INSTRUCTION MANUAL

MULTI-COUNTER

MODELS 255 , 256

KIKUSUI ELECTRONICS CORPORATION

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On Power Supply Source, it is requested to replace the related places in the instruction manual with the following items.

(Please apply the item of mark.)

- [ ] Power Supply Voltage: to _ _ _ _ _ V AC
- [ ] Line Fuse: to _ _ _ _ _ A
- [ ] Power Cable: to 3-core cable (See Fig. 1 for the colors.)

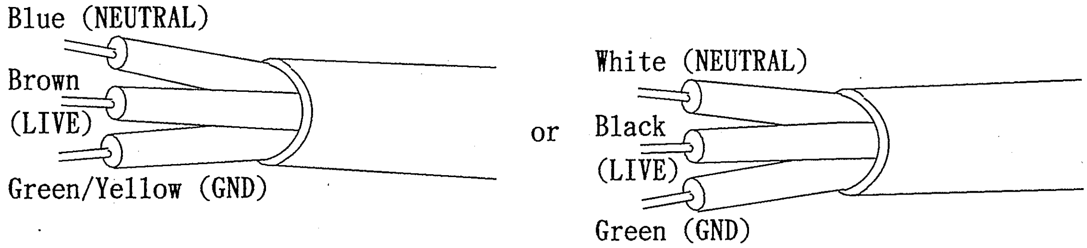

Fig. 1

Please be advised beforehand that the above matter may cause some alteration against explanation or circuit diagram in the instruction manual.

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* AC Plug: In case of Line Voltage 125V AC or more, AC Plug is in principle taken off and delivered, in view of the safety.
(AC Plug on 3-core cable is taken off in regardless of input voltages.)
TO connect the AC plug to the AC power cord, connect the respective pins of the AC plug to the respective core-wires (LIVE, NEUTRAL, and GND) of the AC power cord by referring to the color codes shown in Fig. 1.

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Before using the instrument, it is requested to fix a suitable plug for the voltage used.

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1. GENERAL

Kikusui Model 255 [256] Multicounter is a compact and light instrument. It is capable of frequency measurement, period measurement and revolutionary speed measurement. Frequency measurement covers a wide range of 10 Hz to 150 MHz.

The measured value is displayed with an 8-digit decimal number. The leading zeros are blanked out for ease of reading.

The measuring sensitivity is high (20 mVrms). To ensure correct measurement also of high-level signals, an automatic level control (ALC) amplifier and an input attenuator (ATT) are incorporated.

2. SPECIFICATIONS

Instrument name:	Multi-counter
Model No.:	255 [256]
Display:	7-segment LED readout Leading zeros blanked out No. of digits: 8 OVER and GATE indications Measuring unit: kHz, μsec, decimal point, and rpm
Frequency measurement	Input connected to [CH A]
Measuring range:	10 Hz - 150 MHz
Gate time:	10 sec, 1 sec, 0.1 sec, 0.01 sec. Display is reset as the RESET switch is depressed.
Measuring accuracy:	Accuracy of reference signal generator ±1 count
Period measurement	Input connected to [CH A]
Measuring range:	100 msec to 1 μsec (when multiplication factor is $\times 10^0$, 100 msec to 10 μsec)
Multiplication factors:	$\times 10^0$, $\times 10^1$, $\times 10^2$, $\times 10^3$
Measuring accuracy:	Accuracy of reference signal generator ±1 count ±1 trigger error
Revolutionary speed measurement	Input connected to [CH C]
Response:	100000 pulses/sec
Gate time:	60 sec, 6 sec, 0.6 sec, 0.06 sec
Measuring accuracy:	Accuracy of reference signal generator ±1 count

Input characteristics

Input sensitivity

[CH A]: 10 Hz - 100 Hz, 100 MHz - 150 MHz ..... 50 mVrms
100 Hz - 100 MHz .... 20 mVrms

[CH C]: 5 Vp-p - 20 Vp-p

Input impedance

[CH A]: 1 MΩ ±8%, parallel capacitance not greater than 45 pF

[CH C]: Approx. 10 kΩ

[CH A] attenuator

Range: 0 dB (1/1), 20 dB (1/10)

Relative accuracies between attenuators:

