PIC COUNTER

Hands Electronics

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Thank you for purchasing one of our kits. We hope it will give you many hours of service once built. Our aim is to provide satisfaction and service. If you have any problems with the construction or use of the equipment, please ring, or write to us. We will do all we can to help.If you are new to construction we suggest you read carefully the information about part identity and soldering contained in the tools and construction section.

Sheldon Hands

Tools and Construction Practice

We recommend the following tools to make your **HANDS** kit

15/25w soldering iron
small electrical screwdriver
4inch phillips screwdriver
small side cutters
electricians pliers
snipe nosed pliers
small half round file
multimeter

Below are some notes on construction practice with a heavy emphasis on soldering.

You must use solder with a non-corrosive flux. Acid cored solder MUST NOT be used. A 60/40 type will be ideal. The secret of good soldering is to have the correct temperature at the joint. Make sure the tip of the iron is clean, if necessary clean it on a damp sponge. Do not carry solder on the iron to the joint, by the time you get it there the flux will have burnt or vaporised.

Although it seems to contradict the above, do lightly tin the iron before making a joint. This will aid the heat transfer and lessen the chance of damage to the track or component through prolonged application of the iron.When you are ready to make the joint, apply the iron and the solder at the same time. Do not apply too much solder, a thin gauge helps in this respect. Humps of solder on a joint either means you did not leave the iron on the joint long enough or you used too much solder. Try to get a medium coating over the track and the component lead. If you use too much heat you may damage the track or the component. We suggest you try some test joint on scrap wire, you will find it inspires confidence! When the board is complete check for solder bridges and dry joints, an Ohmmeter can be used for checks.

Most large parts in the kit are readily identifiable, but value identification systems are varied and may pose a problem. For wire ended resistors (ie not SMD) a colour code chart is included at the back of the manual. Most supplies of resistors are coded with 3 bands for the value, i.e. 1st fig, 2nd fig, 3rd multiplier. But we increasingly receive resistors with a 4 band code this then becomes 1st fig, 2nd fig, 3rd fig, 4th multiplier e.g 1k5 = brown, green, black, brown = 1 5 0 0 .

Capacitor identification for electrolytics is straight forward but ceramic caps may pose a problem. Where n values are used n10 = 100pf and 1n = 1000pf, those with just a 3 digit number use the first 2 numbers as figures and the 3rd indicating the number of zeros, i.e. 102 = 1000pf.with a 3 digit number followed by letters treat as a 3 digit number, where only 2 digits and a letter are used this indicates the value is less then 100pf i.e. 82J = 82pf and 4.7C = 4.7pf.

Inductor value systems are as varied as capacitors but generally there are two common types. The first uses coloured bands with the same colour values as resistors, the inductors are the same length as a 0.25w resistor but much thicker with flat ends where the lead exits the body. If checked with an ohmmeter they will show very low resistance values. The second type have the value marked on them with an alpha-numeric code in uh e.g. 2R2K = 2.2uh and 220J = 22uh. To avoid confusion the parts list has the value and the code for each component.

We suggest prior to construction you identify the resistors and capacitors (not the semiconductors) and stick them into a polystyere tile, cut up the packing list and use as labels.

Circuit description.

The frequency counter described was developed for use as an inexpensive digital readout for a receiver or transceiver, as well as a general purpose counter for the shack. Specifications include a maximum count of 130Mhz, sensitivity of less than 10mV across the HF spectrum and a choice of four IF offsets.

Amplification and wave shaping.

The applied signal is amplified by IC4, a high gain monolithic amplifier. Bias to IC4 is via R1, which must be chosen to suit the applied voltage. The formula required to calculate R1 is shown on the circuit diagram. Supply voltage to the rest of the circuit is 5V and is provided by a 78M05 regulator. R2 and R3 bias TR1, a high frequency switching transistor, and were chosen to provide fast switching with low drive. TR1 clocks the prescaler, two JK flip flops, arranged to divide by four. The prescaler increases the maximum count to at least 130Mhz as well as providing wave shaping of the signal, a Fast 74 series device must be used. R4 is used to pull up the TTL level of the 74F112 to the CMOS switching levels of the PIC. The amplified and shaped signal is applied to the timer pin, TOCK1, incrementing the timer with each negative edge.

Reference Oscillator.

The internal clock is used as a reference by connecting a 4Mhz crystal between the OSC1 and OSC2 pins. Use a fundamental mode crystal designed for parallel resonance, high stability types are preferred and will result in a more accurate count. Phase shift capacitors C7 and C8 are used to set the frequency and should be chosen to suit the crystal. The supplier will advertise the required capacitance, usually 30pF, which is made up of C7 and C8 in series. Two disc ceramics will work but for fine tuning use a trimmer for C7.

