

DIRECT CONVERSION SHORT WAVE RECEIVER



by Chris Barlow

- ★ Receives Speech (SSB, DSB, AM) and Morse (CW)
- ★ Choice of Amateur band, 160 metre – 10 metre
- ★ Reduction drive 'Vernier' tuning
- ★ Tuned Active front end
- ★ Signal strength meter
- ★ Buffered RF Oscillator output
- ★ On-board Voltage regulator and Audio power amplifier

Introduction

The receiver described in this article has been designed to have many of the features found on sophisticated ready-made short wave radios. The cost of such radio equipment is generally quite high and this can discourage newcomers to the hobby. However, good results can be achieved using relatively simple home-constructed receivers of the direct conversion design. This type of receiver has the advantage of simplicity of construction and ease of alignment, with the minimum of test gear.

The frequency range of the short wave bands start as low as 1.7MHz and extends up to 30MHz. To include all these bands on one receiver would present switching and tracking problems that would result in a compromise in its performance. For this reason it was decided that the receiver would cover only one band, but which one? Within the short wave spectrum there are segments allocated to amateur radio operators. These are people located all over the world pursuing the hobby of long distance communication using privately owned radio equipment.

There are six main amateur bands, with the addition of three new ones, and the choice of band is entirely up to you. However, the 80 metre band, admittedly not the best band for long distance reception will provide European stations after dark and British amateurs during daylight hours. When conditions are favour-

Specification of Prototype

RF Specifications (80 Metre version)

Tuning Range: 3.490MHz – 3.810MHz
 Frequency Stability: Less than 100Hz/hour drift after 30 minute warm-up
 Sensitivity: 0.1 μ V for a readable signal
 0.3 μ V or less for 10dB (S+N)/N
 Oscillator Output: 450mV RMS off load
 100mV RMS into 50 Ω load

AF Specifications

Bandpass: 2.8kHz at -6dB (175Hz – 3kHz)
 Dynamic range: 90dB
 Signal to Noise: 40dB
 Power Output into 8 Ω : 1W RMS
 Distortion: 1%
 Tape Output: 100mV RMS into 47k Ω
 Headphone Output: 8 Ω – 32 Ω Mono/Stereo

DC Specifications

Unregulated Power Input: 15 – 20V
 Regulated Power Input: 10.5 – 14V
 Quiescent Current at 12V: 147mA
 Current at full Output: 295mA

able and a suitable aerial is used, stations from further afield can be received, such as America, Africa and Australia. A popular higher frequency band is 20 metres, however this and even higher bands are affected by changes in world wide environmental conditions of the upper atmosphere. This tends to leave them inactive or 'dead' for much of the time and this fact should be taken into consideration when choosing the tuning pack associated with this project. A complete list of the HF amateur bands showing the relevant tuning pack you should use is shown in Table 1. **DON'T FORGET TO ORDER THE TUNING PACK WHEN ORDERING YOUR RECEIVER KIT.**

Direct Conversion

A direct conversion receiver achieves in one signal conversion operation what a superhet achieves in two or more. This is done by mixing the incoming RF signal in a non-linear device with a locally generated RF carrier close to the frequency of the incoming signal. One of the resulting products is the audio modulating frequency when receiving single sideband (SSB) or a beat frequency when receiving morse code (CW). This audio signal is then filtered out from the other unwanted mixer products and amplified, forming the audio output of the receiver.

Circuit Description

In addition to the circuit shown in Figure 2, a block diagram is detailed in Figure 1. This should assist you when following the circuit description or fault finding in the completed unit.

The receiver has two DC power inputs, regulated and unregulated. If using the regulated input, the voltage must be between 10.5 to 14V from an external DC regulated supply or batteries. When using the unregulated input, a mains adaptor such as the unregulated 1A (YM85G), set to its 12V output, will supply the necessary voltage to the regulator RG1. This will be in the order of 15 to 20V and RG1 will stabilise this voltage to 12V. It is most important that the DC supply be connected in the correct polarity, with the positive (+V) going to the centre pin of the DC connector SK1 or SK2.

