FREQUENCY COUNTER
USER MANUAL

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1. PRODUCT INTRODUCTION

1-1. Description

The GFC-8010H frequency counter is a general-purpose counter with a measurement range from 0.1Hz~120MHz and 20mVrms high input sensitivity. The incorporation of the most updated semiconductor techniques develops a compact, high performance, highly reliable and high resolution instrument.

1-2. Features

Additionally, the frequency counter offers several other features:

- Extremely high resolution to 1 μHz.
- Worst case guarantee of X'tal stability specifications.
- The line filter is enclosed in a static shield to resist noise.
- Low pass filter for accuracy measurement of low frequency.
- Compact & lightweight.
- Low power consumption.
- High quality crystal allows an extremely accurate measurement of frequencies.

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2. TECHNICAL SPECIFICATIONS

Sensitivity (rms)	10Hz~10MHz 15mV 10MHz~40MHz 20mV 40MHz~80MHz 35mV 80MHz~120MHz 50mV
Input Impedance	1MΩ 35PF.
Max. Input Voltage	150Vrms.
Coupling System	AC coupling.
Time Base	Oscillation Frequency 10MHz. Aging rate: $\pm1\times10^{-6}$ Month. Temp. stability: 25℃±5℃ $\pm5\times10^{-6}$. 0℃~50℃ $\pm2\times10^{-5}$.
Accuracy	1Hz + 1 digit + Time base error.
Counting Capacity	8 digit decimal.
Display System	Digital LED's display.
Gate Time	0.1 sec, 1 sec, 10 sec switch selectable.
Max. Resolution	1 μHz on 10Hz range with 10 seconds gate time. 0.1Hz on 100MHz range with 10 seconds gate time.
Operating Temp. Range	0℃~40℃
Storage Temp. Range	-10℃~+70℃
Power Consumption	Approx. 5W.
Power Requirement	100V, 120V/220V/230V±10%, 50/60Hz.
Dimension	Approx. 245(W) × 95(H) × 280(D) m/m.
Weight	Approx. 1.7kgs.
ACCESSORIES	Instruction manual……………× 1 Test lead GTL-101 …………..× 1

3.PRECAUTIONS BEFORE OPERATION

3-1.Unpacking the Instrument

The instrument has been fully inspected and tested before shipping from the factory. Upon receiving the instrument, please unpack and inspect it to check if there is any damages caused during transportation. If any sign of damage is found, notify the bearer and/or the dealer immediately.

3-2.Checking the Line Voltage

The instrument can be applied any kind of line voltage shown in the table below. Please check the line voltage indicated in the label attached on the real panel to replace correct fuses.

***WARNING.* To avoid electrical shock the power cord protective grounding conductor must be connected to ground.**

When line voltages are changed, replace the required fuses shown as below:

Line voltage	Range	Fuse	Line voltage	Range	Fuse
100V 120V	90-110V 108-132V	T160mA 250V	220V 230V	198-242V 207-253V	T100mA 250V

***WARNING.* To avoid personal injury, disconnect the power cord before removing the fuse holder.**

3-3.Equipment Installation, and Operation

Ensure there is proper ventilation for the vents in the case. If this equipment is used not according to the specification, the protection provided by the equipment may be impaired.

3-4.General Preparation

1) When the impedance is 1MΩ, the maximum voltage applied to the input depends on the frequency and the position of the SENSITIVITY switch. This relationship is shown in Fig. 6, and the values given in this table must be strictly observed. Initially set SENSITIVITY to 1/10, if the counter doesn’t count, set the switch to 1/1 range and then perform measurement. This procedure will reduce the danger of damaging the input circuit.
2) Use an AC power source within 100V, 120V, 220V, or 230V±10%.
3) Use the instrument within an ambient temperature range of 0~40℃. Do not put the counter on the top of high temperature equipment and be sure not to block the ventilation of the instrument.
4) Never permit water to enter the interior of the instrument and never subject the instrument to severe mechanical shock.
5) When the instrument is operated in an especial noisy environments, insert a noise filter into the power source.
6) When low frequencies are measured, push the low pass filter switch can attenuate high frequency components to prevent probable false triggering.

