

5326A/5327A TIMER/COUNTER

OPERATING AND SERVICE MANUAL

SERIAL PREFIX:

5326A — 1136A

5327A — 1120A

This manual applies to HP Model 5326A having serial prefix 1136A and HP Model 5327A having serial prefix 1120A.

SERIAL PREFIXES NOT LISTED

For serial prefixes above 1136A (5326A) and 1120A (5327A), a "Manual Supplement" sheet is included with this manual. For serial prefixes below 1136A and 1120A, refer to Section VII of this manual.

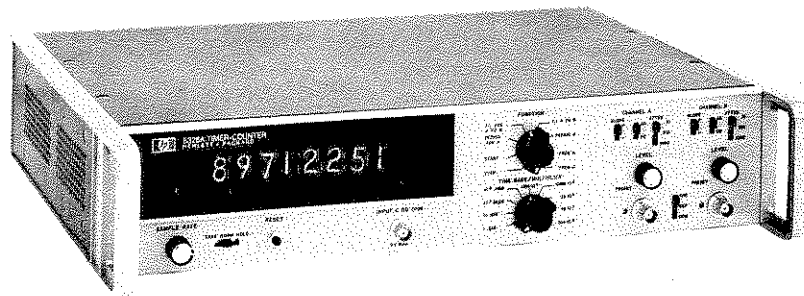
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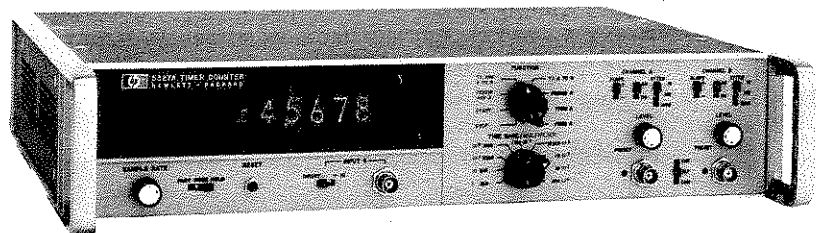
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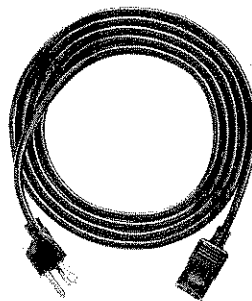
Figure 1-1. HP Model 5326A/5327A Timer/Counter



MODEL 5326A



MODEL 5327A



POWER CORD

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The Hewlett-Packard Models 5326A/5327A are frequency counters that have a variety of functions. The basic difference between the two models is the addition of the prescaler assembly in the 5327A. This assembly increases the upper frequency limit from 50 MHz to 550 MHz. The 5326A uses a high-sensitivity, 50-ohm input amplifier in place of the prescaler.

1-3. The instruments measure frequency, period, period average, time interval, time interval average, and ratio. Features include a 7-digit display (8-digits optional), 1M ohm and 50-ohm inputs, display storage, and blanking for insignificant digits in the display. Decimal point and unit readouts are displayed automatically with each operating selection. Two independent input channels are provided for time interval measurements. Each input channel has an attenuator, trigger slope selector, level control, ac-dc coupling, and an oscilloscope marker output. Table 1-1 lists the electrical and mechanical specifications.

1-4. IDENTIFICATION

1-5. Hewlett-Packard uses a two-section serial number mounted on the rear panel. Earlier instruments use an 8-digit serial number (000-00000). The first three digits are a serial prefix number; the last five digits refer to the specific instrument. Later instruments use a 9-digit serial number (0000A00000). The first four digits are the serial prefix and the last five digits refer to the specific instrument. If the serial prefix of your instrument differs from that listed on the title page of this manual, there are differences between this manual and your instrument. Lower serial prefixes are documented in Section VII, and higher serial prefixes are covered with manual change sheets included with the manual. If the change sheet is missing, contact the nearest Hewlett-Packard Sales and Service Office listed on the inside rear cover of this manual.

1-6. APPLICATIONS

1-7. The 5326A/5327A Counters are particularly adaptable to timing measurements such as pulse width, pulse repetition frequency, and propagation

delay. The time interval average mode measures time interval on repetitive signals with resolution better than one nanosecond. When used with microwave test systems, group delay, phase, and level measurements can be performed.

1-8. OPTIONS

1-9. The instrument can be ordered with the following options: Option 001, 8-digit display; Option 002, remote programming; Option 003, digital recorder outputs; and Option 004, remote programming for all signal input conditions.

Table 1-1. Equipment Supplied

Description	HP Part No.
Detachable Power Cord, 7½ ft. (231 cm) long	8120-1348
Rack Mounting Kit	05326-60029

Table 1-2. Accessories Available

Description	HP Part No.
Digital Recorders	5050B, 5055A
Interconnect Cable, Digital Recorder, 6 ft. (183 cm)	562A-16C
50-ohm BNC to BNC Coaxial Cable, 4 ft. (122 cm)	10503-6001
Circuit Board Extender, 15-pin (two required)	5060-0049
Input Amplifier Circuit Board Extender	10532-60001
Circuit Board Extender, 18-pin	5060-2041
Extender Board Kit; includes two 5060-0049, and one each 5060-2041, and 10532-60001	10532A

Table 1-3. Specifications

INPUT CHANNELS A AND B

Range:

dc coupled: 0-50 MHz
ac coupled: 20 Hz - 50 MHz

Sensitivity:

0.1 V rms sine wave
0.3 V p-p pulse
8 ns minimum pulse width
Sensitivity can be decreased by 10 or 100 times, using the ATTENUATOR switch.

Impedance: 1 M Ω shunted by less than 25 pF

Dynamic Input Voltage Range:

0.1 to 3 V rms ac times attenuator setting
 ± 5 Vdc times attenuator setting.

Trigger Level:

PRESET to center triggering about 0 V or variable over the range of -3 V to +3 V times attenuator setting. Trigger threshold band <1.0 mV, referred to input at maximum frequency.

Overload Protection:

250 V rms on all attenuator settings, except 25 V rms on X1 above 50 kHz.

Slope:

Independent selection of positive or negative slope.

Channel Inputs: Common or separate lines.

Marker Outputs:

Rear panel BNC's DTL pulse, low for approximately 2 μ s after trigger point for A and B channels.

INPUT CHANNEL C

5327A

Range:

direct: 1 kHz - 50 MHz, ac coupled
prescaled: 0-550 MHz, dc coupled

Sensitivity:

direct: 5 mV rms
prescaled: 100 mV rms

Impedance: 50 Ω nominal

Maximum input: 5 volts rms; 7.5 volts peak

Trigger Level: 0 volts

5326A

Range: 0 to 50 MHz, dc coupled

Sensitivity:

5 mV rms

Impedance: 50 Ω nominal

Maximum Input: 5 volts rms; 7.5 volts peak

Trigger Level: 0 volts

CAUTION

Do not exceed voltage specification or damage will occur.

START (Totalizing and Scaling)

Range: 0 - 10 MHz

Factor: 1 - 10⁸ selectable in decade steps

Output: Rear panel TIME BASE BNC

Display:

Channel A input divided by scaling factor

FREQUENCY

Range:

0 - 50 MHz (5326A)
0 - 550 MHz (5327A)

Input:

Channel A; channel C for direct and for prescaled (switchable). Channel A provides triggered frequency measurement

Gate Times: 0.1 μ s to 10 s in decade steps

Accuracy:

Direct: ± 1 count $\pm$ time base accuracy.
Prescaled: ± 10 counts* $\pm$ time base accuracy

Display:

kHz, MHz, or GHz with positioned decimal point

TIME INTERVAL

Range: 0.1 μ s to 10⁹ seconds

Input:

Channels A and B; can be common or separate

Frequency Counted:

10 MHz to 0.1 Hz in decade steps

Accuracy:

± 1 count $\pm$ time base accuracy $\pm$ trigger error.**

Display:

μ s, ms, seconds or 10's of seconds with positioned decimal point

TIME INTERVAL AVERAGE

Range: 0.15 ns to 10 s

Intervals Averaged:

1 - 10⁸ selectable in decade steps

* ± 10 counts of input frequency (± 1 count displayed).

Table 1-3. Specifications (Continued)

Input:
Channels A and B; can be common or separate

Frequency Counted: 10 MHz

Minimum Time Stop to Start: 150 ns

Accuracy: $\pm$ time base accuracy $\pm$ 2 ns

$$\pm \frac{(\text{trigger error}^{**} + 100 \text{ ns})}{\sqrt{\text{intervals averaged}}}$$

Display: ns, μ s with positioned decimal point

PERIOD

Range: 0 - 10 MHz

Input: Channel A

Frequency Counted:
10 MHz to 0.1 Hz in decade steps

Accuracy:
 ± 1 count $\pm$ time base accuracy $\pm$ trigger error.***

Display:
 μ s, ms, seconds or 10's of seconds with positioned decimal point

PERIOD AVERAGE

Range: 0 - 10 MHz

Periods Averaged: 1 - 10^8 selectable in decade steps.