When the power switch S1 is turned on the supply is connected to the main decoupling capacitor C3 and the front panel indicator LD1. LP1 is a wire-ended filament bulb mounted behind the signal strength meter to provide back illumination. The +12V supply then feeds a second voltage regulator, RG2, which is a variable output type and is set to produce +8V by the resistors R2, 4, 5 and RV1. The preset RV1 is a 22-turn cermet type, which is used when setting up the highly

accurate +8V varicap tuning reference. R3, C6 and C7 provide yet more supply decoupling for the rest of the circuit. For the op-amps to function correctly a half supply reference must be generated, this is provided by one half of IC2. The voltage reference applied to the input of this op-amp is derived from the two resistors R6 and R7 which form a potential divider. The op-amp is merely used as a zero gain buffer to provide a low impedance half supply, its output being de-coupled by C80.

The aerial and earth from SK5 connects to pins P10,11 on the circuit board. To reduce the amount of 'out of band' signals reaching the RF amplifier, a series tuned circuit comprising of T1 and C10 is used. At its resonant frequency this circuit has a low impedance and will allow the RF to pass into the low impedance winding of T2. However, to all other frequencies this circuit appears as a high impedance, thus reducing the level of unwanted RF energy reaching T2. The output of T2 is a parallel tuned circuit, with C12, TC1 and the varicap diode VC1 controlling its resonant frequency. The RF signals across this circuit are then applied to the high impedance 'gate one' input of TR1. The other gate has a variable DC bias applied to it, derived from RV2, R19 and is de-coupled to RF by C14. As the bias voltage is increased,

