5370A
UNIVERSAL TIME INTERVAL COUNTER

USERS MANUAL

SERIAL PREFIX: 1936A

This manual applies directly to HP Model 5370A having serial number prefix 1936A and below.

NEW INSTRUMENTS

This manual, with enclosed "Manual Changes" sheet, applies to HP Model 5370A having serial number prefixes as listed on the "Manual Changes" sheets.

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SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. However, warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within the HP service travel area. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses.

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenace by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

MANUAL CHANGES

CHANGE DATE: May 13, 1982
(This change supersedes all earlier
dated changes.)

*** Make all corrections listed
under ERRATA before making
other changes.

*** Check following table for your
instrument's serial prefix or
series number and make listed
change(s) to manual.

```
* * * * * * * * * * * * * * * * * * *
* MANUAL DESCRIPTION              *
* INSTRUMENT:       5370A          *
*                                  *
*   Universal Time Interval Counter *
*     Operating and Service Manual  *
*                                  *
* SERIAL PREFIX:    1936A          *
*                                  *
* DATE PRINTED:     OCT 1979       *
* HP PART NO:       05370-90010    *
* MICROFICHE NO:    05370-90011    *
* * * * * * * * * * * * * * * * * * *
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# INDICATES NEW OR REVISED ITEM   > INDICATES ACTION TO BE TAKEN

SERIAL PREFIX OR SERIES NUMBER	MANUAL CHANGE(S)		SERIAL PREFIX OR SERIES NUMBER	MANUAL CHANGE(S)
2004A	1	**		
2008A	2	**		
2012A	2,3	**		
2016A	2,3,4	**		
2018A	2,3,4,5	**		
2024A	2 thru 6	**		
2036A	2 thru 7	**		
2044A	2 thru 8	**		
2116A	2 thru 9	**		
2116A	2 thru 10	**		
2128A	2 thru 11	**		
2132A	2 thru 12	**		
2132A	2 thru 13	**		
#2213A	2 thru 14	**		

Information for any optional circuit boards described in this manual agrees
with the series numbers on the circuit board(s) for the option, which may not
be the same as the Serial Prefix Number on the rear of the instrument.

(C5370AX) 9625-9593/9871/9919-10277/10432E/3=10283-10424/4=9635-9922-10415/
5=10411/6=10944/7=11272/8=11400E-11274-10818-11352/9=11640/10=12130/11=10909-
12079-12161/E=11429-11581-12130/12=13094/13=13595-13618/E=13868/14=13885

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ERRATA

Page 1-4, paragragh 1-23:
>Change Rack Mount Flange kit from 908 to 913.

Page 3-9, Figure 3-2. Rear Panel Features:
>Change item 5 to read:
   FREQ STD OUTPUT jack provides 10 megahertz internal standard signal for
   external use.   Amplitude is 1 volt rms into 50-ohms.   FREQ STD select
   switch 1 when set to INT position, provides output of the internal 10MHz
   clock.   EXT position provides a buffered output of the external time base
   standard being used.

Page 3-24, Table 3-4. Program Code Set:
>Add to command #10 "NOTE: Intended for use with plus or minus time interval
   arming mode only."

Page 3-26, EXAMPLE 5:
>Add the following directly beneath "EXAMPLE 5":
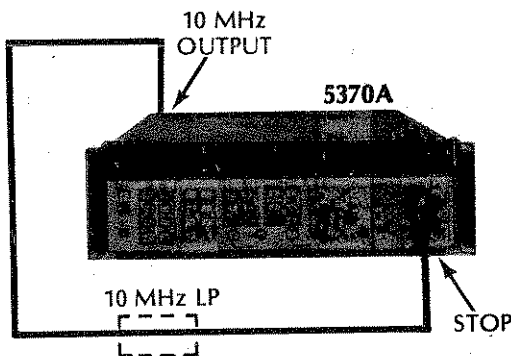   NOTE: Intended for use with plus or minus time interval arming mode only.

Page 4-28, Table 4-3. Performance Test, Part VI:
>Replace the accuracy test with the one shown below.

   VI. ACCURACY
                    Specification: 10 MHz +-.005 Hz
          Connect the 5370A as shown in the following diagram:

                              NOTE
             Use of a 10 MHz lowpass filter may be
             necessary to obtain a stable reading.

      Set the 5370A controls as follows:

                Power on the 5370A.
                FUNCTION .... FREQ
                GATE 1s
                STATISTICS .... MEAN
                STOP CHANNEL
                   IMPEDANCE 50-OHM
                   ATTENUATION .... divide by 1
                   COUPLING .... DC
                   SLOPE .... /
                   LEVEL .... PRESET

ERRATA (Cont'd)
Page 4-28, Table 4-3. Performance Test, Part VI (Cont'd):

Set the 5370A controls as follows (Cont'd):

START COM/SEP .... SEP

Observe the 5370A display. It should display 10 MHz +-.005 Hz.
Mark the results on the test card.

Page 6-6, Table 6-2. A3 Replaceable Parts:
 >Change A3S8 and A3S9 under HP and Mfr Part Numbers to 3101-2334.
 >Change A3S8 and A3S9 check digit (CD) to 6.

Pages 6-8 through 6-24, Table 6-2. MISCELLANEOUS Replaceable Parts:
 >Change HP Part Number of TERMINAL TEST POINT listed under MISCELLANEOUS for
   circuit board assemblies A6-A9, A11, A13, A14, A16-A19, and A21 from 0360-
   0535 to 0360-1682 with Mfr Code 28480 and Mfr Part Number 0360-1682.

Page 6-11, Table 6-2. A9 (05370-60009) Replaceable Parts:
 >Change A9U13 from 1816-0409 to 1816-1156.

Page 6-15, Table 6-2. A15 (05370-60015) Replaceable Parts;
 >Add A15U23*; 05342-80006; IC PROGRAMMED ROM; 28480; 05342-80006. The 05342-
   80006 and 1816-1155 ROM's are directly interchangeable for replacement
   purposes in this instrument.
 >Add A15U26*; 05342-80007; IC PROGRAMMED ROM; 28480; 05342-80007.   The
   0534280007 and 1816-1179 are directly interchangeable for replacement
   purposes in this instrument.

 Page 6-21 and 6-22, Table 6-2. A19 (05370-60119) Replaceable Parts:
 >Change A19L8 to 9140-0142; CD=8; COIL-MLD 2.2UH 10% Q=32; 28480; 9140-0142.
 >Change "CD" for A19R17 (0698-7212) to 9.
 >Change A19U1 from 1820-0753 to 1820-1179, the preferred replacement part.
   The 1820-0753 and 1820-1179 are directly interchangeable for replacement
   purposes in this instrument.

Page 6-26, Table 6-2. A22 (05370-60122) Replaceable Parts:
 >Change A22U19, A22U20 and A22U23 thru A22U27 from 1820-0753 to 1820-1179.
   The   preferred   replacement   part   is   1820-1179,   both   are directly
   interchangeable for replacement purposes.
 >Change A22TP1-TP4 (0360-0535) to 0360-1682; CD=0; TERMINAL TEST POINT PCB;
   28480; 0360-1682.

Page 6-28, Table 6-2. Replaceable Parts:
 >Change A23S33 HP and Mfr Part Numbers to 3101-2220; (CD) to 9.
 >Change 5061-0077 to 5060-0171; KIT, RACK FLANGE (OPTION 913)

Page 6-29 and 6-30, Table 6-2. Replaceable Chassis Parts:
 >Delete S3, 3101-0199, slide switch.
 >Add 5061-2071, Option 913 Rack Mount Kit.

Page 6-30, Table 6-2. Replaceable MISCELLANEOUS PARTS:
 >Change 0340-0486 in "HP" and "Mfr Part Number" columns to 0340-0833 (CD=9).

ERRATA (Cont'd)

Page 7-1, MANUAL CHANGES:
  Delete the NOTE in CHANGE 1 (1928).
  Add the following NOTE to CHANGE 2 (1848).

NOTE

  Instruments with Serial Numbers 1848A00411 through 1848A00490
  (except 1848A00417 and 1848A00425) do not include the
  following change for A3.

Add the following to CHANGE 2 (1848):
  Change A19 (05370-60119) series number from 1928 to 1820.
  Change A19R17 from 0698-7212 (100 OHMS) to 0698-7205; CD=0; RESISTOR
    51.1 OHMS 1% .05W F TC=0/+-100; 24546; C3-1/8-T00-51R1-G
  Change A19L8 from 9140-0142(2.2 UH) to 9100-2265; CD=6; COIL-MLD 10UH
    10% Q=60; 28480; 9100-2265.

Page 8-121, Figure 8-29, A19/A20 Schematic Diagrams:
  Change SERIES number from 1928 to 1820.
  Change R17 from 100 to 51.1 ohms.
  Change L8 from 2.2U to 10U.

Page 8-97, Figure 8-17. A24 Line Module Schematic Diagram:
 >Change values of C1 and C2 to 3200 pF.
 >Change values of L1 and L2 to 465 uH.

Page 8-105, Figure 8-21, A9 (05370-60009) Processor Assembly Schematic Diagram:
 >Change the value of R9 to 31.6K.
 >Change the value of R12 and R13 to 3.16K
 >Change the following on the A9 Component Locator:

  C11 to C13   C13 to C14   C15 to C20   C17 to C16   C20 to C19
  C12 to C11   C14 to C12   C16 to C15   C19 to C17

Page 8-107, Figure 8-22, A11 DISPLAY INTERFACE ASSEMBLY Schematic Diagram:
 >Change U5 to U14.
 >Change U14 to U5.

Page 8-108, Figure 8-22, Caption:
 >Change caption from A22 to A11 DISPLAY INTERFACE ASSEMBLY.

Page 8-113. A15 HP-IB Interface Assembly Schematic Diagram.
 >Add inverter (U7A) to the right of U11; with U7A active low input (pin 3) to
    the left, and output (pin 6) to the right. Connect U7A(3) to U11(12), and
    U7A(6) to U21D(11).
 >Delete the connection between U21D(11) and U17D(11), above the junction of
    U17D(11), U21C(10) and U17C(9).
 >Delete the connection between U1B(8) and U13(6); connect U13(6) to U29(15).

ERRATA (Cont'd)
Page 8-121, Figure 8-29, A19/A20 Schematic Diagram:
 >Change value of R17 from 51.1 to 100 ohms.
 >Change inductance of L8 from 10U to 2.2U.
 >Change SERIES 1820 to SERIES 1928.

Page 8-125, Figure 8-31. A22 Arming Assembly Schematic Diagram:
 >Change reference designation of 221-ohm resistor R115 (bottom left,
   connected between the junction of CR7 and CR8 and -5.2V) to R113.
 >Change value of resistors R113 and R117 to 215 ohms.
 >Change value of resistor R115 (in parallel with C35) to 90.9K.
