Eclipse Series

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R800 Receiver

Operation and Maintainance Manual

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WARNING

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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 Ohm line or direct audio output.

1.1.2 Mon. SQ.

The Mon. SQ. switch allows the normal 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 600Ω 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 NSQ screw clockwise until the noise in the speaker is muted. Then turn the screw one additional turn 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 noise squelch and can be used from 1-200µV 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 the 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. In order of priority the alarms are.

Indication Cadence	Fault Condition
Flashing 5 times, pause	Synthesizer unlocked
Flashing 4 times, pause	Tuning voltage outside limits
Flashing 3 times, pause	Signal level below preset threshold (for fixed links)

Flashing 1 time, pause	dc supply voltage low or high
LED ON continuously	External squelch is active

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

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

2.2 JP2 Audio Response

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

2.3 JP3 Audio Filter In/Out

Condition	Position
Hi-pass & Notch In	2-3*
Flat response to 3 KHz	1-2

2.4 JP4 600 Ohm Line dc Loop COS

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

2.5 JP6 COS Polarity

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

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

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

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

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

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 16Vdc
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 = +5 to +16Vdc
RS232 Data	In Out	15 2	Test and Programming use 9600, 8 data 2 stop
600 Ohm Line	High Low	20 6	Transformer Isolated Balanced 0 dBm Output
150 Ohm/Hybrid Access		7 19	
Discriminator Audio	Disc	18	AC coupled, unsquelched
Direct Audio Output	Audio	17	Direct AC Coupled Audio
Audio Ground	Agnd	5	Direct Audio Ground
Sub-Audible Audio Output	Tone	4	Unsquelched, 1-250 Hz
Carrier Operated Switch	COS+ COS-	3 16	Opto-coupled Transistor Switch (10mA)
External Squelch	Ext Sq	8	<1 Vdc to Squelch >2 Vdc or open ckt to unsquelch

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 TecHelp/ Service Monitor 2000 Software. This software can be run on any IBM compatible PC and provides a number of additional useful facilities.

TecHelp/ 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

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

5 Circuit Description

The following description 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 section helical filter FL1 is used to limit the R.F. bandwidth prior to the R.F. amplifier transistor Q1. The output impedance of FL1 is matched to the input of Q1 by C177, C178 and a microstrip line on the printed circuit board. Q1 is a very low noise device with good intermodulation performance.

A four section filter consisting of FL2 and FL3 is used between Q1 and the mixer MX1. This filter provides additional image and spurious frequency rejection.

MX1 is a high level double balanced diode ring mixer with excellent intermodulation performance. It has a conversion loss of approximately 7dB. The gain between the receiver input and the mixer input is approximately 10dB so that the total gain between the antenna input and the I.F. input is 3-4dB.

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

The network C8, C9, L1-3 and R6 passes the 45MHz I.F. frequency to the I.F. amplifier and terminates the R.F. and L.O. frequency components.

5.2 I.F. Section

The first I.F. amplifier uses two parallel connected JFET transistors Q2 and Q3 to obtain 8-10dB gain. The two transistors provide improved dynamic range and input matching over a single transistor.
A two pole 45MHz crystal filter XF1 is used between the first and second I.F. amplifiers. The second I.F. 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 I.F. image frequency rejection.

U1 is a monolithic oscillator and mixer I.C. It converts the 45MHz I.F. signal down to 455KHz. The second oscillator frequency or 45.455MHz is controlled by crystal Y1. The 455KHz output of the second mixer is fed through the ceramic filter CF1 to the 2nd I.F. amplifier transistor Q27. Q27 provides an additional 15dB gain ahead of the limiter and discriminator I.C. U3.

CF1 provides additional adjacent channel selectivity for 25KHz versions and all of the adjacent channel selectivity for 12.5KHz versions. CF1 and termination resistors R15 and R24 are the only component differences between the 12.5 and 25KHz versions.

The limiter/discriminator I.C. 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 U3.

The limiter section of U3 drives the quadrature detector discriminator. C31 and I.F. 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 V.C.O Section

The Voltage controlled Oscillator uses a bipolar junction transistor Q6 which oscillates at the required mixer injection frequency. A fixed tuned ceramic coaxial resonator CR1 is used to set the tuning range. Varactor diode D18 is used by the P.L.L. circuit to keep the oscillator locked on the desired frequency. Transistor Q7 is used as a filter to reduce the noise on the oscillator supply voltage.

