD active high code applied to the lines selects the required channel. This can be supplied by pre-wiring the rack connector so that each rack position is dedicated to a fixed channel.

BCD switches inside the receiver can be used to pre-set any desired channel. These eliminate the need to externally select the channel.

7.1.5 Microprocessor

A microprocessor is used to control the synthesizer and squelch functions and facilitate the channel frequency programming. With the standard software it also can provide fault monitoring and reporting.

7.2 Physical Configuration

The receiver is designed to fit in a 19 inch rack mounted frame. The installed height is 4 RU (178 mm) and the depth 350 mm. The receiver is 63.5 mm or two Eclipse modules wide.

7.3 Front Panel Controls, Indicators and Test Points

7.3.1 Controls

Mute defeat switch - toggle (Overrides CTCSS, noise and carrier squelch at the monitor output)

Monitor Speaker Volume - Knob

Line Output Level - screwdriver adjust multi-turn pot

Noise Squelch Setting - screwdriver adjust multi-turn pot

Carrier Squelch Setting - screwdriver adjust multi-turn pot

7.3.2 Indicators

Power ON - Green LED

Squelch Open - Yellow LED

Fault Indicator - Flashing Red LED

7.3.3 Test Points

Line Output Level - Pin 6 + Gnd (Pin1)

Receive Signal Strength - Pin 7 + Gnd (Pin 1)

Tuning Voltage - Pin 9 + Gnd (Pin 1)

Serial Data (RS232) - Pin 2/3 + Gnd (Pin 1)

7.4 Electrical Specifications

7.4.1 Power Requirements

Operating Voltage - 10.5 to 16 Vdc

Current Drain - 250mA Max.

Polarity - Negative Ground

7.4.2 Frequency Range and Channel Spacing

215 – 240 MHz 12.5KHz

7.4.3 Frequency Synthesizer Step Size

5.0 or 6.25 KHz

7.4.4 Frequency Stability

+/- 1 ppm, 0 to +60 C

7.4.5 Nominal Antenna Impedance

50Ω

7.4.6 IF Frequencies

First IF frequency 45 MHz

Second IF frequency 455 KHz

7.4.7 Sensitivity

-119 dBm Max. for 12 dB SINAD

-116 dBm Max. for 20 dB Quieting

7.4.8 Selectivity

12 KHz spacing - 70dB per ECR-235

7.4.9 Spurious and Image Rejection

90dB

7.4.10.1 Intermodulation

80dB

7.4.11 Modulation Acceptance BW

12.5 KHz spacing - 3.75 KHz per RS204C

7.4.12 Noise Squelch

Adjustment Range: 6 - 18 dB SINAD

Attack Time: 20 mSec. above 20dB Quieting

Release Time: 150 mSec. at 20dB Quieting decreasing to 20ms above 2~V preset threshold

Hysteresis: Hysteresis is equal to approximately 2dB change in noise quieting

7.4.13 Carrier Level Squelch

Carrier level squelch can be used when it is necessary to set the opening point above 26dB SINAD as may be required in link applications. The minimum adjustment range is 1 to 200~V.

7.4.14 Receiver Frequency Spread

Less than 1 dB change in sensitivity over the band

7.4.15 Receiver Conducted Spurious Emissions

Less than -57dBm from 1 to 2900 MHz

7.4.16 Audio Frequency Response

600hLine and Direct Output: +1/-3dB 300-3000 Hz relative to either a flat response or 750~s de-emphasis with the high pass and notch filters bypassed.

Sub-Audio Output: +1/-3dB 67-250 Hz

7.4.17 Audio Output Level

600hLine: Adjustable -10 to +10dBm

Monitor Loudspeaker: 5 Watts with external speaker, 0.3 Watt with internal speaker

Discriminator and Sub-Audio: Nominally equal to 1 volt peak at rated system deviation

7.4.18 Audio Distortion

750~s De-Emphasis: Less than 3% at 1 KHz and 60% of rated system deviation

Flat Response: Less than 5% at 1 KHz and 60% of rated system deviation

7.4.19 Channel Select Input/Output

Coding: 8 lines BCD coded 00-99

Logic Input Levels: 0 = < 0.4 Volts
1 = > 3.5 Volts

Internal 10K pull down resistors selects Channel 00 when all inputs are O/C.

7.4.20 Carrier Operated Switch Output

Floating Opto-Coupler Output: The carrier operated switch output is via an opto-coupler. Collector and emitter connections are available to allow connection for source or sink.

The opto-coupler can be linked inside the receiver to be on when a carrier is detected or to be on in the absence of carrier.

Connection to Remote Switch via 600h Line: Internal connections are provided so that the opto-coupler can be connected to the 600Ω line for use over a single pair. This permits remote switching with no extra connections.

Current Source/Sink, Collector Voltage: The COS output is implemented with an optocoupler whose ratings are:\\

$I_c = 10\text{mA}, 20\text{mA Maximum}$

$V_c = 30\text{ Volts}, 15\text{ Volts Maximum}$

7.4.21 CTCSS

The CTCSS decoding is provided by a hybrid module. This provides programmable decoding of all 38 EIA and 12 other common tones. Refer to table 4.

Frequency	EIA Number
No Tone	
67.0	A1
69.4	
71.9	B1
74.4	C1
77.0	A2
79.7	C2
82.5	B2
85.4	C3
88.5	A3
91.5	C4
94.8	B3
97.4	
100.0	A4
103.5	B4
107.2	A5
110.9	B5
114.8	A6
118.8	B6
123.0	A7
127.3	B7
131.8	A8
136.5	B8
141.3	A9
146.2	B9
151.4	A10
156.7	B10
159.8	
162.2	A11
165.5	
167.9	B11
171.3	
173.8	A12
177.3	
179.9	B12
183.5	
186.2	A13
189.9	
192.8	B13
196.6	
199.5	
203.5	A14
206.5	
210.7	B14
218.1	A15
225.7	B15
229.1	
233.6	A16
241.8	B16
250.3	A17
254.1	

Table 4: Tone Squelch Frequencies

7.4.22 External Squelch Input

An external input is provided to squelch or mute the receiver audio output. This may be used in conjunction with an external decoder or to mute the receiver during transmissions.

External Squelch Input can be connected to the T/R Relay pin on Eclipse transmitters mute the receiver during transmission.

