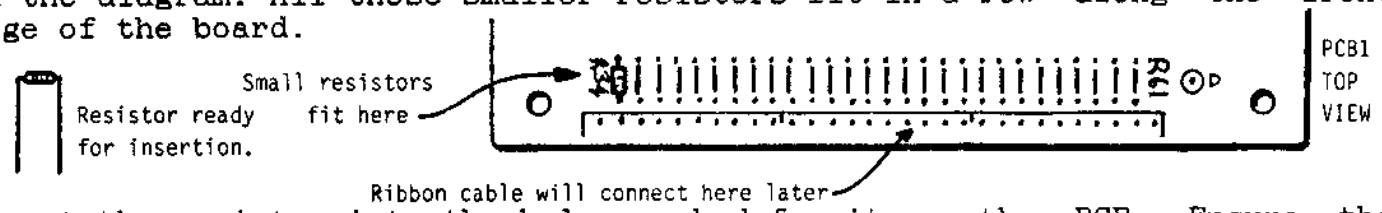
After all the terminal pins are in place, fit the smaller resistors, part numbers R34 to R61. Select the correct components by refering to the Parts List. Bend the resistor's leads ready for insertion into the PCB as shown in the diagram. All these smaller resistors fit in a row along the front edge of the board.

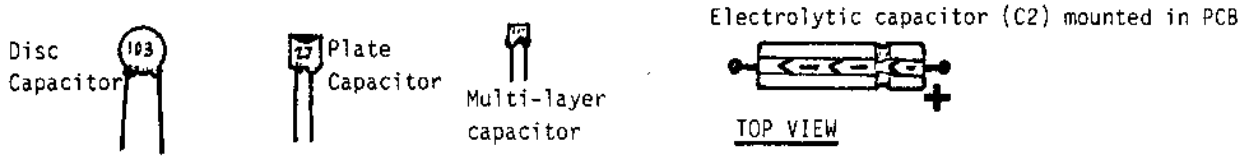


Insert the resistor into the holes marked for it on the PCB. Ensure the body of the component is flat against the board, and then bend the leads out slightly to prevent it falling out. Turn the board over ready for soldering. At the risk of insulting our more experienced constructors: Please read the notes on soldering. Good joints are essential.

Once you have soldered the first resistor in place, cut off the excess lead as close to the joint as possible. Now fit the next small resistor and so on, working your way through all these devices. This will be good soldering practice before you get on to the rest of the kit! When you have soldered a few in place, check your workmanship and make sure you are not "bridging" solder across to the next-door tracks by using too much solder.

Once all the small resistors are soldered in place, work your way through all the other resistors in the Parts List. Be careful when you select these parts that you do not confuse the colour bands - for example red and orange can look very similar under artificial light.

Next fit the ICs taking care that they are inserted the right way round. Refer to the Parts List for details.



Once the chips are neatly soldered in place, fit the capacitors, keeping all the leads as short as possible. C2 must be fitted the right way round, see Parts List for details. Please DO NOT throw the off-cut capacitor leads away. They are needed for making some of the wire links (LK1 etc) on the PCB.

The wire links should be fitted next. Some tinned copper wire is provided in the kit to make the three long links, LK6, LK7 & LK8. All the others are made with the off-cut capacitor leads. Bend the links to length and fit them to the holes marked for them in just the same way as you fitted the resistors. Keep the links straight and flat against the PCB. Use the tinned copper wire to make LK6, LK7 and LK8 first, then fit all the others. Also fit the four links to PCB2 at this point. Do not throw the remaining offcut leads away yet, you will need some for programming the counter later.

The transistors should be fitted next. Again keep the leads short with the body of the device about 3mm above the board in this case. Make sure you fit them the right way round, as indicated by the outline printed on the board. Next fit the diodes followed by the trimmer, CV1, and then finally the crystal "XTAL". Make sure you do not overheat this item.

PCB1 should now be complete with the exception of the offset programming connections. Details of these are given on the "Programming Offsets" page.

The HOWES DFD4 is a digital frequency counter kit with programable offset and up/down counting facilities to enable it to be used as a frequency readout for superhet type receivers and transceivers. It produces only low levels of "digital noise", enabling the counter module to be used with communications equipment with the minimum of EMC problems.

PLEASE READ all the paperwork through at least once, BEFORE starting work.

