TEMPORARY OPERATING AND SERVICE MANUAL

5335A
UNIVERSAL FREQUENCY COUNTER

SERIAL PREFIX: 2024A

This manual applies to Serial Prefix 2024A, unless accompanied by a Manual Change Sheet indicating otherwise.

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HEWLETT-PACKARD COMPANY
5301 Stevens Creek Blvd.
Santa Clara, CA 95050

Carole Weber
Paul Stevenson
V.G. Morgan

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HEWLETT PACKARD

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service Manual contains the information required to install, operate, test, adjust, and service the Hewlett-Packard Model 5335A Universal Frequency Counter. The counter, with DVM Option 020 and C Channel Option 030, is shown in *Figure 1-1* with its supplied accessories.

1-3. MANUAL SUMMARY

1-4. This manual is divided into eight sections, each covering a particular topic for the operation and service of the HP 5335A. The topics by section number are:

SECTION I, GENERAL INFORMATION. Provides the instrument specifications, instrument identification, description of options, accessories and recommended test equipment.

SECTION II, INSTALLATION. Provides information about initial inspection, preparation for use, storage and shipment, field installation of options, and HP-IB interconnections.

SECTION III, OPERATION AND PROGRAMMING. Provides information about operating characteristics, panel features, local and remote operating instructions, operator's maintenance, and programming. The operation of Options 020 and 030 is included in this section.

SECTION IV, OPERATIONAL VERIFICATION. Provides abbreviated procedures for operational verification which give the operator a high degree of confidence that the 5335A is operating properly.

SECTION V, ADJUSTMENTS. Provides the procedures and adjustment locations required to properly maintain the instrument operating characteristics within specifications.

SECTION VI, REPLACEABLE PARTS. Provides ordering information for all replaceable parts and assemblies within the instrument.

SECTION VII, MANUAL CHANGES. This section is reserved for manual change information which effectively "backdates" the technical areas of the manual to apply to older instruments.

SECTION VIII, SERVICE. This section provides the instrument theory of operation, troubleshooting information, repair techniques, and schematic diagrams.

1-5. SPECIFICATIONS

1-6. The instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument may be tested.

1-7. SAFETY CONSIDERATIONS

1-8. The 5335A Universal Counter is a Safety Class I instrument (provided with a protective earth terminal), designed according to international safety standards. This operating and service manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and keep the instrument in safe condition.

INPUT CHARACTERISTICS (Channel A and B)

Range:
DC coupled, 0 to 100 MHz.
AC 1 MΩ, 30 Hz to 100 MHz.
AC 50 Ω, 200 KHz to 100 MHz.
NOTE: Channel A range 200 MHz when in Frequency A and Ratio modes.
Sensitivity (X1):
25 mV rms sine wave.
75 mV peak-to-peak pulse at minimum pulse width of 5 ns.
Dynamic Range (X1):
75 mV to 5V peak-to-peak, to 100 MHz.
75 mV to 2.5V peak-to-peak, > 100 MHz.
Signal Operating Range (X1, DC):
-5V dc to +5V dc.
Crosstalk (X1): < 500 mV rms, 0 to 100 MHz, or < 250 mV rms, 100 to 200 MHz, sine wave in either channel will not affect other channel.
Trigger Level Range (X1):
Auto Trigger OFF:
Preset: Set to OV dc NOMINAL.
Adjustable: -5V dc to +5V dc.
Auto Trigger ON:
Preset: Set to NOMINAL 50% point of input signal.
Adjustable: NOMINALLY between + and - peaks of input signal.
Auto Trigger (X1):
Range (50% duty cycle):
DC coupled, 30 Hz to 200 MHz.
AC 1 MΩ, 30 Hz to 200 MHz.
AC 50 Ω, 200 kHz to 200 MHz.
Minimum Signal: 100 mV rms.
Duty Cycle Range: 10% to 90%.
Response Time: 3 seconds TYPICAL.
NOTE: Auto Trigger requires a repetitive signal.
Coupling: AC or DC, switchable.
Impedance: 1 MΩ NOMINAL shunted by < 35 pf, or 50 Ω NOMINAL, switchable. In COMMON A, 1 MΩ is shunted by < 50 pf.
Attenuator: X1 or X10 NOMINAL, switchable.
Slope: Independent selection of + or - slope.
Channel Input: SEPARATE or COMMON A, switchable.
Damage Level (AC or DC):
1 MΩ X 1:
DC to 2 kHz ..... 250V (DC+AC rms)
2 to 100 kHz .... (5 X 10^5V rms Hz) /FREQ
> 100 kHz ..... 5V rms
1 MΩ X 10:
DC to 20 kHz ..... 250V (DC + AC rms)
20 to 100 kHz ... (5 X 10^6V rms Hz) /FREQ
> 100 kHz ..... 50V rms
50Ω:
DC to 200 MHz ..... 5V rms

FREQUENCY A

Range: 0 to 200 MHz, prescaled by 2.
LSD Displayed:**
$\frac{1\text{ ns}}{\text{Gate Time}}$ X FREQ. (e.g., 9 digits in a second)
Resolution:
$\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{Trigger Error}^{**}}{\text{Gate Time}} \times \text{FREQ}.$
Accuracy: ± (Resolution) ± (Time Base Error) X FREQ.

PERIOD A

Range: 10 ns to 10^7s.
LSD Displayed:**
$\frac{1\text{ ns}}{\text{Gate Time}}$ X PER. (e.g., 9 digits in a second)
Resolution:
$\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{Trigger Error}^{**}}{\text{Gate Time}} \times \text{PER}.$
Accuracy: ± (Resolution) ± (Time Base Error) X PER.
Period Average: User selects MEAN function, and n = 100, or n = 1,000.

TIME INTERVAL A→B

Range: 0 ns to 10^7s.
LSD Displayed:** 1 ns (100 ps using MEAN).
Resolution: ± (2 X LSD) ± (START Trigger Error**) ± (STOP Trigger Error**).
Accuracy: ± (Resolution) ± (Time Base Error) X TI ± (Trigger Level Timing Error**) ± (2 ns).
Gate Mode: MIN only.
Time Interval Average: User selects MEAN function, and n = 100, or n = 1,000.

TIME INTERVAL DELAY (Holdoff)

For Time A→B, 1/Time A→B, Pulse A, (Time B→A, Pulse B), front panel Gate Adjust control inserts a variable delay between START and enabling of STOP. Electrical inputs during delay are ignored. Delay ranges are same as gate time ranges (100 µs to 4s NOMINAL) for gate modes of Fast, Norm, and Manual. Delay measured by pressing Gate Time key. All other specifications are same as Time Interval A→B.

INVERSE TIME INTERVAL A→B

Range: 10^{-7} to 10^9 units/second.
LSD Displayed, Resolution, and **Accuracy** are inverse of Time Interval A→B specifications. If Time Interval A→B is zero, display will be zero.

RISE AND FALL TIME A

Range: 20 ns to 10 ms transitions with 50 Hz to 25 MHz repetition rates (50% duty cycle).
Minimum Pulse Height: 500 mV peak-to-peak.
Minimum Pulse Width: 20 ns.
Duty Cycle Range: 20% to 80%.
LSD Displayed and **Resolution** are same as Time Interval A→B specifications.
Accuracy: ± (TI Accuracy) ± (Trigger Level Setting Error** at 10% point) ± Trigger Level Setting Error** at 90% point).
Input Mode: Automatically set to COMMON A with 10% and 90% trigger levels.
Gate Mode: MIN only.

PULSE WIDTH A

Range: 5 ns to 10^7s.
Trigger Point Range: 40% to 60% of pulse height.
LSD Displayed and **Resolution** are same as Time Interval A→B specifications.
Accuracy: ± (Resolution) ± (Time Base Error) X PULSE ± (Trigger Level Timing Error**) ± 2 ns.

DUTY CYCLE** A

Range: 1% to 99%, 0 to 100 MHz.
Trigger Point Range: 40% to 60% of pulse height.
LSD Displayed:**
$\frac{1\text{ ns}}{\text{PER}} \times 100\%$.
Resolution:
$\pm \left(\frac{\text{PULSE} + |\text{PULSE Resolution}|}{\text{PER} - |\text{PER Resolution}|} \times 100\% - \text{DUTY CY} \right)$.
Accuracy:
$\pm \left(\frac{\text{PULSE} + |\text{PULSE Accuracy}|}{\text{PER} - |\text{PER Accuracy}|} \times 100\% - \text{DUTY CY} \right)$.
Gate Mode: MIN only.
NOTE: Constant duty cycle required during measurement.

SLEW RATE** A

Range: 50 V/s to 10^8 V/s slew rate with 50 Hz to 25 MHz repetition rates (50% duty cycle).
Minimum Pulse Height, Width, and **Duty Cycle Range** are same as Rise and Fall Time A.
LSD Displayed:**
$\frac{1\text{ ns}}{|\text{RISE/FALL}|}$ X SLEW; three digits maximum.
Resolution:
$\pm \left(\frac{|\text{TRIG LVL B} - \text{TRIG LVL A}| + 20\text{ mV}}{|\text{RISE/FALL}| - |\text{RISE/FALL Resolution}|} - |\text{SLEW}| \right)$.
Accuracy:
$\pm \left(\frac{|\text{TRIG LVL B} - \text{TRIG LVL A}| \times 1.003 + 40\text{mV}}{|\text{RISE/FALL}| - |\text{RISE/FALL Accuracy}|} - |\text{SLEW}| \right)$.
Input Mode: Automatically set to COMMON A with 10% and 90% trigger levels.
Gate Mode: MIN only.

RATIO A/B

Range:
Channel A, 0 to 200 MHz (prescaled by 2).
Channel B, 0 to 100 MHz.
LSD Displayed:**
$\frac{\text{RATIO}}{\text{FREQ} \times \text{Gate Time}}$,
where FREQ is higher frequency after prescaling.
Resolution:
$\pm \text{LSD} \pm \frac{\text{Trigger Error}}{\text{Gate Time}} \times \text{RATIO},$
where Trigger Error is on lower frequency after prescaling.
Accuracy: Same as Resolution.

TOTALIZE A

Range: 0 to 100 MHz.
LSD Displayed:** 1 count of input
HP-IB Output: At end of gate.
Manual:
Count Reset: Via RESET key.
HP-IB Output: Totalize data on-the-fly sent if Cycle mode set to Single. Input frequency range in this mode is 0 to 50 Hz NOMINAL.
Gated:
Count Reset: Automatic after measurement.
Resolution: ± LSD
Accuracy: Same as Resolution.

*Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving TYPICAL or NOMINAL, but nonwarranted performance parameters. Definition of terms is provided at the end of the specification section. For a more detailed explanation, see Application Note 200-4 "Understanding Frequency Counter Specifications".

**See Definitions section for further information.

Table 1-1. Specifications (Continued)

PHASE** A rel B

Range: -180° to 360°, Range Hold off, or 0° to 360°, Range Hold on, with signal repetition rates of 30 Hz to 1 MHz.
Minimum Signal: 100 mV rms.
LSD Displayed:** 0.1°.
Resolution:

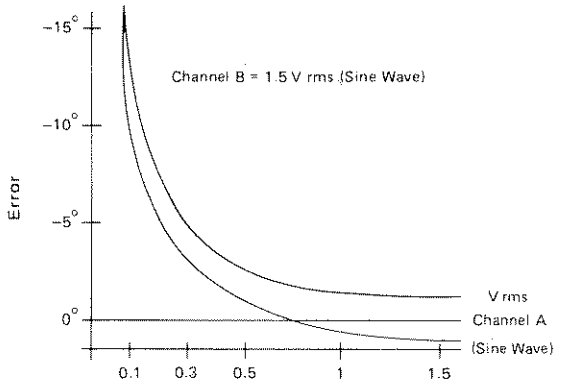
$$\pm\left[\frac{TI_1 + |TI_1\ \text{Resolution}| + TI_2 + |TI_2\ \text{Resolution}|}{2\,[\text{PER A} - |\text{PER A Resolution}|]}\right] \times 360°$$

— PHASE (expressed in ± degrees)

Input Mode: Automatically set to 50% trigger level in A and B channels.
Gate Mode: MIN only.
NOTE: Constant phase required during measurement.
Accuracy:

$$\pm\ \text{Resolution} + \left[\frac{(TI_1 + TI_1\ \text{error}) + (TI_2 + TI_2\ \text{error})}{2\,(\text{PER} + \text{PER}_{\text{error}})}\right] \times 360°$$

— PHASE (expressed in ± degrees)



Typical phase uncertainty for PHASE A rel B measurements where channel B is 1.5 V RMS and channel A is varied in amplitude

NOTE: When signal B is **smaller** than signal A phase measurement uncertainty tends to be positive. TI_1 and TI_2 are times between 50% points of A and B as illustrated in the DEFINITIONS section.

TI_1 error and TI_2 error are the errors due to: 1) Trigger Level Timing Error, 2) Trigger Level Setting Error, and 3) Trigger Error due to noise.

GATE TIME

Range: 100 ns to 10^7s.
LSD Displayed:** Up to three digits with Ext. Arm Enable OFF, 100 ns when ON. MIN Gate Mode display zero.
NOTE: Time displayed and actual gate time may differ due to input signal synchronization of gate.

TRIGGER LEVEL

Range: X1, +5 to -5 volts.
X10, +50 to -50 volts.
Resolution: X1, 10 mV; X10, 100 mV.
Accuracy (X1): ± 20 mV, ± 0.5% of reading.
NOTE: Reading is center point of hysteresis band. When in X10, reading is multiplied by 10.

TIME BASE

Standard Crystal:
Frequency: 10 MHz.
Aging Rate: $< 3 \times 10^{-7}$/month.
Temperature: $< 4 \times 10^{-6}$, 0 to 50°C.
Line Voltage: $< 1 \times 10^{-7}$ for 10% change.
High Stability Crystal: See Option 010.
External Time Base Input: Rear panel BNC accepts 5 or 10 MHz, 200 mV rms into 1 kΩ; 5V rms maximum.
Time Base Out: 10 MHz, >1V p-p into 50 Ω via rear panel.

**See Definitions section for further information.

STATISTICS

Sample Size: Selectable between either N = 100 or N = 1000 samples.
Std. Dev.: Displays a standard deviation of selected sample size.
Mean: Displays mean estimate of selected sample size.
Smooth: Performs a weighted running average and truncates unstable least significant digits from display.
NOTE: Statistics functions performed after Math functions.

MATH

All measurement functions, with exception of GATE TIME and TRIG LVL, may be operated upon by Math functions. Offset, Normalize, and Scale may be used independently or together as follows:

$$\text{Display} = \frac{\text{Measurement} + \text{Offset}}{\text{Normalize}} \times \text{Scale}.$$

Numbers are entered via blue labeled keys. DISABLE key will toggle off and on all active math keys.
Number Value Range: $\pm 1 \times 10^{-9}$ to $\pm 9 \times 10^{9}$.
Last Display: Causes value of previous display to Offset (negative value), Normalize, or Scale all subsequent measurements.
Measurement t-1: Causes each new measurement to be Offset (negative value), Normalized, or Scaled by each immediately preceding measurement.

HEWLETT-PACKARD INTERFACE BUS

Programmable Controls: All measurement functions, Math, Statistics, Reset, Range Hold, Ext. Arm Enable/Slope, Check, Gate Adj. (~1 ms to 1s), Gate Open/Close (gate times to ∞), Gate Mode, Cycle, Preset, Slope, Common A, Auto Trigger.
Special Functions: FREQ B, PULSE B, TIME B→A, TOT A-B, LEARN, MIN, MAX, all internal diagnostic routines.
HP-IB Commands: Trigger, Clear, Remote, Local, Local Lockout, Require Service.
Data Output Rate: Fixed output format consisting of 19 characters plus CR and LF output in TYPICALLY 8 ms. Number of readings second dependent on function, gate, and cycle used (~15 readings second maximum).

GENERAL

Function Memory: Front panel settings for Math, Statistics, Range Hold, Ext. Arm Enable, Gate, and Cycle stored for current function and immediately preceding function. GATE TIME and TRIG LVL do not affect memory.
Gate: Minimum, manual, or continuously variable (NORM/FAST) via Gate Adj. control.
NORM: 20 ms to 4s NOMINAL.
FAST: 100 μs to 20 ms NOMINAL.
MIN: Minimum gate time. Actual time depends on function. For FREQ A, (FREQ B), FREQ C, and PER A, minimum gate = (one period of input) × (prescale factor).
MANUAL: Each press opens or closes gate.
Cycle: Determines delay between measurements.
NORM: No more than 4 readings per second NOMINAL.
MIN: Updates display as rapidly as possible (~15 readings per second, depending on function).
SINGLE: One measurement taken with each press of button.
Arming: Ext. Arm Enable key allows rear panel input to determine Start and/or Stop point of a measurement. External gate defined by both Start and Stop armed. All measurements are armable except Manual Totalize, Phase, and Trigger Level.
Start Arm: + or - slope of arm input signal starts measurement.
Stop Arm: + or - slope of arm input signal stops measurement. When used, Start arm must occur before Stop arm.
Ext. Arm Input: Rear panel BNC accpts TTL into 20 kΩ.
Minimum Start to Stop Time: 200 ns.
Trigger Level Out: DC output into 1 MΩ via rear panel BNC's for Channel A and B; not adjusted for attenuators.
Accuracy at DC (X1): ± 15 mV ± 0.5% of TRIG LVL reading.
Gate Out: TTL level into 1 kΩ; goes low when gate open; rear panel BNC.
Range Hold: Freezes decimal point and exponent of display.
Reset: Starts a new measurement cycle when pressed.
Check: Performs internal self test and lamp test.
Display: 12 digit LED display in engineering format; exponent range of +18 to -18.
Overflow: All measurements which would theoretically cause a display of more than 12 digits will display 12 most significant digits.
Operating Temperature: 0 to 50°C.
Power Requirements: 100, 120, 220, 240 VAC (+5%, -10%), 48-66 Hz; 130 VA max.
Weight: Net, 8.8 kg (19 lbs. 8 oz.); shipping, 13.6 kg (30 lbs.).
Dimensions: 425.5 mm W × 132.6 mm H × 345.4 mm D (16¾" × 5¼" × 13½"), not including removable handles.

OPTIONS

Option 010: High Stability Time Base (Oven)

Frequency: 10 MHz.
Aging Rate: $< 5 \times 10^{-10}$/day after 24 hr. warm up.
Short Term: $< 1 \times 10^{-10}$ rms for 1s average.
Temperature: $< 7 \times 10^{-9}$, 0 to 50°C.
Line Voltage: $< 1 \times 10^{-10}$ for 10% change.
Warm-Up: Within 5×10^{-9} of final value in 20 min.

Option 020: DC Digital Voltmeter

Range: 4 digits, autoranging, autopolarity, in ± 10, ± 100, ± 1000 V ranges.
Sensitivity: 100 μV, 1 mV, 10 mV, 100 mV for ±1V, ± 10V, ± 100V, ± 1000V readings.
LSD Displayed:** Same as sensitivity.
Accuracy (10 min. warm-up): ± 0.045% of reading ± 0.02% of range; for 1000V range, ± 0.06% of reading ±0.02% of range. For 60 days at 24°C ± 5°C, RH < 80%, and gate > 100 ms.
Temperature Coefficient: ± (0.0055% of reading + 0.005% of range)/°C; for 1000V range, ± (0.008% of reading + 0.0005% of range)/°C.

Input Type: Floating pair.
Input Impedance: 10 MΩ ± 1%.
Maximum Input: Hi to Lo, ± 1000V all ranges. Lo to chassis ground, ± 500V.

Response Time: 100 ms to within 1% of final value, within one range.
Normal Mode Rejection: 30 dB at 50/60 Hz.

Effective Common Mode Rejection (1 kΩ unbalanced): ≥ 110 dB at 50/60 Hz.
Filter: Single pole from 10 Hz NOMINAL.

Option 030: 1.3 GHz C Channel

Input Characteristics

Range: 150 MHz to 1.3 GHz, prescaled by 20.
Sensitivity:
10 mV rms sine wave (-27 dBm) to 1 GHz.
100 mV rms sine wave (-7 dBm) to 1.3 GHz.
Sensitivity can be decreased continuously by up to 20 dB NOMINAL, 150 to 1000 MHz and 14 dB NOMINAL, 1 to 1.3 GHz via sensitivity control. Trigger level is fixed at OV NOMINAL.

Dynamic Range:
10 mV to 1 V rms (40 dB), to 1 GHz.
100 mV to 1 V rms (20 dB), to 1.3 GHz.

Signal Operating Range: +5V dc to -5V dc.

Coupling: AC.

Impedance: 50 Ω NOMINAL (VSWR, < 2.5:1 TYPICAL).
Damage Level: ± 8V (DC + AC peak), fuse protected. Fuse located in BNC connector.

Frequency C

Range: 150 MHz to 1.3 GHz, prescaled by 20.
LSD Displayed, Resolution,** and **Accuracy** are same as Frequency A.

Ratio C/A

Range:
Channel A, 0 to 200 MHz (prescaled by 2).
Channel C, 150 to 1300 MHz (prescaled by 20).
LSD Displayed, Resolution,** and **Accuracy** are same as Ratio A/B.

DEFINITIONS

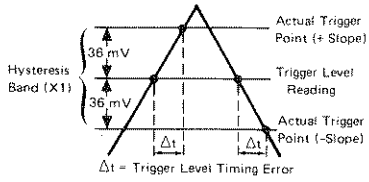
LSD Displayed; Unit value of Least Significant Digit displayed. Calculations should be rounded up to nearest decade, with a 12 digit mantissa maximum. If truncation required, most significant digits are kept.

Trigger Error:

$$\frac{\sqrt{(260\ \mu V)^2 + e_n^2}}{\text{Input slew rate at trigger point}}\ \text{rms typical}$$

where e_n is the rms noise voltage of the input for a 200 MHz bandwidth.

Trigger Level and Trigger Point (X1):



Trigger Level Timing Error (X1): Applies to Time Interval measurements;

$$\frac{36\ \text{mV}}{|\text{Input slew rate at START trigger point}|}$$

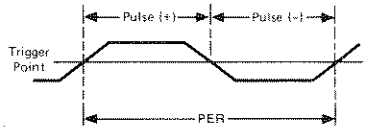
$$\frac{36\ \text{mV}}{|\text{Input slew rate at STOP trigger point}|}$$

Trigger Level Setting Error (X1): Applies to Rise/Fall, Slew, and Phase measurements:

$$\frac{\pm\ 2\%\ \text{of input p-p voltage} \pm 40\ \text{mV}}{\text{Input slew rate at trigger point}}$$

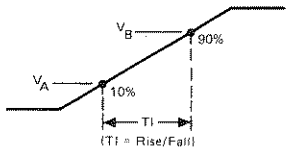
Duty Cycle: Percentage of time a signal is high or low, depending on Slope A setting. Trigger point is high/low dividing point.

$$\text{DUTY CY} = \frac{\text{PULSE}}{\text{PER}} \times 100\%;$$



Slew Rate: Effective slope between 10% and 90% points of rising or falling signal depending on Slope A setting.

$$\text{SLEW} = \frac{V_B - V_A}{TI};$$

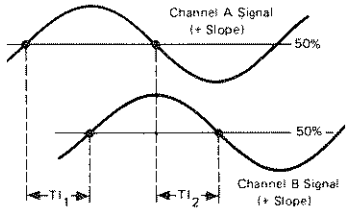


Phase: Angle, with respect to B signal, between 50% points of Channel A and B signals, trigger slopes selected by Channel A and B slope switches.

$$\text{PHASE} = \frac{\frac{TI_1 + TI_2}{2}}{\text{PER}} \times 360°,$$

TI_1 is time between 50% points of A then B signals using slopes defined during Phase measurement.

TI_2 is time between 50% points of A then B signals using complement slopes to TI_1.



1-9. INSTRUMENT IDENTIFICATION

1-10. Hewlett-Packard instruments have a 2-section, 10-character serial number (0000A00000), which is located on the rear panel. The four-digit serial prefix identifies instrument changes. 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. Instruments having higher serial prefixes are covered with a "Manual Changes" sheet included with this manual. If the change sheet is missing, contact the nearest Hewlett-Packard Sales and Service Office listed at the back of this manual. Instruments having a lower serial prefix than that listed on the title page are covered in Section VII.

1-11. ACCESSORIES

1-12. *Table 1-2* lists accessory equipment supplied and *Table 1-3* lists accessories available.