7.5 Connectors

7.5.1 Antenna Connector

Type N Female Mounted on the module rear panel

7.5.2 Power & I/O Connector

25-pin "D" Male Mounted on the rear panel

7.5.3 Test Connector

9-pin "D" Female mounted on the front panel

A Engineering Diagrams

A.1 Circuit diagram

Figure 1 shows the detailed schematic diagram with component numbers and values

B - R220 Parts List**Main PCB Assembly Parts**

Ref.	Description	Part Number
C1	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C2	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C3	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C4	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C5	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C7	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C8	Capacitor 56P 5% 63V NPO SM1206	46/3300/056P
C9	Capacitor 68P 5% 63V NPO SM1206	46/3300/068P
C10	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C11	Capacitor 47P 2% 100V NPO Rad.1	45/2680/047P
C12	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C13	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C14	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C15	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C16	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C17	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C18	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C19	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C20	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C21	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C22	Capacitor 10P 2% 100V NPO Rad.1	45/2680/010P
C23	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C24	Capacitor 22P 2% 100V NPO Rad.1	45/2680/022P
C25	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C26	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C27	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C28	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C29	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C30	Capacitor 10U 35V Rad Electro	41/2001/010U
C31	Capacitor 10P 2% 100V NPO Rad.1	45/2680/010P
C32	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C33	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C34	Capacitor 100P 2% 100V NPO Rad1	45/2680/100P
C35	Capacitor 470N 50% 50V Z5U Rad.2	46/2002/470N
C36	Capacitor 47U 25V RB Electro	41/2001/047U
C37	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C38	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C39	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C40	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C41	Capacitor 10U 35V Rad Electro	41/2001/010U
C42	Capacitor 33P 2% 100V NPO Rad.1	45/2680/033P
C43	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C44	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C45	Capacitor 15P 5% 63V NPO SM1206	46/3300/015P
C46	Capacitor 15P 5% 63V NPO SM1206	46/3300/015P
C47	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C48	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C49	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C50	Capacitor 56P 5% 63V NPO SM1206	46/3300/056P
C53	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C54	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C55	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C56	Capacitor, 8p2 5% 63V NPO SM1206	46/3300/08P2
C57	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C59	Capacitor 10U 35V Rad Electro	41/2001/010U
C60	Capacitor 10P 5% 63V NPO SM1206	46/3300/010P

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Ref.	Description	Part Number
C62	Capacitor 100P 5% 63V NPO 1206	46/3300/100P
C63	Capacitor 100P 5% 63V NPO 1206	46/3300/100P
C64	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C65	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C66	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C67	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C68	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C69	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C70	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C71	Capacitor 47P 2% 100V NPO Rad.1	45/2680/047P
C72	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C73	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C74	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C75	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C76	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C77	Capacitor 10U 35V Rad Electro	41/2001/010U
C78	Capacitor 4N7 10% COG Rad.2	46/2000/04N7
C79	Capacitor 47N 20% 50V X7R Rad.2	46/2001/047N
C80	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C81	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C82	Capacitor 47N 20% 50V X7R Rad.2	46/2001/047N
C83	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C84	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C85	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C86	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C87	Capacitor 4P7 5% 63V NPO SM1206	46/3300/04P7
C88	Capacitor 100N 10% 63V X7R 1206	46/3310/100N
C89	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C90	Capacitor 1N2 5% NPO Rad.2	46/2000/01N2
C91	Capacitor 1UO 10% 50V MKT	47/2007/01UO
C92	Capacitor 100N 5% 50V MKT Rad.2	47/2007/100N
C93	Capacitor 22N 10% 63V MKT Rad.2	47/2007/022N
C94	Capacitor 1N2 5% NPO Rad.2	46/2000/01N2
C95	Capacitor 100N 5% 50V MKT Rad.2	47/2007/100N
C96	Capacitor 22N 10% 63V MKT Rad.2	47/2007/022N
C97	Capacitor 47U 25V RB Electro	41/2001/047U
C98	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C99	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C100	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C101	Capacitor 4N7 10% COG Rad.2	46/2000/04N7
C103	Capacitor 1N5 10% 50V COG Rad.2	46/2000/01N5
C104	Capacitor 100N 5% 50V MKT Rad.2	47/2007/100N
C105	Capacitor 470U 25V RB Electro	41/2001/470U
C106	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C107	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C108	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C109	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C110	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C111	Capacitor 1UO 10% 50V MKT	47/2007/01UO
C112	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C113	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C114	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C115	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C116	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C117	Capacitor 10N 1% 63V KP7.5	47/2007/010N
C118	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C119	Capacitor 47U 25V RB Electro	41/2001/047U
C120	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C121	Capacitor 2N2 5% 400V MKT Rad.2	47/2040/02N2
C122	Capacitor 15N 5% 400V MKT Rad.2	47/2040/015N
C123	Capacitor 33N 5% 400V MKT Rad.2	47/2040/033N

Ref.	Description	Part Number
C124	Capacitor 6N8 10% 400V MKT Rad.2	47/2040/06N8
C125	Capacitor 10N 10% 400V MKT Rad.2	47/2040/010N
C126	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C127	Capacitor 470U 25V RB Electro	41/2001/470U
C128	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C129	Capacitor 47U 25V RB Electro	41/2001/047U
C130	Capacitor 470U 25V RB Electro	41/2001/470U
C131	Capacitor 1UO 10% 50V MKT	47/2007/01U0
C132	Capacitor 1UO 10% 50V MKT	47/2007/01U0
C133	Capacitor 1UO 10% 50V MKT	47/2007/01U0
C134	Capacitor 2U2 10% 100V MKT Rad.2	47/2010/02U2
C135	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C136	Capacitor 470U 25V RB Electro	41/2001/470U
C137	Capacitor 10U 35V Rad Electro	41/2001/010U
C138	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C139	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C140	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C141	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C142	Capacitor 10U 35V Rad Electro	41/2001/010U
C143	Capacitor 10U 35V Rad Electro	41/2001/010U
C144	Capacitor 10U 35V Rad Electro	41/2001/010U
C145	Capacitor 10U 35V Rad Electro	41/2001/010U
C146	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C147	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C148	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C149	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C150	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C151	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C152	Capacitor 470U 25V RB Electro	41/2001/470U
C153	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C154	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C155	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C156	Capacitor 1N0 5% 100V NPO Rad.2	46/2000/01N0
C157	Capacitor 18P 2% 100V NPO Rad.1	45/2680/018P
C158	Capacitor 18P 2% 100V NPO Rad.1	45/2680/018P
C159	Capacitor 10U 35V Rad Electro	41/2001/010U
C160	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C161	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C162	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C163	Capacitor 10U 35V Rad Electro	41/2001/010U
C164	Capacitor 10U 35V Rad Electro	41/2001/010U
C166	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C167	Capacitor 10U 35V Rad Electro	41/2001/010U
C169	Capacitor 12P 5% 63V NPO SM1206	46/3300/012P
C170	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C171	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C172	Capacitor 12P 5% 63V NPO SM1206	46/3300/012P
C175	Capacitor 12P 5% 63V NPO SM1206	46/3300/012P
C176	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C177	Capacitor 12P 5% 63V NPO SM1206	46/3300/012P
C179	Capacitor 10P 5% 63V NPO SM1206	46/3300/010P
C180	Capacitor 1N0 5% 63V NPO SM1206	46/3300/01N0
C185	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
C186	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C187	Capacitor 100N 10% 50V X7R Rad.2	46/2001/100N
C188	Capacitor 10N 10% 50V X7R Rad.2	46/2001/010N
D1	Diode Zen 5V1 BZX84C5V1 SOT	21/3040/C5V1
D2	Diode Band SW BA682 SOD80	21/3050/0682
D3	Diode Schottkey BAT17 SOT23	21/3030/0017
D4	Diode VCapacitor MMBV432L SOT23	21/3060/V432
D5	Diode Silicon IN4148	21/1010/4148
D6	Diode Silicon IN4148	21/1010/4148

