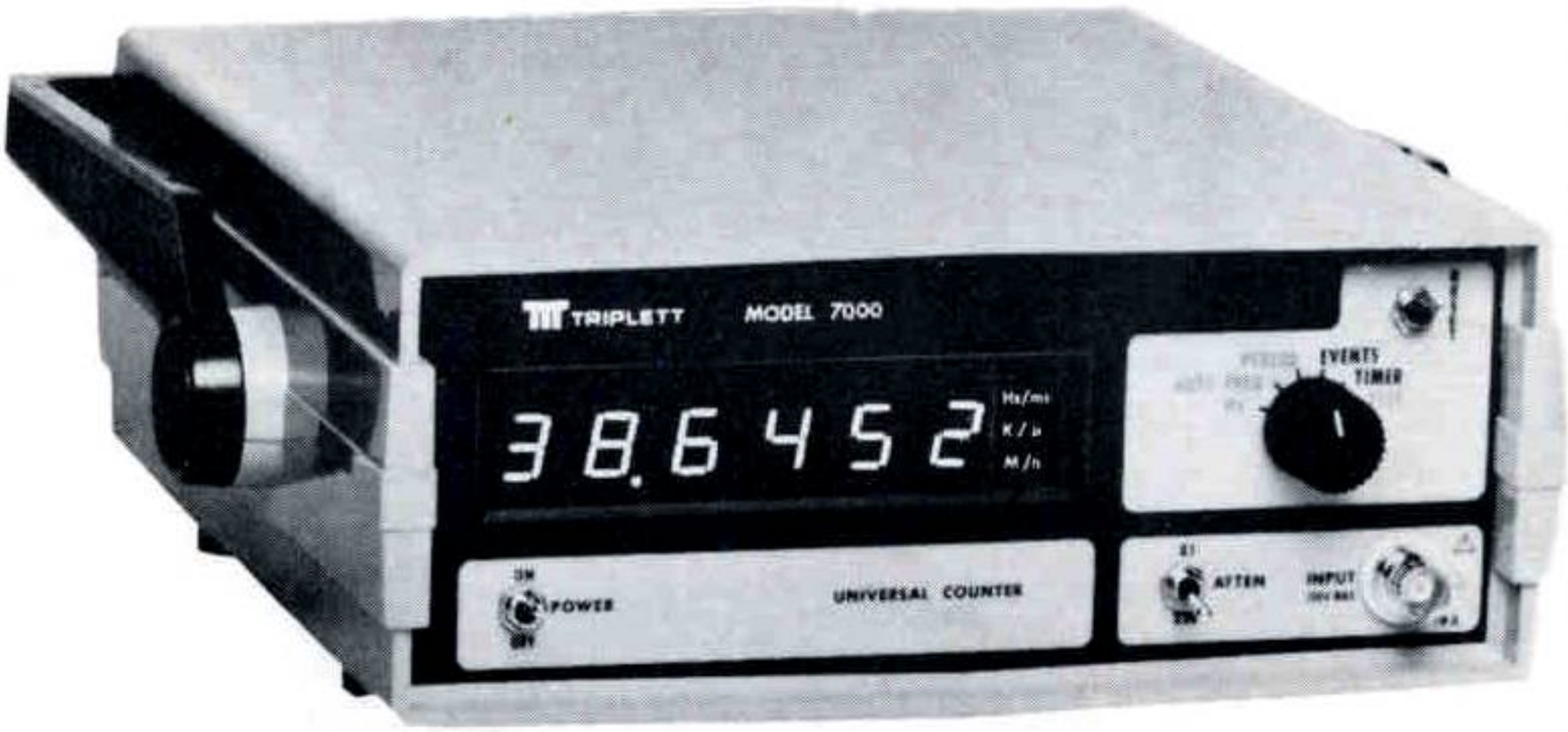

WARNING NOTE

READ THE INSTRUCTIONS ON PAGES
2, 13, & 33 BEFORE USING THIS TESTER.

MODEL 7000

UNIVERSAL COUNTER

TRIPLETT

INSTRUCTION MANUAL

INSTRUCTION MANUAL

TRIPLETT®

MODEL 7000

UNIVERSAL COUNTER

Triplett Corporation
One Triplett Drive
Bluffton, Ohio 45817

SAFETY RULES

Warning

This unit has been designed with the operator's safety in mind. However, no design can completely protect against incorrect use. Electrical circuits can be dangerous and/or lethal when lack of caution or poor safety practices are used.

Read The Manual

Read this Instruction Manual carefully and completely. Voltages within the capability of this test equipment can be hazardous. Follow the instructions in this manual for every measurement. Do not exceed the limits of the unit.

Input Voltages

The rear panel inputs respond to TTL logic levels. The maximum input voltage at these inputs is 5 V peak. The maximum input for the front panel connector is given in the specifications and graphically in Fig. 2. Do not exceed the maximum voltage rating for any input. See CAUTION in the OPERATING INSTRUCTIONS section of this manual.

Measuring Power Line Frequency

Directly connecting the counter to a power line can be hazardous to the instrument and the operator. Before attempting measurement of power line frequency, read the CAUTION in the OPERATING INSTRUCTIONS section of this manual.

TABLE OF CONTENTS

INTRODUCTION

The Triplett Model 7000 is a microprocessor based 80 MHz universal counter. It is capable of measuring both input signal frequency and period over the full 5 Hz to 80 MHz range in one second with six digit resolution. Having both frequency and multiple period averaging measurement capability available, the microprocessor executes the optimum measurement and displays the desired format, frequency or period. Autoranging is, therefore, inherent in the operation of the instrument.

In addition to the automatic modes, AUTO FREQ and PERIOD, a manual mode "Hz" is provided. This mode of operation performs a standard frequency measurement using a one second gate and displays the result with 1 Hz resolution. The megahertz annunciator "M" indicates that the most significant digit(s) has (have) overflowed.

The Model 7000 has two accumulating type functions. The EVENTS counter totalizes to one billion at rates up to 80 MHz. The TIMER displays elapsed time in hours, minutes and seconds for 100 hours with up to 100 μS resolution. For each function counting can be halted by applying a logic "0" to a rear panel connector. The display for each can be reset to zero by the front panel RESET button.

The TEST function performs internal tests to verify proper operation of microprocessor and display electronics.

The six functions are selected by a single rotary function switch. Other than RESET and POWER the only other front panel control is ATTENuator. This switch inserts a X10 attenuator in the signal path to reduce noise on high level signals.

The display consists of six digits of .43 inch high LED's and three multiplier annunciators.

The time base is a 10 MHz crystal controlled oscillator. The unit can be run from an external 10 MHz source, if desired, via a rear panel BNC connector. A rear panel switch selects between time bases. An optional temperature compensated crystal oscillator (TCXO) furnishes a closely controlled time base frequency over a wide temperature range.

Its ease of operation, versatility and accuracy make the Model 7000 an ideal instrument for the hobbyist, production worker, technician or engineer.

SPECIFICATIONS

Input Characteristics

Impedance	1 MΩ shunted by 20 pF.
Connector	Front panel BNC.
Coupling	AC.
Sinewave Sensitivity	30 mVrms from 5 Hz to 40 MHz, 50 mVrms maximum at 80 MHz. See Fig. 1.
Maximum Input	200 V (peak AC + DC) to 500 Hz, derate linearly to 100 V (peak AC + DC) at 1 kHz. 100 V (peak AC + DC) from 1 kHz to 5 MHz, derate linearly to 30 V (peak AC + DC) at 80 MHz. See Fig. 2.
Attenuator	X1 or X10, switch selectable.

Frequency Characteristics "Hz"

Range	5 Hz to 80 MHz.
Accuracy	± time base accuracy ± 1 count.
Resolution	1 Hz.
Gate Time	1 S.
Display	Frequency displayed as a whole number with leading zero blanking.
Overrange	Megahertz indicator "M" automatically turned on when input frequency exceeds 1 MHz.
	6 least significant digits of input frequency displayed.

Frequency Characteristics AUTO FREQ

Range	5 Hz to 80 MHz.
Accuracy	± time base accuracy ± 1 LSD ± trigger error.[1]
Resolution	To 1 ppm.
Gate Time	1 S for frequencies greater than 1 MHz.
	Frequencies less than 1 MHz measured by period averaging technique with number of periods automatically selected such that gate time is between 0.1 S and 1.0 S. Internal frequency counted is 10 MHz.

