HOW TO USE YOUR FREQUENCY COUNTER

HOWS, WHYS AND USES

- How do they work?
- Why are they accurate?
- What's the difference between a handheld and portable, full-featured counter?
- What sort of probes to use?
- How do I choose a counter?

RAMSEY

Ramsey Electronics, Inc.
793 Canning Parkway
Victor, New York 14564
Phone (716) 924-4560
Fax (716) 924-4555

RAMSEY

INTRODUCTION

Thanks for requesting this handy little manual on how to use your frequency counter. We at Ramsey pride ourselves in producing the most cost-effective line of full featured counters in America. All our counters cover the entire spectrum - from low audio all the way thru UHF. We include extensive wave shaping and trigger circuits which cost more, but insure a more stable, reliable count. This is the single most important difference between a cheap hand-held unit and a full function frequency counter.

HOW DO THEY DO THAT?

How a counter works

Technology has brought to the average user counter performance unheard of only a few years ago. But, this performance is now in the hands of the average user rather than the lab engineer, and thus some operating points need explanation. Regardless of the type and complexity of the instrument, all counters measure frequency by comparing the frequency of the input signal with a known frequency or time period. Figure one shows a typical block diagram of a counter.

The main function of the input amp is to convert the broad range of input signals to a signal whose amplitude and waveshape are compatible with the internal circuitry. The input amp is just as important to the counter as the "front end" is to a receiver, it typically contains the most number of discrete components. The output of the input amp is then applied to a gating circuit. The gate simply performs the function of a SPST switch. When the gate control block tells the gate to open, it allows the input amp to be connected to the decade counters. The gate is opened for a predetermined, accurate time interval, and the decade counters count the number of input pulses and display the count. Since the decade counters count only the pulses which pass through the gate, it follows that the accuracy of the instrument is dependent on the length of time the gate is held open. The gate is guided by the gate control which is controlled by the crystal time base via the divider.

CRYSTAL TIME BASE

The time base is crystal controlled and either temperature-compensated or heated with an oven. The divider portion of the counter divides the crystal time base down to the highly accurate time interval for the

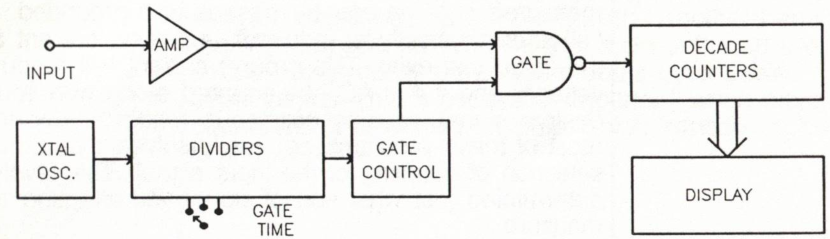


Figure One

GATE TIME

gate. The gate time switch selects what interval of time the gate is held open. A long gate time allows more input pulses to be counted, and the more pulses counted, the better the resolution. The limiting factors governing resolution are the number of digits in the display and the tolerable gate time. Usually 1.0 Hz is the smallest resolution practical for an easy-to-read updated count. Of course it is not necessary to read frequency to the nearest Hertz or wait for a one- second count. By selecting the appropriate output from the divider, you can reduce gate time and resolution to more usable values. It can be seen that the shorter the gate time, the quicker the display update - at the expense of poorer resolution.

How to use your counter

Using your counter is usually just as easy as connecting the signal to the input jack and counting. However, in some instances, such as noisy signals or low frequencies, care must be taken in applying the signal to the counter. The counter has not only a high input impedence, but also high sensitivity. Noise accompaning the desired signal may fall within the counters senstivity and frequency limits, and be counted. This signal plus noise input is amplified and counted within the instrument, and produces a jittery, unstable display.

