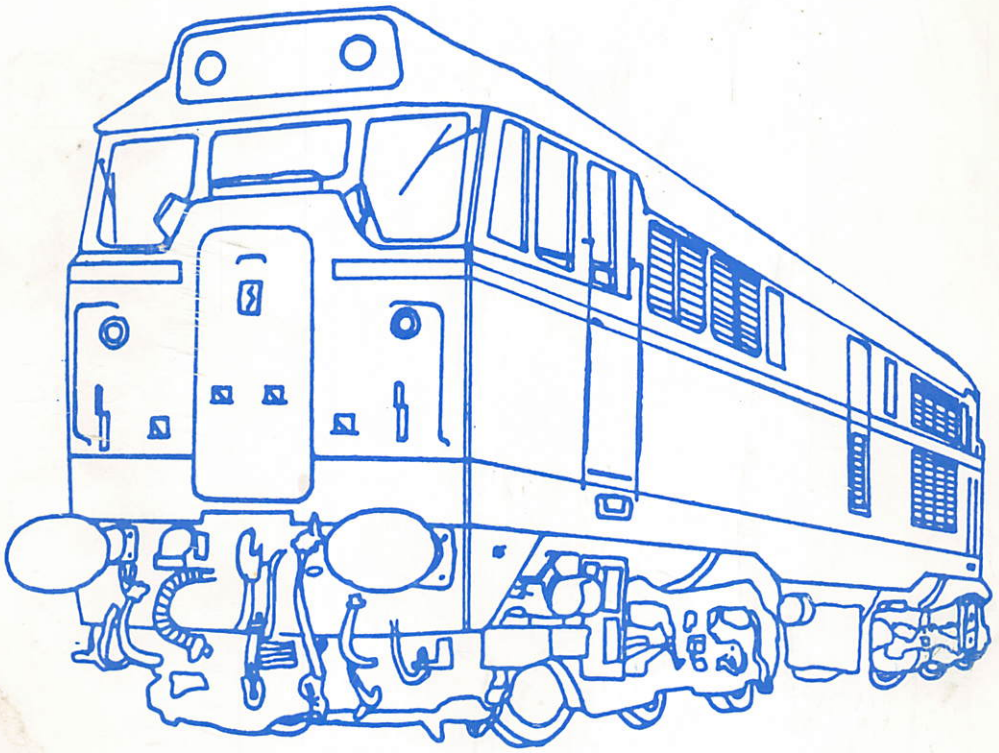
THE MIDNIGHT EXPRESS II



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After you've tried the rest, try the best!

THE MIDNIGHT EXPRESS II

The second edition of the UK CB repair book

THE MIDNIGHT EXPRESS II

Contents

Forward 1
Mic Connections 2
Transistor Comparable Types 3
TC9119/9106 Modification 4
LC7137 Conversions 5
Common Cathode Displays 6
Channel Switch connections 7
Handy Hints 8
Surface Mount Components 9
Designing With Surface Mount 11
Common Faults on Trucks 12
Handy Hints 13
Amstrad and Mustang Faults/mods 14
K40 Microphone diode 15
Voltage Regulator Tweaks 15
Mod Mods and Handy Hints 16
Moonraker Major Layout 18
Make Your Own PCBs 19
Handy Hints 21
Understanding Power Supplies 22
Heatsink Calculations 25
Handy Hints 28
Semiconductor Lead Configurations 29
Nickel-Cadmium Rechargable Batteries 30
PRO 450E Layout 31
NPC5121 PLL update 32
Power Loss in Cables 33
Tony's page 34
Mic Circuit diagrams 35
Zetagi B150 and B300P circuits 36
Bremi BRL200 and BRL210 circuits 37
CB Frequencies Chart 38
Mic Amplifier 39
NiCad Fast Charger 40
Handy Hints 41
80 Watts From Your Amstrad 42
Did You Know? 42
Converting the Cobra Bandswitch 43
1000Hz Sine Wave Generator 43
RF Power transistor list 44
Mosquito Amplifier 45
Turner Mic 46
Multi Purpose Mic Tester 47
10 Amp Power Supply / Handy Hints 48
K40 schematic 49
10 Metre Conversion 50
DA71 Conversion — The secret's out! 53

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No responsibility can be accepted by the author or the publisher for any loss or damage caused either directly or indirectly by the use of information given in this book which is intended for educational purposes only.

Thanks are due to all contributors and to Rob, who provided the help and hardware needed to create this book.

Technical Assistance

Unfortunately neither the author nor Tonks Communications can give assistance relating to the contents of this book. The information is given in good faith but the reader must check the facts against manufacturers' data.

THE MIDNIGHT EXPRESS II

Welcome to edition II of the Midnight Express. Those of you who bought the "Consolidated Midnight Express", or even subscribed to my original but short lived Midnight Express newsletter, will be pleased to see something new, at last!

Steve Tonks has asked me to write this brand new edition so, since I've been away from the CB scene for some time now, I am actually compiling it from the notes of two lads called Dave and Chris, who kindly donated their ideas and findings, plus contributions from other sources.

Steve's request came at a particularly appropriate moment since, having been made redundant from my position of Technical Manager with a large japanese firm, I find myself (temporarily, I hope!) with time on my hands.

Please don't expect miracles from this compilation. I'll do my best to check the facts but there may be a few errors. If you find any mistakes, please write to us and we'll publish an errata sheet.

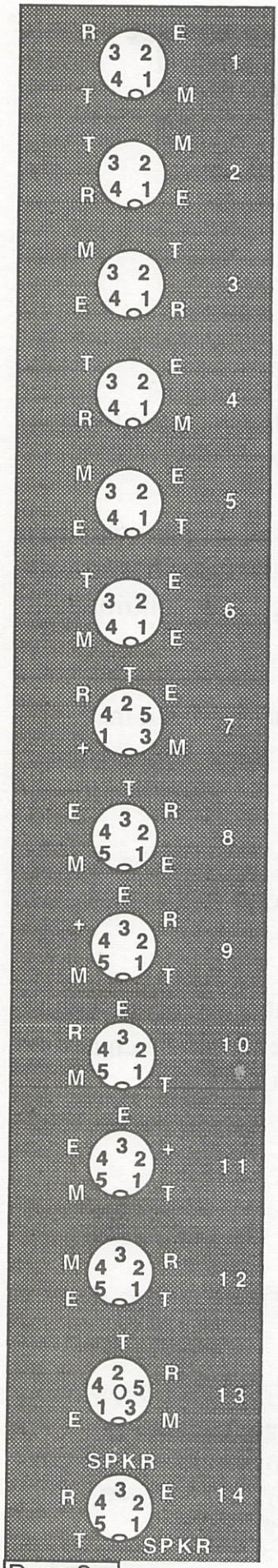
This book is intended to be a reference work and not an incitement to break any law. It is not really for the beginner since it assumes a basic knowledge of radio technology and certain "obvious" (to me) details may be omitted from the text.

I hope you will find the information interesting.

Martin Pickering

("The Specialist")

This book was produced on an Apple Macintosh computer, using SuperPaint ® to draw the artworks, and written in QuarkXPress ® DTP. It was printed out with an Apple "StyleWriter" ® on A4 paper. Special thanks go to Bickerton Phillips Computers of Shrewsbury who provided the StyleWriter printer, system software and advice. QuarkXPress was provided by Computers Unlimited in London.

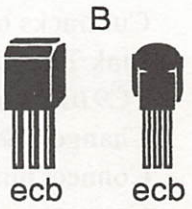


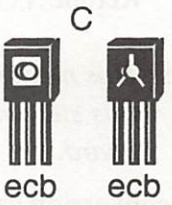
Academy		(3)
Alpha 4000		(13)
Amstrad 900/901		(1)
Atron CB507		(2)
Audioline (all)		(2)
Binatone 5 Star		(1)
Binatone Route 66		(1)
Binatone Beam Breaker		(1)
Breaker 40 FM CEPT		(1)
CB Master 2040		(8)
Cheiza		(3)
Cobra 146 GTL		(2)
Cobra 148 GTL DX		(2)
Cobra 19 GTL		(2)
Cobra 21 GTL		(2)
Colt 210/295/355/720		(8)
Colt 320/444/510/870		(1)
Colt Excalibur		(1)
Commtel		(3)
Commtron V111/CXX		(8)
Communicators		(1)
DNT M40 FM		(11)
Domico Convoy 1		(1)
ELFtone		(3)
Eurosonic Euro-2		(5)
Falcon FCB1281		(1)
Fidelity 1000/3000		(3)
Fidelity 2000		(1)
Formac 88/120	*	(1)
GE 3-5804/3-5805		(12)
GECOL GT858-B		(3)
Grandstand Bluebird		(9)
Grandstand Gemini		(10)
Grandstand Hawk		(1)
Grandstand Homebase		(2)
Ham Concorde II & III		(1)
Ham Explorer		(1)
Ham International UK		(1)
Ham Jumbo		(1)
Ham Major M-360		(1)
Ham Multimode		(1)
Ham Viking		(1)
Harrier CBX		(1)
Harvard 400M		(5)
Harvard 420M		(1)
Harvard Good Buddy		(4)
Hy-Gain V/2795		(1)
Icom ICB-1050		(1)
JWR M2		(1)

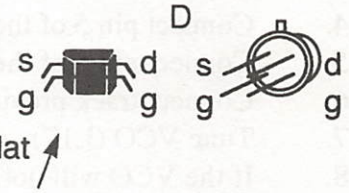
Jaws Mk2		(8)
Kraco KCB-4030		(1)
Kraco KCB-4004		(2)
LCL 2740 FM		(11)
Lake Manxman		(3)
Legionaire		(1)
Maxcom 4E/20E/21E		(8)
Midland 2/3/4001		(1)
Midland 6001/7001		(1)
Midland Transportable		(14)
Mini Midland		(8)
Murphy Homebase CBH1500		(6)
Mustang 1000/3000		(1)
Nato 2000		(1)
Nato 40 FM		(1)
New Formac 88	*	(8)
Pegasus-7		(1)
Planet 2000		(1)
President Adams		(2)
President Andrew J		(2)
President AR-144/AX-144		(2)
President Dwight D		(2)
Radiomobile CB201/202		(1)
Realistic TRC2000/2001		(12)
Rotel RVC 220/240		(1)
Sapphire X2000		(3)
Sapphire X4000		(8)
Scooper MKY-440B/550E		(2)
Serpent UK 4000		(1)
Shogun		(7)
Stalker (all)		(2)
Sun 401		(1)
Superstar 120 FM		(2)
Superstar 2000		(1)
Tokai		(3)
Tristar 727/747/777/797		(1)
Uniace (all)		(2)

Transistor Comparable Types

This	Can be replaced by these	Watts	case
2SA473	985	10	A
2SA564	555,608,673,733,999,1015	0.4	B
2SA608	555,564,673,733,999,1015	0.4	B
2SA683	950,2SB544,2SB647	1	B
2SA1012	2SB566,2SB824	25	A
2SC380	460,829,930,1675	0.3	B
2SC495	1162,2024	1	C
2SC536	460,725,828A,945,1815,2320	0.2	B
2SC945	536,725,1363,1815,2308	0.25	B
2SC1306	1678	12	A
2SC1307	2098	20	A
2SC1318	1213A,1247A,2002,2274	0.6	B
2SC1909	1816,1974,2075,2078,2166	10	A
2SC1969	1307,1817,2098	20	A
2SC2078	1306,2075	10	A
2SC2236	2SD773,2SD468	0.9	B
2SC2314	2036,1957	5	C
2SD313	288,317,526,1061	30	A
2SD325	288,360	10	A
2SD400	467,471,2SC1383,2067,2120	0.9	B
2SD471	400,468,2SC1383,2120	1	B
2SD837	1190	40	A
2SD880	313,743,1035	30	A
3SK45	2N301,MFE131,3SK107	FET	D





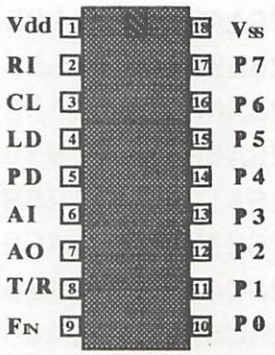


All information in this book is given in good faith. We would welcome your comments, regarding mistakes, or suggestions for more information. However neither S.J. Tonks nor any person or firm associated with the production of this book can accept responsibility for any errors or for any loss, damage or prosecution caused either directly or indirectly by the use of information contained herein. It is the responsibility of the user to check the data supplied by the relevant manufacturer and to check relevant legislation..

WARNING

The following modifications affect the ability of your radio to comply with current legislation. The *possession* of a radio so modified is illegal at the time of writing.

Most rigs which use the TC9106 PLL can be converted to the UK 27/81 frequency band by replacing it with a TC9119 and retuning the VCO and other relevant coils. However, it is usually possible to add the new band and leave the existing one as well. The following text describes such a modification.



TC9119
TC9106

CRAIG L-201 Homebase

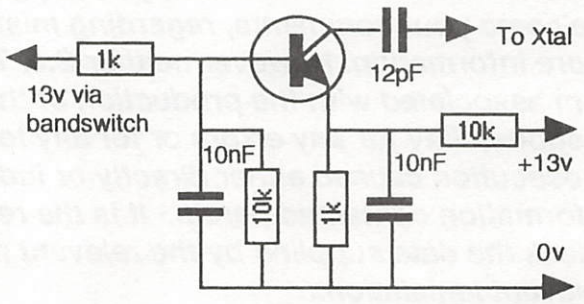
1. Solder TC9119 on top of the TC9106, pin to pin, leaving pins 3, 4, 5, 6 &7 unconnected.
2. Cut tracks to TC9106 pins 4 and 5 beneath the PCB.
3. Link TR17 collector (centre pin) to the track on the opposite side of the TC9106 which you cut away from pin 4.
4. Change C88 (33pF) to 56pF.
5. Connect pin 5 of TC9106 to bottom contact of new band switch.
6. Connect pin 5 of TC9119 to top contact of new bandswitch.
7. Connect track previously cut from pin 5 of TC9106 (non-PLL side of track cut) to bandswitch slider.
8. Retune VCO coil and output coils for operation on both bands.

Note: *This modification adds the UK 40 band but it does not change the modulation method. It is still an A.M. rig. To convert to Frequency Modulation mode you must fit an FM modem board.*

This conversion can also be carried out in reverse. Rigs which use the TC9119 PLL, such as those with Uniden PA 039 and PA 034 chassis, can be changed as follows:

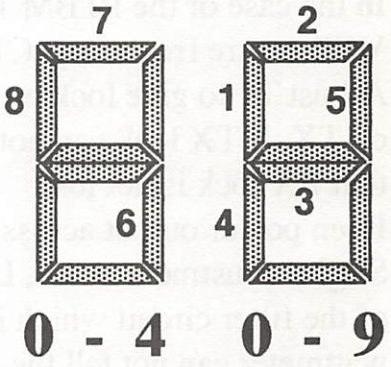
1. Solder the TC9106 on top of the TC9119 leaving pins 3,4,5,6 & 7 unconnected.
2. Cut PCB tracks to pins 4 & 5 of the TC9119 (LD and PD).
3. Link TR17 collector to junction of D6 and R33.
4. Connect pin 5 of the TC9106 to the bottom of the bandswitch.
5. Connect pin 5 of the TC9119 to the top of the bandswitch.
6. Connect track previously disconnected from pin 5 to the bandswitch slider.
7. Tune VCO (L17) and output coils for correct operation on both bands.
8. If the VCO will not lock across both bands change C64 (33pF) to 56pF. C64 is located to the left of the VCO coil.

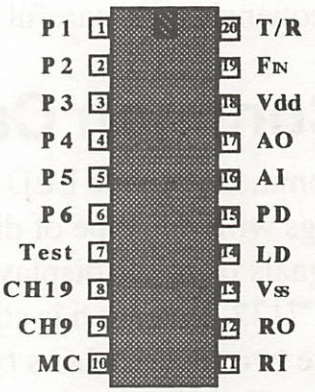
Editor's note: The conversion is incomplete as it is written here. Because the UK frequencies are offset by 1.25kHz and the FCC frequencies by 5kHz there will be an error of 3.75kHz when you switch between the bands. In order to eliminate this discrepancy, it is necessary to add a single transistor circuit to switch in additional capacitance when the UK band is selected. You will need a two-pole bandswitch to achieve this.



LC7137 Conversions

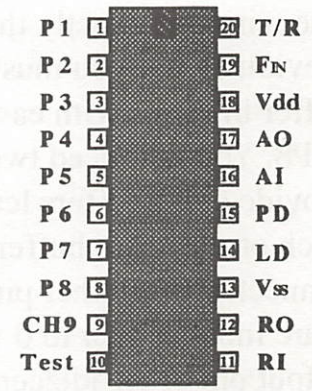
In the same way, rigs which use the LC7137 may have the LC7132 added to produce the CEPT (FCC) band. However, the LC7132 is different from the LC7137 in one important respect. Whereas the LC7137 requires a BCD (Binary Coded Decimal) input on its channel select pins, the LC7132 requires special codes which are derived from the half of the switch which controls the LED channel display. The numbers in the adjacent LED display sketch refer to the corresponding pin numbers of the LC7137. It is possible to "piggy-back" the LC7132 on top of the LC7137, however, with so many pins to wire elsewhere, it is easier to solder it on a separate piece of veroboard. Ribbon cables can be used to connect from one side of the LC7132 to the LC7137 and from the LC7132 to the the switch connections on the channel display board.





LC7137

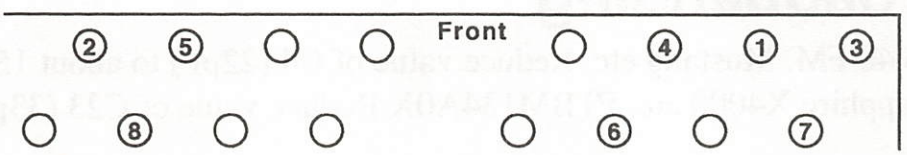
You can determine which segment is which by connecting a 1k resistor to 0v (in the case of a common anode display - common connection will be +ve) or 13v (in the case of a common cathode display). Touch the free end of the resistor to each LED display connection in turn and note which segment lights or glows more brightly. Make a sketch of the connections 1 to 8 as you find them.



LC7132

Cybernet 134 Conversion

1. Cut the track to isolate LC7137 pin 14 (LD).
2. Cut the track to isolate LC7137 pin 15 (PD).
3. Solder LC7132 to a new PCB or veroboard.
4. Connect the following LC7137/7132 pins together: 12, 13, 18, 19, 20 and LC7132 pin 9 to LC7137 pin 10.
5. Connect pin 15 on each PLL I.C. to the top and bottom of a new bandswitch (you could use the tone control).
6. Connect the switch slider to the track previously cut away from pin 15 on LC7137.
7. Using 8-way ribbon cable or 8 individual wires, connect pins 1 to 8 of the LC7132 to the pins of the PTSW 154 A0X display itself (see sketch, below).

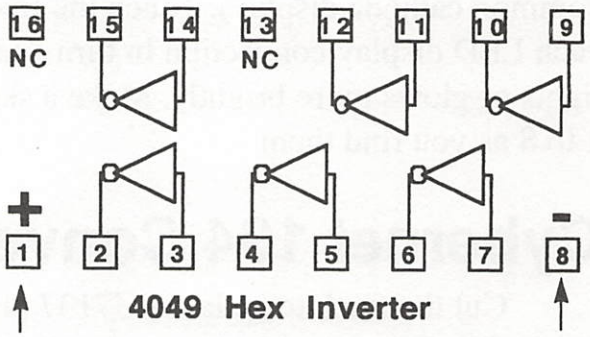


Tuning after Conversion

In the case of the PTBM 134 A0X board, the coil T1 and the trimmer CT1 control the VCO centre frequency. CT1 affects only TX but T1 affects both TX and RX.
Adjust T1 to give lock on RX across all channels. Adjust CT1, if necessary, to give lock on TX. If TX lock can not be obtained on every channel, readjust T1 slightly but ensure that RX lock is not lost.
Even power output across both bands can be achieved by adjustment of T2, T3, and T4. Slight adjustment of L4, L8 and L9 may be needed but bear in mind that these form part of the filter circuit which is designed to prevent the transmission of interference. Your wattmeter can not tell the difference between true 27MHz output and other unwanted frequencies. Be careful not to tune for 4 Watts of unwanted harmonics!

Common Cathode Displays

Common cathode LED channel displays have the common connection connected to 0v. Rigs with this type of display can be converted in much the same way but the eight signals from the display segments must be inverted before being applied to P1 - P8 of the LC7132. Inversion is straightforward but a little tedious to wire up.
Use two inverter I.C.s type 4049. These I.C.s are called "hex buffers" because there are six inverter buffers per chip.
The wiring is exactly the same as described previously but you must connect an inverter buffer in series with each of the eight wires P1 to P8. You will need two inverter I.C.s to provide eight buffers leaving four spare.
Each of the spare buffers must have its input connected to another pin. You can connect these spare inputs either to 0 volts, 13 volts or to the output pin of an adjacent "used" buffer. You must not leave any ***input*** unconnected. However, unused *outputs* must not be connected to anything. For the real dummies, I'd better add that the buffer *output* is the "pointy" end with the bobble and the ***input*** is the flat end without the bobble!

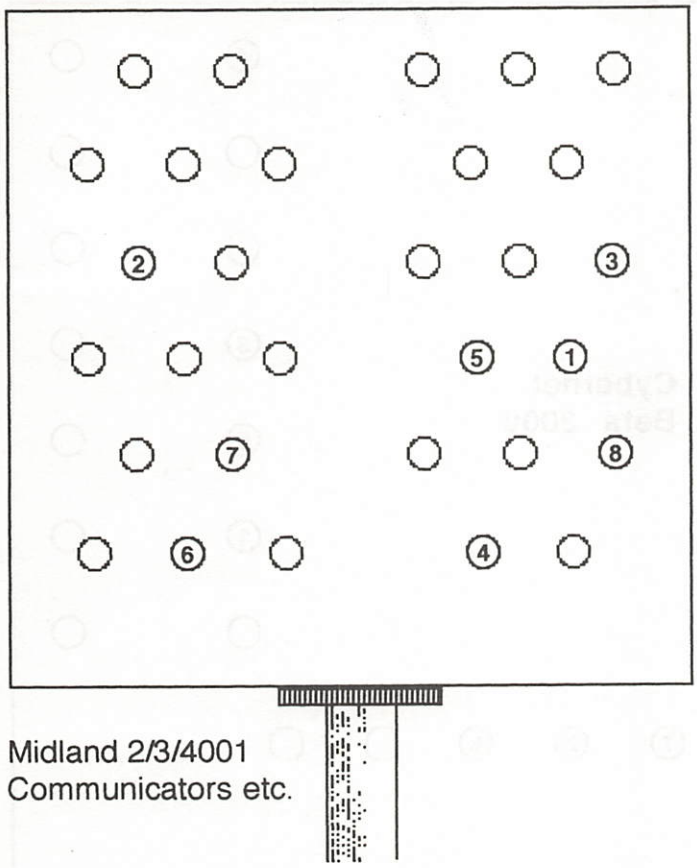


Connect pin 1 to pin 18 of LC7137

By the way, you will find it simplest to mount the two 4049 I.C.s on a PCB or veroboard together with the LC7132 PLL I.C.