Table 1-2. Equipment Supplied

DESCRIPTION	HP PART NUMBER
Detachable Power Cord 229 cm (7½ feet long)	8120-1378

Table 1-3. Accessories Available

DESCRIPTION	HP PART NUMBER
Rack Mounting Adapter Kits:	
Rack Mount with Handles attached	5020-8874
Rack Mount with Handles removed	5020-8862
Signature Analyzer	Model 5004A
2—1300 MHz Preamplifier	Model HP 10855A
Time Interval Probes	Model 5363B

1-13. DESCRIPTION

1-14. The HP Model 5335A is a Universal Counter capable of measuring input signals up to 200 MHz. The instrument's basic measurement functions include Frequency, Period, Time, Ratio, Totalize, and Volts. The resident microprocessor and MRC (multiple-register-counter) greatly expand the usefulness of the counter by performing post measurement data manipulation. This allows the additional power and convenience of user-defined measurement function keys for Statistical Data, Math Functions, Pulse Width, Rise/Fall Time, Slew Rate, Duty Cycle, and Phase Relationship. Interpolating oscillators, phase-locked to the instrument's time base, allow measurements to be resolved near 1 nanosecond.

1-15. The 5335A front-end provides two independent input channels, featuring matched high performance 200 MHz input amplifiers. Each input channel includes a full compliment of input signal conditioning controls. Additionally, the 5335A offers extensive control of triggering and arming. Most measurements are displayed in engineering notation, with the digits grouped into three's for convenience. Four modes of gate selection are provided on the front panel.

1-16. HP-IB provides remote control of programming and data output.

1-17. OPTIONS

1-18. The following lists the options available for the 5335A. Specifications for the options are given in *Table 1-1*. If an option is included in the initial order, it will be installed at the factory and ready for operation upon receipt. If an option is available for field installation, it will be

supplied as a retrofit kit. For field installation of Options 010, 020, and 030, refer to Section II for kit part numbers and instructions.

Option	Description
010	High Stability Time Base (Oven Oscillator)
020	DC Voltmeter Module
030	C Channel Input Module

1-19. RECOMMENDED TEST EQUIPMENT

1-20. The test equipment listed in *Table 1-4* is recommended for use during performance tests, adjustments, and troubleshooting. Substitute test equipment may be used if it meets the required characteristics listed in the table.

Table 1-4. Recommended Test Equipment

INSTRUMENT	REQUIRED SPECIFICATION	RECOMMENDED HP MODEL	USE
Oscilloscope	200 MHz bandwidth, X-Y capability	1715A	T, A
Digital Voltmeter	20V range, 0.05V resolution	3456A/B	A, T
Signature Analyzer	5335A compatibility	5004A	T
Controller	HP-IB compatible	9825A	OV
	• HP-IB interface for 9825A	98034A	OV
	• String-Adv. Programming ROM	98210A	OV
	• Plotter-Gen I/O — Extended I/O	98214A	OV
Function Generator		3312A	A, P, OV
Signal Generator	200 MHz bandwidth	8654A/B	OV, P
50Ω RF Termination	SMC type	1250-0839	T
Synthesized Signal Generator	1300 MHz, 150 mV rms	8660B/86602B	A, OV, P
Front Panel switch replacement tool (heat stacking tool)		5020-8160	T
Flat Ribbon assembly	26-AWG, 18-conductors	8120-2463	T

T = Troubleshooting
A = Adjustments
P = Performance Tests
OV = Operational Verification

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information for unpacking, inspection, storage, and installation.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the instrument for visible damage (scratches, dents, etc.). If the instrument is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual.) Keep the shipping carton and packing material for the carrier's inspection. The Hewlett-Packard Sales and Service Office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. PREPARATION FOR USE

2-6. Power Requirements

2-7. The 5335A requires a power source of 100-, 120-, 220-, or 240-volt ac, +5%, -10%, 48 to 66 Hz single phase.

2-8. Line Voltage Selection

2-9. The HP 5335A Universal Frequency Counter is equipped with a power module that contains a printed circuit line voltage selector card to select 100-, 120-, 220-, or 240-volt ac operation. Before applying power, the pc selector card must be set to the correct position and the correct fuse must be installed as described below.

CAUTION

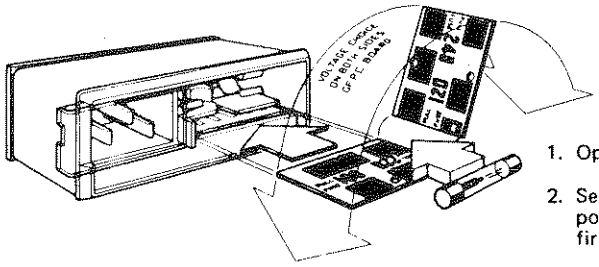
Before connecting the instrument to ac power lines, be sure that the voltage selector is properly positioned as described below.

2-10. Power line connections are selected by the position of the plug-in pc selector card in the module. When the card is plugged into the module, the only visible markings on the card indicate the line voltage to be used. The correct value of line fuse, with a 250-volt rating, must be installed after the card is inserted. This instrument uses a 1A fuse (HP Part No. 2110-0360) for 100/120-volt operation; a 0.5A fuse (HP Part No. 2110-0202 for 220/240-volt operation.

2-11. To convert from one line voltage to another, the power cord must be disconnected from the power module before the sliding window covering the fuse and card compartment can be moved to expose the fuse and circuit card. See *Figure 2-1.*

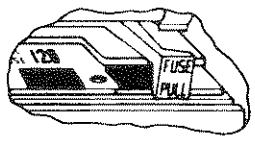
2-12. Pull on the fuse lever to remove the fuse and then pull the card out of the module. The fuse lever must be held to one side to extract and insert the card. Insert the card so the marking that agrees with the line voltage to be used is visible.

2-13. Return fuse lever to normal position, insert correct fuse, slide plastic window over the compartment, and connect the power cord to complete the conversion.



SELECTION OF OPERATING VOLTAGE

1. Open cover door and rotate fuse-pull to left.
2. Select operating voltage by orienting PC board to position desired voltage on top-left side. Push board firmly into module slot.
3. Rotate fuse-pull back into normal position and re-insert fuse in holders, using caution to select correct fuse value.



Operating voltage is shown in module window.

Figure 2-1. Line Voltage Selection

2-14. Power Cable

WARNING

BEFORE SWITCHING ON THIS INSTRUMENT, THE PROTECTIVE EARTH TERMINALS OF THIS INSTRUMENT MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

2-15. The 5335A is shipped with a three-wire power cable. When the cable is connected to an appropriate ac power source, this cable connects the chassis to earth ground. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to *Figure 2-2* for the part numbers of the power cable and plug configurations available.

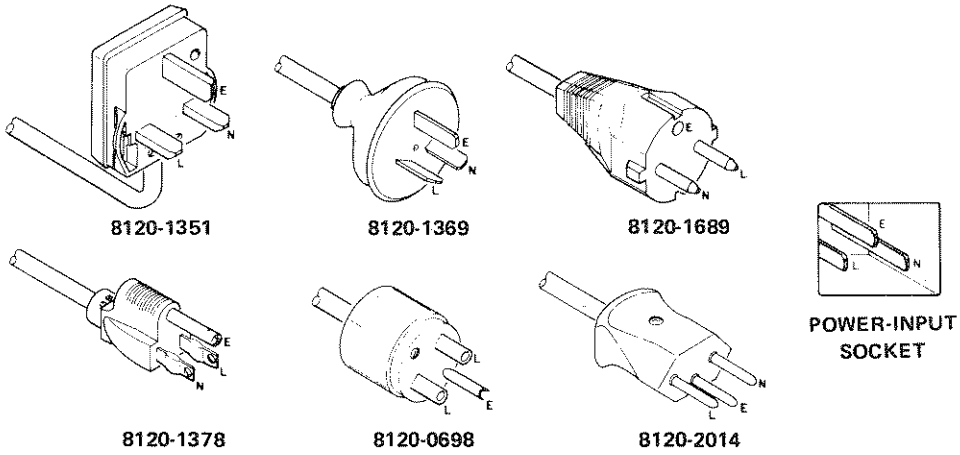


Figure 2-2. Power Cable HP Part Numbers versus Mains Plugs Available

2-16. Operating Environment

2-17. TEMPERATURE. The 5335A may be operated in temperatures from 0°C to +55°C.

2-18. HUMIDITY. The 5335A may be operated in environments with humidity up to 95%. However, it should be protected from temperature extremes which cause condensation in the instrument. Option 020, DVM, may be operated in environments with humidity up to 80%.

2-19. ALTITUDE. The 5335A may be operated at altitudes up to 4,600 metres (15,000 feet).

2-20. HP-IB INTERCONNECTIONS

2-21. HEWLETT-PACKARD INTERFACE BUS. Interconnection data concerning the rear panel HP-IB connector is provided in *Figure 2-3*. This connector is compatible with the HP 10631A/B/C/D HP-IB cables. The HP-IB system allows interconnection of up to 15 (including the controller) HP-IB compatible instruments. The HP-IB cables have identical "piggyback" connectors on both ends so that several cables can be connected to a single source without special adapters or switch boxes. System components and devices may be connected in virtually any configuration desired. There must, of course, be a path from the calculator (or other controller) to every device operating on the bus. As a practical matter, avoid stacking more than three or four cables on any one connector. If the stack gets too large, the force on the stack produces great leverage which can damage the connector mounting. Be sure each connector is firmly (finger tight) screwed in place to keep it from working loose during use.

2-22. CABLE LENGTH RESTRICTIONS. To achieve design performance with the HP-IB, proper voltage levels and timing relationship must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform properly. Therefore, when interconnecting an HP-IB system, it is important to observe the following rules:

a. The total cable length for the system must be less than or equal to 20 metres (65 feet).

b. The total cable length for the system must be equal to or less than 2 metres (6.6 feet) times the total number of devices connected to the bus.

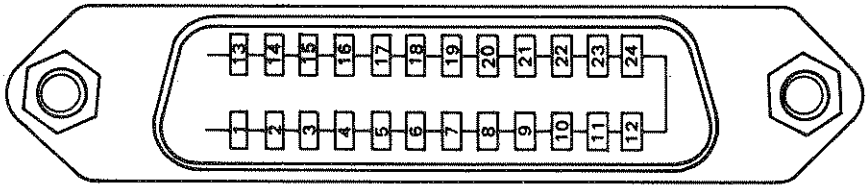
c. To total number of instruments connected to the bus must not exceed 15.

2-23. 5335A HP-IB Address

2-24. The 5335A contains a rear panel HP-IB instrument address selection switch. There are five switches, designated A_5, A_4, A_3, A_2, A_1 which are used to select the address. Instructions for setting and changing the address are provided in Section III of this manual along with programming codes. When the instrument is turned on, the setting of the address switches is momentarily displayed in decimal.

2-25. HP-IB Descriptions

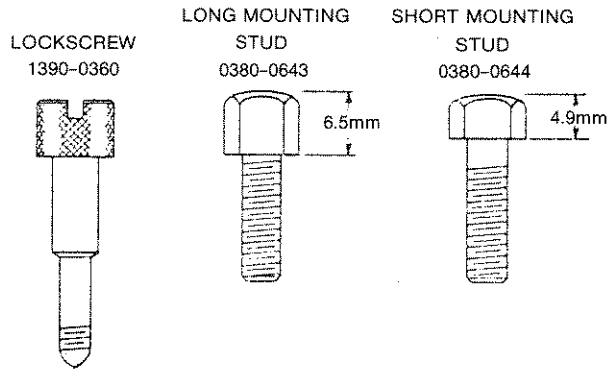
2-26. A description of the HP-IB is provided in Section III of this manual. A study of this information is necessary if the user is not familiar with the HP-IB concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1978, titled *"IEEE Standard Digital Interface for Programmable Instrumentation"*.



PIN	LINE	
1	DIO1	
2	DIO2	
3	DIO3	
4	DIO4	
13	DIO5	
14	DIO6	
15	DIO7	
16	DIO8	
5	EOI	
17	REN	
6	DAV	
7	NRFD	
8	NDAC	
9	IFC	
10	SRQ	
11	ATN	
12	SHIELD-CHASSIS GROUND	
18	P/O TWISTED PAIR WITH PIN 6	THESE PINS ARE INTERNALLY GROUNDED
19	P/O TWISTED PAIR WITH PIN 7	
20	P/O TWISTED PAIR WITH PIN 8	
21	P/O TWISTED PAIR WITH PIN 9	
22	P/O TWISTED PAIR WITH PIN 10	
23	P/O TWISTED PAIR WITH PIN 11	
24	ISOLATED DIGITAL GROUND	

CAUTION

The 5335A contains metric threaded HP-IB cable mounting studs as opposed to English threads. Metric threaded HP 10631A, B, C, or D HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follows.



Logic Levels

The Hewlett-Packard Interface Bus logic levels are TTL compatible, i.e., the true (1) state is 0.0V dc to 0.4V dc and the false (0) state is +2.5V dc to +5.0V dc.

Programming and Output Data Format

Refer to Section III, Operation

Mating Connector

HP 1251-0293; Amphenol 57-30240.

Mating Cables Available

HP 10631A, 1 metre (3.3 ft.), HP 10631B, 2 metres (6.6 ft.),
HP 10631C, 4 metres (13.2 ft.), HP 10631D, 1/2 metre (1.6 ft.).

Cabling Restrictions

1. A Hewlett-Packard Interface Bus System may contain no more than 2 metres (6.6 ft.) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus System is 20.0 metres (65.6 ft.).

Figure 2-3. Hewlett-Packard Interface Bus Connection

2-27. FIELD INSTALLATION OF OPTIONS

2-28. To obtain the necessary parts for installation of an option, order by part number as listed in *Table 2-1.*

Table 2-1. Field Installable Options

OPTION	DESCRIPTION	DESIGNATOR	PART NUMBER	QTY
010	A15 Oven Oscillator Assembly	A15	10811-60101	1
	6/32 × 5/16 screw		2360-0115	2
	Fiber washer		3050-0005	2
	Retrofit Kit Number (includes all parts in Option 020)		**05335-60202**	
020	A8 DVM Board Assembly	A8	05335-60008	1
	DVM Front Panel		05335-00007	1
	Positive Cable Assembly	A8W1	05335-60110	1
	Negative Cable Assembly	A8W2	05335-60111	1
	Plastic nut (3/8 in. - 13 mm)		2950-0144	2
	Retrofit Kit Number (includes all parts in Option 030)		**05335-60203**	
030	A9 Channel C Board Assembly	A9	05335-60009	1
	Channel C Front Panel		05335-00008	1
	Channel C RF Cable Assembly	A9W1	05335-60105	1
	Channel C Sensitivity Cable Assembly	A9W2	05335-60106	1
	Pre-amp Power Cable Assembly	A9W3	05335-60109	1
	Fuse holder		05305-20104	1
	Teflon insulator		05305-20105	1
	Special BNC		05305-60205	1
	SMC Connector		05305-60206	1
	Hex nut		0590-0038	1
	0.12A mini-axial fuse		2110-0301	1
	Lockwasher		2190-0068	1
	Plastic nut (3/8 in. - 13 mm)		2950-0144	1

2-29. Field Installation Of Option 010

2-30. To install Option 010, first obtain parts listed in *Table 2-1*, then proceed as follows:

a. Disconnect the power cable from the 5335A (safety precaution).

WARNING

THE AC POWER CIRCUITS TO TRANSFORMER T1 AND THE UNREGULATED DC VOLTAGE ARE STILL ON EVEN WHEN THE POWER SWITCH IS OFF. CONTACT WITH THESE CIRCUITS CAN RESULT IN INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT.

b. Remove the top and bottom covers of the 5335A.

c. Remove electrical lead (jumper), P/N 8159-0005, that connects A4U1B(6) and U2B(6).

d. Apply power to the 5335A and check all voltages at A4XA15 connector per A4 schematic diagram, especially A4XA15 (14).

e. Disconnect the power cable from the 5335A.

f. Plug the oven oscillator (either 10544A or 10811A) into A4XA15 and secure oven oscillator to A4 assembly from underneath, with two screws (6/32 × 5/16) and fiber washer provided (P/N 3050-0005).

g. Restore top and bottom covers to the 5335A.

h. Apply power to the 5335A and verify counter operation by performing the operational verification in Section IV.

2-31. Field Installation Of Option 020

2-32. To install Option 020, order parts listed in *Table 2-1* or order Retrofit Kit P/N 05335-60202, then proceed as follows:

a. Disconnect power cable from the 5335A (safety precaution).

b. Remove the top and strapped-side cover (right side) of the 5335A.

c. Remove blank panel by removing the two 5/16 nuts that holds the blank panel to the front panel.

d. Install Positive cable assembly, P/N 05335-60110, through the upper hole of the DVM front panel (P/N 05335-00007) and the corresponding hole in the main frame, and secure the cable and panel with 3/8 in. (13 mm) plastic nut, P/N 2950-0144, to the frame.

e. Install Negative cable assembly, P/N 05335-60111, through the lower hole of the DVM front panel and the corresponding hole in the main frame, and secure it with plastic nut.

f. Use tie-wraps to bind the positive and negative cable assemblies together.

g. Connect the Positive cable (red/blue) assembly to terminal marked "INPUT" on the circuit side of the DVM board assembly; connect the Negative cable (black) assembly to terminal marked "COM" on same side of board.

h. Install DVM board into A2XA8 connector of the A2 amplifier support board (see assembly locator, *Figure 8-24*); secure A8 with two pozidriv screws to main frame.

i. Perform Option 020 adjustment as described in paragraph 5-17.

j. Replace side and top covers.

2-33. Field Installation Of Option 030

2-34. To install Option 030, order parts listed in *Table 2-1* or order Retrofit Kit 05335-60203, then proceed as follows:

a. Disconnect power cable from the 5335A (safety precaution).

b. Remove top and strapped-sided cover of the 5335A.

c. Remove blank panel by removing the two 5/6 hex nuts that holds blank panel to the main frame.

d. Install Special Input BNC (provided) through the lower hole of the Channel C front panel (P/N 05335-00008) and the corresponding hole in the main frame, and secure the special BNC and panel with hex nut, P/N 0590-0038, to the frame as illustrated in *Figure 2-4*.

e. Connect the brass SMC connector on one end of A9W1 to the INPUT C BNC; connect the other end of A9W1 to A9J3.

f. Install Preamp Power Cable assembly (A9W3) through the middle hole of Channel C front panel, and secure it with plastic nut, P/N 2950-0144, to the frame; connect the other end of A9W3 red and white wires to A9J4 (to test pins marked "R" and "W").

g. Install Sensitivity cable assembly (A9W2) through the upper hold of Channel C front panel and secure it with a 5/16 hex nut; install the Channel C sensitivity control knob; connect the other end of A9W2 cable to A9J1.

h. Install A9 Channel C board into A2XA9 connector of the A2 amplifier support board (see assembly locator, *Figure 8-24*). Secure A9 with a pozidriv screw to main frame.

i. Perform Option 030 adjustment as described in paragraph 5-19.

j. Replace side and top covers.

2-35. When Option 030 C Channel is installed, the operator may be required to replace the input BNC fuse. This is a 1/8A fuse (HP Part No. 2110-0301) which is located within the INPUT C BNC connector (see *Figure 2-4* for details). To replace the fuse, disconnect the power cord, unscrew the special BNC barrel (P/N 05305-60205) and, with needle-nose pliers, remove and replace the fuse. Reinstall the BNC barrel, and tighten using a BNC cable connector. Be careful not to overtighten.

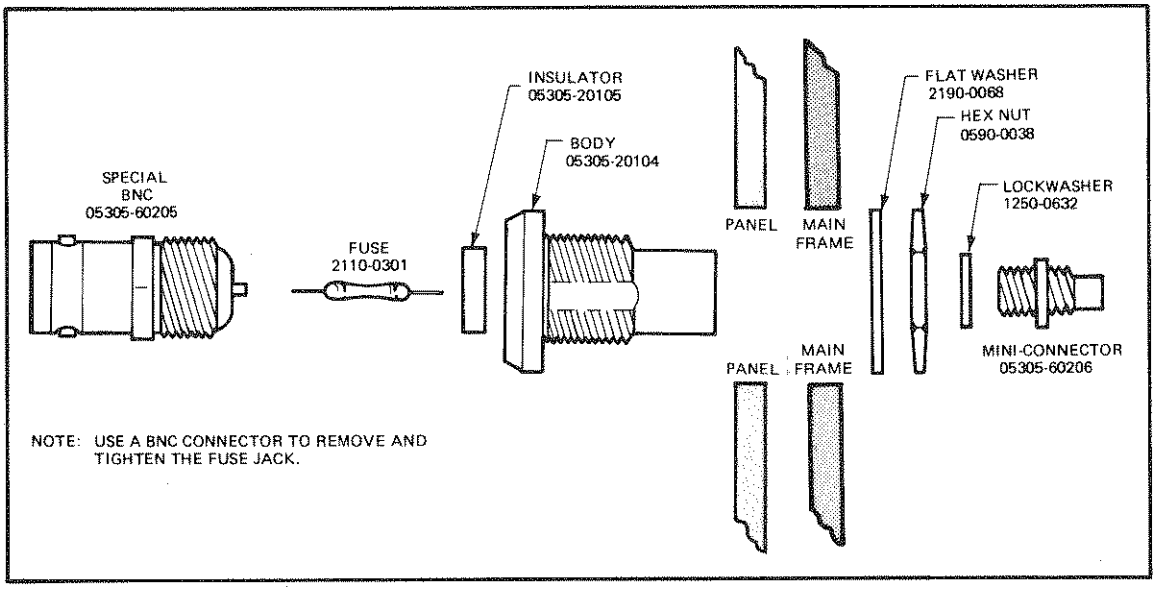


Figure 2-4. Details of Input Connector J1 and Fuse Mounting

2-36. STORAGE AND SHIPMENT

2-37. Environment

2-38. The instrument may be stored or shipped in environments within the following limits:

TEMPERATURE	-40°C to +75°C
HUMIDITY	Up to 95%
ALTITUDE	7,620 metres (25,000 feet)

2-39. The instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-40. Packaging

2-41. ORIGINAL PACKAGING. Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-42. OTHER PACKAGING. The following general instructions should be used for repacking with commercially available materials:

a. Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center, attach tag indicating type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

CAUTION

The instrument front handles must be left attached to avoid damage to controls.

c. Use a layer of shock-absorbing material 70 to 100 mm (3- to 4-inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

SECTION III
OPERATION AND PROGRAMMING

3-1. INTRODUCTION

3-2. This section provides the operating and programming information for the HP 5335A Universal Counter. It explains the operating characteristics, operating functions, controls, and all modes of operation. Detailed operating instructions, an operator's check, and remote programming information are provided in this section.

3-3. OPERATING CHARACTERISTICS

3-4. The 5335A is a system and benchtop universal counter. Basic functions include frequency, period, time, ratio, totalize, and volts. Inputs enter into two 200 MHz matched amplifiers and are measured by the multiple register counter IC (MRC). Raw data from the measurements are used by the counter's microprocessor to compute and format the result for display. Extensive triggering and arming of the counter give the user great control over measurements. Math and statistical functions give the user flexibility over how the measurement is displayed. The operating range, resolution and accuracy for each individual functional mode of operation is given in the Specifications, *Table 1-1*.

3-5. Description, operating and programming instructions for Options 020 and 030 are provided in this section.

3-6. LOCAL OPERATION

3-7. The local operation of the HP 5335A is presented through the following subsections:

GENERAL OPERATION INFORMATION. The general operation information (starting with paragraph 3-13) describes a variety of functionally nonspecific operating instructions, operating characteristics, and indications. It provides a general overview of the front panel operating controls and indicators.

FRONT AND REAR PANEL FEATURES. The front and rear panel features provides a complete functional description of all operator controls and indicators. This information compliments and expands on the front and rear panel foldouts, *Figures 3-1* and *3-2*.

DETAILED OPERATING INSTRUCTIONS. The detailed operating instructions (starting with paragraph 3-93) present the most comprehensive information about each specific measurement function. They are categorized by the labeled function mode (e.g., FREQ A, PER A), and provide simple keystroke examples.

3-8. Additionally, the top cover of the instrument provides an Operating Instructions label. This label summarizes the general operating instructions for most of the counter's functions. A copy of the Operating Instructions label is shown on a foldout at the end of this section.