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Ref.	Description	Part Number
D7	Diode LED Yellow RT ANG MTG	21/1010/LEDY
D8	Diode Zen 1N4751 30V 1W Axial	21/1040/4751
D9	Diode 3Amplifier 1KV Rectifier	21/1080/5408
D10	Diode 8V2 Zener	21/1040/B8V2
D11	Diode LED Red RT ANG MTG	21/1010/LEDR
D12	Diode LED Green RT ANG MTG	21/1010/LEDG
D13	Diode VCapacitor MMBV432L SOT23	21/3060/V432
D14	Diode VCapacitor MMBV432L SOT23	21/3060/V432
D15	Diode VCapacitor MMBV432L SOT23	21/3060/V432
D16	Diode VCapacitor MMBV432L SOT23	21/3060/V432
D17	Diode Silicon IN4148	21/1010/4148
H1	Hybred CTCSS	13/9150/0002
ISO1	IC Opto-Isolator 4N33	25/1010/4N33
JP1	Connector 3 Way Header	35/2501/0003
JP2	Connector 3 Way Header	35/2501/0003
JP3	Connector 3 Way Header	35/2501/0003
JP4	Connector 3 Way Header	35/2501/0003
JP6	Connector 3 Way Header	35/2501/0003
JP7	Connector 3 Way Header	35/2501/0003
JP8	Connector 2 Way Header	35/2501/0002
JP9	Connector 3 Way Header	35/2501/0003
JP11	Connector 3 Way Header	35/2501/0003
JP12	Connector 2 Way Header	35/2501/0002
L1	Inductor 220N 10% Choke SM1008	37/3320/220N
L2	Inductor 220N 10% Choke SM1008	37/3320/220N
L3	Inductor 220N 10% Choke SM1008	37/3320/220N
L4	Inductor 1uH Axial	37/2021/001U
L5	Inductor 680N 10mm	37/2021/680N
L6	Inductor 680N 10mm	37/2021/680N
L7	Inductor 680N 10mm	37/2021/680N
L8	Inductor 680N 10mm	37/2021/680N
L9	Inductor 1.5u 10mm	37/2021/1.5U
L10	Inductor VAR 455KHz 10mm	37/2031/97HM
L11	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L12	Inductor 1uH Axial	37/2021/001U
L13	Inductor 39N 10% Choke SM1008	37/3320/039N
L14	Inductor 220N 10% Choke SM1008	37/3320/220N
L15	Inductor 18N 10% Choke SM1008	37/3320/018N
L16	Inductor 220N 10% Choke SM1008	37/3320/220N
L17	Ferrite Bead SMD	37/3321/LM31
L18	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L19	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L20	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L21	Ferrite Bead SMD	37/3321/LM31
L22	Ferrite Bead SMD	37/3321/LM31
L23	Inductor 150mH 10RBH	37/2021/1RBH
L24	Inductor 6 Hole Ferrite RFC	37/2021/0001
L25	Ferrite Bead SMD	37/3321/LM31
L26	Inductor 1uH Axial	37/2021/001U
L27	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L28	Inductor 8N2 10% Choke SM1008	37/3320/08N2
L29	Coil 10mm 2T Shield Ferrite Core	37/2022/0311
L30	Inductor 680N 10% Choke SM1008	37/3320/680N
L31	Coil 10mm 2T Shield Ferrite Core	37/2022/0311
L32	Inductor 8N2 10% Choke SM1008	37/3320/08N2
L33	Inductor 3U3 10% Choke SM1008	37/3320/03U3
L34	Coil 1 turn, Aluminium Core	37/2021/0310
L35	Inductor 8N2 10% Choke SM1008	37/3320/08N2
L36	Coil 10mm 2T Shield Ferrite Core	37/2022/0311
L37	Inductor 680N 10% Choke SM1008	37/3320/680N
L38	Coil 10mm 2T Shield Ferrite Core	37/2022/0311
L39	Inductor 8N2 10% Choke SM1008	37/3320/08N2

Ref.	Description	Part Number
L40	Inductor 1uH Axial	37/2021/001U
L41	Capacitor, 4p7 5% 63V NPO SM1206	46/3300/04P7
L42	Inductor 220N 10% Choke SM1008	37/3320/220N
MA1	Amplifier MMIC MWA0311 SOT143	24/3010/0311
MA2	Amplifier MMIC VAM-6	24/3010/VAM6
MA3	Amplifier MMIC MWA0311 SOT143	24/3010/0311
MA4	Amplifier MMIC MWA0311 SOT143	24/3010/0311
MX1	Mixer RFMX 1-13	37/2070/0113
P1	Filter D RT AGL 25W M 1NF	35/5011/025M
P3	Filter D RT AGL 9W F Ferrite	35/5012/009F
Q1	Transistor NPN MRF9511 SOT143	27/3020/9511
Q2	FET NJ J309 TO92M	27/2030/J309
Q3	FET NJ J309 TO92M	27/2030/J309
Q4	FET NJ 2N5484 TO92M	27/2030/5484
Q5	Transistor RF NPN MRF5812 SO8	27/3020/5812
Q6	FET NJ MMBFJ309 SOT23	27/3030/J309
Q7	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q8	Transistor GP NPN MPS2369 TO92	27/2010/2369
Q9	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q10	Transistor GP PNP 2N3906 TO92	27/2010/3906
Q11	Transistor GP PNP MPS3640	27/2010/3640
Q12	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q13	Transistor GP PNP MPS3640	27/2010/3640
Q14	Transistor GP NPN MPS2369 TO92	27/2010/2369
Q15	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q16	Transistor GP PNP 2N3906 TO92	27/2010/3906
Q17	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q18	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q19	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q20	Transistor PNP MJF6107 TO220	27/2010/6107
Q21	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q22	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q23	FET NJ 2N5459 TO92M	27/2030/5459
Q24	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q26	Transistor GP NPN 2N3904 TO92	27/2020/3904
Q27	Transistor GP NPN 2N3904 TO92	27/2020/3904
R1	Resistor 220R 5% 0.25W SM1206	51/3380/0220
R2	Resistor 1K0 5% 0.25W SM1206	51/3380/01K0
R3	Resistor 680R 5% 0.25W SM1206	51/3380/0680
R4	Resistor 47R 5% 0.25W SM1206	51/3380/0047
R5	Resistor 47R 5% 0.25W SM1206	51/3380/0047
R6	Resistor 47R 5% 0.25W SM1206	51/3380/0047
R7	Resistor 1R0 5% 0.25W SM1206	51/3380/01R0
R8	Resistor 150R 5% 0.25W Axial	51/1040/0150
R9	Resistor 150R 5% 0.25W Axial	51/1040/0150
R10	Resistor 150R 5% 0.25W Axial	51/1040/0150
R11	Resistor 5K6 5% 0.25W Axial	51/1040/05K6
R12	Resistor 150R 5% 0.25W Axial	51/1040/0150
R13	Resistor 12K 5% 0.25W Axial	51/1040/012K
R15	Resistor 470R 5% 0.25W Axial	51/1040/0470
R14	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R16	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R17	Resistor 68K 5% 0.25W Axial	51/1040/068K
R18	Resistor 470K 5% 0.25W Axial	51/1040/470K
R19	Resistor 10K 5% 0.25W Axial	51/1040/010K
R20	Resistor 10K 5% 0.25W Axial	51/1040/010K
R21	Resistor 470R 5% 0.25W Axial	51/1040/0470
R22	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R23	Resistor 680R 5% 0.25W Axial	51/1040/0680
R24	Resistor 33K 5% 0.25W Axial	51/1040/033K
R25	Resistor 100K 5% 0.25W Axial	51/1040/100K
R26	Resistor 270R 5% 0.25W SM1206	51/3380/0270