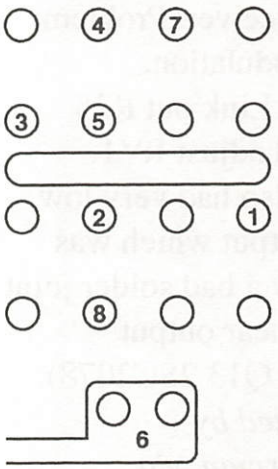
VCO Broadbanding

Amstrad, Nato 40 FM, Mustang etc. Reduce value of C4 (22pF) to about 15pF.
York, Rotel, Sapphire X4000 etc. PTBM134A0X Reduce value of C23 (33pF) to 22pF.

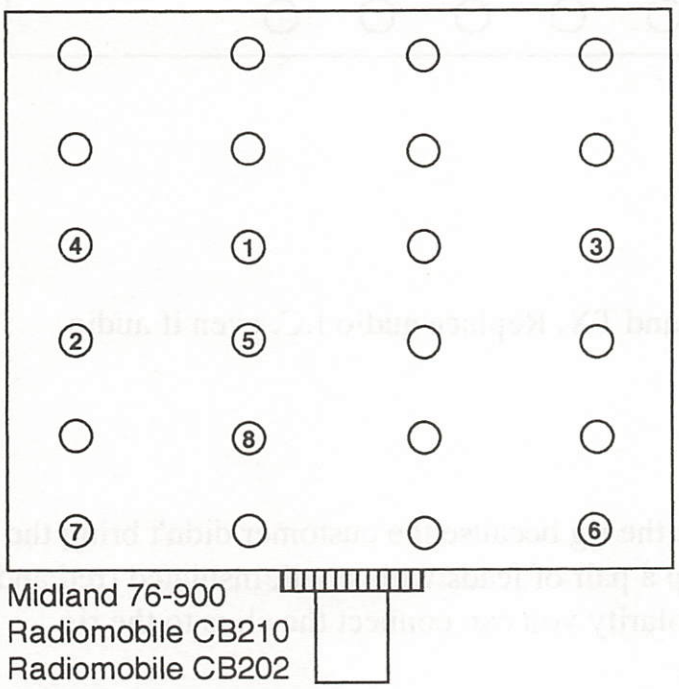


Midland 2/3/4001
Communicators etc.

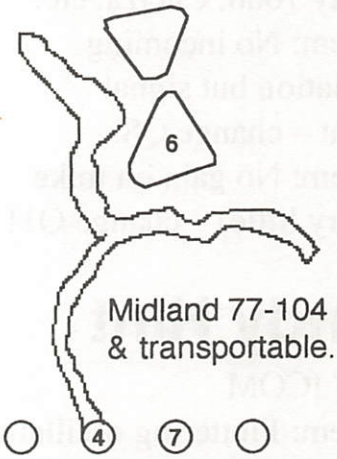
Jesan KT 5005



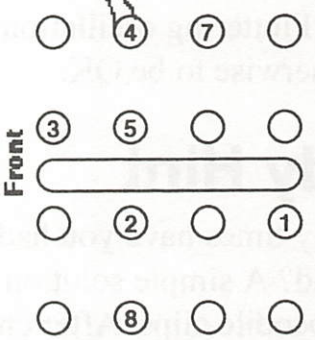
Common
cathode display



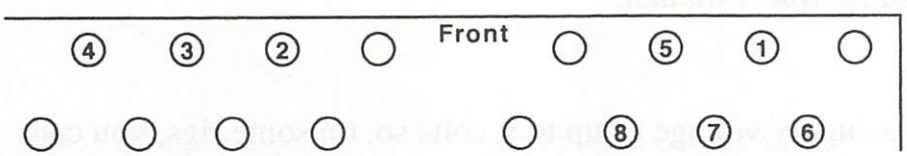
Midland 76-900
Radiomobile CB210
Radiomobile CB202



Midland 77-104
& transportable.



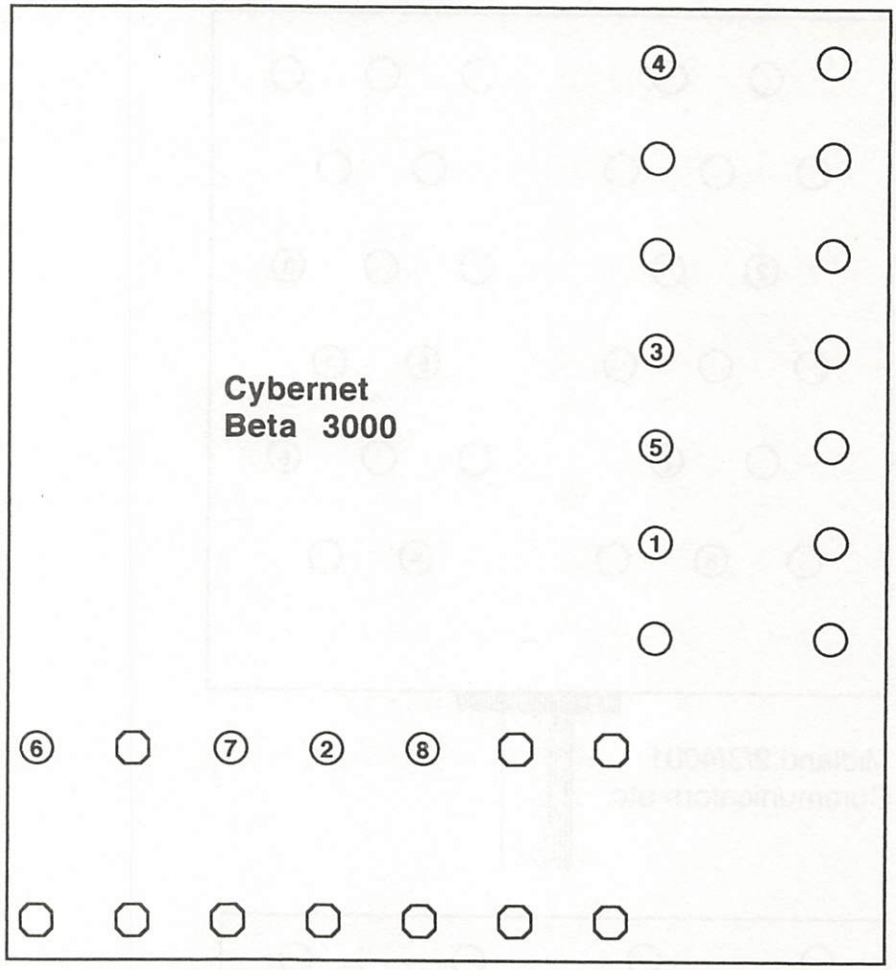
Common cathode display



Wafer switch, Amstrad etc.

Handy Hint

Jesan KT-750 Emergency CB Transceiver. Problem: Weak Modulation. Solution: Link out R25 (18k) and adjust RV1. The set also had very low power output which was caused by a bad solder joint on C71 (near output transistor Q13 2SC2078).
Contributed by J. W. Sturman, via Truck King



Handy Hint

Fidelity 1000, Cheiza, etc. Problem: No incoming modulation but signal present – change Q8. Problem: No gain on mike (or very little) – change Q11.

Handy Hint

JWR / ICOM
Problem: Fluttering oscillation on both RX and TX. Replace audio I.C. even if audio seems otherwise to be OK.

Handy Hint

How many times have you had to hard-wire the rig because the customer didn't bring the power lead? A simple solution is to make up a pair of leads with small, insulated (red and black) crocodile clips. After checking the polarity you can connect the clips to the rig power socket without risk of a short circuit.

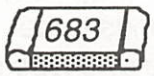
These hints were contributed by Tony Madden.

Did You Know?

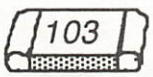
The MC145106 can run on a supply voltage of up to 9 volts so, on some rigs, you can change the PLL I.C. supply voltage from 5 volts to 8.5 volts and extend the VCO range.

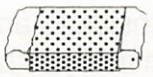
Surface Mount Components

Some of you may be familiar with Surface Mount Components but many people are not. Here is a brief summary of the components you will come across in CB radios.



The most common component is the resistor. Made by depositing a film of conductive material on a little chip of ceramic, the resistor has tinned ends and the value printed on one surface in ordinary numerals. The first two digits represent the numerical resistance value and the third digit gives the number of noughts to be added. The left hand example, above, is 68000 Ohms or 68k while the right hand one is 4700 or 4k7. There is no way to determine the tolerance or the Wattage. The uncoated part of the ceramic body is usually white. The resistor shown on the left is 10k. On the right is a capacitor. These have no markings so the only way to determine the value is to measure it.

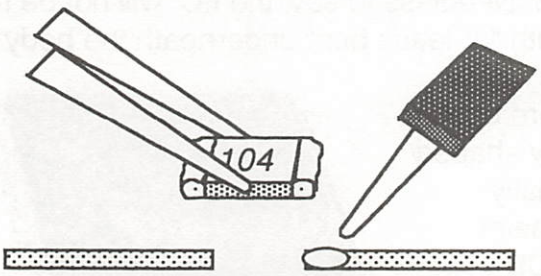


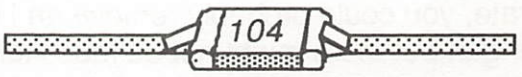


Capacitors are usually uniformly coloured brown or green. Unlike the resistor, the capacitor has no coating on the surface. If you break one in half and examine it under a magnifying glass you will see that it is constructed like a multi-layer sandwich. Layers of metal (silver or lead) are separated by layers of insulating ceramic. Odd layers of metal are connected to one end and even layers to the other.

The end terminations of resistors and capacitors are very delicate. Most manufacturers recommend a maximum *cumulative* soldering time of 5 seconds. When you come to remove one from a PCB, remember that 3 seconds were used up to put it there in the first place! There is little point in expecting to remove one of these devices and to re-use it. Always fit a new one in the following way:

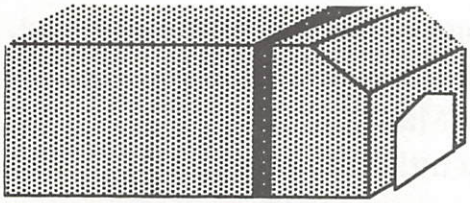
Remove the existing component by applying the soldering iron tip to each end alternately, several times in quick succession, and flicking the component away. Get rid of as much solder from the copper pads as possible. Blob a tiny amount of new solder on the right hand pad (or left if you are left handed). With a pair of tweezers, position the new component and melt the solder blob to secure it. Solder the opposite end. Use a 1.6mm tip (or smaller) and 26 gauge solder (0.5mm). Thicker solder or tips give enormous problems. You should perform the soldering as quickly as possible to avoid separating the end contact from the component. Don't worry about what the joint looks like.





For Surface Mount, the strength of the joint is unimportant. Once the solder has "wetted" the joint, leave it alone.

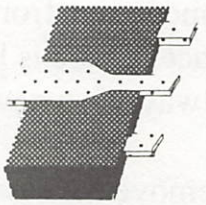
Resistors and capacitors are available in various sizes but the most common is the 1206 size.

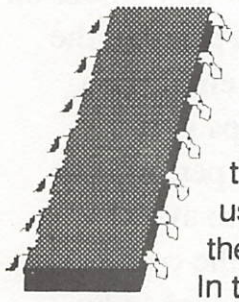


This is certainly the most convenient size to handle and is usually rated at 0.125 Watts for resistors — adequate for most purposes. Where space is at a premium, smaller sizes can be used and where higher Wattage is required, larger resistors are available. Capacitor size tends to be determined by several factors — value, voltage and type of dielectric material. Where a value greater than 330nF is required or tolerance better than 5% the multilayer ceramic capacitor can not be used. For larger capacitance values, a tantalum capacitor might be used, as shown above. The positive end is designated by a chamfer and a stripe. Each end has a flat metal contact which can be soldered. The value and ratings are printed on the top surface.

Transistors and diodes are usually found in the SO23 type package. This is small and fiddly to handle, even with tweezers. To add to the difficulty, the legs are usually made of tinned iron which is attracted to metal tweezers if these become magnetised (as they often do). The device is too small to accommodate the part number so the manufacturer prints his own code on the top surface — usually a single letter and a number only. Some suppliers have standardised on "Z" for zener, "A" for diode and "D" for transistor. In the case of a diode, the middle leg is usually the cathode (striped on conventional diodes) and the other two legs are both connected to the anode. In the case of a transistor the middle leg is the collector, top right (in the picture) is the emitter and bottom right is the base. You will also come across four-legged packages which might contain two or more diodes or, perhaps, an F.E.T. Higher power diodes use the cylindrical "MELF" package.

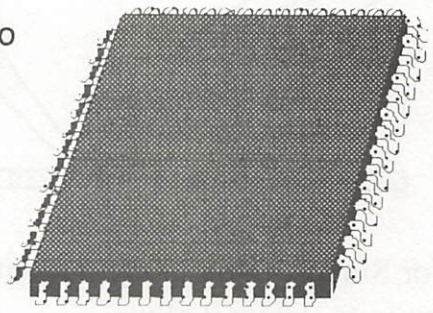
Higher power transistors will be found in the SOT39 package which is shown, here, upside down. The centre leg (collector) is also the heatsink and care must be taken to ensure that this whole area is soldered to the copper track, otherwise the heat may not be dissipated efficiently. The base connection is top right and the emitter is bottom right in this picture.





Integrated Circuits are quite recognisable in SO (Small Outline) packages but the legs are bent outwards "gullwing" fashion. Larger I.C.s use the "Quadpack" shown below, right. I.C.s have the number marked as with conventional components. They are horribly difficult to remove, intact, with a soldering iron. The simplest method is to cut each leg close to the I.C. body then desolder the ends from the PCB. Needless to say, the I.C. will not be re-usable! Even worse are those I.C.s with "J" leads bent underneath the body of the I.C.

In the factory, special hot air "pencils" are used to remove the I.C.s. Alternatively, a specially shaped copper bit is used with the soldering iron. If you are really desperate, you could probably remove an I.C. with a paint-stripper gun but there might not be much left of the PCB unless you mask it with aluminium foil.



Designing with Surface Mount

The previous information covered the most common types of component you are likely to come across when carrying out repairs, but what about new designs?

The first problem is usually to determine exactly what designs can be converted to use surface mount technology. Start with something simple like a crystal oscillator. You must look at each component and decide whether to use a conventional leaded device or to use a Surface Mount component. For every leaded device you can replace, that's at least two holes less to drill.

Guidelines

Change small transistors and diodes, low-wattage resistors and capacitors of value 1nF to 100nF with a tolerance of 20% or greater.

Leave I.C.s, large value or close tolerance capacitors, high wattage resistors and crystals, potentiometers, rectifiers, coils, transformers etc. as conventional leaded devices.

You can actually buy Surface Mount inductors, tantalum capacitors, preset resistors and capacitors, crystals and various other devices but they tend to be twice the price of conventional and save little in space unless you use a double-sided PCB.

Use 1206 size resistors and capacitors because they are quite small but easier to handle than the very small devices.

Semiconductor equivalents can be used as follows:

BC108 .....BCW33	NPN silicon general purpose
BC337 .....BCX19	NPN silicon up to 800mA
BCY71.....BCW30	PNP silicon general purpose
1N4148.....BAS16	silicon small signal diode

Design the PCB with the I.C.s and conventional components on the top and the surface mount devices soldered to the copper beneath. There is often room to put resistors and capacitors between the rows of I.C. pins. Doing it this way keeps the PCB area small. You can, if you wish, bend the legs of a conventional IC and solder it to the copper side of the PCB. In fact you can do this with nearly all components if you wish to avoid drilling holes altogether, but you won't save much space.

When you lay out the copper tracks there is no need to use pads for the Surface Mount devices because they can be soldered to the end of the track itself.

The best way to find out what is possible is to try it for yourself!

Common Faults on Trucks

CB radio lights up but no sound. Only slight click from speaker when switched on. Voltage exceeding 16v causes this fault.

CB radio lights up. Seems to get out well when engine is off. Signal meter registers over 5 on a clear channel. Can be caused by underrated dropper or by heated mirrors (try bigger dropper or mag mount).

CB radio buzzes on TX but only on high power setting. Try replacing dropper for a higher rated one. Also caused by dropper too close to mike socket.

On ERF and Foden fibreglass cabs, place the mag mount in the centre of the sun roof. If there is no sun roof, pop-rivet a sheet of 2 feet square (600mm x 600mm) steel in the centre of the roof and put the mag mount on that.

Handy Hints

Audioline rig — audio I.C. gets very hot. Replace R93 (burnt out) in the middle of the PCB.

Audioline rig — TX light stuck on. Weaker signals can't be heard. Replace TR17 and TR19 in the centre of the PCB.

Midland 2001 — no squelch. Try replacing MC3357. — No TX, no RX, no incoming signals on meter. Try replacing 2SC7808 on the side of the rig.

Before plugging in a homebase rig, make sure that the PSU has not been removed (Dave found this the hard way – ouch!.

Fidelity 2001 — No channel display. Try D400 at the front end of the board or D3.

Fidelity 1000 — No channel display. No RX or TX. Try replacing Q9 and D11 on centre right hand side of board.
No squelch. Try replacing Q7 in front of the audio I.C.

Harrier CBX — No squelch but squelch transistor is OK. Pot is OK. Try replacing 7205 audio I.C.

Cybernet Board — No RX, no TX. Sometimes keys up only 1 channel. Channel changer appears not to work. Try D2 (6.2v zener) next to LC7137. With this fault the voltage on pin 18 of LC7137 will be well below 6 volts.

Handy Hints

Superstar 360 and Cobra 148 — No audio on AM but everything else is OK. Try 1012 on right hand side of board. Also causes no TX but RX OK.
No TX but RX OK. Monitor rig reveals very low signal. OK on SSB but no Amplitude or Frequency Modulation. Replace TR51 (2SA1012) with TIP42 or BD712 (PNP!).

Concorde Mk2 — No TX on AM/FM but SSB is OK. Change voltage regulator 2SD837 on the back plate of rig. This is a "Darlington Pair" transistor and must be replaced with same type.

Midland 77-104 — Very common fault. RX and TX go on and off. Dry joint on centre of board or voltage regulator 7808.

Audioline 340 — No RX (same symptoms as blown audio I.C.) try IC1 in front of discriminator can.

Midland 77-099 — No channel display or only counts up to 9. Try D302 (8v1 zener) or R310 which burns out. Both are at the back of the mike socket.

Transit 40FM — Stuck on 1 channel. Up/Down buttons don't work. Try solder joints on back of the Up/Down channel board. They tend to break away very easily.

Antenna Fault — Transmitted audio breaks up, especially when vehicle is moving. Mike checks out OK. Very common fault with base-loaded antennas. Coil broken.

General faults — No audio. If mike OK, check speaker. Occasionally the connections corrode away on the cardboard cone. Otherwise check for broken track on audio I.C.

PT40, Lowe etc. — Very low modulation. Replace IC5 (BA402), front right of PCB.

Shogun — No channel display until mike keyed. Replace Q401 (2SD667).

Rigs with Cybernet 134 PCB and dimmer knob — No Channel display. Replace Q251 on underside of channel selector PCB (PTSW154A0X) with 2SC1383, 2SC2074, 2SD400 0r 2SD471.

Ham International SSB rigs — No TX or RX. Check for 5.8 volts on pin 1 of PLL02A. If low then replace zener diode.

Amstrad and Mustang Faults/Mods

13 volts on chassis. Caused by short on the mike socket or output socket not insulated properly.

No lights on RX or TX. Try replacing BA656 on front of board.
RX and TX lights stuck on. No RX but slight hiss. Try replacing D20.
Shorts out power supply. 1N4001 is OK. Try replacing LA4422 audio I.C.

No lights but protection diode OK. Look for burnt out track on CB/PA switch PCB.

Lights up but no TX or RX. Check D3 near the PLL I.C. (6v1 zener).

No RX or very low and distorted. Replace FM Detector I.C. U3 (LA1230).

Very low output power on TX. Replace output transistor; use 2SC2166 as fitted originally.

Stuck on TX. replace Q22 (2SA608) located in front of the 455kHz filter.

No TX and TX LED does not light but RX OK. Replace Q18 (2SA608) located to the left of the audio I.C.

Very low RX signal but TX OK. Try replacing diode D11 which can go short circuit.

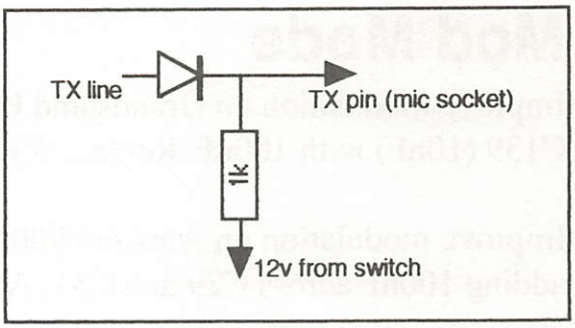
RF Gain Modification
Cut out resistor on the back of the RF gain pot to increase its effectiveness.

Roger Bleep Modification
To alter the duration of the bleep, change the value of C116 (10μF 16v).
On rigs without a roger bleep switch, wire one in to a leg of this capacitor.

Cybernet 134 VCO coil
Can be replaced by VCO coil from Amstrad/Mustang (002F board)

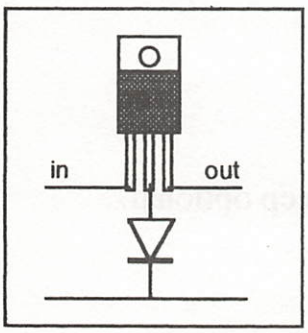
(Who will be the first to scrap their Rotel 240 to fix an Amstrad???)

K40 Microphone

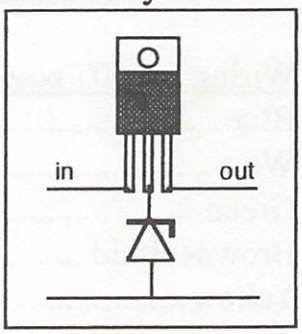


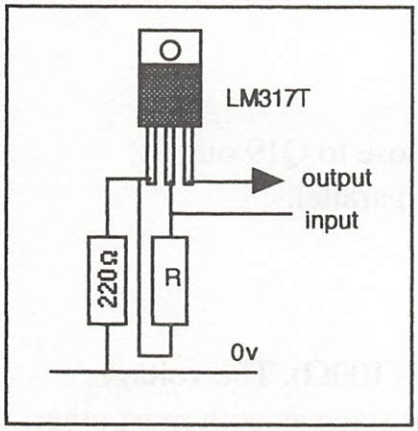
Add this diode and resistor to supply the voltage from the rig. Virtually any diode will do. The resistor value is 1k Ohm (brown/black/red).
Snip the TX wire from the mic socket inside the rig and connect this wire to the diode anode.
Connect the diode cathode to the pin on the socket from which you snipped the wire. Connect the resistor from this pin to the on/off switch (the connection which has no volts when the rig is off!).