 >Reverse diodes CR1 and CR3 (upper right) to show the cathodes connected to
   circuit board common. The anodes connect to the START/STOP EVT OUT lines.

Page 8-127, Figure 8-32, A23 Front Panel Display Assembly Schematic Diagram:
 >Delete connection shown between S26 (EXT ARM) and S32 (MAN INPUT).
 >Connect S32 (open terminal) to circuit board common.

CHANGE 1

In instruments with a 2004A serial number prefix, the HP Model 10544A high stability time base oscillator (formerly Option 001) and associated oven oscillator power supply assembly A7 are supplied in place of the 10 MHz air temperature circuit board oscillator assembly normally used for A69. All references to Option 001 in the Operating and Service Manual should be disregarded.

Page 1-3, Table 1-1, Specifications:
>Change "Specifications" for the TIME BASE to those shown for Option 001.

Page 6-9, Table 6-2, A7 (05370-60007) Replaceable Parts:
>Delete "(A7 USED IN OPTION 001)".

Page 6-28, Table 6-2, A69 and Options, Replaceable Parts:
>Delete A69 (05370-60069) and all replaceable parts for A69.
>Add A69; 10544A; 10 MHz Crystal Oscillator.
>Delete 10544A listing under OPTIONS.

Page 8-101, Figure 8-19, A7 Schematic Diagram:
>Delete "(OPTION 001 ONLY)" in caption and "(OPTION 001)" on top of schematic.

Page 8-129, Figure 8-33, A69 Oscillator Assembly:
>Add SERIAL PREFIX 1936A AND BELOW in captions and at top of 05370-60069.

Page 8-131, Figure 8-34, A69 Oscillator Assembly:
>Add SERIAL PREFIX 2004A in place of OPTION 001 in captions.
>Delete "Option 001" at top schematic diagram.

CHANGE 2

NOTE: INSTRUMENTS WITH SERIAL PREFIX 2008A ARE SUPPLIED WITH AIR TEMPERATURE OSCILLATOR CIRCUIT BOARD ASSEMBLY A69; NOT THE OPTION 001 OSCILLATOR DESCRIBED FOR CHANGE 1.

Page 1-2, Paragraph 1-22, Options:
>Delete Options 907, 908, and 909. The instrument is supplied with the Option 907 front handles. To rack-mount Serial Prefix 2008A instruments (with front handles attached to instrument) use HP Part No. 5020-8874 rack-mount flanges and HP Part No. 2510-0194 #8-32 X 5/8 inch pan-head-pozi screws. If the handles are removed, use HP Part No. 5020-8862 rack-mount flanges and #8-32 X 3/8 inch pan-head-pozi screws (HP Part No. 2510-01930).

CAUTION

The display board will be damaged if the 5/8 inch screws are used to rack-mount an instrument with handles replaced by HP Part No. 5020-8862 Rack-Mount Flanges.

Page 6-29, Table 6-2, Replaceable CHASSIS PARTS:
>Add MP33; 5060-9899; CD=8; HANDLES-FRONT
>Add MP34; 5020-8896; CD=7; TRIM-FRONT HANDLES
>Add MP35; 2510-0195; CD=5; SCREW MACHINE 8-32 X 3/8 FLAT HEAD

CHANGE 3

NOTE: Instruments with Serial Prefix 2012A are supplied with air temperature oscillator circuit board assembly A69; not the Option 001 oscillator for CHANGE 1.

CHANGE 3 (cont'd)
Page 1-4, Paragraph 1-26:
>Add the following sentence,"A HP Model 10834A Adapter is also supplied to
   provide an extension for the HP-IB connector."

Page 6-16, Table 6-2, A16 (05370-60016) Replaceable Parts:
>Change A16J1 from 1200-0499 to 1200-0618 (CD=3).

Page 6-24, Table 6-2, A22 (05370-60022) Replaceable Parts:
>Change A22J1 from 1200-0499 to 1200-0618 (CD=3).
>Change A22 "SERIES" number in Table 6-2 and Schematic Diagram to 2012.

Page 6-27, Table 6-2, "A22 MISCELLANEOUS" Replaceable Parts:
>Delete 5000-9043; PIN:P.C. BOARD EXTRACTOR.
>Delete 5040-6843; EXTRACTOR, P.C. BOARD

Page 6-29, Table 6-2, Replaceable CHASSIS PARTS:
>Add MP31; 05370-00016; CD=1; Qty=2; BRACKET-MP32 MTG; 28480; 05370-00016.
>Add MP32; 05370-00017; CD=2; Qty=1; BRACKET-CKT BD HOLD-DOWN; 28480

Page 6-30, Table 6-2, Replaceable MISCELLANEOUS PARTS:
>Add 1200-0617; CD=2; Qty=2; CLIP, RETAINING (for W11 cable plugs)

Page 6-32, Figure 6-1, Mechanical Parts:
>Add part numbers and descriptions for bracket MP31 and MP32.

CHANGE 4
   NOTE: Instruments with Serial Prefix 2016A are supplied with air
   temperature oscillator circuit board assembly A69; not the Option 001
   oscillator for CHANGE 1.
Page 6-20 thru 6-22, Table 6-2, A19 and A20 (05370-60119) Replaceable Parts:
>Change A19/A20 "SERIES" number to 2016.
>Add A19R72 and R73; 0698-7205; CD=0; RESISTOR 51.1 1% .05W F TC=0+-100.

Page 6-22, Table 6-2, A21 (05370-60024) Replaceable Parts:
>Change "HP" and "Mfr. Part Number" for A21 to 05370-60124 and CD to 8.
>Change A21 "SERIES" number for 05370-60124 to 2016.
>Add A21R45 and R46; 0757-0395; CD=1; RESISTOR 56.2 1% .125W F TC=0+-100.
>Change A21U1 from 1820-1224 (MC10216P) to 1820-0920 (MC1692L) and CD to 4.
NOTE: These two ECL receivers have a different pinout and are not directly
      interchangeable.

Page 6-24, Table 6-2, A22 (05370-60022) Replaceable Parts:
>Change "HP" "Mfr. Part Number" for A22 to 05370-60122 and CD=2.
>Change A21 "SERIES" number for 05370-60122 to 2016.
>Change A22R113, R117 to 0757-0400; CD=9; RESISTOR 90.9 1% .125W F TC=0+-100
>Change A22R115 to 0698-0083; CD=8; RESISTOR 1.96K 1% .125W F TC=0+/-100.
NOTE: The 05370-60022 and 05370-60122 circuit board assemblies are
electrically equivalent except for the values of R113, R115, and R117.   The
05370-60122 arming assembly is compatible with the 05370-60123 front panel
display assembly for A23.   To use the 05370-60122 arming assembly with the
05370-60023 assembly for A23, resistors A22R113, R115, and R117 must be
changed to 215, 90.9K, and 215 ohms (respectively).

CHANGE 4 (cont'd)
Pages 6-27 and 6-28, Table 6-2, A23 (05370-60023) Replaceable Parts:
 >Change "HP" and "Mfr. Part Number" for A23 to 05370-60123 and CD=3.
 >Change A23 "SERIES" number for 05370-60123 to 2016.
 >Change A23R16 to 2100-3849; CD=7; RESISTOR VAR 470K 20% CCWLOG .5W COMP.

Page 8-121, Figure 8-29, A19/A20 START/STOP INTERPOLATOR Assembly Schematic:
 >Change A19/A20 "SERIES" number to 2016.
 >Add R72 (51.1-ohm) in series between U7(13) and the junction of C7, and R21.
 >Add R73 (51.1-ohm) in series between U7(3) and the junction of R22, and R23.

Page 8-123, Figure 8-30, A21 200 MHz Multiplier Assembly Schematic Diagram:
 >Change HP Part Number for A21 from 05370-60024 to 05370-60124.
 >Change A21 "SERIES" number for 05370-60124 to 2016.
 >Add R45 and R46; change connections for U1A,B,C and add U1D; and change
  tables for "Reference Designations" and "Active Elements" as shown in
  attached Figure 1.
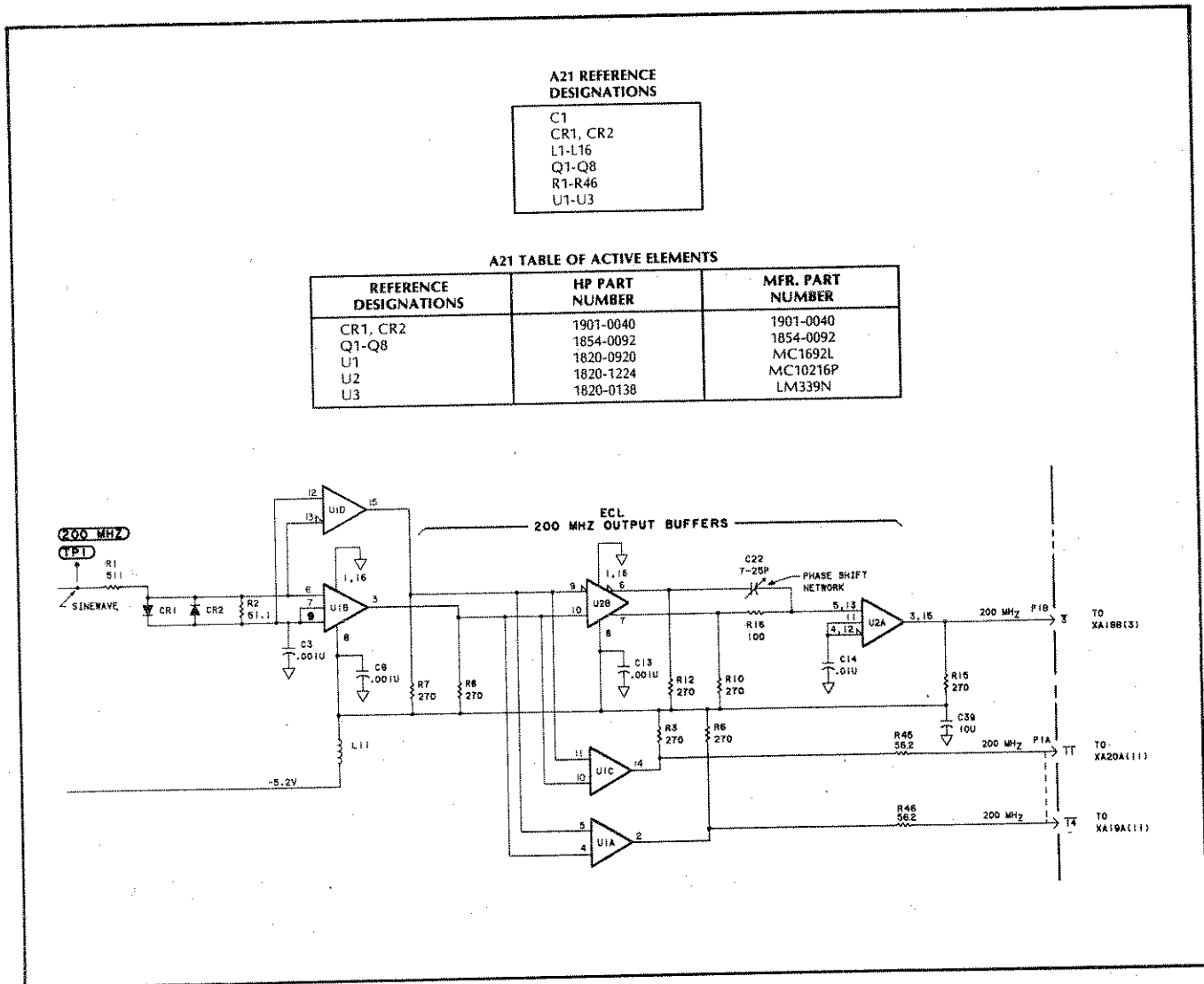
Figure 1. A21 Changes for 05370-60124 200 MHz Multiplier in CHANGE 4

CHANGE 4 (cont'd)
Page 8-125, Figure 8-31, A22 Arming Assembly Schematic Diagram:
 >Change HP Part Number for A22 from 05370-60022 to 05370-60122 (SERIES 2016).