3-9. REMOTE OPERATION

3-10. A description of remote programming operation begins with paragraph 3-151. A good working knowledge of local operation is essential for HP-IB programming, as most of the Data messages contain the same keystroke-like sequences. Where applicable, throughout this section,

program examples are provided. The information within the Remote Operation includes the following:

General HP-IB Information	Learn Mode Programming
Interface Function	SRQ and Status
Bus Messages	Program Execution/Response Times
Address Selection	Output Format
Device Command Definitions	Output Modes
Device Commands	Programming Examples
Default and Power-up States	

3-11. OPERATOR'S SELF-CHECK PROCEDURE

3-12. This section, beginning with paragraph 3-225, includes checks that allow the operator to make a quick evaluation of the counter's operation. These checks will fundamentally verify the following:

Keyboard
Display and Annunciators
Memory; RAM and ROM
HP-IB

3-13. GENERAL OPERATION INFORMATION

WARNING

BEFORE THE INSTRUMENT IS SWITCHED ON, ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTOTRANSFORMERS AND DEVICES CONNECTED TO IT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET. ANY INTERRUPTION OF THE PROTECTIVE EARTH GROUNDING WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY.

ONLY THE 250V FUSES WITH THE REQUIRED RATED CURRENT AND SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORT CIRCUITED FUSEHOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

3-14. Power-Up/Self-Check

3-15. When the counter is turned on, an internal check is made of several major components in its circuitry. During this cycle, all front panel segments and indicators will light momentarily, followed by the momentary display of the instrument's decimal HP-IB address (e.g., HP-IB Addr 28).

3-16. After the power-up sequence, the counter will *initialize* itself. All math and statistics will be off, the function will be Frequency A, and the gate and cycle modes will be in Norm. All of the input controls will be set according to their switch positions.

3-17. Any failures during the power-up cycle will disable the counter and produce a display of numbered error or fail messages. Within the 5335A, fail messages generally indicate a hardware failure, and error messages indicate the user has attempted an improper operation. Refer to Error Messages, paragraph 3-229.

3-18. Display

3-19. The number to be displayed is formatted into engineering notation with the digits grouped into threes for convenient reading and an exponent with a range of ±18. When dis-

playing 11 and 12 digit numbers, the grouping is omitted. The number of digits displayed is determined by the function and gate time. In most cases, a longer gate time gives more digits.

3-20. When resolution calls for more than 12 digits no overflow results. Instead, the MSD's are retained, and the display is reduced to 12 digits.

3-21. The exponent range of the display is ±18. If a number cannot be displayed the display will show one of these two numbers.

0. +19 ..... (0×10^{19}) if the number is too large.
0. −19 ..... (0×10^{-19}) if the number is too small.

NOTE

If you suddenly see two less digits in frequency, period, or time interval measurements, there may be a failure in the interpolators. If you press RESET you may get these digits back, or you may get a FAIL message. See the section on diagnostics in Section VIII.

3-22. Annunciators indicate the Hertz, Seconds, and Volts units. For some functions the units are not indicated, but assumed, such as degrees for phase measurements. For slew rate, both the Volts and Seconds annunciators are on to indicate Volt/second.

3-23. The GATE light shows the status of the counter's gate. Before the measurement starts, this light is off, indicating that the gate is closed. During the measurement, the light is on, indicating that the gate is open.

3-24. The TALK, LISTEN, SRQ, and REMOTE lights monitor the status of the HP-IB. Refer to Programming, paragraph 3-151.

3-25. Keyboard

3-26. The keyboard is divided into several groups, according to the purpose of the keys. From the left, we have MATH/STATISTICS, FUNCTION, GATE/CYCLE, INPUT, and if installed, INPUT C (Option 030), and VOLTS (Option 020). With exceptions, each group operates fairly independently of the others. The operation of each front panel key, within each keyboard group, is presented in Front Panel Features, beginning with paragraph 3-37.

3-27. Key Indicators

3-28. The operation of individual keys is relatively straightforward. Indicator LED's, in the center of many keys, represent that key's status. A steady "on" LED indicates that the key's labeled function is active or in-effect. An "off" LED indicates that the key's labeled function is not active or disabled. Many keys operate in a toggle on/off fashion. The blue colored keys in the MATH function group can be programmed. A "blinking" LED within a blue key is used as a "prompt" for the operator. It indicates that it is waiting for a data entry. Number entries are made from the keys labeled in blue. Refer to paragraph 3-72.

3-29. Keyboard Memory

3-30. To avoid having to re-enter math constants, etc., whenever switching between two functions repetitively, the keyboard has one level of memory. This allows you to set up two functions modes, each with their own set-ups. The key set-ups for each of the keys in the MATH, STATISTICS, FUNCTION, GATE, and CYCLE groups are automatically memorized. Controls within the INPUT group are not memorized.

3-31. Reading the convenience functions GATE TIME or TRIG LVL will not affect the keyboard memory. Any changes to the key set-ups while in these functions will be carried back to the set-up of the function that was active before. GATE TIME and TRIG LVL are not affected by MATH and STATISTIC functions. For example:

1. Presently in FREQ A, we enter an OFFSET of 123.
2. We switch to PER A, where we see by the OFFSET key indicator, that the OFFSET is off.
3. Selecting FREQ A, we see that the OFFSET is again 123.
4. We then select TRIG LVL, and then GATE TIME.
5. While in GATE TIME we set the GATE MODE to FAST.
6. Returning to FREQ A, we still have an OFFSET 123, but also, the GATE MODE is now in FAST.
7. We select PER A, then PULSE A. Now, when we return to FREQ A, all set-ups go to the default positions.

3-32. Key Default

3-33. The initialized and/or default positions for all operator keys and controls are as follows:

Default	MATH	OFF
	STATISTICS	OFF
	RANGE HOLD	OFF
	EXT ARM ENABLE	OFF
	CYCLE	NORM
	GATE MODE	NORM
	GATE MODE (for TIME, 1/TIME, RISE/FALL, SLEW, DUTY CYC, PHASE)	MIN

Initialize Power-Up	FUNCTION	FREQ A
	GATE MODE	NORM
	CYCLE	NORM
	RANGE HOLD	OFF
	EXT ARM ENABLE	OFF
	MATH	OFF
	STATISTICS	OFF
	INPUT, REAR	As set by controls

3-34. Special Function Mode

3-35. The front panel controls allow for a direct, key-per-function selection from 16 labeled function operations. A sequence of keystrokes will allow the operator to enter a *Special Function Mode*, in which the original 16 functions, plus 4 additional unlabeled functions and an extensive diagnostic mode can be accessed. The four unlabeled "phantom" functions are:

FREQ B
PULSE B
TIME B→A
TOTALIZE A–B

3-36. The diagnostic mode allows the user considerable flexibility during troubleshooting through a set of 33 discrete, self-diagnostic test routines. A more complete description of the Special Function Mode and complete procedures using the diagnostic routines are provided in Section VIII.

3-37. FRONT PANEL FEATURES

NOTE

To enhance the descriptions of Front Panel features, fold out *Figure 3-1*, page 3-15, while reviewing these paragraphs.

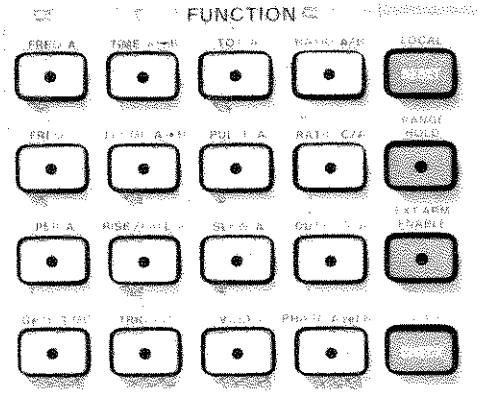
3-38. The front panel controls, indicators, and connectors are located and briefly described in *Figure 3-1*. A good quick reference of the operating details for each function mode is provided in the Function Key Reference Summary, *Table 3-2*.

3-39. The following paragraphs describe the general purpose and use of the operator keys and controls. They are discussed by functional grouping, as follows:

FUNCTION GROUP
GATE CYCLE GROUP
INPUT GROUP
TRIGGERING (MANUAL/AUTO)
MATH GROUP
STATISTICS GROUP
INPUT C (OPTION 030)
VOLTS (OPTION 020)

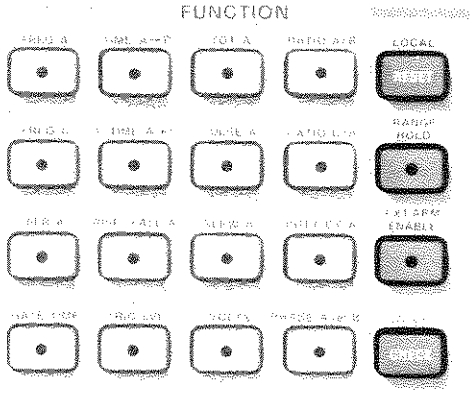
3-40. Function Group

3-41. Function selection for the HP 5335A is done via a simple key per function keyboard. Sixteen function modes (labeled in black) are directly accessible from the four leftmost columns of keys. The indicator LED within the key identifies which one of the functions is active. Several more functions are available, accessed through the HP-IB, and other means (see Special Function Mode, paragraph 3-34, and Diagnostics in Section VIII). During the programming sequence for the MATH group, the functions of these 16 keys (and CHECK) are reassigned to the numeric and special entry values labeled in blue.



3-42. Within the FUNCTION group, the rightmost column contains four keys assigned miscellaneous functions.

3-43. The RESET key will reset the counter and start a new measurement. When pressed, all segments and decimal points in the display should light, momentarily. RESET will not affect any current function selection or key set-ups. If you are currently in GATE TIME or TRIG LEVELS, pressing RESET returns you to the function you were previously in.

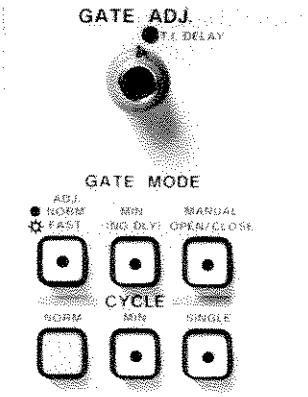


3-44. RANGE HOLD can be used to freeze the decimal point placement and exponent value of the display. Least significant digits are allowed to "fall off" the right of the display. However, the display is programmed to avoid a loss of the most significant digit. RANGE HOLD is useful when the value in the display is rapidly changing in magnitude. In the PHASE A rel B mode, RANGE HOLD will select and maintain the 0° to 360° measurement display range. RANGE HOLD toggles on and off with each press of the key.

3-45. The EXT ARM ENABLE key is used to enable or disable external arming of measurements. When it is on, the Start and/or Stop of the measurement can be armed via a signal connected to the rear panel. When off, the counter ignores the rear panel signal. EXT ARM ENABLE toggles on and off with each press of the key.

3-46. The CHECK key puts the instrument into one of two levels of self-check routines. Pressing the key once will enter a "lamp test loop" flashing all front panel annunciators, key indicators and segments, checking the MRC, and memory circuits. Pressing and holding the key (for approximately 3 seconds) will place the instrument into an extended diagnostic loop of several major circuits (i.e., amplifiers, time base, counting circuitry, and display). This test requires that the user connect the rear panel Time Base Out to the Channel A input, put both channels to 50Ω, and remove any signal to Channel B. See Operational Verification section for further details. Any failures during the diagnostic loop will result in the display of either a numbered FAIL or ERROR message. FAIL messages generally indicate a circuit failure. ERROR messages indicate the user has attempted an improper operation; for example, a misspelled HP-IB command. Refer to ERROR MESSAGES, paragraph 3-229. To exit either self-check routine, press any other function key.

3-47. Gate/Cycle Group



3-48. The GATE ADJ control sets the length of the gate time, continuously adjustable through the ranges set by the GATE MODE keys. In certain time interval functions (i.e., TIME A→B, 1/TIME, PULSE), the actual gate time is automatically determined, dependent on the input signal. In these modes, the gate time controlled by GATE ADJ, can be used as a Hold-Off Delay for the Stop channel. If a T.I. DELAY mode is selected (any GATE MODE except MIN) the red T.I. DELAY indicator will light. In these functions, the normal operation gate mode is MIN if no delay is desired. For more information about the GATE ADJ control during time domain measurements, refer to TIME A→B, paragraph 3-102.

3-49. Gate mode NORM and FAST are two ranges of adjustable gate times. NORM has a range of nominally 20 ms to 4 seconds, and FAST has a range of nominally 100 μs to 20 ms. The one key causes the mode to toggle between NORM and FAST.

3-50. Gate mode MIN specifies the shortest possible gate time. This means that the signal itself usually determines the time. For example, the Frequency A measurement uses a divide-by-2 prescaler. The gate time in this function would be determined by 2 periods of the input. MIN mode is usually the mode used when External Stop Arm is used.

3-51. The MANUAL OPEN/CLOSE key lets you specify the gate time manually. In the manual mode, each press of the key toggles the gate either open or closed. The status of the gate is indicated by the GATE annunciator. Manual mode allows very long gate times.

3-52. Cycle mode NORM specifies about a 250 ms wait time between measurements. This slows the display down to a rate that is more convenient for viewing short gate time measurements.

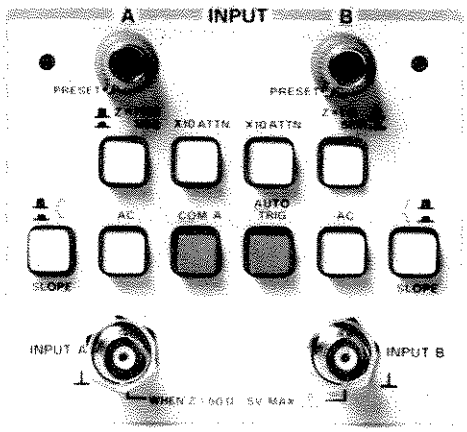
3-53. MIN mode tells the counter to start the next measurement as soon as possible. This gives the most rapid updating of the display.

3-54. SINGLE lets you start measurements upon manual command. Each press of the key starts one measurement. This measurement stays on the display until the key is pressed again (RESET will also start a new measurement).

NOTE

A reminder that this counter uses synchronized gating, and that the input signal also determines the length of the gate time. Additionally, several modes of Arming are available, see Rear Panel Features.

3-55. Input Group



3-56. The INPUT GROUP contains the A Channel and B Channel input BNC's, signal conditioning controls, and triggering controls.

3-57. The SLOPE key determines which edge of the signal to trigger on. For some functions it also takes on other uses. For PULSE, the Slope A switch is used to specify the positive (⎍) or negative (⎏) pulse. For RISE/FALL, it is used to specify whether it is RISE or FALL time being measured. SLOPE A has a similar purpose for SLEW. For DUTY CYC, it determines whether to display the percentage high (⎍) or low (⎏).

3-58. The AC key, when pressed, makes the respective input amplifier ac coupled. This is useful for ignoring dc offsets on a signal.

3-59. The input impedance of each channel is selected by the Z=1MΩ/50Ω key. When in the 50Ω position, the input damage level is 5V.

3-60. For inputs greater than the 5V dynamic range, or to reduce the sensitivity of the front end, the X10 ATTEN key lets you attenuate the signal by a factor of 10. The 5V damage level still applies, however, when Z = 50. For convenience, the trigger level reading function will arithmetically multiply the display by 10 when the attenuators are on.

3-61. Triggering (MANUAL/AUTO)

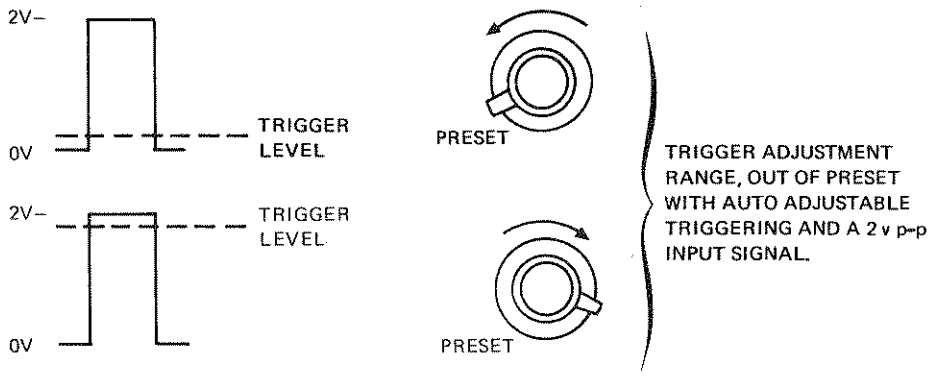
3-62. The HP 5335A has an extensive set of triggering features which make accurate measurements on input signals easier for the user. Four modes of triggering, listed below, are directly accessible from the front panel or via the HP-IB. A fifth mode (see paragraph 3-67) is automatically selected when in the RISE/FALL A or SLEW A function modes.

Manual Adjustable
Manual PRESET
Auto Adjustable
Auto PRESET

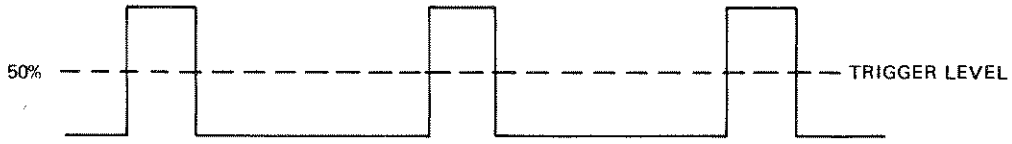
3-63. The Manual Adjustable mode uses the trigger adjustment controls to set the trigger level anywhere between +5 and -5 volts. The actual trigger levels for both channels can be monitored by pressing the TRIG LVL function key. When the control is fully ccw (into detent) the Manual PRESET mode is selected, and the trigger level is set to Ø volts.

3-64. When the Auto Trigger mode is selected, the trigger adjustment controls assume a wholly different meaning. Pressing the AUTO TRIG key selects the Auto Adjustable triggering mode. The range of adjustability for the control is now dependent on the amplitude of the input signal, with the peaks of the input signal nominally setting the control limits.

3-65. Assume, for example, an input signal of 2 volts p-p, with Auto Adjustable triggering selected. The range of the trigger adjustment control outside of PRESET will automatically reduce from ±5V to ØV→+2V. This allows a much finer control over the trigger level setting. The actual trigger levels for both channels can be monitored by pressing the TRIG LVL function key.

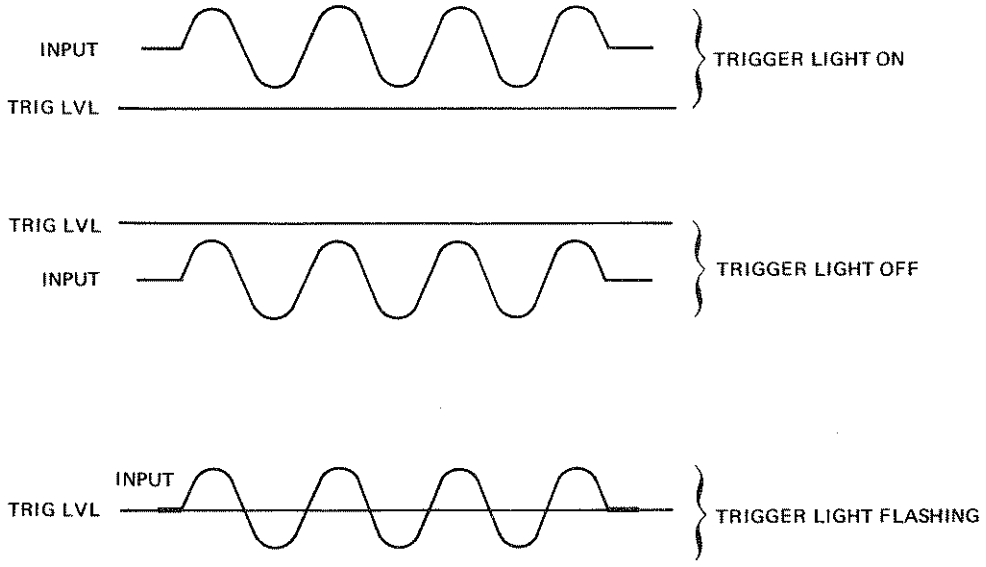


3-66. Pressing the AUTO TRIG key, with the trigger adjustment control in PRESET, selects the Auto PRESET triggering mode. In this mode, peak detectors on both channels determine the peaks of the input signal. The trigger level is automatically set to the 50% point of the peaks, regardless of the dc offset of the input.



3-67. An additional mode of triggering is used by the functions RISE/FALL A and SLEW A. The peaks of the input signal are determined and the 10% and 90% points are found. These dc levels are assigned as trigger levels by the respective SLOPE keys, to Channels A and B. Pressing TRIG LVL will display the 10% and 90% levels determined.

3-68. The front panel 3-state Trigger Lights provide a visual indication of each channel's triggering status. When the light is on, the trigger level is set too low (or the signal is too high). When the light is off, the trigger level is set too high (or the signal is too low). When the light is flashing, the trigger level is set within the peak limits of the input signal (± the hysteresis offset of the input amplifier) and the channel is triggering.

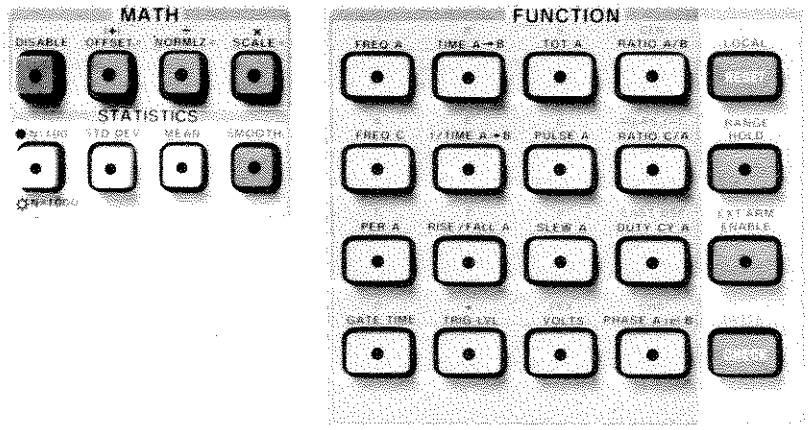


3-69. Math Group

3-70. The functions within the MATH GROUP allow the user to perform a number of mathematical operations on the measurement before it is displayed. The OFFSET, NORMLZ, and SCALE keys allow for the addition, division, and multiplication, respectively, of the measurement by user specified constants. Modification of the display by the Math operations is represented by the following relationship:

$$\text{Display} = \frac{\text{Measurement} + \text{OFFSET}}{\text{NORMLZ}} \times \text{SCALE}$$

3-71. Notice that the OFFSET operation is performed before normalization and scaling. Any single or combination of these operations can be selected. This provides the user with extensive control over the resultant display. It can be used, for example, to subtract systematic errors or display the percentage difference. Additionally, the overall math operation can be disabled and then re-established without having to re-enter constants.



3-72. ENTERING CONSTANTS. The values for the three user specified constants are entered from the keyboard. Entry begins by pressing any one of three blue keys, OFFSET, NORMLZ, or SCALE. That indicator key's light will start to flash, indicating that an entry is expected. During the number entry mode, the FUNCTION keys respond to the functions labled in blue (see *Table 3-1*). Any entry is completed by pressing the ENTER key, at which time the blue key's light will turn on (steadily), indicating that a constant for that operation is stored and in effect. After pressing ENTER, the instrument will immediately begin making measurements, performing the math operation and displaying the result.

NOTE

Numbers greater than 9×10^9 and less than 1×10^{-9} in magnitude can not be stored.

Table 3-1. Function Key Use During Number Entry

FUNCTION KEY	FUNCTION DURING NUMBER ENTRY
0-9, "."	Digit entry. Before EEX is pressed, these are used to enter the mantissa value. Up to 11 digits are allowed. After EEX is pressed, these are used to enter the exponent value.
EEX	Enter Exponent. Begins exponent entry when pressed.
CHS	CHange Sign. Toggles the sign of the mantissa or exponent, depending upon whether EEX was pressed.
CLR	CLeaRs entry.
ENTER	Completes entry of number. After ENTER is pressed, the instrument goes back to making measurements. If the value entered was zero, the specified constant is turned "off". This is indicated by turning the key's LED off. If the value entered was not zero, the specified constant is turned "on". This is indicated by turning the key's LED on. When a constant is "off" it is ignored in the equation.
RESET	During number entry, RESET can be used to abort the entry and return to normal operation.
DISABLE	During number entry, this key produces the same effect as entering zero as the value. The specified constant is turned off and normal operation begins. ENTER does not have to be pressed.
SPECIAL NUMBER ENTRY KEYS	
LAST DISP	This key will put on the display the value that was displayed from the last measurement. If you are presently entering in a value to OFFSET, the last display value is negated. This lets you conveniently subtract our errors or values based on measurements you've made. For NORMLZ and SCALE, the last display value is not negated.
$MEAS_{t-1}$	This key does not specify any unique value, but instead, specifies that as each measurement is made, the previous measurement's value (before any mathematical manipulation) be used. Previous measurement (t_{-1}) — this measurement (t_0) — display 1 2 3 4 5 — 1 2 3 4 6 — 1 This is an example of $MEAS_{t-1}$ with OFFSET. As with LAST DISP, the value is negated for OFFSET, and not for NORMLZ and SCALE.