10 Hz - 100 MHz .... Within ±3 dB

100 MHz - 150 MHz .... Within ±6 dB

Maximum allowable input voltages

[CH A]: 10 Hz - 1 kHz .... 250 Vrms
1 kHz - 100 kHz ..... 20 Vrms
100 kHz - 150 MHz ... 5 Vrms

[CH C]: 20 Vrms

Input coupling: AC coupling [CH A]

Reference signal generator

Frequency: 10 MHz

Accuracy: Aging rate ..... $\pm1 \times 10^{-6}$/month [$\pm3 \times 10^{-7}$/month]

Temperature stability.... $\pm5 \times 10^{-6}$ [$\pm1 \times 10^{-6}$], $5^{\circ}C$ to $35^{\circ}C$ ($41^{\circ}F$ to $95^{\circ}F$)

Reference signal generator output: 10 MHz, square wave, TTL level, fan-out 1 or more

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External reference signal generator input:	10 MHz, input level 2.5 Vp-p to 10 Vp-p, input impedance approx. 600Ω
Ambient temperature and humidity:	5°C to 35°C (41°F to 95°F), 85% RH or less
Withstanding voltage:	Between signal ground and power line ..... 1000 V AC, 1 minute
Insulation resistance:	Between signal ground and power line ..... 100 MΩ or over, with 500 V DC
Power requirements:	100 V ±10%, 50/60Hz AC, approx. 10 VA. (With taps for 115 V, 215 V and 230 V)
External dimensions:	180W × 64H × 200D mm (7.09W × 2.52H × 7.88D in.)
(Maximum dimensions):	180W × 75H × 220D mm (7.09W × 2.96H × 8.67D in.)
Weight:	Approx. 1.7 kg (3.8 lbs.)
Accessories:	Instruction manual 1 copy
	BNC - clip cable 1
	Fuse (0.5 A) 1

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3. OPERATION METHOD

3.1 Description of Front Panel

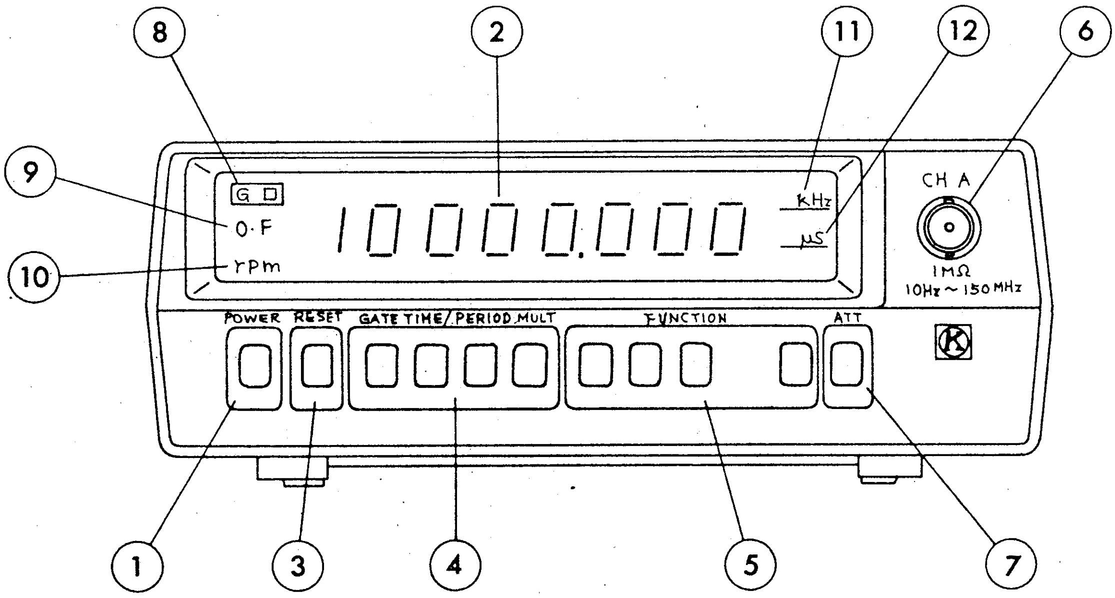

Figure 3-1

(1) POWER switch:

For on-off control of instrument power. When this switch is depressed, the power is turned on and the digital display illuminates. When the switch is unlocked, the power is turned off.

