The HOWES DFD5 is a digital frequency counter kit. Its special feature is a low level of "digital noise", enabling the counter module to be used with communications equipment as a "digital readout" with the minimum of EMC problems.

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

BRIEF SPECIFICATION

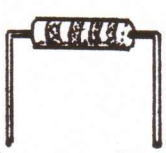
Frequency range: 1 to 35MHz minimum. No prescaling is used.
Resolution: 1kHz or 100Hz, selectable.
Input impedance: Nominal 50R or >5k, selectable.
Input Signal level: -10 to +20dBm (.07 to 2V RMS) at 50R I/P Z.
Clock Frequency: 10MHz, crystal controlled.
Display: 5 digit, 7 segment .43" (11mm) red LED, non-mutiplexed.
Display brightness: selectable between normal and dimmed.
Operating Voltage: +8 to 14V DC at around 400mA maximum.

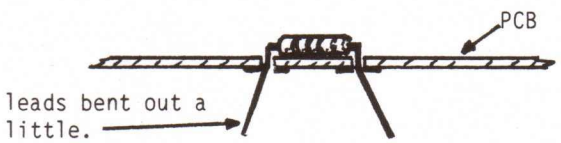
IMPORTANT NOTE.
Although assembly of this kit is quite straightforward with no special skills or equipment being needed, there are a lot of solder joints to be made, and many of them are close together. NEAT SOLDERING IS REQUIRED if the module is to be built successfully. Please examine the PCB before starting work, and decide if you feel happy about your soldering ability. We will willingly exchange the DFD5 kit for an assembled PCB module 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.

BUILDING THE KIT.
Ensure you have all the correct tools and parts to hand BEFORE you start. There are two PCBs in this kit. PCB1 is the main counter board. PCB2 is the display board. These instructions will start with assembly of PCB1, but you can just as easily start by building PCB2 first, if you prefer.

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.
Next fit the resistors. Select the first resistor from the Parts List, being careful that you read the colour code bands correctly (red and orange are easily confused under artificial light). Bend the resistor's leads ready for insertion into the PCB as shown in the diagram.


Resistor ready for insertion in PCB



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.

CONTINUED

Once you have soldered the first resistor in place, cut off the excess lead as close to the joint as possible. Now work your way through all the other resistors in the Parts List. Next fit the ICs taking care that they are inserted the right way round. Refer to the Parts List for details. Please take care not to mistake 74LS47 and 74LS74 devices, the numbers are confusingly similar.

Once the chips are neatly soldered in place, fit the capacitors, keeping all the leads as short as possible. C8 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 the wire links (LK1 etc) on the PCB. These are fitted next. Bend the off-cut leads to length and fit them to the holes marked LK1 to LK25 in just the same way as you fitted the resistors, keeping the links flat against the PCB.

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 trimmer, CV1, and then finally the crystal "XTAL". Make sure you do not overheat this item. PCB1 should now be complete.

PCB2 ASSEMBLY.

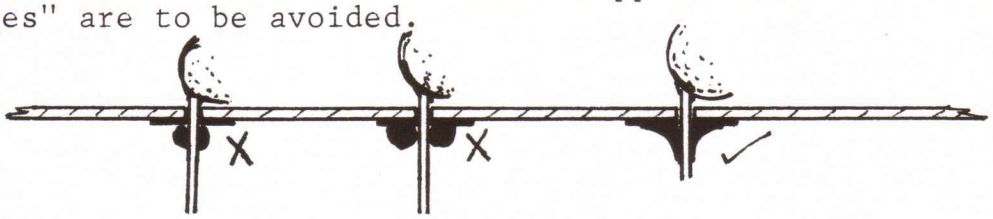
is is the simpler board, but fitting all the resistors will take a little while. Fit the two terminal pins first to the holes marked "A" and "B" on the board. Next fit the LED displays themselves, followed by the resistors. See the Parts List 2 page for details. Because all the displays are the same, and all the resistors are the same value, we have not given them individual parts numbers on this board. Printed rectangles show the location of the LEDs and simple straight lines show the resistor's locations. Keep all the resistors flat against the PCB.

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. No pin pricks of light should be visible on a correctly built board.