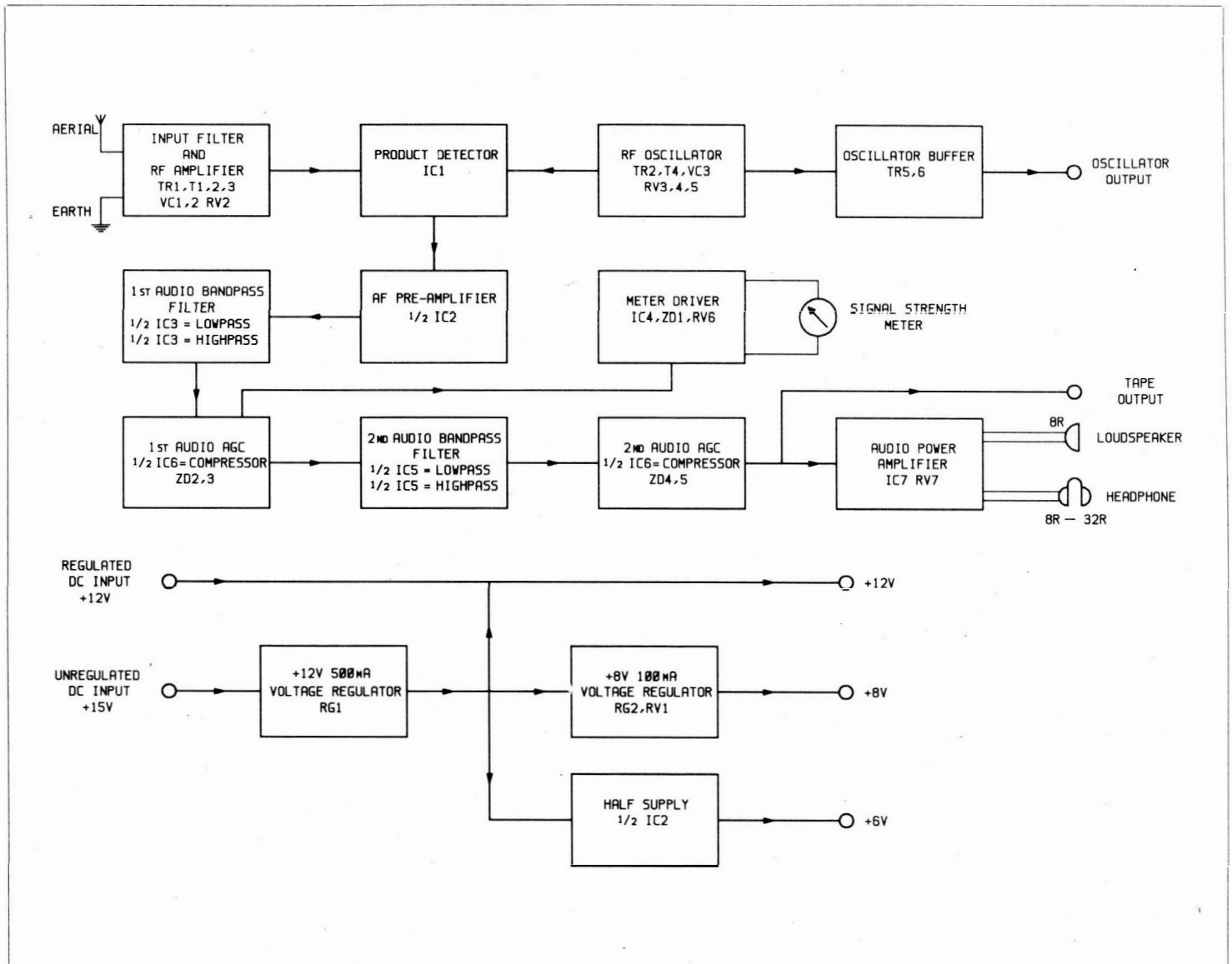


Figure 1. Block diagram.

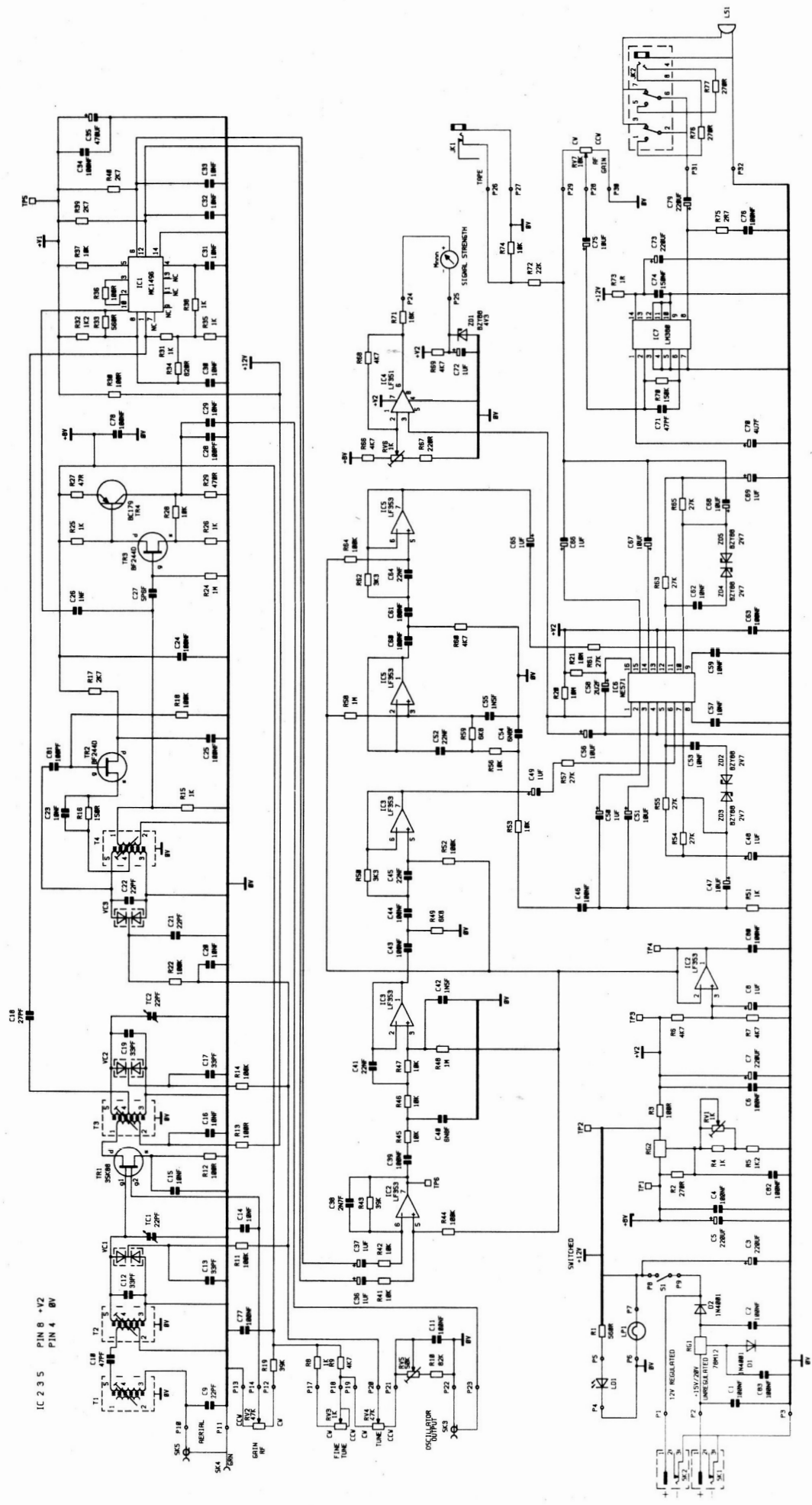


Figure 2. Circuit.