Voltage Regulator Tweaks



If you don't have exactly the right voltage regulator to replace a dud in a rig you can often boost a lower voltage regulator by adding one or more diodes. Almost any silicon diode will do. Adding one diode as in this picture will increase the output voltage by 0.6 volts. Two diodes in series will increase it by 1.2 volts, three diodes by 1.8 volts and so on. To get a bigger increase, use a zener diode as shown in the picture on the right. Note that the ordinary diode is connected with its cathode (banded end) to 0 volts but a zener must be connected the opposite way round. The connections are for the 78xx series of regulators which provide a positive output. With 79xx regulators, turn the diode/zener the opposite way up.





A more versatile way to produce a regulated voltage up to 25 volts is to use an LM317T device. The output voltage is determined by the value of resistor "R", as follows:

Voltage	R	
5	900Ω	(1.5kΩ//2.2kΩ)
6	1.15kΩ	(1.5kΩ//4.7kΩ)
8	1.65kΩ	(1.8kΩ//18kΩ)
12	2.8kΩ	(3.3kΩ//18kΩ)
13.8	3.3kΩ	

Since the resistor values are non-standard you will have to make them up by connecting two in parallel as indicated in brackets ().

The LM317T can provide up to 1.5 Amps (Just enough to run a standard FM rig) provided that it is mounted on a good heatsink. The side panel of a rig is not adequate and you should use a piece of aluminium at least 3mm thick and 40mm square.
With the appropriate selection of resistors you can use this circuit to replace a 7805, 7808, 7812 regulator etc. but take careful note of the connections.

Mod Mods

Improve modulation on Grandstand Hawk/Lowe TX40 by replacing C148 (10nF) and C139 (10nF) with 100nF. Replace R110 (47k) with 100k and adjust deviation pot VR4.

Improve modulation on Amstrad 900/901, Mustang CB3000, Fidelity 2001 etc. by adding 100nF across C29 and C31. Adjust deviation pot RV3.

Improve modulation on Superstar 2000, Tristar 777, Nato 2000 by adding 100nF across C151 (22nF), C149 and C155 (47nF).

Improve modulation on Colt 747, Hy Gain V by adding 100nF across C160 and C162 (22nF).

Handy Hints

Colt Excalibur SSB PTBM121D4X

Add a switch in line with R185 (330k) or C207 to make the Roger Bleep optional.

Wiring for 007 power mike

Blue.....Audio
Whit .....TX
Green .....RX
Brown+Braid .....Earth
Yellow.....Not used

Fidelity 1000, Academy etc

RX OK but no signal indication. Replace D5.
R65 (8.2Ω) burns out causing no TX. This resistor is located close to Q19 output transistor. Replace with 1 Watt resistor or two 0.5 Watt 18Ω in parallel.

LCL 2740 (DNT)

No TX but meter indicates normal operation.
On these rigs the meter is driven via diode D15 and preset R98 (100Ω). The voltage, however, is taken from the *driver* stage and not from the output stage as with most other rigs. The fault can lie anywhere between the driver stage and the antenna socket but is usually the output transistor itself.

Communicator N1 440 DX, Serpent, Planet

No RX or TX but rig lights up. Try replacing the 7808 voltage regulator which is identified on the PCB as Q21 in front of the audio I.C.

Handy Hints

Cheiza, Fidelity 1000, etc.

Very low or no modulation can be caused by Q13 going short circuit. This transistor is next to deviation pot SVR3.

Stuck on TX but frequency not correct. This fault is caused by zener diode D11 going open circuit. D11 is located in front of Q9 voltage regulating transistor.

Cybernet, York, Rotel etc.

Not TX but RX OK. VCO frequency is OK on RX but nothing on TX. Replace faulty TX switch transistor Q2 (JC502) located to the rear of the VCO can.

Red trimmer capacitor used to reduce VCO frequency on TX can malfunction, if sealed with wax, causing intermittent TX. Fit new trimmer or remove old one and repair as follows: heat centre with point of soldering iron then spray with switch cleaner at close range. Repeat until no wax remains.

Audioline 340/341 etc. PA034 and PA039 chassis

No TX but RX OK. Voltage on pin 8 of TC9119 should be 0v on RX and 7.4 volts on TX. If voltage on TX is much lower than 7.4 volts try replacing TR18 (2SA1015)PNP transistor.

Rama Echo Chamber (and similar)

Not working at all. No LED lighting. R.F. choke coil in 0v line goes open circuit. Bridge it with a wire link or a coil from a scrap rig.

RA201 Reverb

Blows fuses. Transistor at front of PCB is actually a S.C.R. (Thyristor). Remove it and reverb will work OK. (Replace it to give over-voltage protection again).

Most Rigs

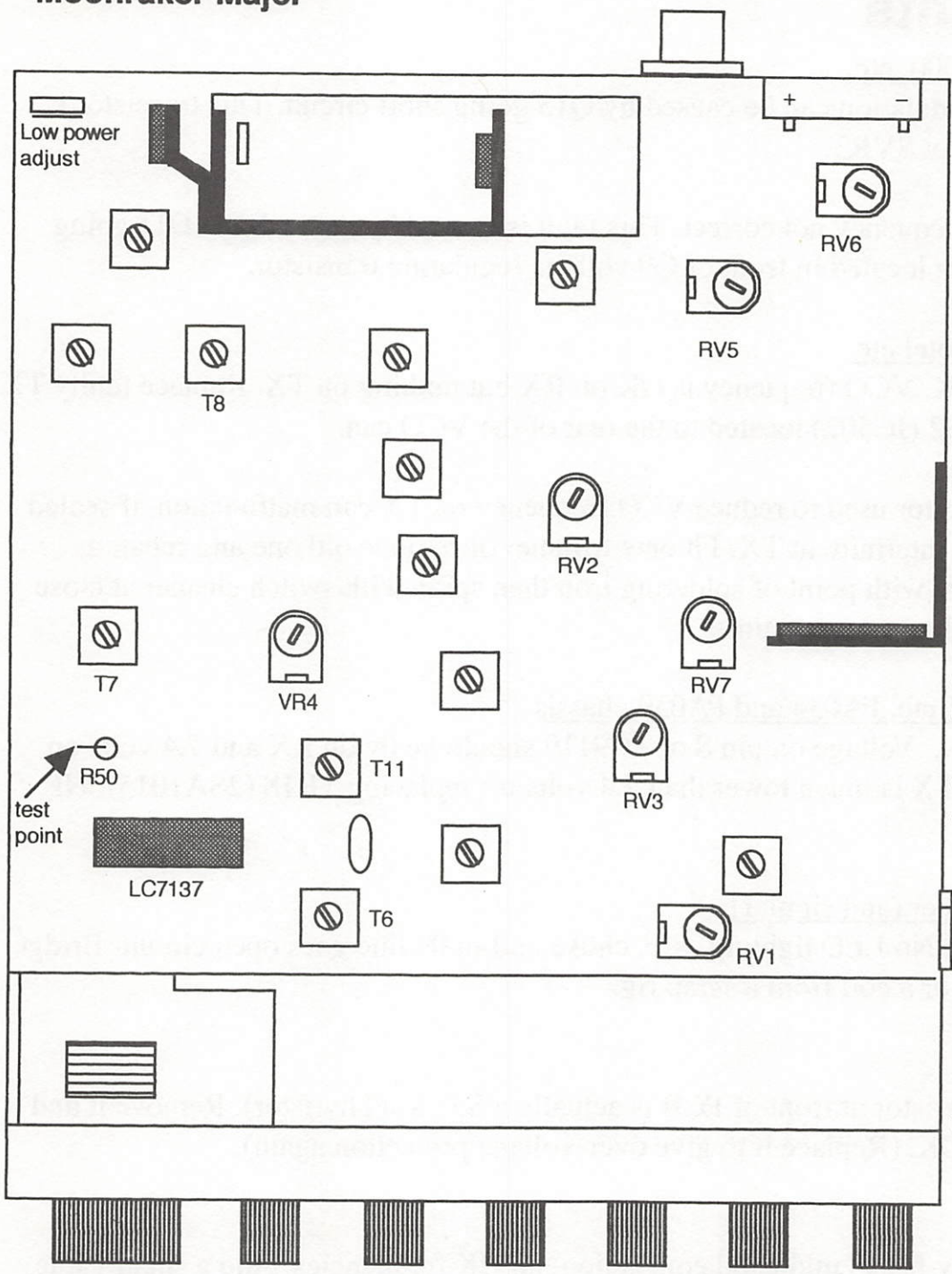
After fitting "piggy-back" mid band conversion, no UK frequencies. Add a small value capacitor between pin 19s on LC7137/7132.

Ham International Jumbo, Colt Excalibur, Marco Excalibur

LED display can be replaced with one from a scrap Fidelity Homebase (yes, we found a use for it, at last!).

PSU Test

After repairing a PSU, connect a 12 volt car indicator bulb across the output to test under load. On larger than 3 Amp, use a headlamp bulb.



Presets

RV1	S meter
RV2	Deviation
RV3	Squelch range
RV4	TX bias adjust for delta tune.
RV5	TX meter
RV6	A.W.I. adjust (set on 0.4W)
RV7	Not connected

VCO Frequencies

	MHz
ch 1 RX	16.90
ch 40 RX	17.29
ch 1 TX	13.8
ch 40 TX	13.99

On TX C201 (68pF) is switched across VCO circuit to drop frequency from 16MHz to 13MHz.

VCO Adjustment

With DC voltmeter connected between test point and 0v, adjust T7 for:

ch 1 RX	1.5 volts
ch 40 RX	3.5 volts (approx.)
ch1 TX	2.8 volts (approx.)
ch 40 TX	5 volts (approx.)

Make Your Own PCBs

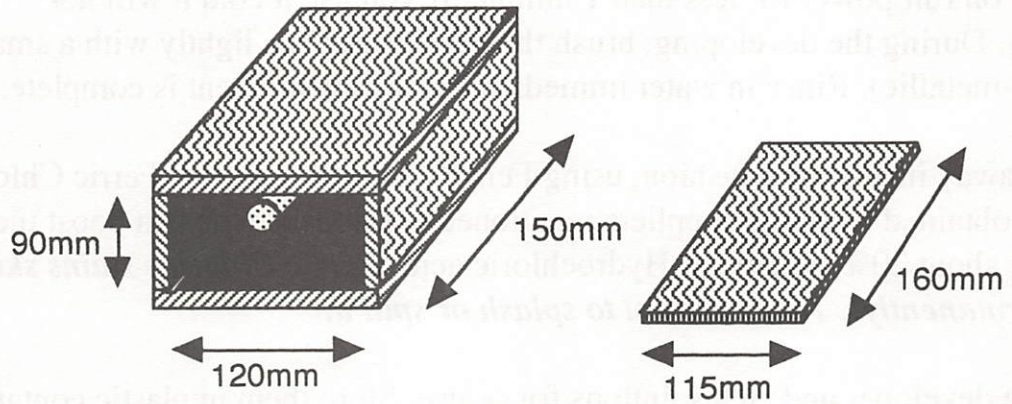
Making Printed Circuit Boards is simple if you have the equipment. Most people are put off by the cost but you can keep this to a minimum, as I did.

Ultra Violet Light Box

First you need a ballast kit for a 12" fluorescent tube. My original one came from Service Trading Co. in Newport St., London but they seem to have disappeared towards Putney, somewhere. However, it should not be difficult to obtain a complete 12" fluorescent light. The most obvious type would be a 12 volt "camping light" of the sort made by Ever Ready. This uses a small electronic oscillator and does not need the ballast and starter unit which are used on mains powered fluorescent lights.

Next you need an Ultra Violet fluorescent tube of the sort used to erase Eproms. This can be obtained from Watford Electronics, Jessa House, 250 Lower High Street, Watford. WD1 2AN. Tel. 0923 37774. Order as "Eprom Eraser, Spare tube". Price is about £10. The so called "black light" tubes are no use at all, by the way. You need the type of UV tube called "actinic" which has an output wavelength of about 250 nanometres.

Construct a wooden box, as shown, and mount the tube inside, using "Terry Clips" to secure it. A small piece of wood is used as a sliding tray to support the PCB.



Make the copper track layout with transfers on a piece of polyester draughting film. You can buy the transfers and film from Farnell Electronic Components Ltd, Canal Road, Leeds. LS12 2TU. Tel. 0532 636311 or from RS Components (Trade only). They can also supply the small scalpel which you will need for cutting and lifting the track transfers or tape. Maplin also supply these things but I found the transfers were not very good.

The PC Board material must be coated with photo etch resist varnish. You can buy the copper-clad board pre-coated from the above suppliers. Maplin and RS also sell aerosols of photo etch resist varnish which you can use to spray your own copper-clad board. This can be cheaper — especially if you scrounge guillotine off-cuts of PCB from your local

PCB manufacturer as I do! Note, however, that the edge of the sprayed PCB will not give good results so, if you do it yourself, always spray a large area of board then cut it to size after etching. The board should be scrubbed clean and be dry before you spray it. Follow the instructions on the can for spraying and drying. You can often speed up drying by using an oven.

Put the coated board on the wooden tray and position your film master on top. Make sure that the master is the correct way up! Keep the film flat against the board by placing on top of it a sheet of thin glass. This should be no more than 2mm thick. I use a piece intended for a welding visor. It is similar to that which is used for microscope slides. Try "Yellow Pages" under "Glass", "Optical" or "Laboratory".

Slide the tray into the box and turn on the U.V. lamp. 20 minutes exposure should be sufficient. The etch-resist varnish that was exposed to the U.V. light will now be washable in a caustic solution. You can use Sodium Hydroxide or whatever is recommended by the manufacturer of the etch-resist varnish. I prefer to use Maplin's Universal PCB Developer (JK73) crystals which can be dissolved in a jar full of warm water.

Pour the developer solution into a plastic tray (such as an empty margarine carton). The solution must be at a temperature of at least 20°C so I normally warm it up in the microwave oven on full power for less than 1 minute. If you use it cold it will not develop properly. During the developing, brush the varnish surface lightly with a small paint brush (non-metallic). Rinse in water immediately the development is complete.

Etch the copper away in a similar fashion, using Ferric Chloride solution. Ferric Chloride chrystals can be obtained from the suppliers mentioned previously. You can boost the action by adding about 20% volume of Hydrochloric acid. ***Ferric Chloride stains skin and clothing permanently! Take care not to splash or spill it.***

You can keep the developer and etch solutions for re-use. Store them in plastic containers with plastic lids, in a cool place, out of direct sunlight.

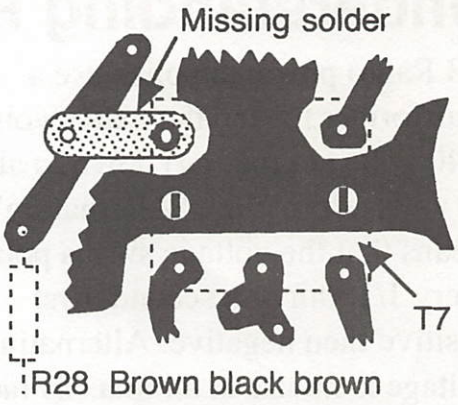
There is often no need to clean off the varnish. It will keep the copper bright and you can solder through it. Take care, however, because it can give off nasty fumes when you apply the soldering iron. Some people can be allergic to the fumes and they are certainly not nice to breathe. Work in a well-ventillated room. The same comment applies, in any case, to the flux used in solder.

For surface mount components there is no need to drill holes. Most boards will need some holes, however. You can use a 0.9mm drill bit with a 12 volt drill obtained from the suppliers mentioned previously.

Handy Hints

Cybernet Beta 3000

Symptom: very low RX signal. RF Gain control increases signal for approximately 3/4 turn clockwise but final 1/4 turn reduces again.



Cause: Someone may have removed solder link underneath the PCB as shown in this sketch.

Jesan KT5005 (white)

D11 (right of output driver) goes open circuit, resulting in no TX.

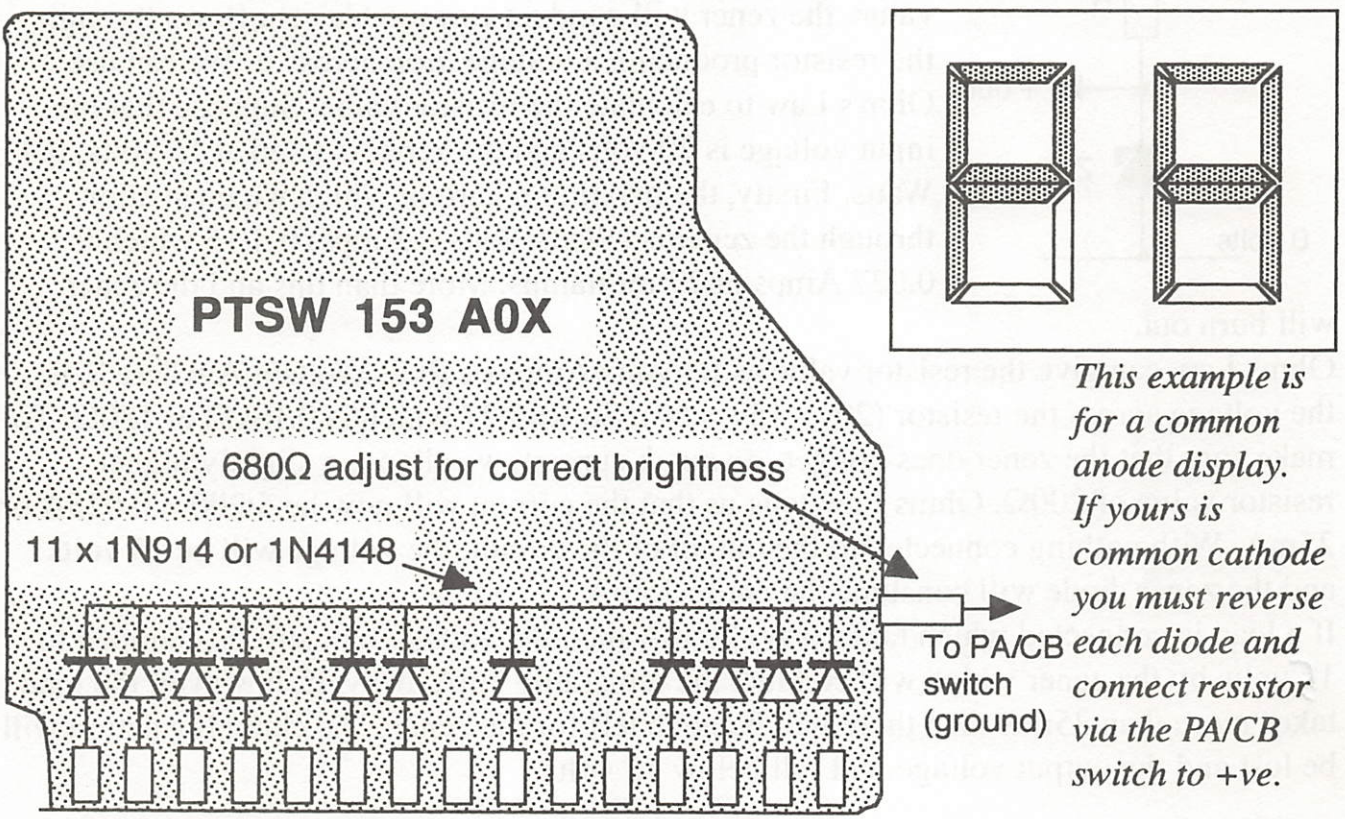
Audioline/Uniden etc.

Problem: Very low and distorted audio.

Solution: Remove mic input PCB and locate coil from earth pin to black wire (0 volt). If this coil is open circuit, replace it with a similar one or simply short it out.

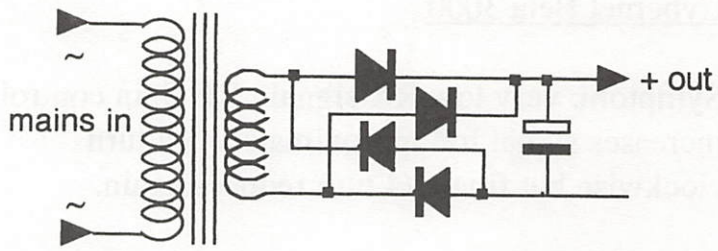
.....

If your channel display goes blank when you switch to P.A. you can add diodes to light up the relevant segments. Here is an example. Most rigs can be changed in a similar way.

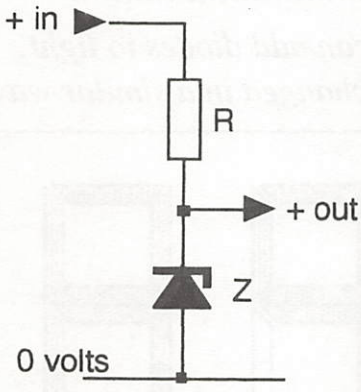


This example is for a common anode display. If yours is common cathode you must reverse each diode and connect resistor via the PA/CB switch to +ve.

Understanding Power Supplies



CB Radio power supplies use a transformer to step the mains voltage (240 volts alternating) down to about 20 volts alternating. "Alternating" means that the voltage swaps polarity every 1/100th of a second, first positive then negative. Alternating voltage is no use at all to a CB radio which needs around 13 volts "Direct Current" (non-alternating). The power supply achieves this requirement by means of four diodes. A diode will let current flow only if its cathode (bar end) is negative with respect to its anode. Imagine that the transformer shown in the sketch is a battery whose connections are being swapped 100 times a second. First one pair of diodes conduct, then the other. The positive voltage is always "steered" out through the cathode ends (in the direction of the arrows). However, although the polarity swapping has now been cured by the diodes, the voltage is still pulsating — it is not a smooth, steady voltage. To cure this problem a large capacitor is connected across the output. The capacitor acts as a reservoir for "spare" current and allows it to "leak out" more slowly in a smoother flow but the voltage is still too high and not stable.To achieve a really smooth voltage we can use a regulator circuit.

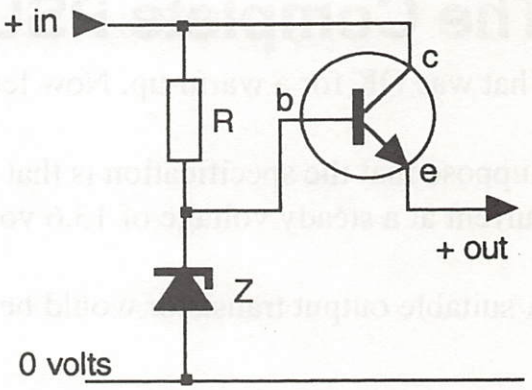


The simplest consists of a resistor and a zener diode. The zener diode ignores any voltage which is less than its rated "clamp" voltage. However, if the voltage is higher than this value, the zener will conduct current. Current flows through the resistor producing a voltage drop across it. We can use Ohm's Law to calculate the resistor value. Suppose that the input voltage is 20 volts and the zener is rated at 15 volts, 0.4 Watts. Firstly, the maximum current which we must allow through the zener is (Watts/Volts = Amps) 0.4/15 which is 0.027 Amps or 27 milliamps. More than this and the zener will burn out.

Ohms Law can give the resistor value as R=Volts/Amps or RkΩ=Volts/mA where V is the voltage across the resistor (20v - 15v = 5v). So R=5/27 which is 0.18kΩ or 180Ω. To make sure that the zener does not get *too much* current, we choose a slightly higher resistor value of 200Ω. Ohms Law tells us that the current will now be 5/200 = 0.025A or 25mA. With nothing connected to the output of the circuit, the voltage will be 15 volts and the zener diode will consume the entire 25mA.