BRIEF SPECIFICATION

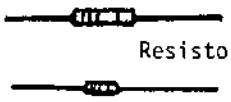
Input frequency range: 500kHz to 25MHz.
Resolution: 100Hz.
Offset: The counter can be programmed for any IF offset (or none).
Input impedance: Nominal 50R on counter board, high(ish) impedance for buffer module. The buffer module is designed to connect to a low impedance circuit without loading it to any significant extent.
Input Signal level: Nominal -10 to +20dBm on main counter board. The Buffer Module has adjustable input level nominaly 0 to +20dBm for -10dBm output
Clock Frequency: 10MHz, crystal controlled.
Display: 4 digit, 7 segment .43" (11mm) red LED, non-mutiplexed.
Display brightness: selectable between normal and dimmed.
Operating Voltage: +8 to 14V DC at around 420mA maximum.

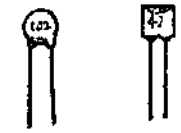
IMPORTANT NOTE.

Although assembly of this kit is quite straightforward with no special skills or equipment being needed, there are a lot of solder joints to be made, and many of them are close together. NEAT SOLDERING IS REQUIRED if the module is to be built successfully. Please examine the PCBs before starting work, and decide if you feel happy about your soldering ability. We will willingly exchange the DFD4 kit for assembled PCB modules if you post the kit to our works, intact and unstarted, with payment for the difference in price.

TOOLS REQUIRED:

Fine tipped soldering iron. A small low powered iron can be used for most joints, but one of at least 25 or 30W will be needed for successful connections to the larger PCB tracks.
Long-nosed pliers. Small side-cutters. A trim tool for CV1.


Resistors


Capacitors


Terminal Pin


Components mounted in PCB (side view)

BUILDING THE KIT.

Ensure you have all the correct tools and parts to hand BEFORE you start. There are three PCBs in this kit. PCB1 is the main counter board. PCB2 is the display board, and PCB3 is the input buffer module. We suggest you start by assembling PCB1 and not the smaller boards.

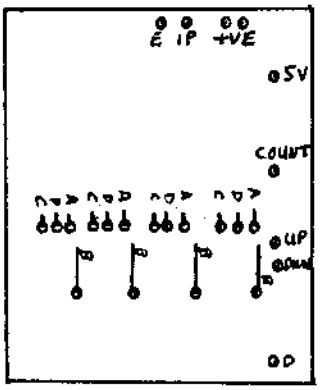
PCB1 ASSEMBLY

Fit the terminal pins first. These are fitted to the holes in the PCB as detailed on the Parts List 1 page. Insert them from the wiring (foil) side of the board, and with the board resting over the edge of the bench, push them home, flush into the board with a hot soldering iron and a touch of solder. Be careful not to slip with the hot iron as you do this.

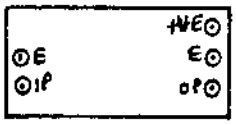
CONTINUED

TERMINAL PINS.

Fit these to the holes in the PCBs shown in the diagram. All these holes have circles printed around them on the component side of the board. Insert the pins from the track side of the PCB and push them fully home with a little solder and a hot soldering iron. BE CAREFUL not to slip with the hot iron when you do this.



PCB1



PCB2

All terminal pin holes have circles printed around them.

.125W RESISTORS

Fit the small .125W resistors first. These are the smaller of the two types of resistor in this kit. All are 1k8 Ohms in value and are colour coded Brown Grey Red Gold. These are part numbers R34 to R61 inclusive, and they all go in a line along the front edge of PCB1.

.25W RESISTORS

Value	Colour Code			Part Numbers PCB1	PCB2 & 3
2R2	Red	Red	Gold	R9 R22	
10R	Brown	Black	Black	R19 R23 R26 R29 R30 R31	
56R	Green	Blue	Black	R4 R21	
100R	Brown	Black	Brown	R7	R66
330R	Orange	Orange	Brown	R12	R64
1k0	Brown	Black	Red		R63 R65
1k2	Brown	Red	Red	R10 R16	
1k8	Brown	Grey	Red	R15	
2k2	Red	Red	Red	R17 R18 R33	R69 R70
4k7	Yellow	Violet	Red	R8 R11 R14 R24 R27	
10k	Brown	Black	Orange	R3 R6 R20 R28 R32	R62 R67 R68
18k	Brown	Grey	Orange	R1 R5 R13	
47k	Yellow	Violet	Orange	R2	
100k	Brown	Black	Yellow	R25	

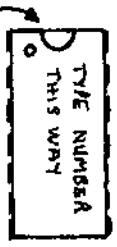
Gold band

INTEGRATED CIRCUITS (chips)

These all have their type numbers marked on them. Be sure you have inserted them into the board the right way round BEFORE soldering them in place. IC sockets should not be used.

