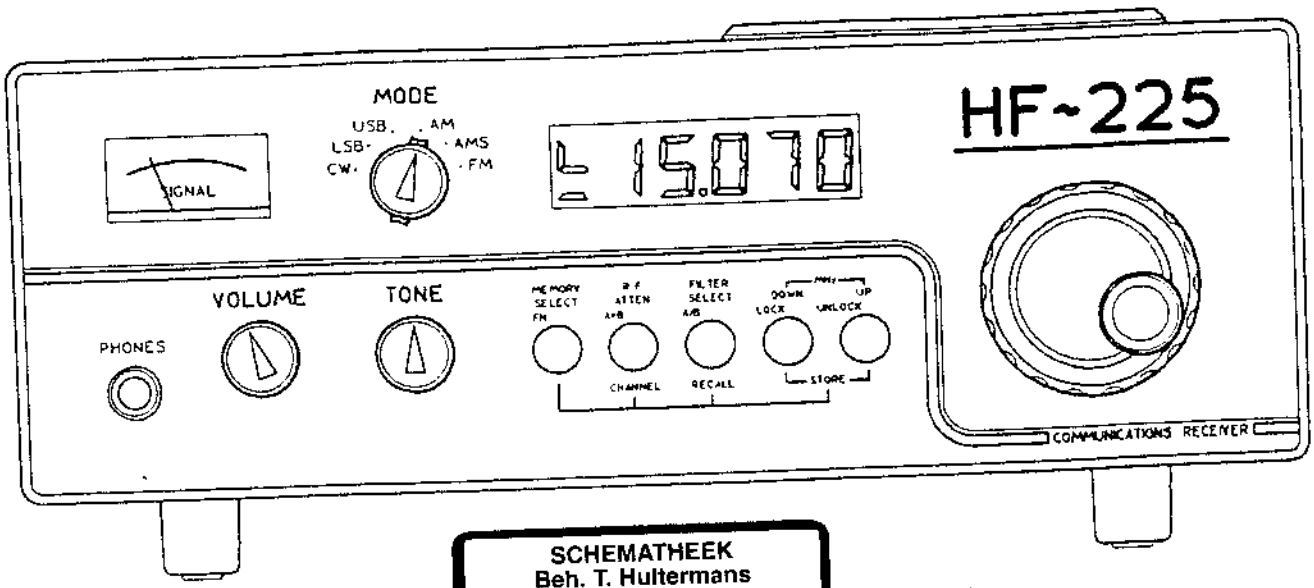
HF-225 General Coverage Receiver.

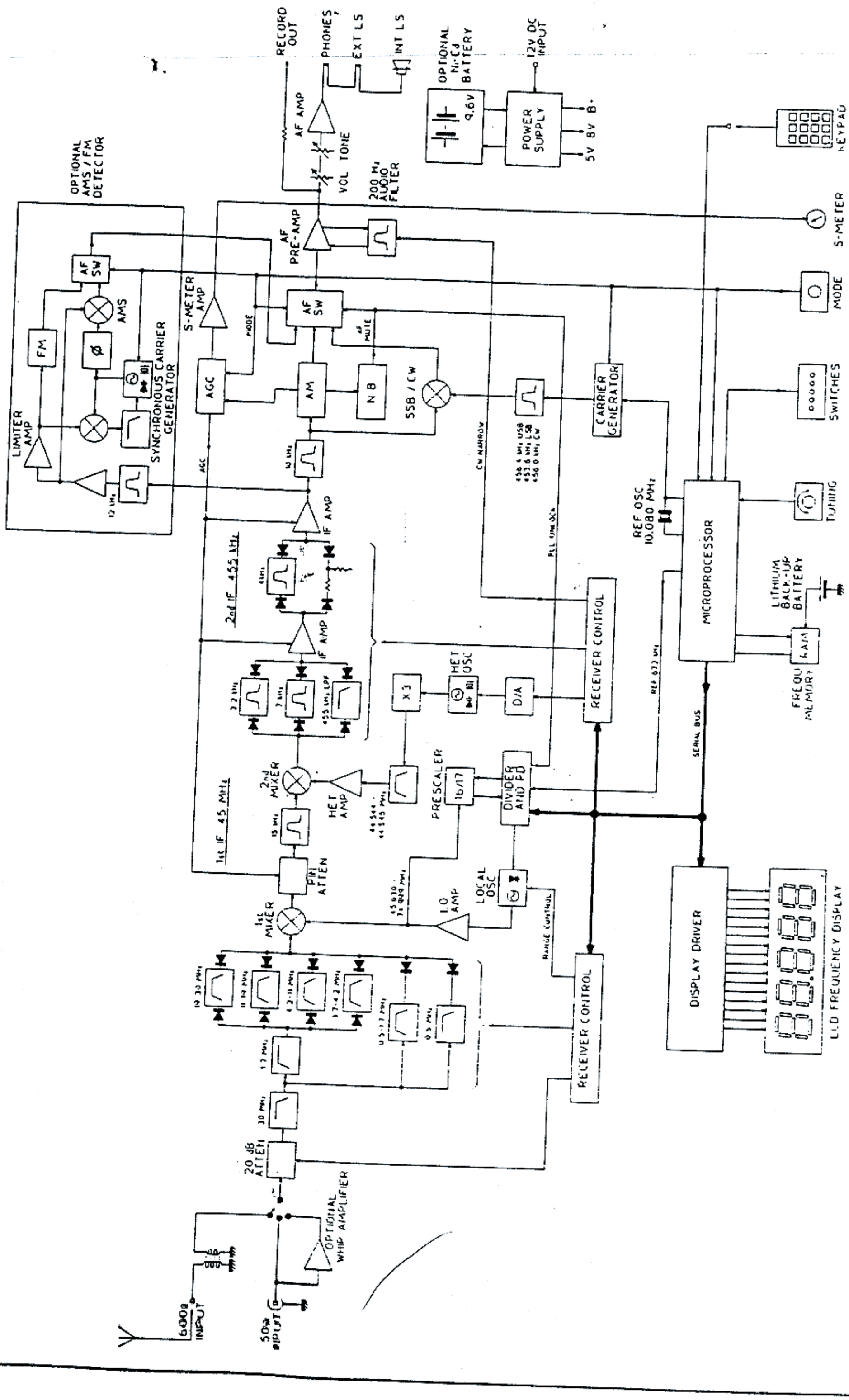
Technical Manual.



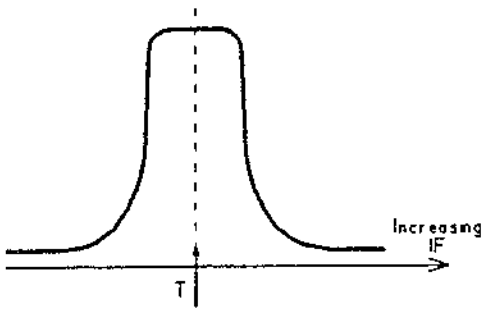
Contents.

Bentley Bridge
Chesterfield Road
Matlock, Derbyshire.
Printed in England. M02-2251

HF-225 BLOCK DIAGRAM

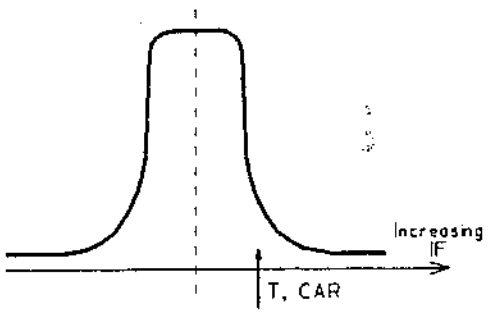


The following diagrams show the relationship between tuned frequency, IF filter centre frequency and carrier reinsertion frequency for each mode.



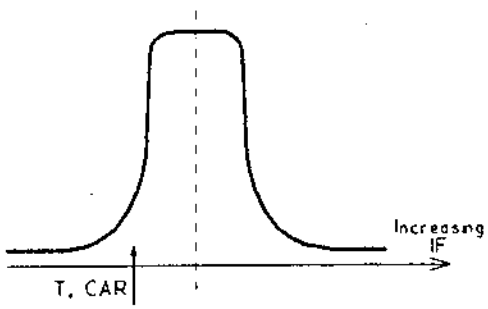
AM and FM modes:

Tuned frequency (T) in centre of filter passband.



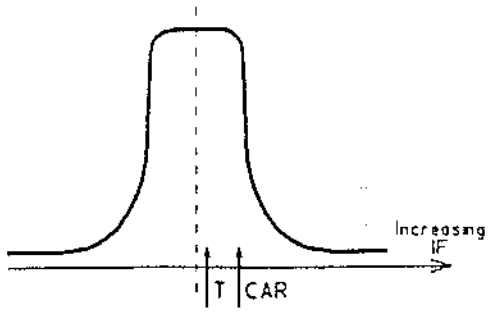
USB mode:

Tuned frequency (T) offset by -1.4 kHz.
Carrier reinsertion (C) offset by +1.4 kHz.



LSB mode:

Tuned frequency (T) offset by +1.4 kHz.
Carrier reinsertion (C) offset by -1.4 kHz.



CW mode:

Tuned frequency (T) offset by -200 Hz.
Carrier reinsertion (C) offset by +1.0 kHz.

1.1 RF preamplifier.

The RF preamplifier is only present when the whip antenna option (W-225) is installed. It offers a high input impedance to give good results at low frequencies with the capacitive load of a whip or a short wire aerial. The JFET input stage, Q1, acts as a source follower to drive the low input impedance of the second bipolar stage, which gives some 10 dB of gain. Transformer T1 provides emitter current feedback to give good linearity, and matches the collector circuit to the 50 ohm input of the receiver.

1.2 Input attenuator and band-pass filters.

Signals from the aerial input of the receiver first pass through the relay-switched attenuator formed by R1 / R2 / R3. The attenuator is bypassed if RL1 is closed, or gives about 20 dB signal reduction if RL2 is closed. Frequencies above 30 MHz are attenuated by the low-pass filter L1 / L2 / C1 / C2 / C3, then signals below 1.7 MHz are separated by the duplexer L21 / L22 / C25. For frequencies above 1.7 MHz, the signal passes through one of four band-pass filters, covering 1.7 to 4.2 MHz, 4.2 to 11 MHz, 11 to 19 MHz and 19 to 30 MHz. Frequencies below 500 kHz have a separate low-pass filter L25 / L26 / C29. These filters all help to reduce spurious mixing effects caused by strong signals outside the frequency band being received.

The appropriate filter is switched into circuit by diodes at the input and output. The control system drives one filter select line low (to ground) whilst holding the others at B+ (about 11V), causing one pair of diodes to conduct, with the remainder reverse-biased. Frequencies below 1.7 MHz are selected only at the output of the filters, and D10 is present to prevent attenuation of signals below 500 kHz by the 0.5 to 1.7 MHz duplexer section. Current for the filter switching diodes first passes through one of the attenuator relay coils, selected by Q5 or Q6.

1.3 1st mixer and 1st IF.

An SL6440 integrated circuit, transistor tree mixer is used to convert the RF signal to the first IF at 45 MHz. Transformer T2 provides a balanced signal feed to the mixer, and the balanced output is matched to the crystal filters X1a and X1b by a tuned transformer T3. Tuning adjustment is provided by TC1. In this configuration the mixer provides enough gain to remove the requirement for a separate RF amplifier stage, and offers more than 90 dB of intermodulation-free dynamic range.

AGC is fed back from the detector stage, via current control Q7, to a PIN attenuator diode D15. This controls the gain of the mixer. Mixer operating current is set by D14 and R17, and the stage is fed from the unregulated B+ supply to maximise dynamic range when the receiver is mains powered but to conserve current when battery operated.

1.4 2nd mixer and 2nd IF.

The second IF section is a cascade of three filters, interspersed with two amplifier stages. There are no adjustments in this section. The IF at 455 kHz is produced by the second mixer, which is also an SL6440 IC, but it is operated at a much reduced current compared to the first mixer. The 15 kHz bandwidth of the first IF filter reduces the dynamic range requirement of the second mixer.

The second mixer output is applied directly to the first group of filters; one of three is selected by the control system. Diode switching passes the signal through either the 2.2 kHz filter (X2), the 7 kHz filter (X3), or through a 500 kHz low-pass filter (C63 / C64 / L34) when the appropriate IF filter select line goes to 5V.

Both of the IF amplifier stages are contained in the SL6700 detector IC, Q5. AGC control to these amplifiers is provided within the integrated circuit. A 4 kHz filter (X4) or a direct connection can be placed between the two amplifiers, again controlled by diode switching. Finally a 10 kHz filter (X5) comes after the second amplifier and before the AM and SSB detectors. A 12 kHz filter is used in place of X5 before the FM and synchronous AM detectors.

IF filter selection is as follows:-

Selected IF bandwidth	1st IF Filter	Filter 1	2nd IF Filter 2	Filter 3
2.2 kHz	15 kHz	2.2 kHz	4 kHz	10 kHz
4 kHz	15 kHz	7 kHz	4 kHz	10 kHz
7 kHz	15 kHz	7 kHz	Thru	10 kHz
10 kHz	15 kHz	500 kHz	Thru	10 kHz

1.5 Detectors and AGC system.

The SL6700 IC contains the AM and SSB detectors, the AGC system and an impulse noise blanker. A full-wave envelope detector provides the AM audio output and feeds an IF signal level to the AGC system. The AGC time constant is provided by C86 and C87 in all modes, and additionally C88 is switched in by Q12 in AM mode to provide slower attack and decay. Transistors Q9 and Q10 provide a fast AGC attack for SSB mode, but this is disabled by Q11 during noise impulses and when the local oscillator is tuning between required frequencies. The AGC voltage is used to drive the S-meter after inversion and amplification by a section of Q24. Diode D40 expands the meter scale for large signals, and VR1 is the S-meter mid-point adjustment.

The noise blanker is triggered by noise spikes about 12 dB above the normal IF level. R54 and C84 determine the blanking period, which is about 0.5 ms. The blanking pulse is fed to the audio muting gate via D28.

1.6 Optional detector unit.

The optional FM and synchronous AM detector is based around the MC3357 narrow-band FM IF integrated circuit. This contains limiting amplifiers and a quadrature FM detector along with a squelch circuit - diodes D1 and D2 rectify the output of an active noise filter to produce a voltage representing the level of audio noise. If this exceeds a level preset by the squelch control then the receiver is muted.

In AMS mode, the resonator X3 provides a narrow range VCO to generate a carrier signal. The mixer inside the MC3357 is used to phase-lock this VCO to the incoming signal after it has passed through a limiting amplifier. Trimmer TC1 adjusts the oscillator centre frequency to 455 kHz. The oscillator signal is fed to mixer Q5 after a 90 degree phase shift, so that the mixer can correctly detect an AM signal. The mixer output is filtered by R29 / C28 to remove the IF component leaving the AMS audio signal.

The FM / AMS audio switching is done by Q10, a CMOS switch, whilst Q7 and Q8 provide switched 8V supplies to the detector stages. Logic circuit Q6 controls supply switching, the squelch enable (FMS) and the audio gate (MUT). Transistor Q9 detects if an audio beat-note is present on the output of the phase-detector (indicating that the AMS detector is out-of-lock) and controls the LCK signal to the front panel lock indicator.

1.7 AF stages.

Audio switching between the SSB and AM detectors is carried out by a CMOS switch Q27. SSB audio from the product detector is buffered by Q23 before the switching circuit. Op-amp Q24 amplifies the audio signal and Q22 provides audio muting at this point. A further section of Q24 acts as a second amplifier that can be switched to a band-pass filter by two further sections of switch Q27. This filter has a -6dB bandwidth of about 200 Hz, centred on 800 Hz, and is used for the narrow CW filter.

The preamplifier output is fed to the record out jack at a constant level, and via the volume and tone controls to the AF amplifier and to the loudspeaker. The final amplifier is fed from the unregulated B+ supply to maximise available audio output power. The tone control is arranged as a bridge circuit giving either treble cut or bass cut.

1.8 Power supply.

Four supply rails are used in the receiver:-

5 Volts for the logic and control system, 455 kHz IF amplifiers and signal switching.

8 Volts for the 45 MHz IF stages, the PLL system and HET oscillator, and the audio preamplifier.

6 Volts specially regulated and smoothed for the local oscillator and buffer amplifiers. (Derived from the 8V supply via Q21).

An unregulated supply between 9V and 15V (B+) for the first mixer and the audio amplifier.

The 8V and 5V supplies are provided by regulators Q32 and Q33 from the B+ supply. A low voltage drop regulator (LM2930 series) is used for the 8V rail to give a stable supply under battery operation when B+ may only be 9V. A large part of the receiver's current consumption is on the 5V supply, and the display illumination LED's are connected between B+ and 5V to take advantage of the voltage drop across the regulator. Transistor Q202 maintains a constant LED brightness.

The battery option B-225 adds a 9.6V rechargeable NiCd battery, which powers the receiver when there is no plug in the DC power input jack. If the receiver is operating from an external supply, the batteries are maintained with a small trickle charge of a few mA via D45 and R141. When the receiver is switched off, the cells are reconnected as two 4.8V batteries, and the charging current increases to about 150 mA for each cell. Resistors R140 and R141 control charging current.

Diode D43 provides protection against a reverse-polarity supply connection, but care should be taken that the normal supply does not exceed 16V. Current consumption is 200 to 250 mA in normal use.

2) PLL section.

2.0 Frequency configuration.

The PLL system and two other signal sources grouped in this section produce the local oscillator (LO), heterodyne (HET) and carrier (CAR) signals that are fed to the IF mixers. There is no signal interconnection between these sources, but their frequencies are controlled together in order to tune the receiver.

The following frequency relationships apply:-

Received frequency = <LO> - <HET> - 455 kHz in AM and FM modes.

Received frequency = <LO> - <HET> - <CAR> in SSB and CW modes.

2.1 Carrier generator.

The carrier generator circuit is split into two sections - a programmable digital divider which is situated on the control unit PCB, and a filter and amplifier which is on the main unit PCB. The programmable divider takes its input from the 10.080 MHz reference oscillator in the microcontroller, Q205. When a carrier signal is needed (in CW, LSB and USB modes) Q208 divides the reference frequency by four to give 2.52 MHz which is fed to programmable counter Q209. The counter division ratio is controlled by the mode setting:-

Selected Mode	Division ratio	Counter o/p frequency	Selected harmonic	CAR frequency
CW	210	12.000 kHz	38 th	456.000 kHz
LSB	250	10.080 kHz	45 th	453.600 kHz
USB	254	9.9213 kHz	46 th	456.378 kHz

The output from the programmable divider is a stream of short pulses, containing many harmonics of the fundamental frequency. This pulse stream is fed through a 4 kHz bandwidth ceramic filter which selects one harmonic near to 455 kHz. This is then amplified and fed to the product detector.

2.2 Heterodyne oscillator.

The heterodyne oscillator, Q19 / X7, is a fundamental mode crystal oscillator running at about 14.848 MHz. The diode D36 in the drain of FET Q19 is operated in its non-linear region and produces strong harmonics of the fundamental frequency. The third harmonic at 44.545 MHz is selected by tank circuit TC4 and L42, amplified by Q4, and fed to the second mixer.

The oscillator frequency is adjusted by TC3 and also by the bias voltage on varicap diode D30. A change of about 0.6V in bias will move the oscillator frequency by 330 Hz, resulting in a 1 kHz change of HET frequency. The bias voltage is derived from a section of the Q24 op-amp which acts as a current-to-voltage converter driven through an R - 2R - 4R ... resistor chain (R85 to R91) from a 7-bit control register. The HET frequency can be controlled in 128 steps across its 1 kHz range, each step being nominally 7.8 Hz.

Variable resistor VR2 adjusts the span of the HET oscillator tuning. Component values in the current-to-voltage converter are chosen so that the setting of VR2 has little effect at the highest bias voltage (corresponding to maximum HET frequency and minimum tuned frequency), allowing VR2 and TC3 to be adjusted independently.

2.3 Local oscillator.

The local oscillator, Q18, is a wide range VCO tuning from 45 MHz to 75 MHz. A JFET is used as the gain element to provide a low-noise signal which is buffered by Q16 / Q17 then fed to the first mixer and the PLL system divider. The oscillator is tuned by varicap diode D29 controlled from the PLL system. Four frequency ranges are available depending on the control voltages on LO1, LO2 and LO3. PIN diodes D31, D32 and D33 select the required inductance value of oscillator coil T4.

Coils and frequency ranges are selected as follows:-

Tuning range (MHz)	LO frequency (MHz)	Select lines LO1	LO2	LO3
0.030 to 4.999	45 to 50	Low	Low	High
5.000 to 10.999	50 to 56	High	Low	High
11.000 to 18.999	56 to 64	Low	High	High
19.000 to 29.999	64 to 75	Low	Low	Low

2.4 PLL system.

The PLL system controls the frequency of the local oscillator using a crystal-derived reference of 672 kHz from the control system. All of the functional blocks of the PLL system are contained in Q29 but a prescaler, Q28, is also required to reduce the local oscillator frequency so that Q29 can operate correctly. Q28 is a dual-modulus prescaler, and can divide by 16 or 17 under the control of Q29 in a pulse-swallowing counter. This counter is arranged as a programmable divider, where the division ratio can be controlled by the receiver's microcontroller.

Both the LO signal and the reference are divided down to 1 kHz and applied to phase detector circuits in Q29. When the phase error is large, a linear digital phase detector can correct the loop error quickly. As the phase error becomes small, the digital detector becomes inactive and an analogue sample-and-hold detector is used instead. This can only correct small phase errors, but offers much better residual noise performance than the digital detector. When the digital detector operates, the out-of-lock output from Q29 goes high, muting the receiver audio.

Both phase detector outputs go to an active integrating loop filter formed by op-amp Q25. The output from this is further filtered by R81 / C115 and then controls varicap diode D29 in the oscillator circuit. To increase the available voltage swing on the tuning diode, its cathode is held at 2 volts below ground. The negative potential is derived from a charge pump C129 / D37 / D38 / C130, driven by an output at 14 kHz from the PLL IC, Q29.

3) Control section.

3.0 Microcontroller and control program.

At the centre of the control system is the microcontroller Q205. This integrated circuit contains all of the elements of a microprocessor system - program memory (ROM), data memory (RAM), a central processing unit and input and output ports. With the exception of the clock oscillator and the REF output at 672 kHz, all lines into and out of the microcontroller are in a static condition unless the receiver's controls are operated, so the signals radiated by the control system are kept at a very low level.

The microcontroller chip contains a control program specific to the HF-225 receiver. This program provides an interface between the operator and the receiver's tuning and filter selection systems, and also provides additional features such as frequency memories. The program accepts commands from the tuning encoder, the function buttons, the mode switch and the remote keypad, and in turn controls the display, the input filters, the RF attenuator, the IF and audio filters, the PLL system and the heterodyne oscillator.

When the control system is in an idle condition, with no controls being operated, the control program remains in a monitoring loop looking for any changes in the controls. If any control is moved, the program detects this and modifies its internal status to suit. This may involve just changing internal memory values, or it may require data to be sent to the display or the receiver control registers. There are four subprograms in the monitoring loop, dealing with the tuning knob, the mode switch, the function buttons and the external keypad.

As an example of the operations performed by the control program, consider the action of the program in response to rotation of the tuning knob.

Tuning encoder rotation is detected:-

Establish direction of rotation (up/down).

Establish speed of rotation (fast/slow).

Check mode selected and look-up tuning rate from internal table.

Increase or decrease stored frequency value by tuning rate value.

Check the new tuning value against the operating frequency limits and inhibit tuning if these are exceeded.

If the kHz digits have changed, convert the frequency value into 7-segment digits and send this data to the display.

Select the appropriate input filters and local oscillator frequency range.

Convert the frequency value into binary form suitable for programming the PLL synthesizer and add an offset value depending on the mode selected.

Send the new frequency information to the heterodyne oscillator and, if they require reprogramming, to the PLL and the receiver control registers.

Store the new frequency value in external non-volatile memory.

Check the tuning encoder for further rotation, and either repeat this sequence or return to the monitoring loop.

All tuning of the receiver is done in terms of fine-tune steps. Each 1 kHz of tuning range is divided into 128 steps, so each step is approximately 8 Hz. One complete rotation of the tuning encoder generates 200 pulses, and each of these pulses will change the frequency by a preset number of steps. The number depends on the tuning rate and the mode selected according to the following table:-

Receiver Mode	Tuning increments (steps of 7.8 Hz)	
	Slow tuning rate	Fast tuning rate
CW, LSB, USB	1	12
AM	6	64
AMS	1	1
FM	16	64

The fast or slow tuning rates are selected according to the rate at which pulses come from the tuning encoder. Note that in practice the fast tuning rate will not be as fast as indicated in the table because some pulses from the encoder will be missed by the control program (when it is involved in other tuning operations), therefore rapid rotation of the tuning knob usually results in a mixture of fast and slow tuning rates.

As each new kHz frequency is tuned the control program establishes which input filter to select and which local oscillator frequency range to select. The same part of the program also checks the frequency range limits, which are normally 30 kHz minimum and 29999 kHz maximum. The limits may be restricted further to frequencies above 148 kHz by insertion of JP1 on the control unit, which takes an input port line to ground and modifies the program operation. Frequencies outside the limits, whether derived from the memories or entered from the external keypad, are converted to the nearest limit frequency.

Filter and oscillator ranges are summarised below:-

Receiver frequency		Input filter	Oscillator range
(Low limit)	30 kHz	1	0
(Low limit *)	148 kHz	1	0
	499 kHz	1	0
	500 kHz	2	0
	1699 kHz	2	0
	1700 kHz	3	0
	4199 kHz	3	0
	4200 kHz	4	0
	4999 kHz	4	0
	5000 kHz	4	1
	10999 kHz	4	1
	11000 kHz	5	2
	18999 kHz	5	2
	19000 kHz	6	3
(High limit)	29999 kHz	6	3

* Restricted range with JP1 installed.