Input: Channel A

Frequency Counted: 10 MHz

Accuracy:
 $\pm$ time base accuracy ± 1 count $\pm$ trigger error***

Display: ns, μ s, with positioned decimal point

RATIO

Display:
 F_A/F_{ext} or F_C/F_{ext} times MULTIPLIER (M).
M = 1 to 10^8 , selectable in decade steps

Range:
 F_A (Channel A or Channel C) 0 - 50 MHz
 F_{ext} (External Oscillator Input) 100 Hz to 10 MHz

Mode:
Operating mode will be either FREQUENCY A or FREQUENCY C

Accuracy:
 ± 1 count of $F_A \pm$ trigger error of F_{ext}

TIME BASE

Crystal Frequency: 10 MHz

Stability:

Aging Rate: <3 parts in 10^7 /mo.
Temperature: $\leq \pm 2.5$ parts in 10^6 , 0° to 50°C .
Line Voltage: $\leq \pm 1$ part in 10^7 for 10% line variation.
Short-term Fluctuation: Typically <5 parts in 10^9 , one-second average (at constant temperature)

Oscillator Output:
10 MHz, TTL type output levels, 50Ω series impedance at rear panel BNC

External Input: 100 Hz - 10 MHz; 1 V rms into $1k\Omega$

Time Base Output:
Negative pulses, +3 V to 0 V (open circuit), typically 100 ns wide. In START, output is 10 MHz divided by TIME BASE/MULTIPLIER switch setting. Available at rear panel BNC.

Gate Output:
TTL level pulses; low while gate open, high while gate closed. Available at rear panel BNC.

GENERAL

Display: 7 digits (8 optional)

Blanking:
Suppresses display of unwanted zeros left of the most significant digit

Display Storage:
Holds reading between samples. Rear panel switch overrides storage

**For any waveshape, trigger error is less than

$$\pm \frac{0.0025}{\text{Signal Slope (V}/\mu\text{s)}} \mu\text{s.}$$

***Trigger error is less than $\pm 0.3\%$ of one period $\pm$ periods averaged for signals with 40 dB or better signal-to-noise ratio and 100 mV rms amplitude.

Table 1-3. Specifications (Continued)

Sample Rate:

FAST position: Continuously variable from less than 100 μ s to approximately 20 ms. NORM position: Continuously variable from less than 20 ms to approximately 5 seconds. HOLD position: Display can be held indefinitely.

Overflow:

Neon indicates when display range is exceeded.

Operating Temperature: 0° to 50°C

Power Requirements:

115 or 230 volts $\pm$ 10%, 50 to 60 Hz, 70 watts maximum

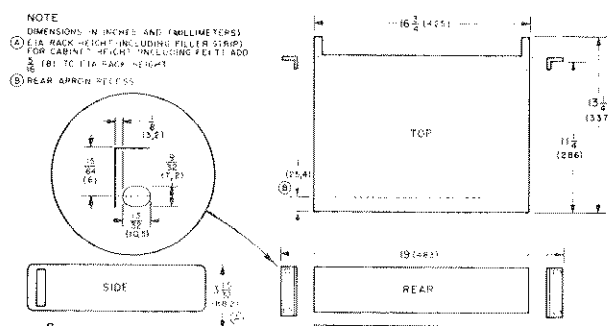
Weight:

Net, 16 lb.(7,4 kg). Shipping, 18 lb. 16 oz(8,7 kg)

Accessories Furnished:

Power Cord, 7½ ft. Rack Mount Kit.

DIMENSIONS



ACCESSORIES AVAILABLE

HP 10503A, 50 Ω BNC Cable, 4 ft (122 cm)

HP 10532A, Extender Board Kit containing 2 ea. 15-pin extender 5060-0049, 1 ea. 18-pin extender 5060-2041, and 1 ea. Amplifier Extender, 10532-60001

HP10542A, Remote Programming Interface enables interfacing between the 5326/5327 Series counter with Option 004 and 40-bit Output Register. Includes two (2) 7-bit Digital-to-Analog Converters for level controls and decoding for time base and function selector.

HP Cable 562A-16C, 6 ft. (183 cm) to connect 5326/5327 Series with Option 003 to HP 5050B or 5055A Digital Recorder

Option 001: 8-digit display

Option 002: Remote programming

Controls:

All front panel controls are single line programmable except:
SEP-COM (separate-common) switch; the check function is programmable

FAST/NORM Mode

Input Attenuators

AC/DC Input Signal Coupling

Control Signal:

Single line control using either contact closure to ground or DTL drive on all lines except trigger levels which are analog programmed ($\pm$ 3 Vdc)

Connector:

Rear panel connector: HP 1251-0085; Amphenol 57-40300-375. (36-pin blue ribbon).

Mating connector: HP 1251-0084; Amphenol 57-30360-375

Option 003: Digital output (for numerals and polarity only)

Code:

4-line 1-2-4-8 BCD, "1" state high. "0" state +0.25 V at -1 mA; "1" state: +5 V open circuit, 2.5 k Ω source impedance nominal

Print Command:

+5 V to 0 V, dc coupled; occurs at end of gate.

Storage:

Buffer storage is provided so BCD output is constant while next measurement is being made

Inhibit Input:

Inhibits gate when instrument's cycle time is less than the time required for external equipment to interrogate BCD outputs. Positive inhibit +5 Vdc

Connector:

Rear panel connector: HP 1251-0087; Amphenol 57-40500-375 (50-pin blue ribbon). Mating connector: HP 1251-0086; Amphenol 57-30500-375

Option 004: Remote Programming including all signal input conditions.

Controls:

All front panel controls are programmable except FAST/NORM Mode.

Control Signal:

Single line control using either contact closure to ground or DTL drive on all lines except trigger levels which are analog programmable ($\pm$ 3 Vdc).

Connector:

Rear panel connector: HP 1251-0087; Amphenol 57-40500-375 (50-pin blue ribbon) Mating Connector: HP 1251-0086; Amphenol 57-30500-375

SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information for unpacking, inspection, repacking, storage, and installation. The instructions for remote programming are also given in this section.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for damage (scratches, dents, broken knobs, etc.). If the instrument is damaged or fails to self-check (Self-Check Procedures, Table 3-1), notify the carrier and nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual). Retain the shipping carton and padding material for the carrier's inspection. The sales and service office will arrange for the repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. STORAGE AND SHIPMENT

2-6. **PACKAGING.** To protect valuable electronic equipment during storage or shipment always use the best packaging methods available. Your Hewlett-Packard Sales and Service Office can provide packing material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Here are two recommended packaging methods:

a. **RUBBERIZED HAIR.** Cover painted surfaces of instrument with protective wrapping paper. Pack instrument securely in strong corrugated container (350 lb/sq. in. bursting test) with 2-inch rubberized hair pads placed along all surfaces of the instrument. Insert fillers between pads and container to ensure a snug fit.

b. **EXCELSIOR.** Cover painted surfaces of instrument with protective wrapping paper. Pack instrument in strong corrugated container (350 lb/sq. in. bursting test) with a layer of excelsior about six inches thick packed firmly against all surfaces of the instrument.

2-7. **ENVIRONMENT.** Conditions during storage and shipment should normally be limited as follows:

- a. Maximum altitude: 25,000 feet.
- b. Minimum temperature: -40°F (-40°C).
- c. Maximum temperature: $+167^{\circ}\text{F}$ ($+75^{\circ}\text{C}$).

2-8. RACK INSTALLATION

2-9. The counter is ready for bench operation as shipped from the factory. Additional parts necessary for rack mounting are packaged with the instrument. To convert to rack installation, proceed as follows:

- a. Remove tilt stand.
- b. Remove feet (press the foot-release button, slide foot toward center of instrument, and lift off).
- c. Remove adhesive-backed trim strips at front end of sides.
- d. Attach filler strip along bottom edge of front panel using two screws on outer edges of filler strip. Omit the center screw.
- e. Attach flanges to front end of sides (larger corner notch toward bottom of instrument). Instrument is now ready to mount in standard rack.

CAUTION

Ambient temperature in rack during operation should not exceed 122°F (50°C). Be sure instrument position in rack permits adequate air circulation and that nearby equipment does not discharge hot air directly on the instrument.

2-10. POWER CONNECTION

2-11. **LINE VOLTAGE.** The counter may be operated from either 115 or 230 volt ($\pm 10\%$) power lines with frequencies from 50 to 60 Hz. A slide switch on the rear panel permits quick conversion for operation from either voltage. Insert a narrow-blade screwdriver in the switch slot and slide the switch to the right for 230 volt operation ("230" marking exposed) or to the left for 115 volt operation ("115" marking exposed). The counter is supplied with a 115 volt fuse; be sure to change this fuse for 230 volt operation, see Table 2-1.