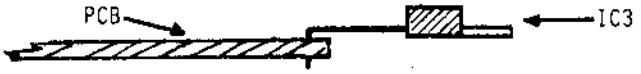
TYPE	Part Numbers
NE555	IC1 IC2
74LS00	IC4 IC8
74LS47	IC17 IC18 IC19 IC20
74LS75	IC13 IC14 IC15 IC16
74LS192	IC9 IC10 IC11 IC12
74LS390	IC5 IC6 IC7

Spot and/or cut-out indicate which way round the IC goes. This corresponds with the outline printed on the PCB.



TOP VIEW

IC3 is a voltage regulator, type 7805. Fit this to the PCB as shown in the diagram. When the module is finished this will have to bolt to the case.



SIDE VIEW

PCB2 ASSEMBLY.
The four links (LK16 to LK20) should have been fitted already. Fit the two resistors (R69 & R70) keeping them flat against the PCB and then fit the four LED displays. These will only go in one way round, but it is important to make sure they all sit with the front faces accurately in line so they will look right in the finished item.

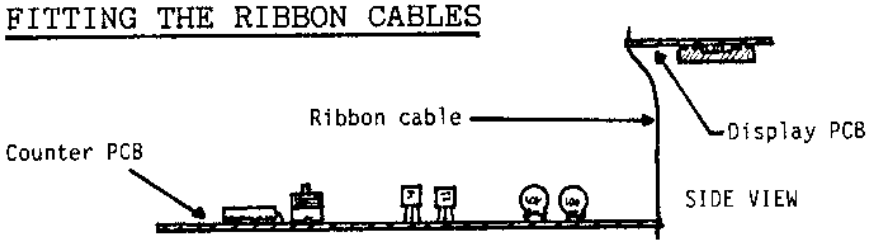
PCB3 ASSEMBLY.
Assemble this in a similar manner to the main board. Fit the terminal pins followed by the resistors, then the capacitors and the transistors.

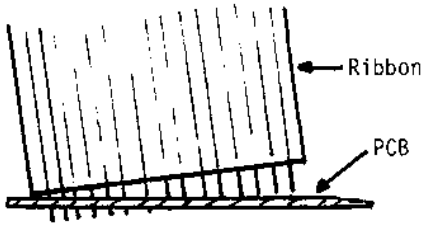
IMPORTANT - DO NOT FIT the inductor, L1 unless you are going to power the buffer via its output cable from the counter module - see the User Information to decide if you need to do this.

CHECKING THE BOARDS
When the boards are complete, hold them up to a bright light so that you are looking at the wiring side of the PCB in silhouette. If you can see any light coming through "a joint", resolder it properly.

In a similar manner check for solder "bridges", particuarly between adjacent IC pins. We have designed the PCB layout so that no IC connection goes directly sideways to the next door pin. Any solder bridge should be removed with solder wick, or a desoldering tool.

FITTING THE RIBBON CABLES

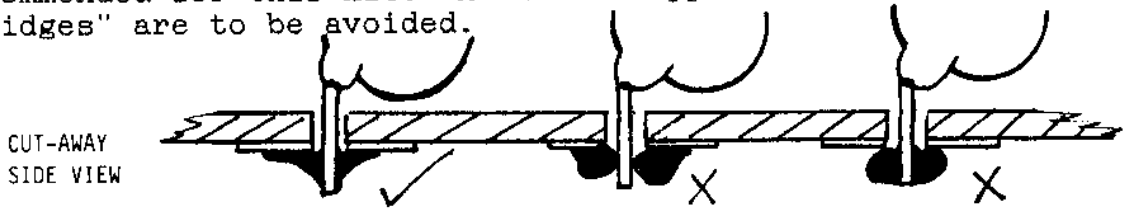




Inserting a ribbon cable

The display PCB is connected to the counter PCB by ribbon cables. Fit the ribbon cable to the counter (PCB1) first, but only solder the end wires at this point. Next fit the other end of the cables to the display board (PCB2) making sure you insert them so the display board is connected the right way round. Again only solder the end wires at this point. Now double check that the display board is connected the right way round, and when you are sure it is correct, solder up all the other wires.

NOTES ON SOLDERING
To solder properly, you must use a suitable soldering iron and good quality multi-cored solder designed for electronic work. Thin 22 s.w.g. solder is recommended for this kit. A fine tipped iron is essential if solder "bridges" are to be avoided.