 >Change R113 and R117 to 90.9 ohms.
 >Change R115 to 1960 ohms.
 >Change connections to A2J3 and wiring to agree with attached Figure 2.

Page 8-127, Figure 8-32, A23 Front Panel Display Assembly Schematic Diagram:
 >Change HP Part Number for A23 from 05370-60023 to 05370-60123 (SERIES 2016).
 >Change wiring and values of EXT LEVEL control (R17) and DISPLAY RATE control
   (R16) as shown in attached Figure 2.
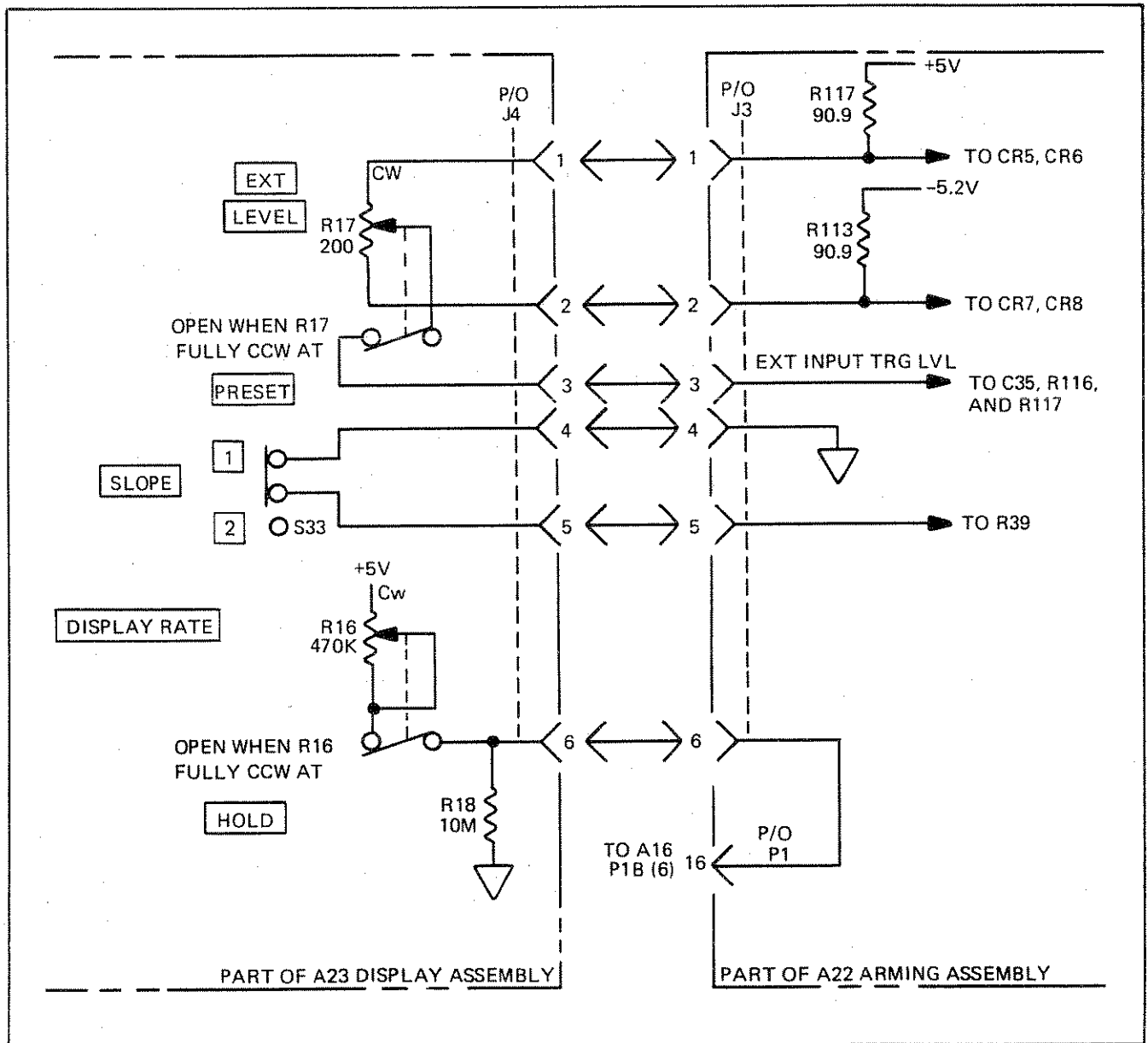
Figure 2. A22 (05370-60122) and A23 (05370-60123) Changes in CHANGE 4

CHANGE 4 (Cont'd)
NOTE: The 05370-60123 front panel display assembly is compatible with the 05370-60122 arming assembly for A22. To use the 05370-60123 display assembly with the 05370-60022 arming assembly, resistors A22R113, R115, and R117 must be changed to 90.9, 1.96K, and 90.9 ohms (respectively).

CHANGE 5
All 5370A counters with CHANGE 5 are supplied with the HP Model 10544A high stability time base oscillator (formerly Option 001) and associated oven oscillator power supply assembly A7 in place of the 10 MHz air temperature circuit board oscillator assembly normally used for A69. All references to Option 001 in the Operating and Service Manual should be disregarded.

Page 1-3, Table 1-1, Specifications:
>Change "Specifications" for the TIME BASE to those shown for Option 001.

Page 6-9, Table 6-2, A7 (05370-60007) Replaceable Parts:
>Delete "(A7 USED IN OPTION 001)".

Page 6-28, Table 6-2, A69 and Options, Replaceable Parts:
>Delete A69 (05370-60069) and all replaceable parts for A69.
>Add A69; 10544A; 10 MHz Crystal Oscillator.
>Delete 10544A listing under OPTIONS.

Page 8-101, Figure 8-19, A7 Oven Oscillator Power Supply Assembly Schematic:
>Delete "(OPTION 001 ONLY)" in caption and "(OPTION 001)" on top of schematic.

Page 8-129, Figure 8-33, A69 10 MHz Oscillator Assembly Schematic Diagram:
>Add "SERIAL PREFIX 1936A AND BELOW, 2008A, 2012A, OR 2016A" in captions and at top of 05370-60069 schematic.

Page 8-131, Figure 8-34, A69 10 MHz Oscillator Assembly Schematic Diagram:
>Add SERIAL PREFIX 2018A AND ABOVE in place of OPTION 001 in captions.
>Delete "Option 001" at top of schematic diagram.

CHANGE 6
Page 6-11, Table 6-2. A9 (05370-60009) Replaceable Parts:
>Change A9R10 from 0698-7252, 4.64K, to 0698-7236, 1.00K, 1%, .05W.
>Change A9R9 from 0698-7272, 31.6K, to 0698-7268, 21.5K, 1%, .05W.
>Change A9R14 from 0757-0472, 200K, to 0757-0465, 100K, 1%, .12W.
>Change A9 SERIES number to 2024.

Page 8-105, Figure 8-21. A9 Processor Assembly Schematic Diagram:
>Change 05370-60009 Series from 1748 to 2024 (Upper left of schematic).
>Change A9R9 from 31.6K to 21.5K.
>Change A9R10 from 4.64K to 1.00K.
>Change A9R14 from 200K to 100K.

CHANGE 7
The 10544A high stability time base oscillator has been replaced with the field repairable 10811A. A separate Service Manual for the 10811A is included with the 5370A Service Manual.

CHANGE 7 (Cont'd)
Page 6-28, Table 6-2, A24 (0960-0443) Replaceable Parts:
>Delete A69, 10544-60011, 10 MHz Crystal Oscillator.
>Add A69 10811-60101, 10 MHz Crystal Oscillator.
>Add in description column: 10811A Operating and Service Manual.

Page 8-131, Figure 8-34. A69 10 MHz Oscillator Schematic Diagram:
>Change A69 Model number at top and bottom of diagram to 10811.

CHANGE 8
 Page 6-24, Table 6-2, A22 (05370-60122) Replaceable Parts:
  >Change series from 2016 to 2044.
  >Add A22R122, 0698-3378, 51 ohms 5% .125 W RF.

 Page 8-125, Figure 8-31, A22 Arming Assembly Schematic Diagram:
  >Change series number from 2016 to 2044.
  >Add R122 (51-ohms) between U16(15) and the junction of U19B(11) and R57.

CHANGE 9
 Page 6-28, Table 6-2. Replaceable Parts, under Options:
  >Change A69 (10811-60101) 10MHz Crystal Oscillator to HP Part No. 10811-60111
    (SERIES 2116).

 Page 8-131, Figure 8-34. A69 10MHz Oscillator Schematic Diagram:
  >Change A69 Series Number to 2116.

CHANGE 10
 Page 6-20, Table 6-2. A19 (05370-60119) Replaceable Parts:
  >Change A19C15* to 0160-3877, CD5, CAPACITOR-FXD 100 PF +/-20% 200VDC CER.

 Page 8-121, Figure 8-29. A19/A20 Start/Stop Interpolator Assembly Schematic:
  >Change the value of C15* to 100 pF.

CHANGE 11
 Page 6-24. A22 (05370-60122) Replaceable Parts:
  >Change series number to 2128.
  >Add A22C37 and C38; 0160-3873; CAPACITOR 4.7pF 5% 200V.
  >Add A22C39 through C44; 0160-3879; CAPACITOR .01uF 20% 100V.
  >Add A22R16, R51, R60, R69 to 0698-3132; RESISTOR 261 1% .125W.
  >Change A22R17, R48, R49, R53, R55, R57, R62, R68, R72, and R99 to 0698-7205;
    RESISTOR 51.1 1% .125W.
  >Change A22R47 to 0698-7207; RESISTOR 61.9 1% .05W.
  >Change A22R64 and R100 to 2698-7222; RESISTOR 261 1% .05W.