CAUTION

Before plugging instrument to ac power line be sure slide switch is properly positioned.

Table 2-1. 115/230 Volt Conversion

Line Voltage Conversion	115 Volt	230 Volt
Slide Switch	Left (115)	Right (230)
AC Line Fuse	1.50 Ampere (Slow-Blow) (HP 2110-0304)	0.8 Ampere (Slow-Blow) (HP 2110-0020)

2-12. **POWER CABLE.** The counter is equipped with a detachable 3-wire power cable. Proceed as follows for installation.

a. Connect plug (3-socket connector) to ac line jack at rear of instrument.

b. Connect plug (2-blade with round grounding pin) to 3-wire (grounded) power outlet. Exposed portions of instrument are grounded through the round pin on the plug for safety; when only 2-blade outlet is available, use connector adapter (HP Part No. 1251-0048), then connect short wire from side of adapter to ground.

2-13. REMOTE PROGRAMMING, OPTION 002

2-14. The following paragraphs describe remote programming requirements for the counter with Option 002. See Paragraph 2-33 for Option 004 programming.

2-15. Front Panel Controls

2-16. The following front-panel controls are programmable:

- FUNCTION
- TIME BASE/MULTIPLIER
- CHECK function
- SLOPE
- SAMPLE RATE and HOLD
- LEVEL controls
- INPUT C switch (5327A only)
- RESET

2-17. The following front-panel controls are NOT programmable:

- AC/DC
- SEP-COM
- FAST/NORM
- ATTEN

2-18. The trigger level controls may be remotely programmed or the front-panel LEVEL controls may be used. It is possible to program the LEVEL controls without programming the remainder of the front-panel controls. When remote programming is used, the LEVEL controls must be set to PRESET. Display time may be remotely programmed and/or the front-panel controls may be used.

2-19. Remote Programming Requirements

2-20. All lines may be controlled by TTL or DTL signals or contact closure to ground when the unit is being remotely programmed: except the trigger levels which are programmed by an analog level (if programmed) and the display time line (Hold), J10 pin 35, which should NOT be pulled up to +5 V by less than 200 Ω while programming.

2-21. When the unit is NOT being programmed (Ext line high), all the lines should be left open or pulled up to +5 V by not less than 5k Ω , except the trigger levels, which should be open circuited.

2-22. Remote Programming Procedure

2-23. In order to remotely program the counter, the following must be done:

- Set FUNCTION switch to any function but START or STOP.
- Ground the EXT line at rear-panel REMOTE PROGRAM connector J10(17). This disables the front panel switches. Ground is available at J10(36).
- Select the desired function.
- Select the desired time base.
- Select the slope (+ or -) for CHANNEL A and B. This is accomplished by grounding the Slope line for (-) and leaving it open for (+). Slope A line is J10(28). Slope B line is J10(29).
- Select the trigger level for input signal.
- Adjust the display time.
- Manual reset is available by grounding (<.7 V) pin 34. Check is available by grounding pin 14.

2-24. Function Selection Programming

2-25. To program the desired function, ground (<.7 V) the proper line at J10 as follows:

STOP	Pin 32
START	Pins 1 and 32
PERIOD AVERAGE	Pin 2
T.I. AVG.	Pin 3
T.I. A to B	Pin 4
PERIOD	Pin 5
FREQ. A	Pin 6
FREQ. C DIRECT	Pin 7
FREQ. C ÷ 10	Pins 7 and 18

2-26. Time Base Selection Programming

2-27. To program the Time Base, ground (<.7 V) the proper line at J10 as follows:

.1 μ s/1	Pin 19
1 μ s/10	Pin 20
10 μ s/10 ²	Pin 21
.1 ms/10 ³	Pin 22
1 ms/10 ⁴	Pin 23
10 ms/10 ⁵	Pin 24
.1 s/10 ⁶	Pin 25
1 s/10 ⁷	Pin 26
10 s/10 ⁸	Pin 27

2-28. Trigger Level Programming

2-29. To program the trigger level, the LEVEL controls must be set to PRESET. Select the trigger level by placing a dc voltage between -3.0 and +3.0 volts on the level input line (Level A = J10 pin 30, Level B = J10 pin 31). This voltage, times the attenuator setting, is the trigger level. Preset is programmed by leaving the pin open on contact closure to ground. Grounding is preferable if noise exists on the remote programming line.

2-30. The front-panel LEVEL controls may be used manually if programming of the trigger levels is undesirable. Also, note the AC/DC and ATTEN switches on the front-panel must be set manually, as they are NOT programmable.

2-31. Sample Rate Adjustment

2-32. Adjusting the display time can be accomplished in several ways:

- Manually adjust the display time by using the front-panel SAMPLE RATE controls.
- Set the SAMPLE RATE control cw and the FAST/NORM/HOLD switch to NORM and connect a 1 megohm pot in series with a 1.5k ohm resistor from +5 V to pin 35. This will give a display time range of about 10 ms to 5 sec. If a shorter time is desired, set the FAST/NORM/HOLD switch to FAST, which gives a range of about 50 μ s to 10 ms.
- Set the SAMPLE RATE control cw in FAST and hold the Hold line (pin 35) to ground for the desired display time. The display will continue for about 100 μ s after the ground is released.

2-33. REMOTE PROGRAMMING, OPTION 004

2-34. The following paragraphs describe remote programming requirements for the counter with Option 004.

2-35. Front Panel Controls

2-36. All front-panel controls are programmable, except the FAST/NORM/HOLD switch. The trigger level controls may be remotely programmed, or the front-panel LEVEL controls may be used. It is possible to program the front-panel LEVEL controls without programming the remainder of the front-panel controls. When remote programming the trigger levels, the LEVEL controls must be set to PRESET. The display time may be remotely programmed and/or the front-panel controls may be used.

2-37. Remote Programming Requirements

2-38. All lines may be controlled by TTL or DTL signals or contact closure to ground when the unit is being remotely programmed: except the trigger levels which are programmed by an analog level (if programmed) and the display time line (Hold), J10 pin 16, which should NOT be pulled up to +5 V by less than 200 Ω while programming.

2-39. When the unit is NOT being programmed (EXT line high), all the lines should be left open or pulled up to +5 V by not less than 5k Ω , except the trigger levels, which should be open circuited.

2-40. Remote Programming Procedure

2-41. In order to remotely program the counter, the following must be done:

- Set FUNCTION switch to any position but START or STOP.
- Ground the EXT line at rear-panel REMOTE PROGRAM connector J10(34). This disables the front panel switches. Ground is available at J10(36).
- Select the desired function.
- Select the desired time base.
- Select the signal conditioning.
- Select the trigger level for input signal.
- Adjust the display time.
- Manual reset is available by ground ($<.7$ V) pin 17. Check is available by grounding pin 37.

2-42. Function Selection Programming

2-43. To program the desired function, ground ($<.7$ V) the proper line at J10 as follows:

STOP	Pin 19
START	Pins 46, 19
PERIOD AVERAGE	Pin 47
T.I. AVG.	Pin 45
T.I. A to B	Pin 44
PERIOD	Pin 43
FREQ. A	Pin 42
FREQ. C DIRECT	Pin 41
FREQ C $\div$ 10 (5327A only)	Pin 33

2-44. Time Base Selection Programming

2-45. To program the time base, ground ($<.7$ V) the proper line at J10 as follows:

.1 μ s/1	Pin 28
1 μ s/10	Pin 29
10 μ s/10 ²	Pin 27
.1 ms/10 ³	Pin 26
1 ms/10 ⁴	Pin 25
10 ms/10 ⁵	Pin 24
.1 s/10 ⁶	Pin 30
1 s/10 ⁷	Pin 31
10 s/10 ⁸	Pin 32

2-46. Signal Conditioning Programming

2-47. Program the input conditions by grounding the proper line as follows:

CONDITION	LINE J10	INPUT
AC/DC A	11	AC=H DC=L
SLOPE A	23	+ = H - = L
ATTENUATOR A	13, 14	13 - H, 14 - H = X1 13 - L, 14 - H = X10 13 - H, 14 - L = X100
AC/DC B	7	AC = H DC = L
SLOPE B	22	+ = H - = L
ATTENUATOR B	9, 10	9 - H, 10 - H = X1 9 - L, 10 - H = X10 9 - H, 10 - L = X100
SEP/COM	6	COM = L, SEP = H
CHECK	37	CHK = L

2-48. Trigger Level Programming

2-49. To program the trigger level, the LEVEL controls must be set to PRESET. Select the trigger level by placing a dc voltage between -3.0 and +3.0 volts on the level input line (Level A = J10 pin 21, Level B = J10 pin 20). This voltage, times the attenuator setting, is the trigger level. Preset is programmed by leaving the pin open or contact closure to ground. Grounding is preferable if noise exists on the remote programming line.

