FREQUENCY COUNTER

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FREQUENCY COUNTER

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Introduction:

A frequency meter is a measuring equipment to measure the frequency or number of cycles per unit time of an input signal to it. Frequency meter can be of analogue type and digital type. In analogue type, the frequency is indicated on a calibrated a needle type meter. Where as, a digital frequency counter gives the frequency reading on a digital display. Digital frequency counter are easy to read and reading error is minimum. There are so many other advantages for a digital frequency counter. Now day analogue frequency meters are used to measure low frequencies only. Digital frequency counter is being used for wide range of application. Digital frequency counter extensively uses digital circuits and hence a fairly good knowledge of digital circuits and of digital integrated circuits is required to understand the operation of the frequency counter. However this article has been written in such a way to assemble the counter by a person who is not familiar with any electronic circuits and experiments.

Theory of operation.

As said earlier, the frequency counter has to count the number

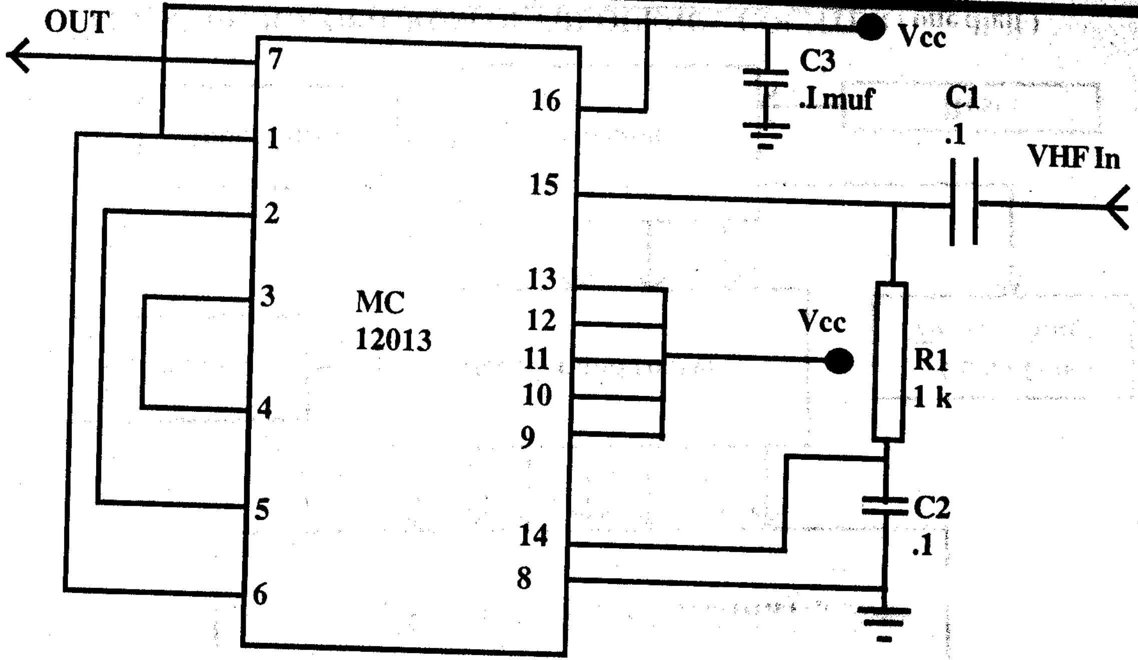


FIG. 5.1 CIRCUIT DIAGRAM OF VHF PRESCALAR

of cycles per second of an incoming signal. Hence we need a device to count. In digital circuits, counter ICs are available for counting. These ICs can count the input digital pulses. The count is given as coded output from the IC (in binary form or in BCD form.) The count value must be converted into decimal digit to be under stood by the human being. More number of ICs can be cascaded to increase the number of digits. The number of digits required for the counter to display the count value depends on the application and the accuracy needed. There is a variety of counter ICs available. In our design we use single 4 bit BCD high-speed CMOS counter chips. One chip is used for one digit and we use 7 similar ICs to get a seven digit counter. Also we use CMOS decoder IC to decode the BCD output of the counter to drive 7 segment displays. The block diagram of a counter is as shown

Since the counter can count only digital pulses, we need to convert the incoming signal wave to digital pulse or we should obtain one pulse for every input wave. Hence we need a special circuit to shape the input wave into a square wave of same frequency and amplitude confined to the TTL signal levels. A signal conditioning section is needed for this purpose.