Hold the hot iron in contact with both the component lead and PCB track for about a second or so to heat them up, then touch the solder onto the junction of iron, lead and track. Feed in just enough solder so that it runs completely round the lead and PCB hole. Wait a further second for the solder to flow fully, and then remove the iron. The hot iron should have been in contact with the work piece for about 3 to 4 seconds in all.

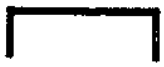
CAPACITORS - When you fit these components, save the offcut leads to make the links on the PCB later.

C17 need not be fitted on assembly - it is an Adjust On Test (AOT) part.

Value	Marking Information	Part Numbers PCB1	PCB3
3p3	Plate marked 3.3		C31
22pF	Plate " 22	C17 (AOT)	
47pF	Plate " 47	C4	
100pF	Disc " 101	C10	
1nF	Disc " 102	C3 C9 C12 C13 C21 C22	C30 C34
.01uF	Disc marked 103	C5 C6 C11 C19	C33
.047uF	M.Layer " 473		C35
.1uF	Disc " 104	C1 C7 C8 C14 C15 C16 C18 C20 C23 C24 C25 C26 C27 C28 C29	C32
*4u7	Marked 4u7 or 4.7uF	C2	

* NOTE - C2 is an electrolytic capacitor and MUST be fitted the right way round. The positive lead of the component must go to the hole marked "+" on the PCB. The negative lead of the capacitor is indicated by the arrows containing "-" signs on the side of the component.

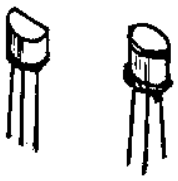
Electrolytic capacitor


Wire Link

LINKS LK6, LK7 & LK8 are made using the tinned copper wire supplied with the kit. Bend the wire neatly with long-nosed pliers and fit the links to the PCB so that they are straight and flat on the board. All the other links in the kit (LK1 etc) are made using the offcut capacitor leads.

TRANSITORS - these all have their type numbers marked on them.

Type	PCB1	PCB2
BC547	TR1 TR2 TR4 TR5	
BC307	TR6	TR8
BSX20	TR3	TR9
2N3819		TR7


Transistors

Band indicated the "+" lead


Diode

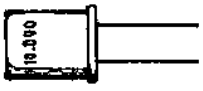
DIODES D1 & D2 - these are both 1N4004 and are marked as such. Fit these the right way round as shown in the diagram.

TRIMMERS

CV1 is a trimmer capacitor

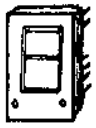
VR1 is a pre-set resistor (PCB2)

10MHz CRYSTAL (XTAL)



Do not overheat this part.

LED DISPLAYS D3, D4, D5 & D6

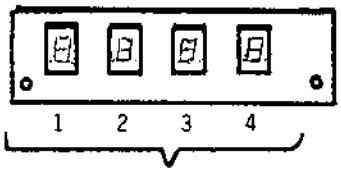


AXIAL INDUCTORS (OPTIONAL PARTS)

Colour code: Red Red Brown Silver.

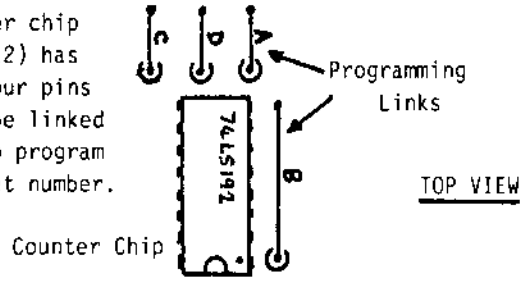
C.M.HOWES COMMUNICATIONS DFD4 PROGRAMMING OFFSETS issue 1

Programming an offset into the DFD4 is quite simple. This can be done directly on the DFD4 PCB as set out below for a single offset. If you need to program a number of switchable offsets, then this is best done by using the matching PMB4 kit which connects to the DFD4 programming pins.



DISPLAY FRONT VIEW

Each counter chip (IC9 to IC12) has a set of four pins which can be linked to earth to program in a pre-set number.



The first digit (No.1) is programmed by links 1A, 1B, 1C & 1D, the second (No.2) by links 2A, 2B, 2C etc.

PROGRAMMING LINKS

Each 74LS192 counter chip has four programming pins on the PCB. When there is no connection to a pin, the chip reads this as a number input. Pin A is read as a decimal number 1, pin B as a number 2, pin C as a number 4 and pin D as number 8. So to program a decimal number 5 you would leave pins C (4) and A (1) disconnected (4+1=5). The other two links must be inserted - these connect the pins to ground. The table below shows how to program any decimal number into the counter.