If a load is connected which takes (say) 20 mA then the voltage will still be clamped to 15 volts by the zener which will conduct the remaining 5mA away. If, however, the load takes more than 25mA then there will be none left for the zener. The clamping action will be lost and the output voltage will fall below 15 volts.

You will see that the maximum current that a simple resistor/zener circuit can provide is limited by the rating of the zener diode itself. The current can be increased by adding a transistor to the circuit.
Now the important factor is the current rating of the transistor because it is providing all of the output current while the zener is simply holding the transistor base connection at a constant voltage.
The emitter of a silicon power transistor is always between 0.6 and 1.2 volts less than the base voltage.

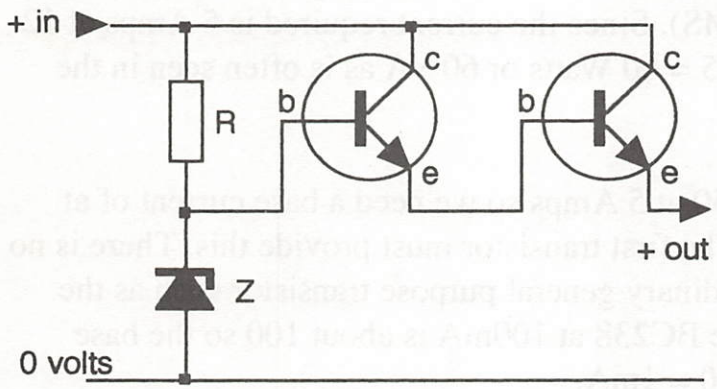


On average you can say that it will be about 0.7 volts less. So, if the zener clamps at 15 volts, the output from the transistor emitter connection will be 15 - 0.7 = 14.3 volts.

Another consideration is the amplification factor or gain of the transistor. At high current this gain will typically be about 50. The current allowed through the transistor is equal to the base input current multiplied by the gain. If we take a typical zener which needs at least 10mA flowing through it to produce a stable reference voltage (but not more than 25mA as we calculated) then that leaves 15mA to feed the transistor base connection. The maximum current flowing from collector to emitter will be

50 x15mA = 750mA.

This is still too small to run the average CB radio, although it's a lot better than 25mA!



To increase the available current still more it is possible to add another transistor. The first transistor can provide 750mA for the base of the second transistor. If this also has a gain of 50 then the maximum current which can flow through it is 37 Amps — more than enough for the radio and more than the rating of the transistor!

However the radio will only take as much current as it actually needs so designing the circuit for more current than is needed simply ensures that the voltage will be stable.

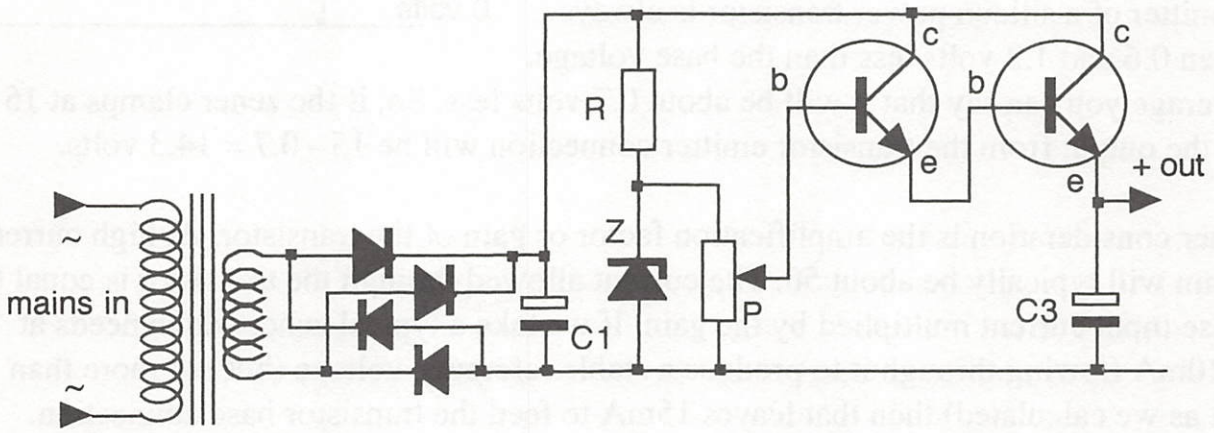
Since there is an extra base-emitter junction in line with the output, another 0.7 volts will be lost. With a 15 volt zener, therefore, the output voltage will stabilise at about 13.6 volts. If a potentiometer is connected across Z, and the base of the first transistor is connected to the slider, the output voltage can be varied from 0 to 13.6 volts.

The Complete PSU Design

That was OK for a warm-up. Now let's look at the design as a whole:

Suppose that the specification is that the PSU should be able to provide 5 Amps of current at a steady voltage of 13.6 volts DC.

A suitable output transistor would be the 2N3055 which is readily capable of providing



this current. To give us a reasonable amount of voltage in hand without forcing the 2N3055 to dissipate too much power, let's provide 3 volts extra so the transformer and diode combination must provide around 17 volts DC at 5 Amps. As a rule, such a combination will produce a voltage which is 1.4 times the rated RMS alternating voltage. In this case, therefore we need to buy a transformer rated at 240 volts mains input and 17/1.4 = 12.14 volts (let's say 12 volts RMS). Since the current required is 5 Amps at 12 volts we need a transformer rated at 12 x 5 = 60 Watts or 60 VA as is often seen in the catalogue.

The current gain of the 2N3055 is about 50 at 5 Amps so we need a base current of at least 5Amps/50 = 0.1 Amps or 100mA. The first transistor must provide this. There is no need to use a power transistor since an ordinary general purpose transistor such as the BC238 is rated at 200mA. The gain of the BC238 at 100mA is about 100 so the base current will need to be at least 100mA/100 = 1mA.

The resistor should be chosen to provide at least 10 times that amount of current to flow through the zener (i.e. 10mA) and its resistance can be calculated as follows:

R = (unregulated supply voltage - zener voltage)/current
R = (17 - 15)/10
R =0. 2kΩ for which the nearest standard value would be 220Ω.

Its Wattage rating must be at least (17 - 15) x 10 = 20 milliwatts. (Negligible!)

Since, in the worst case, the zener will draw 10mA at 15 volts then it must be able to dissipate 10 x 52 = 150 milliwatts. Most zeners are rated at 400mW minimum so this is no problem (but you should always check like this).

The reservoir capacitor, C1, must be rated at 17 volts minimum and the nearest preferred rating is 25 volts. It must also have a ripple-current rating of at least 5 Amps , otherwise it could overheat. As a general rule-of-thumb, its value should be roughly 1000μF for every Amp. In this case, I would use a 4700μF electrolytic capacitor.

A capacitor may be connected across the zener to kill diode noise which might occur.

C3 provides the final output smoothing and is usually about a tenth of the value of the reservoir capacitor. In this case an electrolytic of 470μF rated at 16 volts would do although a 25 volt rating would be a teeny bit safer for the nominal 13.6 volt output, bearing in mind that some twit might turn the adjuster up to the full 19 volts available.

There are lots of complicated calculations which we could make to prove these values but I am giving you the wisdom of my experience because these "rules-of-thumb" are easy to apply and work quite nicely.

If we look, again, at the power transistor we can see that, in the worst case it will be passing 5 Amps while dropping a maximum voltage of 17 - 13.6 = 3.4 volts. Allowing for variations and "pot twiddlers" I would calculate its dissipation (Volts x Amps) as 5 x 5 = 25 Watts. This is well within the capabilities of the 2N3055 provided that it is mounted on a suitable heatsink.

Heatsink calculations

The mathematical equation for calculating the dissipation factor for a heatsink looks a bit daunting but is actually very straightforward. Before I give the formula I want you to visualise exactly what is happening to the power transistor when it is dissipating 25 Watts of power in the form of waste heat. Firstly, the silicon junction itself is effectively acting as a resistance with current flowing through it and, therefore, produces heat. The junction will be at a high temperature because it can not get rid of this heat energy instantaneously.

Imagine the hot silicon chip attached to the metal case of the power transistor. The heat energy has to flow from the chip to the metal but there is a resistance to the flow of heat energy in the form of the bonding glue which can not conduct heat perfectly. The metal case, therefore, will never become quite as hot as the chip itself. We call the difference in temperature between the chip and the case a "temperature gradient". This resistance to heat energy can be given a value which we call the "dissipation factor".

The dissipation factor tells you how many degrees difference there will be between the chip temperature and the case temperature *for each Watt of power produced.*
To make this clear, just suppose that the chip temperature is 60°C and the power being dissipated is 10 Watts. For a 2N3055 transistor, the manufacturer's specification tells us that the chip to case dissipation factor is 1.5 degrees C per Watt (1.5°C/W) so, for every Watt there will be a difference of 1.5°C. If the junction temperature is 60°C then the case temperature will be 1.5 x 10 less than this. It will be 45°C. *This is an important concept.*

If the power transistor is mounted on a heat sink there will be a resistance to heat flow between the case and the heatsink. If, as is usual, there is an electrical insulator between the two — usually a mica washer with silicone grease applied — then this resistance to heat flow will be even higher. In fact, according to the data book, it will be 0.4°C/W. This is a lower value than the resistance between junction and case because the area is so much larger. With 10 Watts being dissipated there will be another 4°C difference in temperature between the transistor case and the heatsink. OK, so much for the theory.

We can get information about dissipation factors from data books and the rest we know. Let's list everything:

Power dissipated by the transistor in our circuit P = 25 W
Maximum allowed chip junction temperature J = 200°C
Chip to case dissipation factor (2N3055) C = 1.5°C/W
Case to heatsink through mica and grease H = 0.4°C/W
Heatsink to air dissipation factor A = ? This is what we need to find.
Maximum ambient air temperature inside PSU box T = 65°C
(We choose this as a reasonable value — any higher than this and we would have reliability problems with capacitors etc.)

The standard equation is:

$$P = \frac{J - T}{A + C + H}$$ but we need to find A

$$A + C + H = \frac{J - T}{P} \quad \text{so} \quad A = \frac{J - T}{P} - (C + H)$$

$$A = \frac{200 - 65}{25} - (1.5 + 0.4)$$ which we can work out to give —

A = 3.5°C/W which is the dissipation of the heatsink.
All we have to do is to look in a catalogue to find the heatsink with the nearest *lower* value to be on the safe side. A "Redpoint 3.5Y" rated at θ = 3.4°C/W looks ideal.

Try it Yourself

The foregoing explanation is a little technical and the best way to understand it is to work out some examples for yourself.

Suppose, for instance, that you were to use a BD935 instead of a 2N3055.
The BD935 is in a TO220 plastic package with metal tab. The information you need to know is:

Chip to case dissipation factor C = 5°C/W
Case to heatsink factor H = 0.9°C/W with a mica washer and silicone grease each side.
Max junction temperature J = 175°C
All the other information is unchanged. Simply substitute these values into the equation.

What does the answer indicate?
If the chip to case factor C = 2°C/W instead of 5, what difference would that make?

You can get lots more information about heatsinks and calculations from the "Redpoint" catalogue — tel. 0973-537861 or write to:
Redpoint Ltd, Cheney Manor, Swindon, Wiltshire. SN2 2QN

Safety Considerations

Safety is important but is often overlooked by foreign PSU manufacturers.
There is a British Standard which gives guidelines for the design of PSUs. These are some of the considerations:

The mains cable Live wire should go directly to a fuse inside the PSU.
Both the Live and the Neutral wires should then go through a two-pole on/off switch before connection to the transformer.
The earth wire should be connected directly to the metal box housing unless the entire PSU is double-insulated. The earth wire connection must *not* share a bolt with anything else. For instance, it should not be bolted down with a bolt which also secures the transformer.

The fuse value can be calculated quite easily. If the PSU is rated at 12 volts 5 Amps, for instance, then 5 is to 12 as "x" is to 240. The fuse rating "x" = 5 x 12/240 Amps.
This would be 0.25 Amps or 250mA. Now multiply this by 2 because the transformer is typically only 50% efficient (half the input power is lost as heat in the transformer so a 60VA transformer actually uses 120 Watts). Because the reservoir capacitor takes a large surge of current at switch-on the fuse should be a Time delay type which would be marked T500mA.

Handy Hints

Team TRX 40

Problem: TX but no modulation. Very common fault.
Cause: Back of mic socket is PCB mounted and the holes in it are far too large. Re-solder the pins in the holes.

Planet 2000

Problem: Received signal disappears after transmitting. Only a hiss can be heard.
Solution: re-tune power coils L8 and L7.

Eprom Board

Problem: Any rig fitted with an Eprom board which is stuck on one channel.
Solution: try replacing 78L05 regulator on the Eprom board.

Cybernet board

Cybernet coil T4 can be replaced by L4 — yellow power coil at the rear of the set.
Remove the T4 can and fit the L4 coil into the pair of holes (not the row of 3 holes).

To increase outgoing modulation, remove R72 next to the modulation preset and replace it with a wire link.

To increase incoming audio, remove R57 from the front of the board and replace it with a wire link.

Uniden PC 40

This rig has 40 FM and 12 AM channels. If you look at the back of the PCB near the front end you will see a 10kΩ resistor. Disconnect this and you will acquire the full 40 FM *and AM* channels. Note that AM will still give only 1 Watt output power.

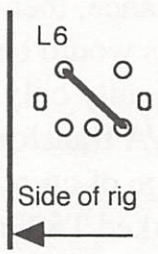
Talk Back

For Superstar 360FM, Cobra 148GTL DX: disconnect one leg of D80 and insert a switch in series with it.

Superstar 3600, 3900; Excalibur SSB; Galaxy 2100; Texas Star 2100: disconnect one leg of D90 and insert a switch in series with it.

Fidelity 1000, Cheiza etc.

Transformer L6 gets damaged as a screw is pushed into it.
As a temporary repair, simply remove it and link diagonally opposite holes. Power will be slightly down but performance will not be affected noticeably.



Semiconductor Lead Configurations

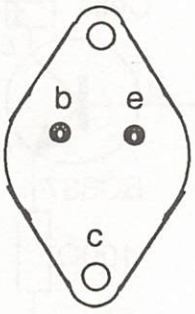
2SB9426

2SB525
2SC2086

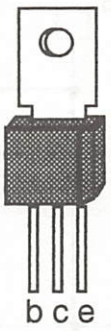
2SA564
2SA733
2SA950
2SC373
2SC380
2SC828
2SC829
2SC945A
2SC1359
2SC1674
2SC1675
2SC1730
2SC1815
2SC2236A
2SC2347
2SD468

BC239
BC328
BC337
2N3906

2N4124
2SC9418
2SC9623
2SC9631
2SC9634

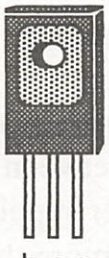


2N3055
2N2955



2SC1096
2SC2036A

2SA473
2SA1012
2SC1306
2SC1969
2SC1974
2SC2075
2SC2078
2SC2166
2SC2312
2SD837B
TIP110
TIP120



2SC495
2SC2314

VN10KM

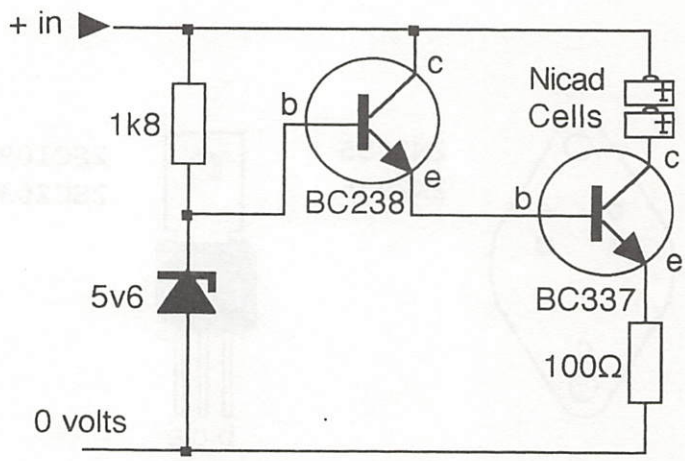
2SC1166

Nickel-Cadmium Rechargable Batteries

Nicad cells have a limited life of about 500 charge-discharge cycles. This life can be extended in ideal conditions or much reduced if they are misused.
Unlike a car battery which needs a constant-voltage supply, a nicad requires a constant-current. Ideally, an AA size nicad should be charged at a current of 45mA for 14 hours, immediately after complete discharge. It is permissible to charge them at 150mA for 4 hours but the life will be greatly reduced. For small electric racing cars the nicad cells are often charged at about 4 Amps for 15 minutes.

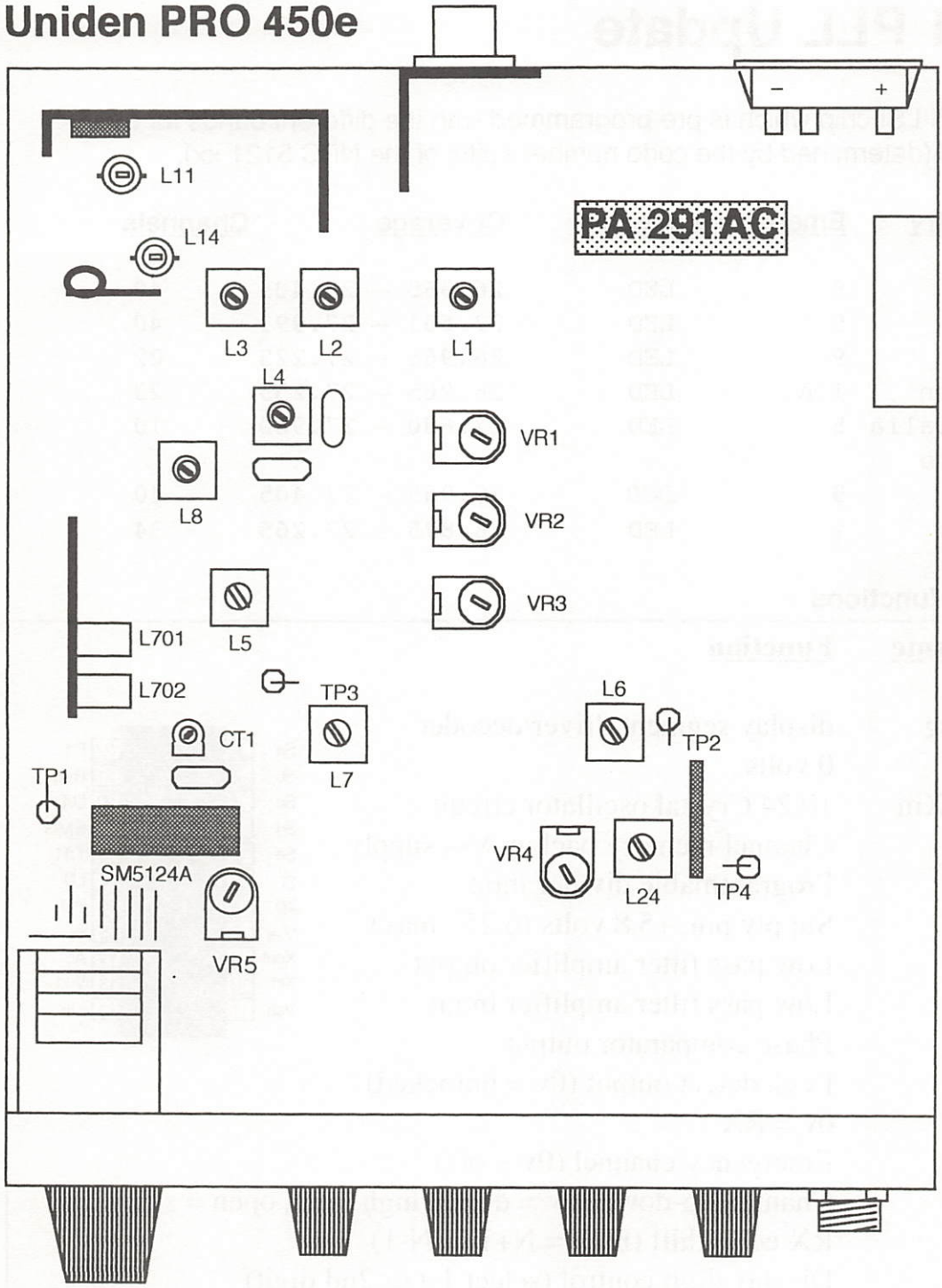
This method provides sufficient energy for a race but the overall life of the cells is reduced so much that after about 50 cycles (races) the cell capacity will be reduced so much that it will not be possible to complete a race. For those of you who *have* to use them like this, I would advise you to keep them cool. Seal them in a polythene bag and place it in a bucket of cold water during charging. The life of each cell will be slightly greater and, when cool, the cells produce maximum output energy for a race.

For CB radio use, the 14 hour charge rate is the best and can be achieved with the simple circuit shown here. This circuit allows a current of 45mA to flow through the cells. The number of cells which can be charged (connected in series) at one time is equal to $\frac{V - 6}{1.35}$ where V is the DC supply voltage.
The maximum supply voltage permitted for this circuit is 20 volts which will allow you to charge any number of cells between 1 and 10.
If you use a car cigar lighter socket to power the circuit (about 14 volts) then you can charge as many as 6 cells.



Remember that the cells should be charged for 14 hours when they have been fully discharged. If you leave them in the discharged state without charging them then they will usually go short-circuit within a few days. At this point it will be impossible to charge them. There is, however, a method to rejuvenate "dead" cells but it doesn't always work and ***must be approached with caution***. Place a guard of wood or plastic between yourself and the cell in case the cell ruptures. Connect the cell to a 12 volt power supply or car battery for *no more than 20 seconds*. If it then gives a voltage reading of more than 1 volt, charge the cell for 14 hours with the 45mA charger unit. The cell's life will have been reduced but it might save the cost of a new one for a few more weeks.

Uniden PRO 450e



Presets

VR1	Squelch
VR2	TX meter
VR3	RX meter
VR4	Mod meter
VR5	FM dev'n
L24	FM discrim
L701	VCO
L702	VCO
L11	RF output
L14	RF output

All others are RX

VCO Frequencies

	MHz
ch 1 RX	16.27
ch 40 RX	16.71

(TX VCO runs at the actual TX frequency.)

Test Points

TP1	VCO
TP2	Input to FM detector IC
TP3	TX VCO
TP4	Audio output from FM detector IC

VCO Adjustment

Connect a DC voltmeter between 0v and TP1.
On ch 1 RX adjust L701 for 2 volt reading.
ch 40 RX should be approximately 4 volts.
On ch 1 TX adjust L702 for 2 volt reading.
ch 40 TX should be 3.5 to 4 volts.

TX Adjustment

Since the VCO runs at the actual TX frequency, the only adjustments to be made are for RF output filtering (L14 and L11 at the back of the rig).

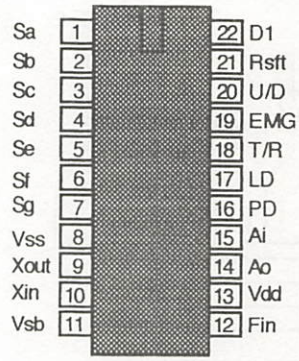
NPC 5121 PLL Update

This is a PLL CMOS LSI chip which is pre-programmed with the different bands for every country in the world (determined by the code number suffix of the NPC 5121 xx).