3.1 Controls.

The front panel controls connect to the microcontroller through an 8-bit input port, P1. The five function buttons each pull an input line down to ground when pressed; there is a pull-up resistor to 5V inside the microcontroller chip. Tuning knob rotation is detected by a mechanical shaft encoder, which generates two streams of pulses which differ in phase. The controller is able to establish the speed and direction of tuning from these two signals after pulse shaping and glitch removal by Q207.

The rotary mode switch controls the receiver state by switching several supply lines (all at 5V) feeding the carrier generator, the AGC system and the detector audio switching. Three of these lines are sampled by the microcontroller through its flag inputs T0, T1 and INT so that tuning rates and frequency offsets can be established. Mode supplies are switched as follows:-

Mode	Supply line state						Flag state		
Selected	SSB	USB	FM	AMS	AM	CW	T0	T1	INT
CW	5V	0V	0V	0V	0V	5V	1	0	1
LSB	5V	5V	0V	0V	0V	0V	1	1	0
USB	5V	0V	0V	0V	0V	0V	1	0	0
AM	0V	0V	0V	0V	5V	5V	0	0	1
AMS	0V	5V	0V	5V	0V	0V	0	1	0
FM	0V	0V	5V	0V	0V	0V	0	0	0

3.2 Frequency memory.

Frequencies stored in the receiver's memories are not held within the microcontroller, but are stored in RAM chip Q204, a CMOS device with its supply maintained by a lithium battery when the receiver is switched off. The tuned VFO frequency is also stored in this RAM so that the receiver can resume operation on its previous frequency at switch-on.

Inside the receiver, frequencies are stored in the form of separate decimal digits for the kHz part (5 digits) and as a 7-bit binary value for the fine tune part (fractions of kHz). The external frequency memory chip is 4-bits wide by 256 locations; each frequency uses eight locations - five for the kHz digits, two for the fine tune value and one unused location. There is room in the memory for 32 frequency entries, but only 31 are used for the 30 memories and the VFO frequency.

Q204 is not attached to the microprocessor bus, but is controlled via an 8-bit output port (for the address information) and a 4-bit wide bidirectional port (for data). The data port is shared with the external keypad. The RAM is controlled by three other lines; read and write strobes from the microcontroller which pulse momentarily low to transfer data to or from the RAM, and a power-down line from voltage detector Q201 which disables the RAM when power is turned off and prevents data corruption.

3.3 Display.

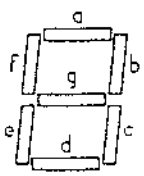
The liquid crystal frequency and function display is driven from a dedicated controller Q206. The LCD segments turn on when a voltage exists between the segment line and the backplane or common. It is important that there is no residual current flow through an LCD, so the segments are driven with a low frequency AC supply produced inside Q206 by oscillator R224 / C212. The backplane connection is fed with a square wave at about 60 Hz, and blank segments are fed with an identical signal. Lit segments are fed with a signal in antiphase to the backplane. The display used is a negative image one, so it is normally all black, and segments become clear when energised.

Segment data is transferred from the microcontroller to the display driver by a two line serial bus; DATA and CLOCK. Data transfer commences when the data line goes high and the clock line pulses low, then the state value of each segment is placed on the data line and the clock line pulsed low again for each segment. Transfer is complete when 35 bits of data have been sent, and then the display will be changed to the new configuration. Further clock pulses will be ignored until the data line goes high again.

Display driver serial data format:-

Bit 0 (start)	always high (1)		Bit 18	digit 5	seg g
Bit 1	memory flag		Bit 19	digit 4	seg b
Bit 2	decimal point		Bit 20		seg a
Bit 3	digit 2	seg e	Bit 21		seg f
Bit 4		seg d	Bit 22		seg g
Bit 5		seg c	Bit 23	digit 3	seg b
Bit 6	digit 3	seg e	Bit 24		seg a
Bit 7		seg d	Bit 25		seg f
Bit 8		seg c	Bit 26		seg g
Bit 9	digit 4	seg e	Bit 27	digit 2	seg b
Bit 10		seg d	Bit 28		seg a
Bit 11		seg c	Bit 29		seg f
Bit 12	digit 5	seg e	Bit 30		seg g
Bit 13		seg d	Bit 31	digit 1	seg b
Bit 14		seg c	Bit 32		seg c
Bit 15		seg b	Bit 33		seg a,d,e,g
Bit 16		seg a	Bit 34	always low (0)	
Bit 17		seg f	Bit 35	always low (0)	

Digit 1 = 10's MHz (Only blank, 1 or 2)
Digit 2 = units MHz
Digit 3 = 100's kHz
Digit 4 = 10's kHz
Digit 5 = units kHz

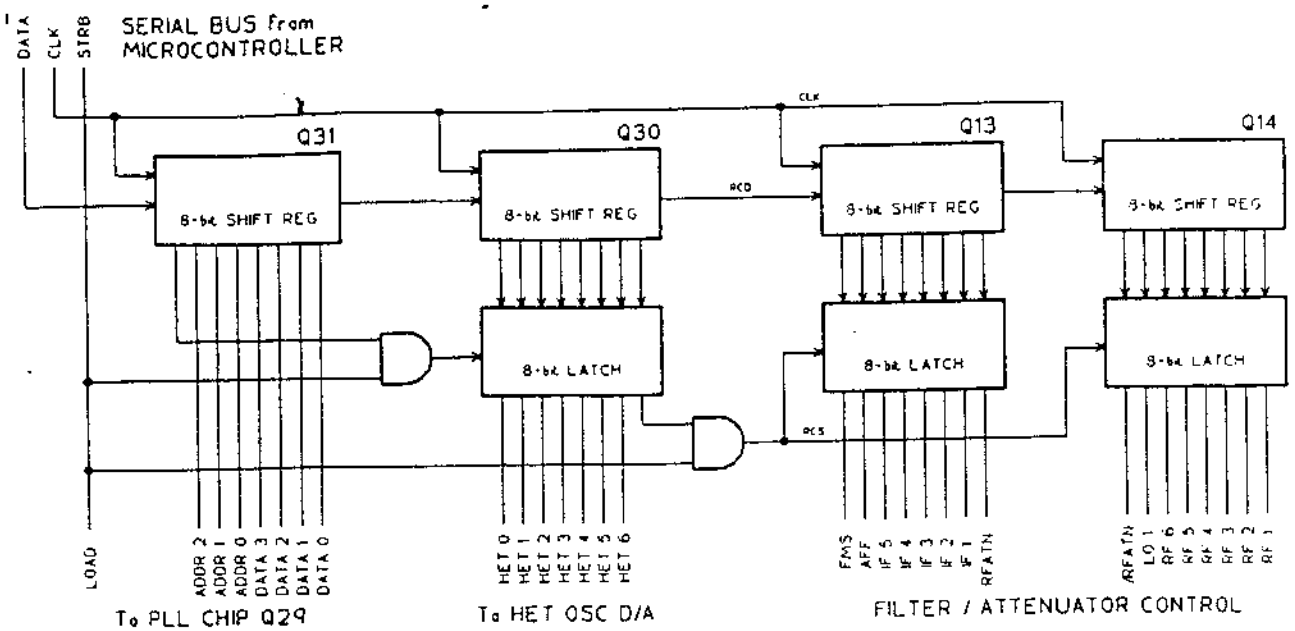


The AMS LOCK indicator segments of the display are not controlled from the display driver chip, but are driven from the exclusive-or gate Q207. This is driven from the LCD backplane signal and provides a true or inverted feed to the two L segments depending on the logic state of the LCK signal from the detector board.

3.4 Receiver interface.

The switching functions within the receiver are controlled via a three line serial bus from the microcontroller, which sends data to registers located on the main receiver circuit board. The three lines (CLK, DATA and STRB) are filtered near to the point of entry to the main unit by L networks to prevent low-level spurious signals from entering the receiver control lines.

The serial data is converted into steady-state signals for receiver control by a series of cascaded shift registers - Q13, Q14, Q30 and Q31 are each 8-bit registers. Because not all of the control lines need to change when the receiver is tuned, the shift register can be split into three sections, effectively limiting its length to 8, 16 or 32 bits. To set the control registers, a data stream of the appropriate length is sent from the microcontroller, each data bit separated by a clock pulse (the CLK line goes momentarily low) The end of the data stream is marked by the STRB line pulsing high. Note that the CLK signal is shared between the display driver and the receiver control, so there will be spurious data and clock signals fed into the registers; only the data stream before a STRB pulse has any effect on the receiver.



Receiver control shift-register arrangement.

The format of receiver control data is shown below:-

Format 1: 8-bit data, PLL register load.

Bit 0 (start)	PLL register data bit 0 (lsb)
bit 1	PLL register data bit 1
bit 2	PLL register data bit 2
bit 3	PLL register data bit 3 (msb)
bit 4	PLL register address bit 0
bit 5	PLL register address bit 1
bit 6	PLL register address bit 2
bit 7	ZERO to select 8-bit shift register length

Format 2: 16-bit data, HET oscillator tune.

Bit 0 (start)	ZERO to select 16-bit shift register length
bit 1	HET tune data bit 6 (msb)
bit 2	HET tune data bit 5
bit 3	HET tune data bit 4
bit 4	HET tune data bit 3
bit 5	HET tune data bit 2
bit 6	HET tune data bit 1
bit 7	HET tune data bit 0 (lsb)
bit 8	ZERO
bit 9	ZERO Null command to PLL chip
bit 10	ZERO (register = 0)
bit 11	ZERO (data = 0)
bit 12	ZERO
bit 13	ZERO
bit 14	ZERO
bit 15	ONE to select 16-bit shift register length

Format 3: 32-bit data, Filter selection.

Bit 0 (start)	Input filter 1 select	ONE for Fr < 500 kHz
bit 1	Input filter 2 select	ONE for 500 kHz to 1.7 MHz
bit 2	Input filter 3 select	ONE for 1.7 to 4.2 MHz
bit 3	Input filter 4 select	ONE for 4.2 to 11 MHz
bit 4	Input filter 5 select	ONE for 11 to 19 MHz
bit 5	Input filter 6 select	ONE for Fr > 19 MHz
bit 6	Local Osc range 1 select	ONE for 5 to 11 MHz
bit 7	RF attenuator control	ZERO to attenuate
bit 8	RF attenuator control	ONE to attenuate
bit 9	IF filter 1 select	ONE for 10 kHz
bit 10	IF filter 2 select	ONE for 4 kHz and 7 kHz
bit 11	IF filter 3 select	ONE for 2.2 kHz
bit 12	IF filter 4 select	ONE for 2.2 kHz and 4 kHz
bit 13	IF filter 5 select	ONE for 7 kHz and 10 kHz
bit 14	Audio filter select	ONE for 200 Hz audio filter
bit 15	FM squelch control	ONE for squelch bypass
Bit 16	ONE to select 32-bit shift register length	
Bits 17 to 31	As format 2, bits 1 to 15	

The PLL synthesizer chip Q29 is programmed on a register by register basis, each one of eight registers selected by the three address lines. To change the PLL frequency, seven of the registers need reprogramming, the remaining register is programmed only when the receiver is first switched on. The programmable divider in Q29 is set with a 17-bit binary number, which is the PLL frequency in kHz.

PLL chip register contents are as follows:-

Register	Address bits			Data bits				
	A2	A1	A0	D3	D2	D1	D0	
0	0	0	0	0	0	0	0	Used as Null command
1	0	0	1	N3	N2	N1	N0	
2	0	1	0	0	0	0	0	Loaded at switch-on
3	0	1	1	N7	N6	N5	N4	
4	1	0	0	0	N10	N9	N8	
5	1	0	1	N14	N13	N12	N11	
6	1	1	0	0	0	N16	N15	
7	1	1	1	0	1	1	1	End programming sequence

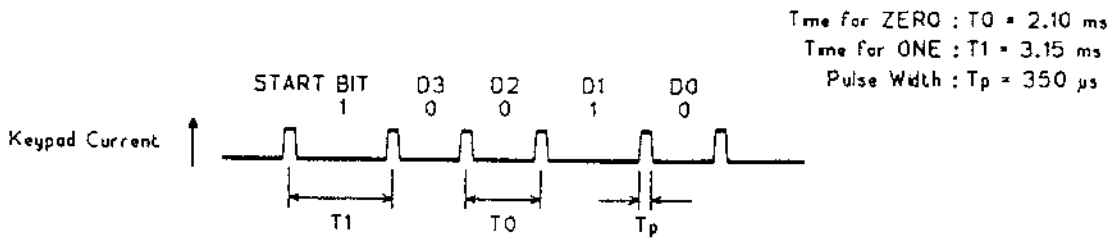
3.5 External keypad.

The remote keypad, K-225, uses a two-wire serial link to communicate with the receiver. Key depressions are converted into an asynchronous PPM (pulse position modulation) data stream by integrated circuit Q1 - each key is uniquely represented by a 5-bit word which is sent repetitively whilst the key is held down. Power for the keypad unit is also sent down the two wires, and data is transmitted by current modulation of this supply. Transistor Q4 is switched by the data output of Q1 to achieve this.

The keypad unit current passes through R204 on the control unit board, and with Q203 this serves to recover the PPM data. Q203 is normally turned off, but when the keypad is operated, charge pump C202 / D203 provides bias to switch the transistor on except for a short period during each data pulse. The PPM data is presented to the microcontroller on P20, one of the RAM data lines. Data stream decoding is done by software within the microcontroller. When a key on the keypad is released, Q203 turns off after a short delay allowing normal RAM data bus operation.

Each key code is transmitted as a series of six current pulses, with the five time intervals between the pulses changed according to the data. The time between pulses may be either 3.15ms, representing a ONE, or 2.1ms, representing a ZERO. These times are in the ratio 3:2, with the pulse width being about one sixth of the ZERO time, ie 350us. The 5-bit key code consists of a ONE followed by the 4-bit key code shown in the table below. Key codes are transmitted continuously, with a gap of about twice the ONE time between each code word.

An example is given for the key 6 (code = 0 0 1 0):-



Key	Data code			
	D3	D2	D1	D0
No key pressed	No data pulses			
0	0	1	0	0
1	1	0	1	1
2	0	1	1	1
3	0	0	1	1
4	1	0	1	0
5	0	1	1	0
6	0	0	1	0
7	1	0	0	1
8	0	1	0	1
9	0	0	0	1
Cancel (*)	1	0	0	0
Enter (#)	0	0	0	0

3.6 Test routines.

A small part of the control program is devoted to test and alignment routines. These check for the correct operation of parts of the control system and provide signals and receiver states convenient for testing and aligning the receiver. The control system tests are not exhaustive, and the fact that the test routines do not report an error should not be used as verification of a faultless unit, but many errors can be detected, and often the type of fault reported is a useful guide to repair.

In test mode the five buttons on the front panel serve to control the program. For convenience these are designated **TEST1** through to **TEST5** (ie **MEMORY SELECT** is **TEST1** and **MHz UP** is **TEST5**). The receiver is set into test mode by depressing the **TEST1** button as it is switched on, and the message **TEST** should appear on the display. This message will remain on the display provided that no faults are found, if a fault condition is detected the display changes to show the **FLT** message. To clear a fault indication the receiver must be switched off.

For instructions on how to use the test routines for checking and alignment, please refer to the **Test and alignment** section of this manual. Here, the testing procedures used by the program are outlined.

When the receiver is switched on, in normal mode or test mode, a brief check is performed on the program memory and microprocessor registers. A failure in this test will result in a fault indication immediately and the receiver will not operate. The remaining tests are initiated by pressing one of the **TEST** buttons. Most tests will operate continuously whilst a **TEST** button is held, allowing serial data lines to be monitored with test equipment.

TEST1 Enters TEST mode from switch-on, and sends test message to display.

TEST2 Programmes and tests the frequency memory RAM chip. Note that any frequencies saved will be lost when this test is executed. A fault indication will result if and data corruption is detected. The frequencies stored in the memory can be later used to test filter and oscillator switching (see below).

TEST3 Programmes the receiver control registers for alignment phase 1 (see below).

TEST4 Programmes the receiver control registers for alignment phase 2 (see below).

TEST5 Returns to normal receiver operating mode (end of test sequences).

Alignment frequencies entered in RAM by TEST2 :-

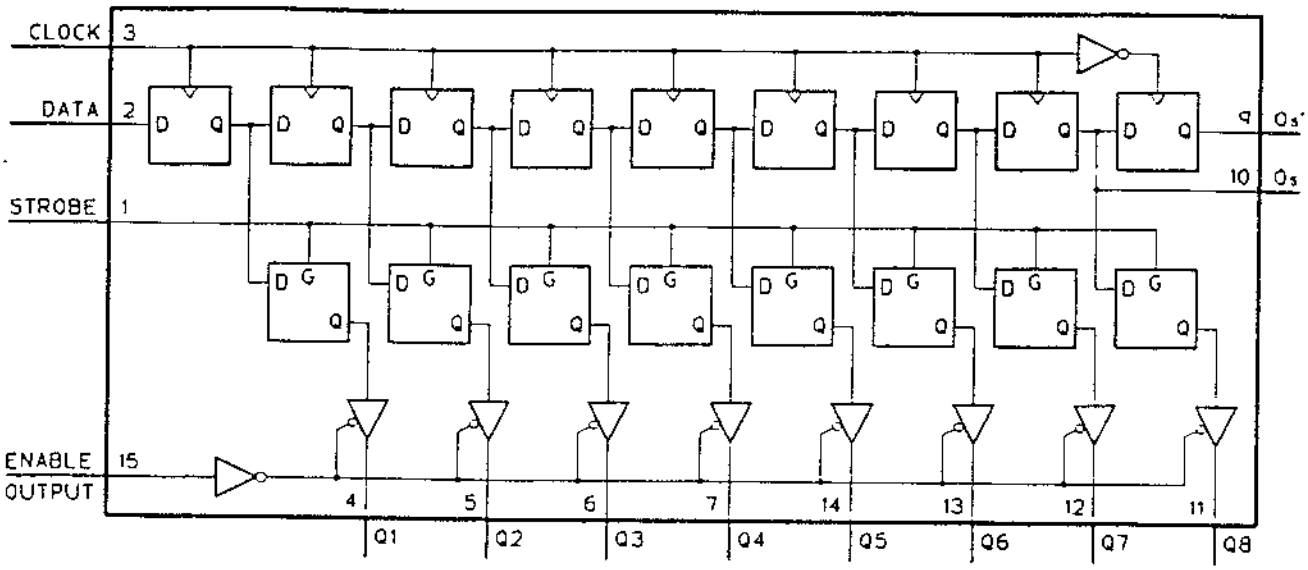
Memory number	Frequency	Purpose
1	29.900 MHz	HF LO adjust, Input filter 6 check
2	19.000 MHz	Local osc range 2 to 3 switching
3	11.000 MHz	Local osc range 1 to 2 switching
4	5.000 MHz	Local osc range 0 to 1 switching
5	100 kHz	Low frequency LO check
6	500 kHz	Input filter 1 and 2 check
7	1.700 MHz	Input filter 2 and 3 check
8	4.200 MHz	Input filter 3 and 4 check
9	11.000 MHz	Input filter 4 and 5 check
10	19.000 MHz	Input filter 5 and 6 check
VFO and all other memories	14.000 MHz	

Receiver state set by TEST3 and TEST4 :-

Control function	TEST3 state	TEST4 state
LO range select	Range 0	Range 0
PLL system	LO frequ = 45.000 MHz	LO frequ = 44.999 MHz
HET oscillator	Data = 0 0 0 0 0 0 0 0	Data = 1 1 1 1 1 1 1 1
	HET frequ = 44.545 MHz	HET frequ = 44.544008 MHz
Input filter select	No filters selected	No filters selected
IF bandwidth select	7 kHz	7 kHz
AF filter select	Normal (wide)	Normal (wide)
FM squelch control	Squelch bypassed	Squelch bypassed
RF attenuator	Out (but both relays off)	Out (but both relays off)

Semiconductor data.

74HC4094 Shift and store bus register, Q13, Q14, Q30 and Q31.



The 4094 consists of an 8-bit shift register, transparent latch and tri-state output buffer. The shift register is loaded serially on the positive edge of each CLOCK pulse. Serial data from the last stage of the register is presented at the Os output, and, delayed until the negative edge of the CLOCK, on the Os' output. (Os' is used for cascading several registers).

Parallel data from the shift register is transferred to the latch when the STROBE line is high, and retained while STROBE is low, so the outputs are unaffected by shift register activity. The outputs are buffered with tri-state devices, but in the HF-225 these are permanently enabled.

Q13 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	Strobe	In	L [H]	RCS, pulses high at end of tune	9	Os	Out	L / H	No connection
2	Data	In	L / H	Serial data, changes during tune	10	Os'	Out	L / H	Serial data, changes during tune
3	Clock	In	H [L]	CLK, pulses low during tuning	11	Q8	Out	L / H	RFATN, high for attenuator
4	Q1	Out	L / H	FMS, high to bypass FM squelch	12	Q7	Out	L / H	IF1, high to select 500 kHz LPF
5	Q2	Out	L / H	AFF, high for narrow CW filter	13	Q6	Out	L / H	IF2, high to select 7 kHz filter
6	Q3	Out	L / H	IF5, complement of IF4	14	Q5	Out	L / H	IF3, high to select 2.2 kHz filter
7	Q4	Out	L / H	IF4, high to select 4 kHz filter	15	EO	In	H	Always high
8	Vss		L	Ground	16	Vdd		H	5V supply

Q14 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	Strobe	In	L [H]	RCS, pulses high at end of tune	9	Os	Out	L / H	No connection
2	Data	In	L / H	Serial data, changes during tune	10	Os'	Out	L / H	No connection
3	Clock	In	H [L]	CLK, pulses low during tuning	11	Q8	Out	L / H	FLT1, high for input filter 1
4	Q1	Out	L / H	/RFATN, low for attenuator	12	Q7	Out	L / H	FLT2, high for input filter 2
5	Q2	Out	L / H	LO1, high for LO range 1	13	Q6	Out	L / H	FLT3, high for input filter 3
6	Q3	Out	L / H	FLT6 / LO3, high for filter 6	14	Q5	Out	L / H	FLT4, high for input filter 4
7	Q4	Out	L / H	FLT5 / LO2, high for filter 5	15	EO	In	H	Always high
8	Vss		L	Ground	16	Vdd		H	5V supply

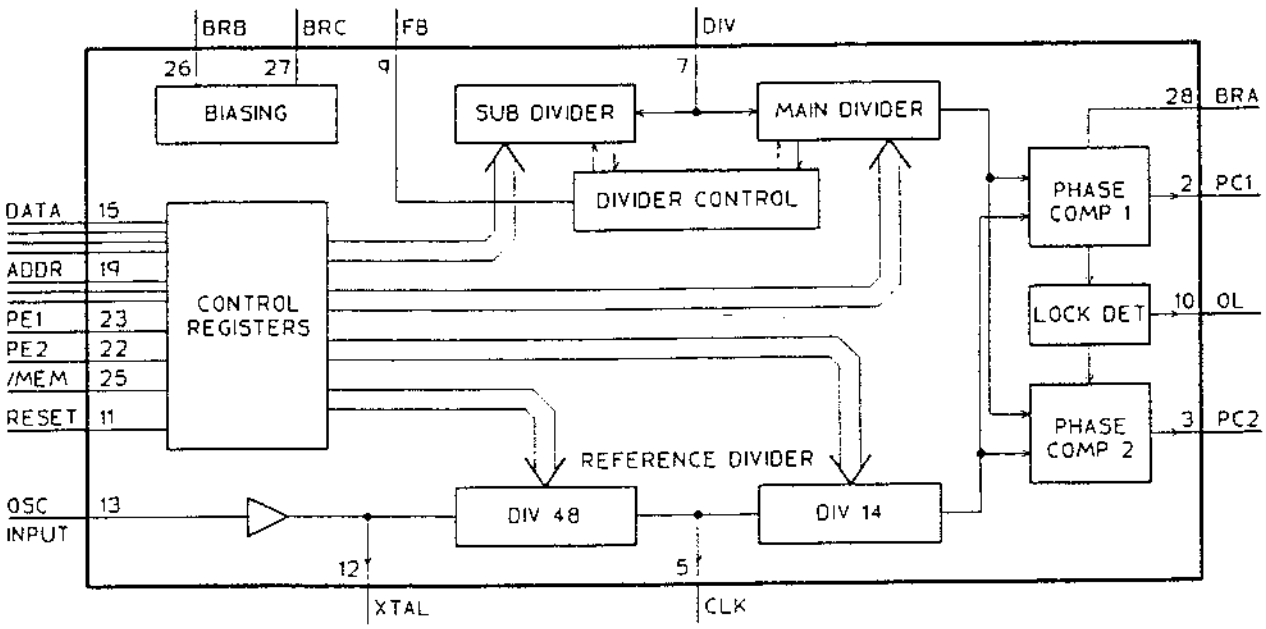
Q30 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	Strobe	In	L [H]	Pulses high at end of tune	9	Os	Out	L / H	No connection
2	Data	In	L / H	Serial data, changes during tune	10	Os'	Out	L / H	Serial data, changes during tune
3	Clock	In	H [L]	CLK, pulses low during tuning	11	Q8	Out	L [H]	Reg load, pulses when filters change
4	Q1	Out	L / H	HET0, Het osc tune bit 0	12	Q7	Out	L / H	HET6, Het osc tune bit 6
5	Q2	Out	L / H	HET1, Het osc tune bit 1	13	Q6	Out	L / H	HET5, Het osc tune bit 5
6	Q3	Out	L / H	HET2, Het osc tune bit 2	14	Q5	Out	L / H	HET4, Het osc tune bit 4
7	Q4	Out	L / H	HET3, Het osc tune bit 3	15	EO	In	H	Always high
8	Vss		L	Ground	16	Vdd		H	5V supply

Q31 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	Strobe	In	H	Always high	9	Os	Out	L / H	No connection
2	Data	In	L [H]	DATA, pulses high during tune	10	Os'	Out	L / H	Serial data, changes during tuning
3	Clock	In	H [L]	CLK, pulses low during tuning	11	Q8	Out	H [L]	PLL D0, pulses low during tuning
4	Q1	Out	L [H]	Reg load, pulses high during tune	12	Q7	Out	L [H]	PLL D1, pulses high during tuning
5	Q2	Out	L [H]	PLL A2, pulses high during tuning	13	Q6	Out	L [H]	PLL D2, pulses high during tuning
6	Q3	Out	L [H]	PLL A1, pulses high during tuning	14	Q5	Out	L [H]	PLL D3, pulses high during tuning
7	Q4	Out	L [H]	PLL A0, pulses high during tuning	15	EO	In	H	Always high
8	Vss		L	Ground	16	Vdd		H	5V supply

TDD1742T PLL frequency synthesizer, Q29.