(2) Digital display:

The digital display is an 8-digit decimal readout with LEDs. When no signal is applied, indications are as shown in the following table depending on setting of the FUNCTION switch and GATE TIME/PERIOD MULT switch.

(1) CHECK

GATE TIME	Display
0.01 s	10000.0 kHz $^{+1}_{-0}$ count
0.1 s	10000.00 kHz $^{+1}_{-0}$ count
1 s	10000.000kHz $^{+1}_{-0}$ count
10 s	0.F 0000.000kHz $^{+1}_{-0}$ count

(2) FREQ or PERIOD

GATE TIME/PERIOD MULT	Display
0.01 s / $\times 10^0$	0.0 kHz/μs
0.1 s / $\times 10^1$	0.00 kHz/μs
1 s / $\times 10^2$	0.000 kHz/μs
10 s / $\times 10^3$	0.0000 kHz/μs

(3) rpm

"00" is displayed irrespective of GATE TIME setting.

3 RESET switch:

When this switch is depressed, the display is reset. So far as this switch is kept depressed, the display indicates zeros for all digits. Counting starts at the moment this switch is released.

4 GATE TIME/PERIOD MULT selector switch:

When in the frequency measurement or revolutionary speed measurement, this switch selects the gate time. When in the revolutionary speed measurement, the gate time is 6 times of that when in frequency measurement. When in the period measurement, this switch selects the multiplication factor.

(5) FUNCTION selector switch:

This switch selects the frequency measurement, period measurement, rpm measurement, or self-check function.

(6) CH A connector:

Input connector for frequency measurement and period measurement.

(7) ATT (attenuator) switch:

When this switch is depressed, the input signal of CH A circuit is attenuated by 20 dB (1/10).
0 dB (1/1) is for no attenuation.

(8) G lamp:

This lamp lights during the period the gate is open. No counting is done unless this lamp is lighted.

(9) OF (overflow) lamp:

This lamp lights to indicate that the counted value has overflowed the display limit.

(10) rpm lamp:

This lamp lights to indicate the rpm measuring mode of operation.

(11) kHz lamp:

This lamp lights to indicate the frequency measuring mode of operation, in the kHz unit.

(12) μs lamp:

This lamp lights to indicate the period measuring mode of operation, in the μsec unit.

3.2 Description of Rear Panel

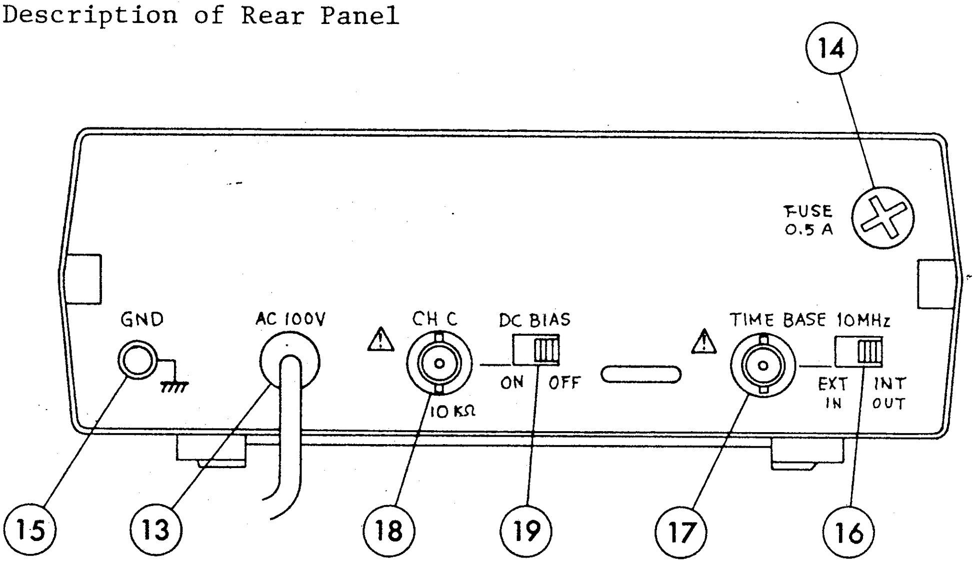

Figure 3-2

(13) AC 100V cord:

AC line power cord

(14) FUSE:

Fuse (0.5 A) of AC line power

(15) GND terminal:

Ground terminal connected to signal ground and instrument case

(16) TIME BASE 10 MHz switch:

This switch selects whether the signal of the internal reference generator or an external signal is to be used as the reference signal for measurement. When a more reliable standard signal generator than the internal reference signal generator is available, this switch may be set to the EXT position and the external signal (10 MHz) may be connected to connector (17). The level of this external signal must be 2.5 Vp-p to 10 Vp-p.