5.4 P.L.L. Section

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

The 12.8MHz output of XO1 is amplified by Q8 to drive the reference input of the P.L.L. synthesizer I.C. U4. This I.C. is a single chip synthesizer which includes a 1.1GHz pre-scaler, programmable divider, reference divider and phase/frequency detector. The frequency data is entered by a serial data link from the microprocessor.

The phase detector output signals from U4 are used to control two switched current sources. The output of the positive and negative sources Q10 and Q15, produce the tuning voltage which is smoothed by the loop filter components to bias the V.C.O. varactor diode D18.

5.5 Audio Signal Processing

A 4KHz low pass filter (U27b) is used to remove high frequency noise from the signal. A 300Hz high pass filter (Y26a,b) then removes the sub-audible tones. A 240Hz notch filter (U26c,d) is used to improve the rejection of tones above 200Hz. The high pass and notch filters can be bypassed by internal jumpers JP1 and JP3.

The audio frequency response can be set for either a 750uS de-emphasis or flat characteristic by JP2. JP2 switches the feedback networks of amplifier U27c to achieve the desired response.
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 microcontroller 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 I.C. (U22a,b). U22 is a dual amplifier connected in a bridge configuration to drive the 600 Ohm 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 10KHz 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 schmidt trigger. The output of U26c goes high when noise is detected. It connects to the microcontroller and to analog switch U17d. U17d varies the gain of the noise amplifier to provide approximately 2dB hysteressis.

5.7 Subtone Filter and C.T.C.S.S.

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 C.T.C.S.S. hybrid and the rear panel system connector. The filtered output can be used for re-transmission of C.T.C.S.S. or D.C.S.

The C.T.C.S.S. decoder module is a microcontroller base hybrid module. Under control of the main microprocessor U15 it can decode all 38 E.I.A. 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 microcontroller 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, a synchronous serial port and an analog to digital convertor.

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 (IS01) output. Internal jumpers (JP4,7,8,9) can be connected to provide loop source, loop switch, free switch and various other configurations.

The C.O.S. can be set to active (switch closed) on carrier or active in the absence of carrier. The generic term “Carrier Operated Switch” may be misleading in this case. If a sub-audible tone has been programmed for the channel current channel, the C.O.S. will be controlled by carrier and tone detection.

5.11 Voltage Regulator

The dc input voltage is regulated down to 9.4Vdc 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.

5.12 Tuning Voltage Supply

U18 is an astable multivibrator. The output from pin 3 of U18 is a rectangular 8 volt waveform with a frequency of approximately 200KHz. This output is connected to a voltage tripler circuit consisting of C170-C173, D13 and D14 to produce +20Vdc. This is used by the frequency synthesizer to provide tuning voltages up to +18Vdc.

6 Alignment Procedure

The following procedures may be used to align the receiver for optimum performance. Normally alignment should only be necessary after repairs on that part of the circuit.

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

6.1 Standard Input Signal

RF Signal Generator
50? output impedence Frequency range 806-950MHz FM modulation at 1KHz 1.5KHz peak for 12.5KHz channel spacing 3.0KHz peak for 25KHz channel spacing

6.2 RF Alignment

Step	Input	Measure	Adjust
1	Select alignment frequency channel	dc Volts on TP3 (next to FL4)	FL4 for maximum dc volts
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 2-3Vdc
3	As above	As above	FL1,FL2,FL3 for maximum reading. Reduce generator output to keep below 3Vdc.