In a similar manner check for solder "bridges", particularly between adjacent IC pins. We have designed the PCB layout so that no IC connection goes directly sideways to the next door pin, except where the very wide earth track joins ICs 12, 13, 14 & 15. Any solder bridge should be removed with solder wick, or a desoldering tool.

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.

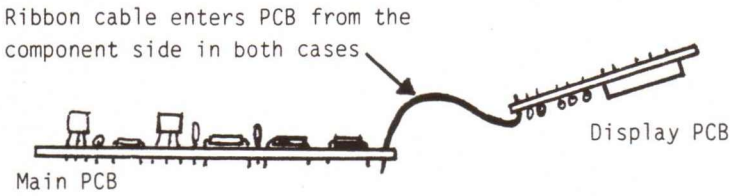


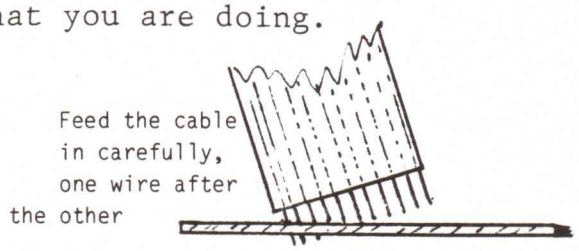
Solder joints should have a concave, not rounded appearance

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.

FITTING THE RIBBON CABLES

The two PCBs are interconnected by two 20 way ribbon cables. Make sure the two PCBs are the right way round/up when you insert these cables. You will need a steady hand and a good light to see what you are doing.





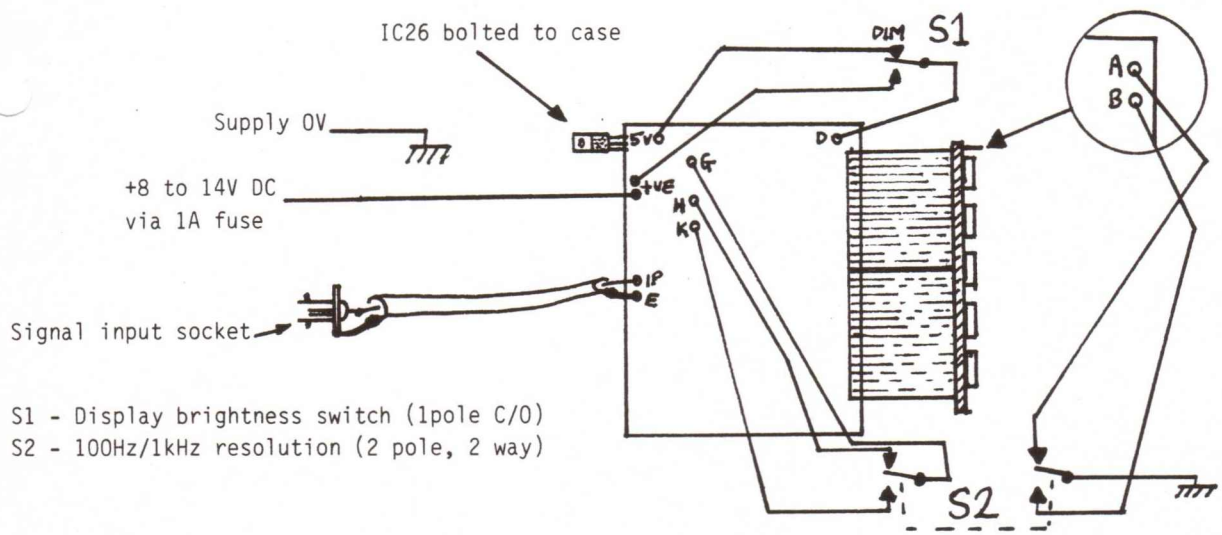
Fit both cables to the main board, PCB1 first. Start by removing the protective strip from one end of one cable. Pull this off carefully, so as not to bend the wires out of line. Straighten any bent wires, then starting at one end, ease the wires, one after the other, into their holes on the board. Solder only one wire at each end of the ribbon at this point.

Now insert the second cable into PCB1 in a similar manner, again solder only the one wire at each end at this point. Next remove the protective strips from the other ends of both cables. Make sure all the wires are dead straight, and ease them, wire by wire, into their holes on PCB2. Do not forget to make sure the board is the right way round first. Again solder only the end wires of each ribbon. Now double check the boards have the right relationship to each other, that the display board is not facing the wrong way, and that the two cables are exactly parallel. You can correct any errors quite easily at this point, as there are only four soldered joints. If everything is OK, solder all the other joints, and trim off the excess wire ends.