NUMBER	A Pin	B Pin	C Pin	D Pin
0	E	E	E	E
1	N/C	E	E	E
2	E	N/C	E	E
3	N/C	N/C	E	E
4	E	E	N/C	E
5	N/C	E	N/C	E
6	E	N/C	N/C	E
7	N/C	N/C	N/C	E
8	E	E	E	N/C
9	N/C	E	E	N/C

N/C = No connection to pin.

E = Pin linked to earth on PCB.

Note - combinations of links not shown in the table will display silly shape numbers!

PROGRAM THE RIGHT DIGIT!

The counter displays the frequency in the format .455.0 indicating 455.0kHz. Make sure you program the hundreds, tens etc with the right digit. As the counter does not display the MHz part of any frequency, there is no need to program the MHz part of any IF offset. For example if your offset is 10.700.0MHz, then you only need to program the .700.0 part of the number. The 10MHz part simply overflows "off the end" of the counter and does not affect the displayed frequency.

PROGRAMMING FOR NO OFFSET.

For use as a straight frequency counter fit the programming links to all programming pins (A,B,C & D) for all four counter chips.

TO CHECK YOUR PROGRAMMING IS CORRECT

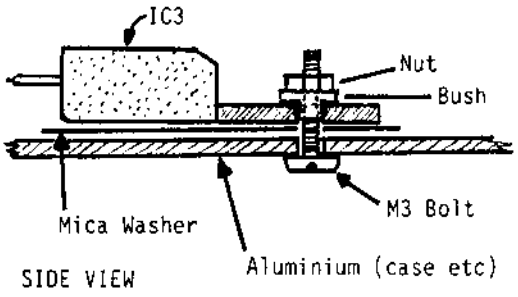
If you power up the DFD4 with the UP/DOWN count link disconnected, the counter will show the offset that has been programmed.

FACTORY ASSEMBLED PCBS

Unless to special order, these are supplied with all programming links in place giving no offset. Simply cut the links to give any offset you require - see programming information and table above.

HEAT

IC3 of the DFD4 module (the voltage regulator) must be bolted to a good size area of aluminium to keep it cool. The insulated washer and bush must be used to prevent the tab of IC3 being shorted to the metalwork. If the DFD4 module is mounted above other circuitry in your project, then the screening plate under the module can double as the heatsink for IC3.



Some of the counter module circuitry runs quite warm. Ensure that heat from the module does not warm up any associated VFO circuitry. Heating a VFO will lead to unwanted frequency drift.

SCREENING

The DFD4 has been designed for lower levels of spurious RF radiation than are usually found with counter circuitry. However screening of the counter should still be regarded as essential. All wiring to and from the DFD4 module must run round the PCB, not over or under it.

MOUNTING THE DISPLAY BOARD.

The display board mounts behind the front panel of your project on two bolts (use M3) located on the front panel. If countersunk bolts are used, their heads can be covered by an escutcheon (see below). The board is spaced the correct distance from the panel by adding nuts/washers behind the panel.

If you are going to do your own metalwork for the display, then the large rectangular hole in the front panel is best cut using a nibbling tool. If you need to cover up any rather dodgy metalwork, simply cut an escutcheon out of card or thin plastic using a sharp modeling knife and ruler, then stick this on to the panel to cover any inaccuracies.

REMOTE LOCATION OF DISPLAY BOARD.

The two ribbon cables supplied with the kit do not have to be used. Longer cables may be fitted in their place, if this is more suitable for your project. Only DC is fed to the displays, they are not multiplexed.

SIMPLIFIED CIRCUIT DESCRIPTION - the DFD4 is simple in outline:-

The seven-segment displays are driven by display driver chips (IC17 to IC20), each of these is driven by a latch (memory, IC13 to IC16) that stores the number to be displayed.

The input signal is amplified by TR3 and fed via the "gate" (IC8) to the UP or DOWN input of the presetable counters, IC9 to IC12. The output of each counter feeds its associated latch chip.

The duration of the count period is determined by the length of time the gate (IC8) allows the signal through to the counters. This gate time is set by the crystal oscillator "clock" (IC4) and its frequency dividers (IC5 to IC7).

After a count is completed, TR2 pulses the latches so that they store the count. TR4 then pulses the counters to reset them to zero. TR5 then pulses on the load input of the counters and the counters are pre-set to the programmed number. The next count will then start from the pre-set number when the count interval timer (IC1) starts a new count by enabling the clock, and the process repeats.