R220 PARTS LIST

Ref.	Description	Part Number
R27	Resistor 270R 5% 0.25W SM1206	51/3380/0270
R28	Resistor 1K0 5% 0.25W SM1206	51/3380/01K0
R29	Resistor 39R 5% 0.25W SM1206	51/3380/0039
R30	Resistor 39R 5% 0.25W SM1206	51/3380/0039
R31	Resistor 180R 5% 0.25W SM1206	51/3380/0180
R32	Resistor 390R 5% 0.25W SM1206	51/3380/0390
R33	Resistor 270R 5% 0.25W SM1206	51/3380/0270
R34	Resistor 10K 5% 0.25W SM1206	51/3380/010K
R35	Resistor 10K 5% 0.25W SM1206	51/3380/010K
R36	Resistor 10R 5% 0.25W SM1206	51/3380/0010
R37	Resistor 2K2 5% 0.25W SM1206	51/3380/02K2
R38	Resistor 1K0 5% 0.25W SM1206	51/3380/01K0
R39	Resistor 100R 5% 0.25W SM1206	51/3380/0100
R40	Resistor 100R 5% 0.25W SM1206	51/3380/0100
R41	Resistor 100R 5% 0.25W SM1206	51/3380/0100
R42	Resistor 100R 5% 0.25W SM1206	51/3380/0100
R43	Resistor 220R 5% 0.25W Axial	51/1040/0220
R44	Resistor 47R 5% 0.25W SM1206	51/3380/0047
R45	Resistor 15R 5% 0.25W SM1206	51/3380/0015
R46	Resistor 22R 5% 0.25W Axial	51/1040/0022
R47	Resistor 560R 5% 0.25W Axial	51/1040/0560
R48	Resistor 680R 5% 0.25W Axial	51/1040/0680
R49	Resistor 680R 5% 0.25W Axial	51/1040/0680
R50	Resistor 100R 5% 0.25W Axial	51/1040/0100
R51	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R52	Resistor 3K3 5% 0.25W Axial	51/1040/03K3
R53	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R54	Resistor 3K3 5% 0.25W Axial	51/1040/03K3
R55	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R56	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R57	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R58	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R59	Resistor 560R 5% 0.25W Axial	51/1040/0560
R60	Resistor 10K 5% 0.25W Axial	51/1040/010K
R61	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R62	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R63	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R64	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R65	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R66	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R67	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R68	Resistor 180R 5% 0.25W SM1206	51/3380/0180
R69	Resistor 18R 5% 0.25W SM1206	51/3380/0018
R70	Resistor 1R0 5% 0.25W SM1206	51/3380/01R0
R71	Resistor 220K 5% 0.25W Axial	51/1040/220K
R72	Resistor 47K 5% 0.25W Axial	51/1040/047K
R73	Resistor 51K 5% 0.25W Axial	51/1040/051K
R74	Resistor 51K 5% 0.25W Axial	51/1040/051K
R75	Resistor 51K 5% 0.25W Axial	51/1040/051K
R76	Resistor 47K 5% 0.25W Axial	51/1040/047K
R77	Resistor 47K 5% 0.25W Axial	51/1040/047K
R78	Resistor 47K 5% 0.25W Axial	51/1040/047K
R79	Resistor 10K 5% 0.25W Axial	51/1040/010K
R80	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R81	Resistor 10K 5% 0.25W Axial	51/1040/010K
R82	Resistor 6K8 5% 0.25W Axial	51/1040/06K8
R83	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R84	Resistor 270K 5% 0.25W Axial	51/1040/270K
R88	Resistor 5K6 5% 0.25W Axial	51/1040/05K6
R89	Resistor 100K 5% 0.25W Axial	51/1040/100K
R90	Resistor 150K 5% 0.25W Axial	51/1040/150K
R91	Resistor 560K 5% 0.25W Axial	51/1040/560K