Code	Country	Emergency	display	Coverage	Channels
C 5121-00	USA	9	LED	26.965 – 27.405	40
C 5121-01	UK	9	LED	27.601 – 27.991	40
C 5121-05	FTZ	9	LED	26.965 – 27.225	22
C 5121-06	Sweden	11A	LED	26.965 – 27.255	23
C 5121-08	Australia marine	5	LED	27.680 – 27.980	10
C 5121-09	USA	9	*LCD*	26.965 – 27.405	40
C 5121-10	Italy	9	LED	26.875 – 27.265	34

Description of pin functions

Pin No.	Pin Name	Function
1 — 7	sa — sg	display segment driver/decoder
8	Vss	0 volts
9, 10	Xout, Xin	10.24 Crystal oscillator circuit
11	Vsb	Channel memory backup Vss supply
12	Fin	Programmable divider input
13	Vdd	Supply pin, +5.8 volts (6.25v max)
14	Ao	Low pass filter amplifier output
15	Ai	Low pass filter amplifier input
16	PD	Phase comparator output
17	LD	Lock detect output (0v = unlocked)
18	T/R	0v = RX
19	EMG	Emergency channel (0v = off)
20	U/D	Channel up-down (0v = down, high = up, open = stop)
21	Rsft	RX code shift (high = N+1 or N-1)
22	D1	Display digit control (select 1st or 2nd digit)



LED Display is always common anode fed by pins 1 — 7 via 150Ω resistors.
D1 output switches alternately high and low and 3 transistors must be used to select the two display cathodes — one high while the other is low.

As with any CMOS Large Scale Integration I.C. the 5121 must be handled with due regard to Electrostatic Protection.

Power Loss in Cables

The power loss in coaxial cable becomes significant if a long length is used.
For instance, the standard RG58 has a loss factor at 27MHz of 1dB per 12 metres.
If we transmit 4 Watts into a 12 metre line, assuming that the aerial is a perfect 50Ω match, then the power loss can be calculated by the well known[1] formula:

$$-1\text{dB} = 10 \log \frac{P2}{P1}$$

where P1 is the power from the rig (4 Watts)
and P2 is the power which reaches the aerial.

$$-1 = 10 \log \frac{P2}{4}$$

$$\frac{-1}{10} = \log \frac{P2}{4}$$

$$\text{Antilog } \frac{-1}{10} = \frac{P2}{4}$$

$$P2 = (\text{Antilog } 0.1) \times 4$$

$$P2 = 3.177 \text{ Watts}$$

[1] *(OK so I had to look it up in a book then get a college lecturer to explain it to me!)*

By substituting 100 instead of 4 in this equation, you can show that a 100 Watt burner will only manage to get 79.4 Watts through this length of cable to the aerial.

Interestingly, this power loss has the effect of making your SWR look better than it really is. After all, if only 3/4 of the power is reaching the aerial and only 3/4 of the reflected portion of that gets back to the rig, then a SWR meter at the rig end of the cable will measure a much smaller Voltage Standing Wave Ratio than it would if it were at the aerial end of the cable.

The moral is:
Always connect your SWR meter at the aerial end of the coax to obtain a true reading.

RG8 cable has a loss factor of only 1dB for every 34 metres so you can use almost three times the length of cable for the same power reduction as RG58.

If your cable is old and moisture has seeped inside, or if it is kinked or damaged, then the loss factor will be increased significantly. Unnecessary joints in the cable will reduce power as will any form of antenna switch or SWR meter. Even the best design of meter will introduce losses, simply because losses occur in the PL connectors used to connect it.

The moral is:
Always avoid having unnecessary connections in the cable between the rig and the aerial.

Where connectors have to be used, always ensure that they are soldered to a cable end.

To keep outdoor connections water-tight, bind them with self-amalgamating tape (sold at Tandy shops) or with DENSO tape. This is a hessian type fabric impregnated with something like gooey black treacle. It is sold by builders merchants for binding joints in underground pipes. It is *very* sticky and, being waterproof, is very difficult to wash off. *Do* wear plastic gloves or polythene bags on your hands and avoid touching your clothing.

Variable Power Supply

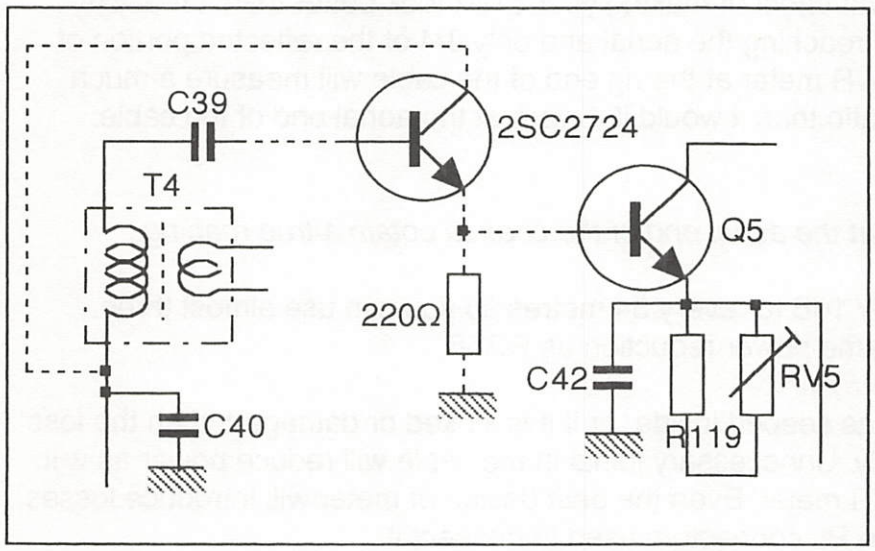
Most budding "Rig Doctors" dabble in electronics and need a bench power supply with a variable output. A cheap answer is to convert an existing CB radio supply.

The BREMI 3 Amp supply is an ideal candidate for conversion. Simply transfer all of the innards to a larger, professional-looking metal housing. Remove the preset resistor and wire in a potentiometer which you can mount on the front panel.

A meter scaled 0 — 20 or 0 — 25 can be mounted on the panel. Connect it across the PSU output terminals with a preset resistor in series with one of its wires. Adjust the preset so that it gives the correct voltage reading (use a multimeter for comparison).

You now have a Power Supply which will supply from 6 to 20 volts at a maximum of 3 Amps — adequate for most circuits.

If you want to make some money, re-sell it for double the amount you paid for it!

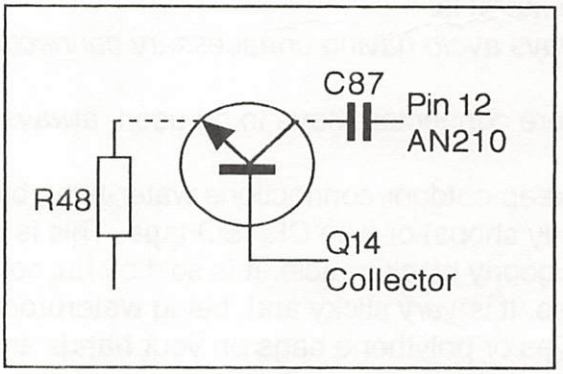


Added Power

You can boost the output power of the Cybernet PTBM134A0X board by adding one transistor and one resistor as shown in the sketch.

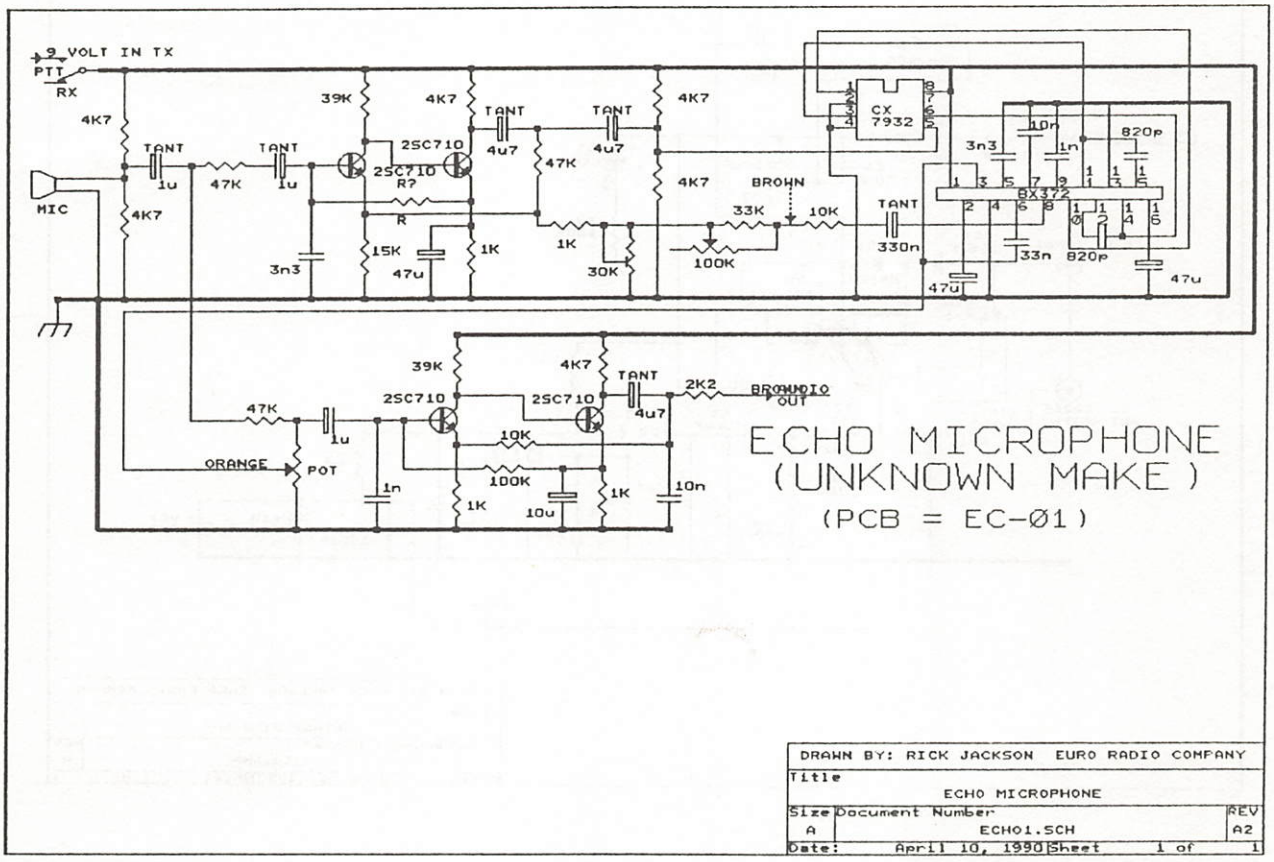
Cybernet Squelch Mod

1. Add 3k3 in series with squelch pot.
2. Add NPN transistor as shown in sketch.
3. Change C109 to 1μF for faster squelch operation.



This page was contributed by Tony Madden

Mic circuit Diagrams



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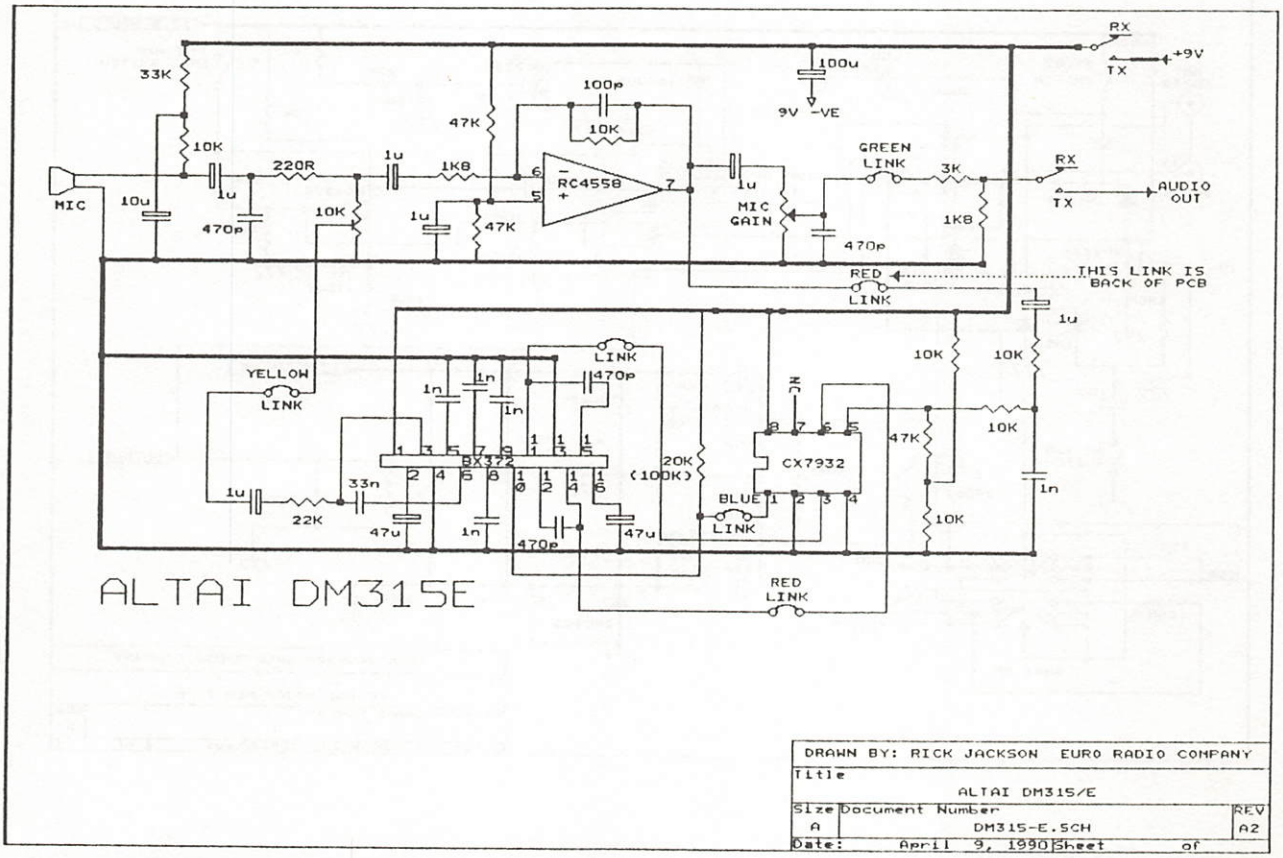

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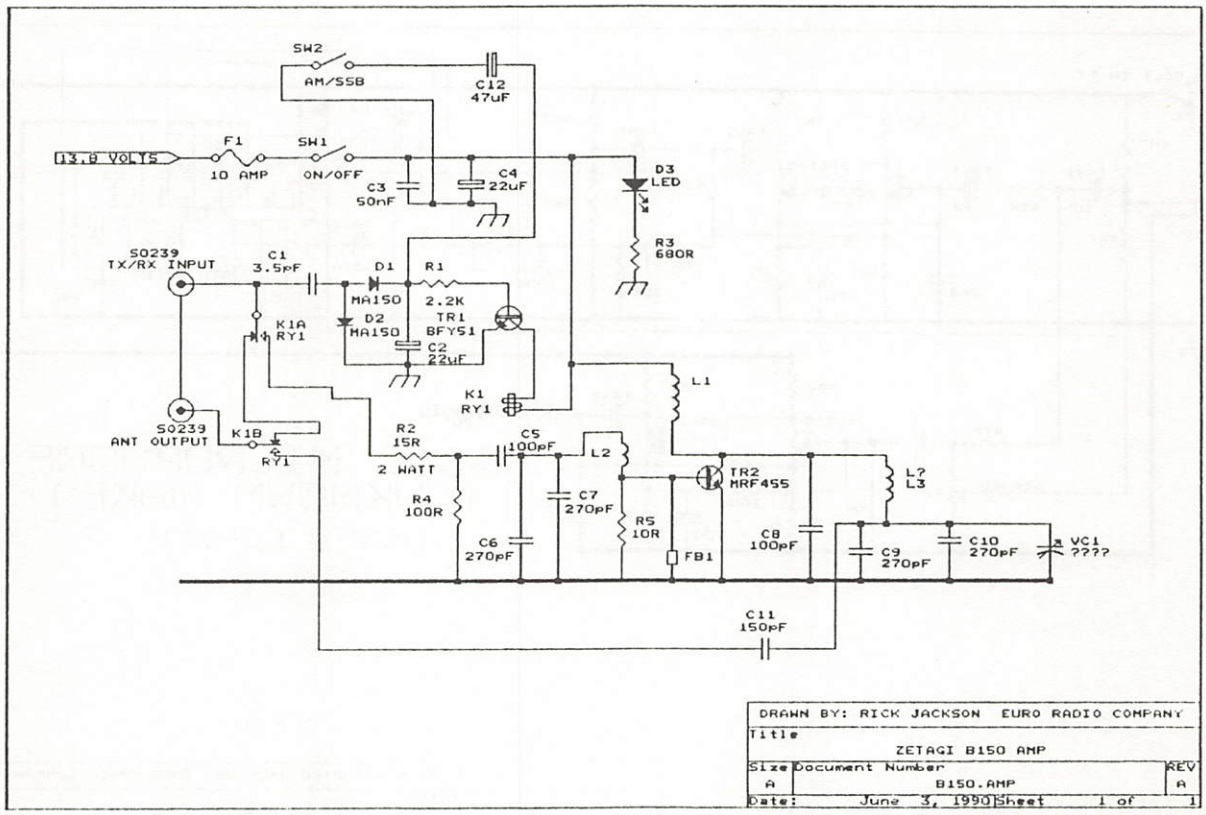
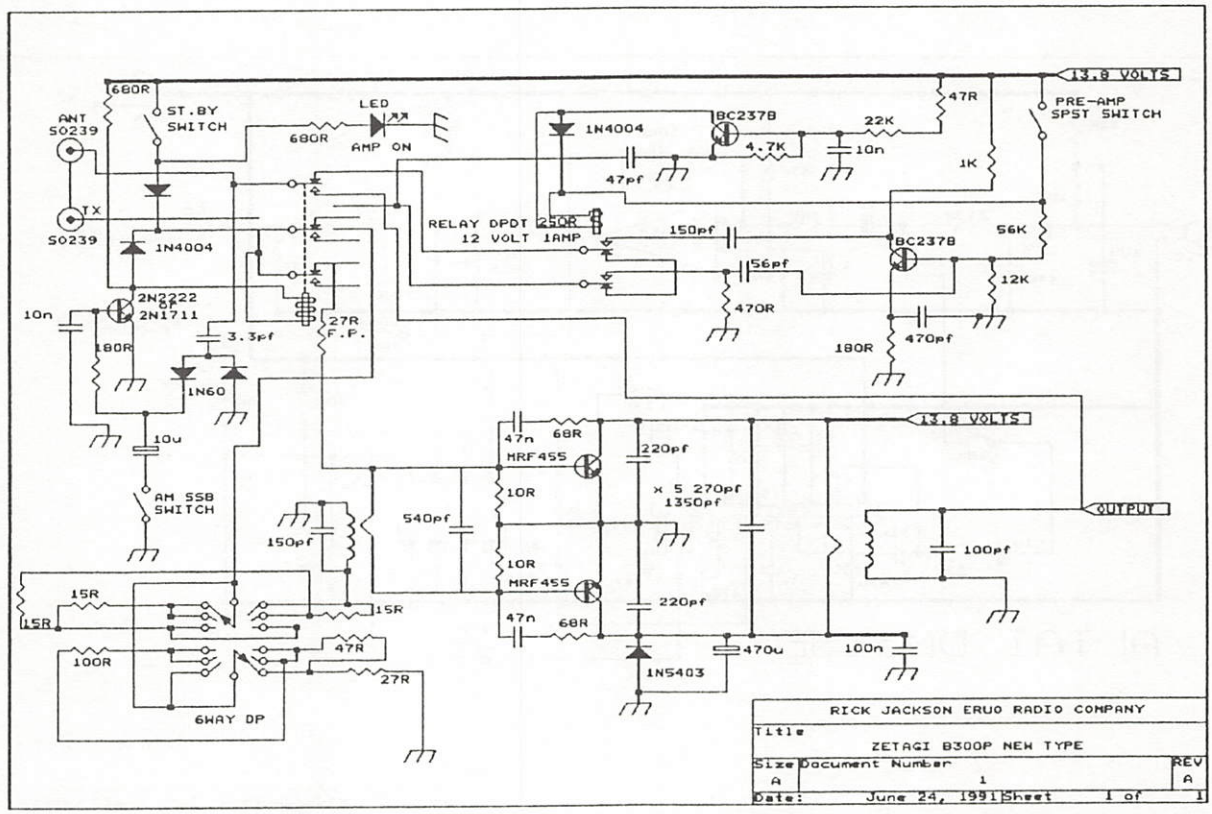
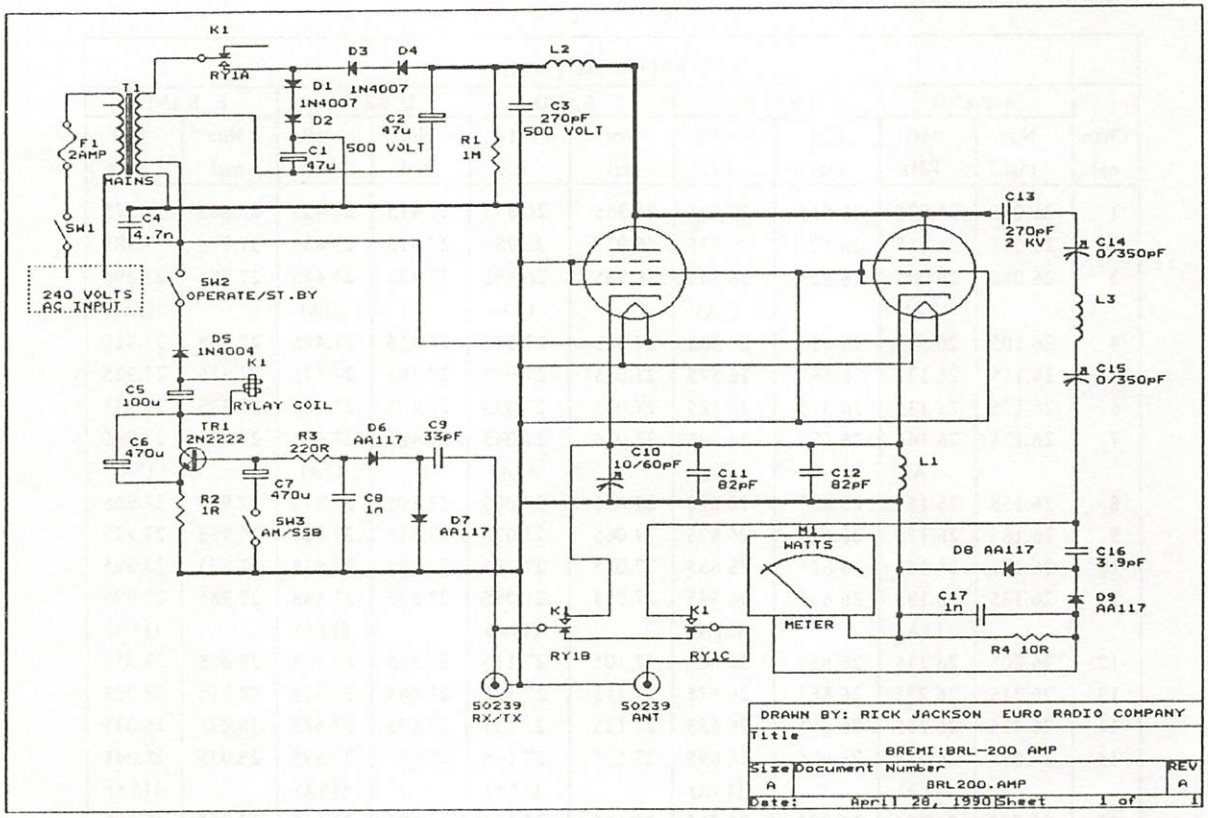
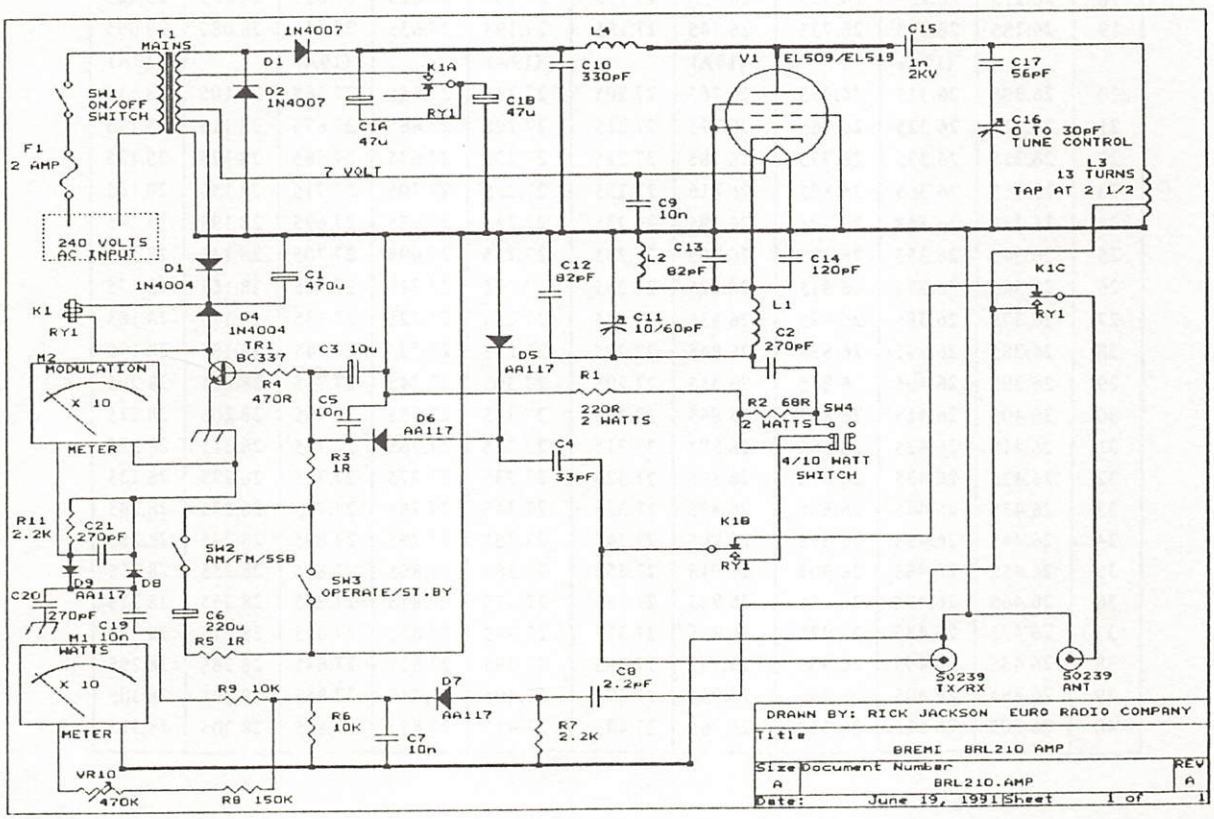
Zetagi B150 and B300P