3-73. REVIEWING CONSTANTS. To review the constants, press any of the blue keys. The counter will cease taking measurements and the presently specified value of the constant will be displayed. The indicator light within the blue key specified will be flashing. At this time, either the value of the constant can be changed by keying in the new number and pressing ENTER, or all of the constants can be reviewed by pressing each blue key in succession. To return to the measurement mode, press either RESET or ENTER.

3-74. DISABLING MATH OPERATIONS. When not in the number entry mode (i.e., a blue key has not been pressed) the DISABLE key can be used to momentarily turn off all of the math functions. The DISABLE function toggles between on and off with each press of the key. The DISABLE key's indicator light turns on when the math functions are disabled and off when the math functions are enabled. While disabled, the indicator lights within the individual math function keys are turned off.

3-75. During the number entry mode (i.e., pressing any blue key) the DISABLE key produces the same effect as entering zero (or one) as the value of the constant. The specified math function is turned off and the counter begins normal measurements. The ENTER key does not have to be pressed and the remaining math functions (if previously loaded) are reinstated.

3-76. If DISABLE is on and a blue key is pressed (number entry mode) the disable condition is defeated for the specified math function *only*. A new constant can be entered, and when ENTER

is pressed, the measurement is displayed with only that specified math function activated. The remaining functions, though programmed with constants, are still DISABLED. To reactivate these stored functions, recall each (by pressing the blue key) and then press ENTER.

3-77. SAMPLE MATH OPERATIONS. The following examples illustrate the operation of the MATH GROUP functions.

A. With an input frequency of 10.001 MHz, enter an offset of -10 MHz:

Keystrokes: OFFSET CHS 1 EEX 7 ENTER
Measured value: 10.001 MHz
Displayed value: 1 kHz

B. Suppose you are currently measuring a 3.56 MHz color TV crystal. To set -3.56 MHz as the offset:

Keystrokes: OFFSET LAST DISP ENTER

-3.56 E6 will be displayed

Measured value: 3.56 MHz
Displayed value: Ø Hz

C. Suppose in the above example you wished to display percentage error instead:

Keystrokes: OFFSET LAST DISP ENTER

-3.56 E6 will be displayed

DISABLE (lets 3.56 MHz be displayed without the offset)

NORMLZ LAST DISP ENTER

3.56 E6 is now in NORMLZ

SCALE 1 0 0 ENTER (100 is now in SCALE)

OFFSET ENTER (turns OFFSET on again)

Measured value: 3.61 MHz
Displayed value: 1.4045 (percent error from 3.56 MHz)

D. To display an measurement in rpm (revolutions per minute):

Keystrokes: SCALE 6 0 ENTER

Measured value: 100

Displayed value: 6.000 E3

E. To show change in frequency per second (approximately, averaged over 1 second gate times):

Set Gate Adjust to a 1-second gate time, and CYCLE Mode to MIN.

Keystrokes: OFFSET $MEAS_{t-1}$ ENTER

A "t-1" will be displayed

Measured value: 1000 Hz
Measured value: 1002 Hz
Displayed value: 2 Hz
Measured value: 1005 Hz
Displayed value: 3 Hz

More precise timing of the gate can be achieved by arming.

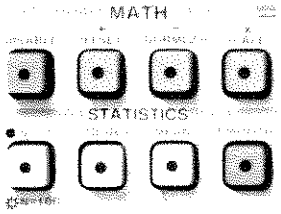
3-78. Statistics Group

3-79. The functions within the STATISTICS GROUP allow the user to automatically accumulate and sample 100 (or 1000) measurements and then determine and display either the standard deviation or the mean (average) of the sampling. These functions are selected by the STD DEV and MEAN keys, respectively, which toggle on and off with each press of the key. The indicator light will light when the function is activated. The sample size is initially set (default state) to 100. Pressing the N = 100/N = 1000 key will alternately toggle the sample size between 100 and 1000. The indicator light within the key will be on for a sample size of 1000, and off for 100.

NOTE

MATH calculations are done *before* statistics when both are activated.

3-80. Selecting MEAN produces one additional digit of resolution. Selecting STD DEV will display three digits for either sample size. Both the Standard Deviation and the Mean can be displayed for a single sample. To do this the measurements must be made with STD DEV on and the CYCLE MODE set to SINGLE. At the end of the N measurements (100 or 1000) the standard deviation is displayed. Then press MEAN to display the mean of the sample. The mean value is displayed with a resolution based on the standard deviation.



NOTE

Statistical calculations sometimes use data from the measurement that is not displayed, from the resolution lost when a number has to be rounded to the best decade.

3-81. The SMOOTH key selects a unique function which "smooths" the display for easier reading. When SMOOTH is on, the counter looks at the resultant measurement and displays only the digits that are relatively stable. In addition, as the measurements continue to cycle, a running average is made to remove small deviations. The running average is made by assigning each new measurement a weight of 1/10, and the last display 9/10.

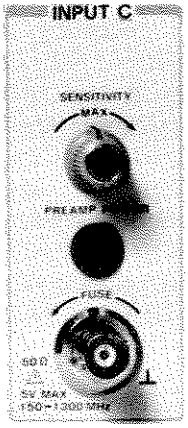
Smooth Display = 1/10 New Measurement + 9/10 Last Display

3-82. This allows for slow drift in the signal, but filters out small transients. The SMOOTH function provides a simple visual way to monitor the stability of a signal. If the stability of the signal decreases, the LSD's of the display will correspondingly begin to blank out. As stability increases, the lost digits of resolution will reappear. The SMOOTH key toggles on and off, and operates independently of all other functions.

NOTE

Because Phase measurements require a steady signal input, the use of Statistics is not valid (i.e., the STD DEV of a steady signal should be Ø, and MEAN should be the same as any one measurement). Therefore, the use of STATISTICS for PHASE measurements is not recommended.

3-83. Input C (Option 030)

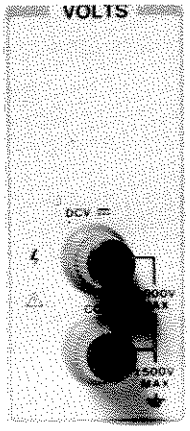


3-84. The INPUT C GROUP contains the C Channel Input BNC, SENSITIVITY control and PREAMP POWER receptacle. The input connector is a special fused BNC. Refer to paragraph 3-221 for replacement instructions. The SENSITIVITY control varies the input sensitivity from MAX (10 mV for 150 MHz to 1.0 GHz, 100 mV for 1.0 GHz to 1.3 GHz), refer to Specifications, *Table 1-1* to greater than 500 mV. The PREAMP POWER jack allows the use of an optional high frequency broadband preamplifier, such as the HP 10855A. The GATE ADJ and GATE MODE controls operate as with A Channel.

NOTE

The PREAMP POWER jack supplies a ≈ +15 vdc and a ground output. This connector will not support a three-wire type power probe.

3-85. Volts (Option 020)



3-86. The VOLTS section contains the HI (Red) and LO (Black) input connectors for the fully floating, autoranging Digital Voltmeter. The voltmeter measures dc inputs up to ±1000 volts. It automatically selects the ±10V, ±100V, or ±1000V range, depending on the input voltage. The sensitivity is 100 μV to 100 mV (depending on the range).

The MATH keys provide for post-measurement manipulation of the display, by the mathematical operations of OFFSET (±), NORMALIZE (÷), and SCALE (×). Values for constants are programmed in via the numeric values of the FUNCTION keys.

The Function keys provides the key-per-function selection of 16 basic function modes, as well as RESET, RANGE HOLD, EXT ARM, and CHECK.

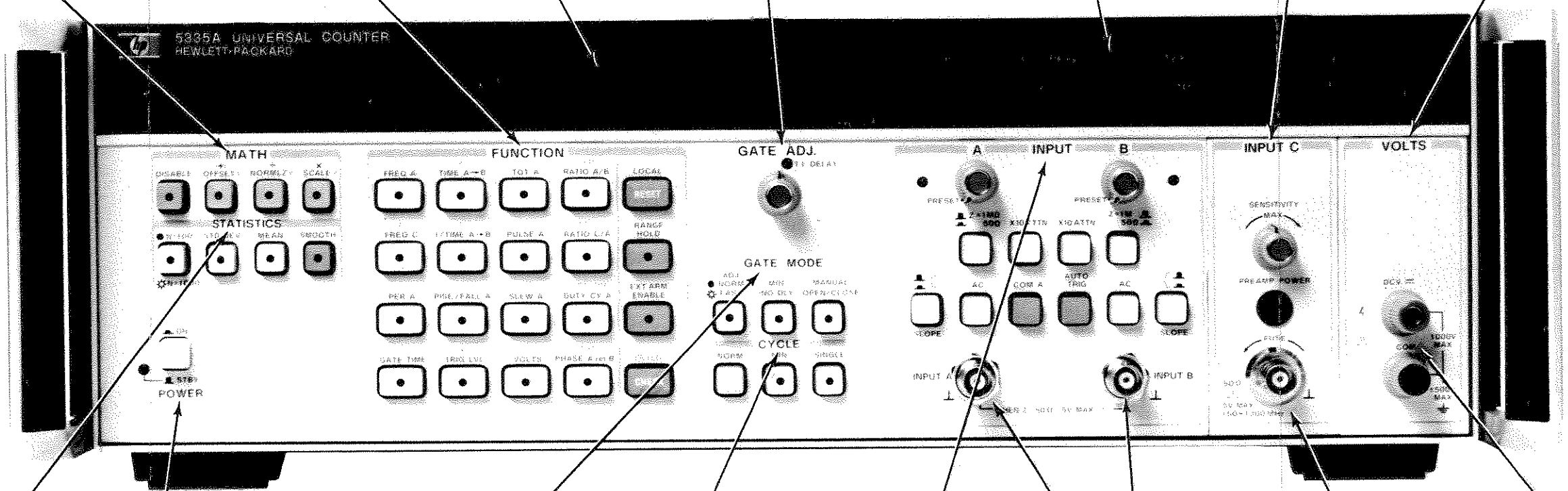
The counter numeric display, providing 12 possible digits of mantissa, an exponent sign (±), and an engineering notation exponent (0, ±3, ±6, ±9 etc.) Mantissa digits are grouped into threes for convenience, whenever possible.

The GATE ADJ control provides the adjustability for the GATE MODES, and for adjustment of the T.I. Delay holdoff.

The display ANNUNCIATOR group provides LED indicators for monitoring the status of the Gate, HP-IB, and units of the measurement.

The INPUT C module, Option 030, provides for FREQUENCY measurements from 150 MHz up to 1.3 GHz. Controls are provided for adjustable SENSITIVITY and PREAMP POWER.

The VOLTS module, Option 020, provides a fully floating auto-ranging DC voltmeter. Input DC voltage range up to 1000V.



The STATISTIC keys allow for the calculation of standard deviation or mean (average) of either 100 or 1000 measurement samples. The SMOOTH function performs a running average of ongoing measuresurements, and displays only the digits which are relatively stable.

The POWER key applies power to the instrument when in the ON position (pressed in). In the STBY position (out), power is applied only to the high stability reference oscillator oven, Option 010.

The GATE MODE keys selects the ranges of gate time. NORM and FAST are adjustable (via GATE ADJ) modes, providing ranges of 20 ms to 4 s and 100 μs to 20 ms, respectively, MIN specifies the shortest possible gate time, dependent on the input signal. MANUAL opens and closes the gate with each successive press.

The CYCLE keys determine the length of time between measurement cycles. The NORM mode specifies about 250 ms wait time, the MIN mode rearms the measurement as soon as possible. The SINGLE mode manually starts one measurement.

The INPUT group keys and controls determine how the input signals are conditioned (with attenuation, impedance, slope, coupling, and common controls) and how the counter is triggered (AUTO TRIG or normal).

The A and B Channel input BNC connectors.

The C Channel input BNC is a special fused connector. The fuse (HP Part No. 2110-0301) is 1/8A, and is accessible (for replacement) from the front panel.

The input connectors for the Option 020 Voltmeter. Input voltage 1000V DC max. COM is floating.

Figure 3-1. Front Panel Features

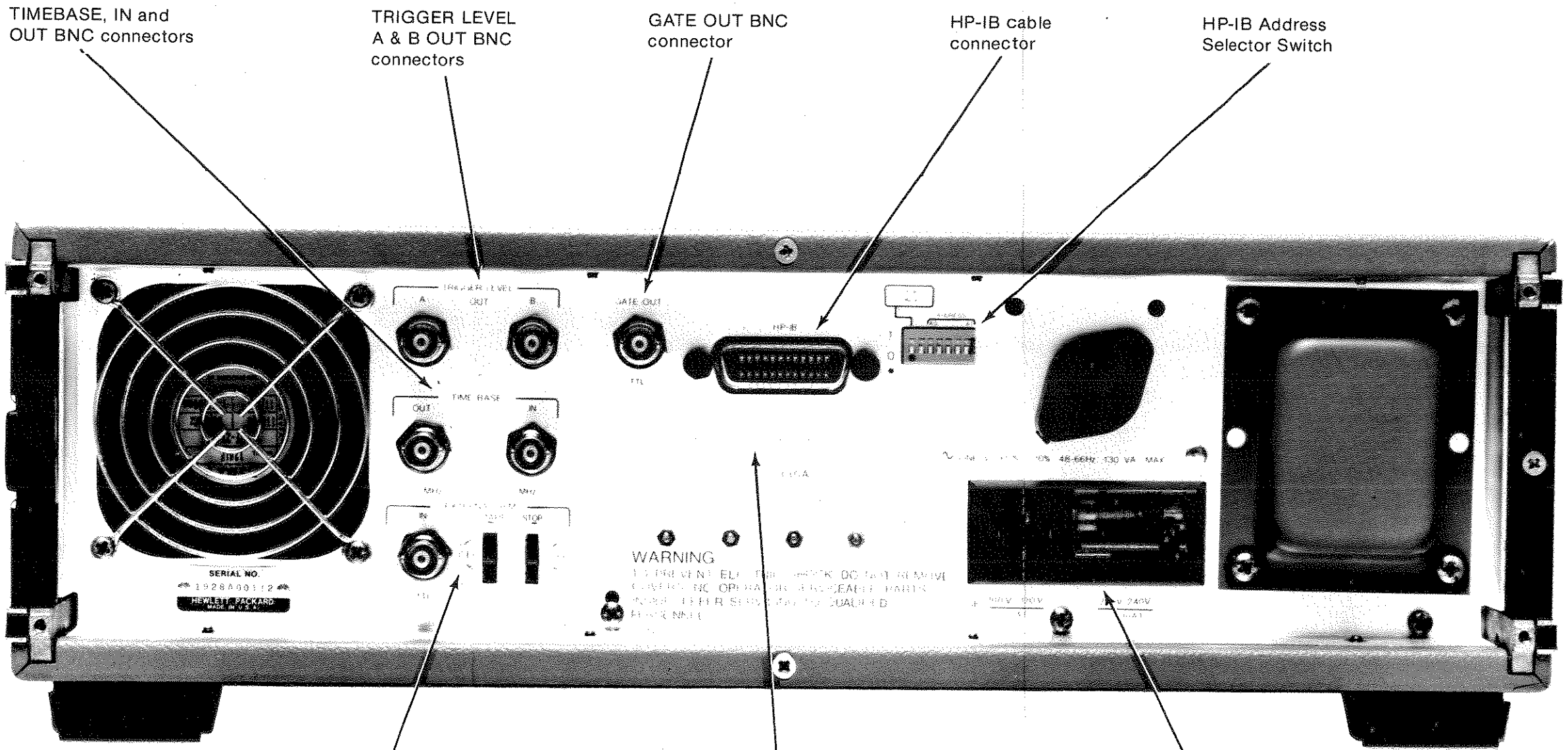


Figure 3-2. Rear Panel Features

3-87. REAR PANEL FEATURES

3-88. A number of signal inputs and outputs are provided on the rear panel. TIME BASE OUT provides a 10 MHz signal that may be used as a reference for other instruments. If the reference to the HP 5335A is provided from another source, connect it to TIME BASE IN. This input accepts either 5 or 10 MHz and internally multiplies it up to 10 MHz. Whenever a reference is applied to the TIME BASE IN connector, the presence of that signal is sensed by internal circuitry, and the HP5335A will automatically switch from the internal reference mode to the external reference mode of operation. This switchover is indicated by the lighting of the EXT TIME BASE annunciator on the front panel display. If the reference is removed, the EXT TIME BASE annunciator will not automatically turn off. Pressing the RESET key will update the status of the reference EXT TIME BASE annunciator. Do not connect TIME BASE IN to OUT. No damage will occur but the reference frequency will be incorrect.

NOTE

Always press RESET after connecting or disconnecting a signal to the TIME BASE IN. Do not connect or disconnect a signal to the TIME BASE IN during measurements. FAIL 5.1 may occur, or the measurement may give a false reading. If FAIL 5.1 does occur in this situation, pressing RESET clears the condition.

3-89. TRIGGER LEVEL OUT provides A and B Channel DC trigger levels for display on scopes. These are handy for a visual verification of proper triggering.

3-90. GATE OUT provides a low signal when the gate is open (see specifications). This can be used in many cases as a visual indication of when the measurement occurs, or the duration of the measurement.

3-91. The EXTERNAL ARM input can be used to specify the start and/or stop of a measurement. The various modes of arming are determined by the two 3-position switches. Refer to ARMING MODES, *Figure 3-3.*

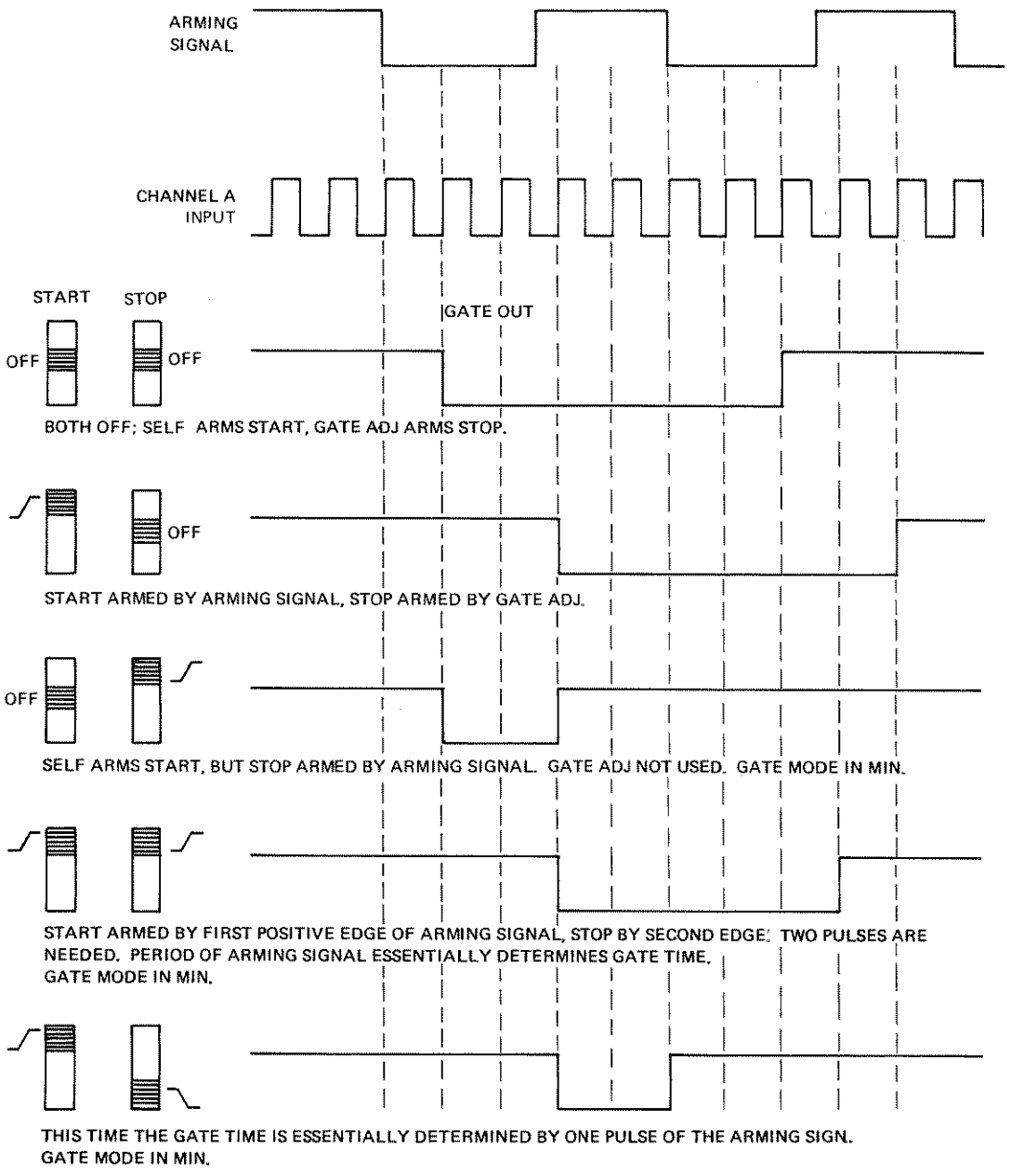


Figure 3-3. Arming Modes

NOTE

When STOP ARM is used the GATE MODE is usually used in MIN. To aid the user in this condition the 5335A will automatically set the GATE MODE to MIN when the STOP ARM is activated. However, the user can override this feature by simply selecting any other GATE MODE after setting up the ARMING modes.

3-92. When the GATE MODE is set to NORM, FAST, or MANUAL, and external arm is on, the Gate Adj timer can be used to hold off the STOP ARM.

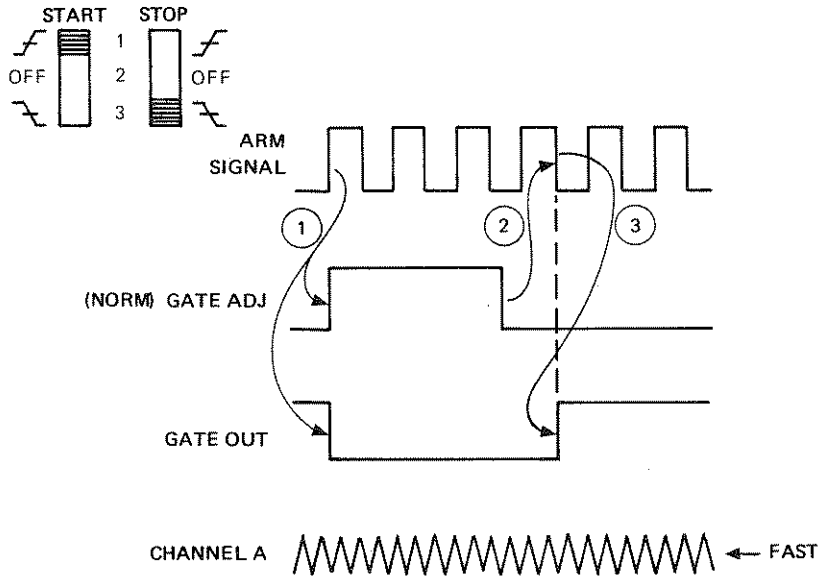
Example:

a. The rising edge of the ARM signal arms the START of the gate and starts the Gate Adj timer (1).

b. The ARM signal is then ignored until the Gate Adj timer times out (2).

c. The next falling edge of the ARM signal (3) then arms the STOP.

In this way, multiples of the arm signal's period can be used to arm the measurement.



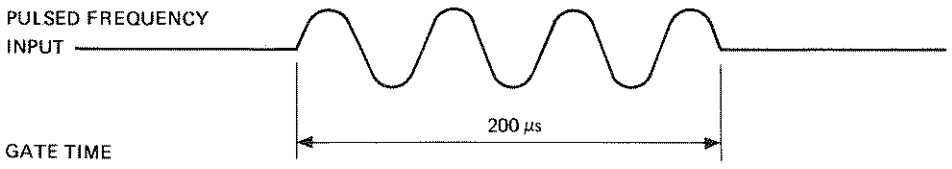
3-93. DETAILED OPERATING INSTRUCTIONS

3-94. The following paragraphs provide detailed operating information. Within a specific function mode, (e.g., FREQ A, PER) a considerable amount of flexibility is present for both the type of input signal and measurement technique. The intent of the following paragraphs is to provide an instructional discussion, which demonstrates the *user control flexibility* for each major function mode. These operating guidelines should assist in making the most useful and accurate measurement possible.