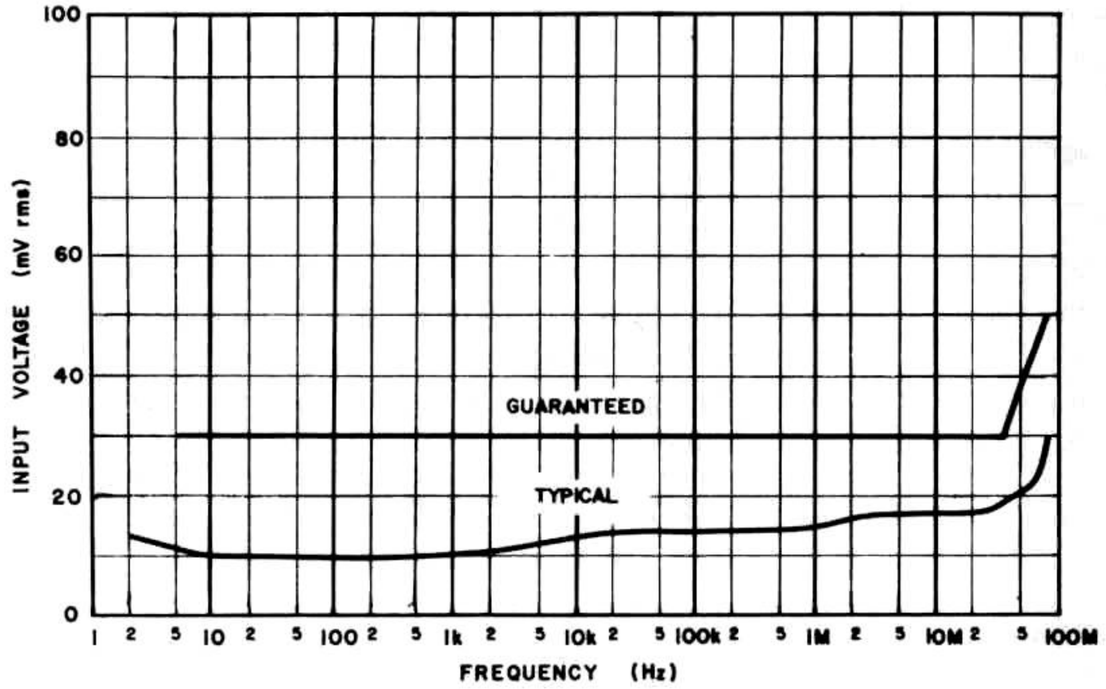

Fig. 1 Input Sensitivity Curve

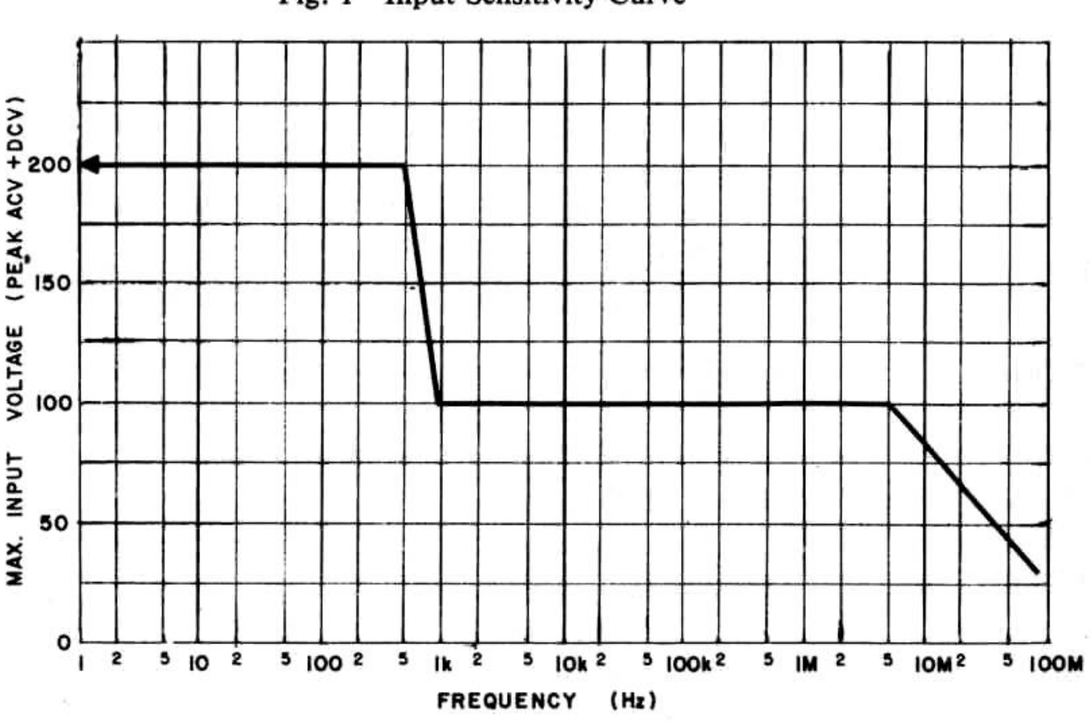

Fig. 2 Maximum Input Voltage Derating Curve

SPECIFICATIONS (Continued)

Display	6 most significant digits of input frequency with automatically positioned decimal point. Units of measurement - Hertz "Hz," Kilohertz "K," or Megahertz "M" are automatically annunciated on the front panel indicators.
Display Update	200 mS to 1.1 S dependant upon input frequency.

PERIOD Characteristics

Range	12.5 nS to 200 mS (5 Hz to 80 MHz).
Accuracy	± time base accuracy ± 1 LSD ± trigger error.[1]
Resolution	To 1 ppm.
Gate Time	Periods less than 1 μs (input frequency greater than 1 MHz) measured as frequency with 1 S gate time. Periods greater than 1 μs are averaged, with the number being averaged sufficient for a gate time of 0.1 S to 1.0 S. Internal frequency counted is 10 MHz.
Display	6 most significant digits of input period with automatically positioned decimal point. Units of measurement millisecond "mS" microsecond "μ" or nanosecond "n" are automatically annunciated on front panel indicators.
Display Update	200 mS to 1.1 S dependant upon period.
No Input Display	With no input or insufficient input, a dashed line appears on the display.

Totalize Characteristics EVENTS

Range	5 Hz to 80 MHz.
Capacity	0 to 999.999 mega events (999,999,000 events).
Reset Control	Front panel manual RESET to 0, provision for user conversion to remote reset via rear panel jack.
Display	
Less than one million events	The count is displayed as whole number with leading zero blanking.

Greater than one million events	6 most significant digits of count displayed with automatically positioned decimal point. The "M" annunciator indicates a multiplier of one million (X1,000,000).
Greater than one billion events	A dashed line is displayed at over flow.
Gate Control	Rear panel connector with TTL or contact closure compatibility (i.e. open circuit enables counting and closed circuit halts counting).

TIMER Characteristics

Range	100 μs to 100 hr (99:59:59).
Accuracy	± time base accuracy ± 1 LSD.
Reset Control	Front panel manual RESET to 0, provision for user conversion to remote reset via rear panel jack.
Display	6 most significant digits of elapsed time in hours: minutes: seconds and fractional seconds in floating format with automatically positioned colons and decimal point. A dashed line is displayed at overflow (100 hrs).
Gate Control	Rear panel connector with TTL or contact closure compatibility (i.e. open circuit enables timer and closed circuit halts timer).

Internal Time Base Characteristics
Referenced to 25°C After ½ Hour Warm-up

Type	Crystal Oscillator.
Frequency	10 MHz.
Setability	± .1 ppm (± 1 Hz).
Line Voltage Stability	Less than ± 1 ppm for ± 10% Line Voltage Variation.
Temperature Stability	Less than ± 10 ppm (± 0.001%) from 0°C to 40°C ambient.
Maximum Aging Rate	± 10 ppm/yr (± 1 ppm/mo).
External Input	TTL Level 50 Ω, 2.5 Vpp, switch selectable, from rear panel.

TCXO Option

Frequency	10 MHz.
Temperature Stability	Less than ± 1 ppm (± 0.0001%) from 0°C to 40°C ambient.
Maximum Aging Rate	± 1.0 ppm/yr.
Warm-up Time	None.
External Output	10 MHz, TTL level signal from TCXO available at rear panel BNC connector.

Display Characteristics

Visual Display	6 digits (high efficiency LED type) .43" high with decimal points and colons. Also three annunciators as follows: Hz/ms, K/μ, M/n
Test Characteristics	This function exercises the electronics of the unit to verify correct operation of internal electronics. The test first exercises the display and then performs internal tests. Upon returning the FUNCTION switch to the desired mode normal operation will take place.

General

Power Requirement	105 V to 130 V or 210 V to 260 V 50/60 Hz with internal transformer jumpers.
Fuse	¼ Amp 3AG slo-blo for 120 Volt operation; ⅛ Amp 3AG slo-blo for 240 Volt operation.
Power Cord	Detachable 3-wire.
Handle	Variable position and tilt stand.
Case	8½W x 9$\frac{3}{32}$D x 3$\frac{7}{16}$H plus handle. Carrying case available; see installation note page 31.
Front Panel Controls	Rotary FUNCTION switch. Miniature toggle switches for POWER and ATTENuator functions. Push button RESET switch.

SPECIFICATIONS (Continued)

Lead Assemblies	Input lead - coax cable, BNC connector one end, alligator clips at other end, 36 in. long. Rear panel accessory lead - molex miniature nylon connector which mates with rear panel connector; other end stripped and tinned, 25 in. long.
Weight	4½ pounds.

[1] Trigger error is typically ± 0.5% of measured value divided by the number of periods averaged, for sinewave input signals having better than 40 dB S/N ratio and 100 mVrms amplitude. Trigger error is zero for input signal frequencies in excess of 1 MHz.

OPERATION

A. CONTROLS AND FEATURES (See Fig. 3 and 4)

1. POWER. Switching this toggle switch to the ON position applies power to the counter. The switch is in the secondary circuit of the transformer.
2. ATTENUATOR. In the X1 position the input is applied to the counter circuitry without attenuation. In the X10 position a X10 attenuator is inserted in the signal path. Trigger uncertainty or miscounting due to noisy or improperly terminated signals can be reduced using the X10 attenuator. This will work only for high level signals however, since the signal level is also attenuated. The attenuator switch setting has no effect on the maximum input level that can be applied. Do not exceed the levels given by Fig. 2.
3. INPUT CONNECTOR. The input signal is applied at this female BNC connector. The impedance of 1 MΩ shunted by 20 pF permits the use of 10:1 compensated scope probes for reduced circuit loading.

CAUTION

The exposed metal parts of this cover are connected to ground through the power cord. The BCN output jacks are also grounded. If this unit is incorrectly connected to an AC power line through the input jack, a short circuit will occur. This will trip the circuit breaker in your AC power source. See page 13 of the Instruction Manual on AC power line measurement.

4. RESET. This push button switch resets the display to zero when using the TIMER or EVENTS functions. It has no effect for other functions.

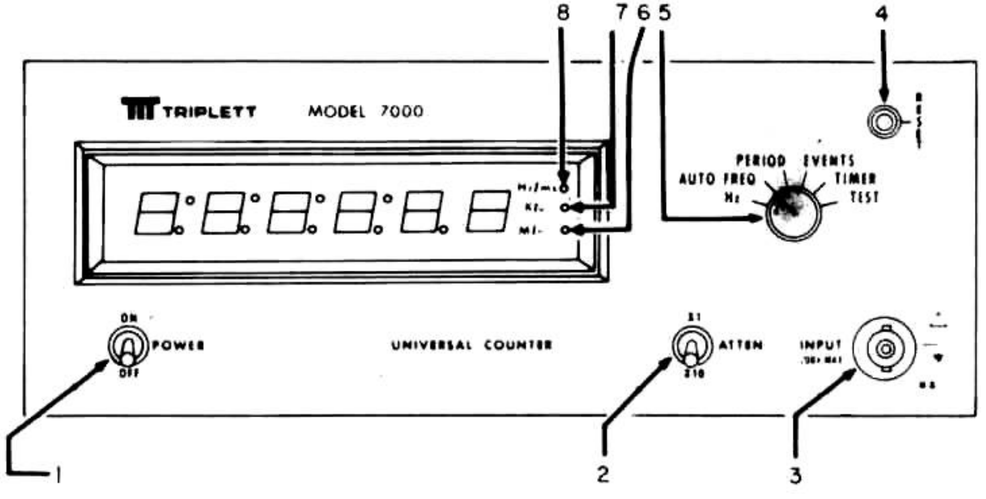

Fig. 3 Front Panel

5. FUNCTION SWITCH. This rotary switch selects one of the six counter functions.
6. M/n ANNUNCIATOR. When this annunciator is lit during operation in the AUTO FREQ mode, the displayed result is in units of MHz. During operation in the PERIOD mode the units displayed are nanoseconds (ns). Also, this annunciator indicates an overflow for the "Hz" mode (i.e. the frequency is greater than 1 MHz). When using the EVENTS counter, the "M" annunciator indicates that the total number of events accumulated is the displayed number times one million.
7. K/μ ANNUNCIATOR. This annunciator is used only for the AUTO FREQ and PERIOD functions, indicating that the units displayed are kHz or μS respectively.
8. Hz/mS ANNUNCIATOR. This annunciator is used only for the AUTO FREQ and PERIOD functions, indicating that the units displayed are Hz or mS respectively.
9. EXTERNAL GATE INPUT. A contact closure to ground or TTL logic "0" at this input (connector center pin) stops the count accumulation for the EVENTS and TIMER functions. There is no effect for other functions. The voltage at this input should not exceed 5 volts peak. The lower pin is at ground potential. The top pin is a provision for remote reset. See "User Conversion to Remote Reset" in the RECALIBRATION AND MAINTENANCE section of this manual.