  >Change A22R118 through R122 to 0698-7205; RESISTOR 51.1 1W .05W.
  >Add A22R123 through R125; 0698-7205; RESISTOR 51.1 1% .05W.
  >Add A22R126 and R127; 0698-7223; RESISTOR 287 1% .05W.
  >Change A22R86 to 0698-3446; RESISTOR 383 1% .125W.

 Page 8-125, Figure 8-31. A22 Arming Assembly Schematic Diagram:
  >Add C37 (4.7pF) between pin 1 and pin 3 of U16.
  >Add C38 (4.7pF) between pin 1 and pin 3 of U15.
  >Add C39 (.01uF) in series between R99 and the node above R99 (left of U29).
  >Change R99 to 51.1 ohms.
  >Add C40 (.01uF) in series between R68 and the node above R68 (right of U29A).

CHANGE 11 (Cont'd)
Page 8-125, Figure 8-31. A22 Arming Assembly Schematic Diagram (Cont'd):
 >Change R64 to 261 ohms.
 >Change R68 to 51.1 ohms.
 >Add C41 (.01uF) in series between R17 and the node above R17 (left of U5D).
 >Change R16 to 261 ohms.
 >Change R17 to 51.1 ohms.
 >Add C42 (.01uF) in series between R62 and the node above R62 (next to TP5).
 >Change R60 to 261 ohms.
 >Change R62 to 51.1 ohms.
 >Add C43 (.01uF) in series between R53 and the node above R53 (next to TP6).
 >Change R51 to 261 ohms.
 >Change R53 to 51.1 ohms.
 >Add C44 (.01uF) in series between R72 and the node above R72 (next to TP7).
 >Change R69 to 261 ohms.
 >Change R72 to 51.1 ohms.
 >Change the value of R122 to 51.1 ohms.
 >Add R123 (51.1-ohms) in series between U20B(11) and the junction of U16(14)
    and R49.
 >Add R124 (51.1-ohms) between pin 14 of U15 and the node to the left of pin
14.
 >Add R125 (51.1-ohms) between pin 15 of U15 and the node to the left of pin
15.
 >Add R128 (51.1-ohms) from the collector of Q8 to circuit board common.
 >Change R100 to 261 ohms (left of U29A).
 >Add R126 (287-ohms) between J7 input and circuit board common.
 >Add R127 (287-ohms) between J8 input and circuit board common.

NOTE: The following instruments contain A22 board SERIES 2044.(See CHANGE 13)
        2128A01271   2128A01281   2128A01286
        2128A01273   2128A01282   2128A01289
        2128A01274   2128A01283   2128A01290
        2128A01278   2128A01285

NOTE: Instruments with serial Numbers 2128A0291 thru 2128A01350 contain A4
        board SERIES 2213.

CHANGE 12
Page 6-5, Table 6-2. A3 (05370-60033) Replaceable Parts:
 >Add the following NOTE in A3 BOARD ASSEMBLIES Description column:
   "NOTE- The A3 BOARD ASSEMBLY do not include IC's U1 and U2 (1826-0088).
        These IC's are sold separately and must be ordered by the customer.
        (Refer to CHASSIS PARTS list)."

Page 6-5, Table 6-2. A4 (05370-60004) Replaceable Parts:
 >Add the following NOTE in A4 BOARD ASSEMBLIES Description column:
   "NOTE- The A4 BOARD ASSEMBLY do not include IC's U1 and U2 (1826-0290).
        These IC's are sold separately and must be ordered by the customer.
        (Refer to CHASSIS PARTS list)."

Page 6-6, Table 6-2. A3 (05370-60033) Replaceable Parts:
 >Delete IC's U1 and U2 (1826-0088).

CHANGE 12 (Cont'd)
Page 6-8, Table 6-2. A4 (05370-60004) Replaceable Parts:
 >Delete IC's U1 and U2 (1826-0290).

Page 6-29, Table 6-2. CHASSIS PARTS:
 >Add A3U1 and A3U2; Qty=2; 1826-0088; IC, LIN 114-BIT WIDE BAND AMPL.
 >Add A4U1 and A4U2; Qty=2; 1826-0290; IC, LINEAR.

CHANGE 13
Page 6-6, Table 6-2. A4 (05370-60004) Replaceable Parts:
 >Change A4 SERIES to 2213.
 >Change R15 and R18 to 0757-1001; RESISTOR 56.2 1% .5W F TC=+-100
 >Change R16 and R19 to 2100-1788; RESISTOR 500 10% C TOP ADJ 1TRN

Page 6-24, Table 6-2. A22 (05370-60122) Replaceable Parts:
 >Change A22 SERIES to 2044.

Page 6-26, Table 6-2. A22 Replaceable Parts:
 >Change R119 and R121 to 0698-3378; RESISTOR 51 5% .125W CC TC=+-270/+540

Page 8-99, Figure 8-18. A4 Input Trigger Assembly Schematic diagram:
 >Change SERIES at top of diagram to 2213.
 >Change R15 and R18 value to 56 ohms.
 >Change R16 and R19 value to 500 ohms.

Page 8-125, Figure 8-31. A22 Arming Assembly Schematic diagram:
 >Change A22 SERIES at top of diagram to 2044.
 >Chnage R119 and R121 value to 51 ohms.

#CHANGE 14
Page 6-24 thru 6-26, Table 6-2. A22 (05370-60122) Replaceable Parts:
 >Change A22 SERIES to 2213.
 >Delete C39 and C40.
 >Change R68 and R99 to 0698-7216; RESISTOR 147 1% .05W TC=0+-100.
 >Change R122 thru R125 to 0698-3378; RESISTOR 51 5% .125W TC=-270/+540.

Page 8-125, Figure 8-31. A22 Arming Assembly Schematic Diagram:
 >Change SERIES at top of diagram to 2213.
 >Delete C39 and C40.
 >Connect R99 directly to the junction of R100 and U29A(6).
 >Connect R68 directly to pin 2 of U29A.
 >Change R99 and R68 values to 147 ohms.
 >Change R122 thru R125 values to 51 ohms.

5370A
UNIVERSAL TIME INTERVAL COUNTER

USERS MANUAL

SERIAL PREFIX: 1936A

This manual applies directly to HP Model 5370A having serial number prefix 1936A and below.

NEW INSTRUMENTS

This manual, with enclosed "Manual Changes" sheet, applies to HP Model 5370A having serial number prefixes as listed on the "Manual Changes" sheets.

M. Lollis
R. Goodner
B. O'Donnell
M. Wilkins

HEWLETT hp *PACKARD*

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SAFETY CONSIDERATIONS

GENERAL

The following safety considerations should be read and fully understood before operating the HP 5391A Frequency and Time Data Acquisition System.

OPERATION

BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage and the correct fuse is installed (see Section II). Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

SERVICE

Although this equipment has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings must be followed to ensure safe operation and to retain the equipment in safe condition. Service and adjustments should be performed only by qualified service personnel.

Any adjustment, maintenance, and repair of the opened equipment under voltage should be avoided as much as possible and, when inevitable, should be carried out by a skilled person who is aware of the hazard involved.

Capacitors inside the equipment may still be charged even if the equipment has been disconnected from its source of supply.

When it is likely that the protection has been impaired, the equipment must be made inoperative and be secured against any unintended operation.
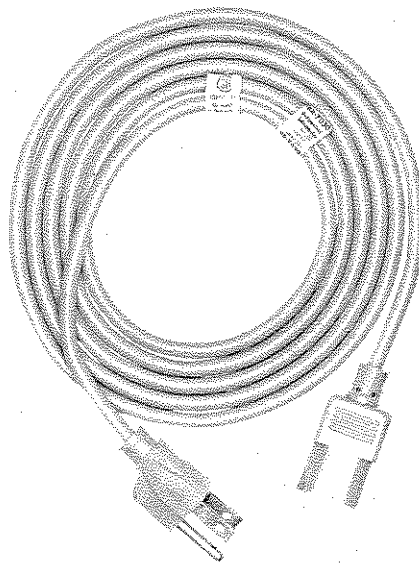
Figure 1-1. HP Model 5370A Universal Time Interval Counter and Accessories Supplied

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual provides information pertaining to the installation, operation, testing, adjustment, and maintenance of the HP Model 5370A Universal Time Interval Counter. *Figure 1-1* shows the 5370A with accessories supplied.

1-3. Packaged with this manual is a Users Manual. This is simply a copy of the first three sections of the operating and service manual. The Users Manual should be kept with the instrument for use by the operator. Additional copies of the Users Manual may be ordered through your nearest Hewlett-Packard Office. The part numbers are listed on the title page of the manual.

1-4. The full manual is divided into eight sections, each covering a particular topic for the operating and service of the HP Model 5370A. The topics by section number are:

Section	Topic
I	General Information
II	Installation
III	Operating and Programming
IV	Performance Tests
V	Adjustments
VI	Replaceable Parts
VII	Manual Changes
VIII	Service

1-5. SPECIFICATIONS

1-6. 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. INSTRUMENTS COVERED BY MANUAL

1-8. If the serial number of your instrument is lower than the serial number on the title page of this manual, you must modify your manual for agreement with your instrument. Refer to Section VII, Manual Changes, for the information that will adapt this manual to your instrument.

1-9. The 5370A Options 001, 907, 908, and 909 are documented in this manual. The differences are noted in the appropriate locations such as Options in Section I, the Replaceable Parts List in Section VI, and the Schematic Diagrams in Section VIII.

1-10. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix(es) as listed under Serial Prefix on the title page.

1-11. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted prefix indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Changes supplement which contains change information that documents the differences.

Table 1-1. HP Model 5370A Specifications

INPUT AMPLIFIERS

SEPARATE INPUTS
Sensitivity: 100 mV p-p, 35 mV rms sine wave times attenuator setting.
Impedance: Selectable 1 MΩ || 30 pF or 50Ω nominal.
Trigger Level: Adjustable from –1.3V to 0.5V with 10 mV displayed resolution.
Trigger Slope: Independent selection of + or – slope.
Attenuators: ÷1 and ÷10 nominal.
Dynamic Range (preset):

50Ω	÷1	100 mV to 1V p-p pulse
	÷10	1V to 7V p-p pulse
1 MΩ	÷1	100 mV to 1V p-p pulse
	÷10	1V to 10V p-p pulse

Dynamic range for rms sine wave is one-third of the above values.

For precise time interval measurements the input signal (V_s) must be at least 150 mV (but not greater than 700 mV) above or below the trigger voltage (V_{TL}):

$$0.15V < | V_s - V_{TL} | < 0.7V$$

Signal Operating Range:

50Ω	÷1	–2.5V to 1V
	÷10	–7V to 7V
1 MΩ	÷1	–2.5V to 1V
	÷10	–25V to 10V

Coupling: AC or DC switch selectable.
