
OPERATION MANUAL

FREQUENCY COUNTER

116, 150

Test Instrument Safety WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Higher voltages pose an even greater threat because such voltage can more easily produce a lethal current. However, voltage as low as 30 volts DC or AC RMS should be considered dangerous and hazardous since it can produce a lethal current under certain conditions.

Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer circuit away from your heart in case of accidental contact with a high voltage you will significantly reduce the risk factor if you know and observe the following safety precautions.

1. Don't Expose High Voltage needlessly. Remove housing and covers only when necessary. Turn off equipment while making test connections in high voltage circuits.
2. Use an insulated floor material or a large insulated floor mat to stand on, and an insulate surface on which to place equipment: And make certain such surfaced are not damp or wet.
3. On test instruments or any equipment with a 3-wire AC power plug, use only a 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.
4. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
5. Also remember that line voltage is present on some power input circuit points such as on-off switches, fuse, power transformers, etc., even when the equipment is turn off.
6. Never work alone. Someone should be near by to render aid if necessary. First aid training is highly recommended.
7. Radiation of the part of EMC in this equipment is designed in order to be satisfied in th condition of below 100mVrms.

Input A and B : below 40mVrms : for FC-116, FC-150
Input C(1.6GHz) : below 100mVrms : for FC-116
Input A : below 40mVrms : FC-150, FC-116
Input B(1.6GHz) : below 100mVrms : FC-116

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INTRODUCTION

The FC-116/FC-150 reciprocal frequency counter series are capable of frequency measurement at high resolution, within a short period of 7 digit display/1 sec. Gate due to the special counter LSI uniquely developed by C & C, as well as the expanding/reciprocal system.

The FC-116 covers a frequency range from 0.2Hz to 1.6GHz (FC-150, 150MHz), and basically 10MHz time base is T.C.O.(temperature controlled oscillator).

■ OUTLINE OF FC-116/FC-150 SPECIFICATION

- * FC-116 : From 0.2Hz to 1.6GHz
- * FC-150 : From 0.2Hz to 150MHz

■ EACH FREQUENCY COUNTER HAVE FOLLOWING ADDITIONAL FUCTIONS

- * 1/10 ATTENUATOR
- * LINE FILTER
- * RPM(ROTATION PER MINUTE) MEASURING FUNCTION
- * INTERNAL/EXTERNAL TIME BASE SELECTOR
- * PERIOD
- * TOTAL

A self test mode is also provided which enables a quick check of several facets of instrument operation, Each operating mode, and one of four decades resolution are selected by front panel push button switches, automatic decimal point placement, leading zero blanking, and large green LED display of proper measurement units. Over range and gate function(indication of a measurement in progress) are also shown on the front panel indicators. The exceptional accuracy, sensitivity, and versatility of this counter makes it an extremely valuable instrument to the scientist, engineer, experimenter, and communications technician. Light weight and compactness make it practical for use by the hobbyist or field technicians.

ELECTRICAL SPECIFICATIONS

■ INPUT A. CHARACTERISTICS (FC-116/FC-150)

- FREQUENCY RANGE : FC-116 : 0.2Hz to 100MHz(DC coupled)/30Hz to 100MHz(AC coupled)
 FC-150 : 0.2Hz to 150MHz(DC coupled)/30Hz to 150MHz(AC coupled)
- SENSITIVITY : FC-116 : 0.2Hz to 100MHz : 25mV
 FC-150 : 0.2Hz to 100MHz : 25mV 100MHz to 150MHz : 50mV
- COUPLING : AC or DC Selectable
- IMPEDANCE : 1mΩ Resistance, Shunted by > 40pF
- ATTENUATOR : ×1 or ×10 Switch Selectable
- LOW PASS FILTER : -3dB Point of 100KHz, Switch Selectable

* Resolution and Number of displayed digit

GATE TIME		INPUT A	
Number Of displayed digit		FREQUENCY	
10S	8	0.2Hz-9.9Hz	100MHz-150MHz
0.01S	5	10Hz-999Hz	10KHz-99MHz
0.1S	6	0.1Hz-9999Hz	100Hz-9.9MHz
1S	7	1Hz-99999Hz	1KHz-99MHz
		0.1Hz-999999Hz	10KHz-9.9MHz
		1Hz-9999999Hz	100KHz-99MHz
		0.1Hz-99999999Hz	1MHz-9.9MHz
		1Hz-999999999Hz	10MHz-99MHz
		10Hz-9999999999Hz	100MHz-150MHz

ACCURACY : ± Time base Error ± Resolution

(Table 1)