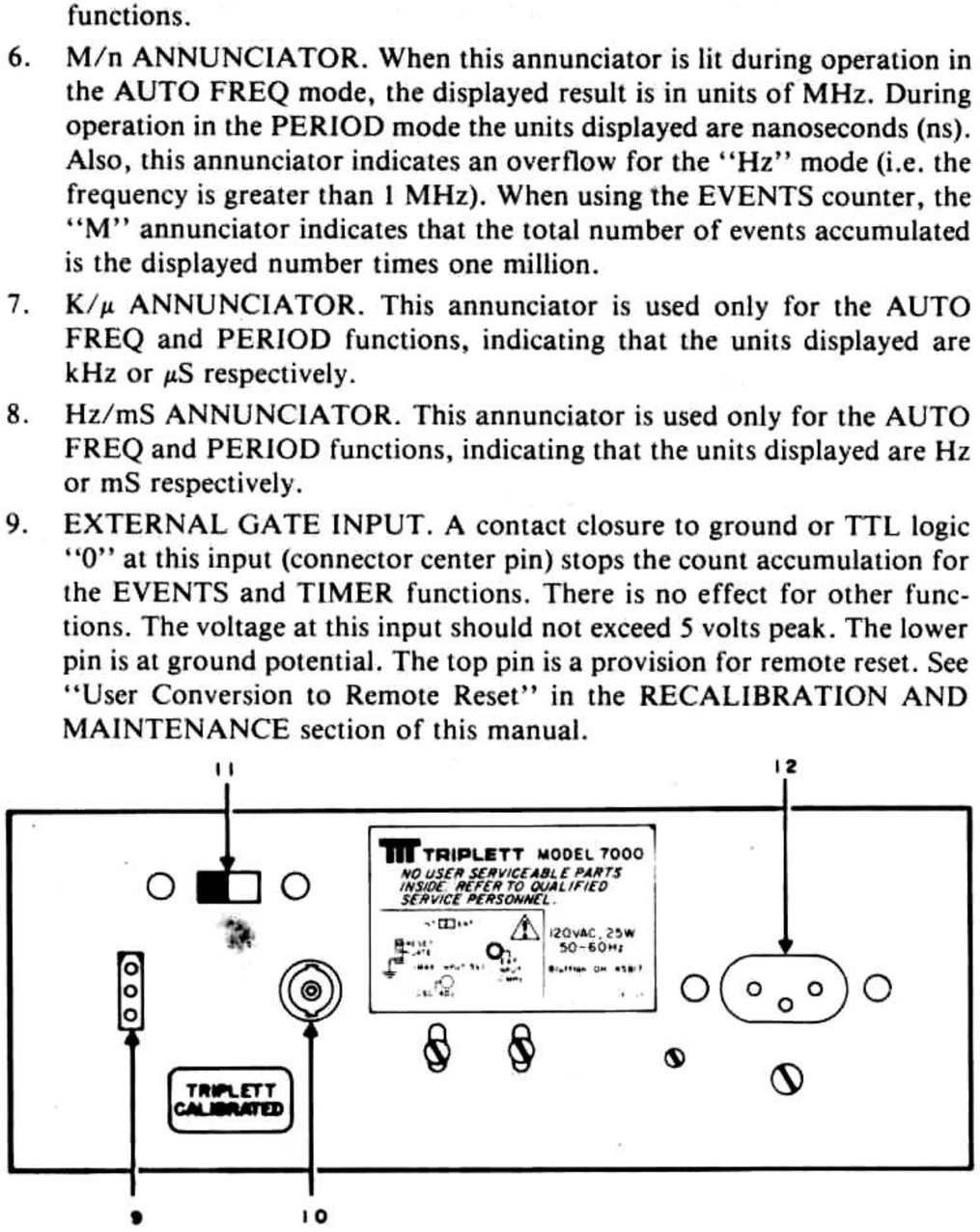

Fig. 4 Rear Panel

10. EXTERNAL INPUT 10 MHz. This female BNC connector accepts an external 10 MHz time base. The signal should be TTL level and should not exceed 5 volts peak. For units with the TCXO option, this jack is an output, which supplies the 10 MHz internal time base at TTL level.
11. TIME BASE SELECTION SWITCH (INT/EXT). This switch selects the time base used, internal or external. The external time base is supplied at the EXTERNAL INPUT 10 MHz. Note that the unit will not operate with the switch in the EXT position unless a TTL level 10 MHz signal is applied to the EXTERNAL INPUT. Since units with the TCXO option operate only with the internal time base, this switch is not used on those units.
12. POWER INPUT. Primary power is applied at this connector. The center pin ground is offset and must be below the plane of the other two pins when inserting the line cord.

B. OPERATING INSTRUCTIONS

CAUTION

Application of signal levels greater than those given in the SPECIFICATION section can result in damage to the counter. Insure that the input signal does not exceed the limitations listed in the specifications.

The X10 ATTENUATOR provides no protection for the counter input. Therefore, do not apply a signal to the input connector with a voltage level in excess of that specified, regardless of the attenuator setting. If necessary use an external attenuator between the source and the input. Insure that this attenuator not only reduces the signal at the counter input to a safe level, but that it is rated for the voltage level of the signal being measured.

It is possible to damage the counter by connecting a radio transmitter directly to the input. See "RF" Transmitter Frequency Measurement" in the APPLICATION NOTES section of this manual.

The input common of the counter is connected to earth ground through the power cord ground lead. A direct connection to a power line of the wrong polarity places the internal signal ground path directly across the power line. This will almost certainly damage the unit and could endanger the operator. It is recommended that a step down ISOLATION transformer (such as a 6.3 volt filament transformer) be used when attempting to measure power line frequency. If connecting directly to the power line, use only the input high lead (input cable center conductor). Leave the input common lead (input cable outer conductor) unconnected; signal return will be provided by the power cord ground wire.

The rear panel inputs respond to the TTL logic levels; do not apply more than 5 volts peak to these inputs.

If the level of the signal to be applied at any of the various inputs is in question, it is advisable to measure it before application. The operator is reminded to exercise care when working with high voltage signals.

NOTES

Standing waves present on the input transmission line can cause measurement errors. For this reason, when the input signal is at radio frequencies or consists of fast rise time pulses, it is necessary to terminate the transmission line in its characteristic impedance. Use a DC blocking capacitor if the resistive load would upset DC voltages in the source.

The counter input impedance is nominally 1 MΩ shunted by 20 pF. This is compatible with compensated high impedance attenuators such as 10:1 scope probes. When using a compensated probe, no line termination is necessary. Note, however, that the minimum input voltage required is multiplied ten times. Do not exceed the maximum voltage rating of the probe.

For more detailed application notes, see the APPLICATIONS section of the manual.

Power Up

When the counter is switched on, regardless of the function selected, it performs a brief internal check and then lights every segment of the display for approximately one second. Fig. 5 shows all segments of the display. The counter then begins to perform the selected function. If the unit fails to start, turn it off, make sure the time base select switch is set to INT and start again. The counter will not run in the EXT position without an external 10 MHz time base being connected to the EXT INPUT 10 MHz jack. Since the microprocessor is reset at power-up, all segments of the display are lit each time the unit is switched on.

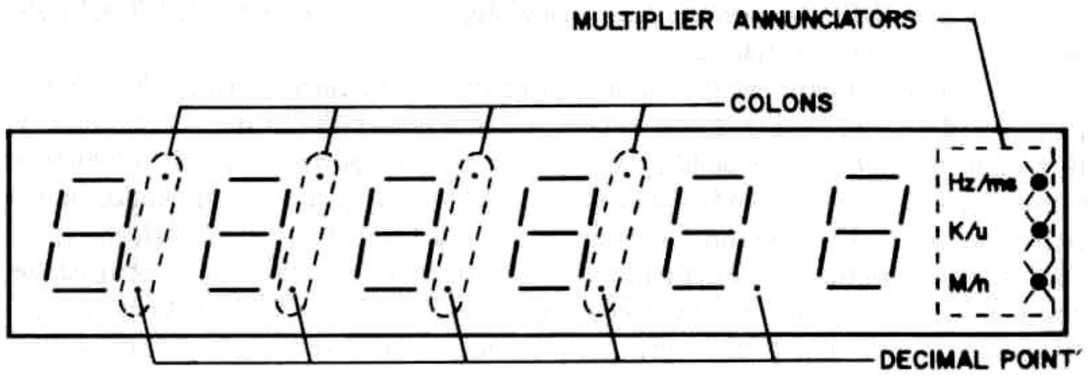

Fig. 5 Display

Frequency Measurements "Hz"

Operating in this mode, the unit performs a standard frequency measurement using a one second gate time.

1. Set the POWER switch to the ON position.
2. Set the FUNCTION switch to the "Hz" position.
3. If necessary set the ATTENuator to the X10 position and/or add an external attenuator.
4. Apply the signal to be measured to the input jack.
5. The input frequency is displayed with a resolution of 1 Hz. The display for an input frequency of 60 Hz is shown in Fig. 6. If the input frequency is greater than or equal to 1 MHz, the "M" annunciator is turned on indicating a display overflow. When an overflow occurs, the six least significant digits of the frequency are displayed. Fig. 7 shows the display for an input frequency of 10,038,725 Hz.

Fig. 6 Display for 60 Hz in "Hz" Function

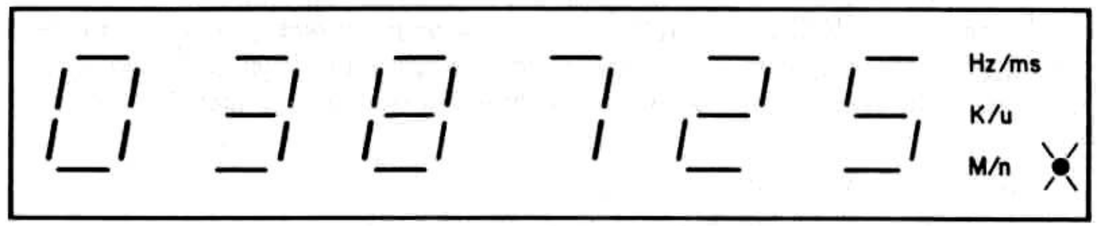

Fig. 7 Display for 10,038,725 Hz in "Hz" Function

Frequency Measurements AUTO FREQ

Operating in AUTO FREQ, the unit automatically measures the input frequency with six digit resolution. With no input or insufficient input level, the display is zero. The unit does not respond to input frequencies less than 2 Hz; zero is displayed.

1. Set POWER switch to the ON position.

2. Set the FUNCTION switch to AUTO FREQ.
3. If necessary set the ATTENuator to the X10 position and/or add an external attenuator.
4. Apply the signal to be measured to the input jack.
5. The six most significant digits of the input frequency are displayed with decimal point. The appropriate multiplier annunciator is turned on to indicate units of Hz, kHz or MHz. For an input frequency of 10,038,725 Hz the display would be as shown in Fig. 8. Referring to Figures 7 and 8, note that for frequencies above 1 MHz, the resolution can be extended to 1 Hz by switching to the "Hz" mode after finding the six most significant digits using the AUTO FREQ mode.