4. PANEL INTRODUCTION

(1).	Counter Input	BNC type connector.
(2).	ATT, 1/1, 1/10	Attenuation button of input sensitivity. 1/1 : Directly connect input signal to input amplifiers. 1/10: Attenuate input signal by a factor of 10.
(3).	LPF ON/OFF	Set to ON position, insert a 100kHz Low Pass Filter into input for low frequency measurement.
(4).	FREQ/PRID	Frequency or period measurement by setting the button.
(5).	Gate Time Selector	Press the gate time button to 10 sec, 1 sec or 0.1 sec for measurement.
(6).	Power ON/OFF	Power on or off by using the button.
(7).	Gate Time(LED)	The gate time of 10 sec, 1 sec or 0.1 sec will be displayed in the LED by setting the Gate button.
(8).	Over (LED)	Overflow indicator shows that one or more of the most significant digits are not displayed.
(9).	Displayed (LED)	Display 8 digits of frequency data.
(10)	Exponent and units (LED)	LED indicator shows S and Hz of the unit and indicate the value of the measurement exponent as shown below: k=1000 M=1,000,000 G=1,000,000,000 m=1/1000 μ=1/1,000,000 n=1/1,000,000,000

- **Front Panel**

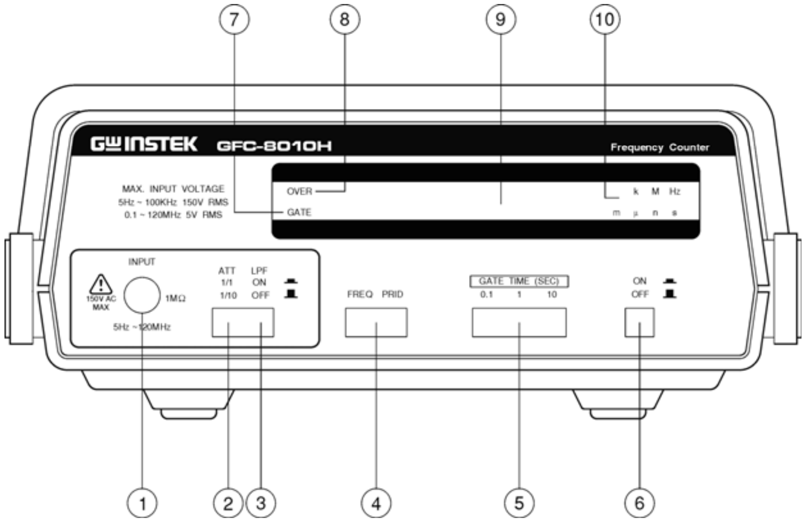


Fig. 1 Front panel

5. APPLICATION

5-1. Sensitivity

The role of the SENSITIVITY (or attenuator) switch in a common measuring instrument is to protect the input circuit and prevent the meter from going off scale.

For a counter, SENSITIVITY is still one of the large roles. Generally, hysteresis occurs in the waveshaping circuit of the counter. In order for the instrument to put up resistance to noise, the circuit will not work even when the noise is lower than the hysteresis applied. The waveshaping circuit is a Schmitt circuit and the operation of this circuit is described below:

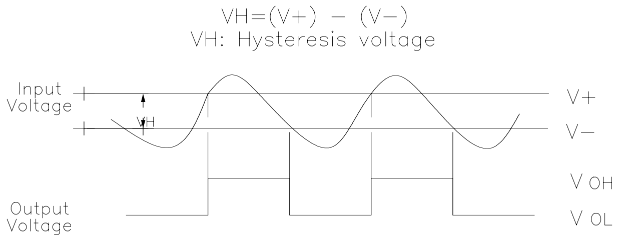


Fig. 2 Operation of the Schmitt circuit

As refer to Fig. 2, when input voltage is at V+, the output voltage is high (V_{OH}), while input voltage is at V^-, the output voltage is low (V_{OL}). The difference between these two voltage $V_H=(V^+)-(V^-)$ is called the hysteresis voltage.

But if both V^+ and V^- don’t react each other, no output will be obtained and the Schmitt circuit will not work out with the states of (1), (2) and (3) of Fig. 3 shown as below.

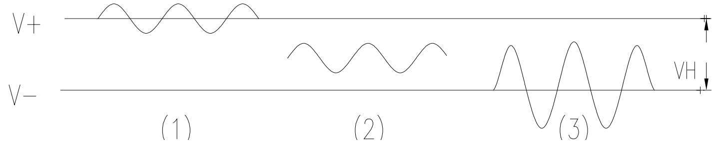


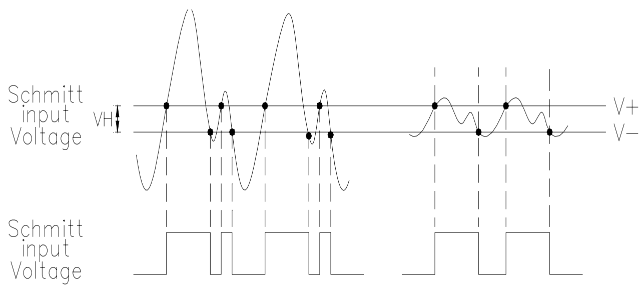
Fig. 3 States under which the schmitt circuit doesn’t work