6.3 IF Alignment

Step	Input	Measure	Adjust
1	Signal generator on centre frequency channel to J1. Modulation OFF.	dc Volts on test socket pin 7 to pin 1	Generator level to read 2-3Vdc.
2	As above	As above	L5,L6,L7,L8 For max. Reduce generator output to keep below 3Vdc
3	Set generator level to 10uV	Frequency U3 pin 9	L9 to read 455KHz +/- 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. 1Vrms
5	As Above	As Above	L10 for maximum
6	As above	Audio level P1 pin 18 to pin 5	RV1 for .5Vrms
7	Set generator level to approx 0.25uV	SINAD on test socket pin 6 to pin 1	Reduce generator level to obtain 12dB SINAD. Carefully adjust L5,L6,L7,L8 to obtain the best SINAD. Reduce the generator output to maintain 12dB 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 775mV rms

6.5 Reference Oscillator Calibration

Step	Input	Measure	Calibration
1	None required	Frequency Junction of R69 and R26 on the top of the PCB. (L.O. input to the mixer)	X01 for L.O. +/- 100Hz L.O. =Fc+45MHz

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 600 Ohm 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. Each channel number can represent a 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 TecHelp/ 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 microporcessor is used to control the synthesizer and squelch functions and facilitate the channel frequency programming. With the standard software it also can provide some rudimentary 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 4RU (178mm) and the depth 350mm. The receiver is 63.5mm or two eclipse modules wide.

7.3 Front Panel Controls, Indicators and Test Points

7.3.1 Controls

Mute Defeat Switch - toggle (Overrides CTCSS and carrier squelch at the monitor output).

Monitor Speaker Volume - Knob

Line Output Level - Screwdriver adjust multiturn pot

Noise Sq. Setting - Screwdriver adjust multiturn pot

Carrier Sq. Setting - Screwdriver adjust multiturn 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 - 6 + Gnd (pin 1)

Receive Signal Strength - 7 + Gnd (pin 1)

Tuning Voltage - 9 + Gnd (pin 1)

Serial data (RS232) - 2/3 + Gnd (pin 1)

7.4 Electrical Specifications

7.4.1 Power Requirements

Operating Voltage - 10.5 to 16Vdc

Current Drain - 500mA Max

Polarity - Negative Ground

7.4.2 Frequency Range and Channel Spacing

Model No.		
Frequency	**25KHz**	**12.5KHz**
800-830MHz	R800A	R800AN
850-870MHz	R800B	R800BN
896-930MHz	R800C	R800CN

7.4.3 Frequency Synthesizer Step Size

-10.0 or 12.5KHz

7.4.4 Frequency Stability

+/- 1ppm, 0 to +60C, Standard

7.4.5 Nominal Antenna Impedance

50 Ohms

7.4.6 IF Frequencies

1st IF Frequency 45MHz

2nd IF Frequency 455KHz

7.4.7 Sensitivity

0.25uV (-119dBm) for 12dB SINAD

0.35uV (-116dBm) for 20dB Quieting

7.4.8 Selectivity

25KHz spacing - 80dB per EIA-603

12.5KHz spacing - 70dB per EIA-603

7.4.9 Spurious and Image Rejection

90dB

7.4.10 Intermodulation

80dB per RS204C

7.4.11 Modulation Acceptance BW

25KHz spacing - 7.5KHz per EIA-603
12.5KHz spacing - 3.75KHz per EIA-603

7.4.12 Noise Squelch

Adjustment Range 6-26dB SINAD, 25KHz Versions
6-18dB SINAD, 12.5KHz Versions

Attack Time 20mSec. above 20dB Quieting

Release Time 150mSec. at 20dB quieting decreasing to 20mSec. above 2uV present 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 200uV.

7.4.14 Receiver Frequency Spread

Less than 1dB change in sensitivity over 10MHz

7.4.15 Receiver Conducted Spurious Emissions

Less than -57dBm from 1 to 2900MHz

7.4.15.1 Audio Frequency Response

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

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

7.4.15.2 Audio Output Level

600 Ohm Line: Adjustable -10 to +10dBm

Monitor Loudspeaker: 5watts with external speaker. 0.3watt with internal speaker.

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

7.4.16 Audio Distortion

With 750uSec. De-Emphasis: Less than 3% at 1KHz and 60% of rated system deviation.

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

7.4.17 Channel Select Input/Output

Coding: 8 Lines BCD coded 00-99

Logic Input Levels: 0=<0.4Volts
1=>3.5Volts
Internal 10K pull down resistors selects Ch.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 600? Line: Internal connections are provided so that the opto-coupler can be connected to the 600? line for use over a single pair.