Bremi BRL200 and BRL210



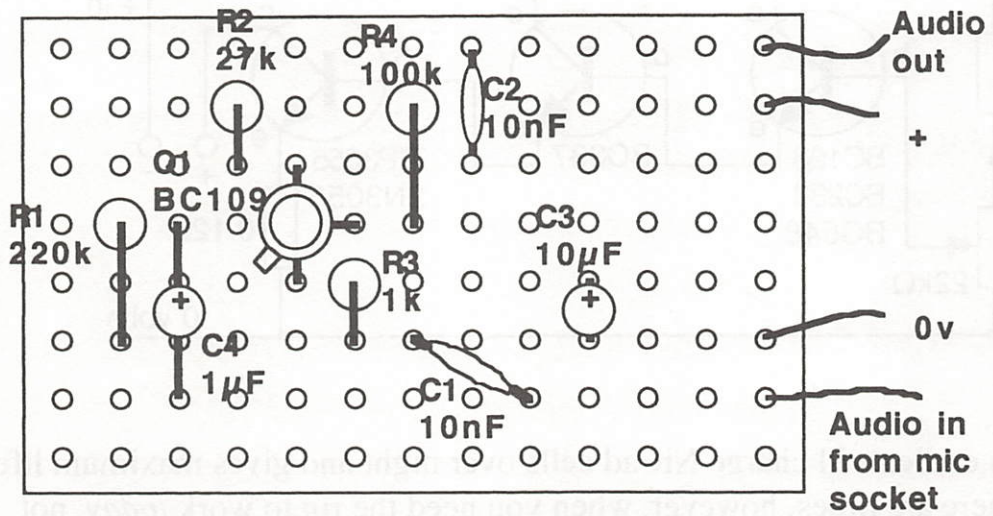


CB Frequencies chart

Frequency Channel Chart (Normal)

	ANT FREQUENCY (MHz)									
	A BAND		B BAND		C BAND		D BAND		E BAND	
Chan nel	Nor mal	+10 KHz	Nor mal	+10 KHz	Nor mal	+10 KHz	Nor mal	+10 KHz	Nor mal	+10 KHz
1	26.065	26.075	26.515	26.525	26.965	26.975	27.415	27.425	27.865	27.875
2	26.075	26.085	26.525	26.535	26.975	26.985	27.425	27.435	27.875	27.885
3	26.085	26.095	26.535	26.545	26.985	26.995	27.435	27.445	27.885	27.895
		(3A)		(3A)		(3A)		(3A)		(3A)
4	26.105	26.115	26.555	26.565	27.005	27.015	27.455	27.465	27.905	27.915
5	26.115	26.125	26.565	26.575	27.015	27.025	27.465	27.475	27.915	27.925
6	26.125	26.135	26.575	26.585	27.025	27.035	27.475	27.485	27.925	27.935
7	26.135	26.145	26.585	26.595	27.035	27.045	27.485	27.495	27.935	27.945
		(7A)		(7A)		(7A)		(7A)		(7A)
8	26.155	26.165	26.605	26.615	27.055	27.065	27.505	27.515	27.955	27.965
9	26.165	26.175	26.615	26.625	27.065	27.075	27.515	27.525	27.965	27.975
10	26.175	26.185	26.625	26.635	27.075	27.085	27.525	27.535	27.975	27.985
11	26.185	26.195	26.635	26.645	27.085	27.095	27.535	27.545	27.985	27.995
		(11A)		(11A)		(11A)		(11A)		(11A)
12	26.205	26.215	26.655	26.665	27.105	27.115	27.555	27.565	28.005	28.015
13	26.215	26.225	26.665	26.675	27.115	27.125	27.565	27.575	28.015	28.025
14	26.225	26.235	26.675	26.685	27.125	27.135	27.575	27.585	28.025	28.035
15	26.235	26.245	26.685	26.695	27.135	27.145	27.585	27.595	28.035	28.045
		(15A)		(15A)		(15A)		(15A)		(15A)
16	26.255	26.265	26.705	26.715	27.155	27.165	27.605	27.615	28.055	28.065
17	26.265	26.275	26.715	26.725	27.165	27.175	27.615	27.625	28.065	28.075
18	26.275	26.285	26.725	26.735	27.175	27.185	27.625	27.635	28.075	28.085
19	26.285	26.295	26.735	26.745	27.185	27.195	27.635	27.645	28.085	28.095
		(19A)		(19A)		(19A)		(19A)		(19A)
20	26.305	26.315	26.755	26.765	27.205	27.215	27.655	27.665	28.105	28.115
21	26.315	26.325	26.765	26.775	27.215	27.225	27.665	27.675	28.115	28.125
22	26.325	26.335	26.775	26.785	27.225	27.235	27.675	27.685	28.125	28.135
23	26.355	26.365	26.805	26.815	27.255	27.265	27.705	27.715	28.155	28.165
24	26.335	26.345	26.785	26.795	27.235	27.245	27.685	27.695	28.135	28.145
25	26.345	26.355	26.795	26.805	27.245	27.255	27.695	27.705	28.145	28.155
26	26.365	26.375	26.815	26.825	27.265	27.275	27.715	27.725	28.165	28.175
27	26.375	26.385	26.825	26.835	27.275	27.285	27.725	27.735	28.175	28.185
28	26.385	26.395	26.835	26.845	27.285	27.295	27.735	27.745	28.185	28.195
29	26.395	26.405	26.845	26.855	27.295	27.305	27.745	27.755	28.195	28.205
30	26.405	26.415	26.855	26.865	27.305	27.315	27.755	27.765	28.205	28.215
31	26.415	26.425	26.865	26.875	27.315	27.325	27.765	27.775	28.215	28.225
32	26.425	26.435	26.875	26.885	27.325	27.335	27.775	27.785	28.225	28.235
33	26.435	26.445	26.885	26.895	27.335	27.345	27.785	27.795	28.235	28.245
34	26.445	26.455	26.895	26.905	27.345	27.355	27.795	27.805	28.245	28.255
35	26.455	26.465	26.905	26.915	27.355	27.365	27.805	27.815	28.255	28.265
36	26.465	26.475	26.915	26.925	27.365	27.375	27.815	27.825	28.265	28.275
37	26.475	26.485	26.925	26.935	27.375	27.385	27.825	27.835	28.275	28.285
38	26.485	26.495	26.935	26.945	27.385	27.395	27.835	27.845	28.285	28.295
39	26.495	26.505	26.945	26.955	27.395	27.405	27.845	27.855	28.295	28.305
40	26.505	26.515	26.955	26.965	27.405	27.415	27.855	27.865	28.305	28.315

Mic Amplifier



Just like having a Leson Power mic inside your rig!

We have used this simple circuit quite a few times when people have complained about poor transmitted audio. Audioline/Uniden especially, while being excellent rigs, have a very bassy audio sound.

So get your cloggs on and build this circuit. (Now you *know* we are from Oldham).

It can be built on veroboard, quickly and without fuss. There are no track cuts to be made and it will fit easily inside most rigs.

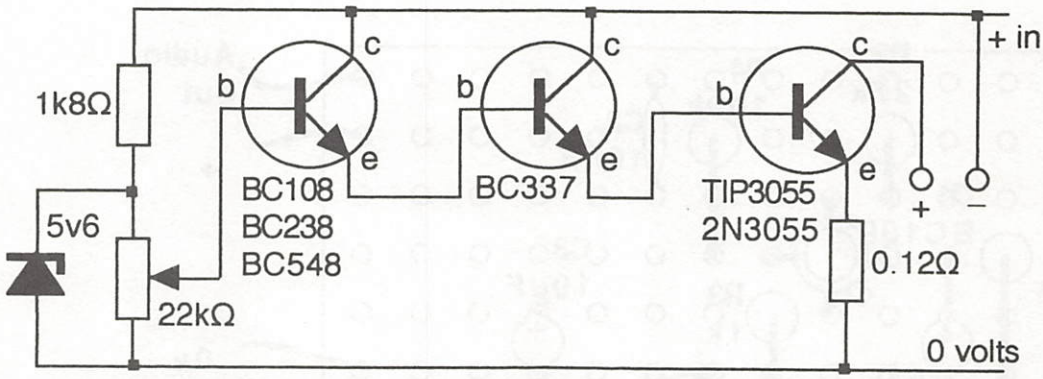
Resistors: R1 = 220kΩ
R2 = 27kΩ
R3 = 1kΩ
R4 = 100kΩ

Capacitors: C1 = 10nF Disc Ceramic
C2 = 10nF Disc Ceramic
C3 = 10µF/16v Electrolytic
C4 = 1µF/35v Tantalum bead

Transistor Q1 can be any low-noise silicon device.
We found that a 2SC458 worked best but a BC109, BC149, BC169 or MPS6521 will also work.

This idea was submitted by Kevin of Millard & Co., Oldham.

Fast NiCad Charger



The design shown earlier will charge NiCad cells over night and gives maximum life from each cell. There are times, however, when you need the rig to work *today*, not tomorrow. If you are prepared to accept that the NiCad cells will not give as many charge/discharge cycles in the long term, you can use this fast charging circuit which will provide up to 4 Amps of current.

The 3055 transistor should be mounted on a large heatsink. You can work out what rating the heatsink should be if you use the information given earlier. Assume that the transistor will be subjected to the full power supply voltage at a current of 4 Amps. If in doubt then use the biggest heatsink you can get!

The power supply voltage must be at least 0.5 volt greater than the total voltage of the cells which you are charging. Ten cells of 1.35 volts would require a supply of 14.0 volts DC, minimum. The cigarette lighter socket in a car will do the job, provided that the engine is running. Alternatively, a 5 Amp CB power supply will do but you may need to increase the output voltage a little above 14 volts.

Connect an ammeter in series with the cells and set the potentiometer to the appropriate current. 4 Amps will charge in about 15 minutes. If possible, keep the cells cool during charging by sealing them in a polythene bag and immersing in a bucket of water. Suck out all the air or the bag will float!

If time permits, charge for longer at a lower current. Remember that a fast charge reduces the life of the NiCad cells. 2 Amps for half an hour is kinder than 4 Amps for 15 minutes and 1 Amp for an hour is kinder still.

This circuit is ideal for charging the battery pack in a model racing car but must *not* be used for lead-acid batteries or gell-cells!

Handy Hints

The bottom of a stud mount will screw into a normal 3/8" socket to adapt from 3/8" to SO259 socket.

A 2SC2086 driver transistor can be replaced by a 2SC2314.

A 2SD471 or 2SD400 can be replaced by a 2SC2236.

A K40 antenna can have the cable replaced. Drill the solder out of the top of the mount where the cable goes in and the cable will pull out. Simply feed back the shield line for a PL259. Push back into hole and re-solder.

Warning: the 1307 device in some burners are not the same as a 2SC1969. They are FETs and can not be replaced by an ordinary RF power transistor.

A microphone plug wired for Cybernet rigs can be turned round to fit a Fidelity 1000 type set if you file a second groove in the plastic part of the plug, opposite the existing groove. Similarly, a Fidelity 1000 plug can be filed to fit a Cybernet type rig.

Audioline

Problem: No incoming audio unless sides of rig are pressed.
Answer: Look for a dry joint on the audio I.C.

Cybernet board
Problem: channels all mixed up.
Answer: Look for dry joints on the channel selector switch.

Problem: Stuck on one channel.
Answer: Change the PLL I.C. LC7137/LC7136.

If you use the low power switch to give extra channels don't just tape the existing wires together. Remove them and bridge PCB pads next to T4 numbered 32 and C6.

Superstar 120 AM - FM
Problem: Stuck on TX. When you press mic button you get RX.
Answer: Replace the diode situated next to the relay.

DNT Transittype rig
Problem: Stuck on channel 9. No RX or TX.
Answer: PLL I.C. type 5121-01 is blown. Currently unavailable.

80 Watts From Your Amstrad

Everyone knows that shorting out the big 3.6Ω resistor will increase the transmitted power to 8 Watts (for at least five minutes until the RF output transistor blows). However, most people ignore the simplest and most reliable method to increase power, as follows.

Connect the rig to a 13.8 volt power supply and ensure that it is operating correctly.

Remove all 8 screws which secure the covers and disconnect the loudspeaker wires. Ensure that the 3.6Ω resistor is still in place and not shorted out. If it has been removed you must replace it. Desolder the RF output transistor Q8. Unscrew it from the side panel and remove it together with its insulating washer. Store these parts in a safe place.

With a really hot soldering iron, solder up the slots in the side panel where the transistor mounting has been pressed out. This will allow the transistor to dissipate far more heat into the surrounding metalwork which will act more efficiently as a heat sink. You may need to use some plumber's flux and rub the soldering iron tip up and down the slot to achieve really good adhesion of the solder. Take a current credit card and telephone 0922646710 to order a CTE747. This is rated at 80 Watts and will easily handle the required power. Replace the original RF power transistor together with its (undamaged) insulating washer. Bolt the transistor in place then solder the leads beneath the PCB.

Reconnect the loudspeaker wires and screw the covers back on. Using a suitable dummy load and wattmeter, ensure that the rig provides just under 4 Watts on a supply voltage of 13.8 volts. Connect the CTE747 and ensure an output of 75 to 80 Watts. If more than 80 Watts is produced, increase the value of the 3.6Ω resistor to 4.7Ω otherwise interference will occur and the unit might also be damaged.

Warning. *The ownership and use of this equipment is illegal.*

Did You Know?

As many as 20% of rig faults are caused by owners trying to mend a fault which wasn't even caused by the rig in the first place.

Most "screwdriver experts" fail because:

1. They don't make a sketch of adjusters, components or wiring before twiddling.
2. They take out more than one component at a time, often mixing them up during replacement.
3. They don't have the basic equipment (solder sucker, fine soldering tip, fine gauge solder, side cutters, pliers, tweezers, circuit diagram and plain common sense).

Converting the Cobra Bandswitch

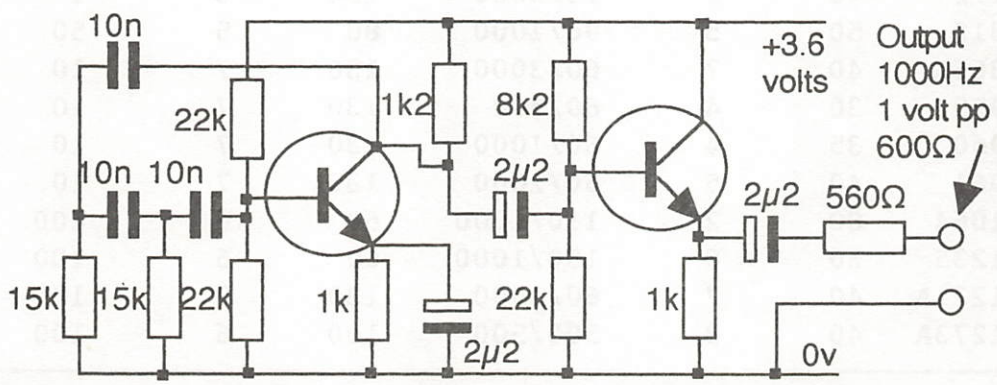
To convert the standard Cobra 148 GTL DX bandswitch from three positions to six:.

* Using side cutters or a knife blade, gently ease up the edges of the plastic rivet heads ***but do not cut them off!***
* Prise off the metal plate.
* Lift off the dark green moulding containing switch contacts.
* Put remaining assembly into a clear polythene bag or you will lose the bits!
* Working inside the bag, prise the circlip off the spindle.
* Remove the spindle then use it to push out the light green rotating part, noting the tiny ball bearing which will fly out!
* Refit the tiny metal rods so that they are equidistant between the pillar mouldings and diametrically opposite to each other.
* Use a smear of grease to hold the ball bearing in place on its spring and refit the rotating part into the housing.
* Push the spindle in and refit the circlip.
* Remove the assembly from the bag and put the dark green switch assembly into the bag, instead.
* Squeeze together the centre clips and separate the two halves.
* Remove any ***one*** of the four contacts and re-assemble the parts.
* Put the green section back onto the spindle of the switch.
* Refit the metal plate and squeeze the plastic rivets with pliers.

The switch will now have six positions.
There are two tags, each connected to a slider or common. These tags are marked with an arrow on the switch. Each slider selects just three of the six contacts. Connect both slider tags together to make one common slider which will select all six contacts.

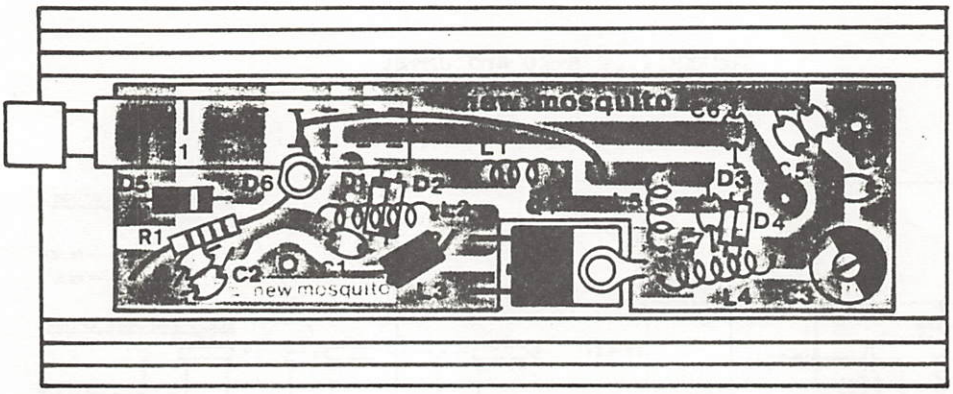
1000Hz Sine Wave Generator

This handy oscillator gives an output of 1 volt peak to peak at 1000Hz and an output impedance of 600 Ohms. It can be built on a piece of veroboard. Two AA 1.5 volt cells should be used to power it. Any general purpose silicon NPN transistors will do.