DFD5 MODULE WIRING INFORMATION

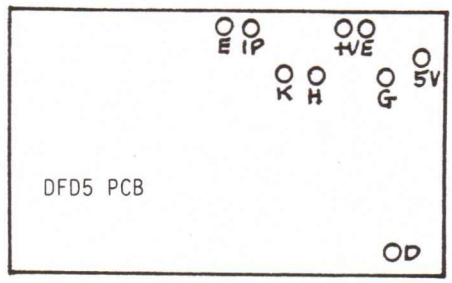
DO NOT APPLY ANY POWER until IC26 has been mounted on a suitable area of metal heatsink (case etc).

Before installing the module, refer to the User Information page to check if you need to instal R18, change R15, or cut LK25 for the various options.



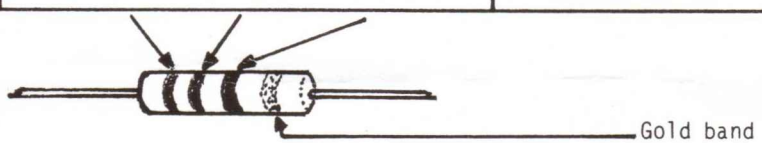
The diagram shows the DFD5 wired for general purpose use in its own case. If it is to be built into a receiver etc, then you may choose to "hard wire" the kHz/100Hz selection instead of fitting a switch. The normal/dim selection could also be hardwired rather than switched.

TERMINAL PINS.
Fit the pins to holes shown in the diagram. Push them fully home with a hot soldering iron and a little solder. BE CAREFUL not to slip with the hot iron.



RESISTORS

Value	Colour Code			Part Numbers
10R	Brown	Black	Black	R41 R42 R43 R44 R45
27R	Red	Violet	Black	R11 R12 R13 R16 R17 R23 R24 R28 R29 R30 R31 R32
56R	Green	Blue	Black	R9 R27 R33
100R	Brown	Black	Brown	R22
330R	Orange	Orange	Brown	R20
1k2	Brown	Red	Red	R7
1k8	Brown	Grey	Red	R3 R8 R40
2k2	Red	Red	Red	R2 R6
4k7	Yellow	Violet	Red	R1 R26 R34
10k	Brown	Black	Orange	R4 R5 R10 R19 R35 R36 R37 R38 R39
18k	Brown	Grey	Orange	R21 R25
47k	Yellow	Violet	Orange	R14
100k	Brown	Black	Yellow	R15

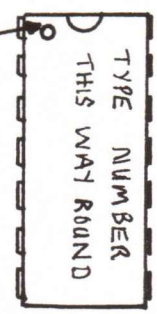


OPTIONAL RESISTORS - you should have two resistors left over. These optional items should kept safe in case they are needed later.

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.

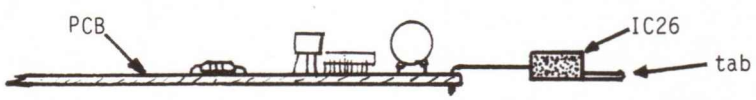
Type	Part Numbers
NE555	IC1 & IC2
74LS74	IC9
74LS47	IC21 IC22 IC23 IC24 IC25
74LS75	IC16 IC17 IC18 IC19 IC20
74LS90	IC4 IC5 IC6 IC7 IC8 IC11 IC12 IC13 IC14 IC15
74LS00	IC3 IC10

The spot or cut-out at one end of the IC should correspond with the outline printed on the PCB when you insert the chip into the board



MAKE SURE YOU GET THE CHIPS ROUND THE RIGHT WAY.

IC26 is the voltage regulator, type 7805. Fit this to the PCB as shown in the diagram. Later, when the module is installed in its case, the tab of this device must be bolted to the metalwork (using the insulated washer and bush provided) to conduct the heat away from this component.