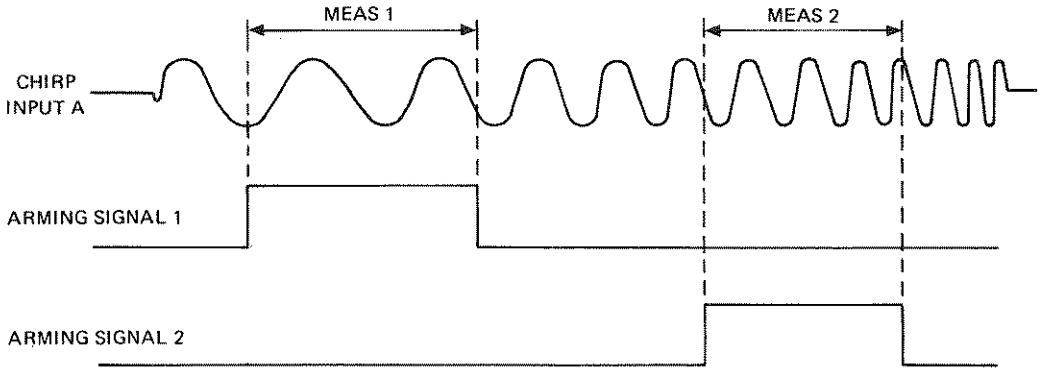
3-95. FREQ A

3-96. The FREQ A mode makes measurements on frequencies up to 200 MHz through the Channel A INPUT. In this function the input is prescaled by two, however, there is no loss of resolution. On power-up, the 5335A assumes the FREQ A function with the GATE MODE in NORM. For a cw signal connected to INPUT A (and within the restrictions set by the input signal conditioning controls) the counter is self-arming, and measurements begin immediately. The displayed resolution is adjusted with the GATE ADJ control.

3-97. Suppose you need to measure a **pulsed frequency**. Assuming no transients occur before the pulse, the frequency of this signal is measured by setting the GATE MODE to FAST, and adjusting for a gate time just under 200 μs. The INPUT A controls are set to ac coupling, separate, with the trigger level control at PRESET. The counter is armed by the signal, and the gate opens automatically just after the start of the pulse.

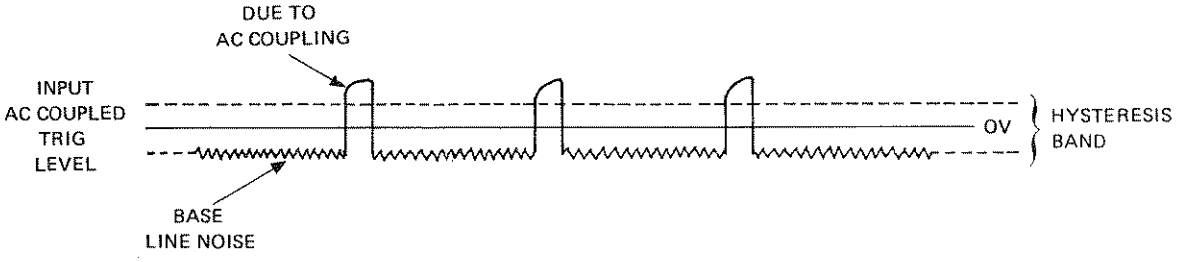


3-98. To measure the frequency at various points along a **chirp**, use the 5335A's arming capability. By setting the START ARM slope to positive and the STOP ARM slope to negative, and then turning EXT ARM ENABLE on, the frequency at various points can be measured. Use an external timing generator to produce the external arm signal.

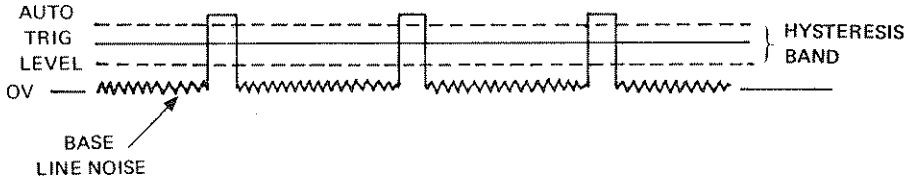


3-99. If the timing generator cannot provide a pulse width of the appropriate width, the STOP ARM can be turned off, which lets the counter stop arm itself. With this setup, you can specify any gate time from 100 μs on up. With GATE MODE in MIN, the counter will measure the frequency based on two periods of the input.

3-100. To measure the frequency of a **pulsed stream**, use the AUTO TRIG mode and dc coupling. AC coupling these types of signals tends to distort them slightly, due to the charging of the coupling capacitor. Additionally, the position of the signal on the zero preset trigger level is determined by the average dc level of the input. Depending on the pulse width and duty cycle, this dc average may be low enough to allow the base line noise to trigger the counter, producing extra counts.



3-101. DC coupling "fixes" the dc level of the input signal. Using AUTO TRIG in Preset or Adjustable allows the trigger level to be easily positioned at an optimum point.

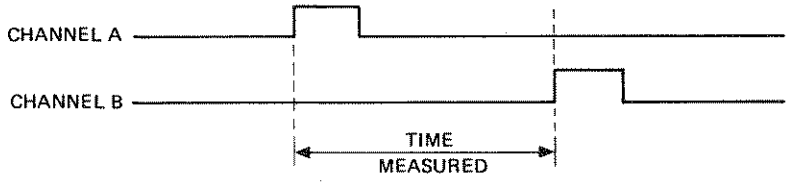


3-102. TIME A → B

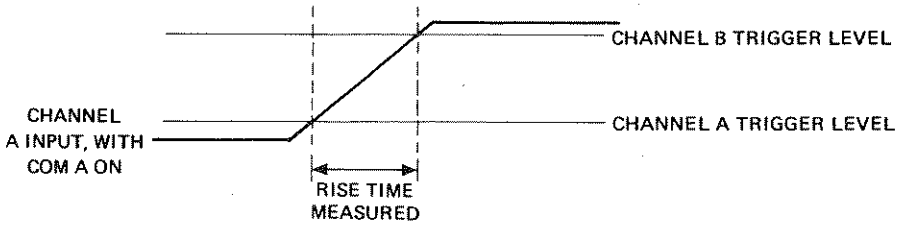
3-103. The TIME A→B mode measures the time interval between a start signal at Channel A and a stop signal at Channel B. The START and STOP slopes, as well as trigger levels, are individually selectable. If the START and STOP signals are to be derived from a single signal, set the INPUT SEPARATE/COMMON key to COM A.

3-104. When TIME A→B is selected, the 5335A automatically shifts the GATE MODE from NORM to MIN (NO DELAY). If a "delay" (stop channel prevented from triggering for a specific period of time) is desired, the NORM, FAST, or MANUAL gate modes may be selected. When the delay is active, the red DELAY indicator will light.

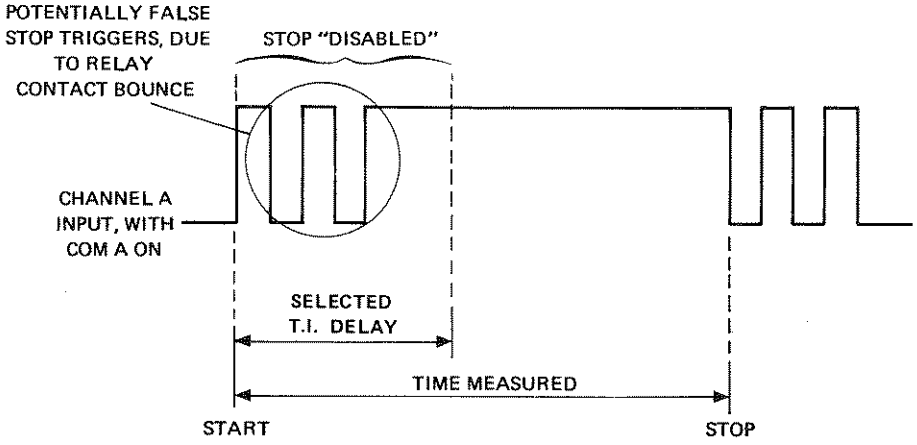
3-105. For a simple **time interval measurement** with both slopes set to positive, the counter will display the time period illustrated above. If the signals are not repetitive, be sure that AUTO TRIG is off.



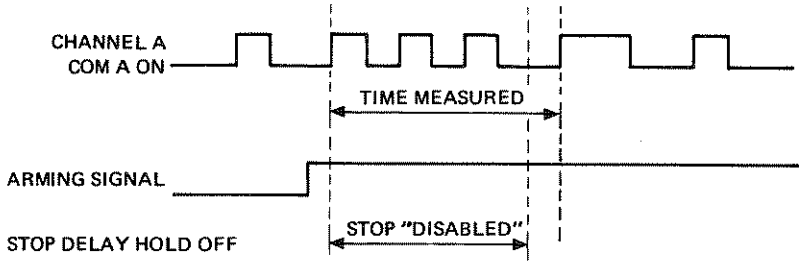
3-106. To measure a specific **rise time manually**, set both slopes to positive and set the INPUT SEPARATE/COMMON key to COM A. Setting the trigger levels to the desired points is simplified by using AUTO TRIG, however, the input signal to Channel A should be continuous. The selected trigger levels may be viewed by pressing the TRIG LVL key, or monitoring the rear panel trigger level outputs. For rise time measurements using the 10% and 90% points, see RISE TIME A.



3-107. The **T.I. DELAY** mode is useful for making time interval measurements on signals, where false triggering (due to settling time, relay contact bounce, etc.) must be avoided. To insert a delay, set the GATE MODE to FAST (for a delay range of 100 μs to 20 ms) or NORM (for a delay range of 20 ms to 4 s) and use the GATE ADJ control to select the required delay.



3-108. To measure the time interval between two arbitrary pulses in a **pulse train**, use the counter's external arming capability. Set the External Arm Start switch to select the starting pulse. Generate the arming signal from a timing generator. If the pulse width of the generator is programmable, you can also use this signal to specify the second pulse. If not, you may be able to use the stop hold-off delay feature described in the previous example.



3-109. TOT A

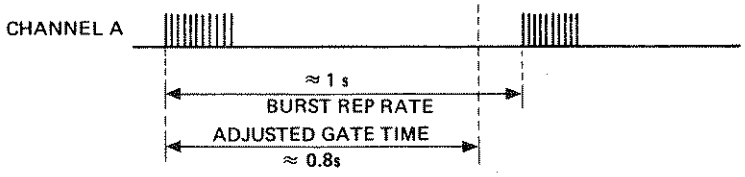
3-110. The TOT A mode will display the number of counts (events) received in Channel A. When TOT A is selected, the 5335A will automatically shift the GATE MODE from NORM to MANUAL, with the Gate initially closed. Pressing the MANUAL key opens the Gate and allows counts to accumulate. To stop counting, press the MANUAL key again. Pressing the MANUAL key once more allows counting to continue without resetting the previous total. To zero the count, press RESET. To begin a new measurement, close the gate and then press RESET. RESET is independent of the Gate.

NOTE

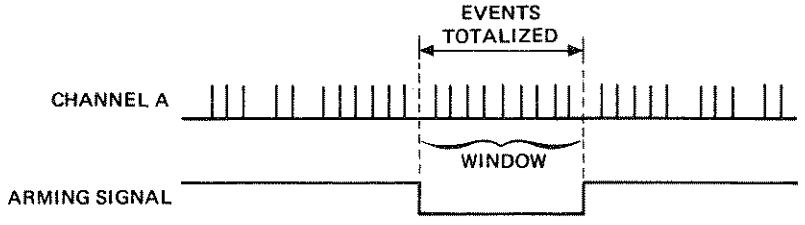
SMOOTH and MATH operations using "$MEAS_{t-1}$" will not operate in manual totalize.

3-111. In other gate modes TOT A behaves slightly differently. With GATE MODE set to NORM or FAST, the totalize acts somewhat like a frequency measurement. Based on the CYCLE and ARM modes, the totalizing will start and stop without the need for manual operation. Also, between measurements, the count will automatically reset itself.

3-112. To totalize the number of events in a **burst of pulses** which occur at one second intervals, set the GATE MODE to NORM. Adjust the GATE ADJ control for a gate time of just under one-second (≈0.8 s). Set CYCLE to MIN. At a one-second rate, the counter will update the display by the number of counts in each burst. The counter will reset and arm itself automatically for each cycle.



3-113. To totalize the number of events within a **specified window**, connect an externally generated arming signal to the rear panel ARM input. Set the START SLOPE switch to negative and the STOP to positive. Press EXT ARM ENABLE, and the counter will display the number of events within the window. If only the start point is specified by the ARMING signal, you may set the STOP SLOPE switch to OFF, and specify the stop point by putting the GATE MODE into FAST or NORM and setting the GATE ADJ control (as in paragraph 3-107). The SMOOTH and MATH operations can also be used for any totalize GATE MODE except MANUAL.



3-114. Normally, the total is not sent to the HP-IB bus until the gate is closed. Some applications call for the total to be sent while the gate is still open and allowing counts. This is called **totalize on the fly**. To totalize on the fly put the counter in Totalize and set the GATE MODE to MANUAL and the CYCLE MODE to SINGLE. Start the count by pressing the MANUAL key. Data will then be sent on the fly during counting and once after the gate is closed. Data is sent only if two successive readings of the counting registers are equal, thus assuring an accurate reading.

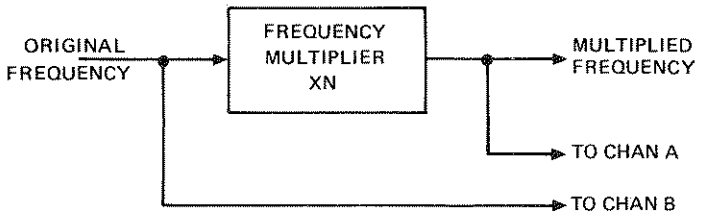
If the gate is reopened, data will once again be sent. The output data byte sent while the gate is open is *not* preceded by the Alpha Character "T", while the data sent after the gate is closed is. For further information on the data output format, refer to paragraph 3-191.

NOTE

Totalizing on the fly should be performed only on signals below 50 Hz.

3-115. RATIO A/B

3-116. The RATIO A/B mode allows the measuring of the ratio between two frequencies. The maximum frequency into Channel A is 200 MHz, and into Channel B it is 100 MHz. The ratio is measured by connecting the original frequency into Channel B and the multiplied frequency into Channel A. The counter will display the multiplying factor "N". The number of digits of resolution is determined by the input frequencies and the Gate Time.



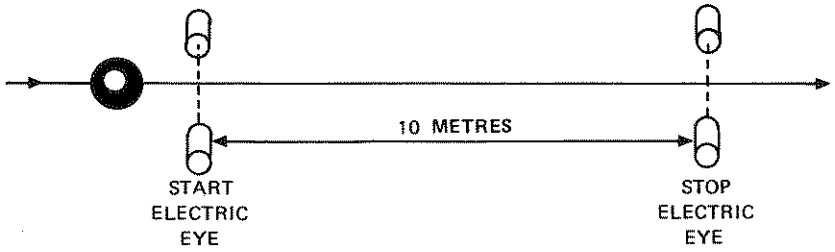
3-117. FREQ C

3-118. The FREQ C mode requires the optional C Channel Input Module. Input signals to INPUT C are prescaled by a-factor-of-20, however, as with FREQ A, there is no loss of resolution. When FREQ C is selected, the Channel A and B INPUT section is disabled. Measurements through C Channel respond to all other controls the same as FREQ A measurement.

3-119. 1/TIME A→B

3-120. The 1/TIME A→B mode performs the standard TIME A→B measurement, mathematically computes the reciprocal value and displays it as units per second. This allows measurement configurations with a direct display of velocity. This mode can also utilize the stop channel delay holdoff (T.I. DELAY) feature, described for TIME A→B.

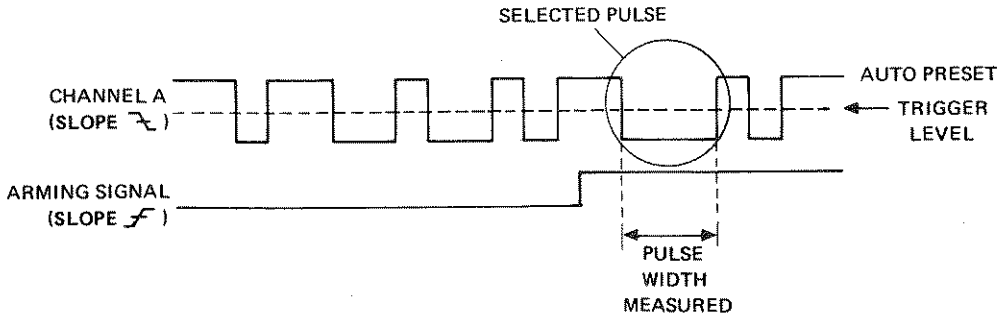
3-121. To determine the **velocity** of a moving object, connect the START electric eye to Channel A, and the STOP electric eye to Channel B. Select the 1/TIME A→B function. In this example the two electric eyes are 10 metres apart, so compensate by setting SCALE to 10. This will produce a measurement readout in metres/per second. If the ball takes 0.25 seconds to travel between the electric eyes, the answer displayed will be 40 (metres per second). If a Ø ns time is measured, a "Ø" result will be displayed.



3-122. PULSE A

3-123. The PULSE A mode measures the width of pulses input into Channel A. With the SLOPE A switch set to ⨍, positive pulses will be measured. With the SLOPE A switch set to ⨍̄, negative pulses will be measured. This mode can also utilize the stop channel delay holdoff (T.I. DELAY) feature, described for TIME A→B.

3-124. For **continuous pulse streams**, set the trigger level for AUTO PRESET. For **single-shot pulses** or special applications, use the manual modes of triggering. To locate and measure a **selected pulse** within a data stream use external arming. Set the START ARMING SLOPE to positive or negative, when measuring a pulse on Channel A. Position the edge of the Arming Signal just ahead of the leading edge of the desired pulse and set EXT ARM ENABLE to on. Set the trigger level for AUTO PRESET (for most continuous signals) to automatically trigger at the 50% point. The GATE MODE will automatically switch to MIN and a single pulse measurement will be made.



NOTE

Pulse measurements are specified for trigger levels between the 40% and 60% points of the signal.

3-125. RATIO C/A

3-126. The RATIO C/A mode is similar to the RATIO A/B mode (paragraph 3-115), with the advantage of an extended frequency range for ratio measurements. The maximum frequency into Channel A is 200 MHz, and into C Channel it is 1300 MHz. Connect the higher of the two frequencies to the C Channel Input and select the RATIO C/A mode. The ratio will be displayed with the resolution being determined by the higher frequency and the selected Gate Time.

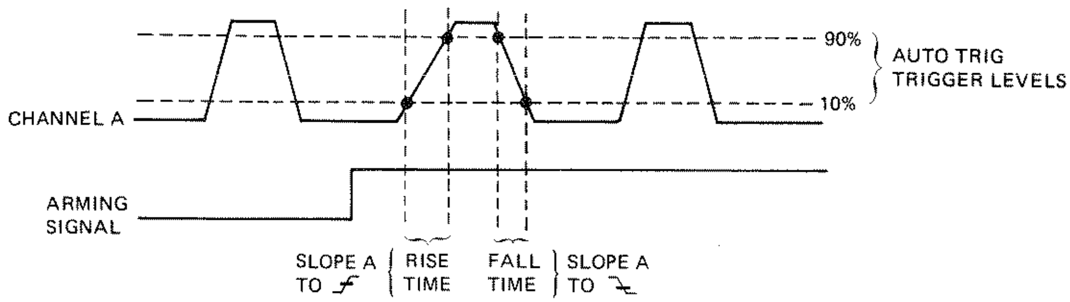
3-127. PER A

3-128. The PER A mode allows single period measurements or multiple period averages to be made on input signals into Channel A. In this mode, the input is not prescaled so the maximum frequency is 100 MHz. In NORM/FAST GATE MODES, a **period average** measurement is made where the number of periods averaged is determined by the setting of the GATE ADJ control and the period of the signal. For **single period** measurements, set the GATE MODE to MIN.

3-129. RISE/FALL A

3-130. The RISE/FALL A mode automatically configures the counter to perform either rise or fall time measurements. The input is automatically set to COM A and triggering to AUTO TRIG. In this mode, AUTO TRIG automatically locates and sets the trigger levels at the 10% and 90% points of the input signal. **Rise time** measurements are made when the SLOPE A control is set to ⨍. **Fall time** measurements are made when the SLOPE A control is set to ⨍̄. For rise and fall measurements, the input signal must be continuous. To measure the rise time on a **selected slope**

of a signal, use external arming. Set the Start Arming Slope to positive and using an oscilloscope, position the leading edge just ahead of the selected slope of the signal. With SLOPE A positive, the counter will display the rise time; with SLOPE A to negative, the counter will display the fall time. Measurements are displayed in units of seconds.



3-131. SLEW A

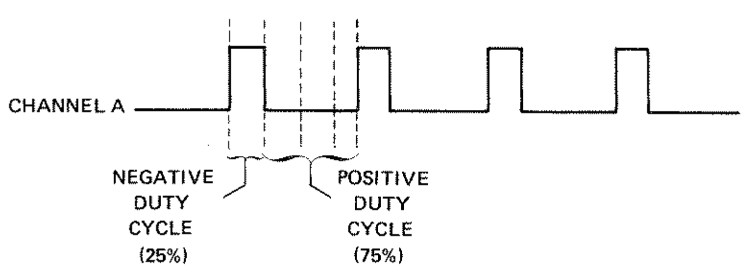
3-132. The SLEW A mode is similar to the RISE/FALL A mode, with the counter automatically selecting COM A and AUTO TRIG. However, to more easily accommodate analog signals, the measurement is displayed in units of Volts/seconds. Additionally, the MATH operations may also be selected to achieve a direct readout of the desired units. For example, programming the NORMLZ function with values of 10^3 or 10^6 will produce slew rates in units of volts/millisecond and volts/microsecond, respectively. As with RISE/FALL A, the measurements with SLEW A are with respect to the 10% and 90% points of the input and the input must be continuous. Also, slew rates on **selected slopes** may be made, using the external arm method.

3-133. DUTY CYC A

3-134. The DUTY CYC A mode measures and displays the proportional percentage of either the positive or negative durations of a given input digital waveform. The percentage of the positive pulse is given when the SLOPE A control is set to ⨍ . The percentage of the negative pulse is given with the control set to ⦣ . In this mode, the counter automatically sets the GATE MODE to MIN.

3-135. Duty cycle is actually measured indirectly through two measurements, Period and Pulse. Therefore, the signal should have a constant duty cycle in order to be accurately measured. If a particular place in a pulse stream needs to be examined in a changing duty cycle environment, be sure that the characteristics are repetitive.

3-136. To measure the positive duty cycle of a **continuous asymmetrical waveform**, select DUTY CYC A, set the SLOPE A control to ⨍ and set triggering to Auto Preset. The counter will display a value, typically between 1 and 99 ("25" in this example) representing the duty cycle. No unit annunciators will light, as duty cycle is assumed as "percentage".



NOTE

Duty Cycle should be measured with the trigger level set between the 40% and 60% points of the signal peaks.

3-137. GATE TIME

3-138. The GATE TIME mode provides an indication of the length of the gate time, displayed to three significant digits. When EXT ARM ENABLE is on, gate time resolution to 100 ns is displayed. The gate time is controlled (except in MIN) by the GATE ADJ control.

NOTE

As the gate is synchronized to the input signal, the actual gate time may be different from the displayed gate.

3-139. When in a TIME domain function mode (e.g., TIME A→B, PULSE A), the GATE TIME mode provides an indication of the amount of **stop delay time** selected. This time is set by the GATE ADJ control. When in a TIME domain function, with the GATE MODE in NORM or FAST, the T.I. DELAY indicator will be lighted.

3-140. Pressing GATE TIME does not affect the function set-up memory of the operating mode. Press the operating mode function key or reset to resume measurements.