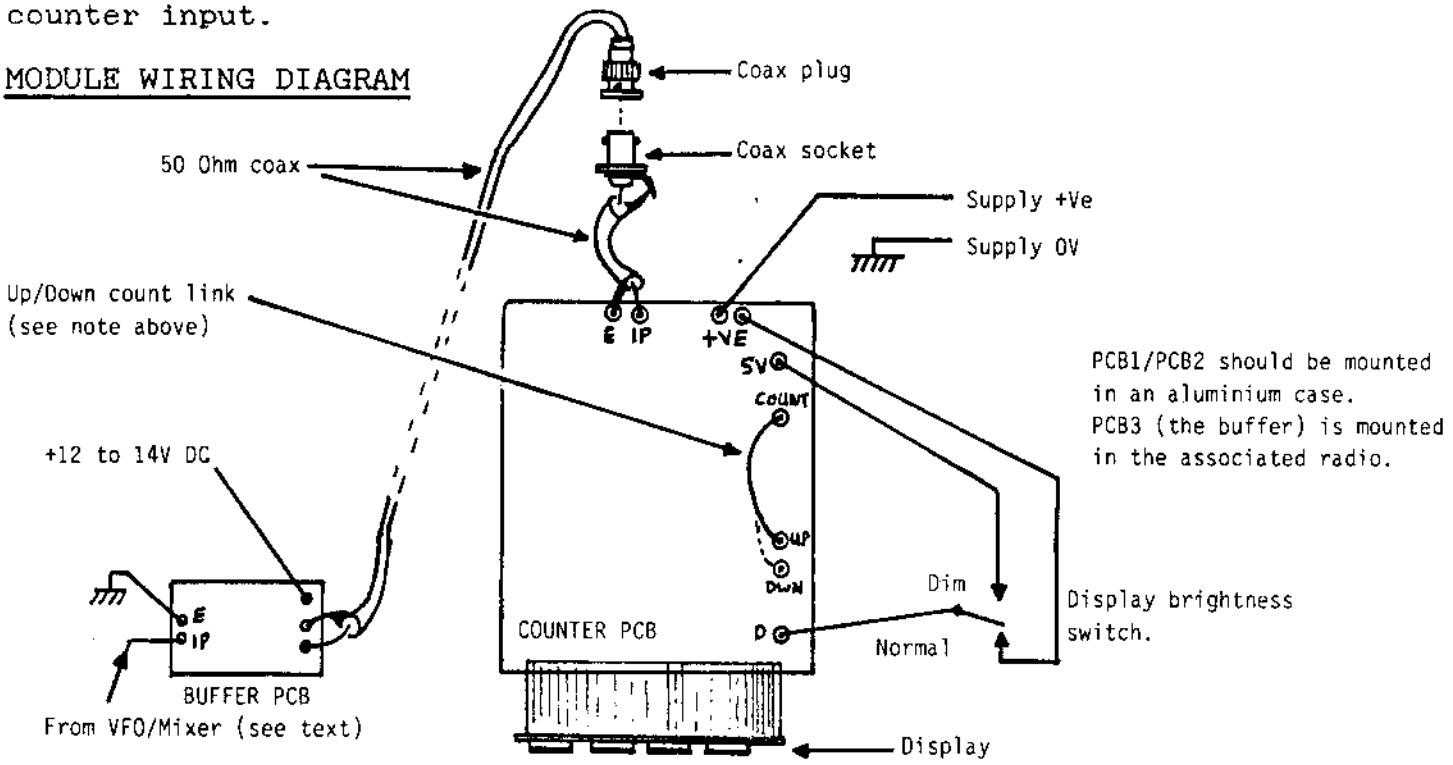
Assembled DFD4 modules should be wired up as shown in the diagram. Note that there are a few options to consider:-

UP/DOWN COUNTING: The "COUNT" terminal on PCB1 is linked to the "UP" terminal by a short wire for normal operation. If the VFO in your equipment tunes "backwards" (the VFO frequency goes down as the operating frequency goes up), then link "COUNT" to the "DWN" (down) terminal instead of "UP".

DISPLAY BRIGHTNESS: This can be switched as shown in the diagram or permanantly wired for a fixed level - this saves on the cost of a switch!

COAX POWERING OF BUFFER: Wire up all the connections as shown on this page with the exception of the coax input to the counter. Refer to the "User Information" page for the details of the coax feed from the buffer to the counter input.