Minimum Pulse Width: 5 ns
Maximum Input:

50Ω	÷1	±7V DC
		7V rms below 5 MHz
		3.5V rms (+24 dBm) above 5 MHz
	÷10	±7V DC, 7V rms (+30 dBm)
1 MΩ	÷1	±350V DC
		250V rms to 20 kHz decreasing to 3.5V rms above 5 MHz
	÷10	±350V
		250V rms to 20 kHz decreasing to 35V rms above 5 MHz.

COMMON INPUT
All specifications are the same as for separate operation with the following differences:
Impedance: 1 MΩ becomes 500 KΩ shunted by <60 pF. 50Ω same as in separate.
Sensitivity (preset):

50Ω	÷1	200 mV p-p, 70 mV rms
	÷10	2V p-p, 700 mV rms
1 MΩ		Same as in separate

Dynamic Range (preset):

50Ω	÷1	200 mV to 2V p-p pulse
	÷10	2V to 5V p-p pulse
1 MΩ		Same as in separate

Maximum Input:
50Ω ±5V DC or 5V rms
1 MΩ same as in separate
Attenuators: Becomes ÷2 and ÷20 for 50Ω.

FREQUENCY AND PERIOD MEASUREMENTS

FREQUENCY RANGE: 0.1 Hz to 100 MHz
PERIOD RANGE: 10 ns to 10 seconds

RESOLUTION: $\dfrac{20 \text{ ps}}{\text{gate time}}$

INTERNAL GATE TIME: 1 period, 0.01, 0.1, 1.0 seconds.
ACCURACY:

$$\frac{100 \text{ ps rms} \pm \text{trigger error}}{\text{gate time}} \pm \text{time base}$$

PERIOD/FREQUENCY STATISTICS: (1 period gate only) mean, standard deviation, maximum, minimum.
Sample Size: 1, 100, 1000, 10,000, 100,000
External Gate Input: 20 ns to 10 s.

TIME INTERVAL MEASUREMENTS

TIME INTERVAL RANGE:
±T.I. Mode –10 seconds to +10 seconds.
+T.I. Only Mode 10 ns to 10 seconds.
TIME INTERVAL STATISTICS: Mean, standard deviation, maximum, minimum.
SAMPLE SIZE: 1, 100, 1000, 10,000, 100,000
MINIMUM TIME BETWEEN MEASUREMENTS: 330 μs (165 μs in the Fast Binary mode).

RESOLUTION: $\dfrac{\pm 20 \text{ ps}}{\sqrt{\text{sample size}}} \pm 2 \text{ ps}$

Displayed resolution also depends on trigger error.
ACCURACY: Jitter ±700 ps systematic ± time base† ± trigger error/$\sqrt{N}$
JITTER: 35 ps rms typical 100 ps rms maximum. The effect of jitter on the mean of a time interval measurement reduces as the $\sqrt{N}$ increases where N is the number of times averaged.
TRIGGER ERROR:

$$\frac{\sqrt{(150 \text{ } \mu V)^2 + e_n^2}}{\substack{\text{Input voltage slew rate at} \\ \text{trigger points (V/s)}}} \text{ sec rms}$$

where 150 μV is the typical input amplifier noise on the 5370A and e_n is the rms noise of the input signal for a 500 MHz bandwidth.

Trigger error due to input signal noise is usually the limiting factor in high resolution frequency measurements at low frequencies. If peak noise amplitude is greater than 10 mV, additional miscounting may occur. (This situation can arise when measuring high-level outputs of broadband synthesized signal sources.)

GENERAL

EXTERNAL GATE
Input Impedance: 1 MΩ || 10 pF nominal.
Slope: Selectable + or –
Level: Continuously adjustable –2V to +2V; preset ØV.
Sensitivity: 100 mV rms
Minimum Pulse Width: 20 ns
External Gate Range: 20 ns to 10 s/sample size
TRIGGER OUTPUTS (rear panel)
Start: Edge going from Ø to –0.7V nominal into 50Ω in sync with the opening of the start channel.
Stop: Ø to 0.7V edge into 50Ω in sync with the closing of the stop channel.

†For time intervals greater than 10 ms the High Stability Time Base Option 001 is recommended.

Table 1-1. HP Model 5370A Specifications (Continued)

FREQUENCY STANDARD INPUT (rear panel)
5 or 10 MHz >1.0V p-p into 1 KΩ. Maximum Input 10V.

FREQUENCY STANDARD OUTPUT (rear panel)
10 MHz
1V p-p into 50Ω in sync with time base chosen (INT or EXT)

DISPLAY: 16 digits + sign, suppressed leading zeros.

DISPLAY RATE: 10 ms to 5 s or hold.

OPERATING TEMPERATURE: 0° to 50°C.

POWER REQUIREMENTS: 100, 120, 220, or 240V ac +5% –10%, 48 to 66 Hz, less than 220 VA.

DIMENSIONS: 425 mm (16¾") wide, 133 mm (5¼") high, 457 mm (18") deep

WEIGHT: 14.55 kg (32 lbs.).

TIME BASE: Crystal Frequency 10 MHz.

STABILITY:
Aging Rate: $<3 \times 10^{-7}$ per month
Short Term: $<2 \times 10^{-9}$ rms for 1 s average
Temperature: $<2 \times 10^{-6}$ 25°C to 35°C
$<5 \times 10^{-6}$ 0°C to 55°C
Line Voltage: $<1 \times 10^{-8}$, ±10% from nominal.

OPTION 001: HIGH STABILITY TIME BASE (HP MODEL 10544A)
Crystal Frequency: 10 MHz
Stability:
Aging Rate: $<5 \times 10^{-10}$* per day
Short Term: $<1 \times 10^{-11}$ for 1 s average
Temperature: $<7 \times 10^{-9}$ 0°C to 50°C
Line Voltage: $<1 \times 10^{-10}$**, ±10% from nominal.

*For oscillator off time less than 24 hours.
**15 minutes after change.

1-12.   In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is keyed to the manual's print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-13.   For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-14.   HP-IB INTERFACING, AND PROGRAMMING INFORMATION

1-15.   Section II of this manual contains instructions for interfacing the Model 5370A with the HP-IB. A brief description of the sequence of events comprising the transfer of data by the HP-IB is provided in Section III, followed by programming information. Information concerning the design criteria of the bus is available in IEEE Standard 488-1975, titled *"IEEE Standard Digital Interface for Programmable Instrumentation"*.

1-16.   SAFETY CONSIDERATIONS

1-17.   This product is a Safety Class I instrument (provided with a protective earth terminal). Safety information pertinent to the operation and servicing of this instrument is included in appropriate sections of this manual.

1-18.   DESCRIPTION

1-19.   The Hewlett-Packard Model 5370A Universal Time Interval (T.I.) Counter is capable of making single-shot T.I. measurements with ±20 ps resolution. It uses a phase-locked vernier interpolating technique in which the interpolating oscillators are locked to the time base, thus retaining its basic accuracy at all times. The technique also allows positive, zero, and negative time interval measurements, and a resident microprocessor extends the usefulness of the instrument by offering statistical data such as mean, standard deviation, max, min, etc., for repetitive time intervals.

1-20.   Other features include pushbutton user-defined time interval reference for systematic error cancellation; "hysteresis" in arming circuitry eliminates possible random fluctuations between + and − measurements in repetitive time intervals. In addition to time interval, high resolution frequency and period measurements can be made with gates from one period to 1 second. Both time and event information are provided for interrogating complex waveforms.

1-21.   The HP 5370A has a sensitive high-speed input amplifier with digital trigger level set, and option for precision crystal oscillator for accurate long T.I. measurements.

1-22.   OPTIONS

1-23.   The following is a list of equipment and accessory options available with the 5370A. Refer to paragraph 2-21 for field installation of Option 001.

Option	Description
001	High Stability Crystal Oven (10544A)
907	Front Handle Assembly
908	Rack Mount Flange Kit
909	Rack Mount Flange Kit/Front Handle Assembly

1-24.   For more information concerning these options, contact your local Hewlett-Packard Sales and Service Office. A list of HP Sales and Service offices is provided at the end of this manual.

1-25.   ACCESSORIES SUPPLIED

1-26.   The only accessory supplied with the HP Model 5370A is a power cord (HP Part Number 8120-1378) as shown in *Figure 1-1.*

1-27.   EQUIPMENT AVAILABLE

1-28.   A service accessory kit for the HP Model 5370A is available for convenience of trouble-shooting and repairing the instrument. The service accessory kit contains extender boards and a service aid board. The accessory kit may be obtained from Hewlett-Packard by ordering Service Accessory Kit Part Number 10870A.

1-29.   RECOMMENDED TEST EQUIPMENT

1-30.   Equipment required to maintain the HP Model 5370A is listed in *Table 1-2.* Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-2. Recommended Test Equipment

Equipment	Required Characteristics	Used For			Recommended HP Model
		Perf. Tests	Adjust.	Trouble-shooting	
Service Kit Consists of:			X	X	10870A
Service Board	No Substitute			X	05370-60014
Extender Board	30 Pin X2			X	5060-0049
Extender Board	22 Pin X2			X	5060-0630
Extender Board	For A22 Arming (No Substitute)			X	05370-60074
Extender Board	For A7 Oscillator Power Supply (6 Pin X2)			X	05370-60076
Extender Board	For Digital Section (A9 through A17)			X	05370-60075
Extender Board	For 5359A Use			X	05359-60078
Extender Board	For Analog Section (A18 through A21)			X	05370-60077
Time Synthesizer	<20 ns Rise Time	X			5359A
Pulse Generator	<5 ns Rise Time		X		8082A
Function Generator	0.1 Hz to 1 MHz	X			3312A
Signal Generator	100 MHz Signal		X		8640B
Frequency Synthesizer	100 MHz Signal	X			8660C
Oscilloscope	200 MHz		X		1725A
Sampling Oscilloscope	1 GHz Bandwidth		X		182C
Sampling Plug-In			X		1810A
Oscilloscope	100 MHz Bandwidth with 50Ω Input			X	180A/1801A/ 1821A
Oscilloscope	100 MHz	X			1740A
Spectrum Analyzer	200 MHz Center Frequency with >100 MHz Bandwidth		X		141T/8552A/ 8554L
Active Probe			X	X	1120A
Probe P.S.			X	X	1122A
Signature Analyzer	No Substitute			X	5004A
DMM	3½ Digit with 0.1% Accuracy		X	X	3435A
Controller	No Substitute	X		X	9825A
Logic Probe				X	545A
Pulser				X	546A
Current Tracer				X	547A
Cables (7)	4' BNC 50Ω Cables (2 matched length within ½")	X	X X	X	11170C
Tuning Wand	Ceramic		X		8730-0013
Tuning Wand	Long Plastic		X		8730-0011

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section provides all information necessary to install the HP 5370A. Covered in this section are initial inspection, power requirements, line voltage selection, interconnection, circuit options, mounting, storage, and repackaging for shipment.