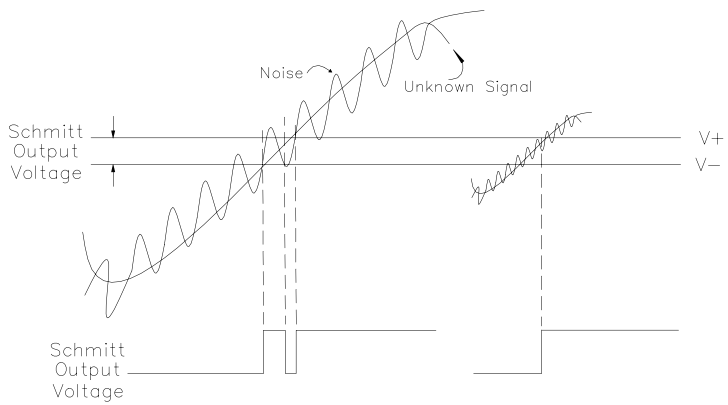
From above description, it can be easily understood whether or not the Schmitt circuit works is attributed to the SENSITIVITY (Attenuator) to determine the magnitude of the input voltage.

An example of preventing erroneous counting by correctly selecting the SENSITIVITY shown as Fig. 4 below:

(a) Correctly counting a distortion signal by selecting suitable SENSITIVITY. However, when the input voltage is too high, a frequency doubles the unknown frequency will be indicated.

(b) Erroneous counting occurs when high frequency noise is superimposed on the unknown signal and the input voltage of the Schmitt circuit is too high. However, a correct counting can be obtained by selecting suitable SENSITIVITY.





The erroneous counting can be prevented by satisfying two conditions below:

a)To make peak-to-peak value of the noise voltage smaller than V_H.

b) When peak-to-peak value of unknown signal is larger than V_H, perform measurements by first setting SENSITIVITY to 1/10, then set it to 1/1 range to protect the input circuit and avoid erroneous counting. One good method is to conduct measurements at the smallest possible input within the counter display value “dispersion” range. When the signal is a pure waveform, it will not occur erroneous counting with any magnitude input lower than the input destroyed voltage.

5-2. Input Sensitivity Characteristic

The input sensitivity of this instrument is shown as Fig. 5.

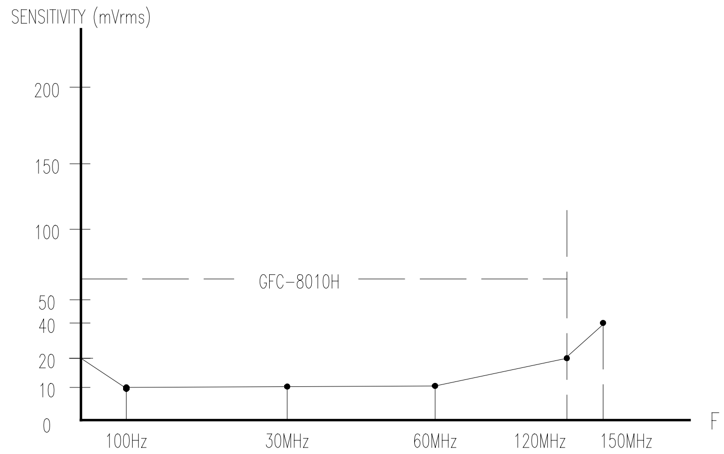


Fig. 5 Input Sensitivity Characteristic

5-3. Maximum input voltage

The maximum input voltage Vs frequency characteristics is shown as Fig. 6.