2-50. The front-panel LEVEL controls may be used manually if programming of the trigger levels is undesirable.

2-51. Sample Rate Adjustment

2-52. Adjusting the display time can be accomplished in several ways:

- Manually adjust the display time by using the front-panel SAMPLE RATE controls.

b. Set the SAMPLE RATE control cw and the FAST/NORM/HOLD switch to NORM and connect a 1 megohm pot in series with a 1.5k ohm resistor from +5 V to pin 16. This will give a display time range of about 10 ms to 5 sec. If a shorter time is desired, set the FAST/NORM/HOLD switch to FAST, which gives a range of about 50 μ s to 10 ms.

c. Set the SAMPLE RATE control cw in FAST and hold the Hold line (pin 16) to ground for the desired display time. The display will continue for about 100 μ s after the ground is released.

2-53. BLANKING DEFEAT

2-54. This counter is designed to blank insignificant zeros (zeros to left of data). When blanking occurs, the digital recorder output for the blanked columns is BCD 15 (HHHH). To use this instrument with a digital-analog converter, it is necessary to defeat the blanking feature by repositioning the two jumpers on the A9 Display board. Move the jumpers to position 2, as shown in A9 Component Locator (Section VIII). This connects pin 10 of A9U7 and A9U8 to +5 V. Also, lift the pin 1 lead of A8U2 and connect pin 1 to ground (available at U2 pin 7).

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. Section III contains the operating information required to obtain the most effective performance from the instrument. This includes a general description of the operating modes, the function of all controls and indicators, a self-check procedure, and setup procedures for making basic measurements.

3-3. OPERATING MODES

3-4. The following paragraphs describe the operating modes of totalize, frequency, period, time interval, and ratio.

3-5. Totalize Mode

3-6. START and STOP positions on the FUNCTION selector allow manual opening and closing of the counter's main gate. When the switch is in the START position, the counter does not measure frequency, but instead, counts the number of times the signal passes through the trigger point. The input signal, connected to the front-panel CHANNEL A jack, is divided by the MULTIPLIER switch setting prior to counting. For example, when the MULTIPLIER switch is set to the 1 position, every pulse is counted. When the switch is set to 10^3 , the counter registers every thousandth pulse. When the FUNCTION switch is set to STOP, the counter stops totalizing and holds the displayed count until the RESET switch is pressed or the MULTIPLIER switch setting is changed. If the FUNCTION switch is again set to START before a reset is generated, the count continues to totalize from the previously displayed value. With the FUNCTION switch set to START, the scaled input signal is available at the rear-panel TIME BASE OUTPUT jack. The unit indicators and decimal points are blanked during the totalize mode. The C light is on (in START), indicating counting is taking place.

3-7. Frequency Modes

3-8. Three frequency modes are available in the 5327A: Frequency A, Frequency C prescaled, and Frequency C direct. (The prescale operation is not included in the 5326A.) In the Frequency A mode, the input signal connects to the high impedance CHANNEL A input jack and can be conditioned with the LEVEL, SLOPE, and ATTEN controls. In the Frequency C modes, the input signal is connected to the INPUT C jack (50 ohm). The signal is not conditioned by any front-panel controls but may be counted either directly (50 MHz) or by prescaling (550 MHz),

depending on the setting of the INPUT C switch. The C channel of the 5326A model counts the signal directly.

3-9. Period Modes

3-10. The period and period average modes allow single period measurements or multiple period averages to be made with input frequencies into CHANNEL A of up to 10 MHz. These modes are useful for making low frequency measurements where maximum resolution is desired.

3-11. For single period measurements, the MULTIPLIER switch scales the time base frequency and selects the placement of the decimal point and determines the resolution of the measurement.

3-12. The period average mode is used for increased resolution and reduced inaccuracies. For example, if 10^2 period averaging is selected, the counter will display the average of 100 periods with the proper decimal point. In this example, trigger error is 100 times less than in a single period measurement.

3-13. Time Interval Modes

3-14. Two modes of time interval measurements can be selected: time interval and time interval average. The time interval modes measure the time between points on a single waveform or between separate input signals; thus, pulse width and phase differences can be measured. Separate slope and level controls allow variable triggering levels on either the + or - slope. Marker A and B outputs are available at the rear panel to intensity-modulate an HP 180A oscilloscope. The markers indicate the trigger point of the counter's input circuits and provide a visual means of adjusting the trigger points to measure the time interval between any two points and are useful to about 100 kHz.

3-15. In time interval measurements, Channel A opens the main gate and Channel B closes the main gate. While the main gate is open, the internal oscillator, divided by the setting of the MULTIPLIER switch, is totalized by the counter and readout on the display. The less the division factor, the more pulses of the internal oscillator there are to count and, therefore, the better the resolution and accuracy.

3-16. With time interval average, the main gate is open for the number of time intervals selected by the MULTIPLIER switch. The internal oscillator pulses (not divided) are totalized only during the individual time intervals. Once Channel B triggers, there must

be a time lapse of 150 ns before Channel A can trigger. Averaging of time intervals results in increased resolutions and reduced inaccuracies. For a further explanation of theory, refer to Paragraph 4-27.

3-17. Ratio

3-18. The counter may be used to measure the ratio of two signals in either the frequency or period mode. By setting the rear-panel OSC INT-EXT switch to EXT, the counter will accept an external signal (F_{ext}) for use as the internal oscillator. This frequency should be 100 Hz to 10 MHz at 1 V rms minimum to 5 V peak maximum. A second signal (F_A), applied to either INPUT A or C jack, is used as the comparator signal. The MULTIPLIER switch controls the resolution of the display. For a ratio of frequencies, the Ratio = $\frac{F_A}{F_{ext}} = \frac{\text{DISPLAYED NUMBER}}{\text{MULTIPLIER SETTING}}$. For a ratio of periods (P), the Ratio =

$$\frac{P_A}{P_{ext}} = \frac{F_{ext}}{F_A} = \frac{\text{DISPLAYED NUMBER}}{\text{MULTIPLIER SETTING}}$$

3-19. Disregard the units and decimal point; also, ignore any zeros to the left of the most significant digit. It makes no difference which signal is higher in frequency, as long as the two frequencies are within the specifications of their respective channels.

3-20. MARKER OUTPUTS

3-21. Two marker output jacks are mounted on the counter's rear panel. These outputs provide a negative-going 2 μ s pulse (approx.) at DTL levels each time the input signal passes through the trigger point of Channel A or B. The pulses may be used to trigger other circuits or may be applied to the Z axis of an HP 180 Oscilloscope. When using the pulses to intensity modulate an oscilloscope, note that the actual trigger point is the leading edge of the pulse. The marker's pulse width determines the upper frequency limit of the input signal. The pulses overlap on the oscilloscope trace when the period of the signal is less than the pulse width.

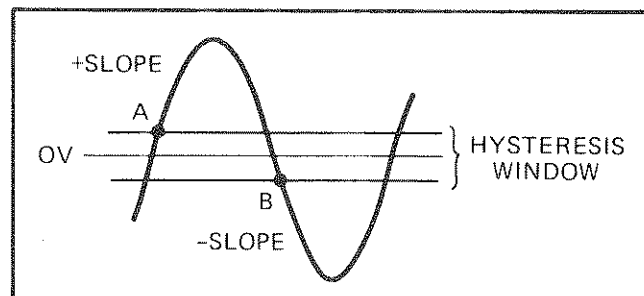
3-22. HYSTERESIS

3-23. Each input channel has a small amount of hysteresis (about 100 mV). If the SLOPE switch is set to "+," the trigger pulse occurs at the top of the hysteresis "window." If the SLOPE switch is set to "-", the pulse occurs on the bottom line of the window. In other words, the signal must pass through the entire hysteresis window before a trigger pulse is generated.

3-2

3-24. When measuring frequency or period, the counter positions the hysteresis band around zero (see Figure 3-1). This assumes a waveform with no dc component and the counter's LEVEL control is in the PRESET position. The input amplifier then yields maximum input sensitivity for both positions of the SLOPE switch. The offset introduces no measurement error, since the trigger point is repetitive from cycle to cycle. The trigger point is point A for + slope and point B for - slope.