3-141. TRIG LVL

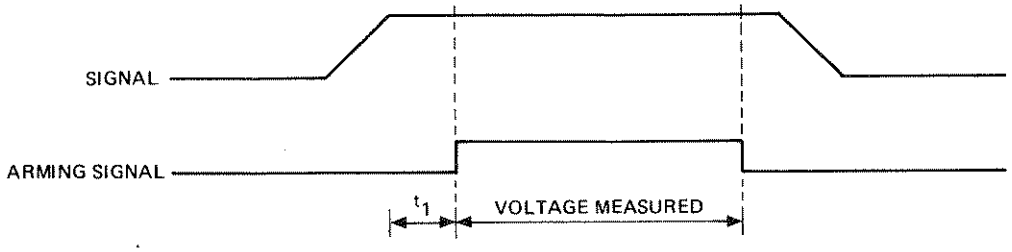
3-142. The TRIG LVL mode displays both the Channel A and B trigger levels. The grouping on the left is Level A and the right is Level B. If the operating function mode, prior to the TRIG LVL, was RISE/FALL or SLEW, the levels displayed will be the 10% and 90% points of the input signal. For PHASE A rel B, the levels will be the 50% points. Pressing TRIG LVL does not affect the function set-up memory of the operating mode. Press the operating mode function key or reset to resume measurements.

3-143. When outputting the Channel A and B Trigger Levels, via the HP-IB, two complete numbers are sent, prefixed with the letters A and B.

3-144. VOLTS

3-145. The VOLTS mode requires the option 020 DVM input module. The DVM is fully floating and autoranging. A unique feature is that there is no need for predetermined gate times. This means that, like frequency, you may gate time to most any setting desired. Also, this means that you can arm both the start *and* the stop of a voltage measurement.

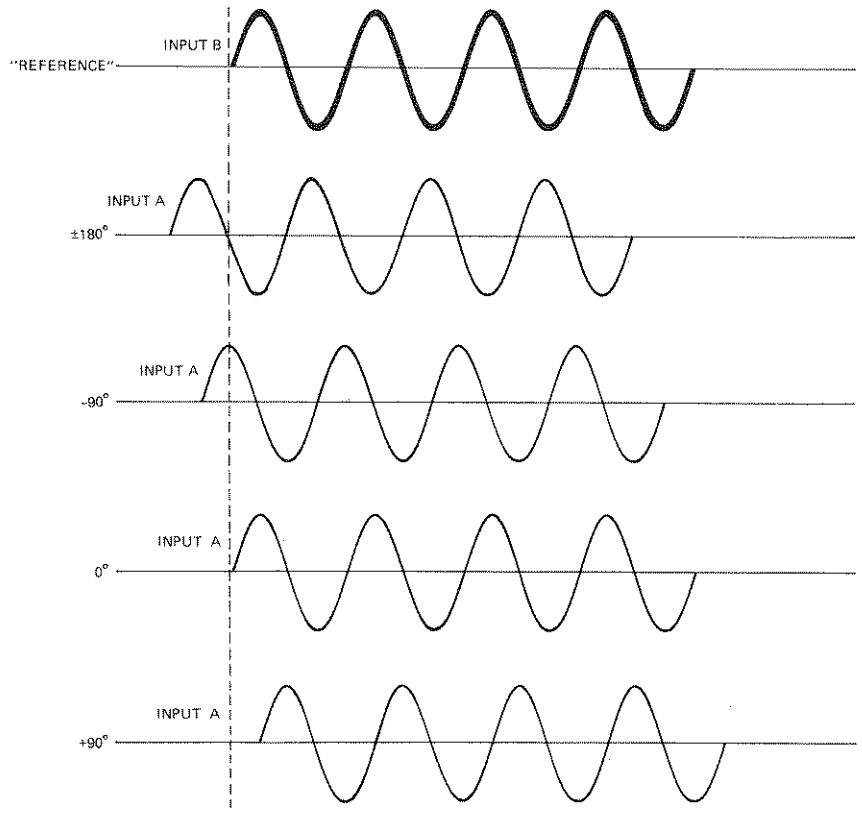
3-146. To measure the voltage of a signal at a **specified point**, use external arming. Set the start arm switch to positive and the stop arm switch to negative. Position the arming signal to allow for the step response time of the voltmeter (t_1). For environments with 50 or 60 Hz noise problems, gate time which are multiples of 100 ms will reduce error in the measurements.



3-147. PHASE A rel B

3-148. The PHASE mode measures the phase of the signal on Input A, relative to the signal on Input B. The phase difference is displayed in degrees. In this mode, Auto Preset triggering is automatically selected. The trigger points are set to the 50% points of each signal, regardless of either signal's offset.

3-149. The overall display range is -180° to +360°. The display of a PHASE measurement is configured such that around 0°, the operating range is -180° to +180°, but around +180° the operating range is 0° to 360°. If RANGE HOLD is on, the range is fixed to 0° to 360°. The PHASE mode cannot be externally armed.



3-150. Phase measurements are made through a series of individual measurements, therefore certain input and operational restrictions apply:

- The frequency and phase angle of the signals should be constant.
- Frequencies can be measured up to 1 MHz.
- PHASE A rel B measurements should be made with the SEP/COM switch in SEP. If COM A is momentarily selected, the RESET key should be pressed.
- RESET should be pressed after any change to the INPUT controls, particularly for SLOPE and SEP/COM controls.

NOTE

Because phase requires a steady signal input, the use of statistics is not valid (i.e., the STD DEV of a steady signal should be Ø, and the MEAN should be the same as any one measurement). Therefore, the use of STATISTICS for PHASE measurements is not recommended.

Table 3-2. Function Key Reference Summary

FUNCTION KEY	UNITS	TRIG MODE	SLOPE A USAGE	ARMING	GATE ADJ	COMMENTS
FREQ A	Hz	Any		Yes	Gate	Prescaled-by-2
TIME A→B	s	Any		Yes	Stop Delay	
TOT A	——	Any		If not in manual	Gate	Smooth and $MEAS_{t-1}$ will not operate when in MANUAL
RATIO A/B	——	Any		Yes	Gate	
FREQ C	Hz	N.A.	N.A.	Yes	Gate	Prescaled-by-20
1/TIME A→B	1/s	Any		Yes	Stop Delay	
PULSE A	s	Any	⌐ = Positive Pulse ¬ = Negative Pulse	Yes	Stop Delay	
RATIO C/A	——	Any		Yes	Gate	"A" prescaled-by-2, "C" prescaled-by-20
PER A	s	Any		Yes	Gate	
RISE/FALL A	s	10%, 90%	⌐ = Rise Time ¬ = Fall Time	Yes	MIN only	Signal should be >50 Hz and <25 MHz.
SLEW A	V/s	10%, 90%	⌐ = Rising Slope ¬ = Falling Slope	Yes	MIN only	Signal should be >50 Hz and <25 MHz.
DUTY CYC A	s	Any	⌐ = % High ¬ = % Low	No	MIN only	Needs constant signal
GATE TIME	s	N.A.		Yes	Shows Gate or Stop Delay	Will not affect function memory
TRIG LVL	V	Follows Last function	N.A.	N.A.	N.A.	Will not affect Function memory, send 2 numbers on HP-IB
VOLTS	V	N.A.	N.A.	Yes	Gate	
PHASE A rel B	°	50%		No arming	MIN only	Needs constant signal. Range 0° to 360° if RANGE HOLD on >30 Hz

3-151. PROGRAMMING

3-152. Introduction

3-153. The 5335A Universal Counter is fully compatible with the Hewlett-Packard Interface bus (HP-IB). The bus capability is installed as standard equipment and allows the counter to respond to remote control instructions and output measurement results via the HP-IB. At the simplest level, the 5335A can output data to other devices such as the 5150A Thermal Printer or the 59303A Digital-to-Analog Converter. In more sophisticated systems, a computing controller or other controllers can remotely program the 5335A to perform a specific type of measurement, trigger the measurement, and read the results.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1978, *"Standard Digital Interface for Programmable Instrumentation"*.

3-154. This section describes how to use the 5335A on the HP-IB. Before programming, the operator must be familiar with the selected computing controller (e.g., the 9825A, 9830A, or 9835/45A calculators), the capabilities of the HP-IB, and the manual operation and capabilities of the 5335A. The following HP manuals provide useful background information:

HP-IB User Guide, 9830A (P/N 59300-90002)
Hewlett-Packard 9825A Calculator General I/O Programming (P/N 09825-90024)
Hewlett-Packard 9825A Calculator Extended I/O Programming (P/N 09825-90025)
Condensed Description of the Hewlett-Packard Interface Bus (P/N 59401-90030)
Abbreviated Description of Hewlett-Packard Interface Bus (P/N 5955-2903)
HP-IB Quick Reference (P/N 5955-2902)

3-155. Interface Function

3-156. The capability of a device connected to the bus is specified by its interface functions. *Table 3-3* lists the 5335A Interface Functions using the terminology of the IEEE 488-1978 standard. These features are also listed below the rear panel HP-IB connector, as follows:

SH1, AH1, T1, TEØ, L2, LEØ, SR1, RL1, PPØ, DC1, DT1, CØ

Table 3-3. HP-IB Interface Capability

INTERFACE FUNCTION SUBSET IDENTIFIER	INTERFACE FUNCTION DESCRIPTION
SH1	Complete source handshake capability.
AH1	Complete acceptor handshake capability.
T1	Talker (basic talker, serial poll, talk only mode)
TEØ	No extended talker capability.
L2	Listener (basic listener, no listen only mode, does not unaddress to listen if addressed to talk).
LEØ	No extended listener capability.
SR1	Service request capability.
RL1	Complete remote/local capability.
PPØ	No parallel poll capability.
DC1	Device clear capability.
DT1	Device trigger capability.
CØ	No controller capability.

3-157. The number following the interface function code indicates the particular capability of that function as listed in Appendix C of IEEE Std. 488-1978. Interface functions provide the means for a device to receive, process, and send messages over the bus.

3-158. Nearly all controls on the 5335A can be programmed remotely, and data from measurements can be sent to other devices through the HP-IB. The TALK, LISTEN, SRQ, and REMOTE annunciators in the display will indicate the state of the instrument. The following paragraphs describe the basic programming capability of the 5335A Universal Counter.

TALK: When addressed as a Talker, whether by a controller or by the TALK ONLY switch, the 5335A will try to send data out to other devices on the bus. Normally this data is the measurement data.

LISTEN:	When addressed as a Listener, the instrument can accept any number of commands from a controller on the bus. These commands will usually be used to program the instrument operation.
SERVICE REQUEST:	SRQ can be sent out to the bus at the end of measurements and on error or failure messages. Normally SRQ is inhibited, but certain commands will enable this feature. See "WA" and "SR".
REMOTE/LOCAL:	Normally the 5335A is under local control. In order to program the instrument it must be in Remote. Once in Remote, all programmable controls are in remote and cannot be affected by manual command. The RESET key may be used to manually return to local control only if Local Lockout is OFF. If Local Lockout is ON, the RESET key is ignored.
PARALLEL POLL:	No parallel poll capability in the 5335A.
DEVICE CLEAR:	When a universal or selected device clear is received, the instrument clears out all input buffers and resets the hardware for a new measurement. The display will flash momentarily. SRQ is also cleared. Device clear can be used to clear an ERROR message.
DEVICE TRIGGER:	When a device trigger is received, a new measurement is started.
CONTROLLER:	No controller capability in the 5335A.

3-159. Bus Messages

3-160. Messages are the means by which devices exchange control and measurement information. There are 12 basic messages which can be sent over the interface. *Table 3-4* lists each bus message, a description of the message, how the 5335A uses that message, and examples of the various controller's implementation of the messages.

3-161. Address Selection

3-162. To use the 5335A in an HP-IB system, first set the rear panel address switches as shown in *Table 3-5*. The leftmost switch sets the counter to the ADDRESSABLE mode or the TALK ONLY mode. ADDRESSABLE mode is used whenever a calculator or other controller is used with the system. TALK ONLY mode is used when the counter is operating under its own control (no controller on bus) and outputs its measured result to another device on the bus, such as a printer.

3-163. The five righthand switches, A_5 through A_1, set the talk and listen addresses of the 5335A when it is used in the ADDRESSABLE mode. *Table 3-5* shows the possible address settings and the corresponding ASCII codes for talk and listen.

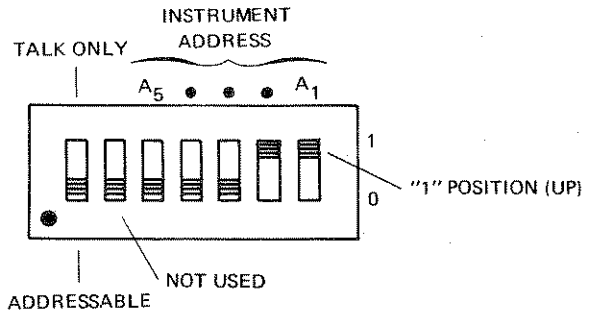
3-164. The examples listed in this section assume an address setting of 00011, which is a 5-bit binary code for the decimal number three. This number is important when using an HP 9825A, 9835A, or 9845A calculator, since the calculator addresses the 5335A to talk and listen by using the code 7Ø3. (The "Ø3" being the 5335A address.) The ASCII characters for this same switch setting are "C" for a talk address and "#" for a listen address. These characters are used when the computing controller is an HP 9830A calculator.

Table 3-4. 5335A Bus Message Usage

Message	Description	5335A Use	Sample 9825 Statements (5335A Set to Address 03)	Sample 9835/45 Statements (5335A Set to Address 03)
Data	Transfers device-dependent information from one device to one or more devices on the bus.	Sends measurement data. See paragraph 3-191 for output format. Accepts program codes. See *Table 3-6* for code set.	red 703, A wrt 703, "FN9"	ENTER 703, A OUTPUT 703, "FN9"
Trigger	Causes a group of selected devices to simultaneously initiate a set of device-dependent actions.	Starts a new measurement.	trg 7 or trg 703	TRIGGER 7 or TRIGGER 703
Clear	Causes an instrument to be set to a predefined state (a certain range, function, etc.)	Sames as front panel RESET. Clears internal count and starts new measurement. Clears any Error condition.	clr 7 or clr 703	CLEAR 7 or CLEAR 703
Remote	Permits selected devices to be set to remote operation, allowing parameters and device characteristics to be controlled by Bus Messages.	Causes counter to go to remote operation if REN is true and counter is addressed to listen. In absence of program data, remote operation is according to state of front panel settings just prior to going to remote. Locks out all pushbuttons except Local	rem 7 or rem 703	REMOTE 7 or REMOTE 703
Local	Causes selected devices to return to local (front panel) operation.	Goes to local front panel control. In absence of front panel data, local operation is according to the state of the remote data just prior to going to local. The following states are invoked; WA0, DR0, and SR0.	lcl 7 or lcl 703	LOCAL 7 or LOCAL 703
Local Lockout	Disables local (front panel) controls fo selected devices	Disables front panel RESET. 5335A remains in remote	llo 7	LOCAL LOCKOUT 7 or LOCAL LOCKOUT 703
Clear Lockout and Local	Returns all devices to local (front panel) control and simultaneously clears the Local Lockout Message.	Local Lockout cleared and returns to local front panel control.	lcl 7 or lcl 703	LOCAL 7 or LOCAL 703
Require Service	Indicates a device's need for interaction with the controller.	Used to flag an error or fail condition or indicate one of several instrument specific messages coded in status byte	rds(7)→A if bit (7, A) (bit 7=1 if SRQ true)	STATUS 703; A
Status Byte	Presents status information of a particular device; one bit indicates whether or not the device currently requires service, the other 7 bits (optional) are used to indicate the type of service required.	Bit 7 is set if service is requested. Additionally, Bit 1, 2, 3, 4, 6, 7, or 8 may be set, indicating a specific instrument condition or status, see *Table 3-7.*	rds(7)→A or rds(703)→A	STATUS 703; A FOR I=7 TO 0 STEP - 1 PRINT I: BIT (A, I) NEXT I END (sample program prints status of Bits 1 through 8)
Status Bit	A single bit of device dependent status information which may be logically combined with status bit information from other devices by the controller.	Does not use	—	—
Pass Control	Passes bus controller responsibilities from the current controller to a device which car assume the Bus supervisory role.	Does not use	—	—
Abort	Unconditionally terminates Bus communications and returns control to the system controller.	Clears Talk, Listen, Serial Poll Enable registers on 5335A HP-IB Interface. Front panel set-up does not change.	cli 7 or cli 703	ABORTIO 7

SWITCHES SHOWN WITH
ADDRESS = 03.

Table 3-5. HP-IB Address Switch Selections



NOTE: THE TALK ONLY SWITCH SHOULD BE CHANGED ONLY WHEN THE INSTRUMENT IS OFF.

ASCII CODE CHARACTER		ADDRESS SWITCHES					DECIMAL EQUIVALENT OF BINARY SWITCH SETTING
LISTEN	TALK	A_5	A_4	A_3	A_2	A_1	
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
—	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
Ø	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	~	1	1	1	1	0	30

3-165. Device Command Definitions

3-166. A device command is a sequence of two or more ASCII-coded bytes, sent to the 5335A over the HP-IB, that causes the counter to perform a specific function. Before discussing individual device commands, it is useful to classify these commands into five types:

1. **Numeric Command:** *Type N;* A sequence of two ASCII-coded bytes followed by a sequence of bytes representing a decimal number and a terminator. A terminator is either a comma, semicolon, space, carriage return, or line feed. A Termination may also be implied with the start of the next command. For a numeric command, the entry must follow the following format:

   <N spaces> [sign] <J digits> [.<K digits>] [E [Sign] <L digits>]

   where:
   N=0 to any value
   J=1 to 12
   K=0 to 11
   L=1 or 2

   and:
   J+K ≤12
   Absolute value of number $<10^{10}$. If more than 12 digits are received, they are ignored.

The following commands are equivalent:

9825A	**9835A/45A**
wrt 703, "RE, MS 123456"	OUTPUT 703; "RE, MS 123456"
wrt 703, ;"REMS+1.23456E+05"	OUTPUT 7,3;"REMS+1.23456E+05"
wrt 703, "RE, MS123.456E3"	OUTPUT 703; "RE, MS123.456E3"
	Scale = 123456
123456→A; wrt "RE MS", A	OUTPUT 703; "RE MS", Scale
wrt 703, "RE, MS123.456E3"	OUTPUT 703; "RE, MS123.456E3"

2. **Binary Command:** *Type B;* A sequence of two ASCII-coded bytes followed by either a 0 or a 1. The 0 indicates the selected function if "OFF" or "FALSE", and the 1 (or any non-zero value) indicates "ON" or "TRUE". The binary command uses the same format as numeric commands. The following are binary commands:

wrt 703, "WA1"	TRUE	OUTPUT 703; "WA1"
wrt 703, "WA0"	FALSE	OUTPUT 7,3; "WA0"
wrt 703, "WA123"	TRUE	OUTPUT 703; "WA123"
		True = 1
1→A; wrt 703, "WA", A	TRUE	OUTPUT 703; "WA", True

3. **Integer Commands:** *Type I;* A sequence of two ASCII-coded bytes followed by a sequence of bytes representing a decimal number and a terminator. For integer commands, negative number are converted to their absolute values. If the number is outside the expected range, the parameter is converted to zero. The integer command uses the same format as numeric commands. The following commands are equivalent:

9825A	**9835A/45A**
wrt 703, "CY2"	OUTPUT 703; "CY2"
wrt 703, "CY-2"	OUTPUT 703; "CY-2"
wrt 703, "CY 0.2E+1"	OUTPUT 703; "CY0.2E+1"

4. **Terse Commands:** *Type T*; A sequence of two ASCII-coded bytes not followed by a numeric or binary number. Requests a specific function or subroutine to be executed. For example, the characters "IN" will cause the counter to **IN**itialize all control settings to default status.

5. **Special Commands:** *Type* *; A sequence of two ASCII-coded bytes followed by a sequence of bytes representing some defined value. For example, the characters "MOD" will program the **M**ath **O**ffset to the value of the last **D**isplay.

3-167. The 5335A DEVICE COMMANDS

3-168. Almost every control on the 5335A can be programmed via the HP-IB. Programming is accomplished by addressing the counter as a listener and sending it device commands. *Table 3-6* shows the complete set of device commands. The commands are organized into functional groups for ease of description and use.

3-169. Commands may be sent upper or lower case. To separate commands, you may use nothing at all or you may use any combination of spaces, commas, semicolons, carriage returns, and line feeds. Spaces are not allowed within a command name. At least one of the separation characters must follow the end of command strings. Usually this is the carriage return and line feed characters sent automatically by a write statement. For example, the command:

9825A	**9835A/45A**
wrt 703, "RE"	OUTPUT 703; "RE"

addresses the counter as a listener and sends it the command to reset. The "wrt" (and OUTPUT) instruction automatically follows the "RE" with a carriage return and a line feed. The one exception to most of these rules is binary programming, which uses the "wtb" (or WRITE BIN) instruction. For further information on binary programming refer to Learn Mode Programming, paragraph 3-181.

3-170. Function Selection FU, FN

3-171. This selects the function. Functions 1 through 16 are the normal functions found on the front panel. Functions above 16 are special functions (see Special Functions). These are provided to enhance system measurements. **FU99** accesses the diagnostic mode. Diagnostics are covered in Section VIII.

3-172. Gate Time Setting GA, GO, GC

3-173. This GA command is used to set the gate time remotely. The range of times is from about 1 ms to about one second. Resolution of the setting is about 2 ms, and accuracy is about 2% ±2 ms. For programmed gate times greater than one second, use GO and GC, to open and close the gate "manually":

9825A	**9835/45A**
wrt 703. "GO"	OUTPUT 703; "GO"
WAIT 30000	WAIT 30000
wrt 703; "GC"	OUTPUT 703; "GC"

This can be useful for totalizing and for extremely long gate times.

NOTE

The 5335A makes no distinction between the GO and GC command. Each time either of these two are received the 5335A treats it like the pressing of MANUAL Gate Mode key.

Table 3-6. 5335A Device Commands

Command Group	Equivalent Key/Control	Description	Command Type	Device Command
	NOTE Bold print indicates the conditions set on power-up or initialization of the counter. Some of the Key/Controls are disabled or set to "off", as indicated in the Description column.			
MATH	**DISABLE**	**Disable Math group**	B	**MDØ**
		Enable Math group	B	MD1
	OFFSET	**Set OFFSET off**	N	**MOØ**
		Set OFFSET value	N	MO<#>
		Set OFFSET to last disp.	*	MOD
		Set OFFSET to $MEAS_{t-1}$	*	MOM
	NORMLZ	**Set NORMLZ off**	N	**MNØ**
		Set NORMLZ value	N	MN<#>
		Set NORMLZ to LAST Disp.	*	MND
		Set NORMLZ to $MEAS_{t-1}$	*	MNM
	SCALE	**Set SCALE off**	N	**MSØ**
		Set SCALE value	N	MS<#>
		Set SCALE to LAST Disp.	*	MSD
		Set SCALE to $MEAS_{t-1}$	*	MSM
STATISTIC	**N=100/1K**	**Set N=100**	B	**SNØ**
		Set N=1000	B	SN1
	STD DEV	**Disable Standard Deviation**	B	**SDØ**
		Enable Standard Deviation	B	SD1
	MEAN	**Disable Mean**	B	**SMØ**
		Enable Mean	B	SM1
	SMOOTH	**Disable Smooth**	B	**SSØ**
		Enable Smooth	B	SS1
	SPECIAL OUTPUT	**Special Output disable**	B	**SOØ**
		Special Output enable	B	SO1
FUNCTION	ALL FUNCT.	Select Function	I	FU<#>
			I	FN<#>
	FREQ A	**Standard Functions**		**FN1**
	TIME A→B			FN2
	TOT A			FN3
	RATIO A/B			FN5
	FREQ C			FN5
	1/TIME A→B			FN6
	PULSE A			FN7
	RATIO C/A			FN8
	RISE/FALL A			FN10
	SLEW A			FN11
	DUTY CY A			FN12
	GATE TIME			FN13
	TRIG LVL			FN14
	VOLTS			FN15
	PHASE A rel B			FN16
	FREQ B	Special Functions		FN17
	TIME B→A			FN18
	TOT A-B			FN19
	PULSE B			FN20
	DIAGNOSTICS	See text		FN99

NOTE

An Error 1.0 will be displayed if an invalid HP-IB Alpha command is sent to the 5335A.

An Error 1.1 will be displayed if an invalid HP-IB Numeric command is sent to the 5335A.