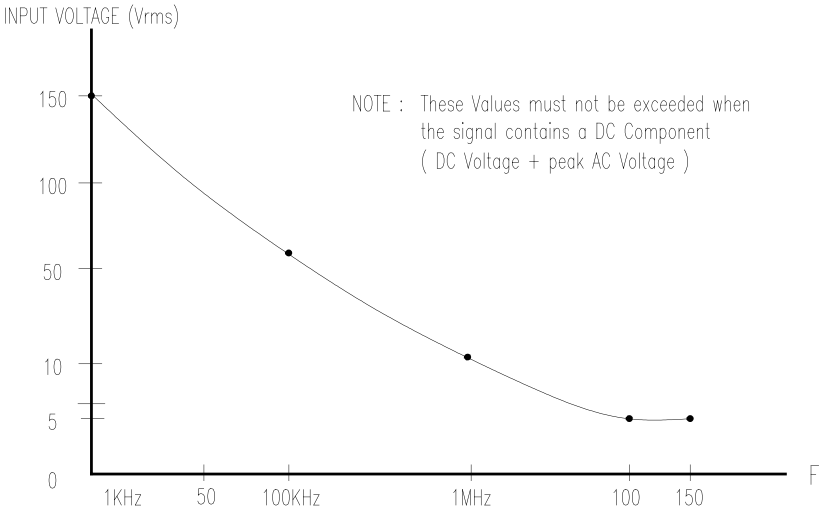


Fig. 6. Maximum Input Voltage-Frequency

5-4. Typical Applications

Several examples for typical applications are described below:

1).The output frequency of a transmitter or transceiver can be measured (if the output power is about 1W) by merely connecting a one turn clip cord to several tens of centimeters from antenna. The length of the distance is determined by the magnitude of the output.

2).Measurement can also be easily performed when calibrating the oscillation frequency of a grid dip meter by merely connecting the one turn clip cord.

3).Measurement of tracking the frequency through the oscillator stage, multiplier stage, and output stage can be performed by making a small 2-3 turn coil and coupling it to each turned circuit (the oscillations may be produced by the input capacitance and its resonant frequency with too many turns of coil.)

Note: As the product has a high sensitivity, induction may cause erroneous counting if you touch the red end (ungrounded side) of the clip cord. Therefore, hold the black clip or coaxial cable when performing measurements according to above method.

Measurement by connecting the accessory cable directly to the test circuit is described below.

4).Measurement can generally be performed by merely connecting the black side of the clip cord to ground (GND) and the red side to the test point.

5).When the capacitance of the cable will have an affection on the test circuit (When measuring turned circuits or high output impedance circuit), perform measurement by inserting a high resistance in series with the red side of the clip cord. Always be sure to ground the cord when perform the measurement of 4) and 5) above. If possible, ground the cable to the ground point of the test circuit. This procedure will reduce the affection of noise. A wide variety of measurement can be conceived in addition to (1~5) fully utilizing the special features of the counter.

6. CIRCUIT DESCRIPTION

6-1. Theory of Operation

In order to get the most benefit from the frequency counter, it's useful to comprehend the circuit thoroughly. We have attempted every possible to utilize the latest developments in large-scale integration to provide the greatest performance for the money and, at the same time, to reduce the complexity of circuit and increase reliability.

Ignoring the prescaler for the moment, let us assume the input signal arrives at the 10MHz to 100MHz input labeled CHA in main board. This signal is first amplified by the Q201~Q202 pair. The three amplifier stages identified as U202 in the schematic are ECL logic stages biased in its linear region, each stage having a gain before feedback of about 5. A positive feedback at the output of the third amplifier when reflected through the gain of the proceeding three amplifier states (including the Q201~Q202 pair) results in about a 5mV hysteresis in the input triggering levels to aid in noise rejection. Q203 and Q204 translate the ECL levels to TTL levels. The signal is presented directly to the counter IC U301.

The IC U301 provides all the functions of the counter and display result through LED.

U201 regulates the input 9 volts signal from the line voltage transformer and rectifier circuit. When the power switch is set to "on" position, approximately 5.0 volts is applied to the circuit.

6-2. Frequency Measurement Accuracy

Measurement Accuracy

Frequency measurement accuracy is determined by the following two conditions:

1) ±1count.
2) Time base accuracy.

The ±1 count error is inherent to digital meters and is produced by the phase relationship between the gate signal and the input signal shown in Fig. 7. The counted result of 1 count increased or decreased depends on the phase difference.

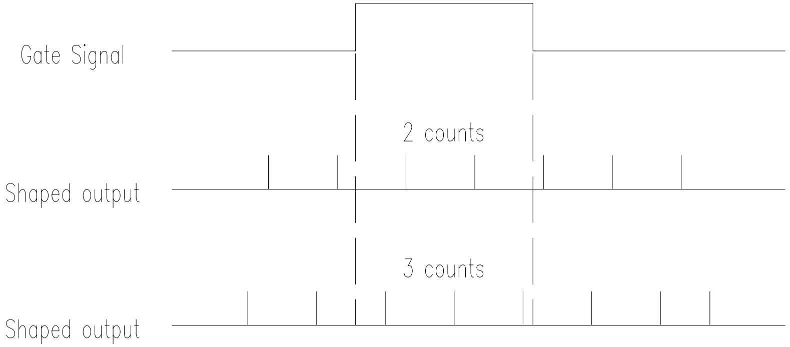


Fig. 7 ±1 count error

High Accuracy Measurement

The accuracy of the time base oscillator is almost completely determined by the characteristics of the crystal oscillator. The specifications of the time base are:

Oscillation frequency	10MHz
Aging rate:	1×10^{-6}/month
Temperature stability	5×10^{-6}(25±5℃)
	$\pm2\times10^{-5}$ (calibration ambient temperature 0~40℃)

The temperature characteristics for the crystal oscillator used in this instrument shown in Fig. 8, in which you can see the temperature coefficient is as large as 25℃.