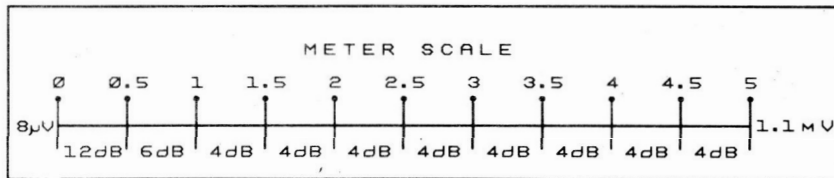


Figure 7. Signal strength meter response.

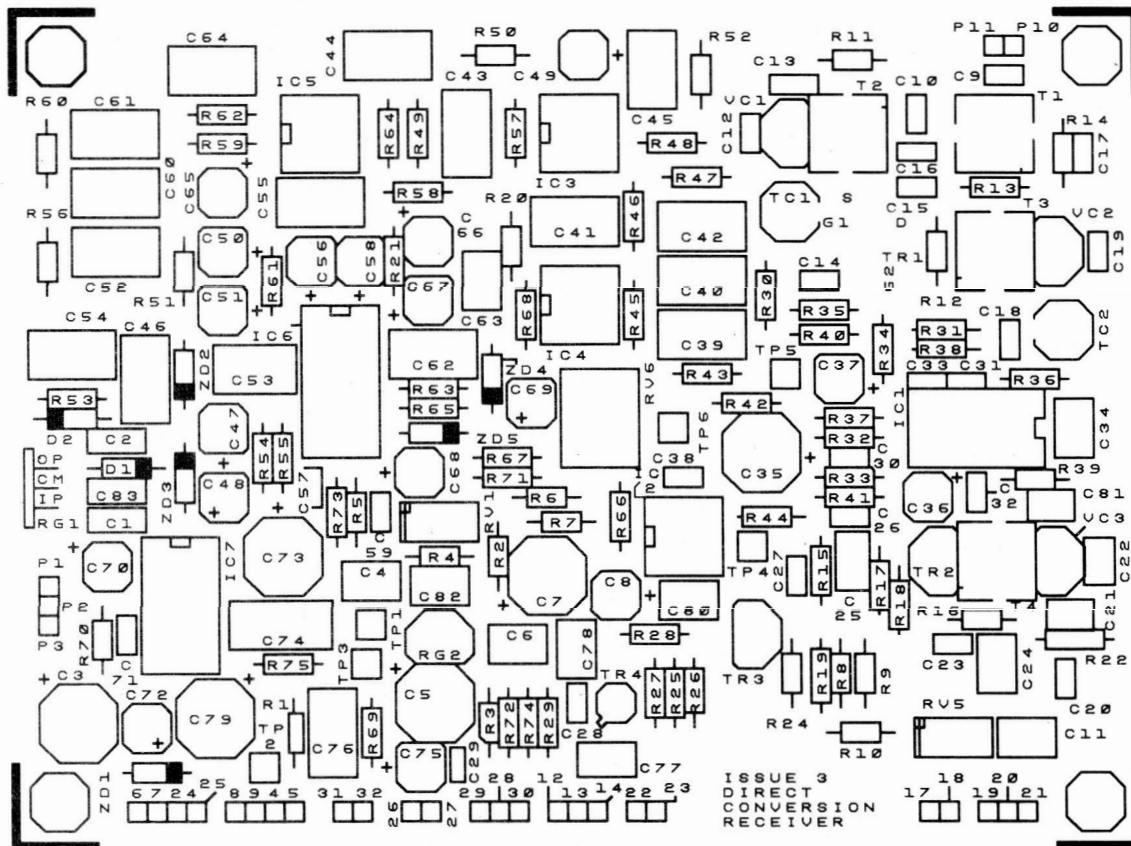


Figure 8. PCB layout.

that you fit RG1 as shown in Figure 15.