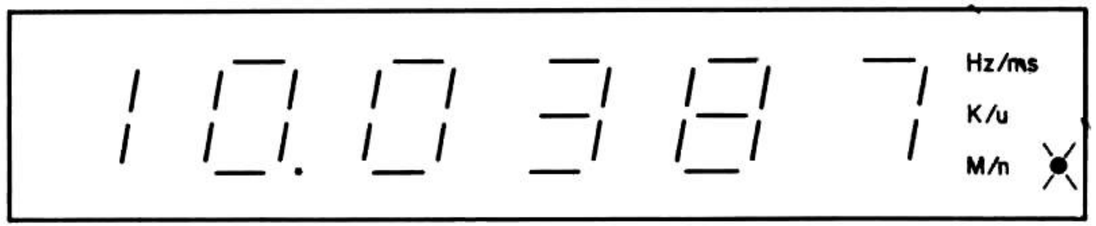

Fig. 8 Display for 10,038,725 Hz in AUTO FREQ Function

PERIOD Measurements

Using the PERIOD function, the input signal period is measured automatically with six digit resolution. With nó input or insufficient input level, a dashed line is displayed. This same display occurs when the input period is greater than 500 mS (i.e. frequency less than 2 Hz).

1. Set POWER switch to ON.
2. Set the FUNCTION switch to PERIOD.
3. If necessary set the ATTENuator to the X10 position and/or add an external attenuator.
4. Apply the signal to be measured to the input jack.
5. The six most significant digits of the input signal period, along with decimal point, are displayed in the same manner as the AUTO FREQ display. In this case, however, the multiplier annunciator indicates units of time - mS, μS or nS.

EVENTS Counting

In EVENTS set the ATTENuator to the X10 position for best operation.

1. Set POWER switch to ON.
2. Set FUNCTION switch to EVENTS.
3. The display is automatically set to zero when the FUNCTION switch is turned to EVENTS. It can be reset to zero at any time desired by depressing the RESET push button.
4. If necessary set the ATTENuator to the X10 position and/or add an external attenuator.
5. Apply the signal to be counted to the input jack. See application note "Events Counting" in the APPLICATIONS section.
6. The display will show the events accumulated up to a total of 999,999 and will update in a continuous fashion. At one million events the unit begins displaying the count in a floating format. The six most significant digits of the count are displayed with decimal point. The "M" annunciator is illuminated to indicate a display multiplier of one million. For example, after 10,038,725 events the display would look as shown in Fig. 9. At one billion events overflow is indicated by a dashed line across the display.
7. When the input source is interrupted, the display will show the events accumulated. The count can also be halted using the external gate control. See EXTERNAL GATE INPUT in the CONTROLS AND FEATURES section of this manual. If counting is resumed without resetting the display, future events will be added to the previous accumulation.

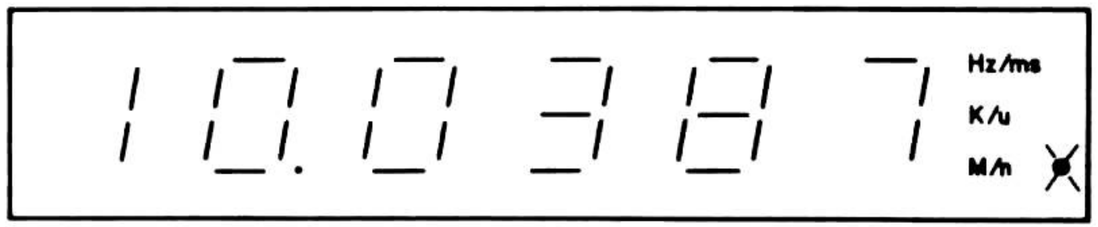

Fig. 9 Display for 10,038,725 Events

TIME Measurements

1. Set POWER switch to ON position.
2. Set FUNCTION switch to TIMER.

3. Beginning at zero, the unit will immediately start to display elapsed time in seconds with 100 μS resolution. At sixty seconds the unit begins displaying time in a floating format with units of hours, minutes and seconds as necessary. Hours, minutes and seconds digits are separated by colons; fractional seconds follow the decimal point. Fig. 10 shows the display after 63.125 seconds have elapsed. The unit displays this time as "1 min:3.125 sec." Note that as each leading digit is added, the least significant fractional second digit is dropped from the display, until finally the least significant digit is whole seconds. Fig. 11 shows the largest time displayed, "99 hrs:59 min:59 sec." Overflow is indicated at 100 hours by a dashed line across the display.

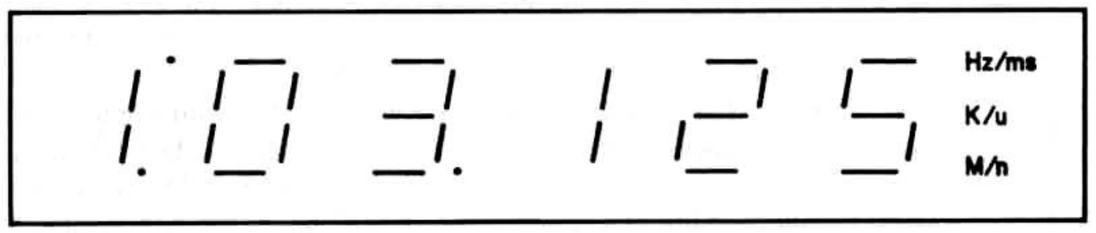

Fig. 10 Display After 63.125 Seconds

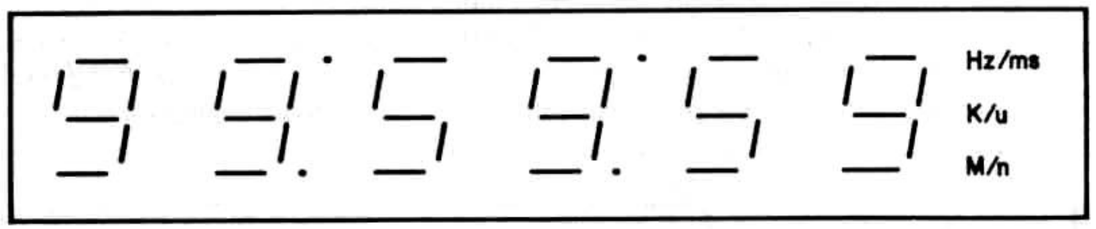

Fig. 11 Display After 99 hrs:59 min: 59 sec

4. The timer can be reset at any time by depressing the RESET push button.
5. The time accumulation can be halted by using the external gate control. See EXTERNAL GATE INPUT in the CONTROLS AND FEATURES section of the manual. If timing is resumed without resetting the display, the display will continue from the previous result. That is, the TIMER measures the total time that the gate is open.
6. The front panel input is not used with the TIMER function.

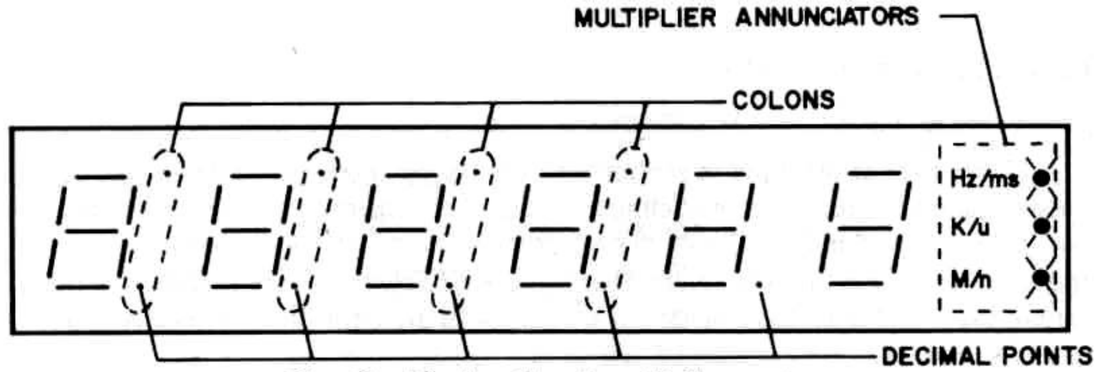

Fig. 12 Display Showing All Segments

TEST Function

Operating in this mode, the microcomputer board circuitry is tested to give the operator some assurance that the control and display sections of the unit are functioning properly. When the FUNCTION switch is rotated to TEST, while POWER is on, the unit immediately begins the test sequence. If the unit is turned on with the FUNCTION switch in the TEST position, the unit performs the POWER UP test prior to the following sequence.

1. The first test is a thorough check of the display. The following steps are displayed, in order, for about 1.5 seconds each. Refer to Fig. 12.
   a. All six digits set to zero, 1st colon on.
   b. Digits set to one, 2nd colon on, "M/n" annunciator on.
   c. Digits set to two, 3rd colon on, "K/μ" on.
   d. Digits set to three, 4th colon on, "M/n" and "K/μ" on.
   e. Digits set to four, 5th decimal point on, "Hz/mS" on.
   f. Digits set to five, 1st colon on, "Hz/mS" and "M/n" on.
   g. Digits set to six, 2nd colon on, "Hz/mS" and "K/μ" on.
   h. Digits set to seven, 3rd colon on, all three annunciators on.
   i. Digits set to eight, 4th colon on.
   j. Digits set to nine, 5th decimal point on.
2. Next, a dashed line is displayed and the "M/n" annunciator is illuminated. A check-sum test is then performed on the program memory.
3. After completing the previous test, "M/n" is turned off and "K/μ" is turned on. A test of the read/write memory (RAM) is then made.
4. Following the RAM test, the "K/μ" annunciator is extinguished, "Hz/mS" is turned on, and a second RAM test is made.
5. When "Hz/mS" goes off (after about ten seconds), the test sequence is complete. The unit then waits until one of the other functions is chosen.

C. APPLICATION NOTES

Measurement Uncertainty Due To Noise

If the noise at the input is greater than the trigger level, an excessive number of pulses will be output from the Schmitt trigger. The trigger level, referred to the input, is typically 15 mV peak with the ATTENuator set to X1 and 150 mV peak with the ATTENuator set to X10. Note, that if the ATTENuator is set to X10 for a noisy signal, the signal must have sufficient amplitude to drive the input, typically 150 mV peak.

Even when the noise level is less than the trigger level, measurement uncertainty still exists, particularly at low frequencies.

For frequencies below 1 MHz, the counter measures period regardless of whether AUTO FREQ or PERIOD is selected. In this case measurement uncertainty is given approximately by the following:

$$\% \text{ UNC} = \frac{100\%}{\pi n(S/N)}$$

S/N is the signal-to-noise ratio and n is the number of periods measured. The values of n for various frequencies are given in the THEORY OF OPERATION section. Even with a noise-free signal, there is a minimun uncertainty due to internal noise, typically 5 mVpp referred to the input. For example, the minimum uncertainty for a sinewave input of 200 Hz (100 periods measured) with an amplitude of 100 mVrms (282 mVpp) is:

$$\% \text{ UNC} = \frac{100\%}{\pi \times 100 \times 282/5} = 0.0056\%$$

When measuring low frequency signals that are low in noise, the uncertainty of the measurement is reduced if the ATTENuator is set to X1. This improves the signal-to-noise ratio at the Schmitt trigger input.

One method for reducing external noise is filtering. A simple low pass filter can be made by putting a resistor in series with the input cable. The capacitance from this point to ground is about 100 pF. A 10 kΩ resistor, then, would attenuate frequencies above 150 kHz. If the resistor value is made large, increased signal drive is necessary.