* MAX. INPUT VOLTAGE LEVEL

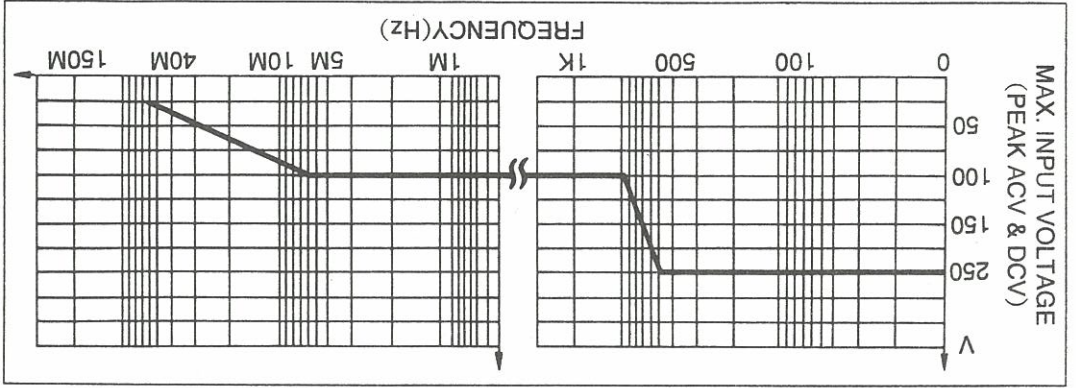


FIG 1. MAX. Input Level.(Input A)

GENERAL INFORMATION

PERIOD : RANGE : 6.7 nSec to 5Sec
 DISPLAY : n.u.m., Sec with decimal point
 TOTAL : RANGE : DC to 10MHZ
 CAPACITY : 0 TO 99 999 999
 OVER FLOW : ..OVER..
 RPM : RANGE : 12 TO 99 999 999 RPM
 OVER FLOW : ..OVER..

■ INPUT B.CHARACTERISTICS (FC-116)

FREQUENCY RANGE : 50MHZ to 1.6GHZ
 SENSITIVITY : 50MHZ to 1100MHZ : 30mV
 1100MHZ to 1.6GHZ : 60mV

* Resolution and Number of displayed digit

GATE TIME	0.01S	0.1S	1S	10S
Number Of displayed digit	5	6	7	8
FREQUENCY	RESOLUTION			
INPUT B				
50MHZ-99MHZ	1KHZ	100HZ	10HZ	1HZ
100MHZ-999MHZ	10KHZ	1KHZ	100HZ	10HZ
1GHZ-1.3GHZ	100KHZ	10KHZ	1KHZ	100HZ

(Table 2)

COUPLING : AC only
 IMPEDANCE : 50Ω ±5%
 MAX. INPUT LEVEL : 3Vrms sine wave

■ TIME BASE CHARACTERISTICS

TYPE : TCO(Temperature controlled oscillator)
 FREQUENCY : 10.00000MHZ
 STABILITY : ±1 PPM(±1 count)
 LINE VOLTAGE STABILITY : Less than ±1 PPM with ±10% line voltage variation
 TEMPERATURE STABILITY : ±5PPM from 0°C to 50°C
 MAX. AGING RATE : ±5PPM/year
 INT. STD. OUT : 10MHZ(internal standard frequency output)
 LEVEL : ≅5Vp-p
 IMPEDANCE : Approx. 50Ω
 EXT. STD. IN : 10MHZ(external standard frequency input)
 LEVEL : 1.5Vrms to 50Vrms
 IMPEDANCE : Approx. 50Ω

■ DISPLAY CHARACTERISTICS

DISPLAY : Eight 0.56" Green Seven Segment LED with M, K/u, Hz, Sec,
 Gate, Hold, and ·OVER· indicators.
 Function and Gate time : User Selected.
 ··OVER·· : Display Shown When Count exceeds 99 999 999

GENERAL DESCRIPTIONS

RESET : Reset the display to initial state.
 HOLD : In Frequency and Period, TOTAL, RPM modes, measurement in
 progress is stopped, and the last complete measurement is displayed.
 When Hold is released, a new measurement begins.
 OPERATING TEMPERATURE : 0 to 40°C (Accuracy Specified at 25°C ±5°C)
 POWER REQUIREMENTS : AC 100V/120V/220V/230V±10% selectable.
 50HZ/60HZ
 POWER CONSUMPTION : Approx. 15VA max.
 DIMENSIONS : 255(W)×80(H)×260(D)m.m
 WEIGHT : Approx. 1.8kg

SUPPLIED ACCESSORIES

- 1. OPERATOR'S MANUAL ————— 1
- 2. BNC CABLE ————— 1
- 3. POWER CORD ————— 1
- 4. SPARE FUSE ————— 1

OPTIONS

- 1. TCXO(Temperature Compensated X-tal Oscillator)
- 2. RS-232C INTERFACE.