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

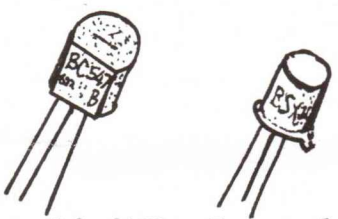
Value	Marking Information	Part Numbers
47pF	Disc marked 47	C3
100pF	" " 101	C11
1nF	" " 102	C6 C13 C17 C25 C41
.01uF	" " 103	C4 C5 C7 C9 C10 C12 C14 C18 C19 C20 C21 C22 C24 C26 C27 C28 C29 C30 C36 C37 C38 C39 C40
.1uF	Disc marked 104	C2 C15 C16 C23 C31 C32 C33 C34 C35
22pF	Plate marked 22	C1
*4u7	marked 4u7 or 4.7uF	C8

* NOTE C8 is an electrolytic type 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 arrows contaning "-" signs on the side of the component.

LINKS - There are quite a few wire links to be made on the PCB. All of them are made with the offcut leads left after fitting the capacitors. Bend these leads to the correct length, and then insert them into the PCB in the holes marked for them. These are given part numbers LK1 to LK25.

TRANSISTORS - these have their type numbers marked on them

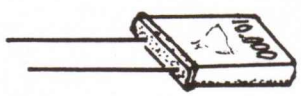
TR1, TR2 & TR3 are BC547
TR4 is a BSX20



Fit these devices the right way round, as indicated by the outline on the PCB.

CV1 Trimmer Capacitor.

10.0MHz Crystal - "XTAL"



Do not overheat this part.

DFD5 PCB2 (display board) Parts List.

Fit terminal pins to the two holes marked "A" and "B".

The seven segment LED displays are fitted to the board as indicated by the printed outlines. These will only fit one way up. All five displays are the same, so they have not be given individual part numbers. Try to ensure you do not scratch the face of these devices when you work on this module.

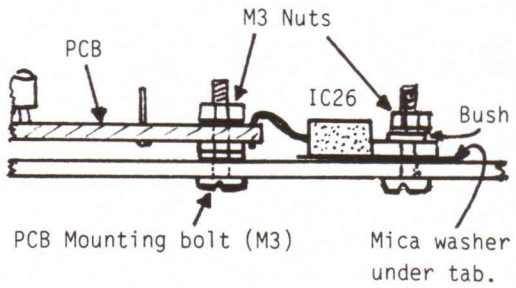
All other components on this board are 1k8 resistors. Their colour code is:

Brown Grey Red Gold.

There are no individual part numbers printed on the board for the resistors, as they are all the same value. There are 38 resistors in all on this board. Make sure you fit them all flat on the PCB.

HEAT

IC26 of the DFD5 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 IC26 being shorted to the metalwork. If the DFD5 module is mounted above other circuitry in your project, then the screening plate under the module can double as the heatsink for IC26.



The display module 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 DFD5 has been designed for lower levels of spurious RF radiation than are usually found with counter circuitry. However screening of the module should still be regarded as essential. The DFD5 module is best mounted above all other circuitry in a receiver/transceiver with an aluminium screen doubling as the mounting plate for the DFD5 module. The screening plate must be well earthed to the main case. All wiring to and from the DFD5 module must run round the PCB, not over or under it. Be especially careful to keep all wires well away from IC15 - most noise (heard as a ticking in the receiver) comes from direct radiation from this chip itself.

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.

The large rectangular hole in the front panel is best cut using a nibbling tool. It can also be made by a series of drilled holes and then filed to shape. To get a really straight, good looking edge to the panal cutout, and 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 the panel to cover any inaccuracies.

OFFSETTING THE DISPLAY BOARD.

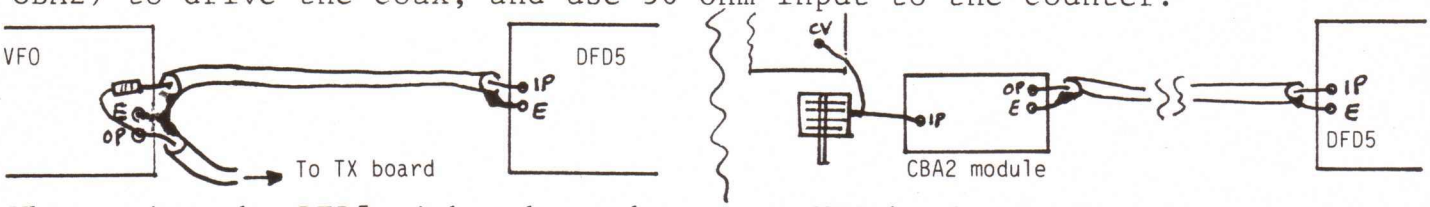
The two ribbon cables supplied with the kit do not have to be used. Longer cables could be fitted in their place, if this is more suitable for your project. With the supplied cables, the display can easily be moved up and down to fit as required, but side to side movement is difficult. This can be made much easier if needed, by using a sharp knife to slit the insulation between every fith wire AFTER the cables have been soldered to the PCBs. Be very careful not to cut the wires themselves if you do this.