When the switch is set in the INT state, connector (17) delivers the 10-MHz signal generated by the internal reference signal generator. This terminal may be used to measure the 10-MHz signal or to used it as a reference signal for other measurement.

(18) CH C connector:

Input connector for rpm measurement

(19) DC BIAS switch:

If this switch is set in the ON position when in rpm measurement, a bias voltage is automatically applied by this instrument to the [CH C] input circuit in order that measurement can be done by connecting a phototransistor or other device directly to the [CH C] input circuit. When an incident light is applied on the phototransistor, a current of approximately 150 μA can be obtained. When no load is connected, the voltage is approximately 1.6 V. Set this switch in the OFF state except when the above feature is utilized.

3.3 Preparations for Measurement

(1) Ensure that the POWER switch on the instrument front panel is set in the OFF state.

(2) Connect the power cord to an AC line outlet (100 V, 50/60 Hz AC).

(3) Turn-on the POWER switch. The display will be turn on as explained in Item (2) of Section 3.1.

(4) The instrument immediately becomes ready for use when its POWER switch is turned on. Allow more than 30 minutes of stabilization period after turning-on the POWER switch.

3.4 Self-check Function

The 255 [256] has a self-check function of its counting operation. For this check, set the FUNCTION switch in the CHECK position, count the 10-MHz reference signal of the internal reference signal generator, and see that the display indicates the value mentioned in Item 2 - (1) of Section 3.1.

3.5 Frequency Measurement

(1) Set the FUNCTION selector in the FREQ state.

(2) Connect to the [CH A] connector the signal to be measured, using the cable supplied as an accessory.

(3) Set the ATT switch to suit the input signal level. If the input signal is predicted to be not higher than approximately 0.2 Vrms, set the ATT switch in the OFF (0 dB) state. If it is predicted to be higher than 0.2 Vrms, set the ATT switch in the depressed state (20 dB attenuation).

(4) Select a GATE TIME depending on the required measuring accuracy. That is, when a measuring accuracy of 0.1 Hz is required, set the GATE TIME selector in the [10 s] state. In a similar manner, for a measuring accuracy of 1 Hz, 10 Hz or 100 Hz, set the selector in the [1 s], [0.1 s] or [0.01 s] state, respectively.

(5) If an input signal of 100 MHz or higher is measured with the GATE TIME selector set in the [1 s] state, the most-significant digit does not display "1" and the OF (overflow) lamp lights instead. When this has occurred, read the most-significant digit as "1".

If an input signal of 10 MHz or higher is measured with the GATE TIME selector set in the [10 s] state, the most-significant digit or its next digit may not be displayed. In such case, measure the most-significant columns with the [1 s] or [0.1 s] gate time and the least-significant columns with the [10 s] gate time.

3.6 Period Measurement

(1) Set the FUNCTION selector switch in the PERIOD state.

(2) Connect to the [CH A] connector the signal to be measured, using the cable supplied as an accessory.

(3) Set the ATT switch to suit the input signal level. If the input signal is predicted to be not higher than approximately 0.2 Vrms, set the ATT switch in the OFF (0 dB) state. If it is predicted to be higher than 0.2 Vrms, set the ATT switch in the depressed state (20 dB attenuation).

(4) Select a PERIOD MULT factor depending on the required measuring accuracy. That is, when a resolution of 0.1 µsec is required, set the PERIOD MULT selector in the [10^0] state. In a similar manner, for a measuring accuracy of 10 nsec, 1 nsec or 0.1 nsec, set the PERIOD MULT selector in the [10^1], [10^2] or [10^3] state, respectively.

(5) Note that no counting is done only when the input signal to be measured is higher than 100 kHz and the PERIOD MULT selector is set in the [10^0] state.

3.7 Resolutionary Speed (rpm) Measurement

(1) Set the FUNCTION selector switch in the [rpm] state.