INTRODUCTION

This section provides all information necessary to install the FC-116/FC-150 Covered in this section are initial inspection, preparation for use, operating environment, and repacking for shipment.

INITIAL INSPECTION

Inspect the shipping container for damage, if the shipping container or cushioning material is damaged, it should be kept until the content of the shipment have been checked for completeness and the shipment has been checked mechanically and electrically.

If the contents are incomplete, if there is mechanical damage or defect notify the nearest C & C representative.

If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the C & C representative.

Keep the shipping material for the carrier's inspection.

PREPARATION FOR USE

The FC-116/FC-150 requires a power source of 100V/120V/220V/230V AC $\pm 10\%$, 50HZ/60HZ single phase, power consumption is 15 VA maximum.

LINE VOLTAGE SELECTION



Before switching on this instrument, make sure the instrument is set to the voltage of the power source.

The voltage at which the unit has been factory set, is indicated on the rear panel voltage selector.

1. Disconnect the power cable.
2. Pull out the fuse holder FIG(2).
3. Select operation voltage by orienting fuse holder to position desired voltage according to '△' mark on the AC INLET.
4. Re-insert the fuse holder AC INLET. Be careful to select correct fuse value.

* Specifications are subject to change without notice.

- (2) HUMIDITY : below 85% RH
- (1) TEMPERATURE : -20°C to +70°C

limits.

The instrument may be stored or shipped in environments within the following

STORAGE ENVIRONMENT

(2) HUMIDITY : The instrument may be operated in environments with relative humidities to 85% to 40°C. However, the instrument must be protected from temperature extremes which cause condensation within the instrument.

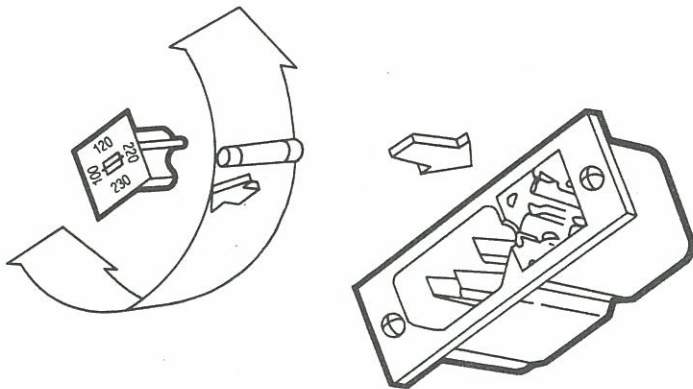
- (1) TEMPERATURE : The instrument may be operated in temperatures from 0°C to +40°C

OPERATING ENVIRONMENT

MAKE SURE THAT ONLY FUSES FOR THE REQUIRED RATED CURRENT AND OF THE SPECIFIED TYPE ARE USED FOR REPLACEMENT.