SIMPLIFIED CIRCUIT DESCRIPTION - the DFD5 is simple in outline:-

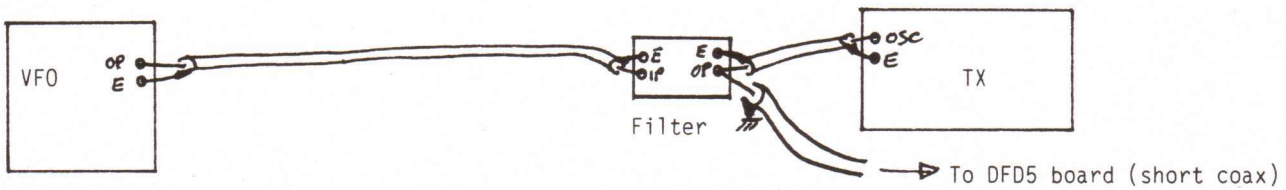
The seven-segment displays are driven by display driver chips (IC21 to IC25), each of these is driven by a latch chip (IC16 to IC20) that stores the number to be displayed. The input signal is amplified by TR4 and fed via IC10 to the decade counters, IC11 to IC15. Each counter feeds its associated latch chip. The duration of the count period is determined by the length of time the gate (IC10) allows the signal through to the counters. This gate time is set by the crystal oscillator "clock" (IC3) and its frequency dividers (IC4 to IC9). After a count is completed, TR4 pulses the latches so they store the new count. TR2 then pulses the counters to reset them to zero. After a short delay, the count interval timer (IC2) starts a new count by enabling the clock, and the process is repeated.

Connecting the DFD5 to HOWES VFO kits.

The DFD5 can be connected to the transmitter output of the VFO module with the DFD5 input set to high impedance (R18 not fitted). With high output level VFOs (CVF series), a 4k7 resistor can be added in series with the feed to the VFO for additional isolation. Only a short (300mm max) interconnecting cable should be used with high impedance counter inputs, or else the capacitance of the cable will cause excessive loading. For longer cable runs, connect a low impedance output buffer amplifier module (ie CBA2) to drive the coax, and use 50 Ohm input to the counter.



When using the DFD5 with a hetrodyne type VFO having a separate outboard filter module fitted between the VFO and transmitter (ie VF160/ AT160), then the counter is best connected to the transmitter side of the filter (to prevent count errors due to pick up of internal VFO oscillators).



Connecting the DFD5 to HOWES Receiver kits.

The DFD5 can be used with all HOWES direct conversion receivers. However an isolating buffer amplifier is required for the connection to the receiver's internal VFO. The HOWES CBA2 is a suitable buffer kit. The buffer is connected directly to the receiver circuitry, its output feeding a coax cable connection to the DFD5. R18 is fitted to the DFD5 to provide a nominal 50 Ohm input impedance to the counter, and therefore a match to the coax impedance. The length of interconnecting coax can therefore be short or long as required.

MODULE ALIGNMENT

There is only one alignment adjustment to make on the DFD5 kit:-
CV1 is to fine tune the counters clock oscillator to obtain maximum display accuracy. It is most easily set by feeding an accurate, known frequency into the DFD5, and adjusting CV1 for the correct display. This is best done at the highest frequency to be used. If the DFD5 is connected to a receiver, then this can be tuned to a station of known frequency, and CV1 adjusted for the exact reading. CV1 should can be set to half mesh as a nominal setting if no alignment facilities are available.

DFD5 USER OPTIONS.