JITTERY READING

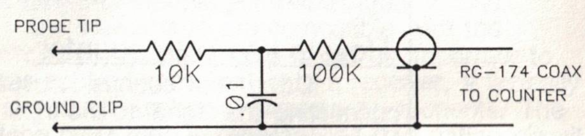
Another problem is ringing at the counter input. Consider the coax cable, as it goes from the signal to be measured to the input jack, it's a transmission line just as your antenna coax on a transmitter is. Being so, a standing wave phenomenon can occur if impedences are mismatched. If a signal from a low impedence source is presented to the coax cable with a high impedence termination (the counter input) the signal will reflect from the input and return again, causing an unstable display.

Yet another consideration is that of ground loops. If your counter probe is grounded to the circuit to be measured and the counter case is also grounded (whether physically or induced), a ground current along the cable can exist. This ground current will produce a voltage, and if it is AC, be counted along with your desired signal, causing erroneous readings. Fortunately, most of these problems are easily solved by careful selection of coupling of the input signal. This involves determining just what sort of signal you attepting to measure.

LOW PASS PROBE

For Low Frequency (less than 50KHz)

Low frequency measurements are usually upset by excessive noise riding on the desired signal, ground loops or ringing. Even though you may feel the signal is very "clean", the counter can count up to VHF and noise or ringing will be counted. The use of a low pass filter or probe will prevent any noise from being presented to the counter. Also, the probe will inhibit ringing from occurring. Preventing a ground loop is not quite as easy as using a different probe. Generally, providing another ground path other than the probe's ground will solve the problem. A simple low pass probe is shown below.

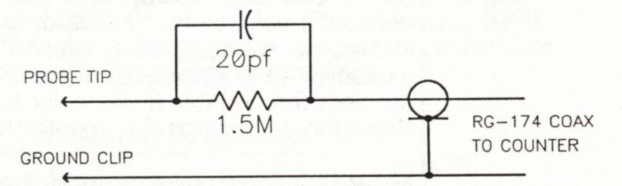


HF AND LOW VHF

For Mid-Frequency Measurement (from 50 KHz to 60 MHz)

The majority of signal measurements are usually within this range. Ringing and noise are the chief culprits in measurements. The only way to counteract these undesirables is to damp the ringing and/or attenuate the noise (with the signal too, unfotunately). A simple 10X oscilloscope probe works as well to attenuate noise as well as providing a light loading probe. If the noise is at a 20 mv level and the signal at 1 volt, the 10X probe will

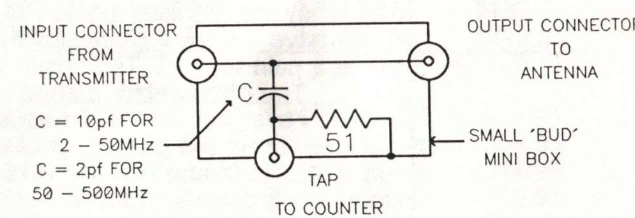
reduce the noise to 2 mv and the signal to 100mv, thus the noise is out of the counter's sensitivity range while the signal isn't. The 10X probe or high impedence probe will also usually damp out the ringing. Another benefit of the high impedence probe is that it doesn't load the circuit being measured by the probe's coax cable capacitance. This is especially important when measuring oscillators or amplifiers. A simple high impedence probe is shown below.



TRANS-MITTER HOOKUP

For Direct Transmitter Measurement:

Measuring transmitters requires coupling enough transmitter energy into the counter for a stable count and not so much as to exceed the counter's safe input. Generally, for VHF work, a small 18" whip antenna will pick up transmitters from 10' away. Direct connections to the transmitter can be made via a coupling box or pick-up coil. The pick up-coil is simply a few turns of wire wrapped around the transmitter's coax and fed to the counter. The coupling box requires breaking into the transmitter's coax. Schematic is shown below.



GETTING ON FREQ

How to Calibrate a Counter

Calibrating a counter can be done in many ways. One way is to simply measure the crystal time base directly and adjust the trimmer until the time base frequency is correct. This method requires the use of another properly calibrated counter.

Another method requires a short- wave radio and signal generator or oscillator capable of operation at 10 or 15 MHz. The first step is to zero beat the oscillator against WWV to insure its accuracy. Then the oscillator signal is applied to the counter, and while the oscillator is zero beated, adjust the counter to read exactly 10 or 15 MHz.