The TDD1742D contains two programmable dividers, two phase comparators and associated logic and control circuits. The reference divider is permanently programmed to divide by 672 in the HF-225, with an intermediate tap after division by 48 giving a 14 kHz CLK signal. The main local osc divider is configured as a 13-bit binary counter, with a 4-bit sub-counter controlling the dual-modulus prescaler Q28 via the FB output.

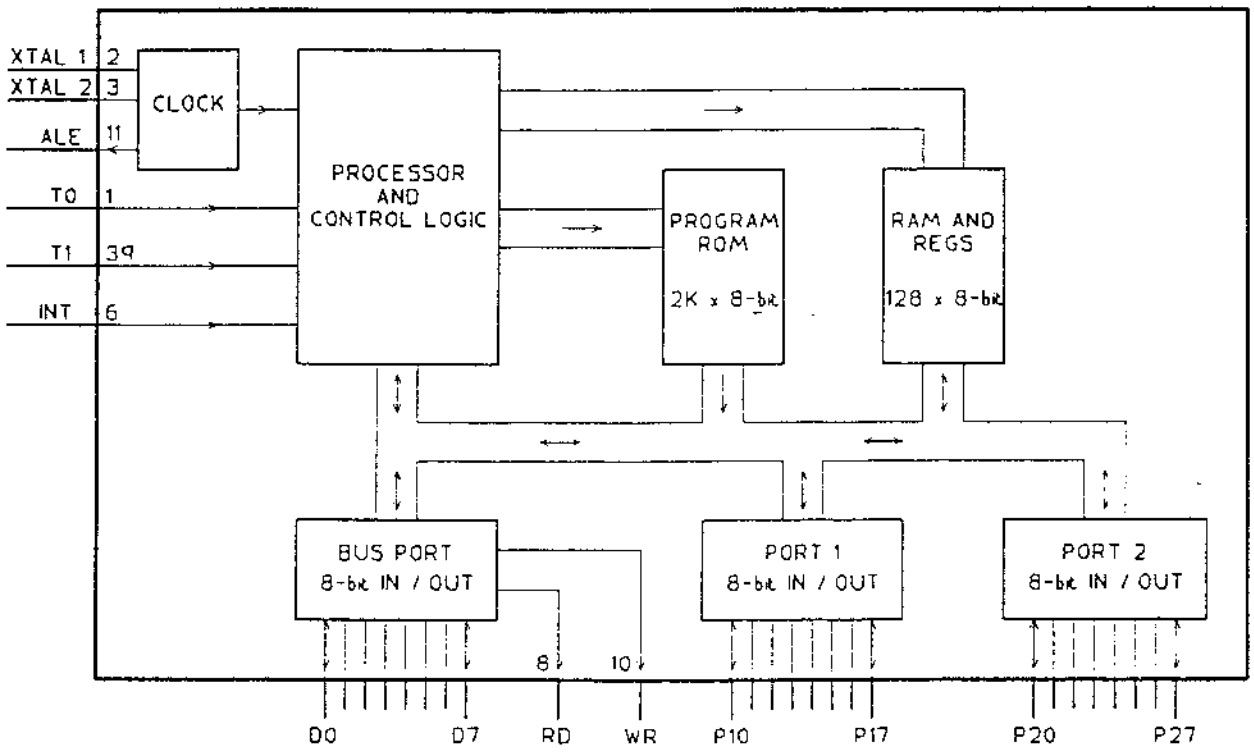
Phase comparator 1 is an analogue phase detector, consisting of a ramp generator and a sample-and-hold amplifier. Whilst the sampling point is within the linear region of the ramp only this phase detector operates, but when its linear range is exceeded digital phase comparator 2 is enabled, and the OL (out of lock) output goes high.

The functions of Q29 are controlled by 8 internal 4-bit registers. These are loaded from the receiver's microcontroller through a 4-bit DATA bus, with register selection on the 3-bit ADDR bus. Input lines PE1, PE2 and /MEM select and control this mode of operation.

Q29 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	Vdd3		8V	8V Supply	15	DB3	In	L [H]	PLL D3, pulses high during tuning
2	PC1	Out	4V	Phase comparator 1 output	16	DB2	In	L [H]	PLL D2, pulses high during tuning
3	PC2	Out	4V	Phase comparator 2 output	17	DB1	In	L [H]	PLL D1, pulses high during tuning
4				No connection	18	DB0	In	H [L]	PLL D0, pulses low during tuning
5	CLK	Out	SIG	14 kHz CLOCK output, 8Vp-p	19	AD0	In	L [H]	PLL A0, pulses high during tuning
6	Vss		L	Ground	20	AD1	In	L [H]	PLL A1, pulses high during tuning
7	DIV	In	SIG	LO in, 3-5 MHz, 1Vp-p on 3.5V	21	AD2	In	L [H]	PLL A2, pulses high during tuning
8	Vdd2		H	5V Supply	22	PE2	In	L	Always low
9	FB	Out	SIG	Psc control, narrow low pulses	23	PE1	In	L [H]	STRB, Pulses high during tuning
10	OL	Out	L	Out - of - lock output	24	MOD			No connection
11	RESET	In	L	Reset, pulses high at switch-on	25	/MEM	In	L	Always low
12	XTAL	Out	SIG	672 kHz ref signal, no connection	26	BRB			No connection
13	OSC	In		672 kHz ref input, 2Vp-p on 4.5V	27	BRC	In	4.8V	Bias current
14	Vdd1		8V	8V Supply	28	BRA	In	6.2V	Bias current

D8749H Microcontroller, Q205.



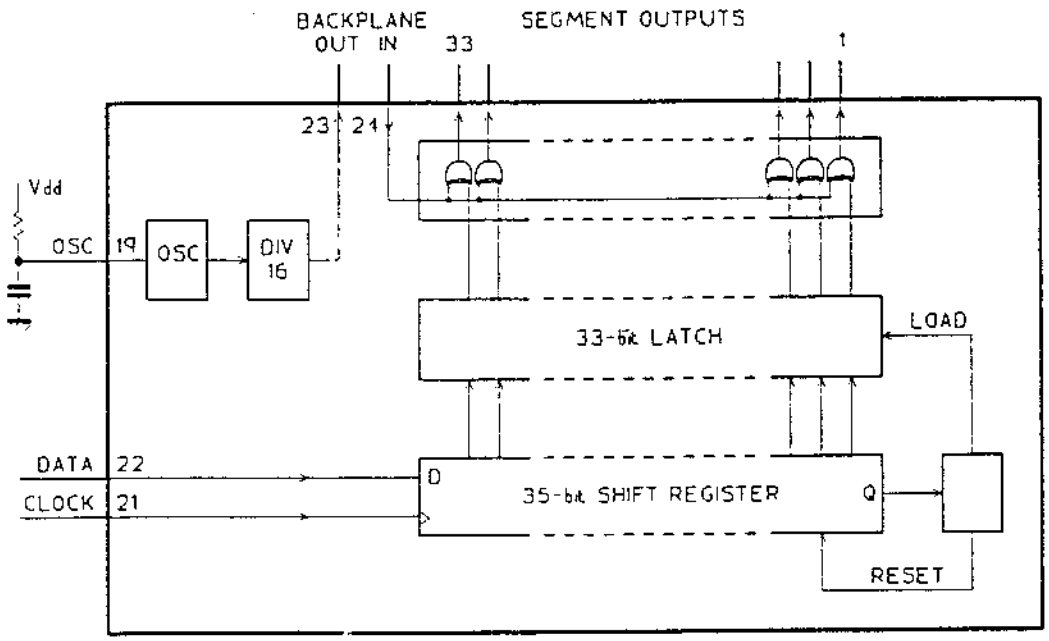
The D8749H contains all of the parts of the microprocessor control system within the HF-225. All input and output is done via three 8-bit ports, and no microprocessor bus signals come out of the chip. The ports can be configured for input or output - in the HF-225 the BUS PORT and PORT 2 are used only for output, PORT 1 is used only for input. The input ports have internal pull-up resistors to Vcc.

The on-chip clock oscillator is used with a 10.080 MHz crystal as the receiver's main reference oscillator. The ALE output is derived from this oscillator through a divide-by-15 counter.

Q205 pin functions.

Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	T0	In	L / H	Mode, high for CW, LSB and USB	21	P20	I/O	H [L]	RAM data bit 0 and keypad data
2	XTL1	In	SIG	Crystal osc input	22	P21	I/O	H [L]	RAM data bit 1
3	XTL2	Out	SIG	Crystal osc, 3Vp-p, 10 MHz	23	P22	I/O	H [L]	RAM data bit 2
4	/RES	In	H	Reset input, low at switch-on	24	P23	I/O	H [L]	RAM data bit 3
5	/SS	In	H	Always high	25	PROG	Out	H	No connection
6	/INT	In	L / H	Mode input, high for CW and AM	26	Vdd		H	5V Supply
7	EA	In	L	Always low	27	P10	In	H [L]	MEMORY SELECT button
8	/RD	Out	H [L]	RAM /WR, pulses for RAM write	28	P11	In	H [L]	RF ATTEN button
9	/PSEN	Out	H	No connection	29	P12	In	H [L]	FILTER SELECT button
10	/WR	Out	H [L]	CLK, pulses low during tuning	30	P13	In	H [L]	MHz DOWN button
11	ALE	Out	SIG	672 kHz REF signal, 3Vp-p	31	P14	In	H [L]	MHz UP button
12	DB0	Out	L [H]	External RAM address, bit 0	32	P15	In	L / H	Low if JP1 linked
13	DB1	Out	H [L]	External RAM address, bit 1	33	P16	In	L / H	Tuning encoder phase A
14	DB2	Out	H [L]	External RAM address, bit 2	34	P17	In	L / H	Tuning encoder phase B
15	DB3	Out	L [H]	External RAM address, bit 3	35	P24	Out	L [H]	Display driver data
16	DB4	Out	L [H]	External RAM address, bit 4	36	P25	Out	H [L]	RAM /RD, low for mem recall etc
17	DB5	Out	L [H]	External RAM address, bit 5	37	P26	Out	L [H]	STRB, pulses high during tuning
18	DB6	Out	L [H]	External RAM address, bit 6	38	P27	Out	L / H	DATA, changes during tuning
19	DB7	Out	L [H]	External RAM address, bit 7	39	T1	In	L / H	Mode input, high for USB and AMS
20	Vss		L	Ground	40	Vcc		H	5V Supply

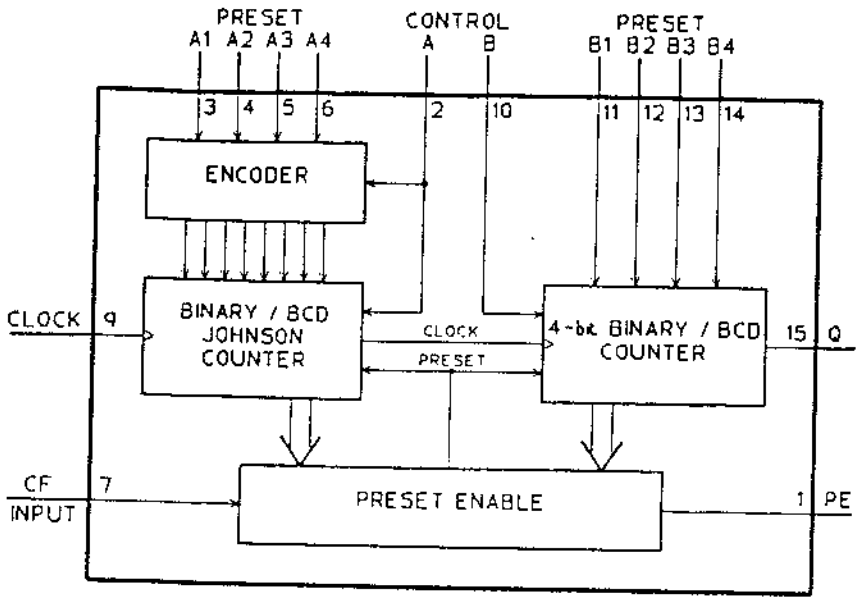
MM5453N Liquid crystal display driver, Q206.



LCD driver MM5453N contains a 35-bit shift register, 33-bit data latch, LCD driver buffers and a backplane signal oscillator. The data latches are loaded when a ONE bit is sent through the shift register. After the latches are loaded the shift register is also cleared, so new data has to pass through the entire length of the register before the latches are reloaded.

The on-chip oscillator feeds a divide by 16 counter which produces the LCD backplane signal with a 50 : 50 mark space ratio at about 60 Hz. The output drivers for each segment produce the same signal in either true or inverted form. All LCD signals swing between Ground and Vdd at 5V.

MC14569BCP Programmable divider, Q209.



The MC14569 contains two 4-bit BCD / binary down-counters that are preset from eight external inputs when the count reaches zero. In the HF-225 the chip is configured to work as a single 8-bit programmable divider. Each time the counter is preset, a pulse one clock cycle wide is produced on the PE output, this signal therefore contains many high-order harmonics of the divider output frequency. The counter is only operated when the receiver is in SSB or CW mode.

Q209 pin functions.

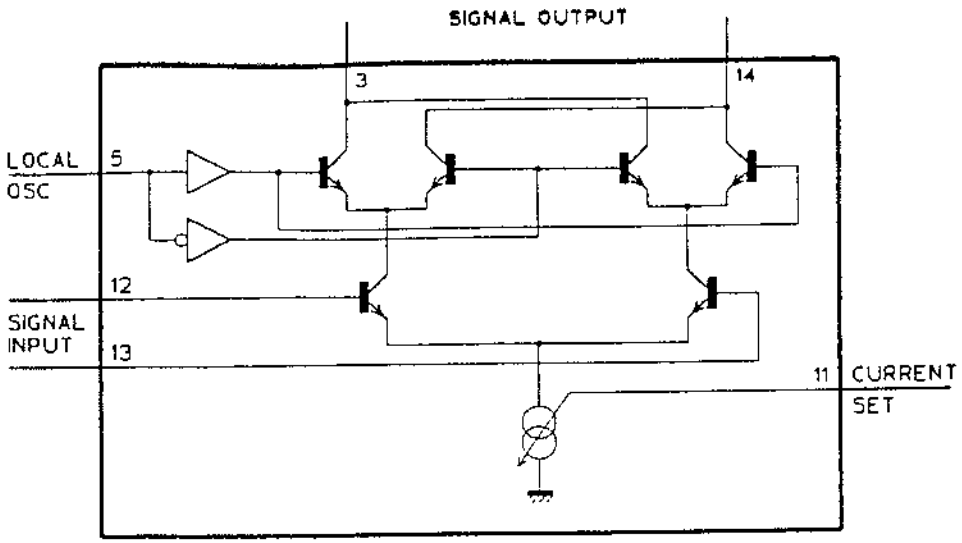
Pin	Name	I/O	State	Function	Pin	Name	I/O	State	Function
1	PE	Out	SIG	Counter output (see section 2.1)	9	Clock	In	SIG	2.52 MHz clock
2	CtrlA	In	L	Always low	10	CtrlB	In	L	Always low
3	PR0	In	L	Preset bit 0, always low	11	PR4	In	H	Preset bit 4, always high
4	PR1	In	H	Preset bit 1, always high	12	PR5	In	L / H	Preset bit 5, low for CW
5	PR2	In	L / H	Preset bit 2, high for USB	13	PR6	In	H	Preset bit 6, always high
6	PR3	In	L / H	Preset bit 3, low for CW	14	PR7	In	H	Preset bit 7, always high
7	CF	In	H	Always high	15	Q	Out	SIG	No connection
8	Vss		L	Ground	16	Vdd		H	5V supply

SL6440CDP High level mixer, Q1 and Q2 (and Q5 in D-225).

The SL6440 integrated circuit, double-balanced mixer combines good strong signal performance and low noise. The mixer has balanced inputs and outputs, but either may be used unbalanced; in the HF-225 two configurations are found. Q1, the first mixer, uses balanced inputs and outputs to obtain maximum gain and lowest noise and distortion. The other two applications use the chip with single, unbalanced input and output lines.

The mixer performance can be adjusted by an external current source into the IP pin, and the best balance of noise, intermodulation and supply current drain can be set. An amplifier for the local oscillator signal is included on the mixer chip.

Pins 1, 2, 7, 8, 9, 10, 15 and 16 are used for thermal bonding only, and are not connected within the mixer IC. In the HF-225 they are bonded to the PCB ground plane.



Q1 pin functions.

Pin	Name	DC Voltage	Signal	Function
3	Output A	10.9V	Some LO (<50 mV)	45 MHz IF output
4	Vcc	7.8V	None	Mixer supply
5	LO in	2.0V	LO 1Vp-p	45 to 75 MHz local oscillator input
6	0V	0V	None	Ground connection
11	IP	2.7V	None	Current program input
12	Input B	5.3V	Slight LO (<10 mV)	RF signal input
13	Input A	5.3V	Slight LO (<10 mV)	RF signal input
14	Output B	10.9V	Some LO (<50 mV)	45 MHz IF output

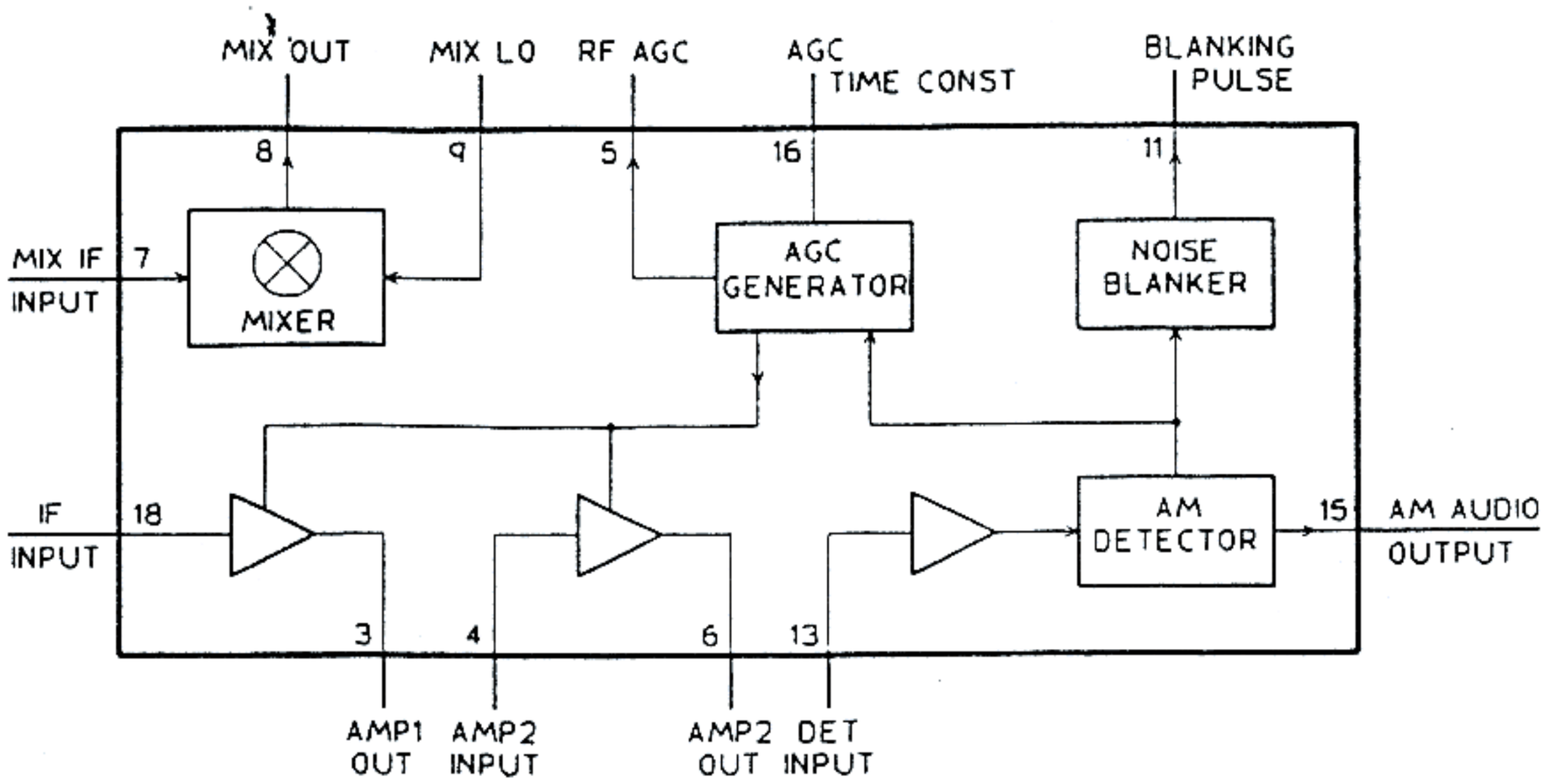
Q2 pin functions.

Pin	Name	DC Voltage	Signal	Function
3	Output A	7.5V	Some HET (<20 mV)	Unused output
4	Vcc	6.0V	None	Mixer supply
5	LO in	2.1V	HET 400mVp-p	44.545 MHz heterodyne oscillator input
6	0V	0V	None	Ground connection
11	IP	1.6V	None	Current program input
12	Input B	3.9V	None	Unused input
13	Input A	3.9V	Slight HET (<5 mV)	45 MHz IF input
14	Output B	7.5V	Some HET (<20 mV)	455 kHz IF output

Q5 in D-225 pin functions. (Receiver in AMS mode)

Pin	Name	DC Voltage	Signal	Function
3	Output A	7.6V	Audio + 910 kHz	Unused output
4	Vcc	6.1V	None	Mixer supply
5	LO in	2.1V	455 kHz 100mVp-p	Synchronised oscillator input
6	0V	0V	None	Ground connection
11	IP	1.6V	None	Current program input
12	Input B	4.0V	455 kHz 150mVp-p	455 kHz IF signal input
13	Input A	4.0V	None	Unused input
14	Output B	7.6V	Audio + 910 kHz	AMS audio output 200mVp-p

SL6700C IF amplifier and AM detector, Q3.



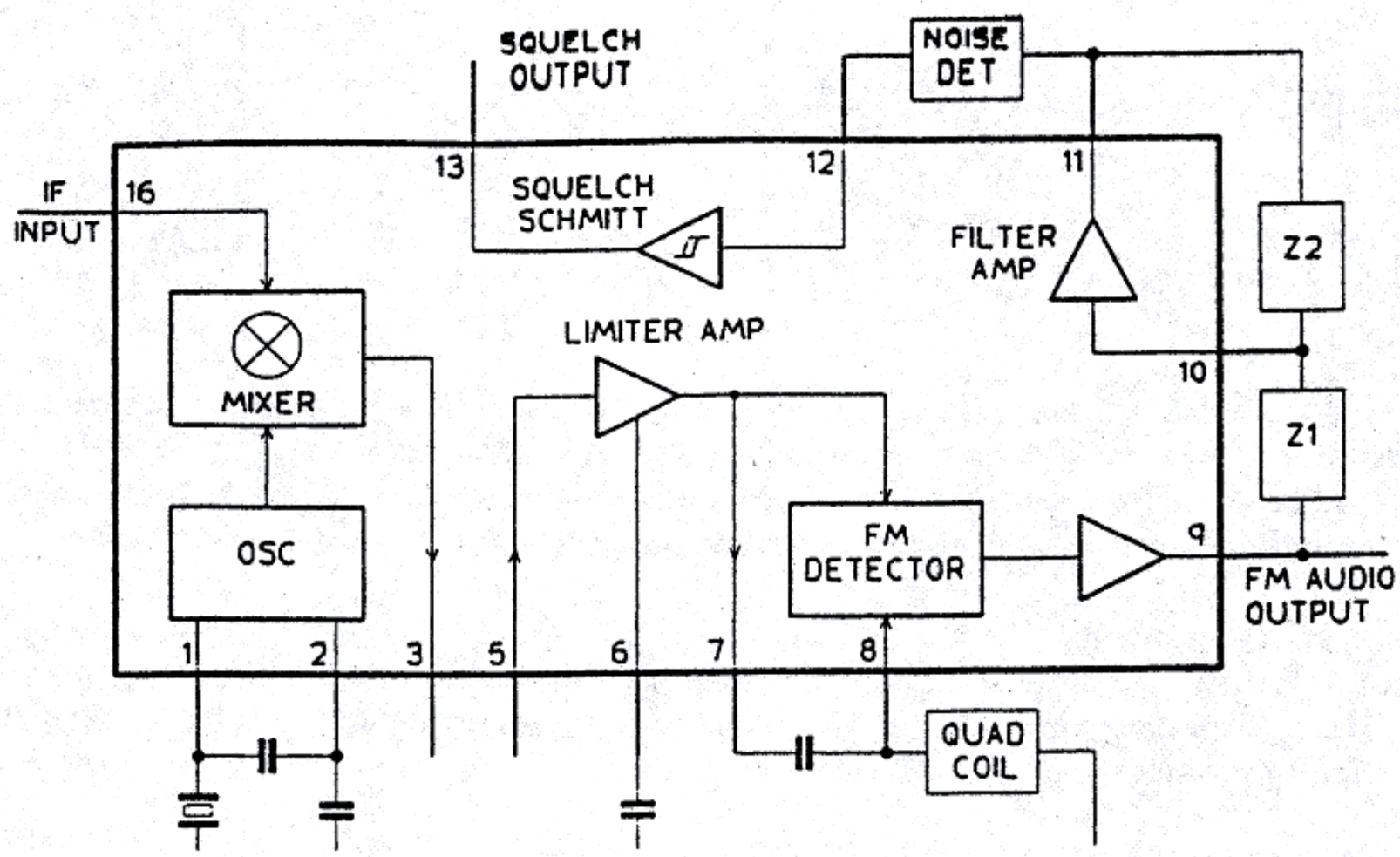
The two IF amplifiers in this chip are both broad-band devices offering about 25dB of gain with AGC control. AGC is produced internally from the AM detector, and these two amplifiers give a combined AGC range of 80dB. A level comparator on the AGC line produces a delayed AGC output for RF stages on pin 5. The value of the resistor between pins 1 and 2 sets the delay threshold.