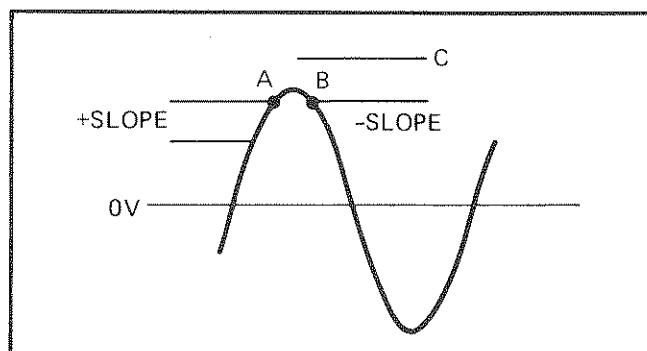
Figure 3-1. Hysteresis Offset



3-25. Time Interval Compensation

3-26. In the time interval modes only, both input amplifiers have an automatic compensation network that keeps the trigger level at the same potential when switching from positive to negative slope (see Figure 3-2). In this example, the window shifts upward to accomplish this. There is the possibility, therefore, that if Point A is near the top of the signal, switching to negative slope will place a portion of the window outside the signal (C). In such case, there would be no triggering. When switching from time interval to frequency, or vice versa, the trigger point shifts by half the hysteresis band.

Figure 3-2. Hysteresis Compensation



3-27. ACCURACY

3-28. FREQUENCY MEASUREMENTS. The basic counter accuracy is determined by two factors. One factor is the aging rate of the 10 MHz crystal standard in the time base (less than 3 parts in 10^7 per month). A second factor is the inherent error of ± 1 count of the

display's least significant digit, which is present in all electronic counters. This error is due to phasing between the timing pulse that operates the electronic gate and the pulses that pass through the gate to the counting assembly. The chart in Figure 3-3 shows the error possible for frequency and period measurements.

3-29. The formula for determining the actual frequency is given as follows:

$$\text{error} = \pm \left(\frac{1}{f_1 \times \text{gate length (sec)}} \right) \pm E$$

The expression

$$\frac{1}{f_1 \times \text{gate length (sec)}}$$

equals the ± 1 count ambiguity, where f_1 equals measured frequency (Hz) and gate length equals the selected gate time in seconds. E equals the time base accuracy (monthly drift rate of the individual time base times the number of months since calibration, frequency change due to ambient temperature change, absolute off-set at standardization, and line voltage effects).

3-30. An example of frequency error calculation is as follows:

$$f_1 = 3 \text{ MHz } (3 \times 10^6 \text{ Hz})$$

$$\text{gate length} = .1 \text{ sec } (1 \times 10^{-1})$$

$$\begin{aligned} E &= 3 \text{ parts in } 10^7 \text{ per month times 2 months} \\ &= 6 \text{ parts in } 10^7 \end{aligned}$$

$$\begin{aligned} \text{error} &= \frac{1}{(3 \times 10^6) (1 \times 10^{-1})} \pm \frac{6}{10^7} \\ &= 3.3 \times 10^{-6} \pm 6 \times 10^{-7} = 3.9 \times 10^{-6} \\ &\text{or } 3.9 \text{ parts in } 10^6 \end{aligned}$$

3-31. PERIOD MEASUREMENTS. There are three factors contributing to the accuracy of period average measurements:

- The aging rate of the 10 MHz crystal standard.
- The ± 1 count ambiguity.
- The trigger error for one period.

Assuming a signal-to-noise ratio of 40 dB, the trigger error is less than 0.3% at rate sensitivity. A general formula for finding the percentage error to be expected under various conditions is as follows:

$$A = 100 \left(\pm \frac{f_2}{nf_1} \pm \frac{e}{n} \pm E \right)$$

A = Accuracy in percent

f_1 = Time base frequency counted

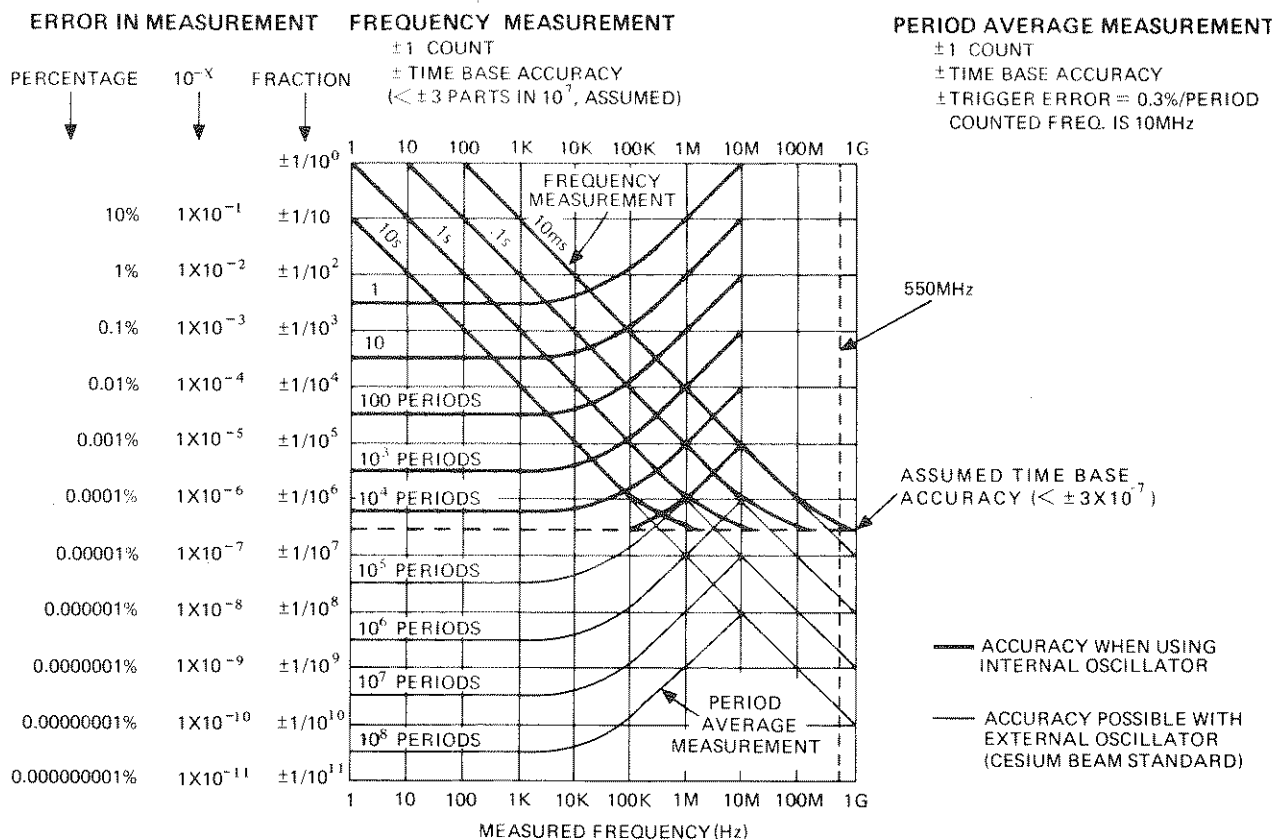
f_2 = Frequency of input signal (Hz)

n = Number of periods averaged

e = 3×10^{-3} (trigger error for one period, 40 dB S/N at rated sensitivity.)

E = time base accuracy (monthly drift rate of individual time base times the number of months since calibration, absolute value of off-set at standardization, frequency change due to ambient temperature change, and line voltage effects). A plot of the above formula is shown in Figure 3-3.

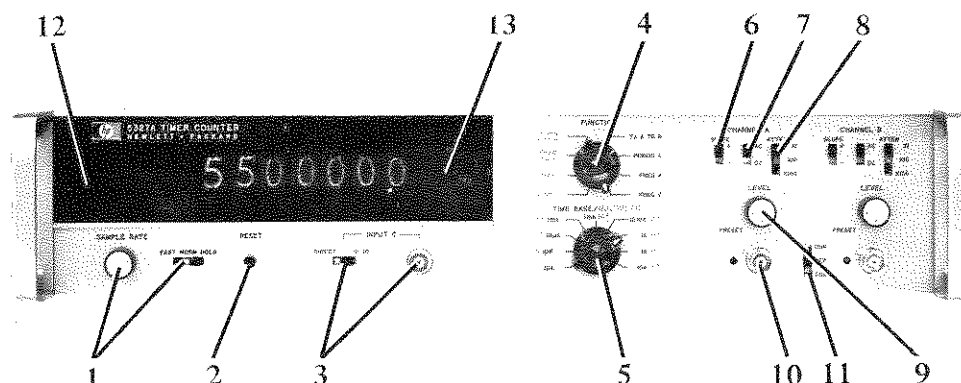
Figure 3-3. Measurement Accuracy



NOTE

FOR 550MHz INPUT ($\div 10$) USE LINE TO RIGHT OF ACTUAL GATE LENGTH TO DETERMINE ACCURACY OF MEASUREMENT, SINCE ± 1 COUNT ERROR REPRESENTS ± 10 COUNTS OF INPUT SIGNAL WHEN PRESCALING BY 10.