2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the shipment has been checked mechanically and electrically. The contents of the shipment should be as shown in *Figure 1-1*. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. Procedures for checking electrical performance are given in Section IV. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for the carrier's inspection.

2-5. PREPARATION FOR USE

2-6. Power Requirements

2-7. The HP 5370A requires a power source of 100, 120, 220, or 240V ac, +5%, –10%, 48 to 66 Hz single phase. Power consumption is approximately 200 watts nominal.

WARNING

IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTOTRANSFORMER FOR VOLTAGE REDUCTION, MAKE SURE THE COMMON TERMINAL IS CON-NECTED TO THE EARTHED POLE OF THE POWER SOURCE.

2-8. Line Voltage Selection

CAUTION

BEFORE SWITCHING ON THIS INSTRUMENT, make sure the instrument is set to the voltage of the power source.

2-9. *Figure 2-1* provides instructions for the line voltage and fuse selection. The line voltage selection card and the proper fuse are factory installed for 120V ac operation.

PC BOARD PART NUMBER IS
HP 5020-8122

VOLTAGE CHOICE
ON BOTH SIDES
OF PC BOARD

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 cautions to
   select correct fuse value.

Operating voltage is shown in module window.

Figure 2-1. Line Voltage Selection

8120-1351   8120-1369   8120-1689

8120-1378   8120-0698   8120-2014

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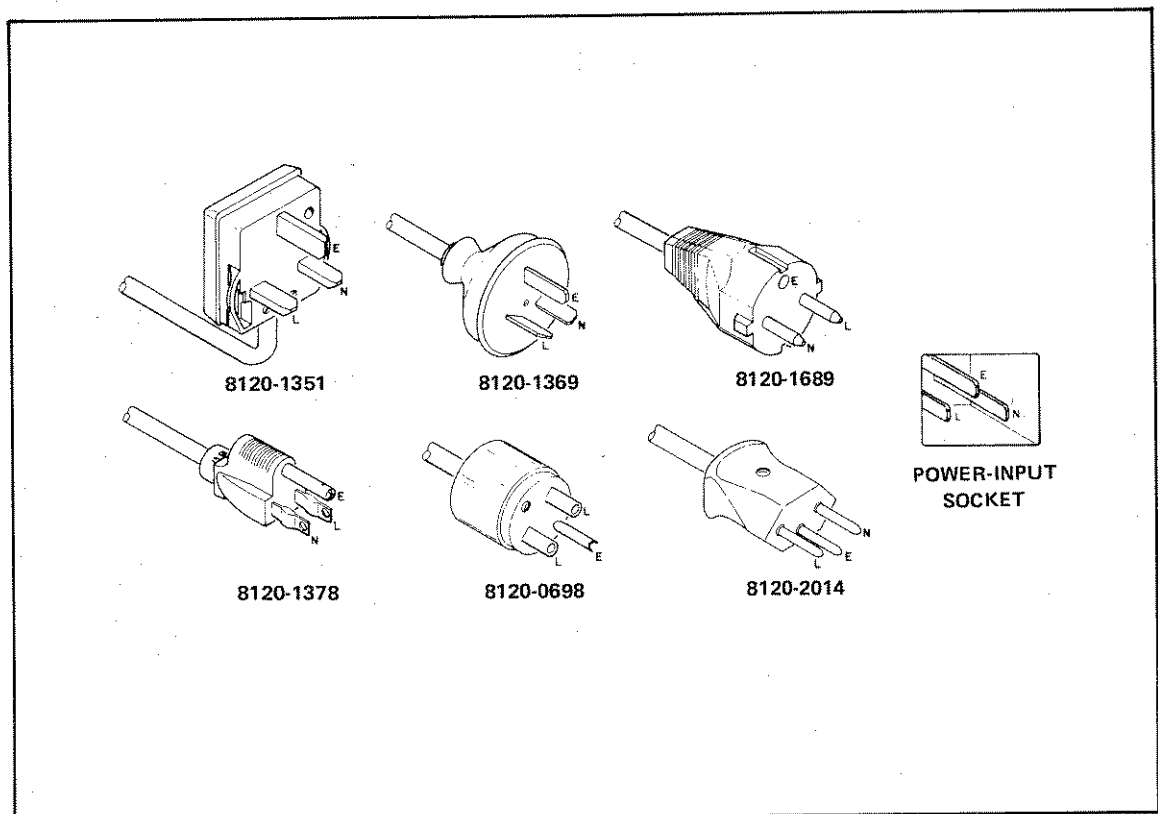
Figure 2-2. Power Cable HP Part Numbers versus Mains Plugs Available

2-10. 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).

2-11.   The 5370A 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.

2-12. Interconnections

2-13.   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. With the HP-IB system, you can interconnect up to 15 (including the controller) HP-IB compatible instruments. The HP-IB cables have identical "piggyback" connectors on both ends so several cables can be connected to a single source without special adapters or switch boxes. You can interconnect system components and devices in virtually any configuration you desire. 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 leverage which can damage the connector mounting. Be sure each connector is firmly screwed in place to keep it from working loose during use.

2-14.   CABLE LENGTH RESTRICTIONS. To achieve design performance with the HP-IB, proper voltage levels and timing relationships 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.   The total number of instruments connected to the bus must not exceed 15.

2-15. 5370A Listen Address

2-16.   The 5370A contains a rear panel HP-IB Instrument ADDRESS SELECTION switch. There are five switches designated (5, 4, 3, 2, 1) which are used to select the address. Instructions for setting and changing the listen address are provided in Section III of this manual along with 5370A programming codes.
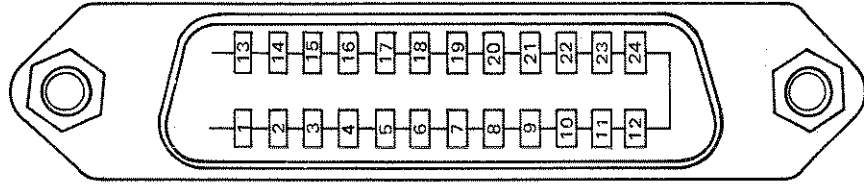
PIN	LINE
1	DIO1
2	DIO2
3	DIO3
4	DIO4
13	DIO5
14	DIO6
15	DIO7
16	DIO8
5	EOI
17	REN
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD-CHASSIS GROUND
18	P/O TWISTED PAIR WITH PIN 6
19	P/O TWISTED PAIR WITH PIN 7
20	P/O TWISTED PAIR WITH PIN 8
21	P/O TWISTED PAIR WITH PIN 9
22	P/O TWISTED PAIR WITH PIN 10
23	P/O TWISTED PAIR WITH PIN 11
24	ISOLATED DIGITAL GROUND

THESE PINS
ARE
INTERNALLY
GROUNDED

CAUTION

The 5370A contains metric threaded HP–IB cable mount-
ing 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 follow.

LOCKSCREW 1390-0360	LONG MOUNTING STUD 0380-0643	SHORT MOUNTING STUD 0380-0644

6.5mm

4.9mm
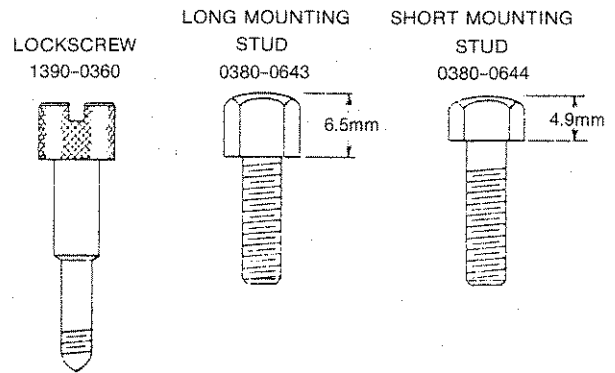
Logic Levels

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 Inter-
    face Bus System is 20.0 metres (65.6 ft.).

Figure 2-3. Hewlett-Packard Interface Bus Connection

2-17. HP-IB Description

2-18. A description of the HP-IB is provided in Section III of this manual. A study of this information is necessary if you are not familiar with the HP-IB concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1975, titled *"IEEE Standard Digital Interface for Programmable Instrumentation"*.

2-19. Bench Operation

2-20. The instrument has plastic feet and a foldaway tilt stand for convenience in bench operation. The tilt stand raises the front of the instrument for easier viewing of the control panel. The plastic feet are shaped to make full width modular instruments self-aligning when stacked.

2-21. INSTALLATION OF OPTION 001

2-22. Refer to *Table 2-1* for instructions on installing Option 001. Field installation of Option 001 should be performed by qualified service personnel only.

Table 2-1. Option 001 Installation Instructions

NOTE
Installation of Option 001 should be performed by qualified service personnel only.
Option 001 consists of the following parts:

HP Part Number	Qty.	Description
10544-60011	1	10544A Crystal Oscillator (Oven)
05370-60007	1	Power Supply Assembly for 10544A
2360-0115	2	6–32 × 3/8" Machine Screw

1. Remove the ac power cord from the 5370A.

2. Remove both the top and bottom covers.

3. Install the 05370-60007 Power Supply Assembly into the A7 Motherboard connector (connector next to the 05370-60008 assembly).

4. Remove the standard A69 Oscillator assembly.

5. Install the 10544A into the A69 Motherboard connector.

6. Turn the 5370A on its side and from the bottom of the 5370A, install the two 6–32 Machine screws, through the holes in the motherboard, into the 10544A. These screws prevent the 10544A from dislodging from the motherboard connector.

Installation of Option 001 is now complete. Immediately refer to *Table 5-8* for Oscillator adjustment.

2-23. OPERATING ENVIRONMENT

2-24. Operating and Storage Temperature

2-25. In order for the 5370A to meet the specifications listed in *Table 1-1*, the operating environment must be within the following limits:

$$
\begin{aligned}
&\text{Temperature} \quad \dotsb \quad 0°\ \text{to} +50°\text{C} \\
&\text{Humidity} \quad \dotsb \quad <80\%\ \text{relative} \\
&\text{Altitude} \quad \dotsb \quad <15{,}000\ \text{feet}
\end{aligned}
$$

2-26. Cooling System

2-27.   A forced air cooling system is used to maintain the operating temperature required by the instrument. The cooling fan is located on the left-side of the rear panel (while looking at the rear panel). When operating the 5370A, choose a location that provides at least 8 cm (3 inches) of clearance at the rear and at least 2 cm (1 inch) for each side. Failure to provide adequate air clearance will result in excessive temperature reducing instrument reliability. The clearances provided by the plastic feet in bench stacking and the filler strip in rack mounting allow air passage across the top and bottom cabinet surfaces.