A full-wave detection system is employed, giving excellent linearity and producing a DC carrier level output to derive AGC. This level can also trigger the noise-blanker monostable. Before the detector is a third IF amplifier with a gain of about 46 dB. The product detector is a double-balanced modulator which operates independently of any other circuits on the chip. In the HF-225 it is used only for SSB and CW reception.

Q3 pin functions. (Levels for USB mode, S9 input signal resolved at 1 kHz)

Pin	Name	DC Voltage	Signal	Function
1	AGC dcpl	2.3V	None	RF AGC decoupling pin
2	AGC bias	2.3V	None	RF AGC threshold adjust resistor
3	AMP1 out	3.6V	IF 10mVp-p	1st IF amplifier output
4	AMP2 in	0.8V	IF 4mVp-p	2nd IF amplifier input
5	Del AGC	0.0V	None	AGC to RF stage
6	IF output	4.2V	IF 2mVp-p	2nd IF amplifier output
7	Mixer in	1.5V	IF 1.5mVp-p	Product detector IF input
8	Mixer out	4.0V	Audio 10mVp-p	SSB audio output
9	LO input	1.5V	CAR 200mVp-p	Product detector CAR osc input
10	Vcc	5.0V	None	5V Supply
11	NB out	0.0V	None	Noise blanker monostable output
12	NB timer	0.0V	None	Monostable R/C
13	Det input	0.8V	IF 1.5mVp-p	AM / AGC detector IF input
14	Decoupling	1.5V	None	AM detector decoupling pin
15	Audio out	0.9V	Some audio	AM audio output
16	AGC dcpl	2.3V	None	AGC level output, AGC time constant
17	Gnd	0V	None	Ground connection
18	IF input	0.8V	IF 2mVp-p	1st IF amplifier input

MC3357P Narrow band FM detector, Q3 in D-225.



The MC3357P contains an IF conversion mixer, a limiter amplifier and a quadrature FM detector. In the D-225 detector unit, the mixer is used as a phase detector for the AMS system, and takes its IF signal from the output of the limiter amplifier.

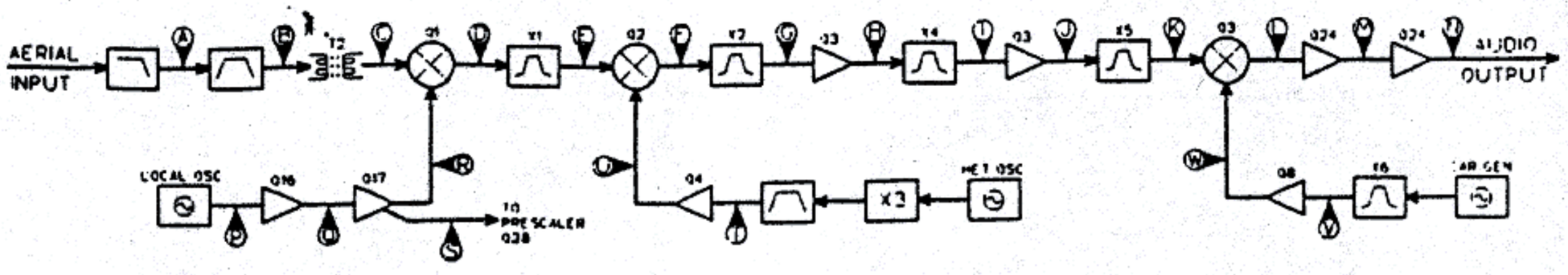
The FM demodulator has two inputs, one fed directly from the limiter amplifier, and the other fed via a frequency sensitive phase-shift network - a ceramic quadrature element is used in the D-225. The two signals are multiplied to give the FM audio signal which then requires de-emphasis. The limiter amplifier removes AM modulation from the incoming IF signal.

The internal audio amplifier is configured as a high-pass filter using external reactive components and samples the audio output to drive the squelch detector and trigger. A Schmitt trigger between pins 12 and 13 prevents squelch jitter.

Q3 in D-225 pin functions. (Levels for AMS mode, S9 input signal modulated at 1 kHz)

Pin	Name	DC Voltage	Signal	Function
1	Osc input	7.9V	455 kHz 1.5Vp-p	Sync CAR oscillator feedback pin
2	Osc output	7.3V	455 kHz 1Vp-p	Sync CAR oscillator output, 455 kHz
3	Mixer out	7.5V	910 kHz 500mVp-p	Sync phase detector output (DC component)
4	Vcc	8.0V	None	8V supply
5	Limiter in	1.1V	IF signal 100mVp-p	455 kHz IF input to limiter amplifier
6	Decoupling	1.1V	None	Limiter amp decoupling pin
7	Limiter out	1.1V	IF 400mVp-p clipped	Limited 455 kHz IF output
8	Quad in	8.0V	IF 100mVp-p pulses	Quadrature detector IF input
9	Demod out	4.1V	IF 500mVp-p pulses	FM audio output
10	Filter in	2.0V	None	Audio noise filter feedback input
11	Filter out	2.0V	AF noise 4Vp-p	Audio noise filter output
12	Squelch in	0.0V	None	DC input to squelch Schmitt trigger
13	Squelch out	7.5V	None	Squelch switch logic output (L to mute)
14	Mute	0.0V	None	No connection
15	Gnd	0V	None	Ground connection
16	Mixer in	2.0V	IF 400mVp-p clipped	455 kHz IF input to sync phase detector

Signal levels.



The signal levels shown here can provide a useful fault finding guide to a partially working receiver, however there are a few points to beware of. All signal levels were measured with a high-impedance probe and a frequency selective level meter. The signals at the outputs of mixers are often swamped by oscillator feed-through and so cannot be measured with a broad-band voltmeter.

The specified input signal level of 50 uV drives the AGC system to reduce the gain of the two IF amplifiers, the RF AGC system should still be at full gain. Because of threshold and gain variations within the IF amplifier chip there may be deviations from the stated signal levels in the 455 kHz IF chain without any fault present.

Signal levels and frequencies. Receiver settings:-

Mode	USB
Frequency	14.200 MHz
IF Filter	2.2 kHz
RF Atten	Off
Input signal	14.201 MHz at 50 uV (-73 dBm) into 50 ohm antenna input.

Point	Connection	Frequency	Level (rms)	Comments
A	D1 Anode	14.201 MHz	40 uV	Band-pass filter input
B	D5 Anode	14.201 MHz	30 uV	Band-pass filter output
C	Q1 pins 12 & 13	14.201 MHz	65 uV	1st mixer input (same signal on both pins)
D	Q1 pin 3	45.000 MHz	750 uV	1st mixer 45 MHz IF output
E	Q2 pin 13	45.000 MHz	650 uV	45 MHz IF filter output / 2nd mixer input
F	Q2 pin 14	455.4 kHz	1.3 mV	2nd mixer 455 kHz IF output
G	Q3 pin 18	455.4 kHz	500 uV	2.2 kHz filter output
H	Q3 pin 3	455.4 kHz	3.3 mV	1st IF amplifier output
I	Q3 pin 4	455.4 kHz	1.3 mV	4 kHz filter output
J	Q3 pin 6	455.4 kHz	700 uV	2nd IF amplifier output
K	Q3 pin 7	455.4 kHz	350 uV	10 kHz filter output
L	Q3 pin 8	1 kHz	3.3 mV	Product detector output
M	Q24 pin 1	1 kHz	380 mV	1st audio preamplifier output
N	Q24 pin 7	1 kHz	580 mV	2nd audio preamplifier output
P	Q16 base	59.201 MHz	150 mV	Local oscillator output
Q	Q16 collector	59.201 MHz	70 mV	Buffer amplifier output
R	Q1 pin 5	59.201 MHz	750 mV	Local oscillator mixer injection
S	Q28 pin 2	59.201 MHz	130 mV	Local oscillator feed to PLL prescaler
T	Q4 base	44.5446 MHz	14 mV	HET oscillator tripler output
U	Q2 pin 5	44.5446 MHz	280 mV	HET oscillator mixer injection
V	Jn R48 / R49	456.4 kHz	2.2 mV	CAR comb filter output
W	Q3 pin 9	456.4 kHz	70 mV	CAR injection to product detector

1.1 Microcontroller function and display driver test.

Switch on the receiver with the **MEMORY SELECT** button pressed, then release the button. The display should show the **TEST** message if the microcontroller, serial bus and display are functioning correctly.

1.2 Frequency memory (RAM chip, Q204) test.

This test will erase any frequencies held in the memories of the receiver, and will preset them with standard frequencies useful for the alignment procedures to follow. The test may be omitted to preserve the memory contents.

With the **TEST** message displayed, press the **RF ATTEN** button.
The display should continue to show the **TEST** message.
Note that the test is continuously repeated until the button is released or a fault is detected.

2) Reference oscillator adjustment.

2.1 With the **TEST** message displayed, press the **FILTER SELECT** button.
Connect a frequency counter to TP3 (Local Osc).

2.2 Adjust **TC201** (on the control unit) for a reading of 45.0000 MHz +/- 20 Hz.

If a stable 45 MHz cannot be obtained check the reference frequency on Q29 pin 13 which should be 672.000 kHz. If this is correct, then the local oscillator, PLL or its control system is at fault. To aid fault finding on the PLL control system, PLL programming data is continuously sent to Q29 whilst the **FILTER SELECT** button is held.

3) Heterodyne oscillator adjustment.

3.1 With the **TEST** message displayed, select USB mode.
Connect a frequency counter to TP4 (Audio).
Set TC4 to mid-position.

3.2 Press the **FILTER SELECT** button.
Adjust TC3 for a reading of 1378 Hz +/- 10 Hz.

3.3 Press the **MHz DOWN** button.
Adjust **VR2** for a reading 8 Hz above that in (3.2) above.

3.4 Repeat (3.2) and (3.3).

Note that it may be possible to obtain two adjustment positions of TC3 to satisfy (3.2), but only one will enable adjustment (3.3) to be made.

The remaining alignment procedures require the receiver to operate in its normal mode.
Press the **MHz UP** button to exit test mode.

4) Local oscillator adjustment.

The only adjustment in the local oscillator is the physical layout of the windings on the oscillator coil **T4.** The coil is factory aligned and then potted in hot-melt adhesive - it is unlikely that any further adjustment will be necessary. It is suggested that the following functional checks are made, and the adjustments only performed if absolutely necessary.

4.1 Local oscillator alignment test.

This test should be performed with the dicast box in place around the oscillator circuit. Following the frequency memory test above, the receiver frequencies used in this test are programmed into the memory numbers shown.

Connect a DVM between **TP1** (-V) and **GROUND.**
Check that the voltage on TP1 is -1.9V +/- 0.1V (ie below ground potential).

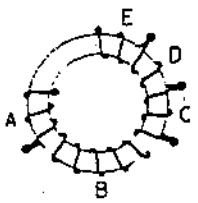
4.2 Connect a DVM between **TP2** (VCO control) and **GROUND.**
Check the voltage on TP2 for receiver frequency settings shown below:-

Frequency	Memory	TP2 Voltage
29.900 MHz	1	< 7.0 V
19.000 MHz	2	> 1.5 V
18.999 MHz		< 7.0 V
11.000 MHz	3	> 1.5 V
10.999 MHz		< 7.0 V
5.000 MHz	4	> 1.5 V
4.999 MHz		< 7.0 V
100 kHz	5	> 1.5 V

4.3 Local oscillator coil adjustment.
Remove the oscillator dicast box and the potting around **T4.** Use a hot air gun to melt the potting compound.

Oscillator coil T4 sections.

A = 3 turns
B = 6 turns
C = 2 turns
D = 2 turns
E = 2 turns



Connect a DVM between **TP2** (VCO control) and **GROUND.**
Space the turns in section B of the coil evenly.

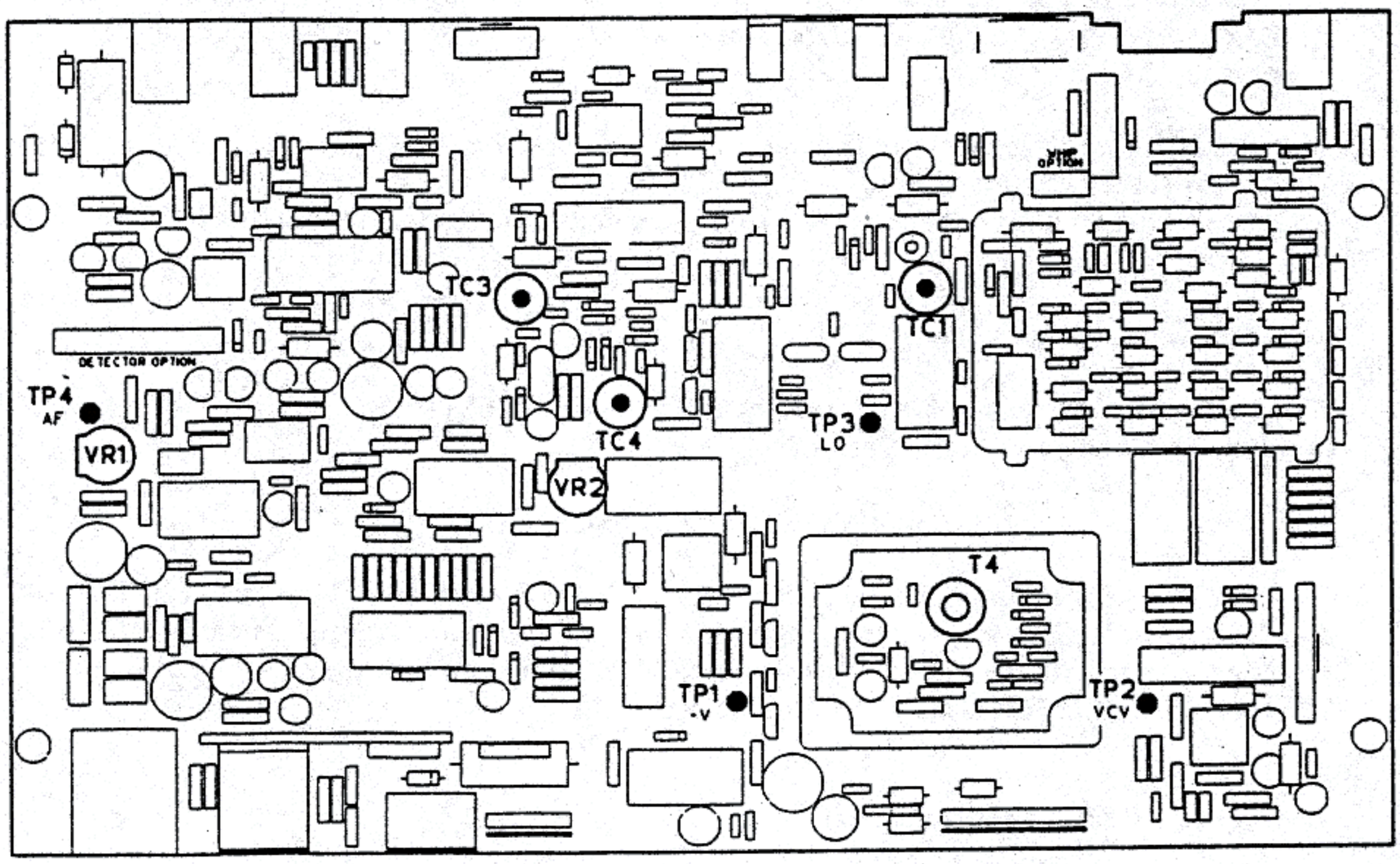
4.3 a Tune to 29.900 MHz, adjust coil section A for 6.5 V on TP2.
4.3 b Tune to 19.000 MHz, check voltage on TP2 is > 1.5 V.
4.3 c Tune to 18.999 MHz, adjust coil section C for < 6.5 V on TP2.
4.3 d Tune to 11.000 MHz, check voltage on TP2 is > 1.5 V.
4.3 e Tune to 10.999 MHz, adjust coil section D for < 6.5 V on TP2.
4.3 f Tune to 5.000 MHz, check voltage on TP2 is > 1.5 V.
4.3 g Tune to 4.999 MHz, adjust coil section E for < 6.5 V on TP2.
4.3 h Tune to 100 kHz, check voltage on TP2 is > 1.5 V.
4.3 i Check the TP2 voltage falls within the 6.5 V and 1.5 V limits for all of the above frequencies.

If any of the voltages on TP2 fall below 1.5 V, then slide the turns in section B of the coil towards the C section, and repeat the adjustment from section (4.3 a).

Test and alignment.

Equipment required:- Frequency counter to operate to 50 MHz.
DVM to measure 10V DC.
HF signal generator with calibrated output.
Audio SINAD meter.

Location of test points and adjustments.



Many of the tests and alignments described here depend on the correct operation and adjustment of other sections of the receiver. It is strongly recommended that this procedure is performed in the order below, and any faults found are rectified before continuing.

The tests listed require the full operating frequency range of the receiver to be available. If JP1 is installed, restricting coverage, it should be removed before carrying out the testing and alignment, and replaced afterwards.

1) Control unit test.

Severe faults in the control system will result in a blank display (no 5V power or faulty display driver) or a display with all segments showing (no microcontroller activity or serial bus fault). If the test routines will run and a malfunction is detected, the display will show the fault symbol **FLT**. The sequence of events before the fault symbol appears can give an indication of the area where the fault was detected.

A fault indication when the receiver is switched on, or during normal operation, is almost certainly due to an internal fault within the microcontroller. Fault indications during test mode apply to the current test selected.

4.4 Repot the oscillator coil with hot-melt adhesive, and refit the dicast oscillator box. Be sure to locate the cover under the PCB correctly so that the cut out edges fit over the PCB tracks.

When the coil and oscillator circuit has cooled to room temperature, carry out the checks in (4.1) and 4.2) above.

5) I F alignment.

5.1 Connect a signal generator to the 50 ohm antenna input socket.
Inject 5 uV at 14.000 MHz modulated with 70% AM at 1kHz.
Tune the receiver to 14.000 MHz (memory 11) and select AM mode.

Check that the receiver resolves the input signal at 1kHz.

5.2 Connect a SINAD meter to the EXT LS socket.
Set the volume and tone controls to mid-position.
Reduce the signal generator output to 0.5 uV.

Adjust TC1 and TC4 for maximum SINAD reading.
Check that the SINAD reading is greater than 8 dB.

6) S-Meter adjustment.

6.1 From (5.2) above, increase the signal generator output to 160 uV.
Adjust VR1 for an S-meter reading of S 9 +10 dB.
Remove the input signal and check that the S-meter returns to the S 1 position.

7) Input filter check.

7.1 Connect a signal generator to the 50 ohm antenna input socket.
Inject a 1 uV signal modulated with 70% AM at 1kHz.
Connect a SINAD meter to the EXT LS socket.
Set the volume and tone controls to mid-position.

Tuning the receiver and signal generator together, check that the SINAD reading is greater than 10 dB at all of the frequencies listed below:-

4.200 MHz (memory 8)
4.199 MHz
11.000 MHz (memory 9)
10.999 MHz
19.000 MHz (memory 10)
18.999 MHz
29.900 MHz (memory 1)

Increase the generator output to 3 uV and check that the SINAD reading is greater than 10 dB at all of the frequencies listed below:-

1.700 MHz (memory 7)
1.699 MHz
500 kHz (memory 6)
499 kHz

Disassembly.

Main Unit.

Access to the main RF unit involves only the removal of the top and bottom case-halves, each secured by two countersunk screws on the sides of the case. The internal loudspeaker should be unplugged from J7 when the top case is removed.

Control Unit.

To work on the control unit, the chassis of the receiver must be removed from the case:-

Remove the main tuning knob. (Use 2mm hexagon key.)
Remove the VOLUME, TONE and MODE knobs. (Prise off the arrowed cap and then loosen the collet screw.)
Remove the two screws holding the control unit brackets to the sides of the case.
If the D-225 unit is fitted, remove the screw holding its bracket to the left hand case side.
Turn the receiver over, and remove the four screws holding the main unit to its support pillars.
Remove the four screws holding the rear panel to the case sides.

The main chassis of the receiver will now slide out of the case with the rear panel attached to the main unit. Care should be taken not to stress the main unit by bending the rear panel as damage to the connectors on the panel may result.

Special note.

When the chassis is replaced in the case, make sure that the S-meter and headphone jack socket locate correctly in the holes in the front panel. The four screws holding the main unit to its support pillars should be left loose until the rear panel is secured. The brackets holding the control unit to the case sides can be adjusted if the control push buttons and spindles do not align correctly with the front panel.

Further disassembly.

The control unit may be separated from the main circuit board by removing the nuts securing the volume and tone controls and unsoldering the 6 and 10-way connectors from the control unit. Care should be taken here to avoid damaging the through-hole plating in the PCB. If the connectors cannot be desoldered cleanly, then cut through each pin to separate the boards and remove the pins individually. The connectors can then be replaced before reassembly.

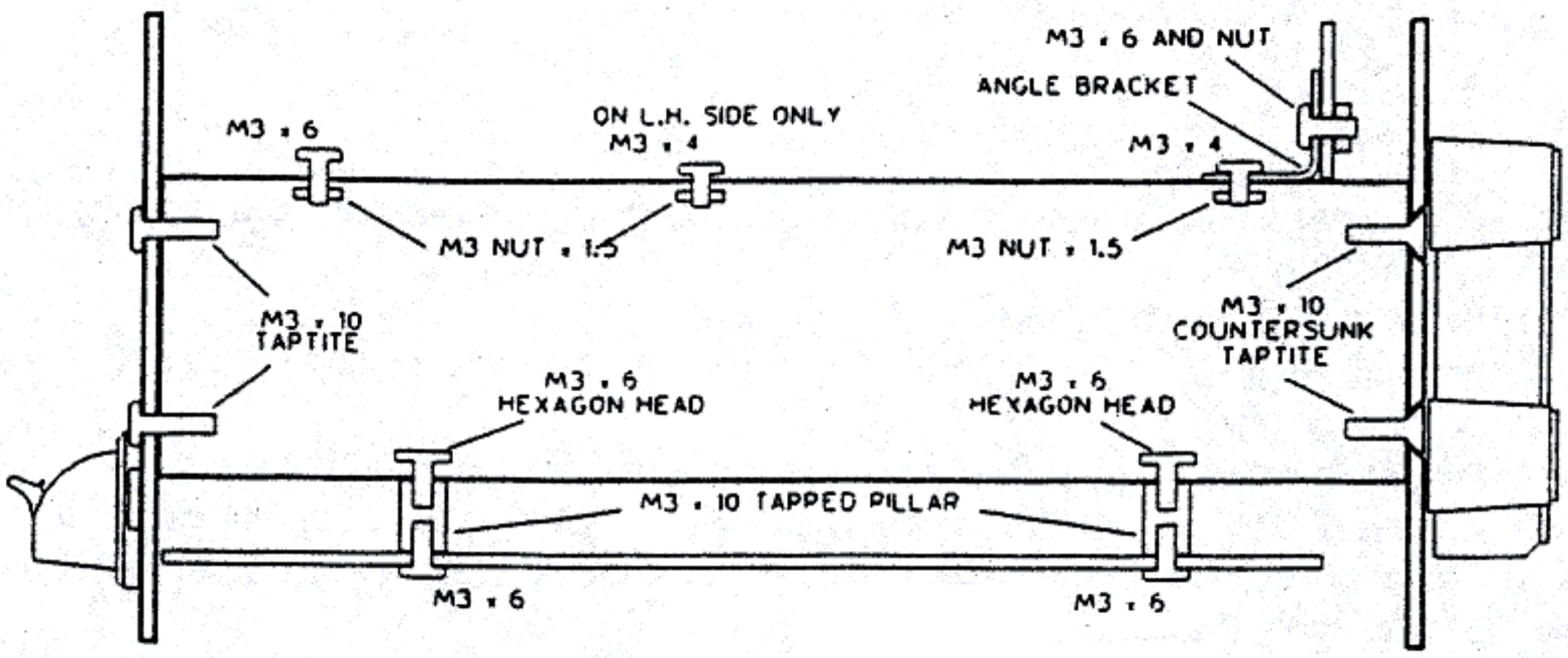
The rear panel may be separated from the main unit by unsoldering connections from the antenna and ground terminals to the top of the PCB, and from the earth solder-tag underneath the board. The panel can be removed after the three jack-socket nuts are undone. If the NiCd battery pack is fitted to the receiver this should be removed from the panel before attempting to unsolder the connections.

Liquid crystal display.