Figure 3-4. Front Panel Controls and Indicators

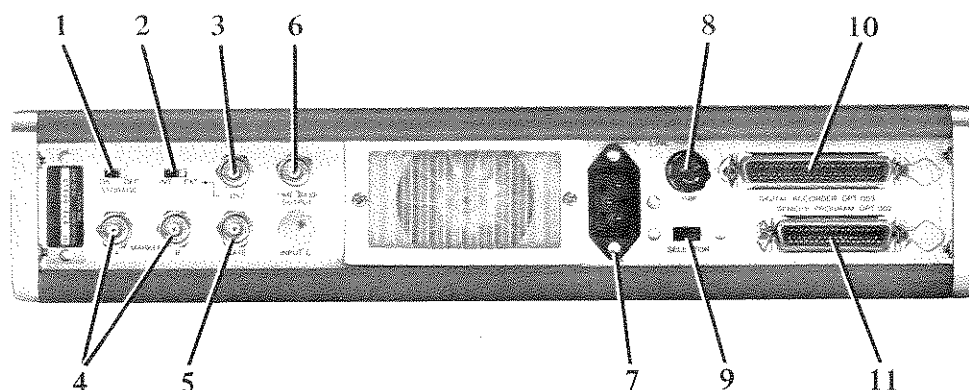


1. **SAMPLE RATE control.** Applies primary power. Works in conjunction with FAST/NORM/HOLD switch to control interval between measurements.
 - a. **FAST** - Varies display time from $<100 \mu\text{s}$ to $>20 \text{ ms}$. STORAGE switch (rear panel) must be ON to use this mode.
 - b. **NORM** - Varies display time from $<20 \text{ ms}$ to $>5 \text{ seconds}$.
 - c. **HOLD** - Holds display indefinitely.
2. **RESET Switch.** Resets display and internal count to zero and starts new measurement.
3. **INPUT C (5327A).** 50-ohm input for 0 to 550 MHz frequency measurements. Has dc coupling (with INPUT C switch in ± 10 position) and sensitivity of 100 mV rms sine wave (300 mV peak-to-peak pulse). Maximum input is ± 5 volts referenced to ground (DO NOT EXCEED). Trigger level is zero volts. The input is ac coupled with the INPUT C switch in DIRECT position. The frequency range is 1 kHz to 50 MHz with a sensitivity of 5 mV.
INPUT C (5326A). 50-ohm input for 0 to 50 MHz frequency measurements. Has dc coupling and sensitivity of 5 mV rms sine wave. Trigger level is zero volts. Maximum input is ± 5 volts referenced to ground (DO NOT EXCEED).
4. **FUNCTION selector.** Selects mode of operation. Blue lettering matches corresponding blue lettering on TIME BASE/MULTIPLIER switch.
 - a. **STOP, START** - Used for totalize mode to manually open and close counter's main gate and to turn scaled output on and off. Frequency input range is 0 to 10 MHz.
 - b. **PERIOD AVG A** - Sets counter to measure period of signal applied to CHANNEL A input. Use MULTIPLIER switch to select number of periods to be averaged. Input frequency range is 0 to 10 MHz.
 - c. **T.I. AVG A to B** - Sets counter to measure average time interval, A to B. Channel A starts interval and Channel B stops the interval. Use MULTIPLIER selector to set number of time intervals to be averaged. Time interval input range is 150 ps to 10 sec; there must be a 150 ns deadtime between intervals.
 - d. **T.I. A to B** - Sets counter to measure time interval A to B. Channel A starts measurement and Channel B stops the measurement. T.I. input range is $0.1 \mu\text{s}$ to 10^9 sec . The internal time base frequency is divided by the setting of the MULTIPLIER switch and totalized for subsequent display. The more cycles of the oscillator frequency that are counted during A to B time, the better the resolution. There must be 150 ns deadtime between Channel B and Channel A trigger points.
 - e. **PERIOD A** - Sets counter to measure a single period of the signal applied to CHANNEL A input. Use MULTIPLIER switch to set counted internal oscillator frequency and therefore the desired resolution. Frequency input range is 0 to 10 MHz.
 - f. **FREQ A** - Sets counter to measure frequency applied to CHANNEL A input. Use TIME BASE switch to set gate time and resolution. Frequency input range is 0 to 50 MHz.

Figure 3-4. Front Panel Controls and Indicators (Continued)

- g. FREQ C - Similar to FREQ A, except sets counter to measure frequency applied to INPUT C jack. 50-ohm input impedance. 5 V rms/7.5 V peak maximum input. Frequency range is 0 to 550 MHz prescaled or 1 kHz to 50 kHz direct. For the 5326B, the frequency range is 0 to 50 MHz. See INPUT C.
5. TIME BASE/MULTIPLIER switch. The function of the switch changes with each mode of operation:
- a. TOTALIZE - Determines scaling factor for input signal prior to counting.
 - b. PERIOD AVG A - Selects number of periods to be averaged.
 - c. T.I. AVG A to B - Selects number of time intervals to be averaged.
 - d. T.I. A to B - Selects scaling factor for internal oscillator signal.
 - e. PERIOD A - Selects scaling factor for internal oscillator signal.
 - f. FREQ A and FREQ C - Sets gate time.
6. SLOPE switch. Permits triggering on positive or negative slope of input signal.
7. AC-DC switch. Selects direct or capacitor coupling for input signal. Minimum input frequency on AC setting is 20 Hz.
8. ATTEN switch. Selects attenuation for input signal. Used in conjunction with LEVEL control to set input triggering point. Maximum input: 250 V rms on all ranges except 25 V rms on X1 range above 50 kHz. Recommended input is 0.1 V rms to 2 V rms times ATTEN setting.
9. LEVEL control. Used in conjunction with ATTEN switch to determine voltage at which triggering occurs. With X1 attenuator setting, level is variable ± 3 V; on X10, ± 30 V; and X100, ± 300 V.
10. Input jacks. Input jacks to Channels A and B. Input impedance is 1 M Ω shunted by less than 25 pF. By using a 10 to 1 divider probe, input impedance can be increased to 10 M Ω .
11. Trigger lamps adjacent to input jacks indicate when amplifier triggering occurs.
12. CHK-SEP-COM-switch. (Check-separate-common)
- a. CHK - Connects internal 10 MHz time base to Channels A and B circuitry to check that unit is functioning. No indication in T.I. or T.I. Avg; ignore displayed digits in period average.
 - b. COM-SEP - Connects A and B inputs in parallel when set to COM position. When applying two separate inputs, set switch to SEP. When set to COM, input impedance is 500 k Ω shunted with less than 50 pF.
13. C (count) light. Lights when counter's main gate is open. For short-duration gate times, the annunciator circuits include a 50 ms one-shot MV to allow a visible flash of the C light.
14. * (asterisk). Indicates that proper units are not displayed with combination of function/time base selection. To interpret display, add a zero to the right of least significant digit displayed on the counter.

Figure 3-5. Rear Panel Controls and Connectors

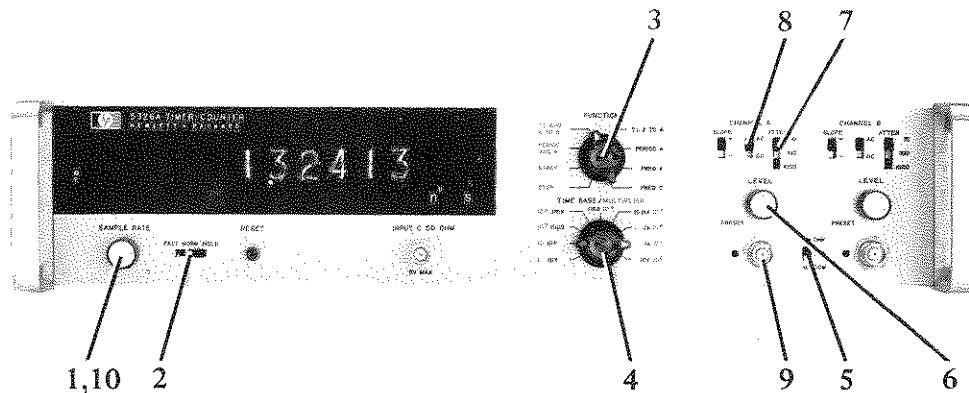


1. STORAGE switch. When set to ON, provides display storage while new measurement is being made. In OFF position, allows continuous display of counting process.
2. OSC INT-EXT switch. In INT position, selects normal counter operation using internal time base. In EXT position, permits use of external time base.
3. OSC jack. With INT-EXT switch set to INT, provides 10 MHz, >3 V p-p output (no load), 50 Ω series impedance. With INT-EXT switch set to EXT, allows use of external time base from 100 Hz to 10 MHz at >1 volt rms (5 V peak maximum).
4. MARKER A and B jacks. Provides marker outputs to intensity modulate HP 180 Oscilloscope. Markers begin coincident with channel trigger points.
5. GATE jack. Provides >2.4 volts output (open circuit) for external use. Has 50 Ω series impedance. Output is low when counter's main gate is open and high when gate is closed.
6. TIME BASE OUTPUT jack. Provides negative going > +3 to 0 V pulses (open circuit), >50 nanoseconds wide. The line has a 50 Ω series impedance. In START, frequency output is CHANNEL A signal divided by MULTIPLIER setting.
7. AC LINE. IEC type with offset pin connected to chassis.
8. AC LINE FUSE. 1.50 A at 115 V, 800 mA at 230 V.
9. 115/230 volt switch. Insert narrow screwdriver and slide switch to show desired voltage.
10. DIGITAL RECORDER connector (Option 003 only). 50-pin connector for digital recorder interconnection.
11. REMOTE PROGRAM connector. Option 002: 36-pin connector to allow remote control of counter modes and functions.
Option 004: 50-pin connector to allow remote control of all counter functions except FAST/NORM.