The input Signal-conditioning section consists of the following stages

* Amplifier or attenuation stage
* TTL level converter stage

Besides the above essential stages, some times a few more

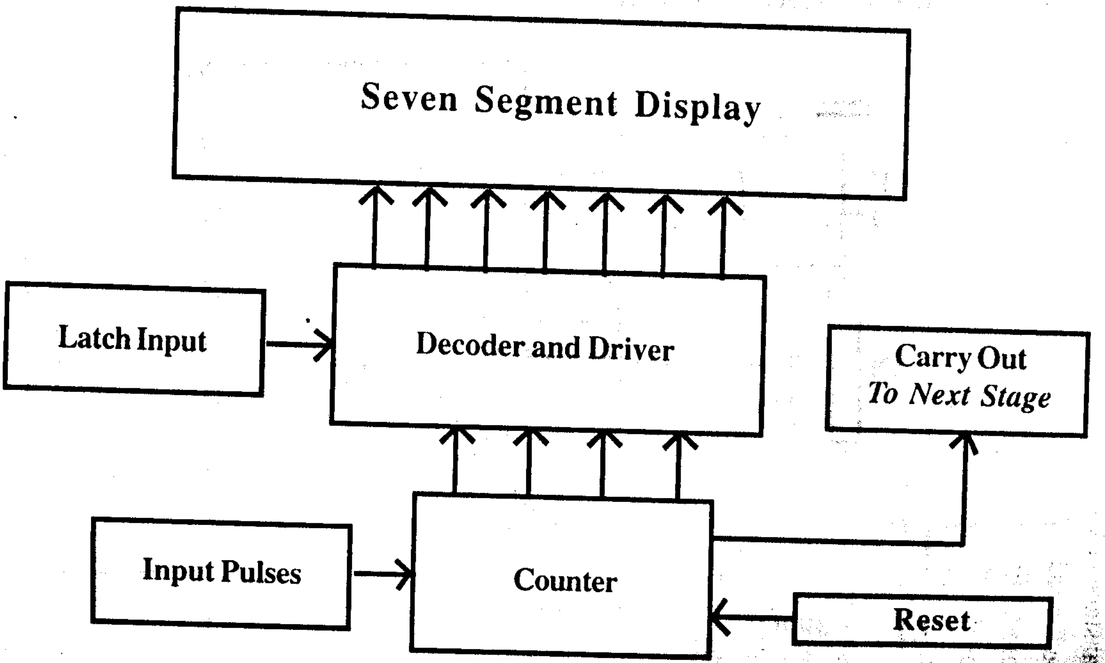


FIG. 5.2 BLOCK DIAGRUM OF FREQUENCY COUNTER (one digit)

additional stages such as input protection stages, filter stages, etc are can be found in some designs. The input whose frequency is to be measured is given to the input stage consisting of the above and the output of this stage is the square pulses. Now this square pulses are given to the counter to count the number of pulses for a fixed duration. If the duration is 1 seconds, then the counter displays a value that is equal to the number of cycles per second. Now if we want to measure a frequency of say 20 MHZ, the counter should display 20000000. This means that the counter should have 8 digits to display. Now the resolution of the counter (minimum change is frequency that can be displayed is 1 HZ. If do not require that much of resolution, we can reduce the number of digits. For example, if we are counting the input cycles for duration of 0.1 seconds, the display shows 2000000. Now if we put a decimal point after two digits from the left of the display, the frequencies can be read in Meg Hertz, in both cases, resolution for the later being 10 Hz. The time for which the counter is counting is called as gating time and if the gating time is say 1 millisecond, we get a display with a resolution of 1 kHz. A frequency counter must always count the input frequency and display the frequency. This means there should be an arrangement to count the input for a fixed time, display the reading. While displaying the reading, the counter should clear again to read the input again. Then only we get a continuous reading that displays the correct frequency at all times. A control circuit is needed to achieve this. The function of the control circuit to generate the following signals.