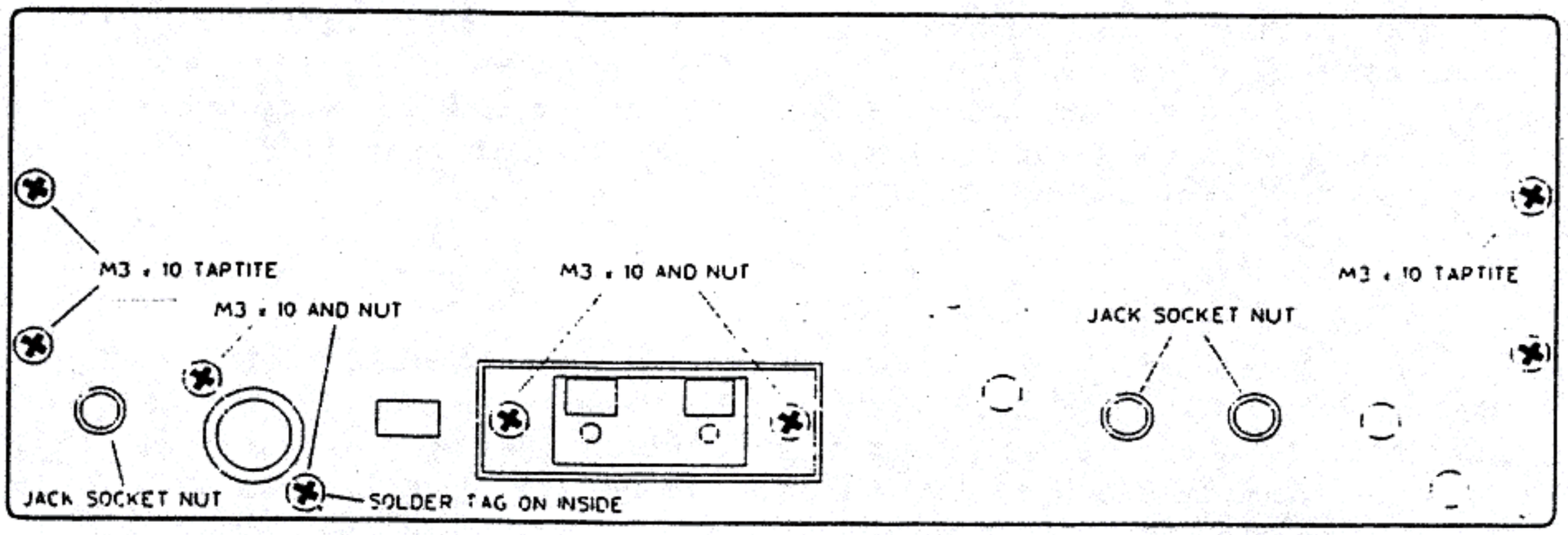
The display is plugged into two 25-way sockets on the control unit, and may be removed by gently levering up first one end then the other. When replacing, be sure to locate the blue dot to the left hand side. Under the display, the light reflector is fixed with adhesive pads to the circuit board, and these will require replacement if it is removed.

Case fastening details.

PCB fixing detail

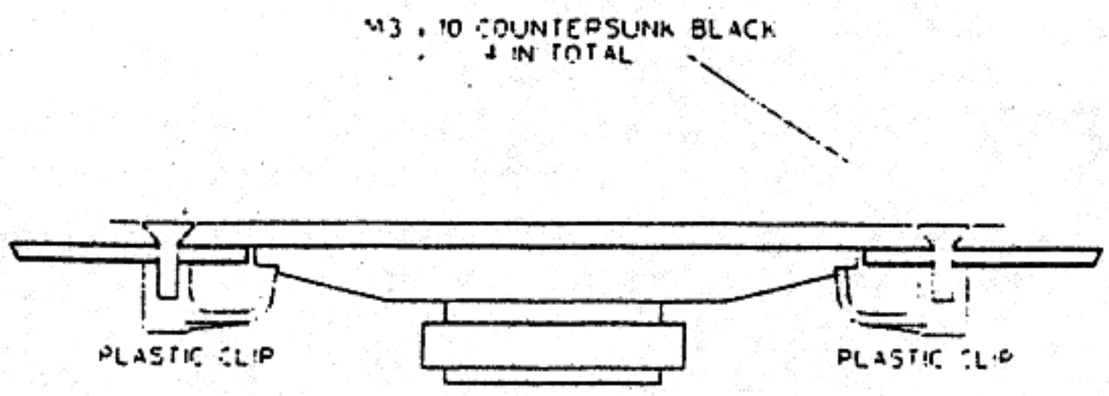


Rear panel detail



Loudspeaker fixing detail

Top and bottom case halves fastened with M3 x 6 countersunk, black. (8 in total).



Option unit installation.

Access to fit the option boards is obtained by removing the top and bottom case-halves of the receiver. The loudspeaker connection, plugged onto connector labelled J7 L.S. may be unplugged, if required, for easier access. The battery option requires only the top case to be removed for fitting. The keypad option needs no internal access.

All of the options will fit into the receiver simultaneously, but if the detector and battery options are both fitted, the FM squelch level control should be fitted before the NiCd battery holders. If fitted afterwards, the left-hand battery holder should be temporarily removed to gain access to the main circuit board. The recommended order of installation is :-

1. Detector unit squelch level control.
2. Battery holders, batteries and retaining bar.
3. Detector unit PCB.
4. Whip amplifier PCB.

B-225 Battery Option.

Kit contains : 2 Battery holders and connector.
8 C-size NiCd cells.
Battery retaining bar.
Screws (4) and nuts (4).

Fasten the two battery holders to the rear panel with the screws and nuts supplied. The wires from the holders should come together in the centre of the panel. Insert the eight NiCd cells into the holders, observing correct polarity. Plug the connector from the batteries onto the pins near the centre of the receiver circuit board labelled J13 BATTERY. The connector orientation is not important, but ensure that it fits correctly onto all four pins.

Remove the two screws from nuts in the case sides (located next to the rear panel), and use these to fix the battery retaining bar in place. The nuts should be slid along the slots in the case sides until they are in the correct position. The lugs on the ends of the retaining bar should point to the rear of the receiver. Press the retaining bar against the NiCd cells before tightening the fixing screws.

D-225 Detector Option.

Kit contains : Detector PCB and fixing bracket.
Squelch level control.
Clip-in spindle.

The FM squelch level control is located at the rear edge of the receiver's main circuit board, next to the labelled hole in the rear panel. Insert the control potentiometer into the board and then clip in the spindle through the hole in the rear panel. When the potentiometer and spindle are correctly aligned, solder the control into the circuit board.

Unscrew the detector mounting screw from the nut in the left-hand case side-member. Insert the detector unit into the main board, there are 10 pins on the unit to pass through the main board. Slide the nut in the left-hand case side so that it is aligned with the right-angle bracket on the detector unit, and fasten the bracket with the screw. Check that the detector unit is vertical and at right-angles to the case side, then tighten both screws holding the unit. Finally solder the 10 pins to the main circuit board.

W-225 Whip Aerial Option.

Kit contains : Amplifier PCB.
Telescopic whip antenna.

Insert the whip amplifier unit into the main circuit board. It is located near to the aerial sockets and is orientated so that the component side is nearest to the front of the receiver. There are 4 pins on the unit to pass through the main board. If the battery option is fitted make sure that the length of neoprene strip is between the amplifier unit and the battery retaining bar. Before soldering the board into position, ensure that it is vertical, and pressed firmly against the receiver circuit board.

Parts list. Main Unit

Component	Type / Value	Part No.
B 1	3V Lithium cell 300mAh	B21-0020
C 1	Ceramic plate N150 100pF 100V	C02-1010
C 2	Ceramic plate N750 180pF 100V	C03-1810
C 3	Ceramic plate N750 220pF 100V	C03-2210
C 4	Ceramic plate medium K 1.5nF 100V	C11-1520
C 5	Ceramic plate medium K 3.3nF 100V	C11-3320
C 6	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 7	Ceramic plate N750 180pF 100V	C03-1810
C 8	Ceramic plate N750 270pF 100V	C03-2710
C 9	Ceramic plate N150 100pF 100V	C02-1010
C 10	Ceramic plate N750 330pF 100V	C03-3310
C 11	Ceramic plate N150 100pF 100V	C02-1010
C 12	Ceramic plate N750 270pF 100V	C03-2710
C 13	Ceramic plate N750 330pF 100V	C03-3310
C 14	Ceramic plate N150 33pF 100V	C02-3300
C 15	Ceramic plate medium K 470pF 100V	C11-4710
C 16	Ceramic plate N750 220pF 100V	C03-2210
C 17	Ceramic plate medium K 560pF 100V	C11-5610
C 18	Ceramic plate medium K 470pF 100V	C11-4710
C 19	Ceramic plate medium K 560pF 100V	C11-5610
C 20	Ceramic plate medium K 390pF 100V	C11-3910
C 21	Ceramic plate medium K 1.5nF 100V	C11-1520
C 22	Ceramic plate medium K 1.2nF 100V	C11-1220
C 23	Ceramic plate medium K 1.5nF 100V	C11-1520
C 24	Ceramic plate medium K 820pF 100V	C11-8210
C 25,26	Ceramic plate medium K 2.2nF 100V	C11-2220
C 27-29	Ceramic plate medium K 4.7nF 100V	C11-4720
C 30	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 31	Ceramic plate medium K 4.7nF 100V	C11-4720
C 32-39	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 40	Ceramic plate high K 22nF 63V	C21-2230
C 41	Ceramic plate NP0 10pF 100V	C01-1000
C 42	Ceramic plate NP0 4.7pF 100V	C01-4790
C 43	Ceramic plate N150 27pF 100V	C02-2700
C 44,45	Ceramic plate high K 22nF 63V	C21-2230
C 46	Ceramic plate N150 100pF 100V	C02-1010
C 47-49	Ceramic plate high K 22nF 63V	C21-2230
C 50	Radial electrolytic 10uF 25V	E03-1000
C 51	Ceramic plate NP0 15pF 100V	C01-1500
C 52,53	Ceramic plate high K 22nF 63V	C21-2230
C 54,55	Ceramic plate medium K 1nF 100V	C11-1020
C 56,57	Ceramic plate high K 22nF 63V	C21-2230
C 58	Ceramic plate high K 10nF 63V	C21-1030
C 59	Ceramic plate N150 100pF 100V	C02-1010
C 60-62	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 63,64	Ceramic plate N750 220pF 100V	C03-2210
C 65,66	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 67	Ceramic plate N150 100pF 100V	C02-1010
C 68	Ceramic plate N750 220pF 100V	C03-2210
C 69,70	Ceramic plate high K 10nF 63V	C21-1030
C 71-73	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 74	Ceramic plate N150 150pF 100V	C02-1510
C 75	Ceramic plate high K 10nF 63V	C21-1030
C 76	Ceramic plate N150 100pF 100V	C02-1010
C 77,78	Ceramic plate high K 10nF 63V	C21-1030
C 79	Radial electrolytic 10uF 25V	E03-1000
C 80	Ceramic plate high K 22nF 63V	C21-2230
C 81	Box polyester 100nF 63V	C31-1041
C 82	Radial electrolytic 10uF 25V	E03-1000
C 83	Ceramic plate medium K 2.2nF 100V	C11-2220
C 84	Box polyester 22nF 100V	C31-2232
C 85	Radial electrolytic 10uF 25V	E03-1000
C 86	Radial electrolytic 100uF 10V	E01-1010
C 87	Radial electrolytic 470uF 16V	E02-4713
C 88	Radial electrolytic 220uF 16V	E02-2212
C 89	Ceramic plate high K 22nF 63V	C21-2230
C 90	Radial electrolytic 10uF 25V	E03-1000
C 91	Ceramic plate N150 33pF 100V	C02-3300
C 92	Ceramic plate NP0 10pF 100V	C01-1000
C 93	Ceramic plate N750 220pF 100V	C03-2210
C 94-98	Ceramic plate high K 22nF 63V	C21-2230
C 99	Ceramic plate NP0 15pF 100V	C01-1500
C 100	Ceramic plate NP0 6.8pF 100V	C01-6890
C 101,102	Ceramic plate high K 22nF 63V	C21-2230
C 103	Ceramic plate N150 33pF 100V	C02-3300
C 104	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 105	Ceramic plate high K 22nF 63V	C21-2230
C 106	Radial electrolytic 10uF 25V	E03-1000
C 107	Radial electrolytic 47uF 25V	E03-4701
C 108-110	Ceramic plate high K 22nF 63V	C21-2230
C 111	Ceramic plate N150 22pF 100V	C02-2200
C 112	Ceramic plate N150 47pF 100V	C02-4700
C 113,114	Ceramic plate NP0 2.2pF 100V	C01-2290
C 115	Radial electrolytic 1uF 50V	E05-1090
C 116	Box polyester 2.2uF 63V	C31-2255
C 117,118	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 119	Ceramic plate N150 100pF 100V	C02-1010
C 120	Radial electrolytic 2.2uF 50V	E05-2290
C 121-124	Ceramic plate high K 22nF 63V	C21-2230
C 125	Radial electrolytic 10uF 25V	E03-1000
C 126	Ceramic plate medium K 1nF 100V	C11-1020
C 127	Ceramic plate high K 22nF 63V	C21-2230
C 128	Radial electrolytic 1uF 50V	E05-1090
C 129	Radial electrolytic 2.2uF 50V	E05-2290
C 130	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 131-133	Ceramic plate N150 100pF 100V	C02-1010
C 134	Radial electrolytic 10uF 25V	E03-1000
C 135	Box polyester 100nF 63V	C31-1041
C 136	Box polyester 33nF 100V	C31-3332
C 137	Ceramic plate high K 10nF 63V	C21-1030
C 138	Box polyester 10nF 100V	C31-1032
C 139	Radial electrolytic 10uF 25V	E03-1000
C 140,141	Box polyester 22nF 100V	C31-2232
C 142,143	Radial electrolytic 2.2uF 50V	E05-2290
C 144	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 145	Radial electrolytic 47uF 25V	E03-4701
C 146	Radial electrolytic 10uF 25V	E03-1000
C 147	Box polyester 100nF 63V	C31-1041
C 148	Radial electrolytic 470uF 16V	E02-4713
C 149	Ceramic plate high K 22nF 63V	C21-2230
C 150	Box polyester 100nF 63V	C31-1041
C 151	Ceramic plate high K 22nF 63V	C21-2230
C 152	Box polyester 220nF 63V	C31-2241
C 153	Ceramic plate high K 10nF 63V	C21-1030
C 154	Radial electrolytic 100uF 25V	E03-1012
C 155	Radial electrolytic 470uF 16V	E02-4713
C 156,157	Radial electrolytic 100uF 10V	E01-1010
C 158-161	Box polyester 220nF 63V	C31-2241
C 162	Radial electrolytic 470uF 16V	E02-4713
C 165	Ceramic plate N150 150pF 100V	C02-1510
D 1-11	PIN switching diode BA244A	D02-0244
D 12,13	Signal diode 1N4148	D01-4148
D 14	Zener diode BZX79C5V1	D21-5190
D 15	PIN attenuator diode MI204	D31-0204
D 16-28	Signal diode 1N4148	D01-4148
D 29,30	Varicap diode BB329	D03-0329
D 31-33	PIN switching diode BA244A	D02-0244
D 34-42	Signal diode 1N4148	D01-4148
D 43-45	Rectifier diode 1N4002	D01-4002
D 46-49	High speed diode BAW62	D02-0062
J 1	Red & black spring terminal block	J21-0010
J 2	Two hole flange mount SO-239	J01-2390
J 3	PCB power socket, 2.1mm	J13-2193
J 4,6,9	PCB jack socket, 3.5mm mono	J11-3593
J 5	PCB jack socket, 6.5mm stereo	J11-0602
J 7	2-way 0.1" wafer, non locking	N01-0020
J 8	2-way 0.1" free socket, IDC	J22-0020
J 10	6-way 0.1" r/a wafer, non locking	N03-0061
J 11	10-way 0.1" r/a wafer, non locking	N03-0101
J 12	5-way 0.1" r/a wafer, non locking	N03-0051
J 13	4-way 0.1" wafer, non locking	N01-0040

L 1,2	Ferrite axial inductor 0.47uH	L01-4782
L 3	Ferrite axial inductor 3.3uH	L01-3392
L 4	Ferrite axial inductor 100uH	L01-1012
L 5,6	Ferrite axial inductor 0.22uH	L01-2282
L 7	Ferrite axial inductor 0.15uH	L01-1582
L 8	Ferrite axial inductor 0.22uH	L01-2282
L 9-12	Ferrite axial inductor 0.47uH	L01-4782
L 13-16	Ferrite axial inductor 1.5uH	L01-1592
L 17-20	Ferrite axial inductor 3.3uH	L01-3392
L 21,22	Ferrite axial inductor 15uH	L01-1502
L 23	Ferrite axial inductor 10uH	L01-1002
L 24	Ferrite axial inductor 100uH	L01-1012
L 25	Ferrite axial inductor 47uH	L01-4702
L 26	Ferrite axial inductor 33uH	L01-3302
L 27,28	Ferrite axial inductor 470uH	L01-4713
L 29-33	Ferrite axial inductor 1mH	L01-1023
L 34	Ferrite axial inductor 100uH	L01-1012
L 35-37	Ferrite axial inductor 1mH	L01-1023
L 38	Ferrite axial inductor 3.3uH	L01-3392
L 39,40	Ferrite axial inductor 1mH	L01-1023
L 41	Ferrite axial inductor 47uH	L01-4702
L 42	Ferrite axial inductor 1uH	L01-1092
L 43,44	Ferrite axial inductor 1mH	L01-1023
L 45-47	Ferrite axial inductor 100uH	L01-1012
L 48	Ferrite axial inductor 470uH	L01-4713
L 49	Ferrite axial inductor 1mH	L01-1023
Q 1,2	High level mixer SL6440CDP	U12-6440
Q 3	IF amp & detector SL6700CDP	U12-6700
Q 4	NPN RF transistor ZTX320	Q16-0320
Q 5-12	NPN transistor BC183L	Q01-1831
Q 13,14	Shift & store register 74HC4094	Z06-4094
Q 15	Seven darlington drivers ULN2003	U41-2003
Q 16,17	NPN RF transistor ZTX320	Q16-0320
Q 18,19	N channel junction FET J310	Q14-0310
Q 20	PNP transistor BC212L	Q01-2121
Q 21-23	NPN transistor BC183L	Q01-1831
Q 24	Quad op-amp MC3403P	U13-3403
Q 25	Dual BiFET op-amp TL062CP	U42-0062
Q 26	Audio amplifier TDA1904	U43-1904
Q 27	Quad analogue switch 74HC4066	Z06-4066
Q 28	Dual modulus prescaler uPB553AC	Z31-0553
Q 29	PLL synthesizer system TDD1742T	U44-1742
Q 30,31	Shift & store register 74HC4094	Z06-4094
Q 32	Voltage regulator, 8V LM2930T-8	U24-0080
Q 33	Voltage regulator, 5V MC78M05CT	U22-0050
R 1	Carbon film 1/3W 5% 56R	R03-5600
R 2	Carbon film 1/3W 5% 270R	R03-2710
R 3	Carbon film 1/3W 5% 56R	R03-5600
R 4	Carbon film 1/3W 5% 10k	R03-1030
R 5-11	Carbon film 1/3W 5% 100R	R03-1010
R 12,13	Carbon film 1/3W 5% 10k	R03-1030
R 14	Carbon film 1/3W 5% 100R	R03-1010
R 15,16	Carbon film 1/3W 5% 1.5k	R03-1520
R 17	Carbon film 1/3W 5% 270R	R03-2710
R 18	Carbon film 1/3W 5% 56R	R03-5600
R 19	Carbon film 1/3W 5% 330R	R03-3310
R 20	Carbon film 1/3W 5% 10k	R03-1030
R 21	Carbon film 1/3W 5% 47k	R03-4730
R 22,23	Carbon film 1/3W 5% 220R	R03-2210
R 24	Carbon film 1/3W 5% 470R	R03-4710
R 25	Carbon film 1/3W 5% 2.7k	R03-2720
R 26	Carbon film 1/3W 5% 1.5k	R03-1520
R 27	Carbon film 1/3W 5% 220k	R03-2240
R 28	Carbon film 1/3W 5% 3.9k	R03-3920
R 29	Carbon film 1/3W 5% 1k	R03-1020
R 30	Carbon film 1/3W 5% 100R	R03-1010
R 31	Carbon film 1/3W 5% 1.5k	R03-1520
R 32	Carbon film 1/3W 5% 100R	R03-1010
R 33	Carbon film 1/3W 5% 220R	R03-2210
R 34	Carbon film 1/3W 5% 270R	R03-2710
R 35-37	Carbon film 1/3W 5% 100R	R03-1010
R 38,39	Carbon film 1/3W 5% 3.9k	R03-3920
R 40	Carbon film 1/3W 5% 1.5k	R03-1520
R 41	Carbon film 1/3W 5% 100R	R03-1010
R 42	Carbon film 1/3W 5% 330R	R03-3310
R 43	Carbon film 1/3W 5% 100R	R03-1010
R 44	Carbon film 1/3W 5% 560R	R03-5610
R 45	Carbon film 1/3W 5% 100R	R03-1010
R 46	Carbon film 1/3W 5% 3.9k	R03-3920
R 47	Carbon film 1/3W 5% 1.5k	R03-1520
R 48	Carbon film 1/3W 5% 1M	R03-1050
R 49	Carbon film 1/3W 5% 1.5k	R03-1520
R 50	Carbon film 1/3W 5% 4.7k	R03-4720
R 51	Carbon film 1/3W 5% 470R	R03-4710
R 52,53	Carbon film 1/3W 5% 10k	R03-1030
R 54	Carbon film 1/3W 5% 15k	R03-1530
R 55	Carbon film 1/3W 5% 1k	R03-1020
R 56	Carbon film 1/3W 5% 56R	R03-5600
R 57	Carbon film 1/3W 5% 220R	R03-2210
R 58	Carbon film 1/3W 5% 22k	R03-2230
R 59	Carbon film 1/3W 5% 220k	R03-2240
R 60	Carbon film 1/3W 5% 330k	R03-3340
R 61	Carbon film 1/3W 5% 47k	R03-4730
R 62,63	Carbon film 1/3W 5% 22k	R03-2230
R 64-66	Carbon film 1/3W 5% 560R	R03-5610
R 67	Carbon film 1/3W 5% 1k	R03-1020
R 68	Carbon film 1/3W 5% 220R	R03-2210
R 69	Carbon film 1/3W 5% 100k	R03-1040
R 70	Carbon film 1/3W 5% 22k	R03-2230
R 71	Carbon film 1/3W 5% 560R	R03-5610
R 72	Carbon film 1/3W 5% 100R	R03-1010
R 73	Carbon film 1/3W 5% 68k	R03-6830
R 74	Carbon film 1/3W 5% 100R	R03-1010
R 75	Carbon film 1/3W 5% 470R	R03-4710
R 76	Carbon film 1/3W 5% 4.7k	R03-4720
R 77	Carbon film 1/3W 5% 47k	R03-4730
R 78	Carbon film 1/3W 5% 150k	R03-1540
R 79	Carbon film 1/3W 5% 1M	R03-1050
R 80,81	Carbon film 1/3W 5% 1.5k	R03-1520
R 82	Carbon film 1/3W 5% 6k8	R03-6820
R 83	Carbon film 1/3W 5% 47k	R03-4730
R 84	Carbon film 1/3W 5% 100k	R03-1040
R 85	Carbon film 1/3W 5% 470k	R03-4740
R 87	Carbon film 1/3W 5% 120k	R03-1240
R 88	Metal film 1/4W 1% 60.4k	R12-6030
R 89	Metal film 1/4W 1% 30.0k	R12-3030
R 90	Metal film 1/4W 1% 15.0k	R12-1530
R 91	Metal film 1/4W 1% 7.50k	R12-7520
R 92	Metal film 1/4W 1% 3.30k	R12-3320
R 93	Metal film 1/4W 1% 13.0k	R12-1330
R 94	Metal film 1/4W 1% 15.0k	R12-1530
R 95	Carbon film 1/3W 5% 330R	R03-3310
R 96	Carbon film 1/3W 5% 2.7k	R03-2720
R 97	Carbon film 1/3W 5% 6k8	R03-6820
R 98	Carbon film 1/3W 5% 4.7M	R03-4750
R 99	Carbon film 1/3W 5% 100k	R03-1040
R 100,101	Carbon film 1/3W 5% 220k	R03-2240
R 102	Carbon film 1/3W 5% 68k	R03-6830
R 103,104	Carbon film 1/3W 5% 100k	R03-1040
R 105	Carbon film 1/3W 5% 2.2M	R03-2250
R 106	Carbon film 1/3W 5% 220k	R03-2240
R 107	Carbon film 1/3W 5% 100k	R03-1040
R 108	Carbon film 1/3W 5% 2.7k	R03-2720
R 109	Carbon film 1/3W 5% 22k	R03-2230
R 110	Carbon film 1/3W 5% 47k	R03-4730
R 111	Carbon film 1/3W 5% 22k	R03-2230
R 112	Carbon film 1/3W 5% 150k	R03-1540
R 113	Carbon film 1/3W 5% 470k	R03-4740
R 114	Carbon film 1/3W 5% 2.7k	R03-2720
R 115,116	Carbon film 1/3W 5% 470R	R03-4710
R 117,118	Carbon film 1/3W 5% 47k	R03-4730
R 119	Carbon film 1/3W 5% 150k	R03-1540
R 120	Carbon film 1/3W 5% 100k	R03-1040
R 121	Carbon film 1/3W 5% 47k	R03-4730
R 122	Carbon film 1/3W 5% 220k	R03-2240
R 123	Carbon film 1/3W 5% 47k	R03-4730
R 124	Carbon film 1/3W 5% 470R	R03-4710
R 125,126	Carbon film 1/3W 5% 15k	R03-1530