Pulse Measurement

Though the counter is specified for sinewave inputs, it does respond to pulses with the following characteristics:

Minimum amplitude	100 mVpp
Maximum rise time	100 mS
Minimum pulse width	10 nS

If pulses occur periodically, this period or the frequency of occurrence can be measured using the period or frequency measuring functions. Note, however, that the unit does not respond to frequencies below 2 Hz in the PERIOD and AUTO FREQ modes of operation.

A problem encountered with pulse inputs is that of ringing on the input cable. This causes extra counts. If the cable is terminated in its characteristic impedance, the ringing is greatly reduced. Also useful for this purpose is a resistor on the order of 100 Ω in series with the cable at its input. A high impedance compensated probe can be used to measure pulses and requires no termination.

EVENTS Counting

The EVENTS function is specified to count input frequencies in the range of 5 Hz to 80 MHz, sinewave. The low frequency limitation is due to the input circuit and is not a lower bound for the event counter itself. There is no lower limit on the rate at which pulses can be accumulated, provided the pulse parameters are within the limitations outlined in the application note "Pulse Measurement." The events do not have to occur periodically.

TIME Measurement

When operating in the TIMER mode, the accumulation can be halted using the EXTERNAL GATE INPUT. When using switches or relays to control the timed interval, the contacts should be "debounced." Fig. 13 shows two examples of "timers" using TTL logic circuits to debounce the switch contacts.

Pulse widths (time duration) can be measured using the TIMER mode. If the pulse is positive going and compatible with TTL logic levels, it can be applied directly to the EXTERNAL GATE INPUT. Make sure the display is reset to zero prior to the occurrence of the pulse. The time duration will be displayed directly.

OPERATION (Continued)

The maximum resolution in the TIMER mode is 100 μS. For narrow pulses the duration can be determined with increased resolution using the EVENTS function.

1. Apply the pulse to the EXTERNAL GATE INPUT as above.
2. Connect the front panel input to a reasonably stable high frequency source, f.
3. If the frequency of this source is not known accurately, measure it using the AUTO FREQ function.
4. Set the FUNCTION SWITCH to EVENTS. The unit will accumulate the input signal for a time equal to the duration of the pulse, T. Make sure the display is reset to zero prior to the occurrence of the pulse. The value displayed is the number of input signal periods, N, during the time, T.
5. The measurement resolution is: 1/f.
6. The pulse duration is: T = N/f.
7. The measurement accuracy is: ± accuracy of f ± trigger error ± 1 LSD. The uncertainty of f, if measured by the Model 7000, is less than 10 ppm. The trigger error is on the order of 10 nS.

The 10 MHz time base output on the rear panel of units with the TCXO option is ideal as a source for the front panel input. It is accurate and provides a measurement with 100 ns resolution.

The measurements above assumed a single pulse. If measurements are made on a train of pulses, the display must be reset before each rising edge or the display will sum the pulse "on" times. This is not possible for high repetition rates. In this case the circuit of Fig. 14 can be used. It applies one pulse from the train to the EXTERNAL GATE INPUT each time the TRIGGER push button is depressed. This allows time to read and reset the display. The TRIGGER button should be held down for a time at least equal to the pulse width to insure triggering. The input of this circuit responds to TTL levels.

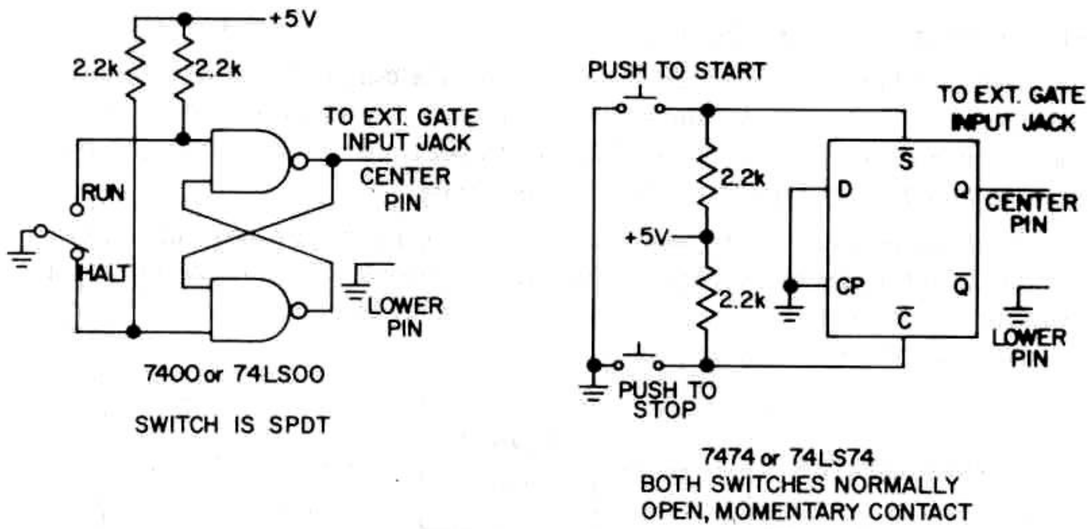

Fig. 13 Debounce Circuits for TIMER or EVENTS

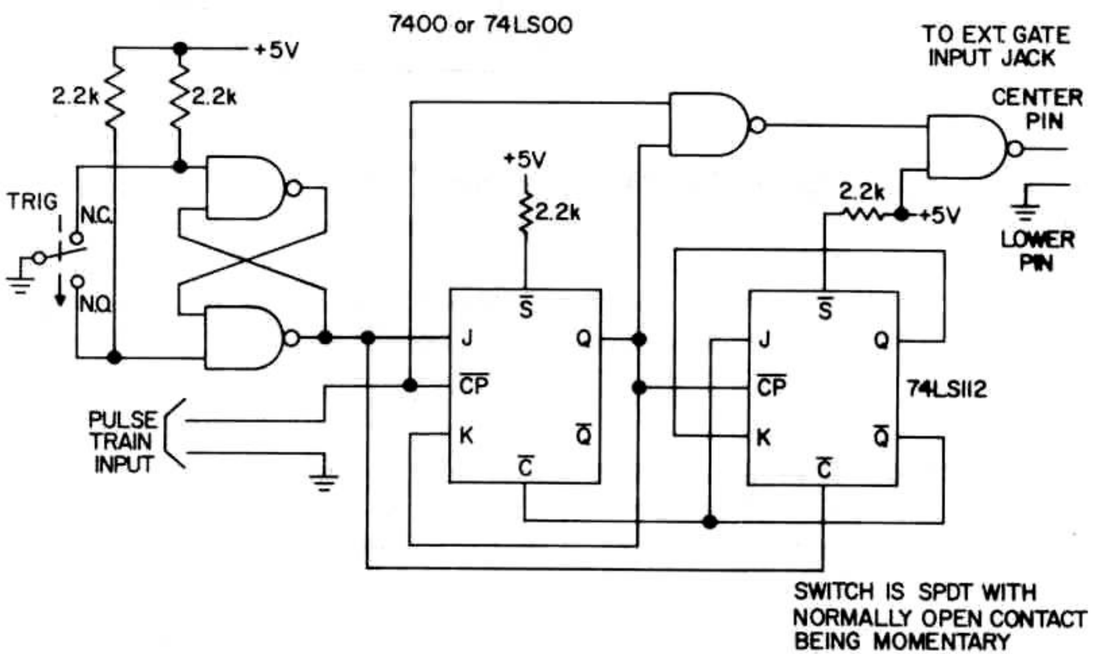

Fig. 14 Signal Pulse Sychronizer

RF Transmitter Frequency Measurement

Shown in Fig. 15 is a method for monitoring the output frequency of transmitters rated at less than 100 W. The load is a non-inductive resistance of 50 Ω; the load must be able to dissipate the power delivered by the transmitter. The signal tap protects the counter input against excessive signal level.

The transmitter should be unmodulated while measuring its frequency. If heavily modulated the carrier level approaches zero at various points in time and at these times may be less than the trigger level of the counter. The result is an unstable and inaccurate display of the frequency.

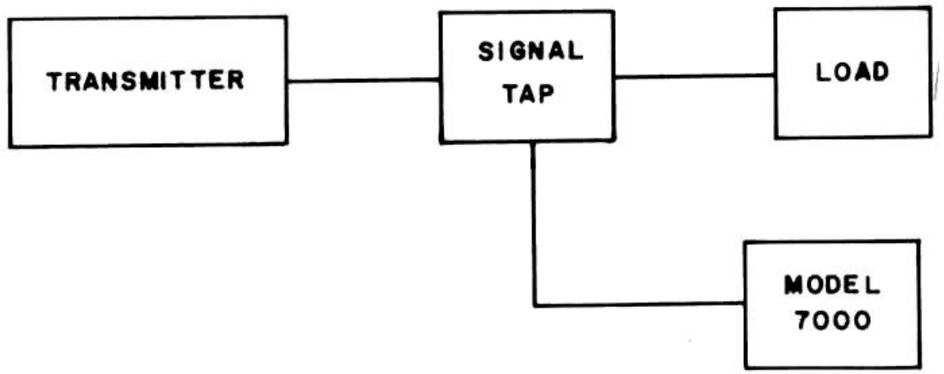

Fig. 15 Transmitter Frequency Measurement

A. CIRCUIT DESCRIPTION

Fig. 16 is a block diagram of the Model 7000. The following description of the circuit refers to this drawing.

Input Circuit

This circuit contains a high impedance buffer to prevent the following stages from loading the source. Preceding the buffer is a clipping circuit which limits the signal to 1.4 Vpp.

Attenuator

Depending on the front panel ATTENuator switch position, the signal from the buffer or 1/10 of this signal is applied to the following block.

Schmitt Trigger

The signal from the attenuator is amplified and then applied to the Schmitt trigger, which converts it to fast risetime pulses.

Steering Circuit

The steering circuit, under control of the microprocessor, applies the input signal and various timing signals to the proper points so that the selected function can be performed.

Accumulator

This is the main counting unit in the instrument. Counting is done in binary by sixteen flip flops. Overflows from this counter are latched for detection by the microprocessor. The processor accumulates the number of overflows in two 8 bit registers. This makes the accumulator effectively 32 bits so that it has a capacity of approximately 4.3 billion. The accumulator can be read by and is under control of the processor.

Gate Generator

This circuit is a programmable divider under control of the processor. Upon command from the processor, it enables the accumulator. After the prescribed number of pulses, input signal or timing, it stops the accumulator.

Time Base Generator

This circuit, Q107, is a crystal controlled oscillator which produces the 10 MHz required for system timing. For the optional TCXO unit, the circuit is replaced by a highly stable and accurate temperature compensated crystal oscillator.