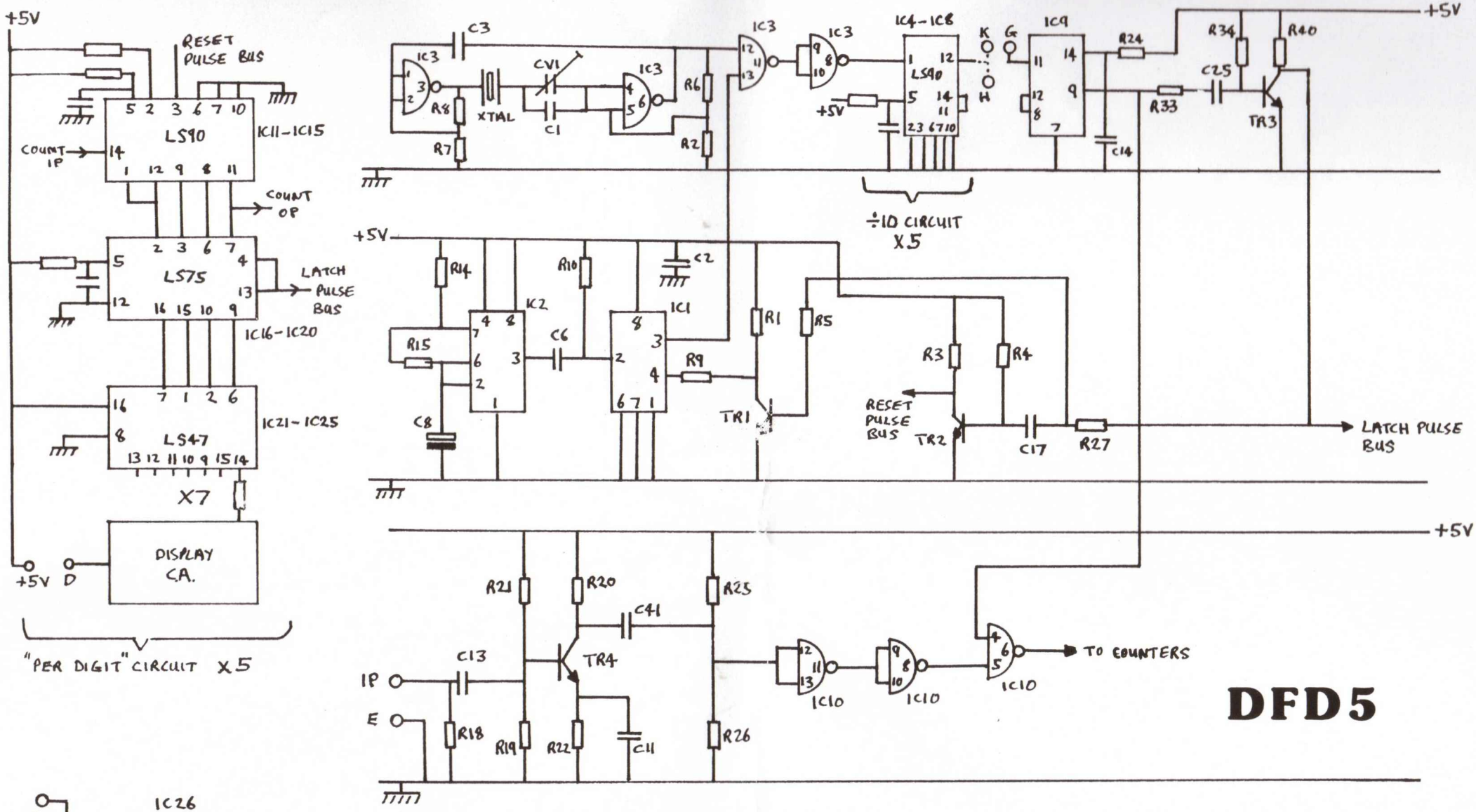
Input Impedance

The input impedance can be selected as "high" (>5k) or "low" (nominal 50R), as required. Fit the spare 56R resistor as R18 if low input impedance is needed.

Count Interval.

To minimise "digital noise" radiation from the counter, the interval between count updates (and therefore digital activity) is best kept as long as practical for the application. If you feel you would like the display to update at more frequent intervals, simply change R15 from 100k to a lower value. An 18k resistor is supplied for this purpose. R15 should not be less than 4k7.

Leading Zero Suppression. Cut LK25 to remove this function, if required.



DFD5

HOWES

NOTE - This circuit has been simplified by only showing one circuit module were the same circuit is repeated five times on the PCB (ie 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 and other interconnects are not shown on this diagram.