R 127	Carbon film 1/3W 5% 10k	R03-1030
R 128	Carbon film 1/3W 5% 100R	R03-1010
R 129	Carbon film 1/3W 5% 3.3R	R03-3390
R 130	Carbon film 1/3W 5% 4.7k	R03-4720
R 131,132	Carbon film 1/3W 5% 220R	R03-2210
R 133,134	Carbon film 1/3W 5% 22k	R03-2230
R 135	Carbon film 1/3W 5% 68k	R03-6830
R 136	Carbon film 1/3W 5% 2.7k	R03-2720
R 137	Carbon film 1/3W 5% 10k	R03-1030
R 138	Carbon film 1/3W 5% 22k	R03-2230
R 139	Carbon film 1/3W 5% 1k	R03-1020
R 140,141	Carbon film 2W 5% 39R	R07-3900
R 142	Carbon film 1/3W 5% 4.7k	R03-4720
RP 1	SIL resistor pack 7 x 100k	R27-1040
RL 1,2	SIL reed relay (1A) 5V, 500R coil	T21-0510
S 1	Miniature r/a slide switch 2-pole 3-way	S03-0320
T 1,2	RF transformer 4 : 14 turns	L21-0010
T 3	RF toroidal coil 5 + 5 turns	L21-0020
T 4	RF toroidal coil 3+6+2+2+2 turns	L21-0040
TC 1	Film trimmer cap 2 to 22pF	C42-5590
TC 3	Film trimmer cap 1 to 5.5pF	C42-2200
TC 4	Film trimmer cap 2 to 10pF	C42-1000
VR 1	Sub-min horizontal preset 10k	G11-1030
VR 2	Sub-min horizontal preset 470k	G11-4710
VR 3	16mm pot + DPDT switch 20kA (log)	G04-2030
VR 4	16mm potentiometer 100kB (lin)	G01-1040
X 1	45 MHz crystal filter 15 kHz b/w (pair)	X11-4500
X 2	455 kHz filter 2.2 kHz b/w CFJ455K14	X24-2290
X 3	455 kHz filter 6 kHz b/w CFW455HT	X23-6090
X 4,6	455 kHz filter 4 kHz b/w CFW455IT	X23-4090
X 5	455 kHz filter 10 kHz b/w CFU455G2	X22-1000
X 7	Quartz crystal 14.8483 MHz	X01-1430
	Local oscillator screening box	H13-0010
	Input filter screening box	H13-0020

Control Unit

C 201	Ceramic plate high K 22nF 63V	C21-2230
C 202	Box polyester 220nF 63V	C31-2241
C 203	Axial electrolytic 4.7uF 63V	E16-4790
C 204	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 205,206	Ceramic plate N150 22pF 100V	C02-2200
C 207,208	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 209,210	Box polyester 22nF 100V	C31-2232
C 211,212	Ceramic plate high K 22nF 63V	C21-2230
C 213	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 214	Ceramic plate N750 220pF 100V	C03-2210
D 201-205	Signal diode 1N4148	D01-4148
D 206	3mm LED, HE green MV5474C	O05-5474
D 207,208	5mm LED, HE green MV5452	O15-5452
D 209	Zener diode BZX79C4V3	D21-4390
J 201	9-way 0.1" x 0.5" board spacer	N02-0090
J 202,203	25-way SIL socket for LCD	N12-0250
LCD 201	6 digit x 12.5mm LCD	O21-1261
M 201	Miniature signal level meter	T01-0010
Q 201,202	PNP transistor BC212L	Q01-2121
Q 203	NPN transistor BC183L	Q01-1831
Q 204	256 x 4bit CMOS memory 5101	Z21-5101
Q 205	Microcontroller inc ROM P8749H	Z22-8749
Q 206	LCD driver MM5453N	Z23-5453
Q 207	Quad XOR gate 74HC86	Z06-0086
Q 208	Dual D-type latch 74HC74	Z06-0074
Q 209	Programmable divider MC14569BCP	Z12-0069

R 201	Carbon film 1/3W 5% 10k	R03-1030
R 202	Carbon film 1/3W 5% 68k	R03-6830
R 203	Carbon film 1/3W 5% 22k	R03-2230
R 204	Carbon film 1W 5% 82R	R05-8200
R 205	Carbon film 1/3W 5% 68k	R03-6830
R 206	Carbon film 1/3W 5% 220k	R03-2240
R 207	Carbon film 1/3W 5% 1k	R03-1020
R 208-210	Carbon film 1/3W 5% 22k	R03-2230
R 211	Carbon film 1/3W 5% 15k	R03-1530
R 212,213	Carbon film 1/3W 5% 1M	R03-1050
R 214,215	Carbon film 1/3W 5% 150k	R03-1540
R 216-219	Carbon film 1/3W 5% 68k	R03-6830
R 220	Carbon film 1/3W 5% 68R	R03-6800
R 221,222	Carbon film 1/3W 5% 47R	R03-4700
R 223	Carbon film 1/3W 5% 2.7k	R03-2720
R 224	Carbon film 1/3W 5% 22k	R03-2230
R 225	Carbon film 1/3W 5% 1M	R03-1050
R 226	Carbon film 1/3W 5% 1k	R03-1020
S 201	Mechanical encoder 2 phase, 50 pulse	S31-5020
S 202	Rotary switch 2-pole 6-way	S12-0620
S 203-207	Push button, black	S23-0010
TC 201	Film trimmer cap 2 to 10pF	C42-1000
X 201	Quartz crystal 10.080 MHz	X01-1031
	Display light guide	H12-0400

Case Assembly

	Case frame complete	H21-2250
	Case side rail	H12-0001
	Tilt feet, set of 4	H22-0050
LS 1	Loudspeaker, 80mm 8 ohms	T11-0800
	Loudspeaker grille	H11-0390
	Front panel overlay	H01-0301
	15mm knob, VOLUME and TONE	K01-0150
	15mm winged knob, MODE	K02-0150
	Black arrow cap for knob	K03-1150
	43mm knob, TUNING	K11-0430
	Hexagonal pillar 10mm x M3	F12-3100
	15mm angle bracket	F41-0010
	Loudspeaker fixing clip	F41-0020
	M3 nut to fit in case side rails	F11-3001
	M3 x 6mm screw, hexagon head	F05-3060
	M3 x 6mm screw, countersunk, black	F02-3061
	M3 x 10mm screw, countersunk, black	F02-3101
	Foam padding, 2mm thick	F23-0010
	Foam padding, 11mm thick	F23-0030

Accessories

12V power supply (240V mains)	A02-0120
Carton	P01-2250
Packing material	P01-2251
	P01-2252
User manual	M01-2250
Technical manual	M02-2251

Options.

B-225 Battery Unit

Battery holder, 4 x C-cell	H31-0040
4-way 0.1" free socket, IDC	J22-0040
Battery retaining bar	H12-0480
NiCd C-cell, 2.0 Ah, sleeved	B12-0200

D-225 Detector Unit

C 1	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 2	Ceramic plate medium K 1nF 100V	C11-1020
C 3	Ceramic plate high K 10nF 63V	C21-1030
C 4	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 5,6	Ceramic plate high K 22nF 63V	C21-2230
C 7	Ceramic plate medium K 3.3nF 100V	C11-3320
C 8	Ceramic plate N150 150pF 100V	C02-1510
C 9	Radial electrolytic 2.2uF 50V	E05-2290
C 10	Ceramic plate high K 22nF 63V	C21-2230
C 11	Ceramic plate N150 100pF 100V	C02-1010
C 12,13	Ceramic plate N150 68pF 100V	C02-6800
C 14	Ceramic plate medium K 1nF 100V	C11-1020
C 15	Ceramic plate high K 22nF 63V	C21-2230
C 16	Radial electrolytic 100uF 10V	E01-1010
C 17	Ceramic plate medium K 820pF 100V	C11-8210
C 18	Ceramic plate medium K 470pF 100V	C11-4710
C 19	Ceramic plate N150 68pF 100V	C02-6800
C 20	Ceramic plate N150 150pF 100V	C02-1510
C 21	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 22	Radial electrolytic 2.2uF 50V	E05-2290
C 23	Radial electrolytic 47uF 10V	E01-4700
C 24	Radial electrolytic 1uF 50V	E05-1090
C 25	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 26	Ceramic plate high K 10nF 63V	C21-1030
C 27	Ceramic plate N150 150pF 100V	C02-1510
C 28	Ceramic plate medium K 3.3nF 100V	C11-3320
C 29	Box polyester 100nF 63V	C31-1041
C 30	Box polyester 220nF 63V	C31-2241
C 31,32	Ceramic plate high K 22nF 63V	C21-2230
C 33	Ceramic plate medium K 1nF 100V	C11-1020
C 34	Box polyester 47nF 100V	C31-4732
C 35,36	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
D 1,2	Signal diode 1N4148	D01-4148
D 3	High speed diode BAW62	D02-0062
D 4	Varicap diode BB329	D03-0329
D 5	Zener diode BZX79C5V1	D21-5190
D 6	Signal diode 1N4148	D01-4148
J 1	10-way 0.1" r/a wafer, non locking	N03-0101
L 1	Ferrite axial inductor 1mH	L01-1023
Q 1,2	NPN transistor BC183L	Q01-1831
Q 3	FM IF system MC3357P	U13-3357
Q 4	PNP transistor BC212L	Q01-2121
Q 5	High level mixer SL6440CDP	U12-6440
Q 6	Quad NOR gate 4001	Z11-0001
Q 7,8	PNP transistor BC212L	Q01-2121
Q 9	NPN transistor BC183L	Q01-1831
Q 10	Quad analogue switch 4066	Z11-0066
R 1	Carbon film 1/3W 5% 1.5k	R03-1520
R 2,3	Carbon film 1/3W 5% 220k	R03-2240
R 4	Carbon film 1/3W 5% 10k	R03-1030
R 5	Carbon film 1/3W 5% 2.2k	R03-2220
R 6	Carbon film 1/3W 5% 1.2k	R03-1220
R 7	Carbon film 1/3W 5% 10k	R03-1030
R 8	Carbon film 1/3W 5% 47k	R03-4730
R 9	Carbon film 1/3W 5% 1.5k	R03-1520
R 10	Carbon film 1/3W 5% 15k	R03-1530
R 11	Carbon film 1/3W 5% 330k	R03-3340
R 12,13	Carbon film 1/3W 5% 3.9k	R03-3920
R 14,15	Carbon film 1/3W 5% 15k	R03-1530
R 16	Carbon film 1/3W 5% 100k	R03-1040
R 17	Carbon film 1/3W 5% 2.7k	R03-2720
R 18	Carbon film 1/3W 5% 2.2k	R03-2220
R 19,21	Carbon film 1/3W 5% 5k6	R03-5620
R 20	Carbon film 1/3W 5% 1k	R03-1020
R 22	Carbon film 1/3W 5% 220k	R03-2240
R 23,24	Carbon film 1/3W 5% 10k	R03-1030
R 25	Carbon film 1/3W 5% 2.7k	R03-2720
R 26	Carbon film 1/3W 5% 470R	R03-4710
R 27,28	Carbon film 1/3W 5% 220R	R03-2210
R 29	Carbon film 1/3W 5% 3.9k	R03-3920
R 30	Carbon film 1/3W 5% 330k	R03-3340
R 31,32	Carbon film 1/3W 5% 47k	R03-4730
R 33,34	Carbon film 1/3W 5% 10k	R03-1030
R 35	Carbon film 1/3W 5% 15k	R03-1530
R 36	Carbon film 1/3W 5% 1M	R03-1050
R 37	Carbon film 1/3W 5% 62k	R03-6230
R 38	Carbon film 1/3W 5% 330k	R03-3340
R 39	Carbon film 1/3W 5% 100k	R03-1040
TC 1	Film trimmer cap 5 to 65pF	C42-6500
VR 5	Min vertical preset 100k	G14-1041
X 1	455 kHz filter 12 kHz b/w CFU455F2	X22-1200
X 2	455 kHz quad element CDB455C7	X04-4510
X 3	455 kHz resonator KBR455H (selected)	X03-4512
	15mm angle bracket	F41-0010
	Knob for FM squelch preset	K21-6126

K-225 Keypad

C 1	Box polyester 33nF 100V	C31-3332
C 2	Radial electrolytic 4.7uF 63V	E06-4790
C 3	Radial electrolytic 100uF 10V	E01-1010
J 2	3.5mm jack plug, plastic shell	J12-3593
Q 1	Keypad PPM generator SL490BDP	U12-0490
Q 2	Voltage regulator, 8V UA78L08CLP	UZ3-0080
Q 3,4	NPN transistor BC183L	Q01-1831
R 1	Metal film 1/4W 1% 68.0k	R12-6830
R 2	Carbon film 1/3W 5% 2.2k	R03-2220
R 3	Carbon film 1/3W 5% 100k	R03-1040
R 4	Carbon film 1/3W 5% 22k	R03-2230
R 5	Carbon film 1/3W 5% 150R	R03-1510
S 1	12-key numeric keypad, 4 x 3 matrix	S32-1210
	Cable tie for strain relief	F22-0920
	Keypad case assembly	H21-0010
	Cable exit panel	H21-0020
	Adhesive feet, 7mm dia	H22-0030
	Keypad cable, 600mm	W11-6090

W-225 Whip antenna amplifier.

C 1,4	Ceramic plate high K 22nF 63V	C21-2230
C 2	Ceramic plate NP0 15pF 100V	C01-1500
C 3	Mulitlayer Ceramic Z5U 100nF 50V	C23-1040
C 5	Ceramic plate medium K 1nF 100V	C11-1020
C 6	Ceramic plate N150 22pF 100V	C02-2200
C 7-9	Ceramic plate high K 22nF 63V	C21-2230
D 1,2	Signal diode 1N4148	D01-4148
J 1	4-way 0.1" r/a wafer, non locking	N03-0041
L 1	Ferrite axial inductor 470uH	L01-4713
Q 1	N channel junction FET J310	Q14-0310
Q 2	NPN RF transistor ZTX327	Q16-0327
Q 3	PNP transistor BC212L	Q01-2121
R 1	Carbon film 1/3W 5% 4.7k	R03-4720
R 2	Carbon film 1/3W 5% 150R	R03-1510
R 3	Carbon film 1/3W 5% 1.5k	R03-1520
R 4	Carbon film 1/3W 5% 56R	R03-5600
R 5	Carbon film 1/3W 5% 47k	R03-4730
R 6	Carbon film 1/3W 5% 220k	R03-2240
T 1	RF transformer 3 : 7+7 turns	L21-0050
	Telescopic whip antenna	A01-0010

Receiver specification.

Description.	
Frequency coverage	30 kHz to 30 MHz continuous coverage. 150 kHz to 26.1 MHz (+).
Reception modes	AM, LSB, USB, CW, Narrow band FM (+), Synchronous AM (AMS) (+).
Receiver system	Microprocessor controlled PLL tuning, dual conversion superheterodyne receiver. First intermediate frequency 44.999 MHz to 45.000 MHz. Second intermediate frequency 455 kHz. R F Input tuning in six bands :- 1. 30 kHz to 500 kHz 2. 500 kHz to 1.7 MHz 3. 1.7 MHz to 4.2 MHz 4. 4.2 MHz to 10 MHz 5. 10 MHz to 19 MHz 6. 19 MHz to 30 MHz
Displays	5-digit backlit LCD showing receiver frequency to the nearest kilohertz. Additional indicators show memory mode and AMS detector lock. Analogue signal strength meter, calibrated S1 to S9, +10dB, +30dB and +50dB.
Tuning	By Spin-wheel, MHz band buttons and Direct keypad frequency entry (+). Tuning rates :- CW, SSB and AMS modes - 8 Hz steps, 1.6 kHz per revolution. AM mode - 50 Hz steps, 9 kHz per revolution. FM mode - 125 Hz steps, 25 kHz per revolution. Tuning step size increases with rapid spin-wheel rotation. Keypad frequency entry is to 1 kHz resolution.
Memories	30 frequency memories selected with tuning spin-wheel. Data held with lithium battery backup for > 5 years. Memories 1 to 10 can be selected from the keypad (+). Memory functions : Store, Recall, Preview and Channel. Two tunable frequency stores, A and B. Receiver frequency is retained while switched off.
I F filters	SSB and AM : Operator selectable 2.2, 4, 7 and 10 kHz. AMS : Operator selectable 2.2, 4, 7 and 12 kHz. CW : 2.2 kHz. FM : 12 kHz. (750 us audio de-emphasis).
Audio filters	200 Hz wide audio peak filter centred on 800Hz, selectable in CW mode. Adjustable high pass / flat / low pass tone control.
R F attenuator	Operator selectable 20 dB attenuator.
Controls	Power on/off and Volume control. Tone control. Mode switch - CW, LSB, USB, AM, AMS, FM. Memory mode select button. RF attenuator / Memory CHANNEL button. Filter select / Memory RECALL button. MHz Down / Memory STORE button. MHz Up / Memory STORE button. Tuning / Memory select spin-wheel. Aerial select switch (on rear panel). FM squelch level (on rear panel) (+).
Aerial inputs	50 ohm input via SO-239 socket. 600 ohm input and Earth connection on spring terminals. High-impedance active aerial input for whip antenna via SO-239 socket (+).
Audio outputs	Record output at approx 200 mV (3.5mm jack socket). External loudspeaker (3.5mm jack socket). Headphone output (mono or stereo headphones) (6.3mm jack socket). The internal loudspeaker is disconnected when headphones or an external LS are plugged in.
Power supply	External 12V DC supply (2.1mm power jack). 240V AC Mains power unit supplied as standard. Internal NiCd rechargeable batteries with charging circuit (+).
Dimensions	Size 253 x 109 x 204 mm (WxHxD, overall). Weight approx 1.9 kg (2.6 kg with internal batteries).

(+) Indicates facility available if appropriate option is fitted.

Performance.

Sensitivity

Signal levels are in micro-volts (uV) PD across the 50 ohm aerial input.
AM and SSB sensitivity measured with 10 dB signal/noise ratio at the receiver output.
FM sensitivity measured for 12dB SINAD.

AM signal	modulated to 70% depth at 1 kHz.
FM signal	deviated by 3 kHz at 1 kHz.
SSB signal	unmodulated, resolved at 1 kHz.

Receiver Frequency		
60 kHz to 2 MHz	AM	< 1.2 uV typically 0.8 uV
	FM	< 1.0 uV typically 0.7 uV
	SSB	< 0.6 uV typically 0.4 uV
2 MHz to 30 MHz	AM	< 0.9 uV typically 0.6 uV
	FM	< 0.9 uV typically 0.6 uV
	SSB	< 0.5 uV typically 0.3 uV

The above figures improve by 6 to 8 dB when the whip antenna amplifier is switched in.

Selectivity

I F Filter	Bandwidth (kHz)		(Shape factor 6:60 dB)	
2.2 kHz	2.3 at -6dB	3.4 at -60dB	5.5 at -80dB	SF 1:1.5
4 kHz	5.9 at -6dB	9.8 at -60dB	10.7 at -80dB	SF 1:1.7
7 kHz	8.8 at -6dB	12.9 at -60dB	14.6 at -80dB	SF 1:1.5
10 kHz	10.5 at -6dB	21.5 at -60dB		SF 1:2

SSB carrier point attenuation (with 2.2 kHz filter) 20 dB.
CW mode filter position relative to carrier frequency :-
-6dB points at -0.8 kHz and +1.35 kHz. Audio output 800 Hz at carrier frequency.
200 Hz audio filter centred on 800 Hz, b/w 170 Hz at -6dB, 850 Hz at -20dB.

FM Adjacent channel selectivity :- 12.5 kHz channels 40 dB (1.5 kHz devn)
25 kHz channels 65 dB (3.0 kHz devn)

FM Signal capture ratio 9 dB

Dynamic range

Reciprocal mixing effects :- (with 2.2 kHz filter)
> 80 dB at 5 kHz from wanted signal
> 90 dB at 10 kHz from wanted signal
> 105 dB at > 100 kHz from wanted signal

Intermodulation effects :- (with 2.2 kHz filter)
At 10 kHz signal separation : 3rd order intercept point > +3 dBm
Intermodulation-free dynamic range > 85 dB
At 50 kHz signal separation : 3rd order intercept point > +12 dBm
Intermodulation-free dynamic range > 93 dB

Spurious responses

Images :-	At + 90 MHz	> 75 dB rejection
	At + 910 kHz	> 90 dB rejection
Fixed :-	At 45 MHz	> 85 dB rejection
	At 455 kHz	> 100 dB rejection
	At 22.5 MHz	> 75 dB rejection

Frequency stability

(Typical performance only - not guaranteed spec)

At constant 20 C	Drift < +/- 30 Hz in one hour
	Frequency error < +/- 50 Hz
-15 C to +50 C	Frequency error < +/- 200 Hz

AGC characteristics

Input signal level	Audio output level (AM mode)	(SSB mode)	
No signal	-11 dB	-21 dB	(noise only)
0.5 uV	-2 dB	-7 dB	
5 uV	0 dB	-1 dB	
50 uV	0 dB	0 dB	(reference level)
100 mV	+0.5 dB	+2 dB	(AGC range limit)

AM mode :	Attack time	500 ms for 60 dB level change
	Release rate	30 dB per second
SSB mode :	Attack time	< 5 ms for 60 dB level change
	Release rate	40 dB per second

Noise blanker

Audio muting triggered by IF signal level. Permanently enabled, operates on all modes.
Blanking period 500 us, threshold level 12 dB above normal carrier.

Audio output

1.6 W into 8 ohms at 5% THD (With supplied 12V power unit).
2.0 W into 4 ohms at 5% THD (With supplied 12V power unit).
External LS output is suitable for loudspeakers with impedances of 4 ohms or greater.
Headphone output : up to 4 Volts from 220 ohms.
Record output : 200 mV from 5 kohms.

Frequency response

(Tone control in central position)

SSB mode :	2.2 kHz filter	370 Hz to 2.5 kHz (-6dB)
AM mode :	2.2 kHz filter	40 Hz to 1.1 kHz (-6dB)
	4 kHz filter	40 Hz to 3.1 kHz (-6dB)
	7 kHz filter	40 Hz to 4.3 kHz (-6dB)
	10 kHz filter	40 Hz to 5.2 kHz (-6dB)

Tone control action (with 7 kHz filter, AM mode)

High pass (clockwise)	330 Hz to 4.4 kHz (-6dB)
Flat (central)	40 Hz to 4.3 kHz (-6dB)
Low pass (c/clockwise)	40 Hz to 1.4 kHz (-6dB)

Distortion

AM mode : 1 kHz signal modulated at 70% depth.
With standard AM detector : THD < 1%
With synchronous detector : THD < 0.6%

SSB mode : 1kHz resolved signal THD < 0.2%
Two-signal IM products > 35 dB below wanted, with signal separation > 180 Hz.

AMS Detector

Lock range : +/- 100 Hz.
Audio distortion under carrier-fade conditions. Signal modulated to 70% wrt full carrier level.

6 dB carrier reduction :	2.8% THD	(23% with conventional AM detector).
10 dB carrier reduction :	4.0% THD	(39% with conventional AM detector).
20 dB carrier reduction :	4.1% THD	(50% with conventional AM detector).

S/N ratio

AM mode : 7 kHz filter, ref 70% modulation at 1kHz.

	Input signal	S/N	Weighted S/N (CCITT P.53A)
	5 uV	29 dB	33 dB
	> 50 uV	47 dB	52 dB
SSB mode :	5 uV	34 dB	37 dB
	> 50 uV	50 dB	54 dB

Power supply

DC supply 10 to 15 V (12 V nominal).
Quiescent current 200 mA (no options, no audio output).
Typical power consumption 250 to 300 mA.

Options and Accessories

B-225 Internal NiCd battery pack giving typically 8 hours operation from a full charge.
The batteries charge from the standard 12V supply when the receiver is switched off.

C-225 Carrying case with shoulder strap.

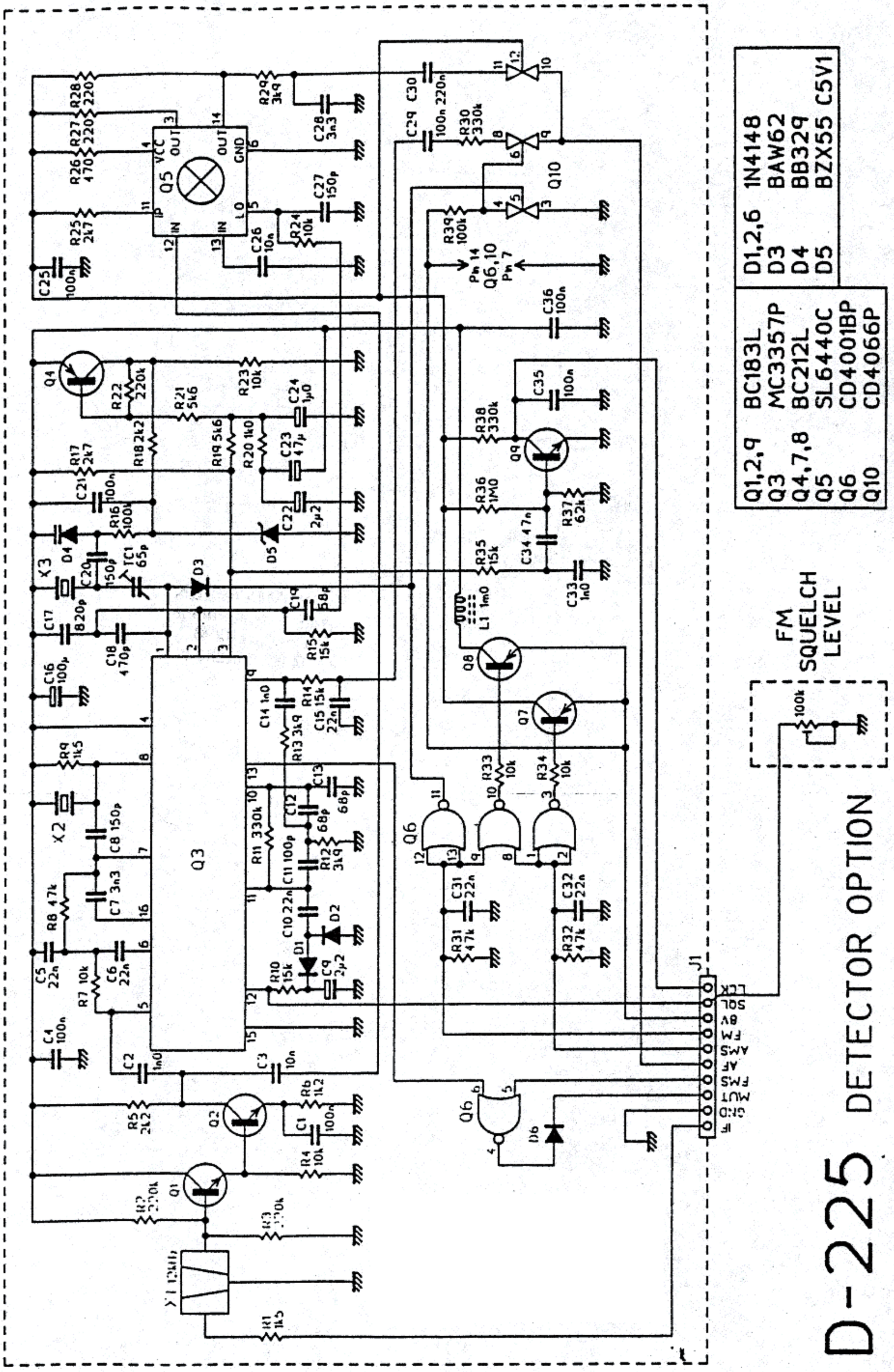
D-225 Additional detector unit providing narrow-band FM and synchronous AM modes.