(2) Connect the signal of an rpm detector to the [CH C] input connector on the rear panel. There are no particular restrictions regarding the rpm detector except that it should provide an output signal of 10^n pulses per revolution. The input signal level must be 5 Vp-p to 20 Vp-p.

(3) Set the GATE TIME selector depending on the measuring sensitivity and rpm detector sensitivity. The gate time when in rpm measurement is 6 times of that when in frequency measurement. That is, when the GATE TIME selector is set in the [10 s], [1 s], [0.1 s] or [0.01 s], the actual gate time is 60 sec, 6 sec, 0.6 sec or 0.06 sec, respectively.
The resolution of revolutionary speed measurement can be expressed as follows:

$$\text{Resolution (rpm)} = \frac{60\ \text{(sec)}}{\text{No. of pulses per revolution}\quad \text{Gate time (sec)}}\ \text{(rpm)}$$

When the number of pulses per revolution is 100 and gate time is 0.6 seconds for example, the resolution is calculated as follows:

$$\text{Resolution (rpm)} = \frac{60\ \text{(sec)}}{100\quad 0.6\ \text{(sec)}}\ \text{(rpm)} = 1\ \text{(rpm)}$$

Select the number of pulses per revolution and gate time which suit the resolution you may require.

(4) Measurement of rpm can be done by directly connecting a phototransistor or photodiode to the input connector, without requiring any external power source for the detector.

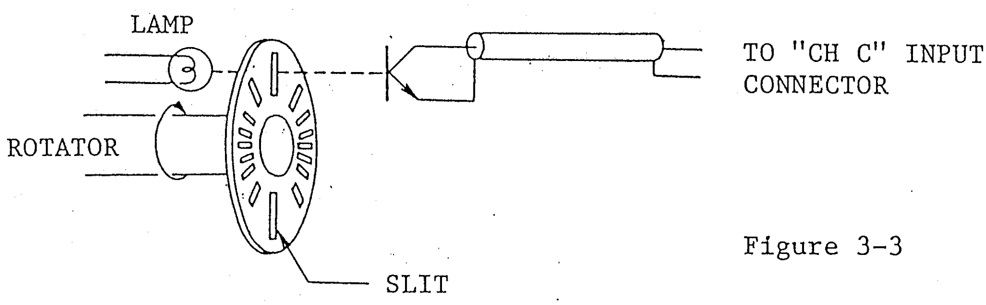

Figure 3-3

When the BIAS switch on the rear panel is set in the ON state, a supply current is automatically fed to the phototransistor or photodiode and the revolutionary speed can be detected with a measuring setup as illustrated.

When in the regular rpm measurement, set the BIAS switch in the OFF state.

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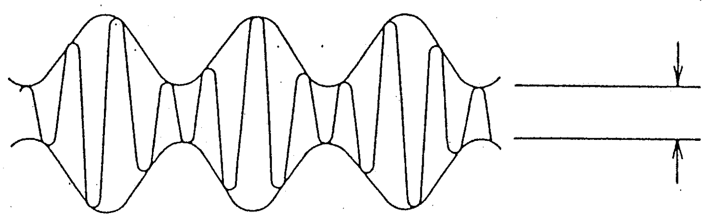
3.8 Notes for Use

Pay attention to the following items regarding the waveform of the signal to be measured.

(1) A triangle signal and a square wave signal also can be measured as well as a sinusoidal signal.

(2) An amplitude-modulated signal (carrier frequency) can be measured provided that the minimum amplitude is larger than the preset level. Therefore, a higher average level is required when the modulation degree is deeper.

Figure 3-4



This amplitude is corresponding to the input sensitivity.

(3) A frequency-modulated signal is measured as an average frequency in the gate time. The measured value will vary for each measuring cycle and no reliable measurement can be done.

(4) When measuring a signal which has noise, set the ATT switch at an appropriate range.

(5) The input impedance of this instrument is resistance approximately 1 MΩ plus parallel capacitance approximately 45 pF. When the measuring cable is used, due to increase in capacitance (capacitance becomes approximately 150 pF), the input impedance will beceme substantially lower at high frequencies. To make the input capacitance as small as practicable, short solid-conductor wires may be used instead of the cable.