Current Source/Sink, Collector Voltage: Ic = 10mA Maximum
Vc = 30Volts 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.

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

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.

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

7.5 Connectors

7.5.1 Antenna Connector

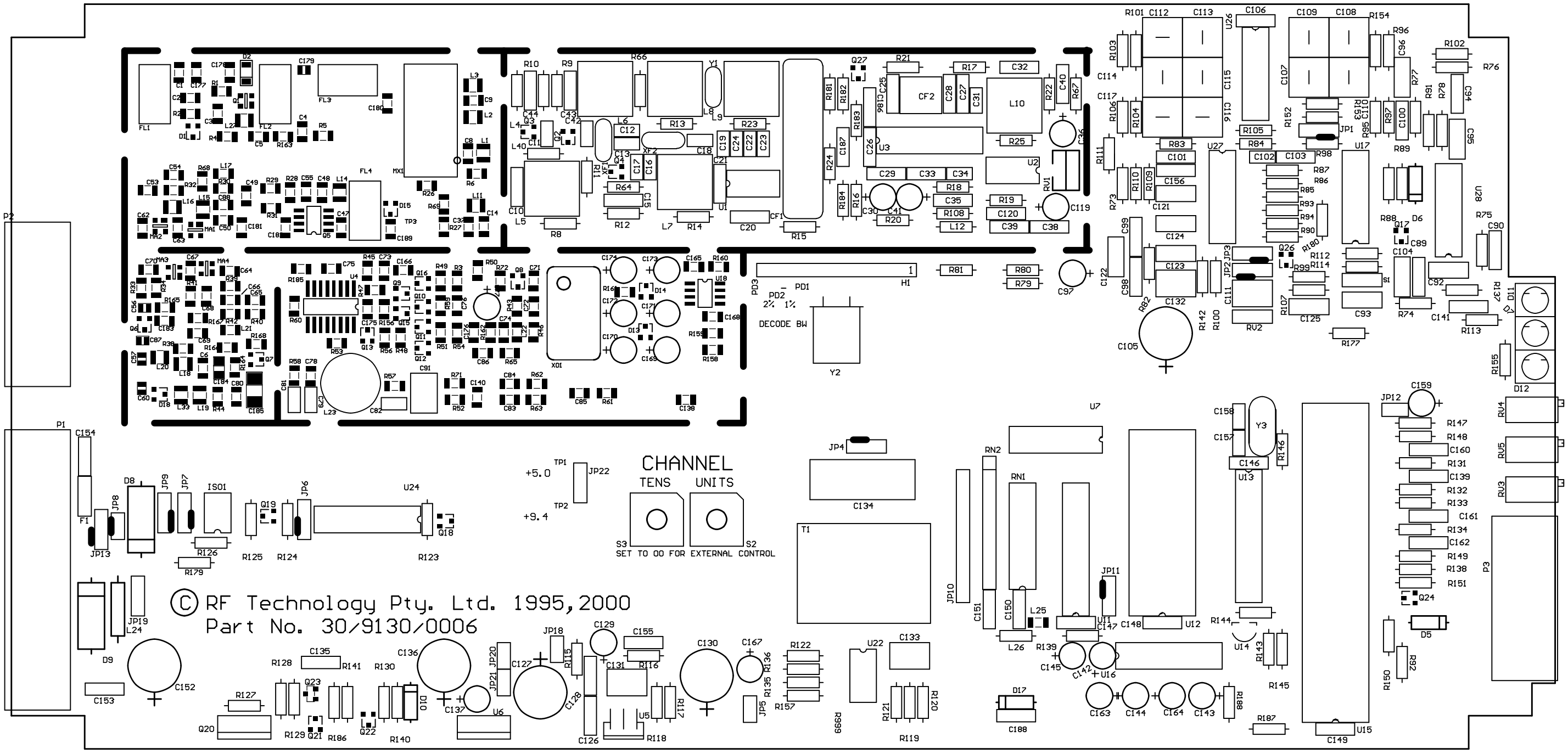
Type N Female Mounted on the module rear panel

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.


CHANNEL
TENS UNITS
S3 S2
SET TO 00 FOR EXTERNAL CONTROL
+5.0
+9.4
DECODE BW
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Part No. 30/9130/0006