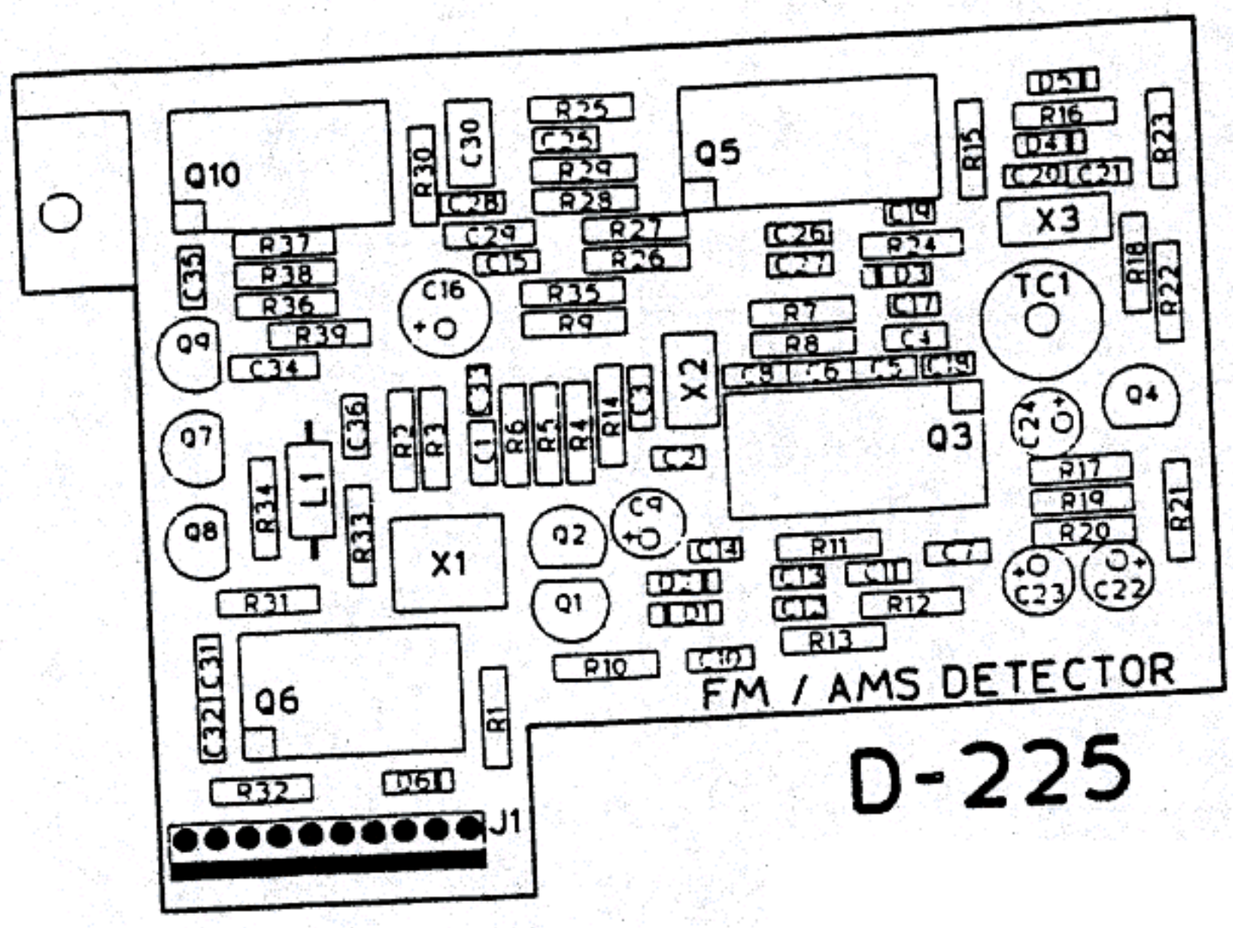
K-225 Remote data entry keypad. (Connected by wire).

S-225 External high-quality loudspeaker, 8 ohms.

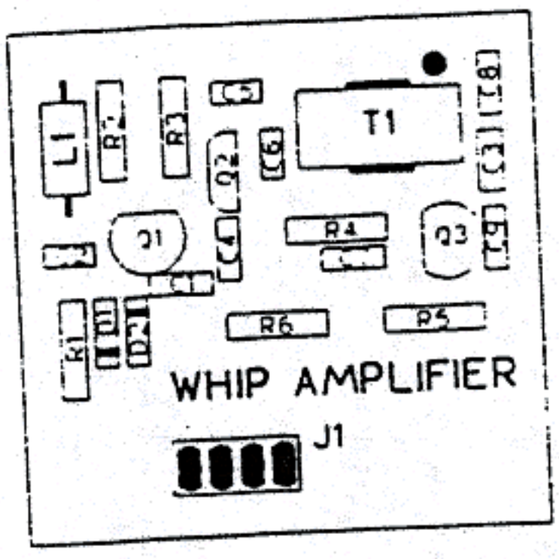
W-225 Telescopic whip antenna (1.2m long) with internally fitted preamplifier and matching unit.

Specification subject to change without notice.

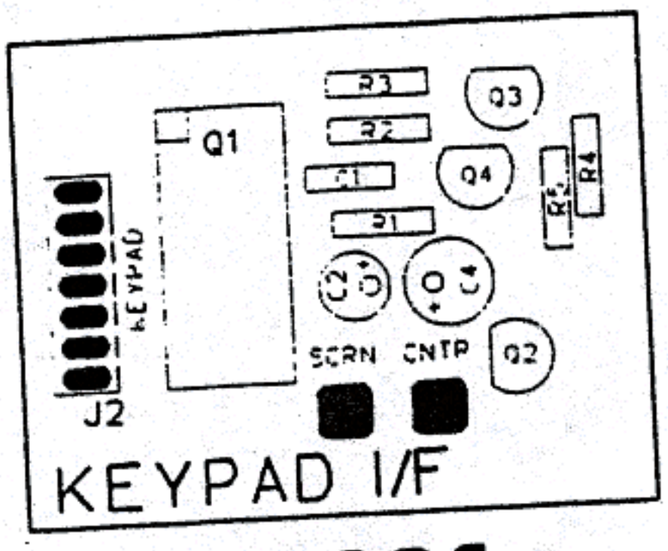

D1,2,6 1N4148
D3 BAW62
D4 BB329
D5 BZX55 C5V1
Q1,2,9 BC183L
Q3 MC3357P
Q4,7,8 BC212L
Q5 SL6440C
Q6 CD4001BP
Q10 CD4066P
FM SQUELCH LEVEL
100k
J1
LCK
SQL
8V
FM
AMS
AF
FMS
MOUT
GND
IF
Q3
Q5
Q10
Q6
Q9
Q8
Q7
Q4
Q2
Q1
X1 12MHz
X2
X3
L1 1m0
D1
D2
D3
D4
D5
D6
IC1 65p
Pin 14 Q6,10 Pin 7
R1 1k5
R2 220k
R3 220k
R4 10k
R5 2k2
Rb 1k2
R7 10k
R8 47k
R9 1k5
R10 15k
R11 330k
R12 3k9
R13 3k9
R14 15k
R15 15k
R16 100k
R17 2k7
R18 2k2
R19 5k6
R20 1k0
R21 5k6
R22 220k
R23 10k
R24 10k
R25 2k7
R26 470
R27 220
R28 220
R29 3k9
R30 330k
R31 47k
R32 47k
R33 10k
R34 10k
R35 15k
R36 1M0
R37 62k
R38 330k
C1 100n
C2 1n0
C3 10n
C4 100n
C5 22n
C6 22n
C7 3n3
C8 150p
C9 2µ2
C10 22n
C11 100p
C12 68p
C13 68p
C14 1n0
C15 22n
C16 100µ
C17 820p
C18 470p
C19 58p
C20 150p
C21 100n
C22 2µ2
C23 47µ
C24 1µ0
C25 100n
C26 10n
C27 150p
C28 3n3
C29 100n
C30 220n
C31 22n
C32 22n
C33 1n0
C34 47n
C35 100n
C36 100n
D-225 DETECTOR OPTION