Table 3-6. 5335A Device Commands (Continued)

Command Group	Equivalent Key/Control	Description	Command Type	Device Command
GATE	GATE ADJ	Set GATE TIME 1 ms to one second	N	GA<#>
	GATE OPEN		T	GO
	GATE CLOSE		T	GC
	GATE MODE	**Set GATE MODE to NORM**	I	**GMØ**
		Set GATE MODE to FAST	I	GM1
		Set GATE MODE to MIN	I	GM2
		Set GATE MODE to MANUAL	I	GM3
CYCLE	**CYCLE MODE**	**Set CYCLE to NORM**	I	**CY1**
		Set CYCLE to MIN	I	CY2
		Set CYCLE to SINGLE	I	CY3
INPUT	**SLOPE A**	**Set SLOPE A POSITIVE**	B	**ASØ**
		Set SLOPE A NEGATIVE	B	AS1
	SLOPE B	**Set SLOPE B POSITIVE**	B	**BSØ**
		Set SLOPE B NEGATIVE	B	BS1
	PRESET A	Set PRESET A off	B	APØ
		Set PRESET A on	B	**AP1**
	PRESET B	Set PRESET B off	B	BPØ
		Set PRESET B on	B	**BP1**
	COM A	**Set COM A off**	B	**COØ**
		Set COM on	B	CO1
	AUTO TRIG	**Set AUTO TRIG off**	B	**AUØ**
		Set AUTO TRIG on	B	AU1
REAR	**EXT START**	External START Arm Slope Positive	I	XA1
		External START Arm off	I	**XA2**
		External START arm Slope Negative	I	XA3
	EXT STOP	External STOP Arm Slope Positive	I	XO1
		External STOP Arm Off	I	**XO2**
		External STOP Arm Slope Negative	I	XO3
DISPLAY	**DISP REMOTE**	**Set display to NORMAL**	B	**DRØ**
		Set Display to REMOTE (blank display)	B	DR1
	DISP DATA	Display data (with display in Remote)	N	DI<#>
BINARY	Request	Request 30 byte binary status	T	P?
		Request 30 byte binary status	T	PQ
	Program	Program with binary status	*	PB<*>
MISC	**Wait**	**WAIT to send mode off**	B	**WAØ**
		WAIT to send mode on	B	WA1
	SRQ	**Service Request disabled**	B	**SRØ**
		Service Request enabled	B	SR1
	INITIALIZE	Initialize everything to default	T	IN
	INTERPOLATOR	**Interpolator enable**	B	**IDØ**
		Interpolator disabled	B	ID1
	RESET	Reset instrument for new measurement.	T	RE
	RANGE HOLD	**Set RANGE HOLD off**	B	**RHØ**
		Set RANGE HOLD on	B	RH1
	EXT ARM EN	**Set EXT ARM EN off**	B	**XEØ**
		Set EXT ARM EN on	B	XE1
	CHECK	Start CHECK*	T	CH

*When selecting the CHECK function via the HP-IB, the HP5335A must NOT be in the "GA" (Gate Adj) function or a "FAIL 4.4" will result.

3-174. Remote Display DRØ, DR1, DI

3-175. This command lets you write to the display remotely. When DR1 is sent, the display can be written to by the DI command. For example, the command:

9825A	9835A/45A
wrt 7Ø3, "DR1, DI12345"	OUTPUT 7Ø3; "DR1, DI12345"

causes the number given by the DI command (12345) to be formatted into engineering notation and displayed. With the display in remote, normal measurements can still be programmed, executed and output through the HP-IB, but the results will not be displayed.

3-176. Default States

3-177. The default state is equivalent to sending all commands with a parameter of zero. This may be different from the power-up state for controls that are found on the rear panel and for the INPUT section on the standard front end, due to the use of detented, not momentary, switches.

3-178. For integer type commands (Type I) the default states are as follows:

FUNCTION	(FUØ is ignored)		
CYCLE	CYØ	equivalent to	CY1 NORM
EXT START	XAØ	equivalent to	XA2 OFF
EXT STOP	XOØ	equivalent to	XO2 OFF

3-179. Initialize

3-180. When INitialize is executed, the following states are NOT affected: DR, WA, SR, SO

The following states will be set:

CHAN A & B PRESET ...	ON
CHAN A & B	$\not f$
SEP/COM	SEP
AUTO TRIG	OFF
EXT ARM	OFF
RANGE HOLD	OFF
FUNCTION	FREQ A
MATH	OFF
STATISTICS	OFF
GATE MODE	NORM
CYCLE MODE	NORM

NOTE

Do not initialize ("IN") the counter when the display is in remote ("DR1"). Whenever the display is in remote, follow the initialize command with "FU1" (or any other function command). For example: wrt "5335A", "IN, FU1, DR1".

3-181. Learn Mode Programming P?, PQ, PB

3-182. The front panel can be used as the medium by which you tell the controller how to program the counter. This is commonly referred to as Learn Mode programming, or Binary Programming.

3-183. With the instrument in Local, the user is allowed to set up the controls in the MATH, STATISTICS, FUNCTION, GATE MODE and CYCLE groups in any way desired. The controller then sends a PQ command and follows this by receiving 30 bytes of binary program data. Later, when the set up is to be duplicated by the controller, the instrument is sent PB followed by the same 30 bytes of binary data.

3-184. If the data contained in the OFFSET, NORMLZ, and SCALE registers is not needed, the 30 bytes can be shortened to just 7 bytes, thus speeding the programming time. Refer to the Programming Examples beginning with paragraph 3-209.

3-185. SRQ and Status SR

3-186. The 5335A has the ability to send a request service (SRQ) message. To enable this feature, the controller must send the SR1 command.

3-187. Request service may be sent upon any error or fail message, and may be sent at the end of a measurement. When request service is sent the seventh bit (bit 7) is set. In addition to this bit, one other bit is also set, representing the status or type of service requested. If service request is not enabled, this second bit is still set, even though bit 7 is not. *Table 3-7* gives the effect of each of the status bits on the service request message. When SRQ is asserted, the 5335A will turn on the "SRQ" annunciator.

3-188. The 5335A will only send SRQ if a measurement is ready for sending, and it is in the WAIT mode, and it is not addressed to TALK or RFD is false.

SRQ if:
(Measurement done)
AND
(in WAIT mode)
AND
[(if not addressed to TALK) or (RFD is false)]

NOTE

Constant reading of the status byte is not recommended. This may slow down the measurement processor time.

Table 3-7. Status Bits Usage with SRQ

SR Status Bits	Usage
BIT 1 (LSB)	Set when measurement is done; and 1) 5335A is in WAIT mode and it is not yet addressed to talk, or 2) 5335A is in WAIT mode and is addressed to talk, but listening device on bus is not yet ready for data (RFD is false).
BIT 2	Set when external time base used.
BIT 3	Set if an ERROR has happened.
BIT 4	Set if a FAIL has happened.
BIT 6	Set when GATE is open.
BIT 7	Set if requesting service.
BIT 8	Set if in diagnostic monitor

3-189. Program Execution/Response Times

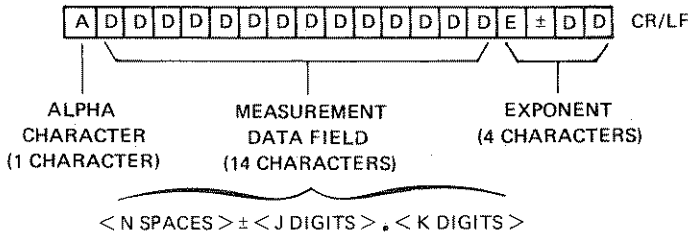
3-190. Program speed is dependent upon the 5335A's HP-IB response time. *Table 3-8* provides some NOMINAL response times for various types of commands, using the 9825A calculator. The examples use the "wrt" instruction. Times are rounded up to 5 ms resolution.

Table 3-8. HP-IB Response Times

Command Mode	Device Command Code	Nominal Response Time
Function Select	FU1	50 ms
	NOTE	
	For RISE/FALL A, SLEW A, and PHASE allow for AUTO TRIG response time).	
Math Set	MS-123456789e-9	75 ms
	MD1	45 ms
Statistics Set	SN1	45 ms
	SD1	45 ms
	SM1	45 ms
	SS1	45 ms
Reset	RE	30 ms
Range Hold	RH1	45 ms
Ext Arm Enable	XE1	45 ms
	XA2	45 ms
Gate Set	GM1	45 ms
	GA 29.111	60 ms
Cycle Set	CY1	45 ms
Input Set	AS1 and AP1	45 ms
	CO1	45 ms
	AU1	45 ms
Display	DR1	25 ms
	DI-123456789e-9	70 ms
	DRØ	45 ms
Initialize	IN	30 ms
Miscellaneous	WA1	45 ms
	SR1	45 ms
	clr (HP-IB clear)	240 ms
	trg (HP-IB trigger)	30 ms
	rds (HP-IB read status)	30 ms
Program Binary	P?	30 ms
	PB (30 bytes)	90 ms
	PB (7 bytes)	40 ms

3-191. Output Format

3-192. After a measurement, the 5335A outputs the data to the HP-IB. The output byte contains 19 characters which are arranged in the following format:



3-193. ALPHA CHARACTER. One of eight single characters which specify the type of measurement. It is generally used to indicate the type of units. The alpha characters are:

F - precedes Frequency measurements; units of Hz (Hertz)

S - precedes Time measurement; units of s (seconds)

V - precedes Voltage measurements; units of V (Volts)

R - precedes Ratio measurement; no units

T - precedes Totalize measurements; no units

sp - precedes 1/TIME, DUTY CYCLE, PHASE; units as specified

A - precedes A Channel TRIG LVL; units of V (Volts)

B - precedes B Channel TRIG LVL; units of V (Volts)

M - precedes MEAN output with SO1

N - precedes MIN output with SO1

X - precedes MAX output with SO1

NOTE

For TRIG LVL, two complete 19 character output bytes are sent in succession. Each Channel requires a complete output sequence.

3-194. MEASUREMENT DATA FIELD. The data field consists of a 14-character string. The number begins with the sign (+ or –), followed by the digits in descending order or significance. The number, however, is right-justified within the data field. To keep the number of characters constant within the total string, spaces (up to 10) will be inserted preceding the sign.

3-195. EXPONENT. Preceded by an "E" and the sign (+ or –), the exponent will be a multiple of 3, similar to the display which is in engineering format. On some occasions, it is possible that the format of the HP-IB output and the display will differ. Nonsignificant zeros in the display are converted to real zeros, and the output is such that there is always a significant digit left of the decimal point.

3-196. The following string illustrates a typical output byte for a FREQ A measurement of 12.3456789 MHz. The output byte is followed by a (CR) carriage return and a (LF) line feed.

F (sp) (sp) +1 2 . 3 4 5 6 7 8 9 0 E + 0 6 (CR) (LF)

NOTE

The Data Output Rate for a complete output string consisting of 19 characters plus a CR and LF is typically 8 ms.

3-197. Output Modes

3-198. The 5335A powers up with the following output modes: WAØ, SRØ, SOØ.

3-199. When the Wait to be Addressed mode is OFF (WAØ) the 5335A will output only if it is addressed to talk and RFD is true and measurement data is ready. If at the end of a measurement the 5335A finds that it is NOT addressed to talk or that RFD is false the measurement data is not sent and a new measurement is started.

3-200. When the Wait to be Addressed mode is ON (WA1) the 5335A will wait to be addressed and for RFD to be true. In this mode, new measurements are not started until the data from the previous measurement is sent, or if a command is sent.

3-201. The Wait to be Addressed mode must be active if you want an SRQ generated at the end of the measurement. Status Bit 1 can be used to monitor the 5335A for the end of measurement occurrence. This bit is effective only if the WAIT mode is ON.

3-202. When receiving trigger level data it is recommended that the WAIT mode be ON. This will assure no loss of data. However, the TRIG LVL function is unique in that it does not show a display until *after* it outputs to the display. Therefore, the WAIT mode should be turned OFF if you wish for the display to update.

3-203. Output of Statistics

3-204. For measurements using statistics the individual measurements are not sent out. Only the result of the statistical calculation is output. The prefix alpha character will be the same as the normal measurement.

3-205. The Special Output command "SO" can be sent to tell the 5335A to send additional secondary data when statistics are enabled:

- When STD DEV is on and SO1 has been sent the following data is given in two complete strings:

  STD DEV
  MEAN (of the same sample, preceded with the letter "M")

- When MEAN is on and SO1 has been sent the following data is given in three complete strings:

  MEAN
  MIN (of the same sample, preceded with the letter "N")
  MAX (of the same sample, preceded with the letter "X")

NOTE

Secondary statistical data will wait for RFD to be true if the listening device is not able to receive the data immediately.

3-206. SPECIAL FUNCTIONS

3-207. Functions 17, 18, 19, and 20 are additional functions that are available in the 5335A.

17 FREQ B
18 TIME B→A
19 TOT A–B
20 PULSE B

These functions are accessed via the HP-IB through the normal FN or FU command, however, they may also be accessed manually through the keyboard. This is an example of invoking FREQ B, function 17:

Press: SCALE SMOOTH 17 ENTER

3-208. After pressing SMOOTH the display will show the word "SPECIAL". After pressing ENTER the counter will be in FREQ B. No function lamp indication is given for these special functions.

- When using TOTALIZE A-B output is given only after the gate is closed. To start the totalizing, a pulse from B must first be received. The TOT A-B (special Function 19) is armed by B. Closing the gate is also synchronized.
- Diagnostics are programmed by sending FN99, followed by a diagnostic code that is programmed into the SCALE register. For example, FN99 MS12, calls up diagnostic 12. (See chapter VIII). Via the keyboard the diagnostics are called similarly. Press SCALE, SMOOTH 99 ENTER, then SCALE 12 ENTER.

3-209. PROGRAMMING EXAMPLES

3-210. The following HP-IB programming examples are provided for information and illustration only. Sample programs are provided for both 9825A and 9835A Computing Controllers, and assume a 5335A address of decimal "3".

EXAMPLE 1. A) TYPICAL MEASUREMENT FORMAT

This program first dimensions a string variable in the controller for the incoming data and then sets the 5335A to its default mode (Initialize) with a gate time of 500 ms (.5 seconds). The counter will then make a simple Frequency A measurement. In step 2 the controller will read the measurement into string A, and then step 3 displays the information. After waiting for 1 second (1000 milliseconds), the program loops back into reading a "new measurement" and the cycle is repeated.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"in,ga.5"
2: red 703,A$
3: dsp A$
4: wait 1000
5: gto -3
6: end
*24362
```

9835A EXAMPLE

```
10    DIM A$[21]
20    OUTPUT 703;"in,ga.5"
30    ENTER 703;A$
40    DISP A$
50    WAIT 1000
60    GOTO 30
70    END
```

EXAMPLE 1. B) TYPICAL MEASUREMENT FORMAT

This is an example of how the controller can be used to display a measurement once every 5 seconds. After a measurement is accepted in step 2, the HP-IB's RFD (Ready For Data) line is held false until another read instructions is executed. This means that during the wait statement in step 4, the RFD line is false. The 5335A will check the RFD line whenever it is addressed to talk to make sure that the listening device is ready for data. If it finds RFD false and the wait mode is off, the counter will skip trying to output the data and start a new measurement.

In this example the 5335A will continue to make measurements without sending data until 5 seconds have passed. After 5 seconds, the next measurement that comes is sent.

Note that this check of the RFD line is done for the first character of a measurement data string only. Subsequent characters are sent normally.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"in"
2: red 703,A$
3: dsp A$
4: wait 5000
5: gto -3
6: end
*12686
```

9835A EXAMPLE

```
10    DIM A$[21]
20    OUTPUT 703;"in"
30    ENTER 703;A$
40    DISP A$
50    WAIT 5000
60    GOTO 30
70    END
```

EXAMPLE 2. WAIT MODE

The wa1 command tells the 5335A to wait at the end of each measurement to output data, even if not presently address to talk. During the 5 second wait period in step 4 if a measurement ends the counter will wait until it can send its data before starting the next measurement.

Note that if the gate time of the measurement is very short, the data that gets displayed in this example is about 5 seconds old.

9825A EXAMPLE

```
0: dim A$[211
1: wrt 703,"in,wa1"
2: red 703,A$
3: dsp A$
4: wait 5000
5: gto -3
6: end
*22874
```

9835A EXAMPLE

```
10    DIM A$[211
20    OUTPUT 703;"in,wa1"
30    ENTER 703;A$
40    DISP A$
50    WAIT 5000
60    GOTO 30
70    END
```

EXAMPLE 3. TIME INTERVAL AND PULSE WIDTH

This program will set the 5335A for a Time Interval measurement (fu2), com A (co1) and channel B slope to negative (bs1), in step 0. Step 1 causes the counter to read into the simple variable A and step 2 sets up the controller for a specific floating format. Step 3 displays the contents of the simple variable A; format: "T.I. =_____s.". After waiting for 3 seconds in step 4, the controller will set up the 5335A for a Pulse A measurement (fu7) in step 5. In step 6, the 5335A will read into the simple variable B. Step 7 will display the contents of variable B formatted as follows: "PULSE A = _____s.". Following 3 seconds of waiting, the whole process is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu2,co1,bs1"
1: red 703,A
2: flt 5
3: dsp "T.I.=",A,"sec."
4: wait 3000
5: wrt 703,"infu7"
6: red 703,B
7: dsp "PULSE A=",B,"sec."
8: wait 3000
9: gto 0
10: end
*6527
```

9835A EXAMPLE

```
10    OUTPUT 703;"in,fu2,co1,bs1"
20    ENTER 703;A
30    FLOAT 5
40    DISP "T.I.=";A;"sec."
50    WAIT 3000
60    OUTPUT 703;"infu7"
70    ENTER 703;B
80    DISP "PULSE A=";B;"sec."
90    WAIT 3000
100   GOTO 10
110   END
```

EXAMPLE 4. RISE/FALL TIME AND SLEW RATE

In this example, step Ø sets the 5335A for Rise Time (in, fu10). After a pause of 3 seconds in step 1, (this pause is recommended for allowing the Auto trigger circuitry to settle down). step 2 will force the counter to read into simple variable A. Step 3 sets up the 9825A for a given floating format. In step 4, the 9825A will display: "RISE TIME =_____s.", showing the contents of simple register A. The controller sets up the counter for Positive Slew Rate A (fu11) in step 6, and in step 7, the 5335A reads into simple variable B. In step 8 the controller will display: "POS. SLEW RATE = _____V/S" showing the contents of variable B. The controller sets up the counter for Fall Time (fu10 as1) and waits for 3 seconds in steps 9 and 10. In step 11, the information from the 5335A is read into simple variable A. The controller will display: "FALL TIME =_____s." and the contents of variable A in step 12. The 5335A is set up for a Negative Slew Rate A in step 14, and the controller reads this information into variable B in step 15; then the 9825A will show the contents of B along with the display: "NEG. SLEW RATE =_____V/S" in step 16, after which the whole process is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu10"
1: wait 3000
2: red 703,A
3: flt 5
4: dsp "RISE TIME=",A,"sec."
5: wait 2000
6: wrt 703,"infu11"
7: red 703,B
8: dsp "POS. SLEW RATE=",B,"V/s"
9: wrt 703,"fu10,as1"
10: wait 3000
11: red 703,A
12: dsp "FALL TIME=",A,"sec."
13: wait 2000
14: wrt 703,"fu11"
15: red 703,B
16: dsp "NEG. SLEW RATE=",B,"V/s"
17: gto 0
18: end
*28502
```

9835A EXAMPLE

```
10    OUTPUT 703;"in,fu10"
20    WAIT 3000
30    ENTER 703;A
40    FLOAT 5
50    DISP "RISE TIME=";A;"sec."
60    WAIT 2000
70    OUTPUT 703;"infu11"
80    ENTER 703;B
90    DISP "POS. SLEW RATE=";B;"V/s"
100   OUTPUT 703;"fu10,as1"
110   WAIT 3000
120   ENTER 703;A
130   DISP "FALL TIME=";A;"sec."
140   WAIT 2000
150   OUTPUT 703;"fu11"
160   ENTER 703;B
170   DISP "NEG. SLEW RATE=";B;"V/s"
180   GOTO 10
190   END
```

EXAMPLE 5. DUTY CYCLE

This program will set up the 5335A for a Duty Cycle measurement (positive portion of waveform, in fu12) in step 0; then, in step 2, forces the counter to read into simple variable A. Step 3 displays the contents of variable A, format: "'UP' Duty Cycle =_____%" and maintains the display for 3 seconds (step 4). In step 5, the 5335A is programmed for a Duty Cycle measurement of the negative portion of the wave form (as1) and in step 7, the 9825A will display: "'DOWN' Duty Cycle =_____%"; after waiting for 3 seconds, the total cycle is repeated.

9825A EXAMPLE

```
0: wrt 703,"in,fu12"
1: fxd 4
2: red 703,A
3: dsp "'UP' Duty Cycle=",A,"%"
4: wait 3000
5: wrt 703,"as1"
6: red 703,B
7: dsp "'DOWN' Duty Cycle=",B,"%"
8: wait 3000
9: gto 0
10: end
*8772
```

9835A EXAMPLE

```
10      OUTPUT 703;"in,fu12"
20      FIXED 4
30      ENTER 703;A
40      DISP "'UP' Duty Cycle=";A;"%"
50      WAIT 3000
60      OUTPUT 703;"as1"
70      ENTER 703;B
80      DISP "'DOWN' Duty Cycle=";B;"%"
90      WAIT 3000
100     GOTO 10
110     END
```

EXAMPLE 6. MATH PROGRAMMING EXAMPLE

To demonstrate the 5335A flexibility in mathematical manipulations, apply a signal to INPUT A of different frequencies. Step 2 will request the Offset, Normalize, and Scale factors which are used to program the 5335A in step 3. The manipulated measurement is read into string variable A (step 4). Steps 5 through 10 will print the Offset, Normalize, and Scale factors, respectively; steps 11 and 12 will print the final result.

9825A EXAMPLE

```
0: dim A$[21]
1: fxd 0
2: ent "OFFSET ?",O,"NORMALIZE ?",N,"SCALE ?",S
3: wrt 703,"in,mo",O,"mn",N,"ms",S
4: red 703,A$
5: prt "OFFSET=",O
6: spc
7: prt "NORMALIZE=",N
8: spc
9: prt "SCALE=",S
10: spc 2
11: wrt 16,"RESULT="
12: wrt 16,A$[1,11],A$[5,19]
13: end
*25419
```

9825A PRINTED RESULTS:

```
OFFSET=    100000

NORMALIZE=     50

SCALE=         25


RESULT=
F+50.5014734E+03
```

9835A EXAMPLE

```
10      DIM A$[21]
20      FIXED 0
30      INPUT "OFFSET ?",O
40         INPUT "NORMALIZE ?",N
50         INPUT "SCALE ?",S
60      OUTPUT 703;"in,mo";O;"mn";N;"ms";S
70      ENTER 703;A$
80      PRINT "OFFSET=",O
90      PRINT LIN(1)
100     PRINT "NORMALIZE=",N
110     PRINT LIN(1)
120     PRINT "SCALE=",S
130     PRINT LIN(2)
140     OUTPUT 16;"RESULT=      ";A$[1,11];A$[5,19]
150     END
```

EXAMPLE 7. REMOTE DISPLAY

This program will set up the 5335A for the remote display function, to acquire a measurement, modify and format the measurement into engineering notation, and send the result to the display of the counter.

Step 0 programs the counter for Frequency A and Remote Display (fu1 dr1); the unmodified measurement then is read into simple variable A in step 1. This measurement is modified and stored in variable B (step 2), then sent to the 5335A display in step 3. The cycle is again repeated in step 4.

9825A EXAMPLE

```
0: wrt 703,"fu1dr1"
1: red 703,A
2: A+1e6→B
3: wrt 703,"di",B
4: gto 1
5: end
*27213
```

9835A EXAMPLE

```
10    OUTPUT 703;"fu1dr1"
20    ENTER 703;A
30    B=A+1E6
40    OUTPUT 703;"di";B
50    GOTO 20
60    END
```

EXAMPLE 8. TEACH—LEARN

The following program serves as an example of the TEACH—LEARN mode (Binary Program mode). It will allow you to manually set-up the 5335A front panel, after which the 9825A will read into column matrix A, 30 bytes of binary programming data (steps 4 through 7), after which the controller will beep indicating the end of data transfer. (Information recorded: MATH, STATISTICS, FUNCTION, GATE MODE and CYCLE) Then the controller will allow the user to change the front panel settings of the counter (steps 10 and 11). Also, it will allow the user to suppress the MATH information and thereby speeding up the transfer of data (steps 12, 13, and 14). Note however, that the OFFSET, NORMALIZE and SCALE LED will be ON although no information was transferred into their registers. In step 15 the controller will transfer all 30 bytes of binary programming data that it recorded earlier, to the 5335A; at the end of data transfer, the controller will beep twice. The counter is returned to local control in step 19, completing the exercise.