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(6) The [0 dB] range of the ATT selector provides a very high sensitivity. When the instrument is set at this range, the display may fluctuate if the input voltage is abnormally high or low, if an abnormally long input cable is used, if the input signal line is not fully shielded, or if the measuring setup is not properly grounded.

  * The signal level range for stable operation of the counter is as illustrated below.

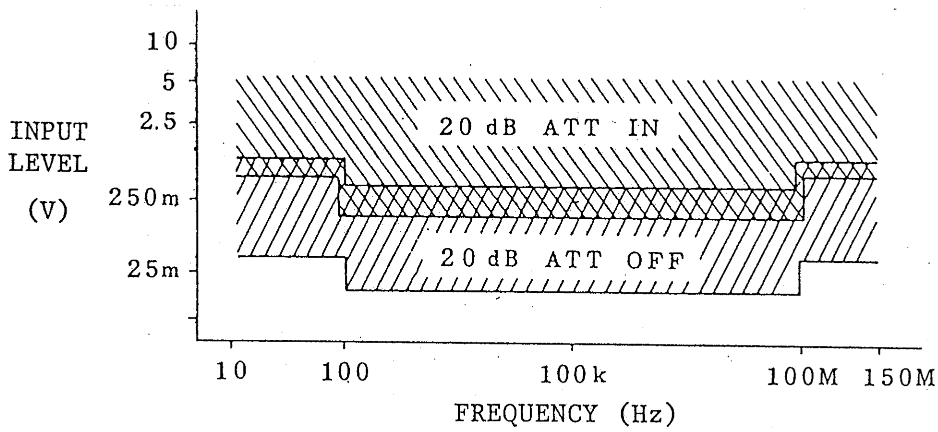


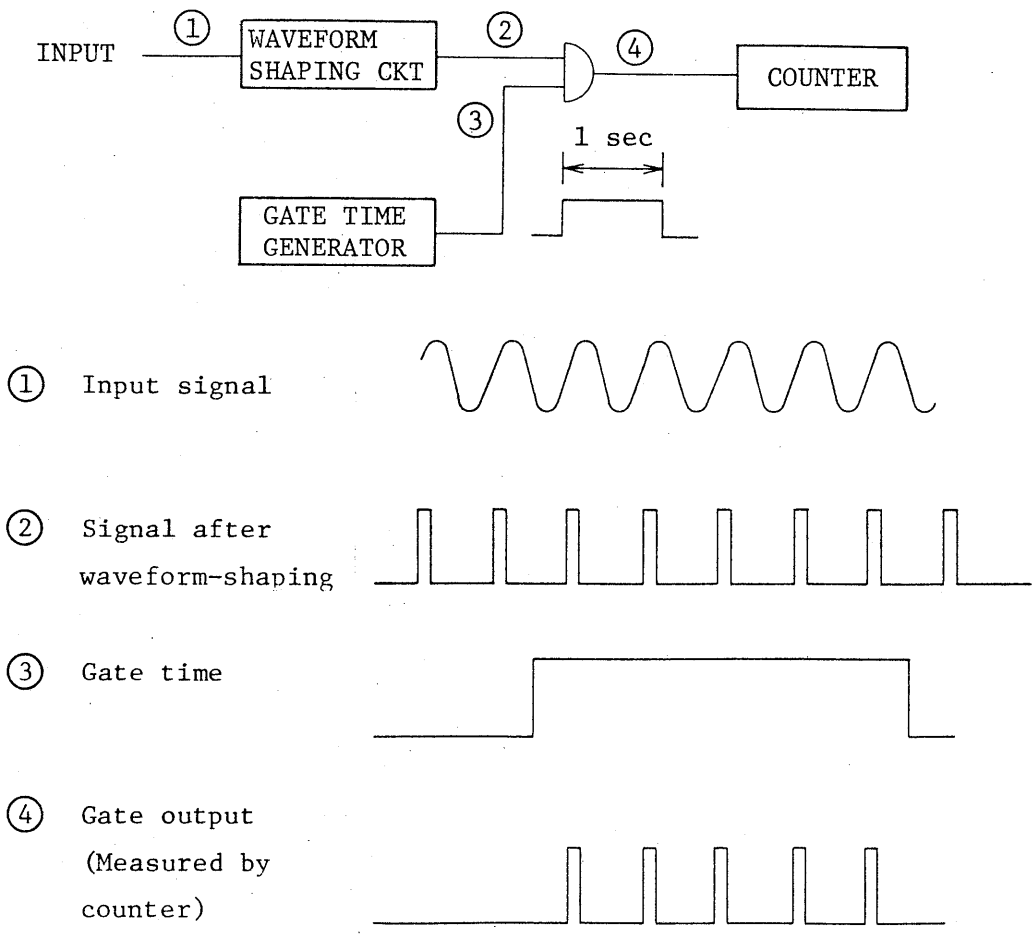
Figure 3-5

4. OPERATING PRINCIPLE

4.1 Description

(1) Frequency measurement

The term "frequency" is the number of repetitions or cycles per second. By measuring the signal with a gate time of 1 second, the frequency of the signal can be directly known. The measuring principle is as shown in the following.



5 counts = 5 Hz

Figure 4-1

(2) Period measurement

Period measurement is to determine the time duration for one complete cycle of the signal. Relationships between input signal and gate time in this case is reciprocal of that when in frequency measurement. A block diagram of the period measuring system is shown in the following.