Ref.	Description	Part Number
R92	Resistor 10K 5% 0.25W Axial	51/1040/010K
R93	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R94	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R95	Resistor 64K9 1% 0.25W Axial	51/1010/64K9
R96	Resistor 64K9 1% 0.25W Axial	51/1010/64K9
R97	Resistor 64K9 1% 0.25W Axial	51/1010/64K9
R98	Resistor 15K 5% 0.25W Axial	51/1040/015K
R99	Resistor 15K 5% 0.25W Axial	51/1040/015K
R100	Resistor 10M 5% 0.25W Axial	51/1040/010M
R101	Resistor 6K49 1% 0.25W Axial	51/1010/6K49
R102	Resistor 28K7 1% 0.25W Axial	51/1010/28K7
R103	Resistor 562K 1% 0.25W Axial	51/1010/562K
R104	Resistor 28K7 1% 0.25W Axial	51/1010/28K7
R105	Resistor 6K49 1% 0.25W Axial	51/1010/6K49
R106	Resistor 562K 1% 0.25W Axial	51/1010/562K
R107	Resistor 75K 1% 0.25W Axial	51/1010/075K
R108	Resistor 10K 5% 0.25W Axial	51/1040/010K
R109	Resistor 3K57 1% 0.25W Axial	51/1010/3K57
R110	Resistor 3K57 1% 0.25W Axial	51/1010/3K57
R111	Resistor 3K57 1% 0.25W Axial	51/1010/3K57
R112	Resistor 10K 5% 0.25W Axial	51/1040/010K
R113	Resistor 390R 5% 0.25W Axial	51/1040/0390
R114	Resistor 10K 5% 0.25W Axial	51/1040/010K
R115	Resistor 39R 5% 0.25W Axial	51/1040/0039
R116	Resistor 220R 5% 0.25W Axial	51/1040/0220
R117	Resistor 10R 5% 0.25W Axial	51/1040/0010
R118	Resistor 2R2 5% 0.25W Axial	51/1040/02R2
R119	Resistor 10K 5% 0.25W Axial	51/1040/010K
R120	Resistor 330R 5% 0.25W Axial	51/1040/0330
R121	Resistor 33K 5% 0.25W Axial	51/1040/033K
R122	Resistor 270R 5% 0.25W Axial	51/1040/0270
R123	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R124	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R125	Resistor 680R 5% 0.25W Axial	51/1040/0680
R126	Resistor 680R 5% 0.25W Axial	51/1040/0680
R127	Resistor 680R 5% 0.25W Axial	51/1040/0680
R128	Resistor 1K5 5% 0.25W Axial	51/1040/01K5
R129	Resistor 6K8 5% 0.25W Axial	51/1040/06K8
R130	Resistor 680R 5% 0.25W Axial	51/1040/0680
R131	Resistor 10K 5% 0.25W Axial	51/1040/010K
R132	Resistor 51K1 1% 0.25W Axial	51/1010/51K1
R129	Resistor 6K8 5% 0.25W Axial	51/1040/06K8
R130	Resistor 680R 5% 0.25W Axial	51/1040/0680
R131	Resistor 10K 5% 0.25W Axial	51/1040/010K
R132	Resistor 51K1 1% 0.25W Axial	51/1010/51K1
R133	Resistor 274K 1% 0.25W Axial	51/1010/274K
R134	Resistor 10K 5% 0.25W Axial	51/1040/010K
R135	Resistor 10K 5% 0.25W Axial	51/1040/010K
R136	Resistor 10K 5% 0.25W Axial	51/1040/010K
R137	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R138	Resistor 5K11 1% 0.25W Axial	51/1010/5K11
R139	Resistor 47R 5% 0.25W Axial	51/1040/0047
R140	Resistor 680R 5% 0.25W Axial	51/1040/0680
R141	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R142	Resistor 10M 5% 0.25W Axial	51/1040/010M
R143	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R144	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R145	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R146	Resistor 10M 5% 0.25W Axial	51/1040/010M
R147	Resistor 10K 5% 0.25W Axial	51/1040/010K
R148	Resistor 1K0 5% 0.25W Axial	51/1040/01K0

R220 PARTS LIST

Ref.	Description	Part Number
R149	Resistor 5K11 1% 0.25W Axial	51/1010/5K11
R150	Resistor 2K2 5% 0.25W Axial	51/1040/02K2
R151	Resistor 680R 5% 0.25W Axial	51/1040/0680
R152	Resistor 5K11 1% 0.25W Axial	51/1010/5K11
R153	Resistor 100K 5% 0.25W Axial	51/1040/100K
R154	Resistor 64K9 1% 0.25W Axial	51/1010/64K9
R155	Resistor 680R 5% 0.25W Axial	51/1040/0680
R156	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R157	Resistor 10K 5% 0.25W Axial	51/1040/010K
R160	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R161	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R162	Resistor 270R 5% 0.25W SM1206	51/3380/0270
R163	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R164	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R166	Resistor 15R 5% 0.25W SM1206	51/3380/0015
R168	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R169	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R170	Resistor 270R 5% 0.25W SM1206	51/3380/0270
R171	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R172	Resistor 100K 5% 0.25W SM1206	51/3380/100K
R177	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R178	Resistor 1K0 5% 0.25W Axial	51/1040/01K0
R179	Resistor 680R 5% 0.25W Axial	51/1040/0680
R180	Resistor 470K 5% 0.25W Axial	51/1040/470K
R181	Resistor 4K7 5% 0.25W Axial	51/1040/04K7
R182	Resistor 100R 5% 0.25W Axial	51/1040/0100
R183	Resistor 3K3 5% 0.25W Axial	51/1040/03K3
R184	Resistor 3K3 5% 0.25W Axial	51/1040/03K3
R185	Resistor 470K 5% 0.25W SM1206	51/3380/470K
R186	Resistor 10R 5% 0.25W Axial	51/1040/0010
R187	Resistor 100K 5% 0.25W Axial	51/1040/100K
R188	Resistor 10K 5% 0.25W Axial	51/1040/010K
RN1	Resistor Pack 100K X8 DIP16	52/2002/100K
RN2	Resistor Pack 10K SIP10	52/2002/010K
RV1	Trimpot 10K 1 Turn Vertical	53/1020/010K
RV3	Trimpot 10K Multi-turn Horizontal	53/2060/010K
RV4	Trimpot 10K Multi-turn Horizontal	53/2060/010K
RV5	Trimpot 10K Multi-turn Horizontal	53/2060/010K
T1	Transformer Line 600 Ohm	37/2040/5065
U1	IC Mixer RX NE612N	25/2050/612N
U2	IC Dual OP Amplifier MC3458	25/2050/3458
U3	IC IF Amplifier LIM DISC NE614A	25/2020/614A
U4	IC Frequency SYN MB1501 SO16SP	26/2000/1501
U5	IC Audio Amplifier TDA2003	25/2070/2003
U6	IC Volt Regulator LM7805	25/2040/7805
U7	IC Quad Nand 74C00 DIP14	26/2031/4C00
U11	IC 3 State BUF 74HC244N	26/2030/244N
U12	IC EPROM 27C256	26/2090/C256
U13	IC 8 BIT LATCH 74HC573N	26/2030/C573
U14	IC Micro Super MC34064P-5	26/2000/064P
U15	IC Micro 68HC11A1P	26/2000/HC11
U16	IC RS232 Inter MAX232C	26/2001/232C
U17	IC Analogue Gate MC14066B	26/2040/4066
U22	IC Dual OP Amplifier MC1458B	25/2050/1458
U24	IC Hex Invert CD4049	26/2040/4049
U26	IC Quad OP Amplifier TLC274	25/2050/274C
U27	IC Quad OP Amplifier TLC274	25/2050/274C
U28	IC Quad OP Amplifier TLC274	25/2050/274C
XF1	Crystal Filter	33/2000/45MZ
XF2	Crystal Filter	33/2000/45MZ
Y1	Crystal 45.455 HC-45/U	32/2045/M455
Y2	Crystal 4.0MHz	32/2049/04M0