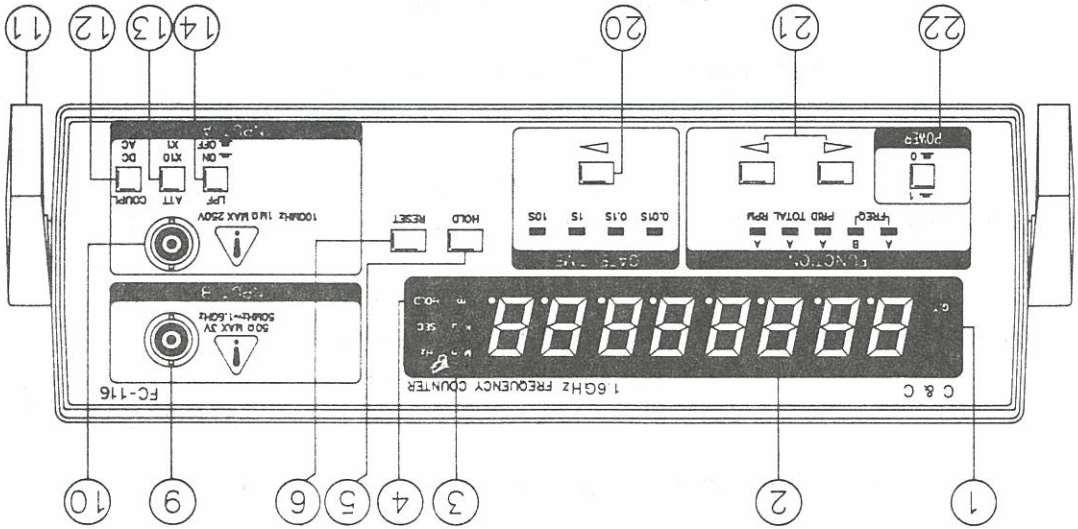
CAUTION 

FIG.2 VOLTAGE AND FUSE SELECTION

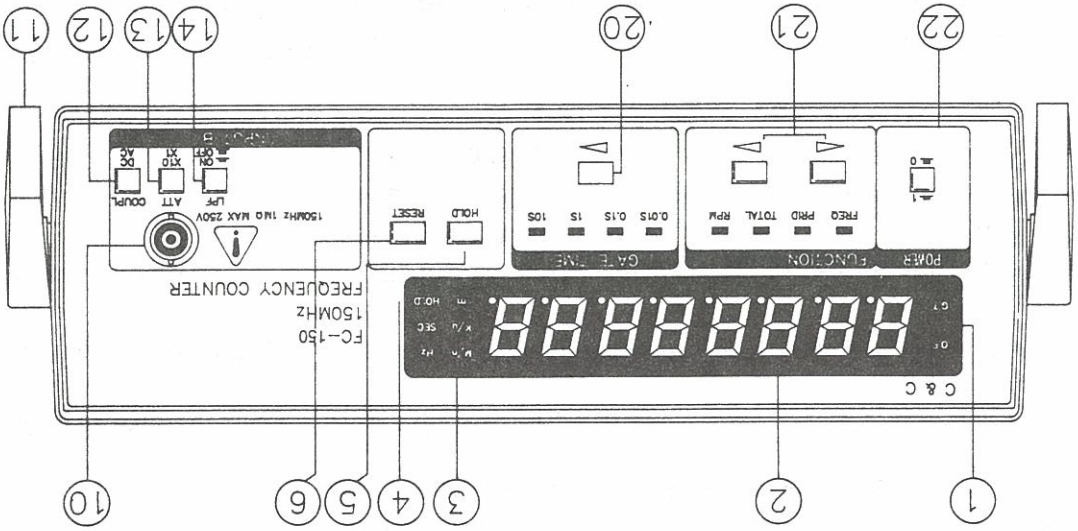


OPERATING VOLTAGE	220V OR 230V
FUSE	T 200mA 250V
	T 500mA 250V

PANEL CONTROL AND INDICATOR
FRONT PANEL



FIG(3) FRONT PANEL (MODEL : FC-116)



FIG(4) FRONT PANEL (MODEL : FC-150)

- ① GATE INDICATOR : The gate light, when lit, indicates the main gate is open and measurement in progress.
- ② DISPLAY : 8 digit(0.56") green LED display used for all read-readings. When lit, indicates that the frequency displayed is in KHz or MHz, and period is in.u.Sec.
- ④ HOLD INDICATOR : When lit, engaged the hold function
- ⑤ HOLD SWITCH : In hold function, the display held but the counter continue to increment. When the hold is released, the display is updated and resumes counting.
- ⑥ RESET SWITCH : In all mode, pushing this monetary switch reset the counter to initial state.
- ⑨ INPUT B, BNC : Input for all frequency measurements above 50MHZ female BNC connector terminated in 50 Ω .
- ⑩ INPUT A, BNC : Input for frequency measurements below 100MHZ (FC-150 : 150MHZ), and all PERIOD, TOTAL, RPM measurement. Female BNC connector terminated in 1M Ω input resistance, shunted by >40pF capacitance.
- ⑪ HANDLE : Pull out 1cm, to adjust tilt.
- ⑫ COUPL, SWITCH : The switch is used to select the input coupling mode AC or DC.
- ⑬ ATT. SWITCH : When this switch is set to $\times 10$ (pushed in) the input A is attenuated 10 : 1 before application to the counter with the switch set to $\times 1$ (pushed out), the input A signal is applied unattenuated.
- The attenuator has no effect on the input B ⑨.
- ⑭ LOW PASS FILTER: With this switch pushed in, the input A is routed through a low-pass filter with a-3dB point of approximately 100KHZ. SWITCH(LPF)
- When it is released, the input A signal is applied to the counter.

⑳ GATE TIME SWITCH This switch select the degree of resolution of the display in all modes except TOTAL and RPM.