Still another way is to measure the television network's color burst standard. During live network shows, (ie: news, sporting events) the burst frequency is locked to an extremely accurate atomic standard. Simply connect the counter to the color burst oscillator in the television and adjust the counter to read 3.579545 MHz.

RECEIVER DIGITAL DIAL

How to measure received frequency

Measuring your receiver requires the use of an offset mixer, or pre-loading of the counter. The reason for pre-loading or using an off-set mixer lies in super-hetrodyne receiver theory.

In a receiver, the incoming signal is mixed with a local oscillator to produce an IF. For this to happen, the local oscillator's frequency is offset from the incoming signal by the IF's frequency. An example will make this clear. Say, for example, the IF is 455 KHz, and the desired frequency to be received is 1520 KHz, the local oscillator must be either 1065 KHz (low side injection) or 1975 KHz (high side injection). In this case, we will dictate the receiver to use high side injection; therefore, the local oscillator's signal is 1975 khz. If this signal is applied to the counter, it will display to us whatever signal frequency we are listening to PLUS 455 KHz. This is fine if you have a pocket calculator handy to subtract with, but is a pain to read. The offset mixer solves this.

The offset mixer can be used to offset the local oscillator's signal by the IF frequency and then feed it to the counter. In the preceding case, the offset mixer would run at 455 KHz and mix the 1975 khz local oscillator signal back down to the received 1520 KHz signal. Then the counter would display the proper frequency. Obviously, since we're regenerating the receive frequency, all leads must be kept sheilded to prevent any of this signal from leaking back into the receiver.

The pre-load scheme does the IF frequency subtraction process electronically. The decade counters

within the frequency counter are atificially preloaded with an initial count before the gate is opened. When the gate is opened, new input pulses are added to the forced initial count. The sum of these two counts indicates the received frequency. The preload count is entered into the counter on a diode matrix in the CT-50 receive adapter kit. Note that the preload method doesn't generate any new frequencies, and thus no extra shielding is required.

Conclusion

Hopefully, this small booklet will help you gain more experience in using your counter. The counter is one of the most valuable pieces of test equipment one can own, providing you know it's abilities.

WHICH ONE DO I CHOOSE?

Ramsey Frequency Counters

Ramsey Electronics has been manufacturing electronic test equipment for over 15 years in one of America's original high-tech cities, Rochester, New York. We're proud to be one of the largest manufacturers of low cost test equiptment designed for both hobbyists and professionals. Compare the features: all our counters are made in the USA, cover the full frequency range, from audio thru VHF/UHF, have FET high impedance inputs to reduce circuit loading, extensive waveshaping circuitry to enable solid, jitter-free counting, top quality epoxy glass, plated PC boards and are covered by a full one year warranty on parts, labor and even calibration!

Model	Frequency	Digits	Resolution	Price
CT-50	600 Mhz	8	1,10 Hz	$189.95
CT-70	550 Mhz	7	1,10,100 Hz	$139.95
CT-90	600 Mhz	9	.1.1,10 Hz	$169.95
CT-125	1300 Mhz	9	.1,1,10 Hz	$189.95
CT-250	3000 Mhz	9	.1,1,10 Hz	$249.95

Frequency Counter Accessories

PR-2 Broadband Preamp 25 db 1-1000 Mhz	$59.95
PS-2 Audio Multiplier for low freq measurements	$69.95
HP-1 High Impedance Probe	$16.95
LP-1 Low Pass Audio Probe	$16.95
DC-1 Direct Connect Probe	$16.95
AW-10 BNC telescopic whip antenna	$11.95
RF-1 Sniff-it sensitive RF detector probe	$19.95
Already have a counter? Upgrade with a prescaler...	
PS-10B 1.5 Ghz divide by 1000 prescaler	$89.95
PS-1B 600 Mhz divide by 10 prescaler	$59.95

PRICE: $5.00

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793 Canning Parkway
Victor, New York 14564

• (716) 924-4560 (Voice)
• (716) 924-4555 (FAX)