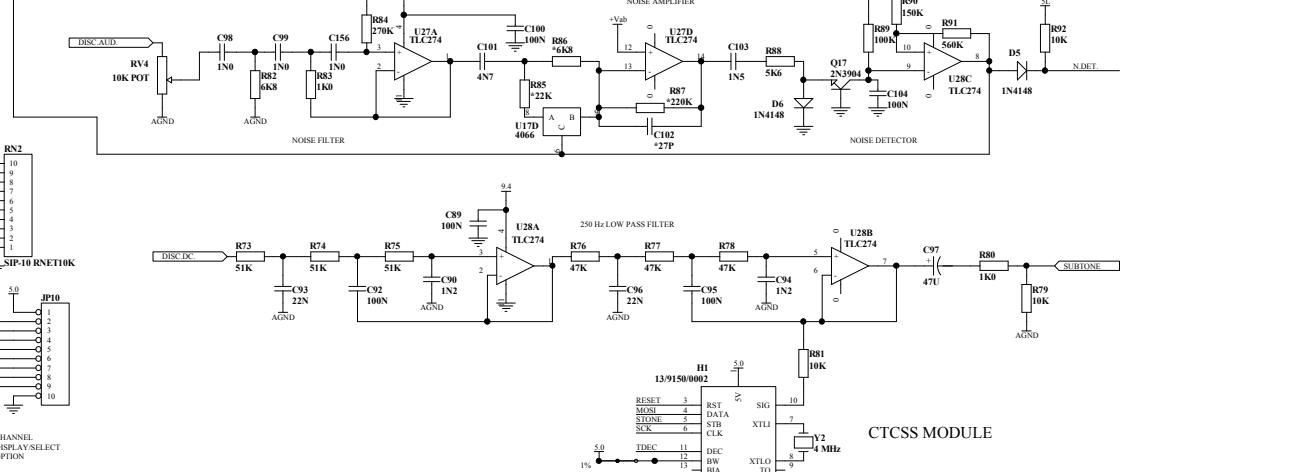
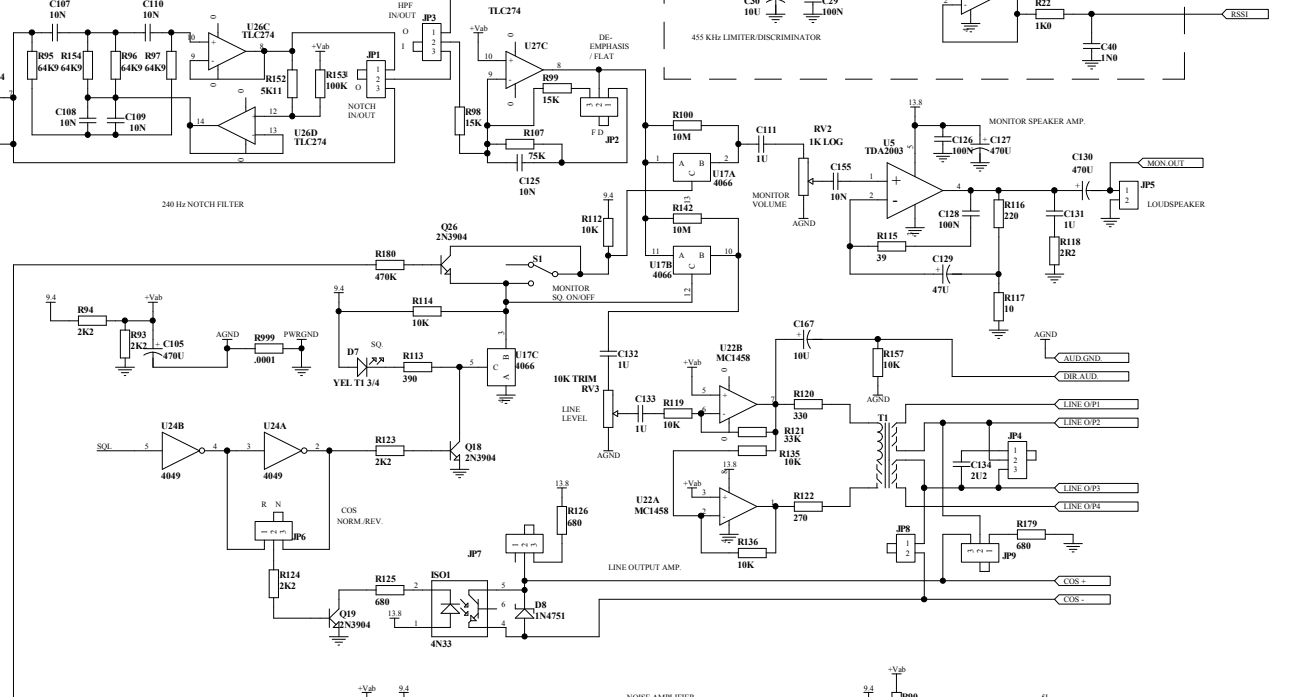
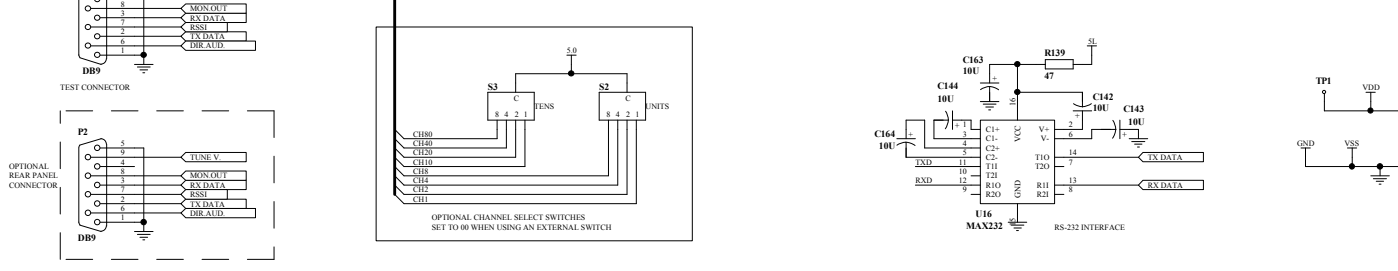
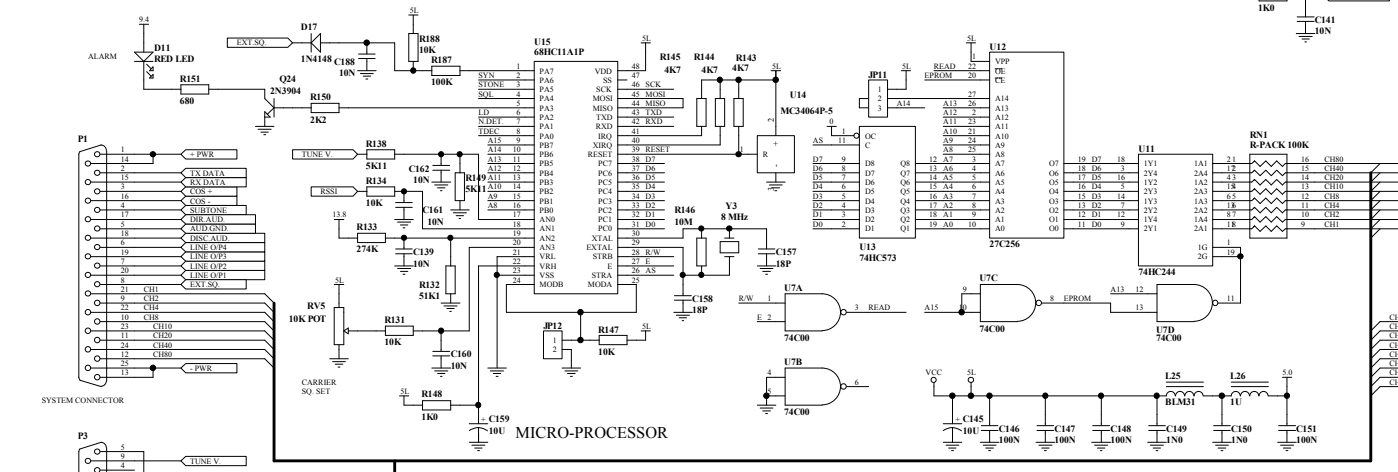