9825A EXAMPLE

Press CONTINUE TO RESUME

0 = SHORT DATA TRANSFER
1 = LONG DATA TRANSFER

```
0: dim A[30]
1: lcl 703
2: dsp "Manually set-up 5335A controls"
3: stp
4: wrt 703,"pq"
5: for I=1 to 30
6: rdb(703)>A[I]
7: next I
8: beep
9: lcl 703
10: dsp "Now, change the 5335A controls"
11: stp
12: ent "Do you need MATH functions ?",B
13: if B;gto "LONG"
14: wtb 703,"pb"
15: wtb 703,A[1],A[2],A[3],A[4],A[5],A[6],255
16: beep
17: wait 500
18: beep
19: gto 27
20: "LONG":wtb 703,"pb"
21: for I=1 to 30
22: wtb 703,A[I]
23: next I
24: beep
25: wait 500
26: beep
27: lcl 703
28: end
*28738
```

(Continued)

EXAMPLE 8 (Continued)

9835A EXAMPLE

```
10      DIM A$[30]
20      LOCAL 703
30      DISP "MANUALLY SET-UP 5335A CONTROLS.
                                  PRESS 'CONT' WHEN READY"
40      PAUSE
50      OUTPUT 703;"pq"
60      ENTER 703 USING "#,30A";A$
61      LOCAL 703
62      BEEP
80      DISP "NOW, CHANGE THE 5335A CONTROLS.
                                  PRESS 'CONT' WHEN READY"
90      PAUSE
100     INPUT "DO YOU NEED MATH FUNCTIONS ?
                                        (YES OR NO)",B$
110     IF B$[1,1]="Y" THEN GOTO Long
120     OUTPUT 703 USING "#,2A,6A,B";"pb",A$,255
130     BEEP
140     WAIT 500
150     BEEP
160     GOTO 210
170 Long: OUTPUT 703 USING "#,2A,30A";"pb",A$
180     BEEP
190     WAIT 500
200     BEEP
210     LOCAL 703
220     END
```

Press CONTINUE TO RESUME

0 = SHORT DATA TRANSFER

1 = LONG DATA TRANSFER

EXAMPLE 9. STATISTICS OUTPUT EXAMPLE

This is an example of the use of Statistic Output format. The controller will request from the user the sample size, either 100 or 1000 (step 1); it will then program the 5335A for a Frequency A measurement with the selected sample size, and special statistics output for MEAN computation (SM1, SO1) in step 2. Step 3 causes the counter to read into the three string variables; the contents of the strings with appropriate leader information will be printed in steps 4 through 10.

The controller will then set up the 5335A for a Standard Deviation measurement and it will store the result in the two string variables (step 11); in steps 12 through 25, the 9825A will print the contents of the variables with appropriate identification.

9825A EXAMPLE

```
0: dim A$[21],B$[21],C$[21]
1: ent "Sample size: 100/1000 (N=0/1) ?",N
2: wrt 703,"insn",N,"sm1,so1"
3: red 703,A$,B$,C$
4: prt "FRECUENCY A"
5: prt "STATISTICS"
6: spc 2
7: prt "MEAN="
8: wrt 16,A$[1,1],A$[5,19]
9: spc
10: prt "MIN="
11: wrt 16,B$[1,1],B$[5,19]
12: spc
13: prt "MAX="
14: wrt 16,C$[1,1],C$[5,19]
15: spc 3
16: beep
17: wrt 703,"sd1"
18: red 703,A$,B$
19: prt "STANDARD DEV.="
20: wrt 16,A$[1,1],A$[5,19]
21: spc
22: prt "MEAN="
23: wrt 16,B$[1,1],B$[5,19]
24: spc 3
25: beep
26: lcl 703
27: end
*32154
```

(Continued)

EXAMPLE 9 (Continued)

9825A PRINTED RESULTS:

```
FREQUENCY A
STATICTICS


MEAN=
F+107.009501E+03

MIN=
N+106.999793E+03

MAX=
X+107.018802E+03



STANDARD DEV.=
F      +3.34E+00

MEAN=
M   +107.0020E+03
```

9835A EXAMPLE

```
10      DIM A$[21],B$[21],C$[21]
20      INPUT "Sample size: 100/1000 (N=0/1) ?",N
30      OUTPUT 703;"insn";N;"sm1,so1"
40      ENTER 703;A$,B$,C$
50      PRINT "********  FREQUENCY  A  STATISTICS  ********"
70      PRINT LIN(2)
71      PRINT CHR$(27)&"l"                                  !FREEZES TITLE
80      PRINT "          MEAN=    ";A$
110     PRINT "           MIN=    ";B$
140     PRINT "           MAX=    ";C$
160     PRINT LIN(2)
161     BEEP
170     OUTPUT 703;"sd1"
180     ENTER 703;A$,B$
190     PRINT "STANDARD DEV =    ";A$
220     PRINT "          MEAN=    ";B$
240     PRINT LIN(3)
270     BEEP
280     LOCAL 703
290     END
```

EXAMPLE 10. HIGH SPEED MEASUREMENT (COMPUTER DUMP)

This following program will illustrate how the 5335A can be set-up to perform a high speed transfer of data with the 9825A controller. Line 2 specifies a "fast read-write buffer" labeled "SJ", allocating 2100 bytes of memory. Line 3 initializes the 5335A for a measurement; the buffer is cleared in line 4. In line 5, 100 measurements are transferred directly into buffer "SJ" from the counter; line 6 check for a completed transfer of data, after which, the controller will beep.

The 9835A will, in lines 8 through 10, remove 21 bytes at a time from buffer "SJ" and store them temporarily in A$, display this information as well as the measurement number; this operation is performed N times.

9825A EXAMPLE

```
0: dim A$[21]
1: 100→N
2: buf "SJ",21*N,3
3: wrt 703,"in,gm2,cy2"
4: buf "SJ"
5: tfr 703,"SJ",N*21
6: if rds("SJ")=-1;jmp 0
7: beep
8: for X=1 to N
9: red "SJ",A$
10: fxd 0
11: dsp A$,X
12: wait 500
13: next X
14: beep
15: end
*5418
```

9835A EXAMPLE

```
10      OPTION BASE 1
20      FIXED 0
30      DIM A$[21],B$(100)[21]
40      N=100
50      OUTPUT 703;"in,gm2,cy2"
60      ENTER 703 BFHS 2100;B$(*)
70      BEEP
80      FOR X=1 TO 100
90      PRINT USING "DDD,XXX,21A";X,B$(X)
91      WAIT 500
100     NEXT X
101     BEEP
110     END
```

EXAMPLE 11. SERVICE REQUEST and WAIT

The following program serves as an example of the SRQ (Service Request) feature in the 5335A. As the controller is executing each program line, it logs in the interrupt request and assigns it a priority; the 9825A will finish the current line and then branch to the service routine (End of Line branching—EOL). Once the service routine is completed (by executing its "iret" statement), the main program pointer will return to the following line from where the interrupt occurred. Line 1 sets up the 5335A into the WAIT mode and enables the sending of SRQ at the end of a measurement; line 2 specifies where to go when the 9825A receives a SRQ, and line 3 enables the use of SRQ. Line 4 simply loops, doing nothing. Lines 5 through 8 are executed whenever an SRQ from the counter is received, a measurement data is then read and the counter is reset.

9825A EXAMPLE

```
0: dim A$[21]
1: wrt 703,"wai,sr1"
2: oni 7,"SRQ"
3: eir 7
4: gto 3
5: "SRQ":
6: if bit(6,rds(703))
7: red 703,A$
8: dsp A$
9: wrt 703,"re"
10: iret
11: end
*2714
```

9835A EXAMPLE

```
10      DIM A$[21]
20      OUTPUT 703;"wai,sr1"
30      ON INT #7 GOSUB Srq              !ENABLE END-OF-LINE BRANCHES.
40      CONTROL MASK 7;128               !SET UP INTERRUPT CONDITION.
50         CARD ENABLE 7                 !ENABLE CARD FOR INTERRUPTS.
51         WAIT 100
60      GOTO 40
70 Srq:    !
80      STATUS 703;Temp
90        IF NOT BIT(Temp,6) THEN 100
100     ENTER 703;A$
110     DISP A$
120     OUTPUT 703;"re"
121     WAIT 100
130     RETURN
140     END
```

EXAMPLE 12. TRIGGER LEVEL

In this example, the controller will set up the counter for trigger Level function (fu14) in step 1; then the 5335A will read into two string variables A$ and B$ in step 2 (2 complete 19 character sets are sent out in succession, one for each channel). Steps 3 and 4 will display the contents of the string variables; the whole process is repeated in step 5.

9825A EXAMPLE

```
0: dim A$[21],B$[21]
1: wrt 703,"fu14"
2: red 703,A$,B$
3: dsp "TRIGGER LEVEL A=",A$[11,19];wait 3000
4: dsp "TRIGGER LEVEL B=",B$[11,19];wait 3000
5: gto 1
6: end
*28390
```

9835A EXAMPLE

```
10      DIM A$[21],B$[21]
20      OUTPUT 703;"fu14"
30      ENTER 703;A$,B$
40      PRINT "TRIGGER LEVEL A=       ";A$[11,19]
41      PRINT LIN(3)
50      PRINT "TRIGGER LEVEL B=       ";B$[11,19]
70      END
```

3-211. OPTIONS

3-212. The operating characteristics of the 5335A are affected by the addition of any of the options described in the following paragraphs.

3-213. Time Base Option 010

3-214. Option 010 provides an Oven-Controlled Crystal Oscillator Time Base, that results in higher accuracy and longer periods between calibration (refer to *Table 1-1*). The oven temperature is maintained when the 5335A LINE switch is in either the ON or the STBY position (provided the instrument is connected to the power mains).

NOTE

The Option 010 Oven-Controlled-Oscillator, HP Model 10811A, is a direct replacement for the previous HP Model 10544A. Service documentation for the *older* 10544A is provided in SECTION VIII under Assembly A12 Oven Oscillator. All service documentation for the newer HP 10811A is provided in the HP 10811A Operating and Service Manual, (HP Part Number 10811-90002) included with Option 010.

3-215. Digital Voltmeter Option 020

3-216. Option 020 provides a fully floating, autoranging digital voltmeter. This module measures dc inputs up to 1000 volts through front panel connectors. Refer to Specificatons, *Table 1-1*, for the specific operating characteristics.

3-217. C Channel Option 030

3-218. Option 030 provides a C Channel Input Module, which expands the frequency counting range of the counter to 1.3 GHz. A front panel control adjusts the input sensitivity. A front panel preamp power receptacle is provided. Refer to Specifications, *Table 1-1*, for the specific operating characteristics.

3-219. OPERATOR'S MAINTENANCE

3-220. The only maintenance the operator should normally performs is replacement of the primary power fuse located within the Line Module Assembly. For instructions on how to change the fuse, refer to Section II, Line Voltage Selection.

CAUTION

Make sure that only fuses with the required rated current and of the slow-blow type are used for replacement. The use of repaired fuses and the short-circuiting of fuse-holders must be avoided.

3-221. When Option 030 C Channel is installed, the operator may be required to replace the input BNC fuse. This is a 1/8A fuse (HP Part No. 2110-0301) which is located within the INPUT C BNC connector (see *Figure 3-4* for details). To replace the fuse, disconnect the power cord, unscrew the special BNC barrel (P/N 05305-60205) and, with needle-nose pliers, remove and replace the fuse. Reinstall the BNC barrel, and tighten using a BNC cable connector. Be careful not to overtighten.

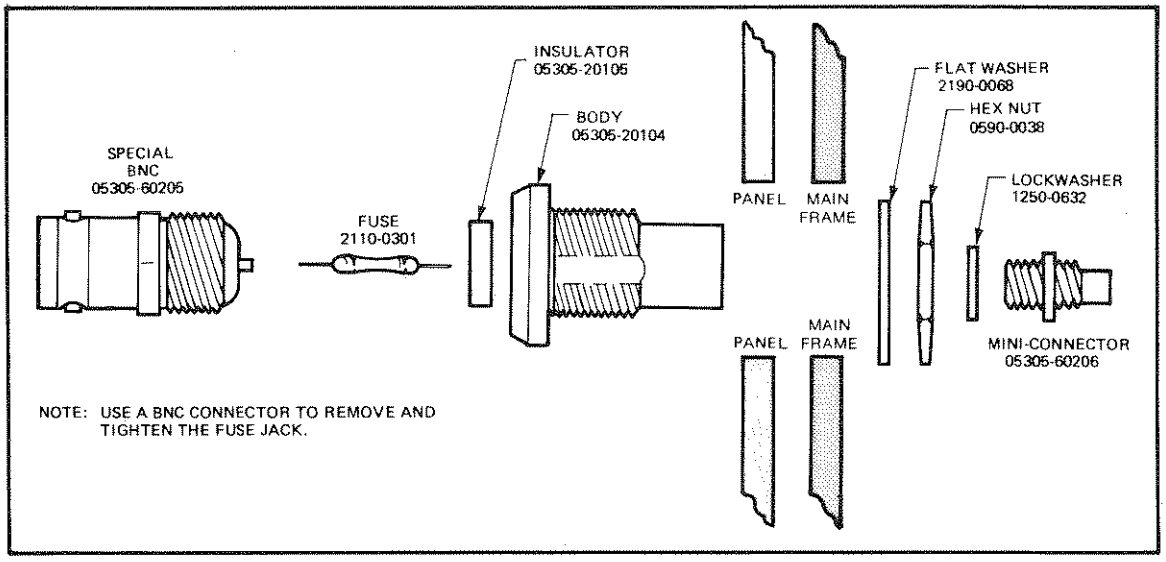


Figure 3-4. Details of Input Connector J1 and Fuse Mounting

3-222. Power/Warm-Up

3-223. The HP Model 5335A requires a power source of 100, 120, 220, or 240V ac, +5%, -10%, 48 to 66 Hz single phase. The selection of line voltage and input power fuse is described in Section II, paragraph 2-5, Preparation for Use.

3-224. The 5335A has a two-position power switch, STBY and ON. For 5335A Option 010 only, it is important that the instrument remain connected to the power source in the STBY mode when not in use. This supplies power to the crystal oven maintaining a constant oven temperature, thus eliminating the need for a warm-up period. When the STBY mode is not used and power is disconnected from the instrument, allow 30 minutes from the application of external power in the ON mode for the instrument (crystal oven) to warm-up.

WARNING

POWER IS ALWAYS PRESENT AT THE LINE SWITCH AND TRANSFORMER, AND UNREGULATED DC IS PRESENT WHENEVER THE LINE CORD IS ATTACHED. UNPLUGGING THE POWER CORD IS NECESSARY TO REMOVE ALL POWER FROM THE INSTRUMENT.

3-225 OPERATOR'S CHECK

3-226. The following procedures will verify the basic operation of the HP5335A Universal Counter. These tests are not intended to verify the overall accuracy or performance specifications of the instrument. They should, however, provide the operator a quick method of determining that the counter is operating properly. The tests are provided in two levels; a DISPLAY CHECK and a FRONT PANEL CHECK. The operator should perform both tests.

A. DISPLAY CHECK

To perform the HP5335A DISPLAY CHECK, momentarily press the key labeled "CHECK". Verify that all display annunciators, except "STBY" and the A and B Channel Trigger lights, cycle ON and OFF. Pressing any Function key will return normal operation.

B. FRONT PANEL CHECK

To perform the HP5335A FRONT PANEL CHECK, use a BNC cable to connect the rear panel TBO (Time Base Output) to the front panel INPUT A. Set the HP5335A controls as follows:

1M/50 Ω ..... 50 Ω

3-227. Press and hold the "CHECK" button for about three seconds. Verify that all HP5335A display annunciators turn ON for approximately ten seconds; during which the front end amplifiers are checked for the accuracy, cross-talk, attenuation and separate/common with the input signal. Successful completion of the test loop is indicated by a display of "FE PASS". Any failures are identified by a numbered fail message. For a description of the numbered FAIL messages, refer to paragraph 3-229.

3-228. The FRONT PANEL CHECK is a built-in continuous loop, which will repeat until manually reset. To halt the test and return to normal operation, press any Function key.

3-229. ERROR/FAIL MESSAGES

3-230. Under certain conditions the 5335A will display either Error or Fail type messages. These messages typically occur during the power-up cycle. The fail messages are displayed in a continuous loop, and generally indicate a hardware related problem. Error messages indicate that the user has attempted an improper operation, either through the keyboard or the HP-IB. *Table 3-9* lists the Error Messages, and *Table 3-10* lists the Fail Messages. If a Fail message is displayed, refer to the troubleshooting information in Section VIII.

Table 3-9. Error Messages

1.0	HP-IB Error:	Incorrect command
1.1	HP-IB Error:	Number out of range or incorrect number within command
7.0	Check Error:	Cable may not be connected between T.B.O. and INPUT A for extended CHECK, Diag 01 or Diag 14.

Table 3-10. Fail Messages

FAIL	1.0 - 1.4	ROM FAILURE (U22)
	1.5 - 1.8	ROM FAILURE (U23)
	1.9	ROM FAILURE (SPECIALS)
	2.0	RAM FAILURE (6802)
	2.1	RAM FAILURE (U25)
	2.2	RAM FAILURE (U26)
	3.1	OUT-BUS PROBLEM (BIT 5 OR 7)
	3.2	OUT-BUS PROBLEM (BITS 0-7, OR U8,
	3.3	U9, U13, U14, U6, OR U7)
	3.4	START ARM SWITCH PROBLEM
	3.5	STOP ARM SWITCH PROBLEM
	4.1	MRC STATUS REGISTER WON'T RESET (U6-U7)
	4.2	MRC E-REG WON'T RESET
	4.3	MRC T-REG WON'T RESET
	4.4	IMPROPER MID-MEAS REGISTER STATUS
	4.5	IMPROPER END-OF-MEAS REGISTER STATUS
	4.6	MRC COUNTING PROBLEM IN REG-E OR T
	4.7	MRC E-REG OVERFLOW PROBLEM
	4.8	MRC T-REG OVERFLOW PROBLEM
	4.9	MRC O/F COUNTING PROB IN REG-E OR T
	5.1	START INTERPOLATOR PROBLEM
	5.2	STOP INTERPOLATOR PROBLEM
	5.3	INTERPOLATOR COUNTING PROBLEM
	5.4	INTERPOLATOR RESET PROBLEM
	6.1	FAILURE TO MEASURE T/L REFERENCE GND.
	6.2	FAILURE TO MEASURE T/L REFERENCE +5V.
	6.3	FAILURE TO MEASURE T/L REFERENCE -5V.
	7.1	CH-A FREQUENCY NOT CORRECT
	7.2	COM/SEP RELAY COUPLING SIGNAL TO CH-B
	7.3	CH-B UNABLE TO TRIG THRU COMMON-A.
	7.4	CH-B FREQUENCY NOT CORRECT
	7.5	CH-A PRESCALER NOT FUNCTIONING PROPERLY

5335A OPERATING INSTRUCTIONS

FUNCTION SELECTION

* KEY PER FUNCTION. SETTINGS FOR MATH, STATISTICS, RANGE HOLD, EXT ARM ENABLE, GATE/DELAY AND CYCLE ARE REMEMBERED FROM PREVIOUS FUNCTION. RETURNING TO PREVIOUS FUNCTION RETURNS THESE SETTINGS.

GATE MODES

* NORM: .20 MS – 4 SEC. FAST: 100 NS – 20 MS. SET VIA GATE ADJUST CONTROL.
* MIN: SHORTEST POSSIBLE GATE TIME.
* MANUAL: EACH PRESS WILL OPEN OR CLOSE THE GATE. GATE STATUS IS INDICATED BY GATE LAMP.

T1 DELAY

* FOR MEASUREMENTS WITH T1 DELAY, SET THE GATE MODE TO NORM, FAST, OR MANUAL. THE T1 LAMP WILL BE ON. SETTING DELAY IS THE SAME AS FOR GATE TIME.
* FOR TIME A→B, TIME A→B AND PULSE A, SET THE GATE MODE TO MIN (NO DLY). IF T1 DELAY IS NOT TO BE USED.

CYCLE MODES

* NORM: ≤ 4 READINGS/SECOND OR LESS.
* MIN: FAST AS POSSIBLE UP TO ~ 15 READINGS/SECOND.
* SINGLE: EACH PRESS STARTS ONE MEASUREMENT.

TRIGGER LEVELS

* AUTO TRIG OFF
  * PRESET: TRIGGER POINT IS 0V.
  * ADJUSTMENT RANGE IS -5V TO +5V.
* AUTO TRIG ON: (50 Hz MINIMUM FREQUENCY)
  * PRESET: TRIGGER POINT SET TO 50% LEVEL OF INPUT SIGNAL.
  * ADJUSTMENT RANGE IS BETWEEN NEGATIVE AND POSITIVE PEAKS OF INPUT SIGNAL.

GENERAL

* MATCHED 200 MHz AMPLIFIERS, 25 MV RMS SENSITIVITY, 8V PP MAX, 2 PARTS IN 10^9/SECOND OR 2NS BASIC RESOLUTION.
* RESET STARTS A NEW MEASUREMENT, IN TOTALIZE THE COUNT IS RESET TO ZERO.
* RANGE HOLD FREEZES EXPONENT UNLESS OVERFLOW OCCURS.
* EXT. ARM ENABLE: WHEN ON, ALLOWS REAR PANEL ARMING OF START AND/OR STOP OF MEASUREMENT. SLOPES ARE DETERMINED BY REAR PANEL SWITCHES. EXT GATE: SAME AS EXT ARM WITH BOTH START AND STOP ARM ACTIVE, AND GATE MODE IN MIN.
* CHECK: DOES INTERNAL SELF TEST. PRESS ANY OTHER KEY TO EXIT. SEE MANUAL IF ERROR 7.0 RESULTS.

MATH

* ALL MEASUREMENTS, EXCEPT GATE TIME AND TRG LVL, MAY BE MODIFIED BY OFFSETTING, NORMALIZING AND SCALING.

DISPLAY = (MEASUREMENT + OFFSET) / NORMLZ × SCALE

* NUMBER ENTRY:

ENTER VALUES INTO THE OFFSET, NORMLZ, OR SCALE REGISTERS BY USING THE SHIFTED BLUE LABELED KEYS.

PRESSING ANY OF THE THREE BLUE KEYS STARTS THE NUMBER ENTRY. THAT KEY'S LABEL WILL FLASH, AND THE DISPLAY WILL SHOW THE CURRENT VALUE IN THAT REGISTER.

ENTER A NUMBER, IF NEEDED. "CHS" CHANGES SIGN OF THE MANTISSA OR EXPONENT.

"EEX" STARTS EXPONENT ENTRY.

SETTING OFFSET TO "LAST DISP" SUBTRACTS THE LAST DISPLAYED VALUE FROM ALL FUTURE MEASUREMENTS. SETTING OFFSET TO "MEAS (-)" SUBTRACTS FROM EACH NEW MEASUREMENT THE VALUE OF THE PREVIOUS MEASUREMENT. (MEAS (-) IS INDICATED BY "-").

COMPLETE ENTRY BY PRESSING "ENTER". IF THE PARTICULAR MATH FUNCTION IS TO BE TURNED OFF PRESS "DISABLE" INSTEAD.

A MATH FUNCTION IS ON IF IT'S ASSOCIATED LAMP IS ON. DURING NORMAL OPERATION ALL ACTIVE MATH FUNCTIONS MAY BE TOGGLED ON OR OFF BY PRESSING "DISABLE".

STATISTICS

* STD. DEV. IS A SAMPLE STANDARD DEVIATION. SEE MANUAL FOR HP-IB OUTPUT.
* MEAN IS THE AVERAGE OF THE SAMPLE.
* SAMPLE SIZE TOGGLES BETWEEN 100 AND 1000 WITH EACH PRESS OF THE N=100/N KEY.
* SMOOTH PERFORMS A RUNNING AVERAGE AND TRUNCATES UNSTABLE DIGITS.

HP-IB

* WHEN ADDRESSED TO TALK, MEASUREMENT DATA IS SENT IN THE FORMAT:
(ALPHA) (14 CHAR DIGIT FIELD) E ± (2 DIGITS) CR/LF
* USE UNDERLINED CHARACTERS ON FRONT PANEL FOR THE TWO LETTER COMMAND NAMES.
USE COMMA, SEMICOLON, SPACE, CARRIAGE RETURN/LINE FEED FOR OPTIONAL DELIMITERS.
LAST CHARACTER IN A COMMAND STRING MUST BE A DELIMITER.
* STATUS: BIT 1 (LSB): MEASUREMENT DONE. BIT 2: EXT. OSC. USED. BIT 3: ERROR.
BIT 4: FAIL. BIT 5: GATE. ERROR 1.0: BAD COMMAND. ERROR 1.1: BAD NUMBER. FAIL: SEE MANUAL.
* OTHER COMMANDS: DR, DI IN, PO, HR, ST, WA, GO, GC, ID.

Figure 3-5. 5335A Operating Instructions Label