MODULE WIRING DIAGRAM



CALIBRATION AND ALIGNMENT

The trimmer capacitor CV1 gives fine tuning of the counter's internal "clock" frequency to enable you to set the counter for maximum accuracy. This can be adjusted by listening to the 10.000 MHz internal "clock" oscillator with an accurate receiver or feeding in an accurate known frequency to the counter and adjusting for the correct display. Don't forget to allow for any programmed offset if you use this method.

If there is not quite enough adjustment range on CV1, then add the AOT (adjust on test) capacitor C17. If you have no suitable test equipment for carrying out this adjustment, simply set CV1 so that its plates are half meshed - you should not be much out!

Set the signal level at the buffer's input by adjusting VR1. This should be set so that the buffer feeds about -10 to 0dBm (1mW) to the counter. If you have no test equipment to check this, simply turn VR1 fully anti-clockwise, and then slowly advance the trimmer clockwise a little at a time until the counter is counting reliably. If the signal input level to the counter is rather marginal, then the counter may count irractically.

USE WITH AN ANOLOGUE TRANSCEIVER TO ADD DIGITAL READOUT.

You will need a copy of the block diagram and circuit for your equipment if you are to work out the correct connection for the DFD4. We are building up a collection of connection information for various equipment as and when we can obtain it, and may be able to help with advice on your particular radio. Please 'phone for details on availablity of information.

DO NOT ATTEMPT to carry out installation of the DFD4 buffer module in the receiver/transceiver unless you are sure you have the knowledge to do this safely. A reputable amateur radio dealer/ repair shop should be able to do this for you if you are in any doubt. NEVER WORK ON "LIVE" EQUIPMENT.

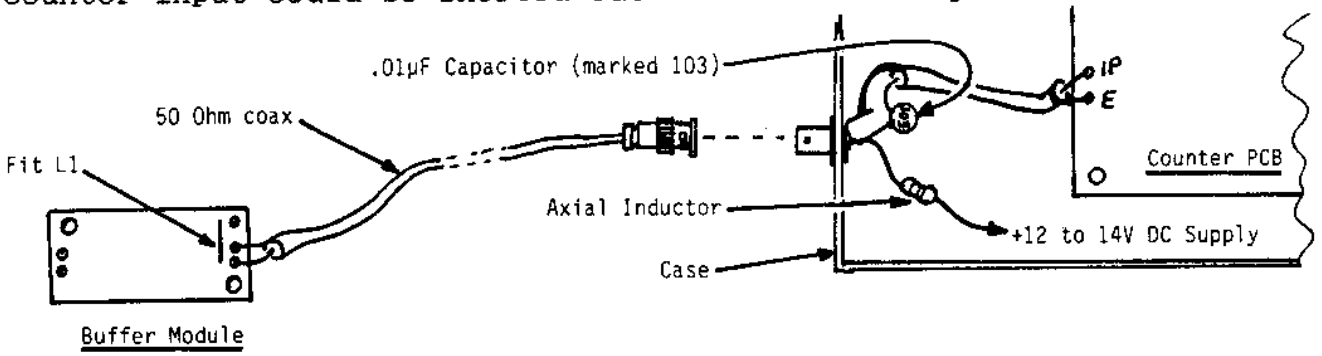
The DFD4's buffer should be connected to the output of the radios' VFO or at the input to the transmit/receive mixer stage. The signal level at the connection needs to be about 0dBm to +10dBm (1 to 10mW). If the level is higher than this, then it can be reduced by adjusting the preset VR1.

CAUTION - Care should be taken in valve equipment that the voltage at the connection point does not exceed 50V DC.

The IF offset should be programmed on the DFD4, or if more than one offset is required to allow for different modes etc, then the optional PMB4 switchable programming matrix should be added to the counter. The counter can be set to count down for reverse tuning VFOs (FRG7 etc), or to count up for the majority of rigs.

DC FEED TO THE BUFFER

The buffer can be powered from the receiver/transceivers 12 to 14V rail if this is convienient. If the correct voltage is not avaialable in the radio, then the DC power can be fed up the interconnecting coax from the DFD4 counter board as shown in the diagram. If you use this coax powering, then you must not connect the counter to any other item or the DC voltage on the counter input could be shorted out or cause other problems.