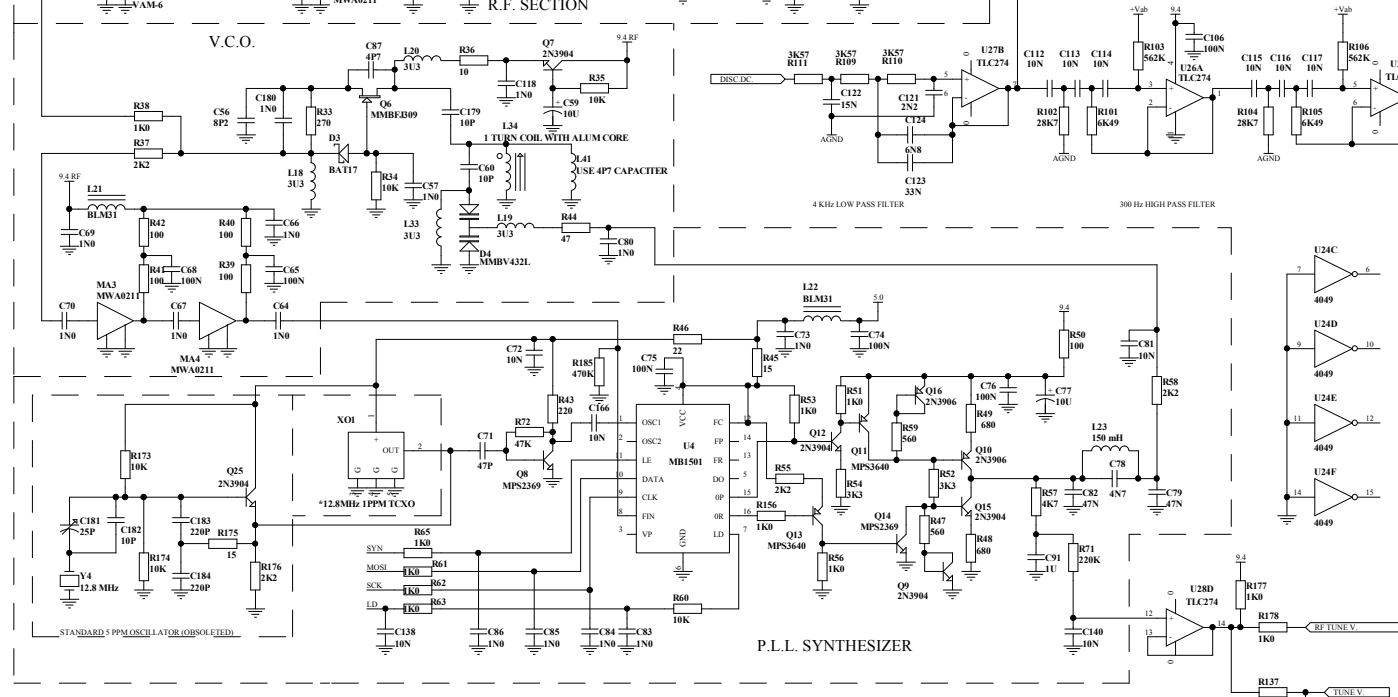
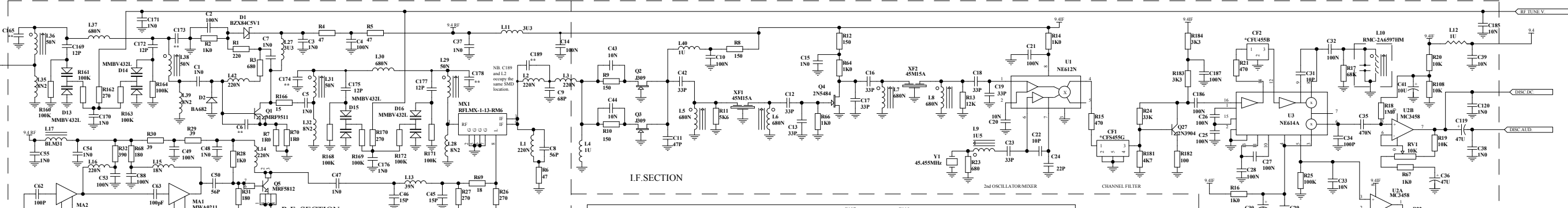
Ref.	Description	Part Number
Y3	Crystal 8.0MHz	32/2049/08M0