1. Clear the counter for a fresh reading
2. Provide a precision gating signal to allow the input pulses to

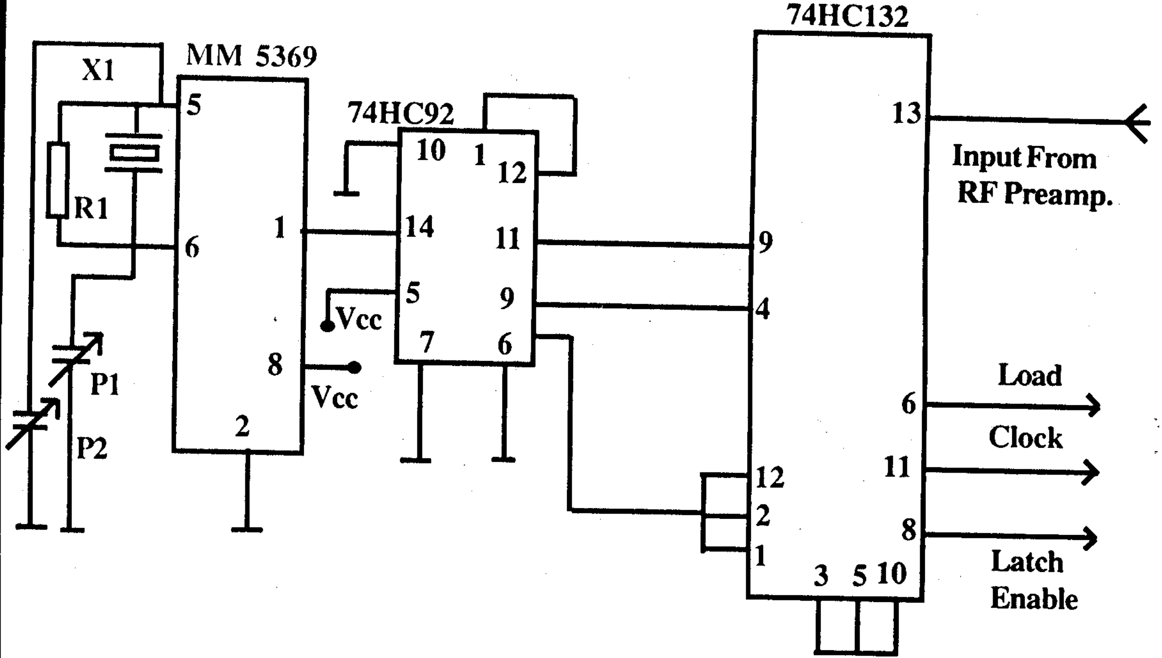


FIG. 5.3 DIAGRAM OF TIME BASE CIRCUIT

the counter to count

3. Latch the count value to decode and display.
4. Repeat the above steps continuously to get a continuous reading

The control circuit must operate with precision timing. This is achieved by deriving all timing signals from a crystal oscillator or time base circuit. The accuracy of the counter solely depends on the stability and accuracy of the time base circuit.

THE CIRCUIT

The counter circuit is designed using discrete digital ICs. The numbers of ICs are more in this design. However cost of the counter well lower than a single IC design. The circuit is capable of counting up, counting down and also capable of programming with an initial count value. This feature is often required if you want to know the frequency of a station tuned by using your super heterodyne receiver. We can display the station tuned in by measuring the local oscillator frequency. The actual frequency is + or - If frequency from the local Oscillator frequency. The IF frequency can be loaded by using the dip switches on the counter board. (BCD value).

The counter chip used is 74hct190. This IC consumes less power and counts up to say 50 MHZ. If you are not is a position to get HCT version you can replace the same with any family of 74 series. The decoder IC is CD4511. This is a CMOS IC consisting of a latch, decoder, and seven segment LED driver.