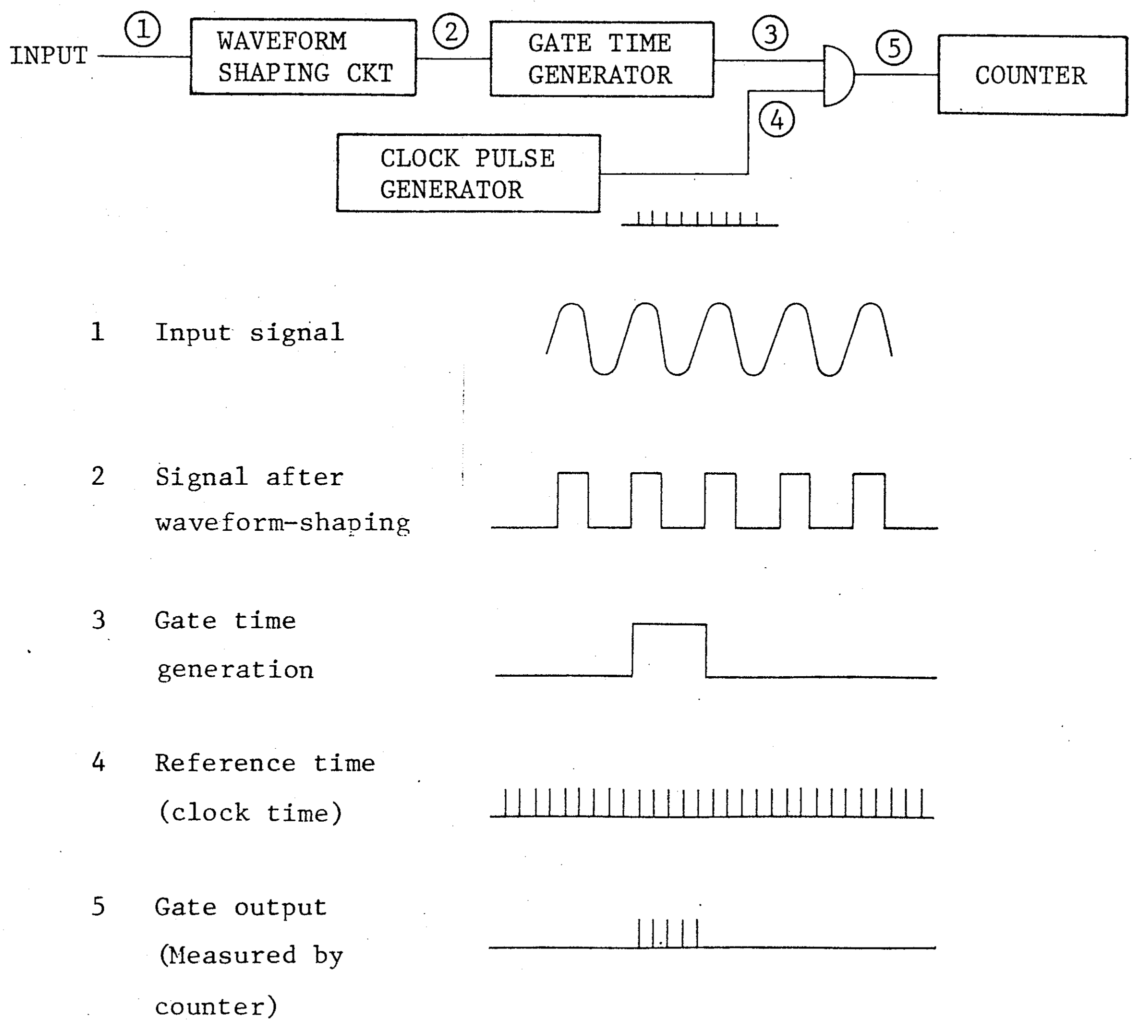


Figure 4-2

4.2 Waveform-shaping Circuit

This circuit conditions the input signal into a constant-amplitude pulse signal of sharp rise and fall edges. For the initial stage, an FET is used as a source follower to provide a high impedance. The signal is converted into a pulse signal by the subsequent stage.

4.3 Counting Circuit

The counting circuit is an 8-digit decimal counting circuit. The readout of the display section is with 7-segment LEDs. The leading zeros are blanked out for ease of reading.

4.4 Reference Time Generator (Clock Pulse Generator)

A 10-MHz crystal oscillator is used for the clock pulse generator. This oscillator is required to be very accurate since the accuracy of the entire measuring system depends primarily on the accuracy of this generator.

4.5 Gate Time Generator

For frequency measurement, the 10-MHz clock pulse signal is frequency-divided into gate time of 0.01 sec, 0.1 sec, 1 sec and 10 sec. For period measurement, the input signal dictates the gate time.