㉑ FUNCTION SWITCH Select the desired operating mode.

a. FREQ. A. When this mode is selected, the counter reads the frequency of the input A ⑩. Resolution is selected using the GATE TIME ㉑.

b. FREQ. B. When this mode is selected, the counter reads the frequency of the input B ⑨. all readings are in MHZ.

c. PERIOD A. When this mode is selected, the counter read the period of the input A ⑩. Resolution is selected using the GATE TIME ㉑.

d. TOTAL A. When this mode is selected, the unit counts cycles of the input A signal and continuously displays that count.

e. RPM A. When this mode is selected, the unit displays the RPM(rotation per minute) of the input A signal.

㉒ POWER SWITCH

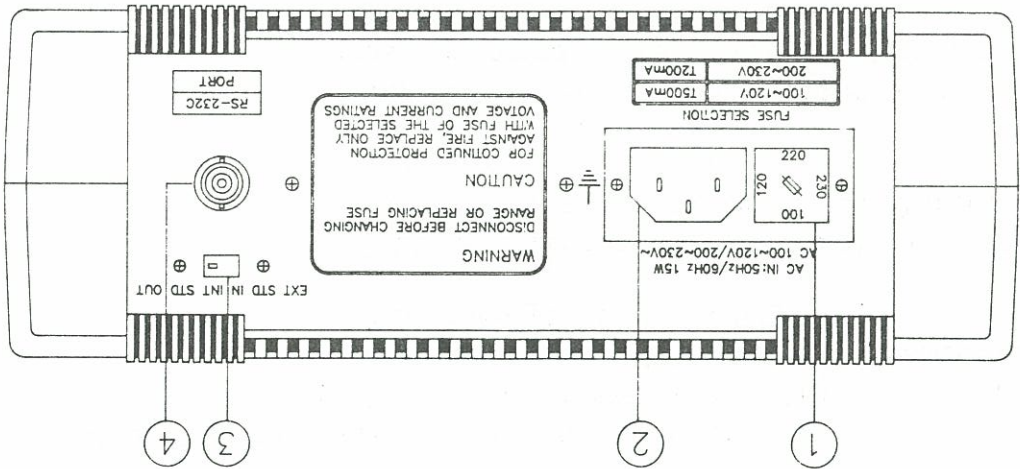
Push in the unit ON and push out the unit OFF.

- ④ INT/EXT TIME BASE BNC : Serves as a monitoring point for the internal time base signal, or provides an input path for an external time base signal, depending on the EXT/INT switch setting.
The external signal should have a voltage range of 1.5V~5Vrms.
- ③ INT/EXT TIME BASE SELECTOR : Select the time base, switch position EXT. STD. IN provides a nominal 50Ω input impedance path for an external 10MHz time base. switch position INT. STD. OUT monitors the internal timebase-signal.
- ② POWER RECEPTACLE : Input connector for power cord safety coded. observe and set line voltage selector for the correct voltage level before operating the instrument.

CAUTION 

- ① VOLTAGE SELECTOR : Select of your line voltage.

FIG(5) REAR PANEL



REAR PANEL

OPERATING INTRODUCTIONS

The following paragraphs describe operating information needed for FC-116/FC-150 frequency counter. Number in parentheses refer to items in 'panel control and indicators' section and FIG(3, 4, 5)

CAUTION

Before connecting unit to AC power, check the line voltage selector correctly for your particular line voltage.

- a. Connect the unit to AC power.
- b. Turn on the power S.W⁽²⁾. Then function indicator position is FREQ, A, Gate time indicator position is 1 Sec position.

CAUTION

* Application of input voltages higher than the limits listed in the "SPECIFICATIONS" section may damage the counter. Before applying any signal to the inputs, make

* Frequency counter ground points are connected directly to earth ground. Always connect frequency counter ground only to ground points in the circuit under test.

FREQUENCY MEASUREMENTS

(INPUT A : 0.2HZ to 150MHZ : 150/0.2HZ to 100MHZ : 116) a. Apply the signal to be measured to the input A BNC ⁽¹⁰⁾.

b. Set the FREQ. A of function switch ⁽²¹⁾.

c. Select the degree of resolution desired, using the gate time selector switch ⁽²⁰⁾.

d. Frequency is given by the display ②. The gate indicator ① lights while each measurement in progress, and the display is updated at the end of each measurement interval.

e. Engaging the hold switch ⑤ “freezes” the display at the existing reading. When hold is released, the display is updated and resumes counting.

f. Pushing the reset switch ⑥ resets the display to initial state.