The control circuit is designed using the freely available

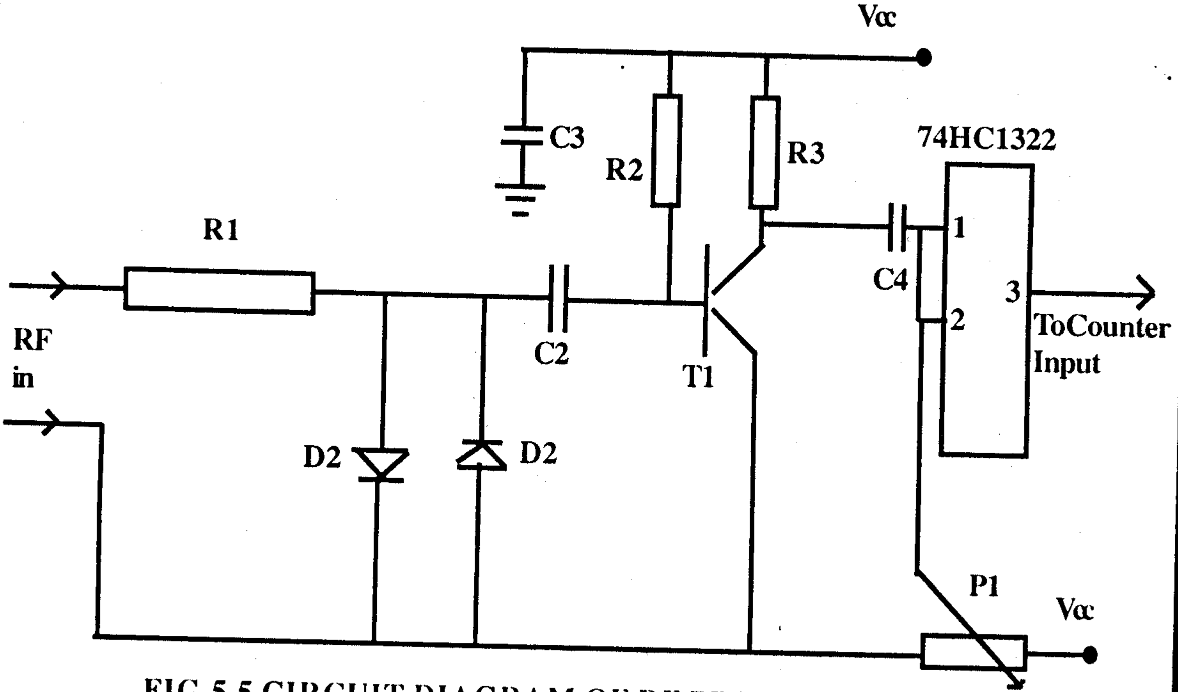
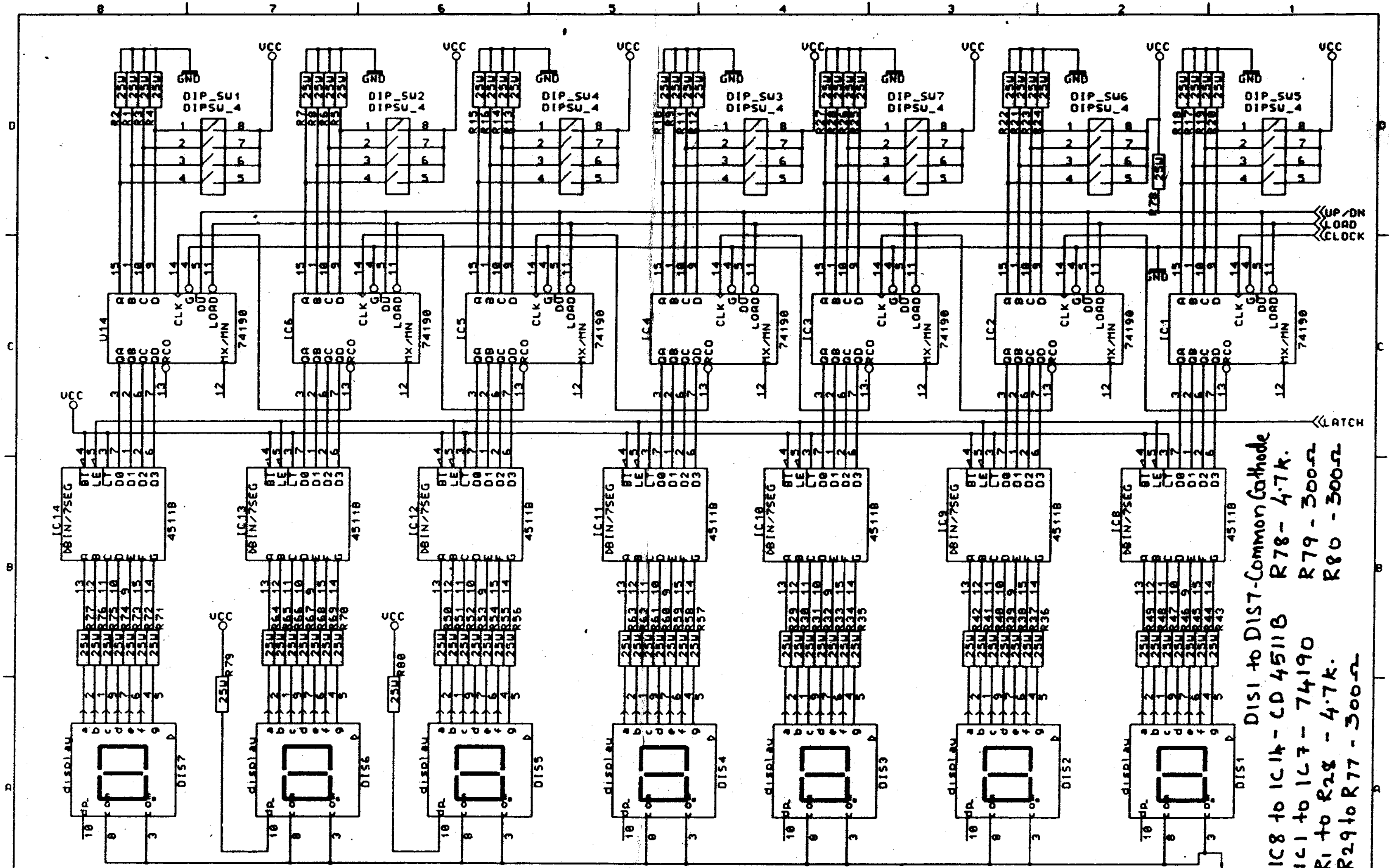