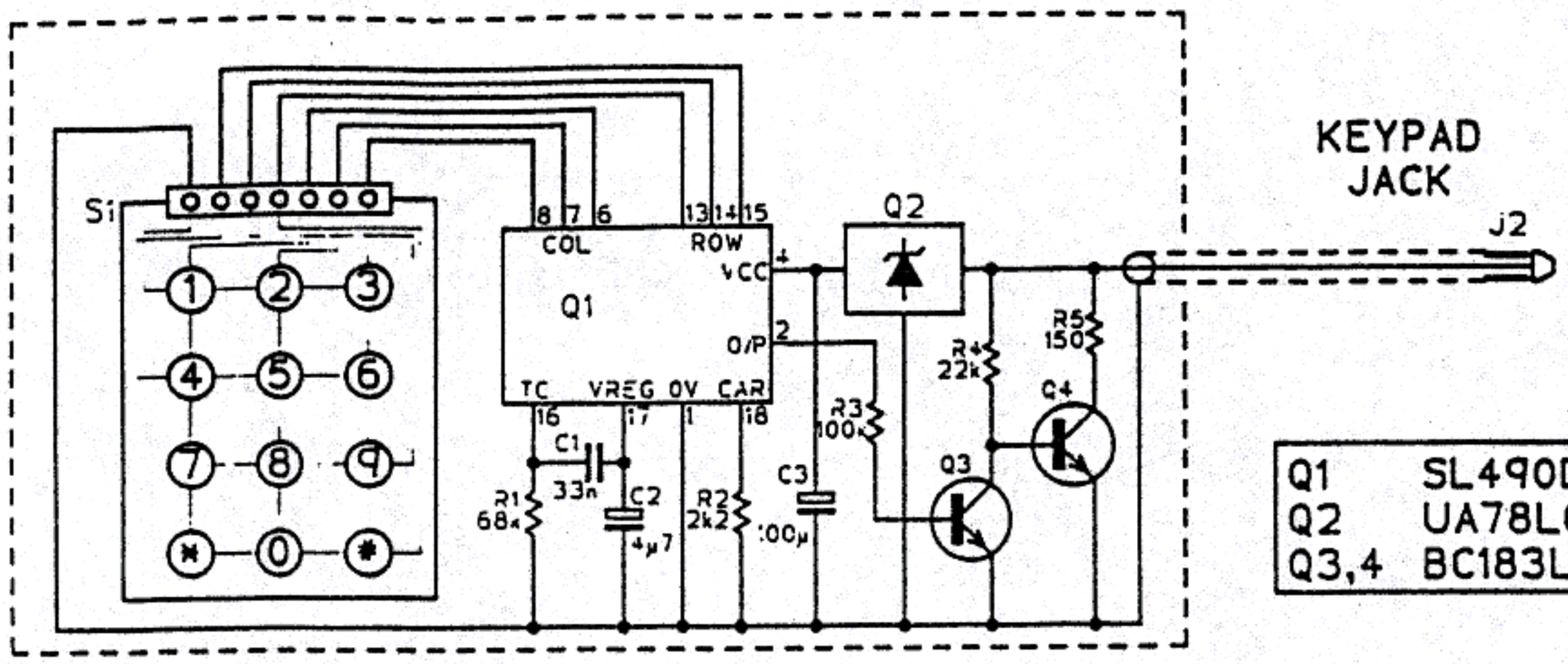
D-225



W-225

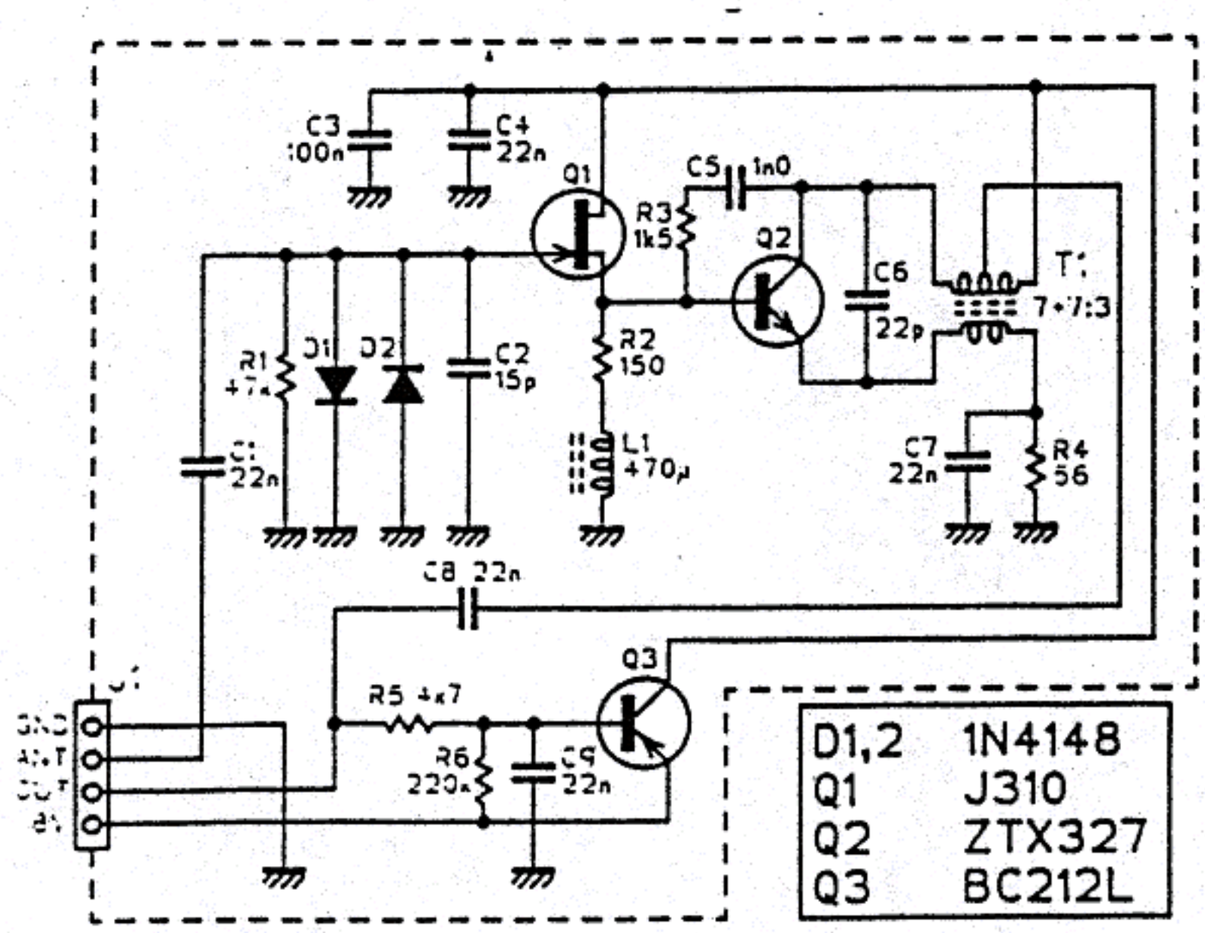


K-225



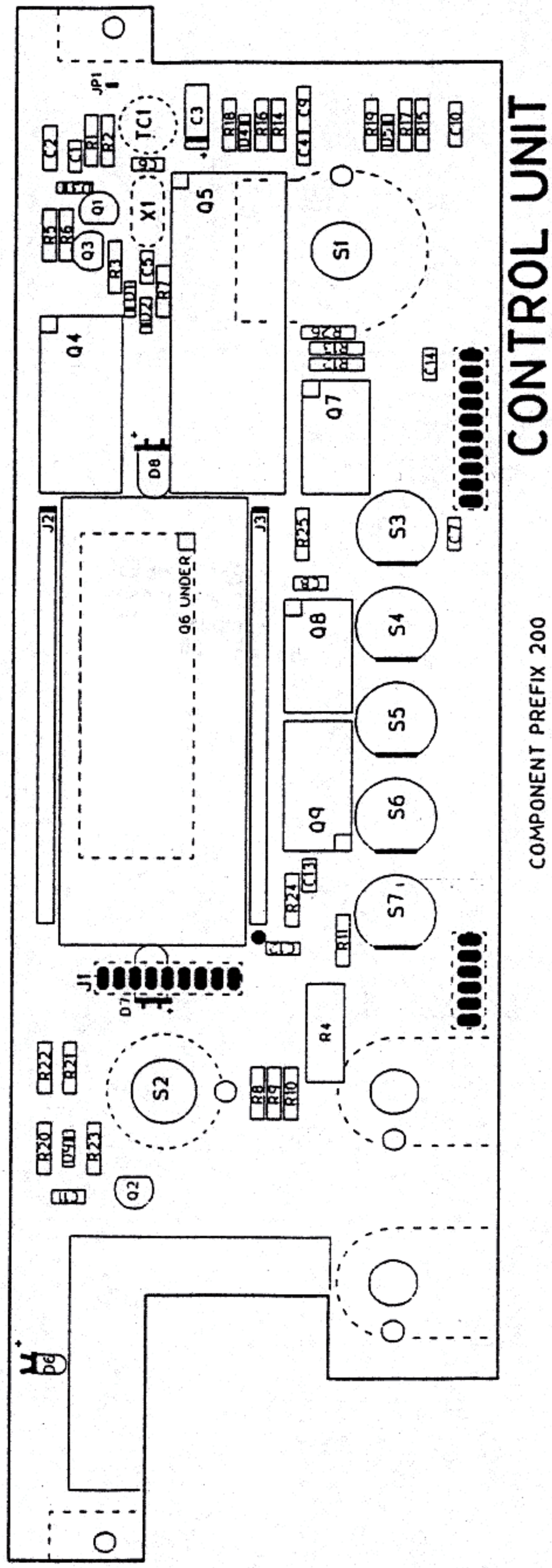
Q1	SL490DP
Q2	UA78L08
Q3,4	BC183L

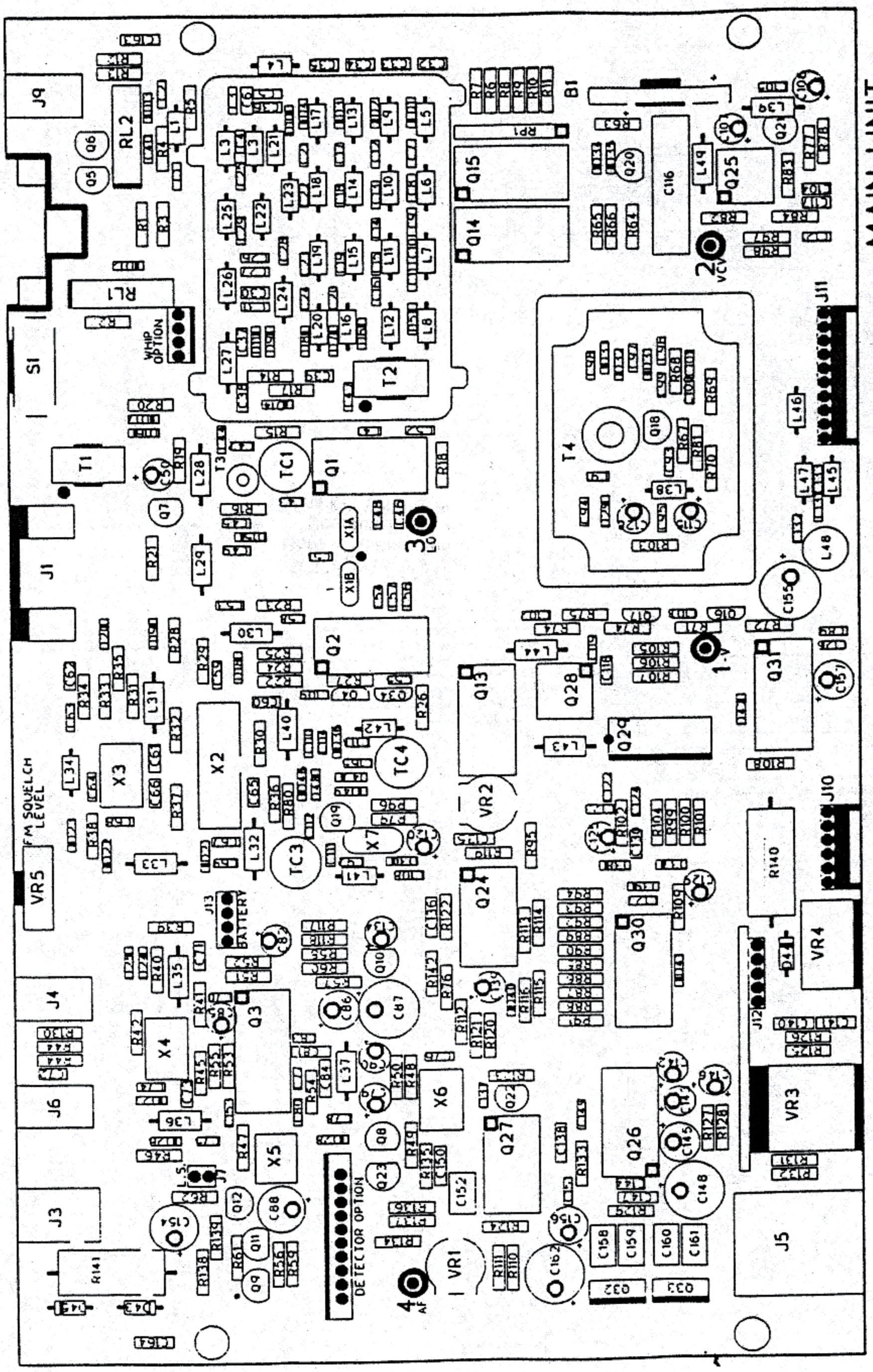
K-225 EXTERNAL KEYPAD

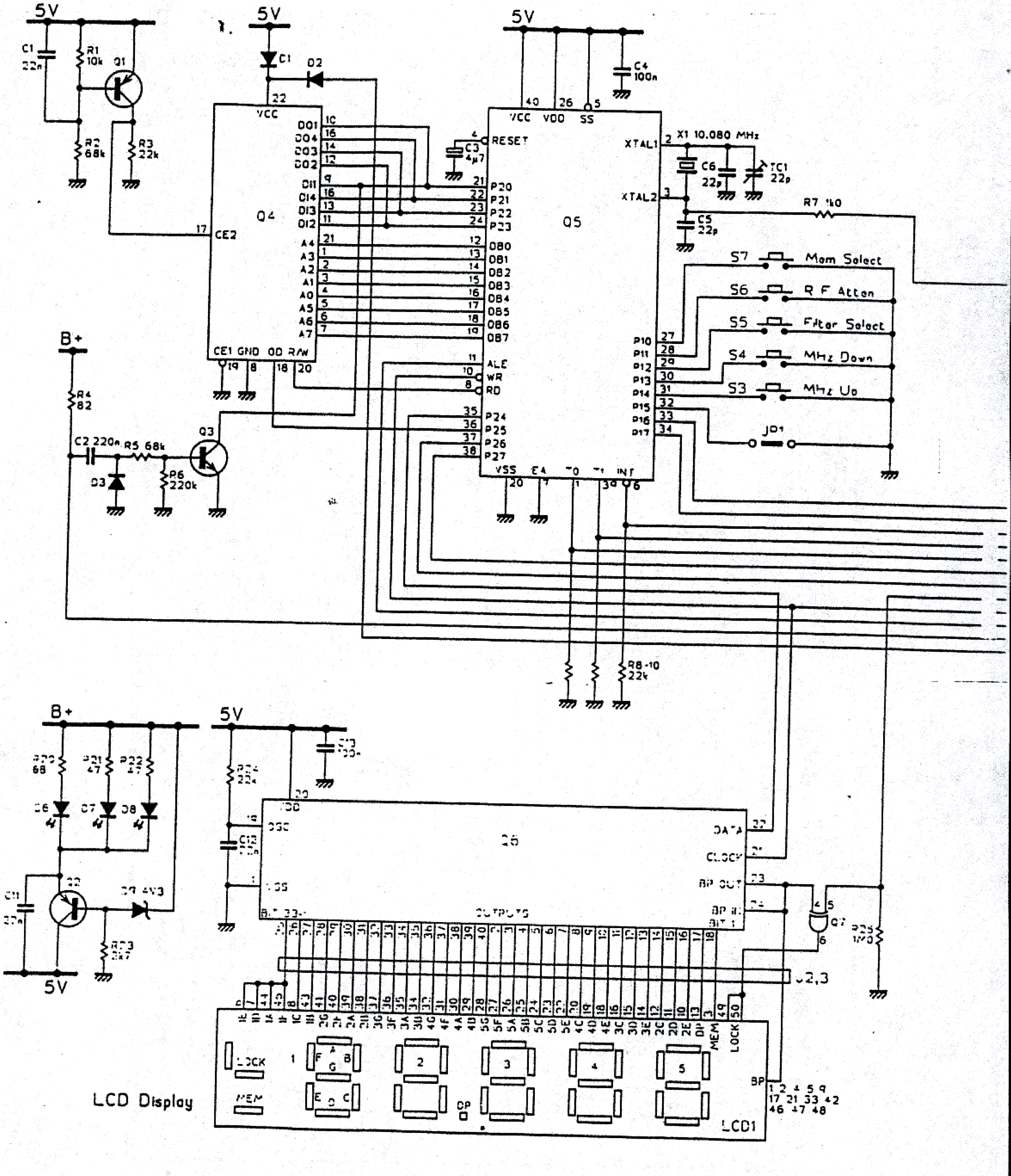


D1,2	1N4148
Q1	J310
Q2	ZTX327
Q3	BC212L

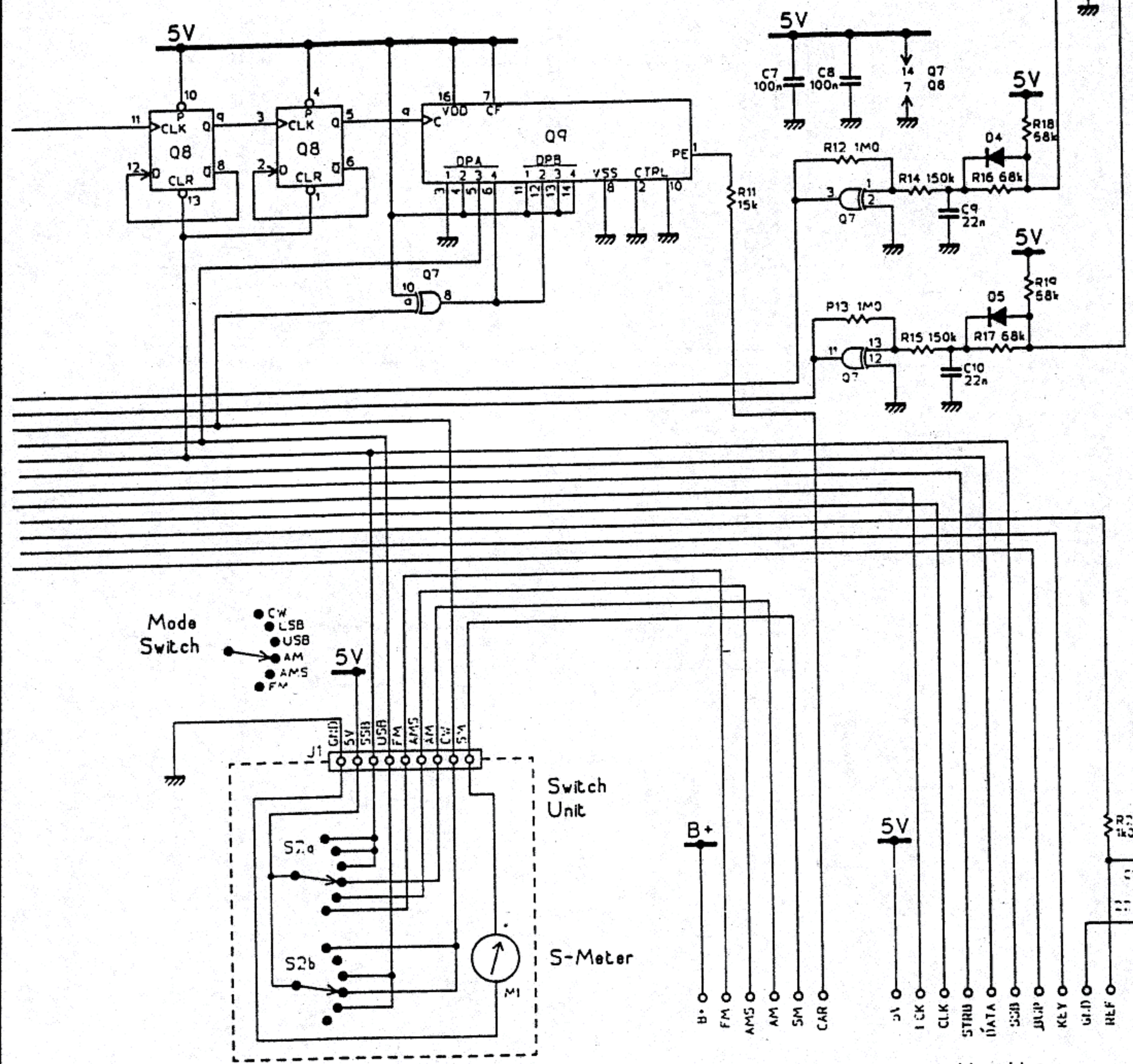
W-225 WHIP OPTION


CONTROL UNIT
COMPONENT PREFIX 200
JP1
TC1
C3
C2
C1
R1
R2
R18
D10
R16
R14
C4
C9
R19
D5
R17
R15
C10
Q1
X1
Q5
R5
R6
Q3
R3
C5
D1
D2
R7
S1
Q4
D8
Q7
C11
R25
J2
J3
Q6 UNDER
S3
C7
Q8
S4
S5
Q9
S6
C13
R24
S7
R11
F1
J1
D7
R4
S2
R22
R21
R8
R9
R10
R20
D9
R23
F2
Q2
D6


MAIN UNIT
J9
RL2
Q6
Q5
RL1
WHIP OPTION
S1
J1
T1
TC1
Q1
T2
T3
L28
L29
X1A
X1B
L30
Q2
L31
R28
R29
R35
R33
R34
R31
L34
X3
X2
L32
TC3
TC4
VR2
Q24
Q30
Q29
Q28
Q13
Q3
J13
BATTERY
FM SQUELCH LEVEL
VR5
J4
J6
J3
X4
X5
X6
Q27
Q26
VR3
VR4
J12
J10
J5
R140
R141
DETECTOR OPTION
VR1
AF
RP1
B1
Q15
Q14
C116
Q20
Q25
L49
L39
Q21
R77
R78
R83
R84
R97
R98
R65
R66
R64
2 VCV
J11
T4
Q18
R68
R69
R67
R81
R70
L38
L46
L47
L45
L48
C155
1 V
Q17
Q16
R74
R75
R105
R107
L44
L43
R108
R102
R104
R99
R100
R101
L42
L41
R95
R109
R113
R114
C136
R122
R142
R76
R112
R121
R120
R116
R115
C87
C86
Q10
R41
R42
R45
R55
R53
R54
L37
R50
R48
R49
R135
C150
C152
Q23
Q8
R47
L36
R46
C154
Q12
C88
Q11
R61
R56
R59
R138
R139
L35
R40
C84
C85
Q22
Q31
R106
R127
R128
C145
C148
C147
R124
R125
R126
R111
R110
C162
C158
C159
C160
C161
Q32
Q33
L40
R36
R80
Q19
X7
C33
C64
L33
R37
R38
R30
R31
C62
C63
C66
C65
R26
R27
R24
R25
L26
L24
L27
L20
L16
L12
L8
L25
L22
L23
L18
L14
L10
L6
L3
L21
L17
L13
L9
L5
L1
R5
R4
R3
R1
R2
R7
R6
R8
R9
R10
R11
C10
C9
C8
C7
C6
C5
C4
C3
C2
C1
L4
R18
R19
C59
R21
R22
R23
L22
L19
L15
L11
L7
L3
L2
L1
R14
R15
R16
R17
R20


5V
C1 22n
R1 10k
Q1
R2 68k
R3 22k
5V
D1
D2
Q4
VCC
DO1
DO4
DO3
DO2
DI1
DI4
DI3
DI2
A4
A3
A2
A1
A0
A5
A6
A7
CE2
CE1 GND OD R/W
B+
R4 82
C2 220n
R5 68k
R6 220k
D3
Q3
5V
C4 100n
VCC VDD SS
RESET
C3 4µ7
P20
P21
P22
P23
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
ALE
WR
RD
P24
P25
P26
P27
VSS EA T0 T1 INT
Q5
XTAL1
XTAL2
X1 10.080 MHz
C6 22p
TC1 22p
C5 22p
R7 1k0
P10
P11
P12
P13
P14
P15
P16
P17
S7 Mem Select
S6 R F Atten
S5 Filter Select
S4 MHz Down
S3 MHz Up
JP1
R8-10 22k
B+
R20 68
R21 47
R22 47
D6
D7
D8
Q2
C11 22n
D9 4V3
R23 2k7
5V
5V
C13 100n
R24 22k
C12 22n
VDD
OSC
VSS
Q6
DATA
CLOCK
BP OUT
BP IN
BIT 1
OUTPUTS
Q7
R25 1k0
J2,3
LOCK
MEM
DP
BP
1 2 4 5 9
17 21 33 42
46 47 48
LCD1
LCD Display

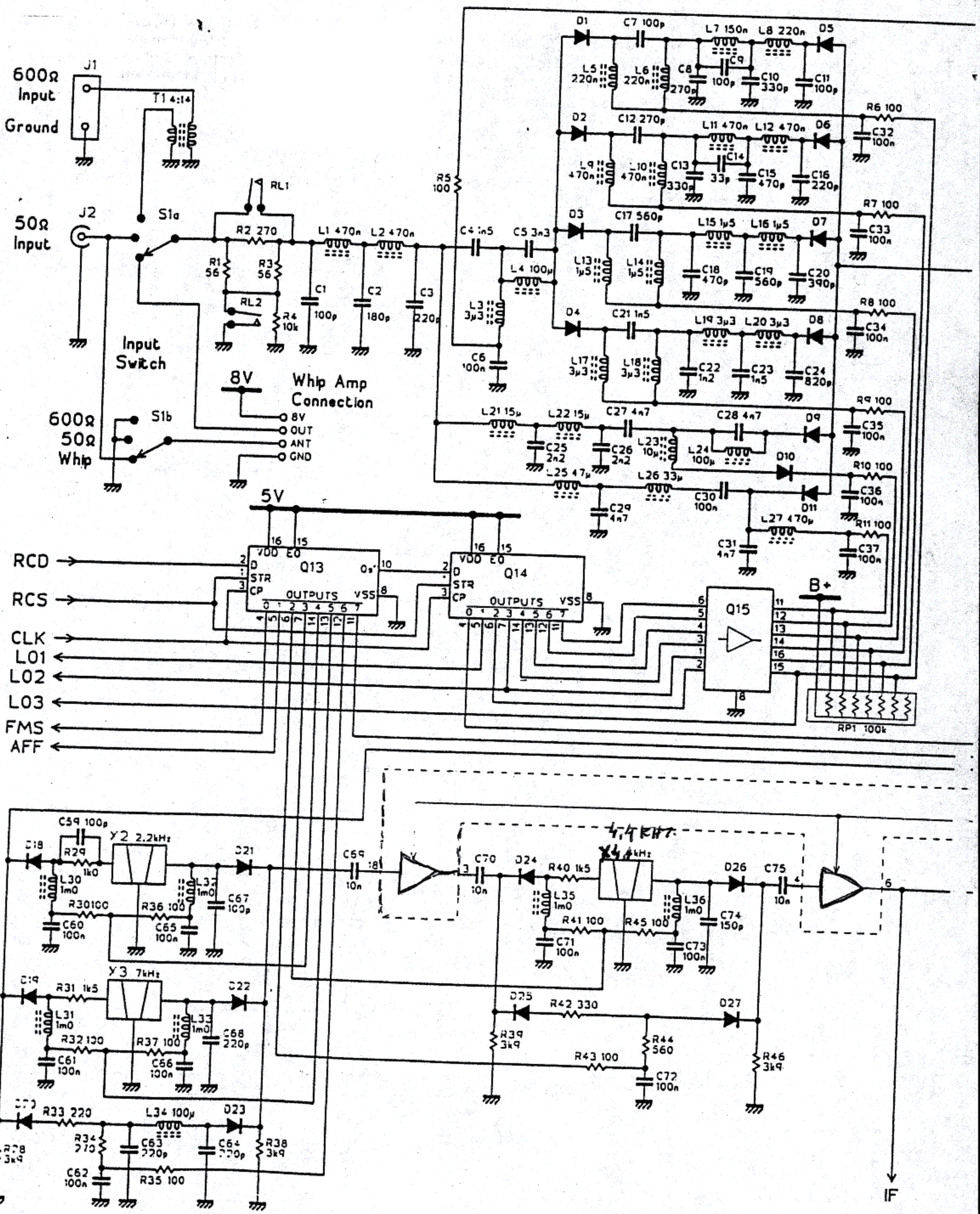
Q1,2	BC212L	Q6	MM5453N	D1-5	1N4148
Q3	BC183L	Q7	74HC86P	D6	MV5474C
Q4	5101P	Q8	74HC74P	D7,8	MV5452
Q5	P8749H	Q9	MC14569BCP	D9	BZX55 C4V3



Connection to Main Unit

HF-225 CONTROL UNIT

COMPONENT PREFIX 200.

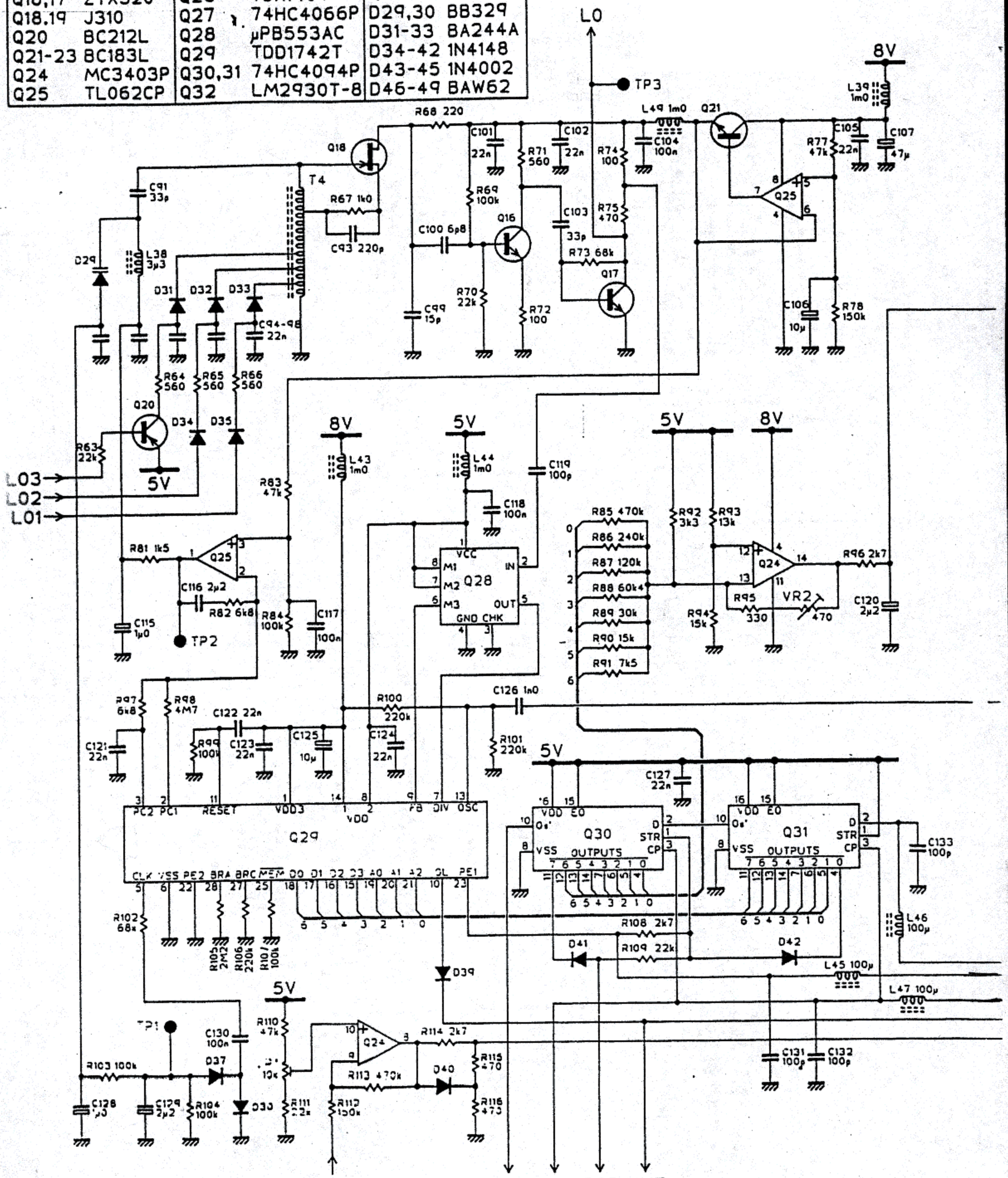

600Ω Input
Ground
J1
T1 4:14
RL1
50Ω Input
J2
S1a
R2 270
L1 470n
L2 470n
R1 56
R3 56
RL2
R4 10k
C1 100p
C2 180p
C3 220p
Input Switch
8V
Whip Amp Connection
8V
OUT
ANT
GND
600Ω 50Ω Whip
S1b
R5 100
C4 1n5
C5 3n3
L4 100µ
L3 3µ3
C6 100n
D1
C7 100p
L7 150n
L8 220n
D5
L5 220n
L6 220n
C8 270p
C9 100p
C10 330p
C11 100p
R6 100
C32 100n
D2
C12 270p
L11 470n
L12 470n
D6
L9 470n
L10 470n
C13 330p
C14 33p
C15 470p
C16 220p
R7 100
C33 100n
D3
C17 560p
L15 1µ5
L16 1µ5
D7
L13 1µ5
L14 1µ5
C18 470p
C19 560p
C20 390p
R8 100
C34 100n
D4
C21 1n5
L19 3µ3
L20 3µ3
D8
L17 3µ3
L18 3µ3
C22 1n2
C23 1n5
C24 820p
R9 100
C35 100n
L21 15µ
L22 15µ
C27 4n7
C28 4n7
D9
C25 2n2
C26 2n2
L23 10µ
L24 100µ
D10
L25 47µ
L26 33µ
C29 4n7
C30 100n
D11
R10 100
C36 100n
L27 470µ
C31 4n7
R11 100
C37 100n
5V
RCD
RCS
CLK
L01
L02
L03
FMS
AFF
Q13
Q14
Q15
VDD EO
D STR CP
OUTPUTS
VSS
B+
RP1 100k
C59 100p
Y2 2.2kHz
D18
R29 1k0
L30 1m0
L32 1m0
C67 100p
R30 100
R36 100
C60 100n
C65 100n
D21
C69 10n
C70 10n
D24
R40 1k5
L35 1m0
R41 100
C71 100n
Y4 4kHz
R45 100
L36 1m0
C73 100n
C74 150p
D26
C75 10n
Y3 7kHz
D19
R31 1k5
L31 1m0
L33 1m0
C68 220p
R32 100
R37 100
C61 100n
C66 100n
D22
D25
R42 330
R39 3k9
R44 560
R43 100
C72 100n
D27
R46 3k9
D20
R33 220
L34 100µ
D23
R34 270
C63 220p
C64 220p
R38 3k9
C62 100n
R35 100
R28 3k9
IF

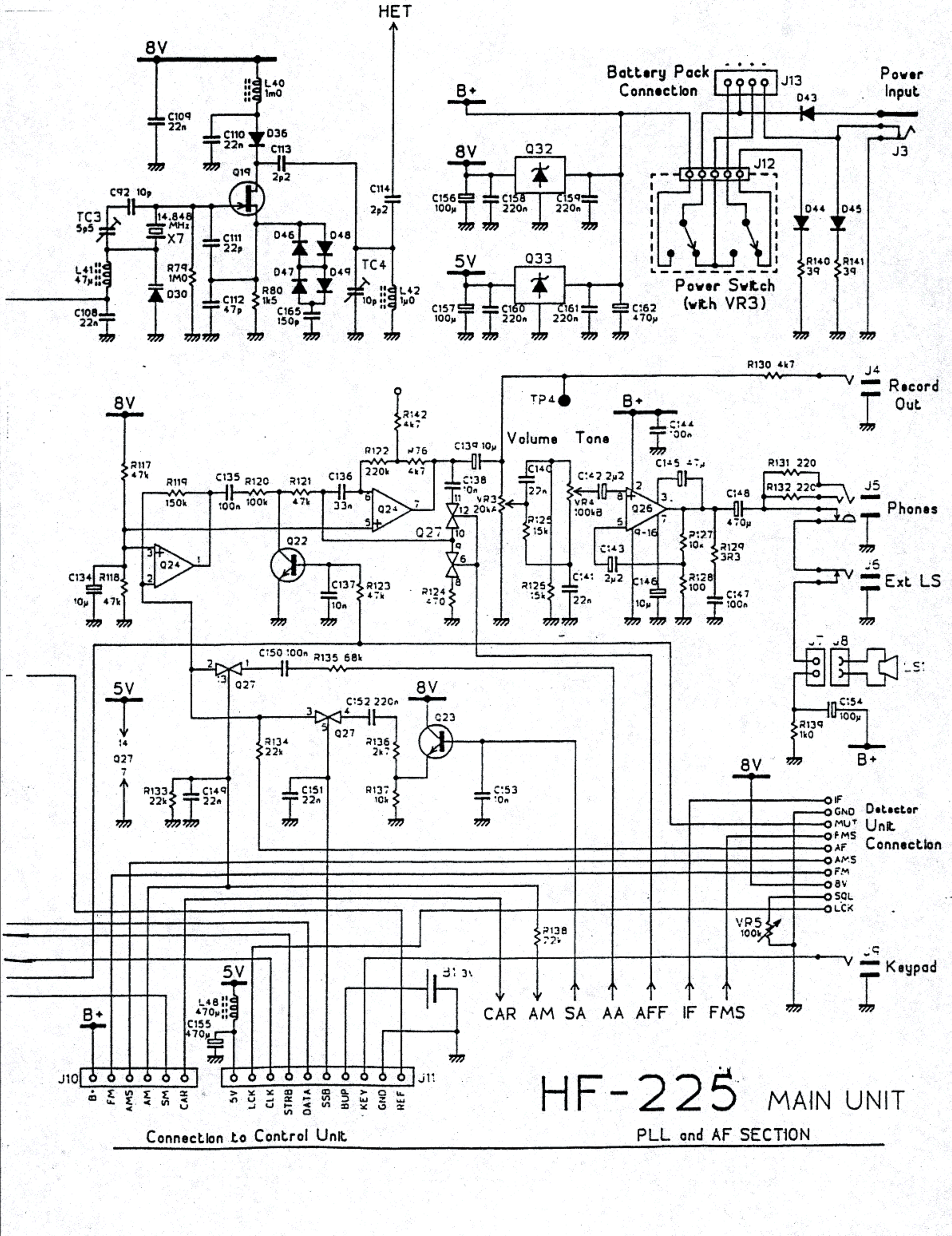
Q1,2	SL6440CDP	D1-11	BA244A
Q3	SL9700CDP	D12,13	1N4148
Q4	ZTX320	D14	BZX55C5V1
Q5-12	BC183L	D15	MI204
Q13,14	74HC4094P	D16-28	1N4148
Q15	ULN2003		

HF-225 MAIN UNIT

RF and IF SECTION

Q16,17	ZTX320	Q26	TDA1904	Q33	78M05
Q18.19	J310	Q27	74HC4066P	D29,30	BB329
Q20	BC212L	Q28	µPB553AC	D31-33	BA244A
Q21-23	BC183L	Q29	TDD1742T	D34-42	1N4148
Q24	MC3403P	Q30,31	74HC4094P	D43-45	1N4002
Q25	TL062CP	Q32	LM2930T-8	D46-49	BAW62




HET
8V
L40 1m0
C109 22n
C110 22n
D36
C113 2p2
Q19
C92 10p
TC3 5p5
14.848 MHz X7
C111 22p
D46
D48
D47
D49
TC4
C114 2p2
L41 47µ
R79 1M0
D30
C112 47p
R80 1k5
C165 150p
10p
L42 1µ0
C108 22n
B+
Battery Pack Connection
J13
D43
Power Input
J3
Q32
C156 100µ
C158 220n
C159 220n
J12
D44
D45
5V
Q33
C157 100µ
C160 220n
C161 220n
C162 470µ
R140 39
R141 39
Power Switch (with VR3)
R130 4k7
J4
Record Out
TP4
Volume
Tone
C144 100n
R142 4k7
R117 47k
R119 150k
C135 100n
R120 100k
R121 47k
C136 33n
R122 220k
R76 4k7
C139 10µ
C138 10n
VR3 20kA
C140 22n
C142 2µ2
VR4 100kB
C145 47µ
R131 220
R132 220
J5
Phones
C148 470µ
R125 15k
C141 22n
C143 2µ2
C146 10µ
R127 10k
R129 3R3
R128 100
C147 100n
C134 10µ
R118 47k
Q24
Q22
C137 10n
R123 47k
R124 470
C150 100n
R135 68k
Q27
C152 220n
Q23
R134 22k
R136 2k7
R133 22k
C149 22n
C151 22n
R137 10k
C153 10n
J6
Ext LS
J7
J8
LS1
C154 100µ
R139 1k0
IF
GND
MUT
FMS
AF
AMS
FM
8V
SQL
LCK
Detector Unit Connection
R138 22k
VR5 100k
Keypad
L48 470µ
C155 470µ
J10
B+
FM
AMS
AM
SM
CAR
J11
5V
LCK
CLK
STRB
DATA
SSB
BUP
KEY
GND
REF
CAR AM SA AA AFF IF FMS
Connection to Control Unit
HF-225 MAIN UNIT
PLL and AF SECTION