When reset is released, a new measurement begins, but the display remains at zero until the new measurement is complete.

g. If necessary, engage the attenuator switch ⑬.

When set to $\times 10$ (pushed in), this switch attenuates the input A signal by a factor of approximately 10 before application to the counter. This helps prevent miscounting caused by noisy or improperly terminated high amplitude signals.

h. If necessary, engage the LPF (low pass filter) switch ⑭.

This route the input A through a low pass filter (-3dB point of approximately 100KHZ) before application to the frequency counter. This helps eliminate counting errors in low frequency measurements by minimizing effects of high frequency noise present on the input.

i. When measurement the lower cut-off frequency (10Hz), pushed in DC coupling position, switch ⑰.

(INPUT B : 50MHZ to 1.6GHZ)

CAUTION

The maximum input limit to this input is 3Vrms maximum over the input frequency range. The $\times 10$ attenuator does not apply.

a. Apply the signal to be measured to the input B. BNC ⑨.

b. Set the function indicator to the FREQ. B position ⑳.

c. Select the degree of resolution desired, using the gate time switch ⑳.

d. Frequency is given by the display ②. The indicator ① lights while each measurement is in progress.

e. Engaging the hold mode same as paragraphs (Freq. measurement, input), "e"

f. Reset mode is same as paragraphs (Freq. measurement, input A), "f"

g. The attenuator ⑬ and LPF ⑭ coupling ⑫ switch have no effect in input B.

PERIOD MEASUREMENTS

a. Apply the signal to be measured to the input A BNC ⑩.

b. Select the degree of resolution desired, using the gate time switch ⑳.

c. Period is given by the display ②. The gate indicator ① lights while each measurement is in progress.

d. Hold, reset, attenuator, low pass filter, coupling switch application is same as frequency measurements mode.

TOTAL MEASUREMENTS

The total mode is used to count the total number of events occurring during a specific time period. Maximum frequency is 10MHZ.

a. Set the total mode ㉑. Any gate ㉒ units ㉓ setting is ignored.

b. Apply the signal to be measured to input A ⑩, and then the counter display is the count continually. Maximum count is 99999999. If this is exceeded, the overflow message display as "...OVER...".

c. Low pass filter and attenuator, coupling switch application is same as frequency measurements mode.

- a. Set the RPM mode ⑳. Any gate time ㉑ units ㉒ setting is ignored
- b. Apply the signal to be measured to the input A, BNC ⑩, and then the counter displays the RPM. Maximum count is 99999999.
- c. Low pass filter and attenuator, coupling switch application is same as frequency measurements mode.

RPM (ROTATION PER MINUTE) MEASUREMENT

The hold switch may be used to latch the display. However, the counter to increment and when the hold is released, the update count is display.

NOTE

BNC CABLE CONSIDERATIONS

Accuracy of radio frequency measurements can be affected by connections between signal source and counter. Main considerations are standing waves and shunt cable capacitance.

Standing wave are usually present due to reflections when a transmission line is not terminated in its characteristic impedance. These standing waves may cause damage to the signal source or produce inaccurate measurements, and their effects increase as cable length reaches one-fourth of the wavelength for the frequency being measure.

Standing wave can be minimized by keeping cable lengths short, and more important, providing a proper termination.

The cable's characteristic impedance and the terminating impedance should match the source impedance. For example, for a source impedance of $50\ \Omega$, use $50\ \Omega$ coaxial cable terminated with a $50\ \Omega$ resistive load.

Use DC blocking capacitor in situations where bias voltage or other DC voltages could be affected by the termination resistor.

Shunt cable capacitance, which can cause undesirable signal attenuation, increases with increased cable length. It is recommended that for radio frequency measurements, the cable be no longer than three feet (90cm), to keep shunt capacitance within acceptable limit.

In $50\ \Omega$ systems the internal $50\ \Omega$ input termination of the input B. BNC minimizes reflections and the resulting standing waves.

Thus, the need for an external termination is eliminated. Also, shunt capacitance has a much lesser effect at this BNC than at the input A, and the above restriction on cable length is reduced. However, prescale measurements must always be taken from a $50\ \Omega$ point in the circuit under test.

USE OF ATTENUATOR PROBES

Input A resistance ($1\text{M}\ \Omega$) and input capacitance ($<40\text{pF}$) are independent of the ATT switch, TO decrease loading, a high impedance oscilloscope probe such as the following may be used with input A.

Use the probe in the $\times 10$ position whenever possible for less circuit loading.