This completes the assembly of the PCB and you should now check your work very carefully making sure that all the solder joints are sound. It is also very important that the solder side of the circuit board does not have any trimmed component leads standing proud by more than 3mm, as this may result in a short circuit. Further information on soldering and assembly techniques can be found in the 'Constructors Guide' included in the kit. Photo 2 shows the completed PCB in clear detail.

Final Assembly

The unit is designed to fit in to a metal case type 2408/160 (Maplin code XJ33L) which is also available ready drilled (Maplin

code YT05F). An internal chassis is also available for this box (XJ41U) and indeed this has been incorporated in the design, once again a ready drilled version is available (YT04E). However, if you wish to make up your own box, drilling details for the box and the chassis are given in Figure 10. Also shown in Figure 10 are details of the potentiometer mounting bracket should you wish to make your own, this item too is available ready made (JG47B). Custom made stick-on panels can be purchased to enhance the final look. When fitting ensure that the front and back metal panels of the box are clean then remove the protective backing from the self-adhesive decorative trims. Carefully position and firmly push down using a dry, clean cloth until the

trims are securely in place. Photo 3 shows the rear trim.

Before fitting the headphone jack JK2 remove its forward facing locating tag. When installing the two jack sockets, position a pot washer between the steel chassis and the back of the front panel, see Figure 11. Next prepare the four rotary potentiometers by cutting the shafts to a length of 12mm. When mounting the AF, RF gain and fine tuning pots use two nuts as shown in Figure 12. Before mounting the main tuning control, rotate its shaft to its fully clockwise position. Then back it off a small amount to set the wiper onto the start of the active part of its carbon track. Set the vernier dial to read 100 and remove the small bolt at the rear of the dial. Do not remove

DIRECT CONVERSION RECEIVER PARTS LIST

RESISTORS: All 0.6W 1% Metal Film

R1,33	560Ω	2	(M560R)
R2,76,77	270Ω	3	(M270R)
R3,12,13,30, 36	100Ω	5	(M100R)
R4,15,25,26,31,35, 38,51	1k	8	(M1K)
R5,32	1k2	2	(M1K2)
R6,7,60,66, 68,69	4k7	6	(M4K7)
R17,39,40	2k7	3	(M2K7)
R11,14,18,22, 44,52,64	100k	7	(M100K)
R16	150Ω	1	(M150R)
R19,43	39k	2	(M39K)
R20,21	10M	2	(M10M)
R24,48,58	1M	3	(M1M)
R27	47Ω	1	(M47R)
R28,37,41,42,45, 46,47,53,56,74	10k	10	(M10K)
R29	470Ω	1	(M470R)
R34	820Ω	1	(M820R)
R49,59	6k8	2	(M6K8)
R50,62	3k3	2	(M3K3)
R54,55,57,61, 63,65	27k	6	(M27K)
R67	220Ω	1	(M220R)
R70	150k	1	(M150K)
R71	18k	1	(M18K)
R72	22k	1	(M22K)
R73	1Ω	1	(M1R)
R75	2Ω7	1	(M2R7)
RV1	1k Cermet 22T	1	(UH23A)
RV2,4	47k Pot Lin	2	(FW04E)
RV3	1k Pot Lin	1	(FW00A)
RV5	50k Cermet 22T	1	(UH26D)
RV6	1k Hor Preset	1	(UH00A)
RV7	10k Pot Log	1	(FW22Y)

CAPACITORS

C1,2,4,6,11,24,25, 34,63,77,78,80, 82,83	100nF Minidisc	14	(YR75S)
C3,5,7,73,79	220μF 16V PC Electrolytic	5	(FF13P)
C8,36,37,48,49,50, 65,66,69,72	1μF 100V PC Electrolytic	10	(FF01B)
C9	22pF Ceramic	1	(WX48C)
C71	47pF Ceramic	1	(WX52G)
C14,15,16,20,23, 29,30,31,32,33, 57,59	10nF Ceramic	12	(WX77T)
C26	1nF Ceramic	1	(WX68Y)
C27	5p6F Ceramic	1	(WX41U)
C28	100pF Ceramic	1	(WX56L)
C35	470μF 16V PC Electrolytic	1	(FF15R)
C38	2n7F Ceramic	1	(WX73Q)
C39,43,44,46,60, 61,76	100nF Polylayer	7	(WW41U)
C40,54	6n8F Polylayer	2	(WW27E)
C41,45,52,64	22nF Polylayer	4	(WW33L)
C42,55	1n5F Polylayer	2	(WW23A)
C47,51,56,67, 68,75	10μF 50V PC Electrolytic	6	(FF04E)
C53,62	10nF Polylayer	2	(WW29G)
C58	2μ2F 100V PC Electrolytic	1	(FF02C)
C70	4μ7F 63V PC Electrolytic	1	(FF03D)
C74	150nF Polylayer	1	(WW43W)
C81	100pF Polystyrene	1	(BX28F)
TC1,2	22pF Trimmer	2	(WL70M)