R220 Parts for 7.5KHz Channel Spacing.

CF1	Filter Ceramic CFS455H	34/2000/CFSH
CF2	Filter Ceramic CFU455T	34/2000/CFUT
R85	Resistor 3K3 5% 0.25W Axial	51/1040/03K3
R86	Resistor 1K 5% 0.25W Axial	51/1040/01K0
R87	Resistor 470K 5% 0.25W Axial	51/1040/470K
C102	(Not fitted for 7.5KHz Channel Spacing)	-----
XO1	TCXO 12 MHz,HI-Q TCO474	32/3031/12.0

R220 Parts for 12.5KHz Channel Spacing.

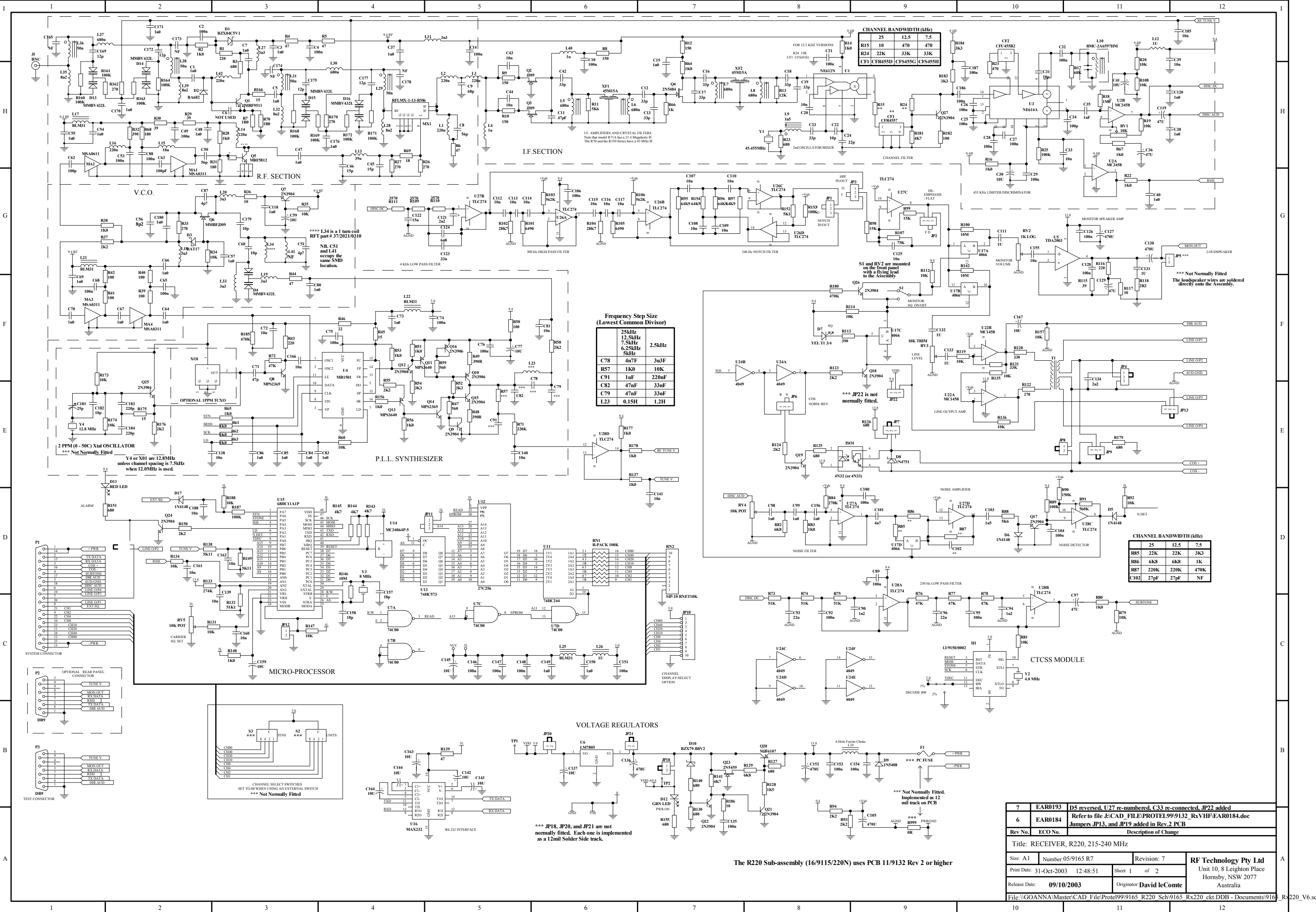
CF1	Filter Ceramic CFS455G	34/2000/CFSG
CF2	Filter Ceramic CFU455B	34/2000/CFUB
R85	Resistor 22K 5% 0.25W Axial	51/1040/022K
R86	Resistor 6K8 5% 0.25W Axial	51/1040/06K8
R87	Resistor 220K 5% 0.25W Axial	51/1040/220K
C102	Capacitor 27P 2% 100V NPO Rad.1	45/2680/027P
XO1	TCXO 12.8 MHz,HI-Q TCO474	32/3031/12.8



CHANNEL SPACING TABLE

	XO1	CF1	CF2	R85	R86	R87	C102
12.5kHz	12.8M TCXO	CFS455G	CFU455B	22K	6K8	220K	27P
7.5kHz	12M TCXO	CFS455H	CFU455H	3K3	1K	470K	**

NOTE:
COMPONENTS VALUE START WITH * ARE FOR DEFAULT
12.5kHz CH SPACING, REFER ABOVE TABLE FOR 7.5kHz SPACING
VALUE WITH ** MEANS COMPONENT NEED NOT FIT ON PCB



CHANNEL BANDWIDTH (kHz)

25	12.5	7.5
R15	10	470
R24	22K	33K
C71	CFR45SD	CFR45SG
	CFR45SH	CFR45SI

Frequency Step Size (Lowest Common Divisor)

25kHz	12.5kHz	7.5kHz	6.25kHz	5kHz	2.5kHz
C78	4n7F	3n3F			
R57	1K0	10K			
C91	1uF	220nF			
C82	47nF	33nF			
C79	47nF	33nF			
L23	0.15H	1.2H			

CHANNEL BANDWIDTH (kHz)

25	12.5	7.5
R85	22K	22K
R86	6K8	6K8
R87	220K	220K
C102	27pF	27pF
		NF

7	EAR0193	D5 reversed, U27 re-numbered, C33 re-connected, JP22 added
6	EAR0184	Refer to file J/CAD_FILE/PROTEL99/132_RxVHF/EAR0184.doc Jumpers JP13, and JP19 added in Rev.2 PCB
Rev No.	ECO No.	Description of Change
Title: RECEIVER, R220, 215-240 MHz		
Size: A1	Number:05/9165 R7	Revision: 7
Print Date: 31-Oct-2003 12:48:51	Sheet 1 of 2	RF Technology Pty Ltd Unit 10, 8 Leighton Place Hornsby, NSW 2077 Australia
Release Date: 09/10/2003	Originator:David leComte	
File: \\GOANNA\Master\CAD File\Protel99\9165 R220_Sch\9165 Rx220_ckt.DDB - Documents\9165_R220_V6.scl		

The R220 Sub-assembly (16/9115/220N) uses PCB 11/9132 Rev 2 or higher

*** JP18, JP20, and JP21 are not normally fitted. Each one is implemented as a 12mil Solder Side track.

*** Not Normally Fitted. Implemented as 12 mil track on PCB

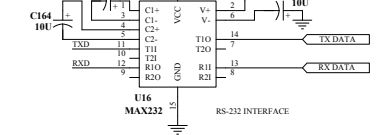
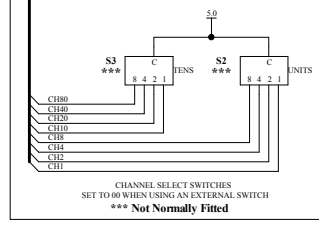
*** Not Normally Fitted
The loudspeaker wires are soldered directly onto the Assembly.

*** L34 is a 1 turn coil
RFT part # 372021/0310
NB, C51 and L41 occupy the same SMD location.

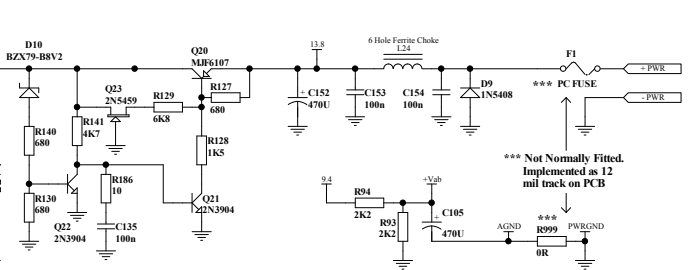
2 PPM (0 - 50C) Xtal OSCILLATOR
*** Not Normally Fitted
Y4 or X01 are 12.8MHz unless channel spacing is 7.5kHz when 12.0MHz is used.

OPTIONAL REAR PANEL CONNECTOR

TEST CONNECTOR



VOLTAGE REGULATORS



CTSS MODULE