Table 3-1. Self-Check

1. Set SAMPLE RATE control slightly clockwise out of OFF.	Time Interval Average Self Check		
	MULTIPLIER	DISPLAY	ANNUNCIATOR
2. Set FAST/NORM/HOLD switch to NORM.	1	.0	μ s
	10	.00	μ s
	10^2	.000	μ s
3. Set FUNCTION switch to STOP.	10^3	.0	ns
	10^4	.00	ns
	10^5	.000	ns
4. Set MULTIPLIER selector to 1.	10^6	.0000	ns
	10^7	.00000	ns
	10^8	.000000	ns
5. Set CHK-SEP-COM switch to CHK.			
6. Press RESET and check that counter's right hand column displays a 0 and all other digits are blanked.	11. Set FUNCTION to T. I. A to B. Rotate MULTIPLIER switch as shown in the following table (Step 12) and check for proper display.		
7. Set FUNCTION switch to START and check that counter totalizes and C light is on. Check that OF light goes on as display overflows. Set TIME BASE/MULTIPLIER to each position and check that counter totalizes in each position.	12. Set FUNCTION to PERIOD A. Set MULTIPLIER switch as shown in the following table and check for proper display.		
Time Interval and Period Self-Check			
	MULTIPLIER	DISPLAY	ANNUNCIATOR
8. Set FUNCTION switch to STOP. Check that C light goes out and display is held.	1^*	.1 $\pm$ 1 count	μ s
	10	0	μ s
	10^2	.00	ms
	10^3	.0	ms
	10^4	0	ms
	10^5	.00	s
	10^6	.0	s
	10^7	0	s
9. Set FUNCTION to PERIOD AVG A. Set MULTIPLIER as shown in table below and check for proper display.	10^8	0	*
	Period Average Self-Check		
MULTIPLIER	DISPLAY	ANNUNCIATOR	
1	.1	μ s	
10	.10	μ s	
10^2	.100	μ s	
10^3	100.0	ns	
10^4	100.00	ns	
10^5	100.000	ns	
10^6	100.0000	ns	
10^7 Standard	00.00000	ns OF	
10^7 Option 001	100.00000	ns	
10^8 Standard	0.000000	ns OF after 10 sec	
10^8 Option 001	00.000000	ns OF	
NOTE			
Digits noted are for reference, actual display may differ by several counts.			
10. Set FUNCTION to T.I. AVG A to B. Set MULTIPLIER as shown in table below and check for proper display.	Frequency A Self Check		
	TIME BASE	DISPLAY	ANNUNCIATOR
	.1 μ s	.01	$\pm$ 1 count GHz
	1 μ s	10	$\pm$ 1 count MHz
	10 μ s	10.0	$\pm$ 1 count MHz
	.1 ms	10.00	$\pm$ 1 count MHz
	1 ms	10.000	$\pm$ 1 count MHz
	10 ms	10000.0	$\pm$ 1 count kHz
	.1 s	10000.00	$\pm$ 1 count kHz
	1 s	0000.000	$\pm$ 1 count kHz OF
		10000.000	$\pm$ 1 count kHz (Option 001)
	10 s	000.0000	$\pm$ 1 count kHz OF
		0000.0000	$\pm$ 1 count kHz OF (Opt. 001)

Figure 3-6. Frequency A Measurements

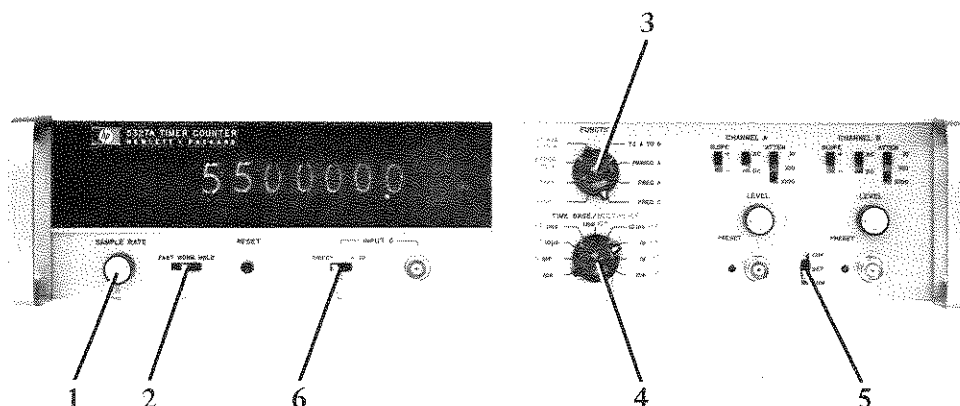


1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to FREQ A.
4. Set TIME BASE switch for desired gate time.
5. Set CHK-SEP-COM switch to SEP.
6. Set CHANNEL A LEVEL control to desired trigger level or to PRESET to trigger at zero volts.
7. Set ATTEN switch to match input signal amplitude.
8. Set AC-DC switch to AC or DC.
9. Connect input signal (0 to 50 MHz) to CHANNEL A input jack.
10. Adjust SAMPLE RATE control for convenient measurement interval.

NOTE

When the input signal is removed from CHANNEL A or the signal level is insufficient to trigger Channel A, the count light (C) will not cycle. This is normal for this counter and does not indicate a malfunction.

Figure 3-7. Frequency C Measurements



1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to FREQ C.
4. Set TIME BASE switch for desired resolution.
5. Set CHK-SEP-COM switch to SEP.
6. Set INPUT C switch to DIRECT.
7. Connect input signal (1 kHz to 50 MHz, ± 5 V peak maximum, 5 mV rms minimum) to INPUT C connector (rear panel). Input impedance is 50 Ω nominal. For the 5326A, input frequency is 0 to 50 MHz.

8. Adjust SAMPLE RATE control for convenient measurement interval.

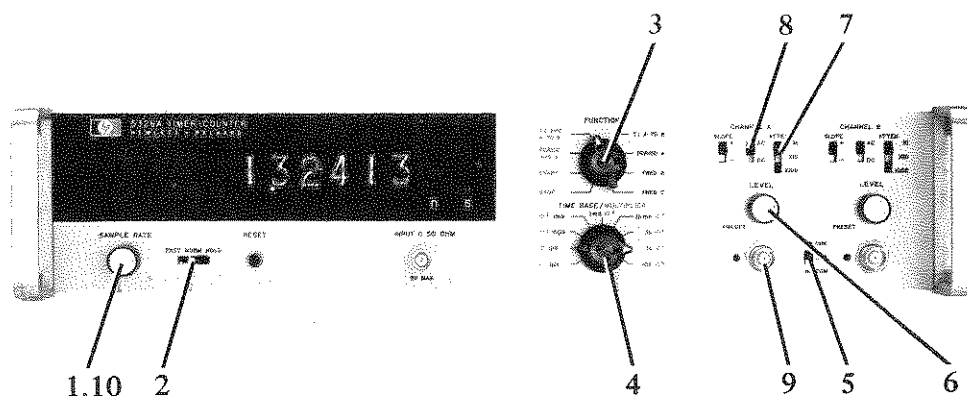
NOTE

For frequencies from 0 to 550 MHz with minimum levels of 100 mV rms, connect signal to INPUT C jack and place INPUT C switch in $\div 10$ position.

CAUTION

Damage will occur if INPUT C voltage specifications are exceeded.