Display.

Five LED displays are multiplexed and driven directly by the PIC. All eight corresponding segments are tied together and connected to Port C via current limiting resistors. The cathode of each display is switched by transistors TR2 - TR6, low cost plastic package devices, used to limit the current drain of the PIC. Several displays have been tested and all worked well, but high brightness types gave the best results.

Offsets.

Header PP together with R6/11 provide the user with a means of programming the PIC, allowing the addition or subtraction of fixed IF and BFO offsets. R6/11are [ullup resitors placing a logic high or open switch on ports RA1-RB2. For a closed switch or logic low a thru link is made from the pad below the header to the ground plane. Alternativly the ground plane may be countersunk and switch pins installed for general purpose use.

The following tables summarise the function of each switch.

Switch	Function	Closed	Open
1	IF offset select	No	Yes
2	IF offset	Add	Subtract
3	BFO offset select	No	Yes
4	BFO offset	Add	Subtract

Offset Switch

5	6	IF offset
Closed	Closed	455Khz
Closed	Open	4.433Mhz
Open	Closed	9Mhz
Open	Open	10.7Mhz

Software.

A PIC16C55 is used as the processor due to the low cost, several limitations are overcome with software. The internal timer, used to hold the count, is only eight bits wide but an onboard prescaler is programmed to increment the timer every 256 clock pulses. This resultes in a 16 bit timer but only the high eight bits can be read, the low eight bits are stored in the prescaler. In order to read the prescaler, after each gate period, the TOCK1 pin is repeatedly clocked until the timer is incremented. This is done after each gate period using RA0, configured as an output.

The prescaler value can then be calculated as 256 minus the number of clocks required. RA0 also holds TOCK1 low in-between gate periods. A 16 bit count would limit the maximum frequency to 65.535Mhz, 17 bits were needed to extend this to 130Mhz. The 17th bit is deduced by first gating for 1ms and observing the count. A count of 16386 or more would mean an overflow would occur after a 4ms gate and, if so, the 17th bit is flagged. Frequencies below 10Mhz are automatically gated for 40ms and below 1Mhz a 400ms gate is used. This results in a resolution of 100hz or 10hz and no leading zero's.

Above 100Mhz the gate time is held at 4ms and the most significant digit lost. This maintains a resolution of 1Khz and shouldn't present any problems since the lost digit is always a one. When an IF offset is selected, the gate time is fixed at 4ms and after each count the offset is added or subtracted using a simple 16 bit binary addition routine. Should a BFO offset be selected, a further 2Khz is added or subtracted before the result is displayed. All six switches are monitored continuously and can be changed while counting is in progress. Once the count is ready for display, a 17 bit binary to BCD routine is used and the code needed for the port pins found in a look-up table. The five digits are then multiplexed onto the displays. To avoid unacceptable flicker, the display routine is written to take exactly 4ms. This enables the display to be continually refreshed even during gate periods with the display routine also used as the delay for timing the gate periods.

Specifications.

Sensitivity: <10mV 1Mhz - 50Mhz
<100mV 100Khz - 130Mhz

Input impedance: 50 ohms nominal.

Maximum input: 15 dbm (approx. 1.2 volts rms).

Accuracy: +/- Crystal inaccuracy, +/- 1 count.

Gate times:	4ms	40ms	400ms
Resolution:	1000hz	100hz	10hz
Decimal point:	Mhz	Mhz	Khz

Automatic gating for best resolution unless IF offset selected.
Gate time fixed at 4ms when IF offset selected.

Construction .

- Install the 28 pin IC holder at IC1. The cut out on the holder must agree with the board outline. This is the pin 1 end and is further identified by a square pad on the track side. Bend pin 4 out so that it contacts the topside groundplane. Solder the ic pins on the track side then pin 4 to the ground plane.

- Install the 16 pin IC holder at IC2 as before but bend pin 8 out so that it contacts the topside groundplane. Solder the ic pins then pin 8 to the ground plane.

- Fit the PCB pins listed below by pressing the pins home from the TRACK side with a hot iron and then soldering to the track.

- Pcb Pins-: +12V, RF,K1-5

- Fit and solder R1-24. For the vertical mount resistors bend one lead back alongside the body and fit the body in the inner circle of the legend outline.