SEMICONDUCTORS

IC1	MC1496	1	(QH47B)
IC2,3,6	LF353	3	(WQ31J)
IC4	LF351	1	(WQ30H)
IC6	NE571	1	(YJ87U)
IC7	LM380	1	(QH40T)
D1,2	1N4001	2	(QL73Q)
TR1	3SK88	1	(UH63T)
TR2,3	BF244	2	(QF16S)

TR4	BC179	1	(QB54J)
VC1,2,3	BB212 Varicap	3	(YH83E)
RG1	78M12UC	1	(QL29G)
RG2	LM317LZ	1	(RA87U)
ZD1	BZY88C4V3	1	(QH05F)
ZD2,3,4,5	BZY88C2V7	4	(QH00A)
LD1	LED Red	1	(QY48C)

MISCELLANEOUS

S1	Sub-min Toggle A	1	(FH00A)
M1	Signal Strength Meter	1	(LB80B)
LS1	4in. Spkr 8Ω	1	(YJ16S)
	Pin 2145	1 Pkt	(FL24B)
	P.C. Board	1	(GD78K)
LP1	Wire Bulb 12V	1	(WQ13P)
SK1,2	Power Socket 2.5mm	2	(HH86T)
SK3	BNC Socket 50Ω	1	(HH18U)
SK4	Terminal Post Green 4mm	1	(HF05F)
SK5	Socket SO239	1	(BW84F)
JK1	Jack Socket 3.5mm	1	(HF82D)
JK2	Switched Jack Socket ½in.	1	(BW80B)
	Vernier Dial Ratio 7.5:1	1	(RX40T)
	DIL Socket 8-pin	4	(BL17T)
	DIL Socket 14-pin	2	(BL18U)
	DIL Socket 16-pin	1	(BL19V)
	Minicon Latch Plug 2W	5	(RK65V)
	Minicon Latch Plug 3W	4	(BX96E)
	Minicon Latch Plug 4W	2	(YW11M)
	Minicon Latch Housing 2W	5	(HB59P)
	Minicon Latch Housing 3W	4	(BX97F)
	Minicon Latch Housing 4W	2	(HB58N)
	Minicon Terminal	3 Pkts	(YW25C)
	Kit P Plas	1	(WR23A)
	Knob K7B	3	(YX02C)
	Hook-up Wire Black	1 Pkt	(BL00A)
	Hook-up Wire Blue	1 Pkt	(BL01B)
	Hook-up Wire Green	1 Pkt	(BL04E)
	Hook-up Wire Red	1 Pkt	(BL07H)
	Hook-up Wire White	1 Pkt	(BL09K)
	Hook-up Wire Yellow	1 Pkt	(BL10L)
	Zip Wire	1 Mtr	(XR39N)
	Low Noise Screened Cable	1 Mtr	(XR18U)
	Quickstick Pads	1 Stp	(HB22Y)
	Constructor's Guide	1	(XH79L)