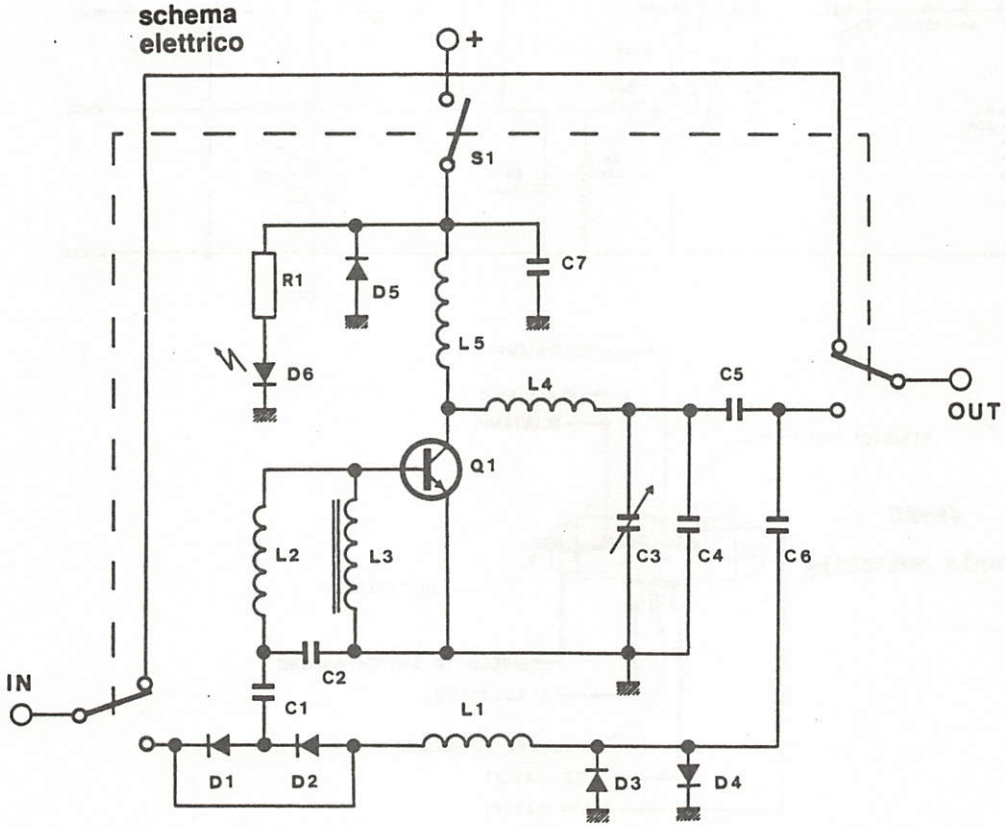


RF Power Transistors

	Watts	Amps	h_{FE}/mA	V_{CBO}	V_{EBO}	I_{CBO}
2SC1678	10	3	15/500	65	5	10
2SC1964	12.5	3.5	50/100	80	4	500
2SC1969	20	6	50/10	60	5	100
2SC2075	10	4	25/500	80	4	10
2SC2078	10	3	25/500	80	5	10
2SC2098	20	6	100/4000	70	4	100
2SC2166	12.5	4	70/100	75	5	100
2SC2312	25	6	50/100	40	4	500
2SC2315	50	6	800/500	80	6	100
2SC2316	50	6	800/500	100	6	100
2SC2393	12.5	4	50/2000	80	4	15
2SC2394	20	6	20/1000	45	4	100
2SC2527	60	10	110/1000	120	5	50
2SC2562	25	5	70/1000	60	5	1
2SC2563	80	8	120/1000	120	5	50
2SC2588A	120	12	150/2000	130	5	50
2SC2766A	150	15	150/2000	180	5	50
2SC2823	70	7	15000/1A	120	5	50
2SC2825	70	6	800/1000	80	6	100
2SC2837	100	10	60/3000	150	5	100
2SC2987A	120	12	130/2000	140	5	50
2SC3012	100	10	130/2000	130	5	50
2SC3144	20	3	5000/1.5A	70	5	100
2SC3145	30	5	5000/2.5A	70	5	100
2SC3146	40	7	5000/3.5A	70	5	100
2SC3252	30	3	170/1000	80	6	100
2SC3253	30	5	170/1000	80	5	100
2SC3254	35	7	170/1000	80	5	100
2SC3255	40	10	170/1000	80	5	100
2SC3256	70	15	170/1000	80	6	100
2SC3263	130	15	70/5000	230	5	100
2SC3264	200	17	70/5000	230	5	100
2SC3519A	130	15	80/5000	160	5	100
2SD288	20	3	100/500	80	5	10
2SD568	40	7	40/3000	100	7	10
2SD772	40	5	14/5000	150	6	1
2SD812	50	5	90/1000	80	5	50
2SD866A	40	7	60/3000	130	7	10
2SD959	30	4	60/500	130	7	10
2SD960	35	4	60/1000	130	7	10
2SD961	40	5	60/2000	130	7	10
2SD1064	80	2	110/1000	60	6	100
2SD1235	30	8	150/1000	60	6	100
2SD1271A	40	7	60/3000	130	7	10
2SD1273A	40	3	500/500	100	6	100



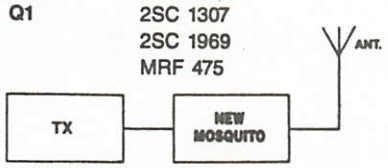
schema elettrico

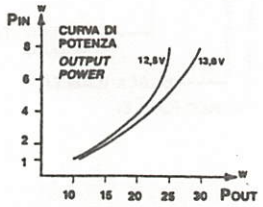


MOSQUITO

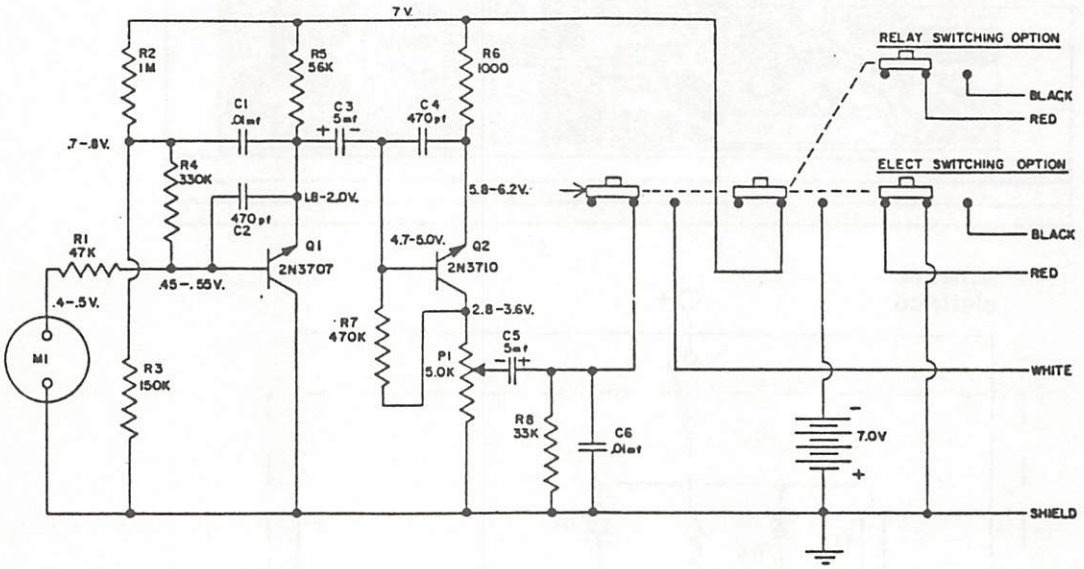
Elenco Componenti - *Parts List*

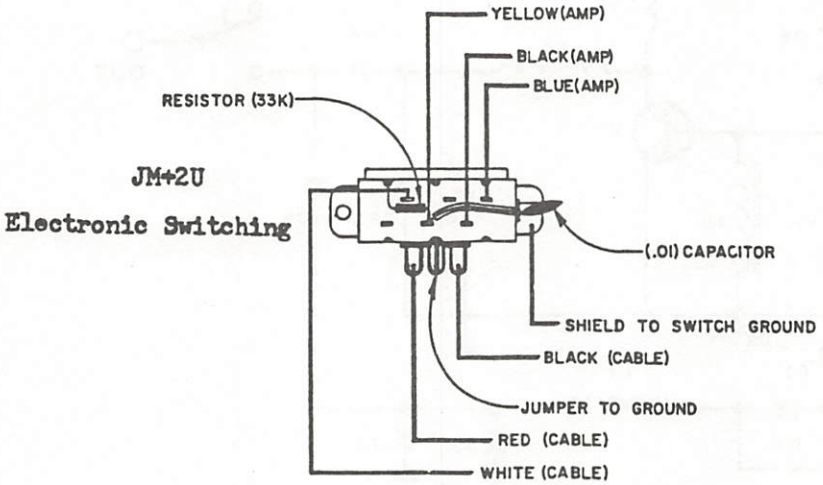
R1	820 Ohm	**D1**	1N 4148
C1	68 pF NPO	**D2**	1N 4148
C2	160 pF	**D3**	1N 4148
C3	10÷60 pF Trimmer	**D4**	1N 4148
C4	100 pF	**D5**	BY 255
C5	130 pF	**D6**	Led ∅ 5 mm
C6	33 pF		
C7	100 nF		
Q1	2SC 1307		
	2SC 1969		
	MRF 475		

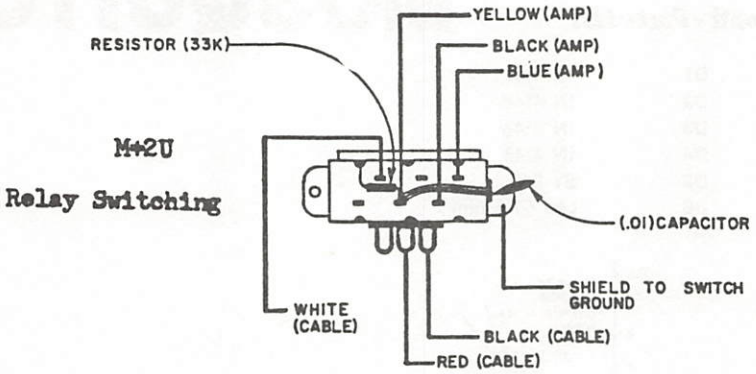




TURNER..... M+2U and JM+2U







Multi Purpose Mic Tester & Interface Box

The unit is built into a diecast aluminium box and can be used simply to connect any microphone to any rig or can be used as a piece of microphone or rig test equipment. Two sockets are fitted to connect a microphone and two leads are provided, with plugs, for the rig connection.

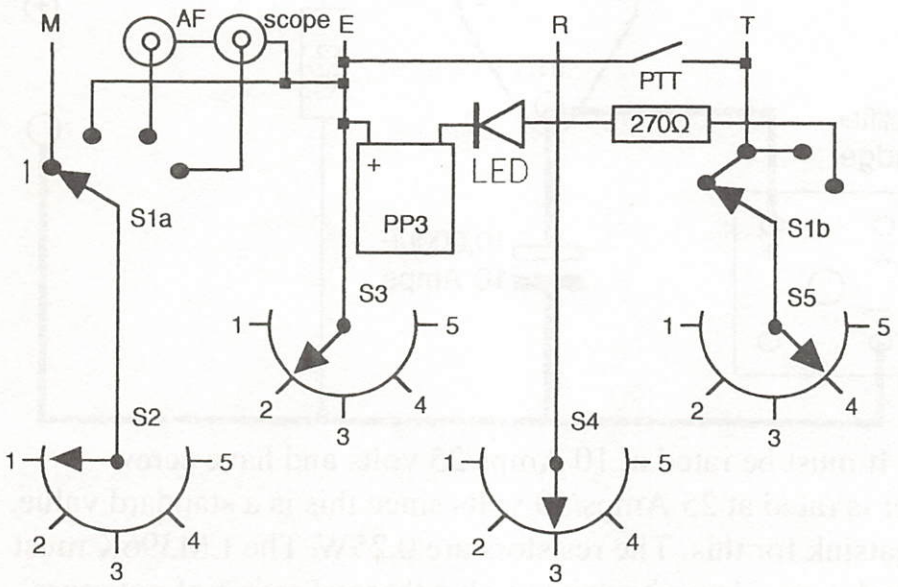
The thumbwheel switches are wired so that the common terminals are connected to Mic and PTT switch, "M", "E", "R" and "T" (see page 2). Only switch positions one to five are used on the thumbwheel switches. These are wired via two leads to a standard 4 pin mic plug and a 180° five pin DIN plug.

The wiring is the same to all four switches. Switch position one to pin one on both plugs, switch position two to pin 2 ... etc. (Position five is ignored in the case of the four pin plug). Thus, any combination of "M", "E", "R", "T" can be reproduced by flicking four switches. (Label each switch S2 to S5 "M", "E", "R" and "T", respectively).

The two-pole four-way switch provides the following functions:

1) Switch pos. 1 Mic and PTT in circuit for normal operation.
2) Switch pos. 2 Mic shorted for SSB nul, quiescent current etc.
3) Switch pos. 3 Mic input switched to BNC socket for use with AF generator
4) Switch pos. 4 Now this is the complete function change position.

The four and five wire leads have been paralleled to panel-mounted four and five pin sockets. With the thumbwheels set for the relevant mic, a mic may be tested by connecting your scope (or audio amplifier) to the second BNC socket. The PTT is checked by the PP3, 270Ω and LED circuit, whilst mic audio is routed to the scope for output distortion checks.



Only brief details are given here. You should be able to use the ideas presented to design your own unit.

Thumbwheel switches (ordinary, *not* BCD) can be obtained from BULL ELECTRICAL, Dept ME, 250 Portland Road, Hove, Brighton, Sussex. BN3 5QT

Contributed by Jim Ellis,
Triple "E" (South West), 5 Church Park, Bodmin, Cornwall.
Communications specialists — CB, Amateur, Marine, etc.

Handy Hints

Midland 77099

To increase RF output to 8 Watts, link the two legs of RV103 together (ignoring the centre leg). Retune the RF output stages.

Midland 099

Fault: Very faint outgoing audio.
Solution: Replace Q306.

10 Amp Power Supply

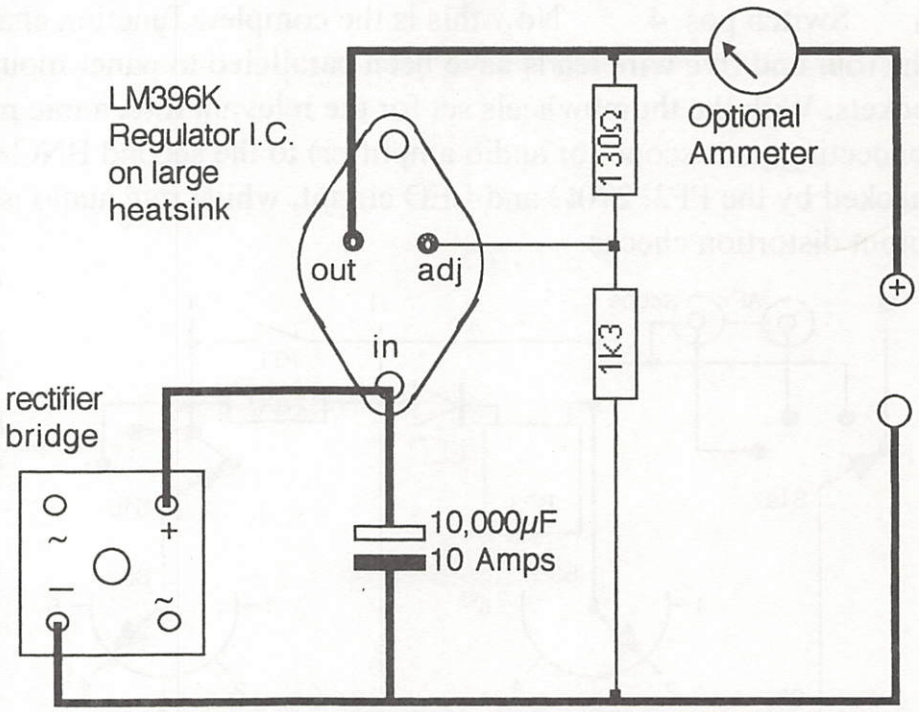
The power supply shown below is extremely simple to build but very effective. To buy such a unit would cost in excess of £60 but this could be made for half that price. The basic elements are as follows. An LM396K variable voltage regulator I.C. which looks like a 2N3055 but costs over £20! A transformer (not shown). I used a toroidal transformer rated at 20 volts, 10 Amps. Ordinary Laminated core transformers are cheaper but larger. An electrolytic capacitor with 10 Amps ripple current rating. You

The LM396K will give 12 Amps for short periods.

The LM396K is sold by Macro Marketing, Burnham Lane, Slough. SL1 6LN tel: 0628 64422

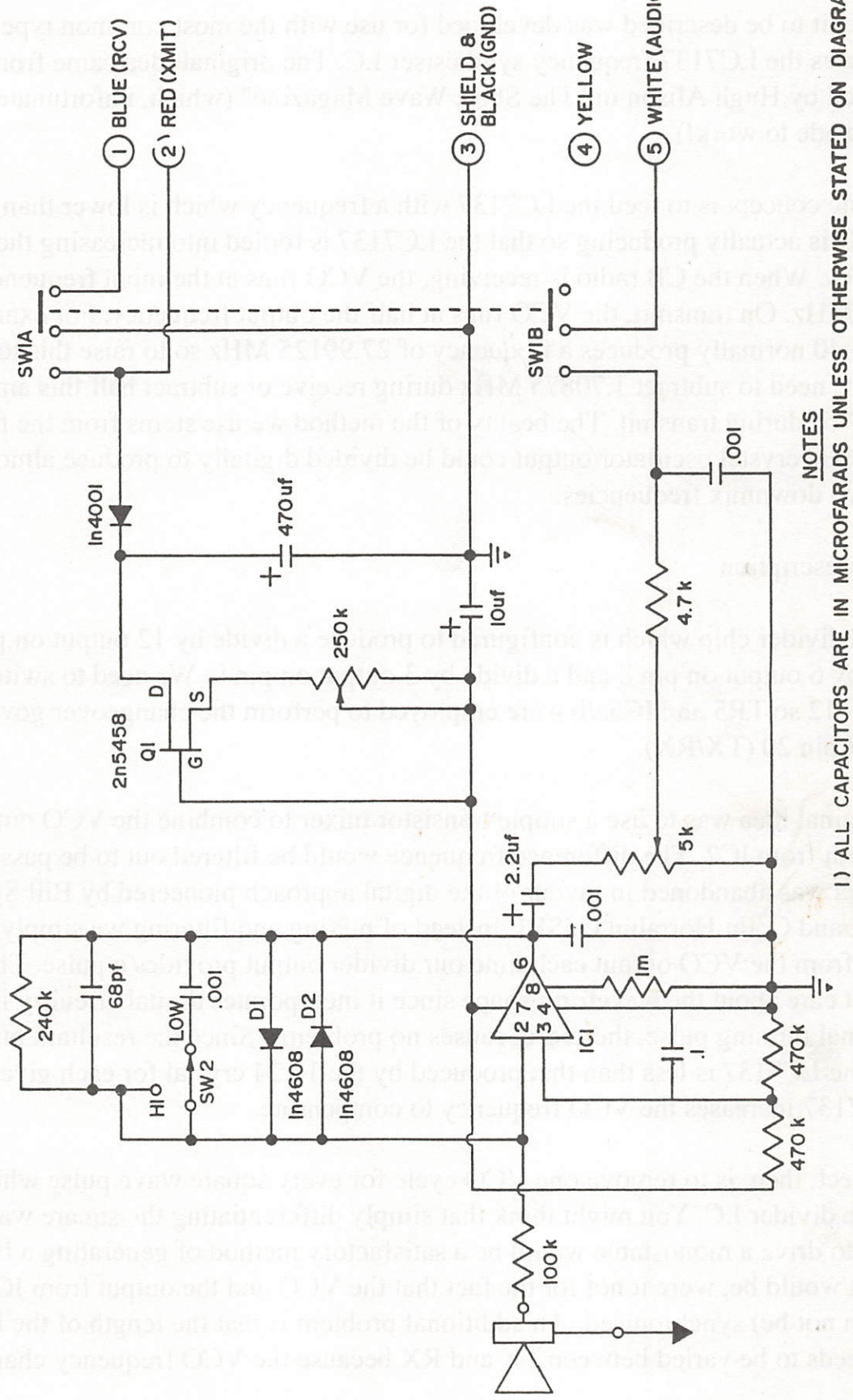
Capacitor and ammeter are usually available at radio rallies.

Don't buy the metal cabinet until you know the size of the transformer!



can't use any old thing, here. It must be rated at 10 Amps/25 volts and have screw terminals. The bridge rectifier is rated at 25 Amps/50 volts since this is a standard value. Use the metal cabinet as a heatsink for this. The resistors are 0.25W. The LM396K must be mounted with an insulating kit on a *large* heatsink with a thermal rating of not more than 1.6°C/W. A Redpoint 3P-1 is ideal. The Ammeter is optional. The resistor wiring can be thin but all the other wiring must be thick enough to carry the full 10 Amps. Put a 1 Amp fuse on the mains input. The LM396K is short-circuit protected but fit a 2 Amp fuse on the output when testing standard rigs. The resistors are chosen to give 13.8 volts.

K40 Mic Schematic



Convert your Cybernet to 10 metres

The circuit to be described was developed for use with the most common type of radio which uses the LC7137 frequency synthesiser I.C. The original idea came from a circuit published by Hugh Alison in "The Short Wave Magazine" (which, unfortunately, could not be made to work!)

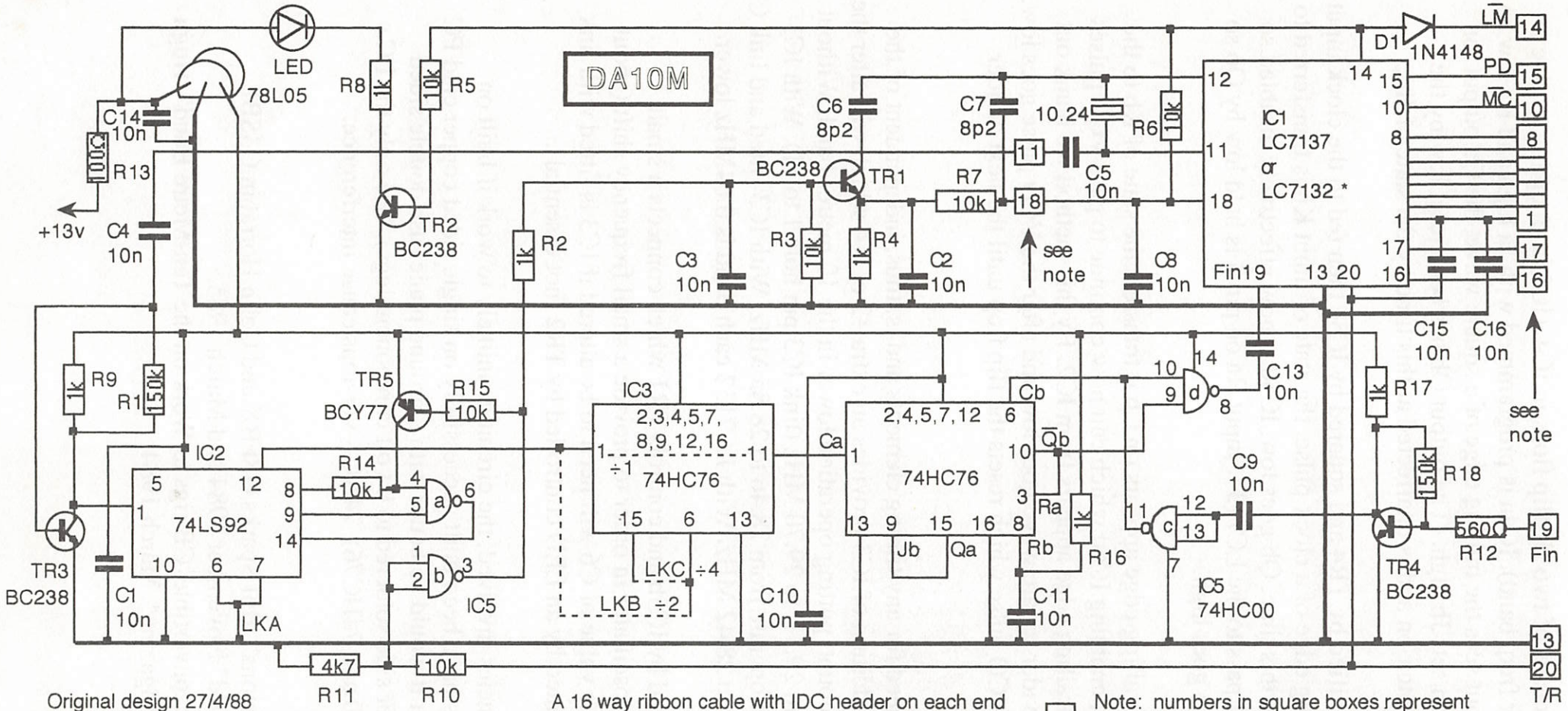
The basic concept is to feed the LC7137 with a frequency which is lower than that which the VCO is actually producing so that the LC7137 is fooled into increasing the VCO frequency. When the CB radio is receiving, the VCO runs at the input frequency minus 10.695 MHz. On transmit, the VCO runs at half the output frequency. For example: channel 40 normally produces a frequency of 27.99125 MHz so to raise this to, say, 29.70 we need to subtract 1.70875 MHz during receive or subtract half this amount (0.854375) during transmit. The beauty of the method we use stems from the fact that the 10.24 MHz crystal oscillator output could be divided digitally to produce almost exactly these two downmix frequencies.