FIG.5.5 CIRCUIT DIAGRAM OF RF PRE AMPLIFIER



CIRCUIT DIAGRAM OF FREQUENCY COUNTER

time base chip MM 5369 and other two TTL chips. The 5369 consists of a crystal oscillator and a divider. If we connect a crystal of 3.579 MHZ we get 60 Hz frequency as output. This frequency is divided again by divided by 12 counter chip IC 7492. Together with 7492 and the schmitt trigger NAND gates the necessary control signals are derived . The gating time is 100 milli seconds and hence the frequency shown is 1/10 th of the actual frequency in Hz.

The input section consists of a single transistor RF pre amplifier. Diode limiters are provided at the input to protect the transistor from high RF voltages if applied. The sensitivity of the counter is around 100 milli volts. A potentiometer is included in the circuit to adjust for proper operation of the counter. If you need more sensitivity, you can add a preamplifier to the front end. If you need to measure audio frequencies using this counter, then the preamplifier must be changed.

The counter is capable of counting frequencies of all HF signals, but if you need to measure VHF frequencies, you need a pre-scalar. Which divides the input by a factor say 10 so that the output is now 1/10 of the input. This frequency is now in the HF range and can be easily read by the counter. Actual frequency is now 10 times the displayed frequency. A suitable pre scalar for VHF counting is also given in the circuit. The Pre-scalar needs an input voltage of 500 mV to function. Hence you may require a VHF preamplifier to measure signals below 500mV amplitude.

CONSTRUCTION

Proper care is to be taken in selecting the components, han dling and soldering the components. It is always better to assemble the circuit on a printed circuit board. The author can provide the PCBs, provided the over all requirements are about 25. IC bases are highly recommended for the homebrewed who's not very familiar with digital circuits while IC bases are not recommended for an experienced builder as IC bases may cause loose connections and decrease the high frequency performance.

Procure all components from a reliable source so as to avoid confusion in a later stage.

Assemble the IC bases and connectors first, followed by all resistors and capacitors. Control circuit can be tested easily with a logic probe. The preamplifier also can be tested with the help of RF probe. Normally there wont be any problem if every thing is assembled in a proper way.

The counter needs a 5V highly stabilised power supply capable of delivering about 1 amperes. 3 terminal regulator IC 7805 is sufficient for this purpose. If power supply is not proper there can have malfunctioning for the counter.

Power supply to all IC's are to be decoupled with .01 uf capacitor connected across the Vcc and Gnd pin with shorter leads . There can have several malfunctions if power is not properly decoupled .

COMPONENTS DETAILS FOR TIME BASE CIRCUIT .

No.	Item ID.	Description .
1.	R1	1 M
2.	X1	3.579 MHz
3.	P2	22 PF TRIMMER
4.	P1	33 PF
5.	IC'S	MM 5369 74HC92 74HC132

COMPONENT DETAILS FOR RF PRE.AMP .

1.	R1	1 K
2.	R2	1M
3.	R3	2.2 K
4.	P1	10 K
5.	DI	IN 4148
6.	D6	IN 4148
7.	C2	.1 UF
8.	C3	.1 UF
9.	C4	.1 UF
10.	T1	2N 918
11.	IC	74HC132