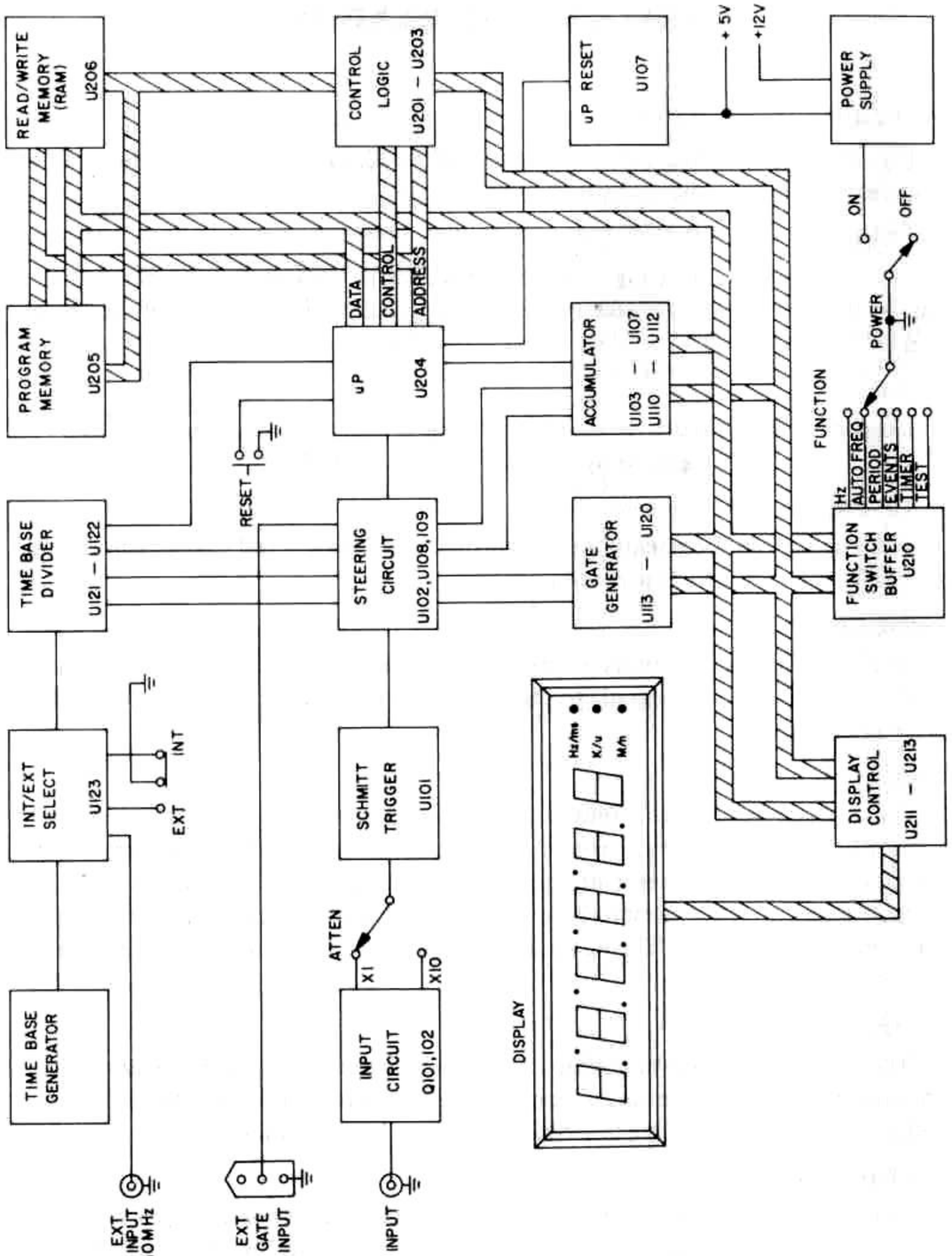

Fig. 16 Model 7000 Block Drawing

THEORY OF OPERATION (Continued)

Int/Ext Select Switch

A BNC connector on the rear panel allows the Model 7000 to be operated with an external 10 MHz time base. This circuit, under control of the rear panel switch, selects between the external source and the internal oscillator.

Time Base Divider

The time base divider derives from the 10 MHz time base the various timing frequencies needed by the unit. These frequencies and their uses are listed below.

10 MHz = time reference for period measurements.
1 MHz = microprocessor clock.
100 kHz = time reference for generation of 0.1 and 1.0 sec gates.
10 kHz = time reference for TIMER function.

Microprocessor (μP)

This integrated circuit is the central processing unit for the computer which controls all counter operations.

Program Memory

This read-only memory contains the instruction set which the processor executes.

Read/Write Memory (RAM)

This memory is used for temporary storage of data.

Control Logic

Signals from the processor control bus and address bus are decoded so that it can control the various external devices.

Microprocessor Reset

Part of U107 is utilized to generate a reset pulse for the processor when the unit is turned on. This starts the processor at the beginning of the program.

Function Switch Buffer

This buffer provides a means by which the processor can determine which set of operations to perform.

Display Control

The display contains six multiplexed digits. U211 is an integrated circuit display controller which continuously supplies segment and digit strobes to the display based upon output from the processor. U213 buffers the digit strobes from the display controller. U212 drives the colons and multiplier annunciators.

B. CIRCUIT OPERATION

Hz Function

Operating in the "Hz" mode, the unit makes a normal frequency measurement:

1. The gate generator supplies a 1 S gate to the accumulator.
2. During this time input pulses are counted in the accumulator.
3. The six least significant digits of the count are displayed.

AUTO FREQ/PERIOD Functions

Except for the output to the display, the operation for both of these functions is the same. The type of measurement made, period or frequency, depends on the input frequency, not the function selected.

1. The input is accumulated for 0.1 S to roughly determine its frequency. The next action is shown in the following table:

Input Frequency	Action
Less than 10 Hz	Measure 1 period
10 to 100 Hz	Measure 10 periods
100 to 1 kHz	Measure 100 periods
1 k to 10 kHz	Measure 1,000 periods
10 k to 100 kHz	Measure 10,000 periods
100 k to 1 MHz	Measure 100,000 periods
Greater than 1 MHz	Measure frequency

2. Frequency measurements are made the same way as in the "Hz" mode. However, the six most significant digits of the accumulation are displayed if AUTO FREQ is selected. If PERIOD is selected, the processor calculates 1/f and displays the period.
3. For period measurements the input is connected to the gate generator which enables the accumulator for a fixed number of input periods. During this time the accumulator counts the time base. The time for one period is calculated and displayed when PERIOD is selected. When AUTO FREQ is selected, the processor calculates 1/T and displays the frequency.

EVENTS Function

1. The accumulator gate is connected to the rear panel EXTERNAL GATE INPUT. This is wired such that the gate is held open unless this input is pulled low.

2. The input signal is applied to the accumulator input.
3. The accumulator contents are read periodically by the processor and output to the display controller.
4. After one million counts are accumulated, the processor outputs only the six most significant digits to the display.
5. The reset push button causes a processor interrupt at which time a subroutine that clears the accumulator and the display is executed.

TIMER Function

1. The accumulator gate is connected to the rear panel EXTERNAL GATE INPUT. This is wired such that the gate is held open unless this input is pulled low.
2. 10 kHz from the time base divider is applied to the accumulator input.
3. The accumulator contents are read periodically by the processor with each count representing 100 μs.
4. The processor calculates the elapsed time in hours, minutes and seconds and then outputs the six most significant digits to the display controller.
5. The reset push button causes a processor interrupt at which time a subroutine that clears the accumulator and the display is executed.

RECALIBRATION AND MAINTENANCE

Calibration, repair and modification of the unit should not be attempted by other than qualified personnel.

The Model 7000 was checked and calibrated at the factory. The only adjustment in the unit is the time base frequency trimmer, C123. This trimmer is located at the right rear of the lower PC board and is accessible through a hole in the rear panel. The hole is covered at the factory by a calibration label.

A. CALIBRATION

To calibrate the time base oscillator it is necessary to have a frequency standard of 10 MHz ± 0.1 Hz if the time base is to be set within 1 Hz of 10 MHz. If the standard used is less accurate or at a lower frequency, the resulting calibration uncertainty will be larger than 1 Hz.

1. Allow the unit to warm-up for 1 hour before making the adjustment. If possible, calibrate the unit in an environment at the same temperature as that in which it will be used. Do not calibrate the unit outside its case.
2. Connect the frequency standard to the front panel input.
3. Set the FUNCTION switch to AUTO FREQ. The display should indicate 10 MHz, or the standard frequency being used. If the source waveform is pulses, multiple counting could occur. See the APPLICATIONS note "Pulse Measurement" if the display does not read very close to the calibrating standard frequency.
4. Change the FUNCTION switch to "Hz."
5. Remove the calibration label.
6. With a non-metallic alignment tool, adjust C123 (through the hole in the panel) until the display is zero ± 1 count. This assumes that the standard frequency used is 10 MHz. If some other frequency is used, the display should indicate the six least significant digits of that frequency ± 1 count.

B. REMOVING CASE TOP

To remove case top, proceed as follows:

1. Unplug unit power cord.
2. Adjust the case handle so that it points toward the front.
3. Turn the unit over and remove the four screws holding the feet on.
4. Holding the unit together, turn back over, top side up.

5. Holding the sides in position, pull the top straight up.
6. To replace top, repeat the above procedure in reverse. Make sure the front and rear panels are lined-up with their respective slots.

C. BASIC TROUBLE SHOOTING

Should the Model 7000 fail to function, check the following before assuming there is a defective component:

1. Make sure the unit is plugged into a live AC outlet.
2. Make sure the unit is turned on.
3. Make sure the fuse is not open. To replace fuse, remove the case top (see procedure "B" above). The fuse is on the lower PC board in the left rear corner. Replace with the same type fuse.
4. Make sure the line cord has continuity.
5. Make sure the time base select switch (INT/EXT) is in the INT position if not using an external time base.

D. MODIFICATION FOR CARRYING CASE

The case feet must be removed before the unit can be inserted into its optional carrying case.

1. Unplug unit power cord.
2. Adjust case handle so that it points toward the front.
3. Turn the unit over so that it rests on its top.
4. Remove one of the screws that hold the feet in place. Remove the foot and replace the screw. Repeat for the other three feet.

E. 240 VOLT LINE OPERATION

The Model 7000 is factory wired for 120 V, 50/60 Hz AC line input. To convert to 240 V 50/60 Hz operation, proceed as follows:

1. Remove case top. See procedure "B" in this section.
2. The case sides can now be removed. Lift both sides off together (they are connected by the handle).
3. Wiring modifications must be made to the lower PC board. On the left edge, mid-way are two jumper wires. Each of these connects the center hole to the hole marked "120." See PC board 100 layout drawing on the printed insert.

4. Remove each wire and replace it from the center hole to the hole marked "240."
5. Replace the ¼ Amp Type 3AG slo-blo fuse with a ⅛ Amp Type 3AG slo-blo fuse.
6. Reassemble in the reverse order. Make sure that the front and rear panels fit into their alignment slots.
7. Connect the proper plug to match the intended outlet after the U. S.-Style plug has been removed.