Circuit description

IC2 is a divider chip which is configured to produce a divide by 12 output on pin 12, a divide by 6 output on pin 8 and a divide by 3 output on pin 9. We need to switch between ÷6 and ÷12 so TR5 and IC5a/b were employed to perform the changeover governed by LC7137 pin 20 (TX/RX).

The original idea was to use a simple transistor mixer to combine the VCO output with the output from IC2. The difference frequence would be filtered out to be passed to IC1. This idea was abandoned in favour of the digital approach pioneered by Bill Sparks G8FBX and Colin Horrabin G3SBI. Instead of mixing and filtering we simply blank out a cycle from the VCO output each time our divider output provides a pulse. The LC7137 does not care about the waveform shape since it incorporates digital circuitry itself. The occasional missing pulse, therefore, causes no problems. Since the resultant pulse count inside the LC7137 is less than that produced by the 10.24 crystal for each given channel, the LC7137 increases the VCO frequency to compensate.

The object, then, is to remove one VCO cycle for every square wave pulse which appears from the divider I.C. You might think that simply differentiating the square wave to form a pulse to drive a monostable would be a satisfactory method of generating a blanking pulse. It would be, were it not for the fact that the VCO and the output from IC3 are not (and can not be) synchronised. An additional problem is that the length of the blanking pulse needs to be varied between TX and RX because the VCO frequency changes.



Original design 27/4/88
© 1991 M T Pickering

A 16 way ribbon cable with IDC header on each end is used to connect DA10M to main PCB.

Note: numbers in square boxes represent pin numbers of LC7137/7132 in main PCB

PCB Artwork held by Tonks Communications. Enquiries for bare PCB and construction details welcomed.

*Use I.C. as fitted in rig.

All 10n are SMD

Only rigs using LC7137 can be modified to operate on 29.31 to 29.70 MHz. LC7132 bands start 0.64 MHz lower and have 'gaps'.

10 Metre Conversion Schematic

The problem is solved by means of two JK flip flops in IC4. (IC3 is an option to give an extra ÷4, producing a lower freq. band). IC4a is programmed with Ja high and Ka low so that each time the clock input sees the trailing edge of a square wave, the Qa output on pin 15 goes high. This action sets Jb high. (The output Qb has been reset low by the combination R16/C11 at switch-on and is unaffected at this time by the state of Jb).

The VCO waveform is amplified by TR4 and squared by IC5c then fed to the clock input Cb. When Cb sees the falling edge of a clock pulse, the state of input Kb is transferred to output Qb. Consequently, at this time, Qb goes low. IC5d is now effectively disabled so the next VCO pulse can not pass to the LC7137. Input Ra on pin 3 is held low by Qb so Qa is reset low and input Kb goes high.

When the next clock pulse trailing edge appears on Cb it transfers the state of Kb to the output Qb which goes high, enabling IC5d which can now continue to pass VCO pulses until the next square wave trailing edge appears from IC2. By this method we blank out one VCO pulse after the divider square wave goes low and after the VCO pulse goes low, thus blanking out the next VCO pulse which resets the flip flop until the next divider pulse arrives.

The circuit eliminates the need for any timing elements and is, thus, independent of the frequencies involved. The addition of IC3 provides an extra ÷2 or ÷4 which will alter the frequencies by a smaller amount, putting operation lower in the 10 metres band. Without IC3 the rig will operate from 29.31 to 29.70 MHz (link IC3 pin hole 1 to 11). With IC3 fitted and link B the rig will operate from 28.46 to 28.85 MHz. With IC3 fitted and link C the rig operates from 28.03 to 28.42 MHz. With LC7132 each band is 0.64MHz lower.

The TX/RX signal is inverted by IC5b and controls TR1 which connects a small capacitor to the 10.24 MHz oscillator in order to provide a small frequency shift (about 2kHz lower) during TX. The value of C6 will need to be altered if IC3 is fitted with link B (4p7). VCO lock is indicated by an LED controlled by TR2 (not essential).

Because of the high frequencies involved, the circuit is unlikely to work if built on veroboard. Several versions have been built successfully on single sided copper clad PC Board but tests indicate that it would be better with a ground plane (use double sided PCB with the unused copper side soldered to 0 volt component legs). Use only the I.C.s specified (74LS92, 74HC00 and 74HC76). 74AC-- versions cause interference.

References:

1. "27-29 MHz Conversions". Bill Sparks G8FBX and Colin Horrabin G3SBI. "Radio and Electronics World" November 1984 and March 1985.
2. "How to Convert 'Unconvertible' CB rigs to Work on the Ten-Metre Band". Hugh Alison. "The Short Wave Magazine". March 1984.

DA71 Conversion

The DA71 conversion board was developed early in 1986 to provide a simple, cheap method of providing the CEPT frequencies on a legal UK rig which used the LC7137. Unfortunately, it became clear that ownership of dual standard rigs would never be legal because it is quite impossible to convert any existing rig to meet the requirements of MPT1333. By "impossible" we mean that it would cost too much and take too long. In defence of the DA71, however, it must be said that the resultant dual-band performance is scarcely worse than that of the original unmodified set. There are no adjustments to be made on the conversion board and adjustments required in the rig itself are minimal. Unlike some earlier conversion boards, the DA71 does not rely on frequency mixing techniques which can produce interference. Nor can it be abused to provide illegal frequencies.

Circuit Description and History of Variants

The issue letter of the unit can be found etched in the copper after "DALC7137". The DA71 was originally sold as version "B" with a TC9109 I.C. to produce the CEPT channels. The basic method of operation is the same for all variants and relies upon an on-board 10.24 MHz crystal oscillator to provide the reference frequency for both I.C.s. The crystal is always connected to the LC7137 internal amplifier so, if this I.C. is not fitted or not working, there will be no oscillator. The crystals are from a single batch and no adjustment is required since the accuracy of these particular crystals has always been good. The frequency is, however, affected by the termination of the white wire which expects to see about 56pF to ground, as fitted in most Cybernet rigs. The white wire sends the 10.24 MHz to the receiver mixer and, without it, receive performance will be weak or non-existent. Should the crystal ever need to be replaced, it may be necessary to change the values of the two associated capacitors. Most units had 22pF capacitors but a few used 18pF instead. The capacitor between the crystal and 0v determines the frequency on both CEPT and UK band and must be adjusted with UK band selected. The other capacitor is switched in by the transistor for CEPT band only when the LD output of the TC9109 goes high.

The two bands are selected simply by switching between the PD outputs of the I.C.s. This switching is external to the unit and the connecting wires must be kept short because the PD outputs produce a series of short risetime pulses which can generate interference. Provided that one of the I.C.s is "in lock", the LED will light, driven by a transistor which provides a low resistance path to 0v on the ribbon connector pin 14 (without which the rig will not transmit). For the purpose of test it is possible to short this pin to 0v while the VCO is adjusted.

The TC9109 expects to receive eight inputs from an LED channel display, whereas the

LC7137 uses a Binary Coded Decimal input on six inputs from the channel selector. This problem is overcome by interposing an EPROM between the LC7137 inputs and the TC9109 inputs. The EPROM is encoded to produce the correct codes for the TC9109 and, in addition, provides override codes for channels 9 and 19. Because the Eprom will not tolerate an input voltage greater than 5.25 volts, a resistor network is used to protect it from the 7 volts coming from the channel selector.

The TC9109 has a filter capacitor connected to pin 3 which determines the settling time (the time taken to "lock" the VCO each time the frequency is changed, especially between TX and RX). This capacitor is nominally a 2.4μF tantalum bead but can be decreased to 100nF in most rigs.

The voltage regulator uses a 9v1 zener diode and produces about 8.5 volts at the emitter of the transistor which could be a ZTX450, ZTX451, BC337, BC635, BC639 or 2SD471. The voltage is dropped to 5v for the EPROM by a 62Ω resistor. If you change the EPROM you might need to alter this resistor value to maintain the voltage between 4.75 and 5.25 volts. Note that this voltage can change slightly as different channels are selected so a borderline voltage can produce strange effects! An early problem was caused by reverse assembled 10μF bead capacitors which would go short circuit and burn out the 18Ω resistor. This problem resulted in a reputation for bad regulator design — a little unfair because it was an assembly error, not a design fault. All units returned with this fault were replaced and there should be no more remaining now.

Version "C" was designed to use the new LC7132 synthesiser I.C. which was cheaper than the TC9109. Version "C" was never sold, however, because we suddenly realised that the VN10KM VMOS FET could be eliminated by using, instead, the MOS transistor inside the LC7132 itself.

Version "D" was introduced with the LC7132 and without the VN10KM and, because the LC7132 is slightly longer than the TC9109, the board was widened by 1.5mm. The LC7132 is fussy about its input voltage and the EPROM connections were changed to make it "float" 3 volts above zero. The resistor input network was changed to a row of diodes and the EPROM codes were changed to suit the LC7132 which, although using seven segment code like the TC9109, uses different segments to obtain the code!

Version "E" was evolved because it was such a nuisance to have to program EPROMs whose price was gradually rising in any case. The LC7132 uses 7 segment input code and the LC7137 uses BCD. What could be more sensible, therefore, than to use a standard BCD to 7 segment decoder I.C.? Of course, it wasn't quite that simple. Channel 40 code is 000000 for the LC7137 so a couple of logic gates were needed to cope with that one discrepancy. A couple more gates were required to maintain our channel 9 and 19 override facility for those who wanted it (did anybody?). The 74LS247 decoder was the

only suitable I.C. and not many companies stocked it. Since it has open collector outputs we had to provide pull-up resistors on its outputs and, since it requires a 5 volt supply, we used a 470Ω resistor to reduce the 8.5v supply. This caused some problems which were solved by introducing a 100Ω resistor to make it "float" above 0v.

A few units had been returned with damaged I.C.s and this problem was caused by people who were accidentally shorting the band-select wires to 0v. The PD outputs don't like to drive a short circuit so 1kΩ resistors were added in series with these wires. They can be added in series with the green and blue wires on all earlier versions if required.

The final problem reported was a buzzing or singing note on rigs based on the Amstrad design. This noise was caused by the fast risetime pulses on the blue wire which were interfering with the audio circuits. The simplest solution was to short the PD output to 0v when the UK band was selected. An extra transistor and resistor were added to achieve this and version "F" was born. These components can be added to earlier versions.

Most of the problems we have come across have been caused by PCB tracks shorted together or fractured. Unfortunately, the tracks have to be narrow to minimise the size of the unit and this has resulted occasionally in track faults. Watch out for over-etching of the tracks near the edge of the PCB. Look for dry joints and solder shorts. Occasionally the ribbon connector can go faulty and must be replaced. The tracks joining the solder pads of the ribbon connector can fracture due to flexing of the ribbon and this fault is especially difficult to find. Another occasional problem is cracked resistors which, again, are not easy to see. Failure of EPROMS is possible although rare. Bear in mind that there are two different program versions — TC9109 and LC7132. Sometimes the EPROM voltage can be low, causing it to work on some channels but not others.

Refusal to "lock" can be caused by the PLL synthesiser I.C. failing to receive the VCO signal from the main board (track short or break) or by failure of the 10.24 MHz oscillator. An open circuit track to the LED will cause the MOS transistor to remain off even when lock is achieved. The likely result is TX but no RX and the LED not lit. If the LED lights for one state but not the other, check that the voltage on the LC7137 pin 20 toggles between high on RX and low on TX. Clues can be gained by monitoring voltages on the PD outputs, using a DC voltmeter on the pink wire shorted first to the green and then to the blue wire. The voltage should increase in tiny increments as the channel frequency is increased. If it does not then the I.C. is not receiving the 10.24 MHz oscillator signal or it is not receiving the VCO signal or the binary inputs are not changing or are of the wrong voltage or the supply voltage is too low or the I.C. is dead! The only other reason is that the VCO core is wrongly adjusted or the PD output is not connected to the VCO varactor diode.

DA71 circuits available from Tonks Communications. State TC9109/LC7132/EPROM.

TC9119, 9109, 9106 CODES

CH	17	16	15	14	13	12	11	10 - pin
40	0	1	0	0	0	1	0	0
39	1	0	0	1	1	0	0	0
38	1	0	0	0	0	0	0	0
37	1	0	0	1	1	1	0	1
36	1	0	0	0	0	0	1	0
35	1	0	0	0	1	0	0	0
34	1	0	0	1	1	0	1	0
33	1	0	0	0	1	0	0	1
32	1	0	0	0	0	0	0	1
31	1	0	0	1	1	1	1	1
30	1	0	0	0	0	1	0	0
29	1	0	1	1	1	0	0	0
28	1	0	1	0	0	0	0	0
27	1	0	1	1	1	1	0	1
26	1	0	1	0	0	0	1	0
25	1	0	1	0	1	0	0	0
24	1	0	1	1	1	0	1	0
23	1	0	1	0	1	0	0	1
22	1	0	1	0	0	0	0	1
21	1	0	1	1	1	1	1	1
20	1	0	1	0	0	1	0	0
19	1	1	0	1	1	0	0	0
18	1	1	0	0	0	0	0	0
17	1	1	0	1	1	1	0	1
16	1	1	0	0	0	0	1	0
15	1	1	0	0	1	0	0	0
14	1	1	0	1	1	0	1	0
13	1	1	0	0	1	0	0	1
12	1	1	0	0	0	0	0	1
11	1	1	0	1	1	1	1	1
10	1	1	0	0	0	1	0	0
9	1	1	1	1	1	0	0	0
8	1	1	1	0	0	0	0	0
7	1	1	1	1	1	1	0	1
6	1	1	1	0	0	0	1	0
5	1	1	1	0	1	0	0	0
4	1	1	1	1	1	0	1	0
3	1	1	1	0	1	0	0	1
2	1	1	1	0	0	0	0	1
1	1	1	1	1	1	1	1	1

On page 57 you will find the actual EPROM codes used in the two DA71 variants. Unlisted locations can be any value. See "The CB EPROM Data Book" for more information.

LC7132 CODES

CH	8	7	6	5	4	3	2	1 - pin
40	0	1	0	0	0	1	0	0
39	1	0	0	0	1	0	0	0
38	1	0	0	0	0	0	0	0
37	1	0	0	0	1	1	0	X
36	1	0	0	1	0	0	0	0
35	1	0	0	1	1	0	0	0
34	1	0	0	0	1	0	1	0
33	1	0	0	0	1	0	0	1
32	1	0	0	0	0	0	0	1
31	1	0	0	0	1	1	1	1
30	1	0	0	0	0	1	0	0
29	1	0	1	0	1	0	0	0
28	1	0	1	0	0	0	0	0
27	1	0	1	0	1	1	0	X
26	1	0	1	1	0	0	0	0
25	1	0	1	1	1	0	0	0
24	1	0	1	0	1	0	1	0
23	1	0	1	0	1	0	0	1
22	1	0	1	0	0	0	0	1
21	1	0	1	0	1	1	1	1
20	1	0	1	0	0	1	0	0
19	1	1	0	0	1	0	0	0
18	1	1	0	0	0	0	0	0
17	1	1	0	0	1	1	0	X
16	1	1	0	1	0	0	0	0
15	1	1	0	1	1	0	0	0
14	1	1	0	0	1	0	1	0
13	1	1	0	0	1	0	0	1
12	1	1	0	0	0	0	0	1
11	1	1	0	0	1	1	1	1
10	1	1	0	0	0	1	0	0
9	1	1	1	0	1	0	0	0
8	1	1	1	0	0	0	0	0
7	1	1	1	0	1	1	0	X
6	1	1	1	1	0	0	0	0
5	1	1	1	1	1	0	0	0
4	1	1	1	0	1	0	1	0
3	1	1	1	0	1	0	0	1
2	1	1	1	0	0	0	0	1
1	1	1	1	0	1	1	1	1

X = doesn't care

Miscode calls channel 19

EPROM codes for DA71 (LC7132)

0000	22	25	23	21	07	05	03	01
0008	57	55	53	51	FF	FF	FF	FF
0010	87	85	83	81	FF	FF	FF	FF
0018	0F	0D	0B	09	FF	FF	FF	FF
0020	F7	F5	F3	F1	17	15	13	11
0028	1F	1D	1B	19	FF	FF	FF	FF
0030	97	95	93	91	FF	FF	FF	FF
0038	B7	B5	B3	B1	FF	FF	FF	FF
0100	13	13	13	13	13	13	13	13
0108	13	13	13	13	FF	FF	FF	FF
0110	13	13	13	13	FF	FF	FF	FF
0118	13	13	13	13	FF	FF	FF	FF
0120	13	13	13	13	13	13	13	13
0128	13	13	13	13	FF	FF	FF	FF
0130	13	13	13	13	FF	FF	FF	FF
0138	13	13	13	13	FF	FF	FF	FF
0200	17	17	17	17	17	17	17	17
0208	17	17	17	17	FF	FF	FF	FF
0210	17	17	17	17	FF	FF	FF	FF
0218	17	17	17	17	FF	FF	FF	FF
0220	17	17	17	17	17	17	17	17
0228	17	17	17	17	FF	FF	FF	FF
0230	17	17	17	17	FF	FF	FF	FF
0238	17	17	17	17	FF	FF	FF	FF

1 — 40

channel 19

channel 9

LC7137 CODES

CH	6	5	4	3	2	1 - pin
40	0	0	0	0	0	0
39	1	1	1	0	0	1
38	1	1	1	0	0	0
37	1	1	0	1	1	1
36	1	1	0	1	1	0
35	1	1	0	1	0	1
34	1	1	0	1	0	0
33	1	1	0	0	1	1
32	1	1	0	0	1	0
31	1	1	0	0	0	1
30	1	1	0	0	0	0
29	1	0	1	0	0	1
28	1	0	1	0	0	0
27	1	0	0	1	1	1
26	1	0	0	1	1	0
25	1	0	0	1	0	1
24	1	0	0	1	0	0
23	1	0	0	0	1	1
22	1	0	0	0	1	0
21	1	0	0	0	0	1
20	1	0	0	0	0	0
19	0	1	1	0	0	1
18	0	1	1	0	0	0
17	0	1	0	1	1	1
16	0	1	0	1	1	0
15	0	1	0	1	0	1
14	0	1	0	1	0	0
13	0	1	0	0	1	1
12	0	1	0	0	1	0
11	0	1	0	0	0	1
10	0	1	0	0	0	0
9	0	0	1	0	0	1
8	0	0	1	0	0	0
7	0	0	0	1	1	1
6	0	0	0	1	1	0
5	0	0	0	1	0	1
4	0	0	0	1	0	0
3	0	0	0	0	1	1
2	0	0	0	0	1	0
1	0	0	0	0	0	1

EPROM codes for DA71 (TC9109)

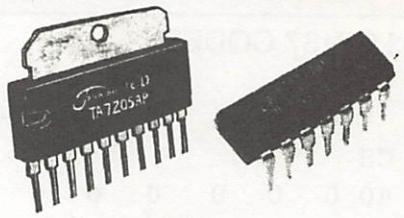
0000	22	25	23	21	07	05	03	01
0008	5F	5D	5B	59	FF	FF	FF	FF
0010	87	85	83	81	FF	FF	FF	FF
0018	47	45	43	41	FF	FF	FF	FF
0020	FF	FD	FB	F9	1F	1D	1B	19
0028	17	15	13	11	FF	FF	FF	FF
0030	97	95	93	91	FF	FF	FF	FF
0038	BF	BD	BB	B9	FF	FF	FF	FF
0100	1B	1B	1B	1B	1B	1B	1B	1B
0108	1B	1B	1B	1B	FF	FF	FF	FF
0110	1B	1B	1B	1B	FF	FF	FF	FF
0118	1B	1B	1B	1B	FF	FF	FF	FF
0120	1B	1B	1B	1B	1B	1B	1B	1B
0128	1B	1B	1B	1B	FF	FF	FF	FF
0130	1B	1B	1B	1B	FF	FF	FF	FF
0138	1B	1B	1B	1B	FF	FF	FF	FF
0200	1F	1F	1F	1F	1F	1F	1F	1F
0208	1F	1F	1F	1F	FF	FF	FF	FF
0210	1F	1F	1F	1F	FF	FF	FF	FF
0218	1F	1F	1F	1F	FF	FF	FF	FF
0220	1F	1F	1F	1F	1F	1F	1F	1F
0228	1F	1F	1F	1F	FF	FF	FF	FF
0230	1F	1F	1F	1F	FF	FF	FF	FF
0238	1F	1F	1F	1F	FF	FF	FF	FF

1 — 40

channel 19

channel 9

S. J. TONKS



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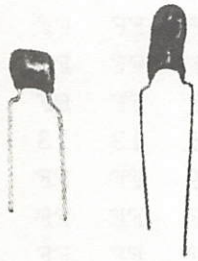

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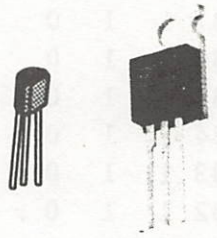

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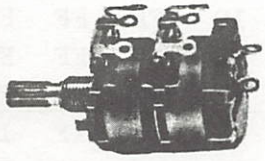

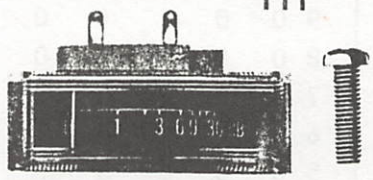

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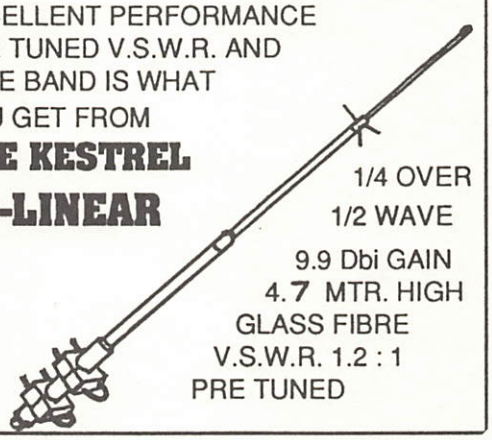

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