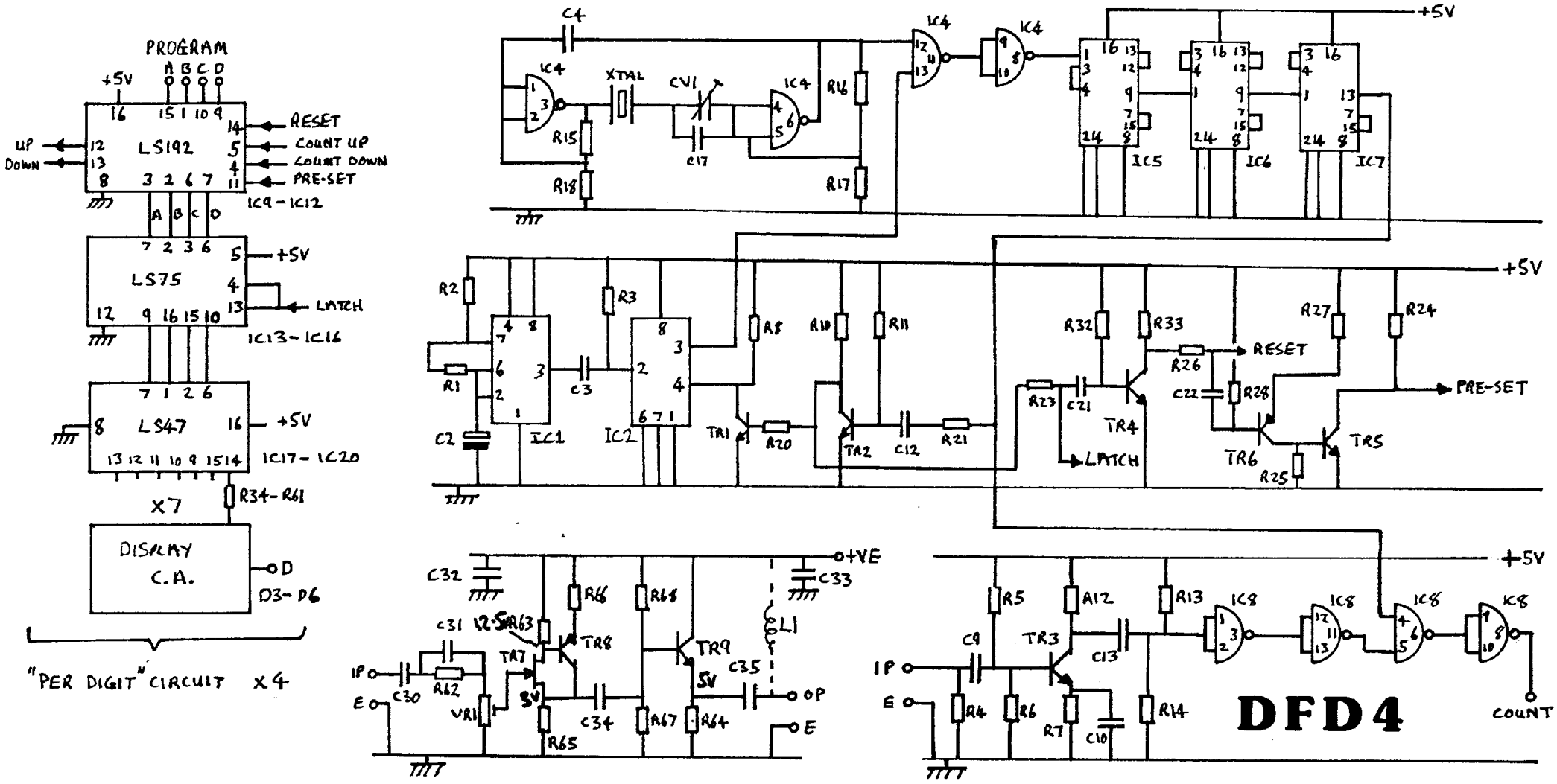
USE WITH A HOWES VFO KIT

The DFD4's buffer is connected directly to the VFO output and used to feed the DFD4 counter board. On simple VFOs for Direct Conversion type transceivers (CVF80 etc) no offset is required.

Were the VFO is mixed with an IF frequency (VF10 etc), then the output from the VFO is again fed directly to the buffer and thence to the counter board. In this case the counter should be programmed with the IF offset (nominally .995.7 for HTX10/VF10 combination set for USB)

USE WITH A DIRECT CONVERSION HF RECEIVER.

The input impedance of the DFD4's buffer is not high enough to connect directly to the receiver's internal VFO tuned circuit. A specialised very high input impedance buffer (HOWES CBA2 etc) is needed for this.



NOTE - This circuit has been simplified by only showing one circuit module were the same circuit is repeated four times on the PCB (the "per digit" circuit). The information shown on this diagram should be satisfactory for maintenance purposes. However the PCB layout should be followed when any fault tracing is done, as the many links, other interconnects and decoupling components are not shown on this diagram.

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