Use caution in measuring the line frequency of an AC outlet. Using the probe tip only, measure both sides of the line. The ground side will give a zero reading and the hot side will provide the desired measurement. Do not use the "ground" lead of the probe. Remember that the chassis of the counter and the "ground" lead of the probe are already at earth ground (via the 3-wire power cord of the instrument.) Touching the "ground" lead to the "hot" side of the line would place a direct short on the power line through the probe cable, resulting in possible injury and damage to the probe cable.

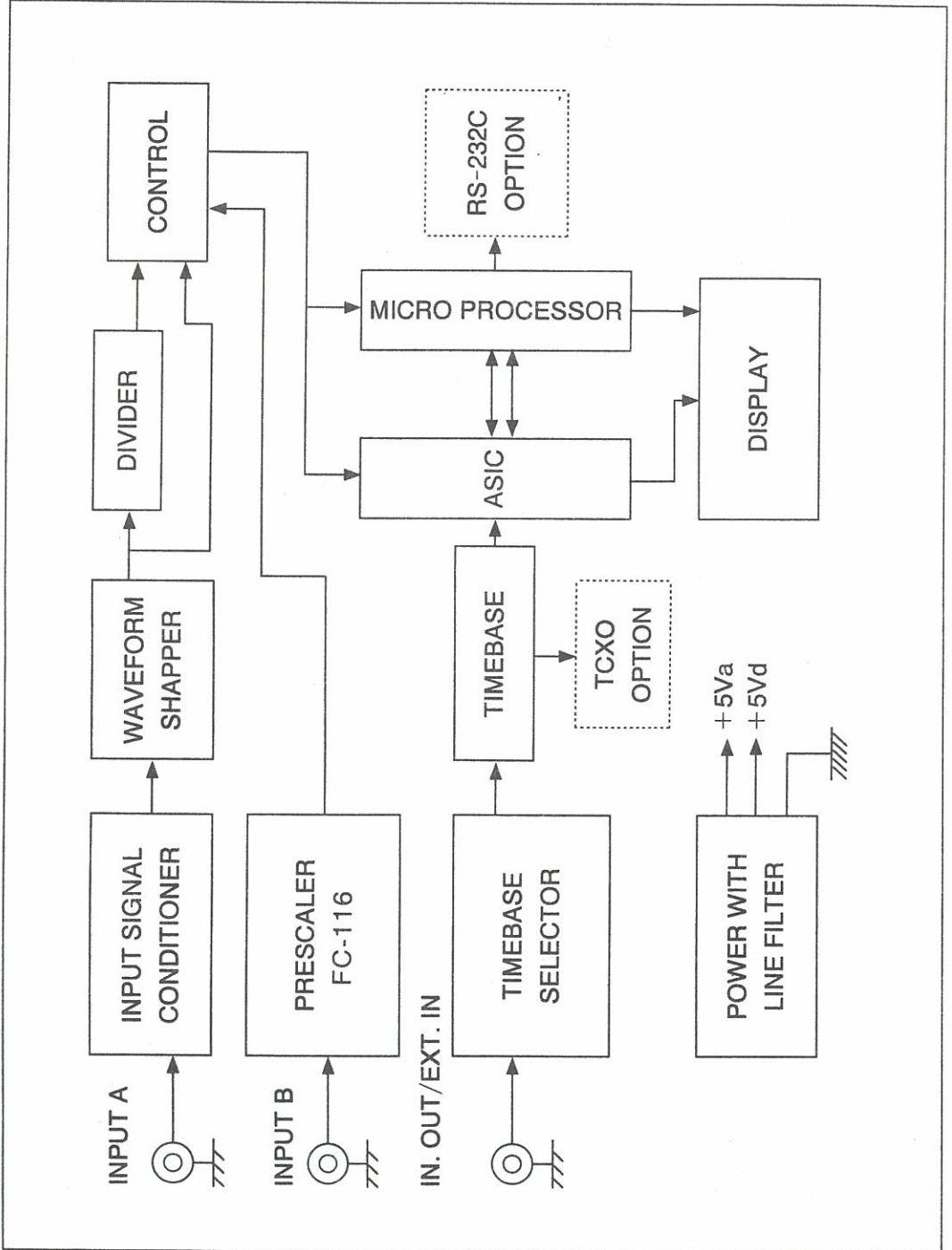
WARNING

Use of the attenuator, low pass filter, and/or a $\times 10$ probe is advisable when measuring line frequency, because of the high amplitude signal, and because noise is usually present and can cause mis-counting.