2-28. STORAGE AND SHIPMENT

2-29. Environment

2-30.   The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

$$\begin{array}{ll}
\text{Temperature} \dotfill & -40°C \text{ to } +75°C \\
\text{Humidity} \dotfill & <95\% \text{ relative} \\
\text{Altitude} \dotfill & <50,000 \text{ feet}
\end{array}$$

2-31. Packaging

2-32.   ORIGINAL PACKAGING. Containers and materials equivalent 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 assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-33.   OTHER PACKAGING. The following general instructions should be used for repackaging with commercially available materials.

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

   b.   Use a strong shipping container. A doublewall carton made of 250 pound test material is adequate.

   c.   Use enough shock-absorbing material (3– to 4–inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

   d.   Seal the shipping container securely.

   e.   Mark the shipping container FRAGILE to assure careful handling.

SECTION III
OPERATING AND PROGRAMMING

3-1. INTRODUCTION

3-2. This section provides complete operating and programming information needed for the HP Model 5370A Universal Time Interval Counter. This section includes a description of all front and rear panel controls, connectors and indicators, operator's check, operating instructions both manually and remotely, and operator's maintenance.

3-3. OPERATING CHARACTERISTICS

3-4. The following paragraphs describe the operating ranges, resolution, and accuracy for Frequency, Period, and Time Interval modes.

3-5. Frequency Mode

3-6. All frequency measurements are made through the STOP channel input. The frequency range is 0.1 Hz to 100 MHz with a minimum input level of 100 mV p-p, or 35 mV rms sine wave times attenuator setting. The 5370A has 12 digits resolution with a 1-second measurement time. The accuracy is described using the following formula:

$$\text{Accuracy} = \frac{100 \text{ ps rms} \pm \text{trigger error}}{\text{gate time}} \pm \text{time base}$$

3-7. Period Mode

3-8. The 5370A makes period measurements from 10 nanoseconds to 10 seconds with a minimum input signal level of 100 mV p-p, or 35 mV rms sine wave times the attenuator setting. All period measurements are made through the STOP channel input jack. The 5370A gives 12 digits resolution using a 1-second measurement (gate time). The resolution is described using the following formula:

$$\text{Resolution} = \frac{20 \text{ ps}}{\text{gate time}}$$

The accuracy is the same as for the frequency measurements as described in paragraph 3-6.

3-9. Time Interval Mode

3-10. The 5370A measures time intervals from 10 nanoseconds to 10 seconds in +T.I. ONLY, and –10 seconds to +10 seconds in ±T.I. The minimum input level for a two source T.I. measurement is 100 mV p-p times the attenuator setting. For a one source measurement, the input signal must be input to the START channel input jack, the SEP/COM switch in COM, both attenuators must be set to the same impedance, and the minimum input level is double that for two source measurments. That is 200 mV p-p times the attenuator setting. The resolution is given using the following formula:

$$\text{Resolution} = \frac{\pm 20 \text{ ps}}{\sqrt{\text{sample size}}} \pm 2 \text{ ps}$$

The accuracy is described using the following formula: Accuracy = jitter ±1 ns systematic ± time base $\frac{\pm \text{trigger error}}{\sqrt{N}}$ where jitter equals 35 ps typical, trigger error equals $\frac{\pm 2 \times \text{noise peak voltage}}{\text{Signal Slope V/}\mu s}$ microseconds and N equals sample size.

3-11. PANEL FEATURES

3-12. Front and rear panel features of the HP Model 5370A are described in *Figure 3-1* and *Figure 3-2*, respectively. These figures contain a description of the controls and connectors. Front panel indicators are described in *Figure 3-3*. Description numbers match the numbers on the illustrations.

3-13. OPERATOR'S CHECKS

3-14. A procedure for verifying the major functions of the HP Model 5370A is provided in *Figure 3-4*. The only accessory needed for the verification procedure is a 4-foot length coaxial BNC cable HP Part Number 10503A or equivalent and a 5 kHz oscilloscope.

3-15. OPERATING INSTRUCTIONS

WARNING

BEFORE THE INSTRUMENT IS SWITCHED ON, ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTOTRANSFORMERS, AND DEVICES CONNECTED TO THE INSTRUMENT 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.

WARNING

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

CAUTION

BEFORE THE INSTRUMENT IS TURNED ON, it must be set to the voltage of the power source, or damage to the instrument could result.

3-16. *Figures 3-5, 3-6, 3-7,* and *3-8* show general operating procedures with the HP Model 5370A Universal Time Interval Counter connected in a typical measurement test setup. Many other applications are possible but not shown because the general operating procedure is the same. Description numbers match the group containing the particular designated switch.

3-17. External Arming/External Holdoff

3-18. The EXTERNAL Input jack (front panel) allows the 5370A to be externally armed and held off. The input works in conjunction with the EXT HOLDOFF, EXT ARM, and MAN INPUT switches. The specifications for the input signal are in *Table 1-1*.

3-19. EXTERNAL ARMING. To operate the counter in the EXTERNAL ARM mode, press the EXT ARM switch on the front panel. The selected trigger edge at the external input then arms the counter. The next START or STOP input pulse begins the measurement as illustrated in the diagram.
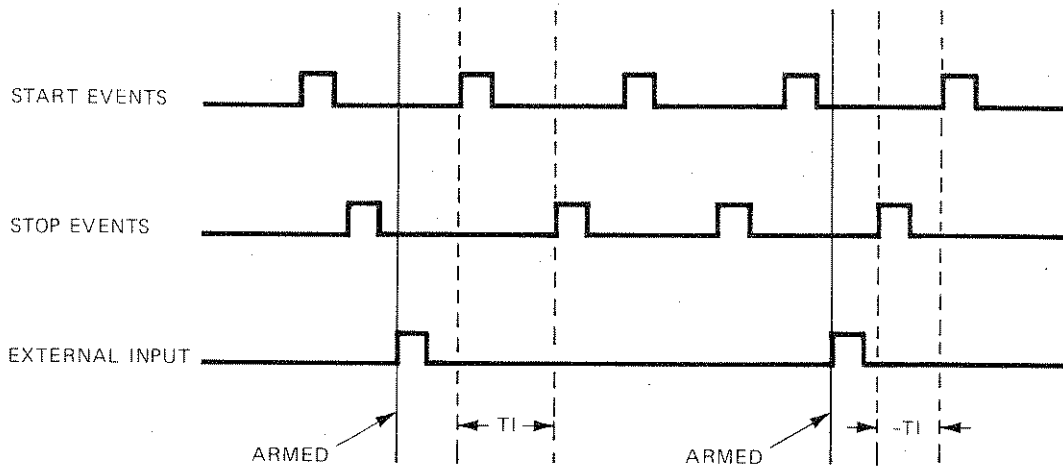
3-20. **EXTERNAL ARM/EXTERNAL HOLDOFF.** To operate the counter in the EXTERNAL HOLD-OFF mode, press the EXT HOLDOFF switch on the front panel. The selected trigger edge at the external input then arms the counter. The next START input pulse begins the measurement. The STOP pulses are held off as long as the external input holdoff is present as illustrated in the diagram.
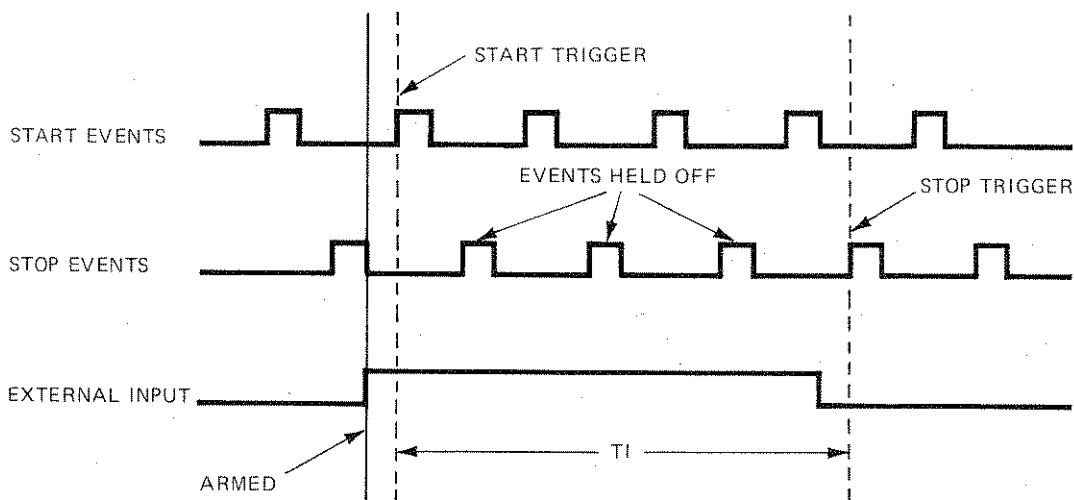

The number of events held off are counted and stored by the 5370A and can be displayed by pressing the DSP EVTS switch on the front panel.

3-21. **EXTERNAL GATE.** The 5370A may be operated in the External Gate mode for Frequency and Period measurements. To do this, press the EXT HOLDOFF switch on the front panel. The selected trigger edge at the external input then opens the main gate. The next edge then closes the gate. The diagram on page 3-4 illustrates the gate times for external gates with the 5370A front panel SLOPE switch set to *positive* and *negative*, respectively.

NOTE

Regardless of the length of the external gate, the 5370A displays 12 digits.
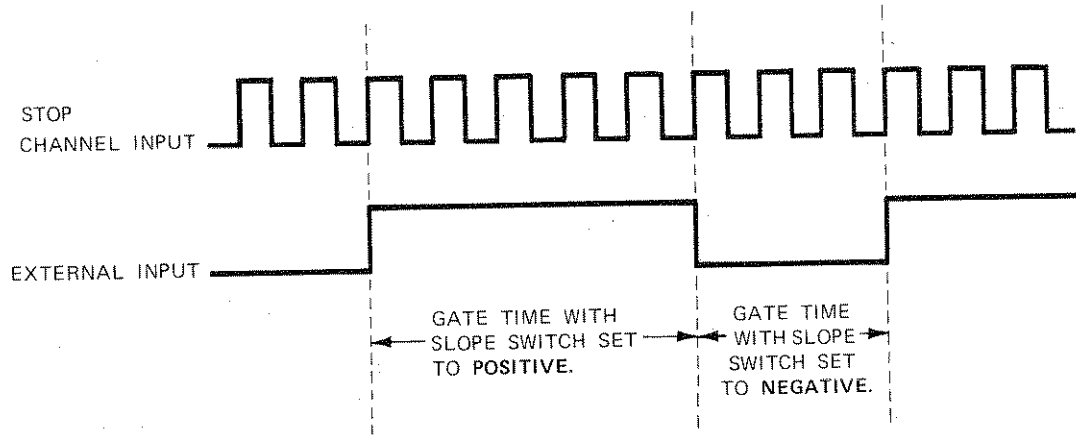
3-22. **Error Messages**

3-23. Under certain conditions, the 5370A will display an Error message (number). There are eight messages in all as listed below. Errors 6.n and 7.n pertain to power-up only. The remaining messages occur under certain operating conditions. In remote operation, the error message remains in the Status Byte until the initiation of the next measurement.