   Black - To Unit Fuse
   White - Return
   Green - Chassis, Safety Ground

F. REMOTE RESET

Provision has been made on the printed circuit boards for adding remote reset. The unit is reset by a TTL logic "0" or contact closure to ground at this input when operating in the EVENTS or TIMER mode. Counting will resume from zero when the input is opened or raised to TTL logic "1", provided the gate is open. See EXTERNAL GATE INPUT in the CONTROLS AND FEATURES section. Maximum input is 5 V peak. The input is added at the top of the EXTERNAL GATE INPUT connector, item 9 on Fig. 4. A kit for this conversion is available; order Triplett Part No. 12458. Installation is as follows:

1. Remove case top (Procedure "B", RECALIBRATION and MAINTENANCE section of manual).
2. Slide the case sides off; pull both sides straight up together.
3. Insert the connector socket into the EXTERNAL GATE INPUT connector (top hole) from the inside of the case. It should snap into position so that it cannot be pulled back out.
4. Solder the wire that is crimped to the socket to the pad marked "ERS" on PC board 100. This pad is just below the connector.
5. Two parts must be soldered to PC board 200 (the upper board), a 100 Ω resistor and a zener diode 1N4732A. Locate the positions of these parts, R201 and D201, on the layout drawing for PC board 200. They are in the corner by the reset switch. A zener diode symbol marks the position of that part. Note that the board is mounted in the unit component side down. The parts can easily be soldered to the upper (solder) side of the board, so that the board does not have to be removed.
6. Put the case back together in the reverse order that it was disassembled, making sure the panels are aligned in their slots.

The Triplett Corporation warrants instruments and test equipment manufactured by it to be free from defective material or factory workmanship and agrees to repair or replace such products which, under normal use and service, disclose the defect to be the fault of our manufacturing, with no charge for parts and service. If we are unable to repair or replace the product, we will make a refund of the purchase price. Consult the Instruction Manual for instructions regarding the proper use and servicing of instruments and test equipment. Our obligation under this warranty is limited to repairing, replacing or making refund on any instrument or test equipment which proves to be defective within one year from the date of the original purchase.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons in any way so as, in our sole judgment, to injure their stability or reliability, or which have been subject to misuse, abuse, misapplication, negligence or accident or which have had the serial numbers altered, defaced, or removed. Accessories, including batteries, not of our manufacture used with this product are not covered by this warranty.

To register a claim under the provisions of this warranty, return the instrument or test equipment to Triplett Corporation, Bluffton, Ohio 45817, transportation prepaid. Upon our inspection of the product, we will advise you as to the disposition of your claim.

ALL WARRANTIES IMPLIED BY LAW ARE HEREBY LIMITED TO A PERIOD OF ONE YEAR, AND THE PROVISIONS OF THE WARRANTY ARE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES EXPRESSED OR IMPLIED.

The purchaser agrees to assume all liability for any damages and bodily injury which may result from the use or misuse of the product by the purchaser, his employees, or others, and the remedies provided for in this warranty are expressly in lieu of any other liability Triplett Corporation may have, including incidental or consequential damages.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. No representative of Triplett Corporation or any other person is authorized to extend the liability of Triplett Corporation in connection with the sale of its products beyond the terms hereof.

LIMITED WARRANTY (Continued)

Triplett Corporation reserves the right to discontinue models at any time, or change specifications, price or design, without notice and without incurring any obligation.

This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

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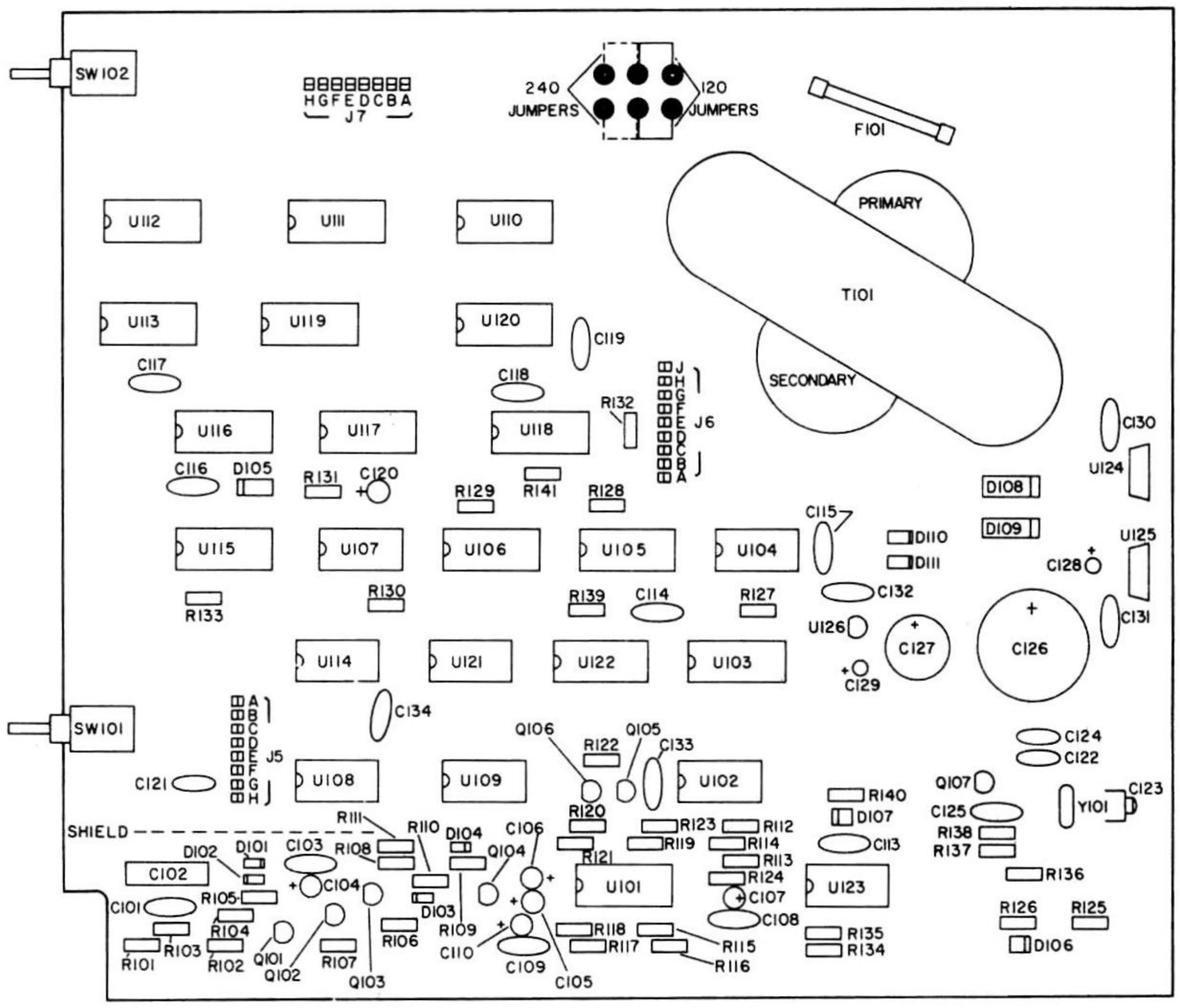
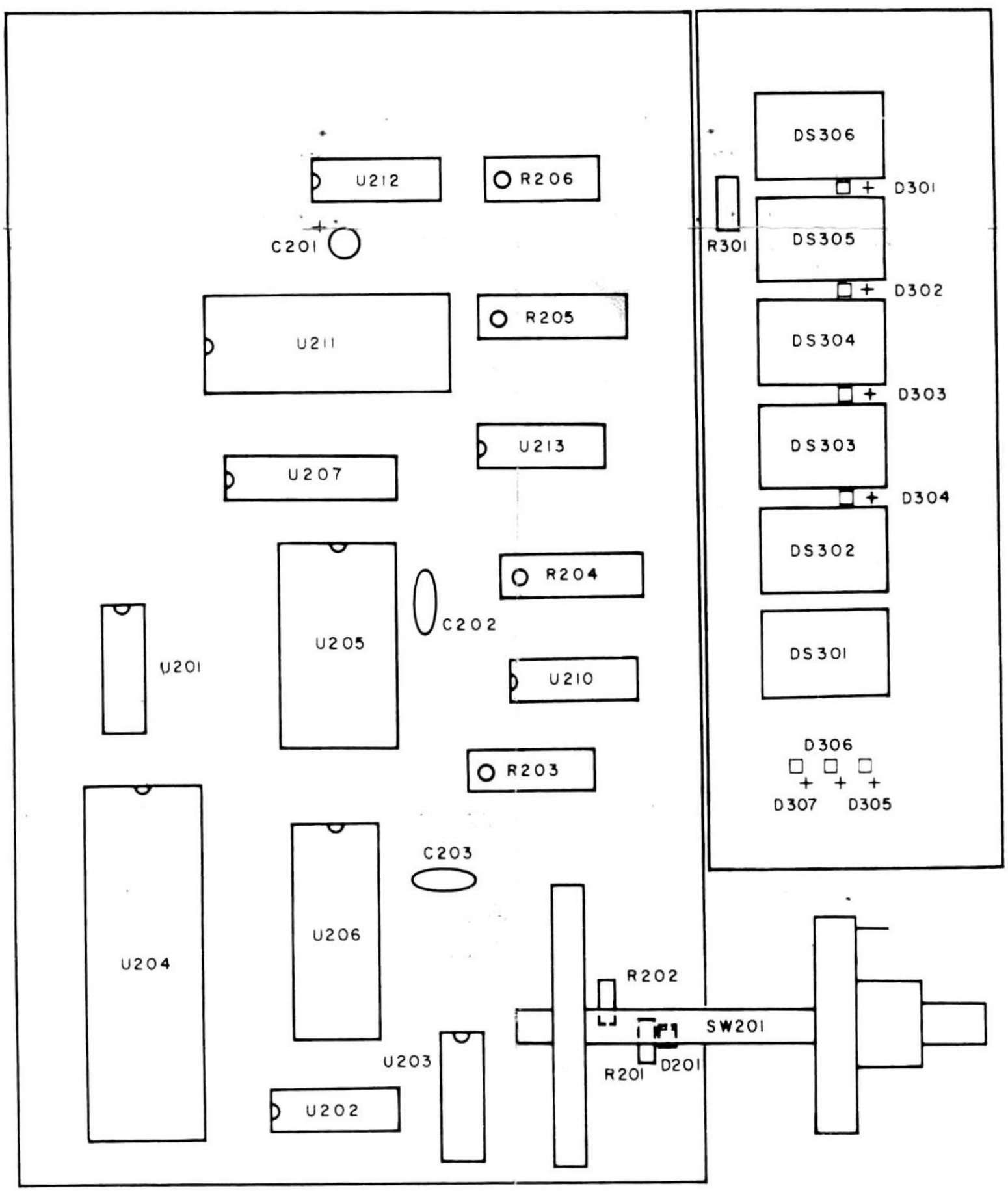
Bluffton, Ohio 45817

Printed in U.S.A.