LINE FREQUENCY MEASUREMENTS

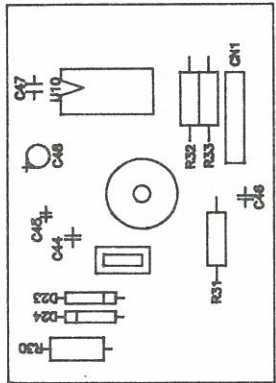
Do not use a $\times 10$ probe with the input B, the probe is designed for $\times 10$: 1 attenuator with a counter input resistance of $1\text{ m}\Omega$. The $50\ \Omega$ termination of the input B would result in unacceptably high attenuation.

NOTE

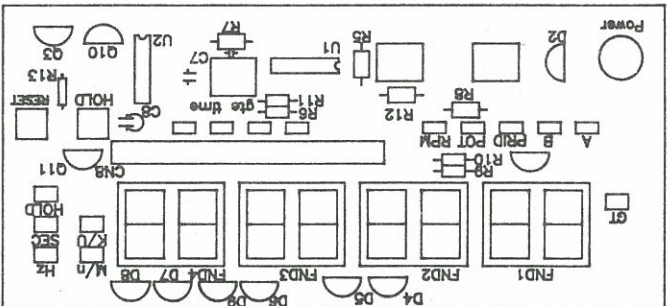


BLOCK DIAGRAM & COMPONENT LOCATIONS

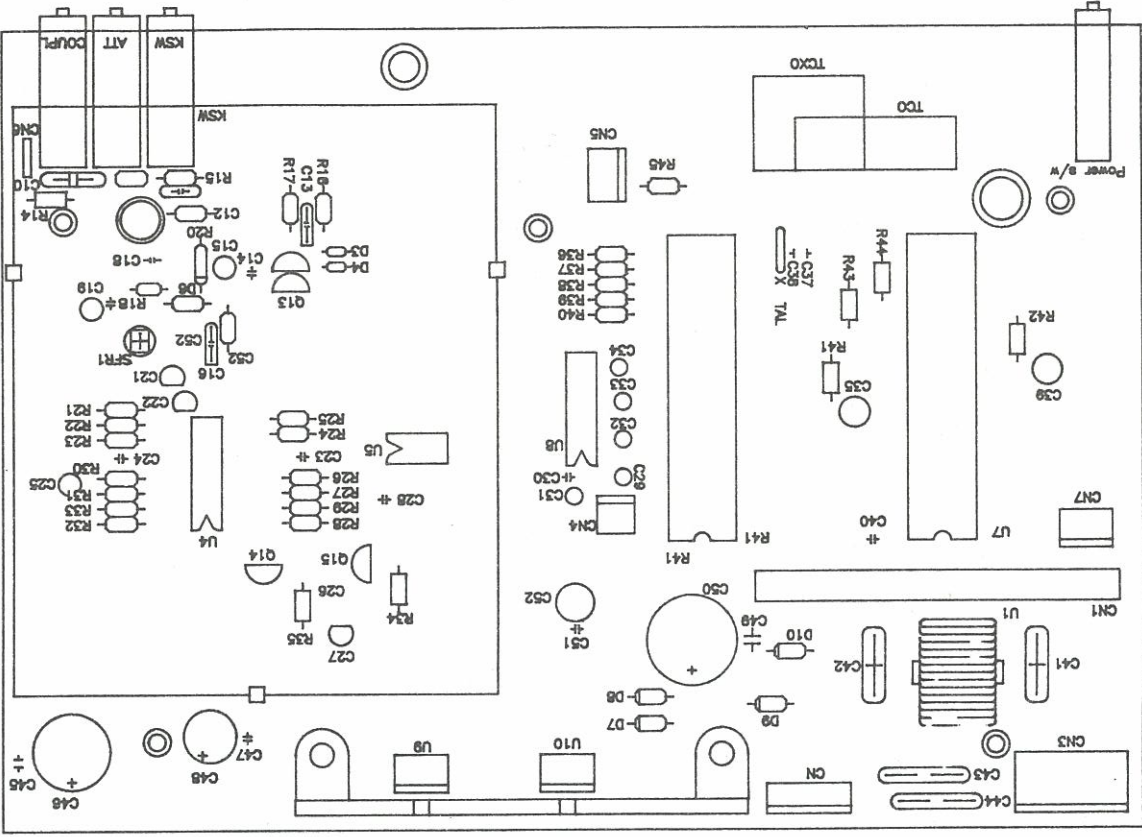
COMPONENT LOCATIONS



PRESCALER



DISPLAY



MAIN