Figure 3-8. Period Measurements



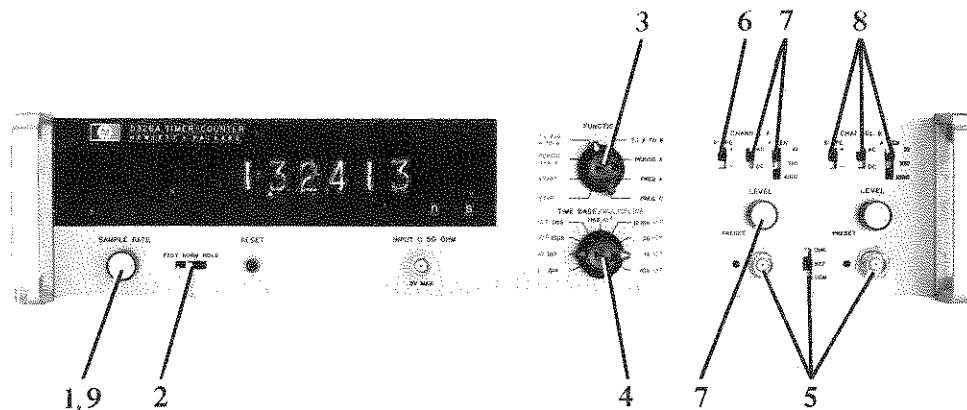
Period

1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to PERIOD A.
4. Set MULTIPLIER switch for desired resolution.
5. Set CHK-SEP-COM switch to SEP.
6. Set CHANNEL A LEVEL control to desired trigger level or to PRESET to trigger at zero volts.
7. Set ATTEN switch to match input signal's amplitude.
8. Set AC-DC switch to AC or DC.
9. Connect input signal (0 to 10 MHz) to CHANNEL A input jack.
10. Adjust SAMPLE RATE control for a convenient interval between measurements.

Period Average

1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to PERIOD AVG A.
4. Set MULTIPLIER switch to number of periods to be averaged.
5. Set CHK-SEP-COM switch to SEP.
6. Set CHANNEL A LEVEL control to desired trigger level or to PRESET to trigger at zero volts.
7. Set ATTEN switch to match input signal amplitude.
8. Set AC-DC switch to AC or DC.
9. Connect input signal (0 to 10 MHz) to CHANNEL A input jack.
10. Adjust SAMPLE RATE control for convenient measurement interval.

Figure 3-9. Time Interval Measurements



Single Time Interval

1. Set SAMPLE RATE control slightly clock-wise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to T.I. A to B.
4. Set MULTIPLIER switch for desired resolution.
5. If start-stop signals are from a common source, connect signal to CHANNEL A input and set CHK-SEP-COM switch to COM. If start-stop signals are from separate sources, connect start signal to CHANNEL A input and stop signal to CHANNEL B input and CHK-SEP-COM switch to SEP.
6. Set CHANNEL A SLOPE switch to + for triggering on positive slope of signal or to - for triggering on negative slope of signal.
7. Set CHANNEL A LEVEL and ATTN switches to start measurement at desired voltage level. Select AC or DC coupling. For frequencies below 100 kHz, use MARKER A OUTPUT jack on rear panel to display starting point on an oscilloscope.
8. Set CHANNEL B, AC-DC, LEVEL, SLOPE, and ATTN controls to stop measurement at desired level. For frequencies below 100 kHz, use MARKER B OUTPUT to display stopping point on oscilloscope.
9. Adjust SAMPLE RATE control for convenient measurement interval.

NOTE

There must be at least 150 ns between the STOP pulse (Channel B trigger) and the next START pulse (Channel A trigger).

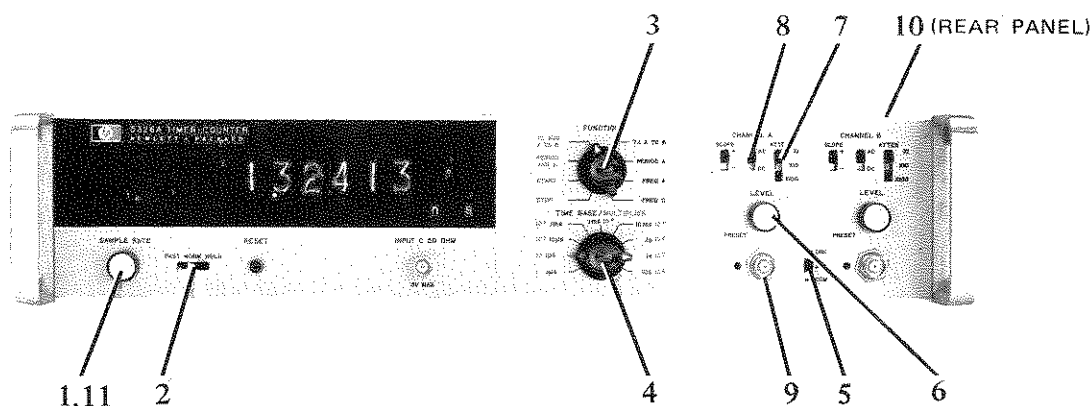
Time Interval Average

1. Set SAMPLE RATE control slightly clock-wise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch T.I. AVG A.
4. Set MULTIPLIER switch to number of time intervals to be averaged.
5. If start-stop signals are from a common source, connect signal to CHANNEL A input and set CHK-SEP-COM switch to COM. If start-stop signals are from separate sources, connect start signal to CHANNEL A input and stop signal to CHANNEL B input and CHK-SEP-COM switch to SEP.
6. Set CHANNEL A SLOPE switch to + for triggering on positive slope of signal or to - for triggering on negative slope of signal.
7. Set CHANNEL A, LEVEL, and ATTN to start the measurement at desired voltage level. Select AC or DC coupling. For frequencies below 100 kHz, use MARKER A OUTPUT jack on rear panel to display starting point on oscilloscope.
8. Set CHANNEL B, AC-DC, LEVEL, SLOPE, and ATTN to stop the measurement at desired level. For frequencies below 100 kHz, use MARKER B OUTPUT to display stopping point on oscilloscope.
9. Adjust SAMPLE RATE control for convenient measurement interval.

NOTE

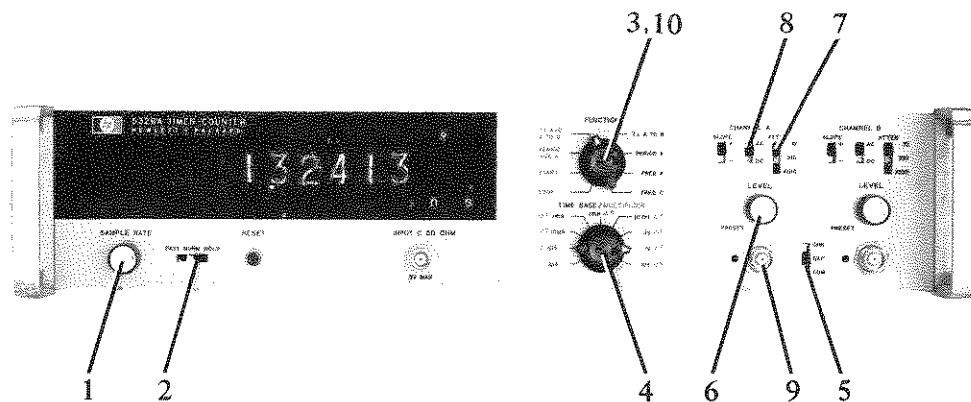
STOP to START delay must be ≥ 150 ns and input rate should not be $10 \text{ MHz} \times \frac{M}{N}$ (M and N integers).

Figure 3-10. Ratio Measurements



1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to FREQ A or FREQ C, direct or prescaled.
4. Set MULTIPLIER switch to desired dividing factor for F_{ext} .
5. Set CHK-SEP-COM switch to SEP.
6. Set CHANNEL A LEVEL control to desired trigger level or to PRESET to trigger at zero volts.
7. Set ATTEN switch to match input amplitude.
8. Set AC-DC switch to AC or DC.
9. Connect F_A (0 to 50 MHz) to CHANNEL A input jack or F_C to INPUT C.
10. Set OSC INT-EXT switch to EXT (rear-panel). Connect F_{ext} to OSC jack. F_{ext} can be 100 Hz to 10 MHz 1 V rms (min) to 5 V peak maximum.
11. Adjust SAMPLE RATE control for convenient measurement interval.
12.
$$\text{Ratio} = \frac{F_A \text{ or } F_C}{F_{ext}} = \frac{\text{DISPLAY}}{\text{MULTIPLIER}}$$
 Disregard units and decimal point.

Figure 3-11. Totalize Measurements



1. Set SAMPLE RATE control slightly clockwise out of OFF.
2. Set FAST/NORM/HOLD switch to NORM.
3. Set FUNCTION switch to STOP.
4. Set MULTIPLIER switch to input signal scaling factor.
5. Set CHK-SEP-COM switch to SEP.
6. Set LEVEL control to desired trigger level or to PRESET for triggering at zero volts.
7. Set ATTN switch to match input signal's amplitude.
8. Set AC-DC switch to AC or DC.
9. Connect input signal (0 to 10 MHz) to CHANNEL A input jack.
10. Set FUNCTION switch to START.

NOTE

A scaled output of the input signal is available at the rear-panel TIME BASE OUTPUT BNC. The division is determined by the MULTIPLIER switch setting.