Part No. 84-345A



Component Layout P.C. Board 100



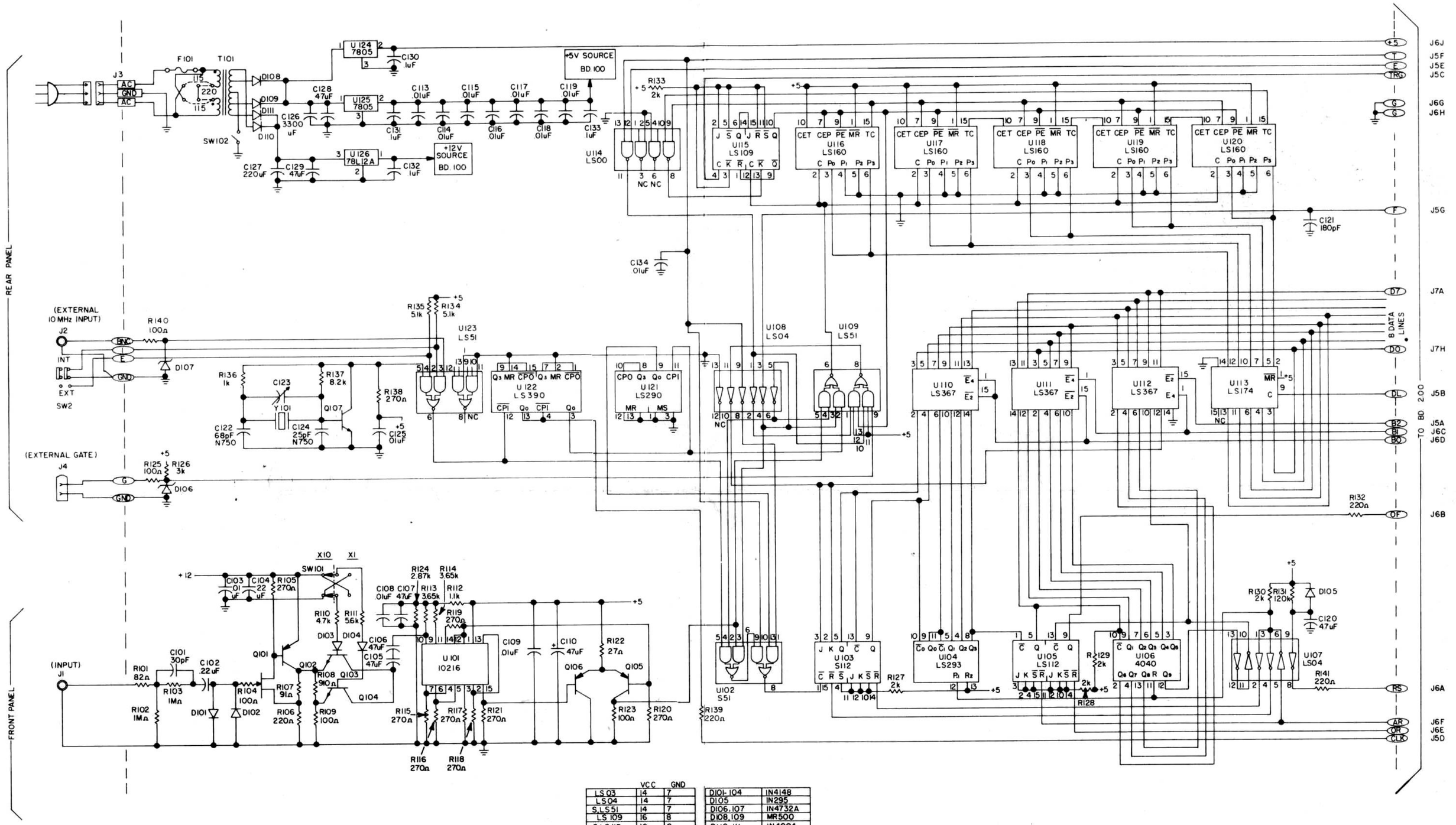
Component Layout P.C. Boards 200 and 300

MODEL 7000
UNIVERSAL COUNTER
Part No. 84-353A

REPLACEABLE PARTS MODEL 7000

Ref. No.	Description	Part No.
C101	Capacitor, 30 pF NPO Disk	43-489
C102	Capacitor, .22 μF 250V Polyester	43-492
C103, 108, 109, 113, 114, 115, 116, 117, 118, 119, 125, 134	Capacitor, .01 μF Disk	43-363
C104	Capacitor, 22 μF 15V Tant.	43-411
C105, 106, 107, 110, 201	Capacitor, 47 μF 6V Tant.	43-399
C120	Capacitor, 4.7 μF 35V Tant.	43-418
C121	Capacitor, 180 pF Disk	43-383
C122	Capacitor, 50 pF N750 Disk	43-508
C123	Capacitor, Trimmer 2.5-20 pF	43-495
C124	Capacitor, 25 pF N750 Disk	43-490
C126	Capacitor, 3300 μF 16V Electrolytic	43-491
C127	Capacitor 220 μF Electrolytic	43-494
C128, 129	Capacitor, .47 μF 35V Tant.	43-386
C130, 131, 133, 202, 203	Capacitor, .1 μF Disk	43-324
C132	Capacitor, .1 μF Disk	43-493
D101, 102, 103, 104	Diode, 1N4148	127-114
D105	Diode, 1N295	11056
D106, 107	Diode, 1N4732A	127-133
D108, 109	Diode, MR500, 3 Amp	127-130
D110, 111	Diode, 1N4004	127-93
D301, 302, 303, 304, 305, 306, 307	Diode, Light Emitting 5082-4160	127-137
DS301, 302, 303, 304, 305, 306	Diode, Light Emitting 5082-7653	127-131
F101	Fuse, ¼ Amp, 3AG, Slo blo	3207-40
*F101	Fuse, ⅛ Amp, 3AG, Slo blo	3207-38
J1, 2	Connector, BNC	2455-361
J3	Socket, Rear Panel	2455-350
J4	Socket, Rear Panel	2455-359
J5, 7	Ribbon Cable, 8 Conductor	26-593
J6	Ribbon Cable, 9 Conductor	26-594
Q101	FET, 2N5950	127-136
Q102, 105, 106	Transistor, PNP, MPS 3640	127-134
Q103, 104, 107	Transistor, NPN, MPS 2369	127-135
R101	Resistor, 82Ω ¼W 5% Carbon	15R-820JB
R102, 103	Resistor, 1 MΩ ¼W 5% Carbon	15R-105JB
R104, 109, 123, 125, 142	Resistor, 100Ω ¼W 5% Carbon	15R-101JB
R105, 115, 116, 117, 118, 119, 120, 121, 138	Resistor, 270Ω ¼W 5% Carbon	15R-271JB
R106, 132, 139, 141	Resistor, 220Ω ¼W 5% Carbon	15R-221JB
R107	Resistor, 91Ω ¼W 5% Carbon	15R-910JB
R108	Resistor, 910Ω ¼W 5% Carbon	15R-911JB
R110	Resistor, 4.7kΩ ¼W 5% Carbon	15R-472JB
R111	Resistor, 5.6kΩ ¼W 5% Carbon	15-562JB
R112	Resistor, 1.1kΩ 1% Metal Film	15K-1101TA3
R113, 114	Resistor, 3.65kΩ 1% Metal Film	15K-3651TA3
R122	Resistor, 27Ω ¼W 5% Carbon	15R-270JB
R124	Resistor, 2.87kΩ 1% Metal Film	15K-2871TA3
R126, 202	Resistor, 3kΩ ¼W 5% Carbon	15R-302JB
R127, 128, 129, 130, 133	Resistor, 2kΩ ¼W 5% Carbon	15R-202JB
R131	Resistor, 120kΩ ¼W 5% Carbon	15R-124JB
R134, 135	Resistor, 5.1kΩ ¼W 5% Carbon	15-512JB
R136	Resistor 1kΩ ¼ W 5% Carbon	15R-102JB
R137	Resistor, 8.2kΩ ¼W 5% Carbon	15R-822JB
R203	Resistor Network, 5.1kΩ, 7 Resistors	15-5776
R204	Resistor Network, 5.1kΩ, 8 Resistors	15-5777
R205	Resistor Network, 33Ω, 8 Resistors	15-5779
R206	Resistor Network, 1kΩ, 7 Resistors	15-5778
R301	Resistor, 120Ω ¼W 5% Carbon	15R-121JB
SW1	Switch, Pushbutton	22-727
SW2	Switch, Slide	22-152
SW101	Toggle Switch, Double Pole	22-729
SW102	Toggle Switch, Single Pole	22-728
SW201	Switch, Rotary	22-730
T101	Transformer	23-222
U101	I. C. 10216	126-97
U102	I. C. 74S51	126-86
U103	I. C. 74S112	126-95
U104	I. C. 74LS293	126-85
U105	I. C. 74LS112	126-89
U106	I. C. 4040B	126-96
U107, 108	I. C. 74LS04	126-81
U109, 123	I. C. 74LS51	126-83
U110, 111, 112, 210	I. C. 74LS367	126-93
U113, 212	I. C. 74LS174	126-92
U114, 203	I. C. 74LS00	126-80
U115	I. C. 74LS109	126-88
U116, 117, 118, 119, 120	I. C. 74LS160	126-91
U121	I. C. 74LS290	126-84
U122	I. C. 74LS390	126-94
U124, 125	I. C. 7805	126-106
U126	I. C. 78L12A	126-110
U201	I. C. 74LS138	126-90
U202	I. C. 74LS32	126-82
U204	I. C. 2650A	126-101
U205	I. C. ROM 2616	126-105
U206	I. C. RAM 6810	126-99
U207	I. C. 74LS245	126-98
U211	I. C. 74C912	126-100
U213	I. C. 75492	126-87
Y101	Crystal, 10 MHz	12453
	Bezel, Molded	10-3007
	Bushing	39-127
	Case Bottom	10-2991
	Case Side	10-2993
	Case Top	10-2992
	Handle, Case Model 7000	3206-61
	Knob, Rotary Switch	34-190
	Lead Assembly, Model 7000	79-481
	Lead Assembly, Rear Panel	79-475
	Line Cord	2566-56
	Manual, Instruction	84-345
	Plug, Cap	2455-346
	Ribbon Cable, 21 Conductor	26-595
	Spring, Handle	42-303
	Washer, Shouldered Insul.	14-303
	Window, Bezel	19-252

*F101 For 240V Units Only



	VCC	GND
LS03	14	7
LS04	14	7
S,LS51	14	7
LS109	16	8
S,LS112	16	8
LS160	16	8
LS293	14	7
LS367	16	8
LS390	16	8
LS174	16	8
4040	16	8
10216	16	8

D101-104	IN4148
D105	IN295
D106,107	IN4732A
D108,109	MR500
D110,111	IN4004
Q101	2N5950
Q102,105,106	MPS3640
Q103,104,107	MPS2369

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	+5	GND
LS00	14	7
LS 32	14	7
LS138	16	8
LS174	16	8
LS245	20	10
LS367	16	8
C912	20	15
75492	11	4
2616	24	12
2650	39	21
6810	24	1

U206 6810

U205 2616

U204 2650

U207 LS 245

J7H J7A

TO BD 100

8 DATA LINES

U212 LS 174

1k x 7 R206

BD200 BD300

U211 74C912

33Ω x 8 R205

D307 M/n

D306 kΩ

D305 HΩms

DS 301 (LSD)

DS 302

DS 303

DS 304

DS 305

DS 306 (MSD)

D304 COL4

D303 COL3

D302 COL2

D301 COL1

R301 120Ω

(FRONT PANEL)

RESET SW1

+5 SOURCE BD 200

R202 3k

C201 47uF

C202 .1uF

C203 1uF

J6J +5

J6G G

J6H G

J5D CLK

J6B OE

J5G T

J6A RS

J5C TRG

J6F AR

J6E OR

J6D B0

J6C B1

J5A B2

J5B DL

J5F T

J5E E

TO BD 100

U202 LS32

U201, LS138

PART OF R203

PART OF U202

U203 LS00

5.1k x 8 R 204

5.1k x 7 R 203

U210 LS 367

75492 U 213

X T E P F H

SW201