- Fit and solder the ceramic decoulpling capacitors. Where you see a ground legend on a capacitor this end is soldered to the top foil of the pcb termed GROUNDPLANE. The groundplane acts as a large heat sink so always tin the pcb with solder around the area of the connection first. Cut the ground side capacitor lead back to about 3mm before fitting. If the connections are too long and obstruct another pad angle the component or its lead to a free area of groundplane.

- Fit and solder the electrolytic capacitors. Where the negative lead is made off to the groundplane, bend the lead at a right angle immediately under the body.

- Fit and solder RFC1/2.

- Fit and solder TR2/6. Make sure that the transistor outline agrees with the board ledgend. The emmiter lead is soldered to the ground plane and is the un-etched hole.

- Fit and solder TR1. Make sure the can tab agrees with the board ledgend. The emmiter lead is soldered to the ground plane and is the un-etched hole.

- Fit and solder IC3 . This located adjacent to the 12v pin in the oblong outline. Bend the leads at the necked section down so that the meatal face and tab contact the pcb. The ic may be bedded in heatsink compund to improve the heat dissapation. Note that the center connection is soldered to the ground plane.

- Fit and solder X1

- Fit and solder TC1. Install so that the slit side tag is grounded by bending the tab at a right angle to the body.

- Make up the display board on PCB2. Fit the wire links on the component side as indicated on the layout diagram. DO NOT attempt to flatten links after installation as track damage is sure to result.

- Fit the led displays. The decimal point on the display face should locate next to edge with the K1-5 pad/pins

- Fit and solder IC4. This is soldered to the underside of the board, the dot on the package is next to the C1 and the RF input pin. View the dot through the groundplane hole.

- Fit and solder the 8 pin header for the display a-dp output.

- Connect the display to the board using ribbon cable or individual wires, keep the length of the cable as short as possible to avoid radiation. The connection may be hardwired to the pins or socketed.

- DO NOT install the PIC or 74F112 yet. Apply 12v [max 13.8v] to the 12v pin and a earth return via the ground plane. Check for about 7.5 volts at the output of IC4, if there is a large deviation R1 will need correction. Check for around around 2 to 3 volts at the collector of TR1 and 5 volts at IC1 and IC2 supply pins. If all is well fit the PIC IC and 74F112 and apply power again, the counter is now ready for use.

- The counter may adjusted against a standard with TC1

Use

The header block PP allows the counter to be configured as table 1. The settings may be hard wired as shorting pins for a closed switch. For a panel select switch lightly counter sink the ground plane holes to clear the ground plane and make fly lead connections.

The fast edges in digital electronics can give rise to harmonics. In transceiver applications the unit should be screened . Except for a short connection from enclosure to the RF pin, minature coaxial cable is preferred.

When used with a receiver/transceiver , use just enough injection to give a reliable count. A small value capacitor should be used to connect the receiver local oscillator to the counter, this will also minimise loading.

When used with an aerial to check transmitters, care should be taken to limit the drive to a level that will not overdrive the MAR-8 amplifier. The maximum input power must be limited to 15 dbm to avoid permanent damage.

In future service TR1 should not be substituted but TR2 - TR6 are less critical and any general purpose transistors should do the job.