OPTIONAL

	Power Supply Unregulated	1	(YM85G)
	Power Plug 2.5mm	2	(HH63T)
	Fuse Holder In-line	1	(RX51F)
	Fuse 1.25in. 1A	1	(WR11M)
	Trim Tool Set	1	(BK34M)
	Preset Trim Tool	1	(BK49D)
	Pot Nut M10	1 Pkt	(FP06G)
	Pot Washer M10	1 Pkt	(FP07H)
	Grommet Small	1	(FW59P)
	Box Pre-drilled	1	(YT05F)
	Chassis Pre-drilled	1	(YT04E)
	Pot Mounting Bracket	1	(JG47B)
	Front Panel Stick-on	1	(JG48C)
	Back Panel Stick-on	1	(JG49D)
	Spacer Tapped 6BA x ½in.	1 Pkt	(FD10L)
	Bolt 6BA x ½in.	1 Pkt	(BF06G)
	Nut 6BA	1 Pkt	(BF18U)
	Shake Washer 6BA	1 Pkt	(BF26D)
	Isobolt M2 x 6mm	1 Pkt	(JD11M)
	Isobolt M3 x 10mm	1 Pkt	(HY30H)
	Isolut M3	1 Pkt	(BF58N)
	Isoshake M3	1 Pkt	(BF44X)
	Isobolt M4 x 12mm	1 Pkt	(BF49D)
	Isolut M4	1 Pkt	(BF57M)
	Isoshake M4	1 Pkt	(BF43W)

The parts listed above, excluding Optional, are available as a kit, but is not shown in our 1988 catalogue:

**Order As LM60Q (Direct Conversion Receiver Kit)
Price £69.95**

The following items are also available separately:

Box Pre-drilled **Order As YT05F Price £17.95**

Chassis Pre-drilled **Order As YT04E Price £3.95**

Pot Mounting Bracket **Order As JG47B Price 78p**

Front Panel **Order As JG48C Price £1.98**

Rear Panel **Order As JG49D Price 60p**

Direct Convrsn Rec PCB **Order As GD78K Price £11.95**

PARTS LIST TUNING KIT 1

RESISTORS: All 0.6W 1% Metal Film

1k	1	(M1K)
4k7	1	(M4K7)
22k	2	(M22K)
82k	1	(M82K)

CAPACITORS

27pF Ceramic	1	(WX49D)
33pF Ceramic	4	(WX50E)
47pF Ceramic	1	(WX52G)
100pF Ceramic	1	(WX56L)
120pF Ceramic	4	(WX57M)
180pF Ceramic	1	(WX59P)
22pF Polystyrene	2	(BX24B)
100pF Polystyrene	2	(BX28F)

MISCELLANEOUS

RF Transformer KANK 3333R	4	(FD02C)
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PARTS LIST TUNING KIT 2

RESISTORS: All 0.6W 1% Metal Film

1k	1	(M1K)
2k2	1	(M2K2)
10k	1	(M10K)
150k	1	(M150K)
180k	1	(M180K)

CAPACITORS

27pF Ceramic	1	(WX49D)
47pF Ceramic	5	(WX52G)
120pF Ceramic	4	(WX57M)
180pF Ceramic	1	(WX59P)
33pF Polystyrene	2	(BX25C)
100pF Polystyrene	2	(BX28F)

MISCELLANEOUS

RF Transformer KANK 3334R	4	(FD03D)
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PARTS LIST TUNING KIT 3

RESISTORS: All 0.6W 1% Metal Film

1k	1	(M1K)
2k2	1	(M2K2)
4k7	1	(M4K7)
180k	1	(M180K)
220k	1	(M220K)
330k	1	(M330K)

CAPACITORS

15pF Ceramic	1	(WX46A)
27pF Ceramic	1	(WX49D)
47pF Ceramic	4	(WX52G)
68pF Ceramic	4	(WX54J)
100pF Ceramic	4	(WX56L)
180pF Ceramic	1	(WX59P)
220pF Ceramic	1	(WX60Q)
47pF Polystyrene	2	(BX26D)
68pF Polystyrene	2	(BX27E)
100pF Polystyrene	2	(BX28F)

MISCELLANEOUS

RF Transformer KANK 3335R	4	(FD04E)
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PARTS LIST TUNING KIT 4

RESISTORS: All 0.6W 1% Metal Film

1k	1	(M1K)
2k2	1	(M2K2)
560k	1	(M560K)

CAPACITORS

15pF Ceramic	5	(WX46A)
22pF Ceramic	4	(WX48C)
27pF Ceramic	1	(WX49D)
56pF Ceramic	1	(WX53H)
22pF Polystyrene	2	(BX24B)

MISCELLANEOUS

RF Transformer KANK 3335R	4	(FD04E)
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All 4 Tuning Kits are available, but are not shown in our 1988 catalogue:

Order As LM61R (Tuning Kit 1) Price £2.95

Order As LM62S (Tuning Kit 2) Price £2.95

Order As LM63T (Tuning Kit 3) Price £2.95

Order As LM64U (Tuning Kit 4) Price £2.95

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