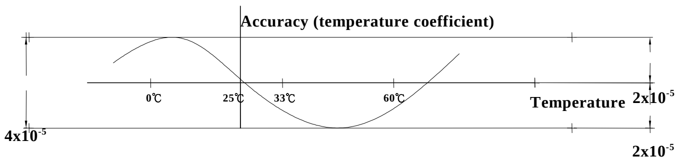


Fig. 8 Temperature characteristics of the crystal oscillator

The temperature stability of the crystal oscillator is: 2×10^{-5} (temperature 0~60℃) with 25℃ as reference. The temperature of 0~60℃ is given here because the internal temperature rise is approximately 20℃ and the 0~40℃ ambient temperature is because the crystal oscillator is similar to it. If the temperature of the crystal oscillator is assumed to be 25℃ and set to 10MHz that is over the worst case temperature stability of 2×10^{-5} (0~60℃) temperature range and since the frequency is 10MHz, a variation of only $(10\times10^6)\times(2\times10^{-5}) = 2\times10^2$=200Hz is possible. In actual use, worst case conditions are produced in two circumstances:

1) Frequency calibration is performed as soon as the switch is set to ON at an ambient temperature of 0℃ and measurement is performed after ample time has elapsed after the switch is turned ON at an ambient temperature of 40℃.
2) Calibration is performed after ample time has elapsed after the switch has been turned ON at an ambient temperature of 40℃ and measurement is performed as soon as the switch is turned ON at an ambient temperature of 0℃.

Under these worst case conditions, the guarantee accuracy is 4×10^{-5} (calibration temperature:0~40℃) and becomes 0.004%.

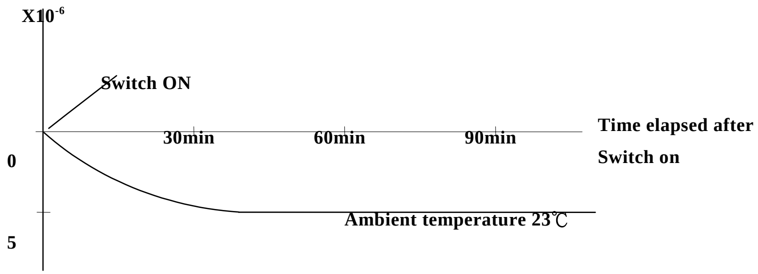


Fig. 9 Example of crystal oscillator rise characteristics

In actual practice, the worst case conditions described above are almost never encountered, and furthermore, the high accuracy state is maintained. An example of rise characteristics given in Fig. 9 and the frequency changes following after the change of temperature. As shown from the figure, the crystal oscillator of this instrument reached the thermally balanced state for about 50 minutes after turning on the switch. This instrument is calibrated about 60 minutes before shipment at the place of 25℃ ambient temperature.

If measurement is performed more than 1 hour after switching on and an instrument is calibrated under 20~30℃ ambient temperature, 5×10^{-6} can be guaranteed even when the worst crystal oscillator is used.

The 5×10^{-6} (25±5℃) represented as a percentage becomes 0.0005%. Aging rate 1×10^{-6}/month means that the change after one week under the constant ambient temperature state, as a percentage of 0.0001%.

7.MAINTENENCE

The following instructions are executed by qualified personnel only. To avoid electrical shock, do not perform any servicing other than the operating instructions unless you are qualified to do so.

7-1.Standard method for calibration

After 50 minutes warm-up, apply the STD OUT signal of a standard or high accuracy of 1×10^{-7} to the input of the frequency counter. Adjust Trimmer SVC301 to display value of 10.000000MHz with the standard of 10MHz and the resolution of 1s. An accuracy of over 1×10^{-7} can be obtained through this procedure. Use a screwdriver (not metal tip) to adjust the trimmer.

7-2.Cleaning

To clean the instrument, use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the instrument because it may leak into the cabinet and cause damage.

Do not use chemicals containing benzine, benzene, toluene, xylene, acetone, or similar solvents. Do not use abrasive cleaners on any portion of the instrument.