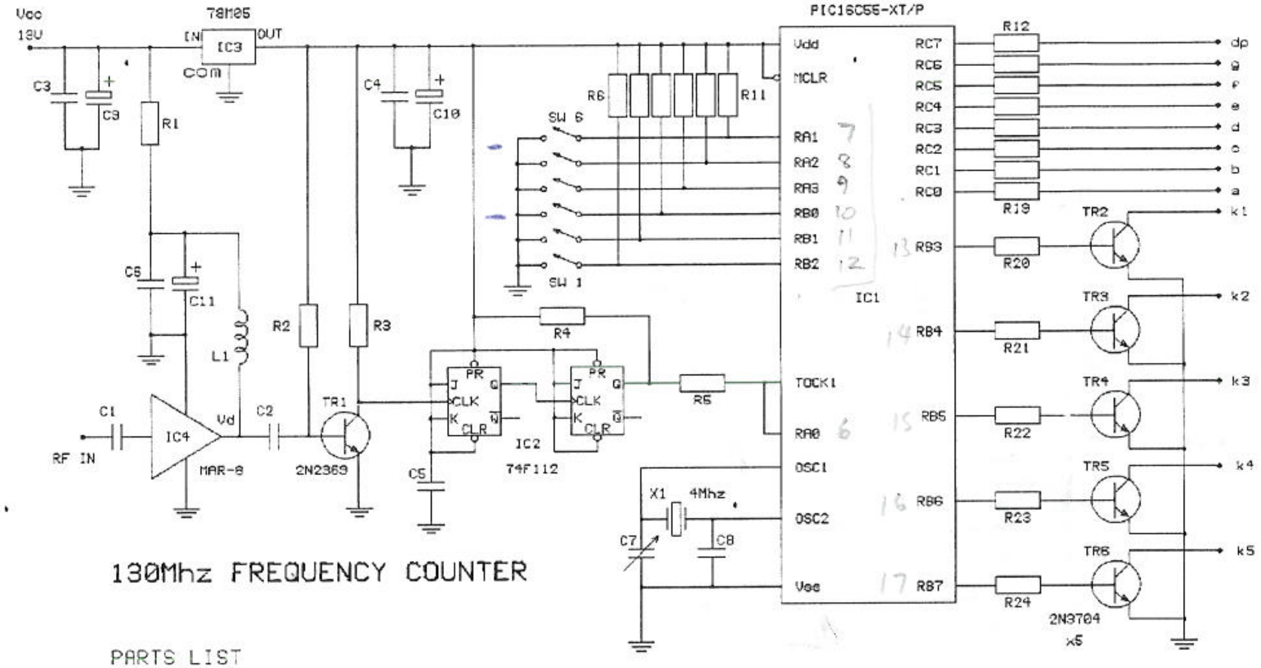
Parts List

IC1	PIC16C55
IC2	74F112
IC3	78M05
IC4	MAR8
TR1	2N2363
TR2-6	2N3704
C1-5	100N [104]
C6	1N [102]
C7	56P
C8	27P
C9	100MFD
C10	47MFD
C11	4.7MFD

R1	TYP 120R [SEE NOTE]
R2	5K6
R3,4	12OR
R5	470R
R6-11	47K
R12-19	220R
R20-24	4K7
X1	4MHZ
L1	1UH[SILVER\BROWN\BLACK\RED]

NOTE R1 chosen to bias MAR8 at Vd=7.5v, Id=36ma

R1+R[L1] = (Vcc-Vd)/Id ohms



130Mhz FREQUENCY COUNTER

PARTS LIST

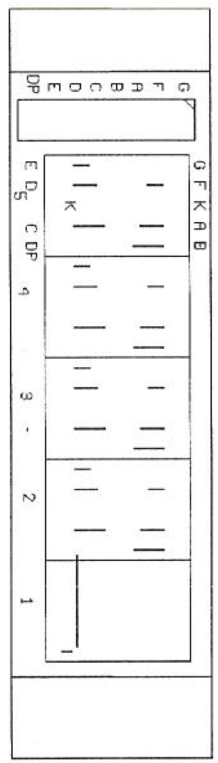
IC1	PIC16C55-XT/P	C6	0.001uF	R3, R4	120
IC2	74F112	C7, C8	To suit xtal	R5	470
IC3	78M05	C9	100uF	R6 - R11	47K
IC4	MAR-8	C10	47uF	R12 - R19	220
TR1	2N2369	C11	4.7uF	R20 - R24	4.7K
TR2 - TR6	2N3704	R1	See note	X1	4Mhz
C1 - C5	0.1uF	R2	5.6K	L1	1mH

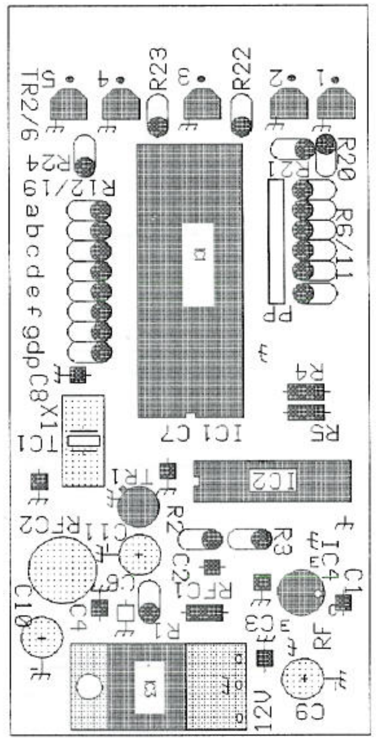
Note:

R1 chosen to bias MAR-8 at

Vd = 7.5 volts, Id = 36mA.