5. MAINTENANCE

5.1 Removing the Casing

Remove the case after removing the two clamping-screws from each of the side panels and rear panel.

5.2 Layout of Components

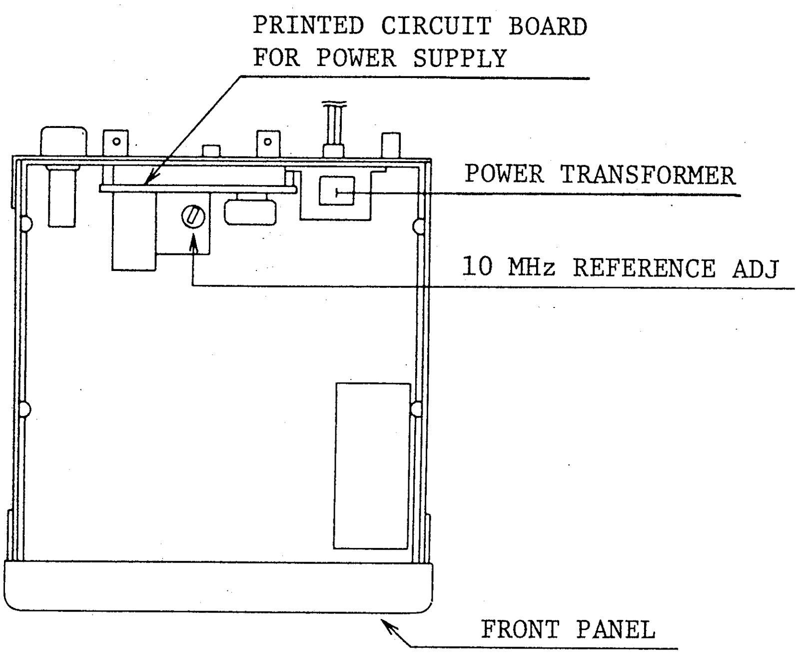


Figure 5-1 (Top view)

5.3 Calibration of 10-MHz Reference Signal

It is recommended to calibrate the 10-MHz reference signal at every six months or thereabout. For this calibration, connect the 10 MHz output signal to other reliable frequency counter (accuracy: $\pm 1 \times 10^{-8}$ or better) or other frequency calibrating device and adjust the frequency accurately at 10 MHz. As an alternative method, apply a calibrating signal (accuracy: 1×10^{-8} or better) of a known frequency (such as with a synthesizer oscillator of 10 MHz or over), and so adjust this instrument that it displays the corresponding frequency.

For the above calibration, be sure to allow more than 60 minutes of stabilization period after turning-on the instrument power.