$$R1 + R_{L1} = \frac{Vcc - Vd}{Id} \text{ ohms}$$

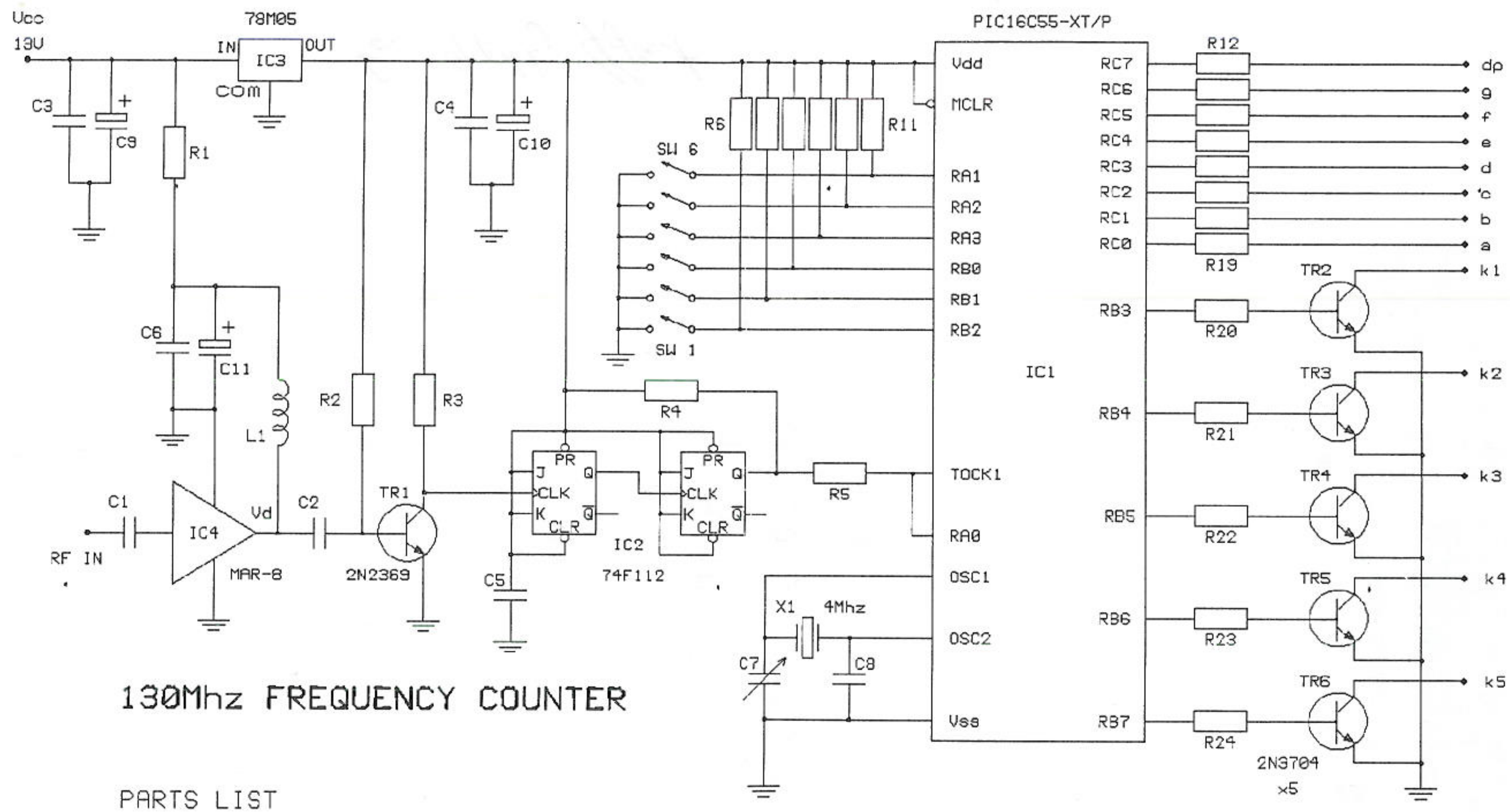




for 9Mhz offset

I/C Pins 7 - Lo.
8 - Hi
9 - D.C.

10 - Lo
11 - Hi
12 - Hi



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IC2	74F112	C7, C8	To suit xtal	R5	470
IC3	78M05	C9	100uF	R6 - R11	47K
IC4	MAR-8	C10	47uF	R12 - R19	220
TR1	2N2369	C11	4.7uf	R20 - R24	4.7K
TR2 - TR6	2N3704	R1	See note	X1	4Mhz
C1 - C5	0.1uF	R2	5.6K	L1	1mH

Note:

Rl chosen to bias MAR-8 at

Vd = 7.5 volts, Id = 36mA.

$$Rl + R_{L1} = \frac{Vcc - Vd}{Id} \text{ ohms}$$