ERROR	MESSAGE
Error 0	A measurement has been completed and the 5370A has not yet been addressed.
Error 1	Indicates an illegal remote command or an undefined function (HP-IB) sent to 5370A.
Error 2	Data out of range (overrange).
Error 3	Illegal key combination (local or HP-IB).
Error 4	Phase-locked-loop out of lock.
Error 5	Undefined key (hardware problem).
Error 6.n	RAM error — processor writes into RAM (checker board pattern) and verifies error in RAM n.
Error 7.n	ROM error — processor computes check sum; error in ROM n.

3-24. OPERATOR'S MAINTENANCE

3-25. The only maintenance the operator should normally perform 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.**
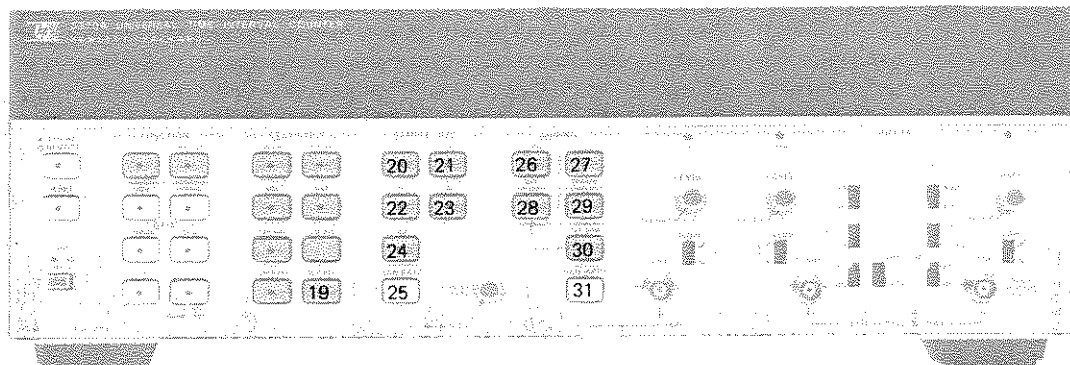
3-26. **Power/Warm-Up**

3-27. The HP Model 5370A 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.

3-28.   The 5370A has a two-position power switch, STBY and ON. For 5370A Option 001 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.
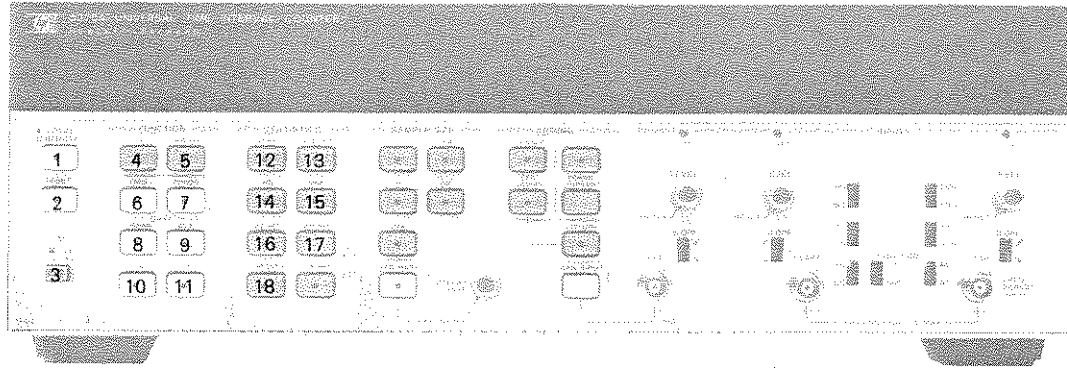
[1]	**LOCAL REMOTE**	Returns control from HP-IB to front panel.
[2]	**RESET**	Aborts current sample, performs lamp test, clears display, prepares machine to accept new samples and disarms instrument if manually armed. It does not destroy REFERENCE, EVENTS HOLDOFF, or the machine configuration.
[3]	**STBY ON**	Supplies power to entire machine in the ON position. Supplies power only to the oscillator oven (Option 001 only) in the STBY (standby) position.
[4]	**T.I.**	Time Interval function measures time differences from START channel to STOP channel.
[5]	**TRIG LVL**	Measures the voltage of the trigger levels of the START and STOP input channels and simultaneously displays them continuously.
[6]	**FREQ**	Measures frequency of the STOP channel signal by taking the reciprocal of a period average. START channel is ignored.
[7]	**PERIOD**	Measures a period average of STOP channel input events. START channel is ignored. Input amplifier control switch must be set to SEP.
[8]	**1 PERIOD**	Measures one period of the input signal of the STOP channel and displays it as either frequency or period depending on the chosen function. 1 PERIOD is disabled when machine is in Time Interval function.

NOTE

Gate Times [9], [10], and [11] are for frequency and period measurements only.

[9]	**0.01 s**	Gate time of 0.01 second is enabled.
[10]	**0.1 s**	Gate time of 0.1 second is enabled.
[11]	**1 s**	Gate time of 1 second is enabled.
[12]	**MEAN**	Causes counter to measure and display the mean estimate which is the sample average from N time interval measurements minus a constant REFERENCE value.
[13]	**STD DEV**	Displays the standard deviation estimate for the selected sample size.
[14]	**MIN**	Displays the minimum time interval within the sample minus the REFERENCE.
[15]	**MAX**	Displays the maximum time interval within the sample minus the REFERENCE.
[16]	**DSP REF**	Displays the current value of REFERENCE stored. This value remains constant until changed by switch SET REF or by switch CLR REF. The power-up value of REFERENCE is zero.
[17]	**CLR REF**	Sets REFERENCE value to zero.
[18]	**DSP EVTS**	Displays the number of events input to the STOP channel which were held off during the sample measurement window. If HOLDOFF signal is not present, it displays the number of samples that have occurred per display cycle.

*Figure 3-1. Front Panel Controls, Indicators, and Connectors*

19	SET REF	Establishes a new REFERENCE value equal to the average time interval of the latest sample.
20	1	Instrument makes one measurement and displays result.
21	100	Instrument makes one hundred measurements and displays result.
22	1K	Instrument makes one thousand measurements and displays result.
23	10K	Instrument makes ten thousand measurements and displays result.
24	100K	Instrument makes one hundred thousand measurements and displays result.

NOTE

SAMPLE SIZE operates only with 1 PERIOD GATE. When gates other than 1 PERIOD are selected, SAMPLE SIZE is disabled. When a SAMPLE SIZE is selected, the 5370A automatically goes to 1 PERIOD mode.

25	MAN RATE	Initiates a new sample for measurement when DISPLAY RATE control is in HOLD position. Old measurement value remains on display until replaced by new value. Also see DISPLAY RATE 32.
26	+T.I. ONLY	In the +T.I. ONLY mode, all STOP channel events are ignored until the arrival of the START event. The counter is armed internally.
27	±T.I.	In the ±T.I. mode, START event occurring before STOP event will automatically be assigned as a positive time interval and vice versa as a negative time interval. First incoming signal (either START or STOP) arms the counter.
28	EXT HOLDOFF	Used in conjunction with EXT ARM mode switch; it enables the EXTERNAL HOLDOFF signal to inhibit STOP channel input signal.
29	PERIOD COMPLMNT	When the PERIOD COMPLMNT switch is activated repeatedly, the measurement will switch from +T.I. to –T.I. or vice versa in a toggle fashion. Period Complement is operational only in the ±T.I. mode. Once a mode is selected, the ±T.I. range holds and the reading will not flicker between the two results. This switch has no effect when the instrument is externally armed, or when the T.I. is less than 10 nanoseconds.
30	EXT ARM	In ±T.I. mode, the START and STOP channels are simultaneously armed after the arrival of the EXT input signal. As soon as the channels are armed, the time interval defined by the first event occurring in each channel is measured, regardless of the order of arrival. In +T.I. ONLY mode the START channel is armed after the arrival of the EXT input. Time Interval is defined by the first event in the START channel and the first event in the STOP channel arriving **after** the first event in the START channel.
31	MAN INPUT	EXT INPUT signals for EXT ARM and/or EXT HOLDOFF functions can be generated manually through the MAN INPUT switch.

Figure 3-1. Front Panel Controls, Indicators, and Connectors (Continued)
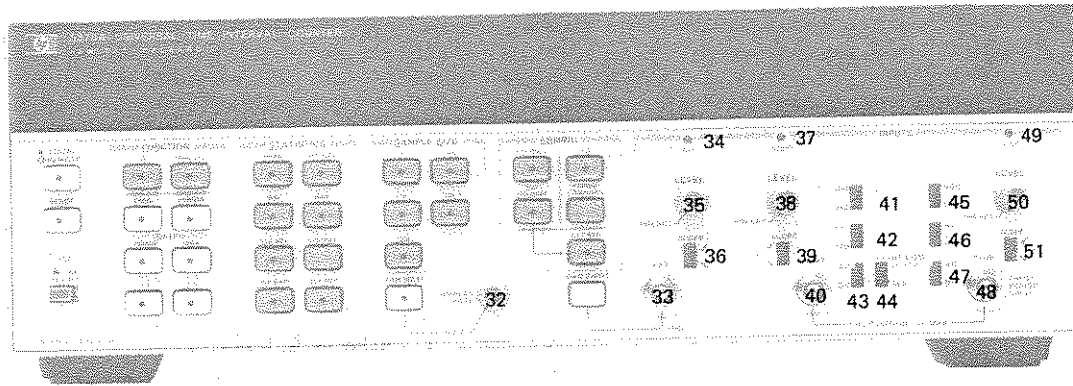
| 32 | **DISPLAY RATE** | Determines time between sample measurements. Rotating this control more counter-clockwise will add more time between measurements which in turn, displays previous measurements longer and gives a more stable display. |

When the DISPLAY RATE control is in the HOLD position, a new measurement can be initiated in several ways:

1. Pressing MAN RATE (25)
2. Changing functions (4) through (7)
3. Changing gate times (8) through (11)
4. Changing sample size (20) through (24)
5. Changing arming mode (±T.I. to +T.I. or reverse)

33	**J1**	Input BNC connector for the EXT HOLDOFF and/or EXT ARM signals with an input load impedance of 1 megohm. See *Table 1-1* for specifications.
34	**EXT**	LED indicator which when blinking, indicates that the external signal is triggering.
35	**LEVEL**	Trigger level control for the external input signal.
36	**1 SE 2**	This switch setting determines which slope of the external input signal will be used as the triggering slope.
37 49		LED indicators which when blinking, indicate that the START and/or STOP channel is triggering the machine.
38 50		LEVEL controls used in conjunction with attenuator switches 42, 46 to select voltage at which triggering occurs.
39 51		This switch setting determines which slope of the START and STOP channel input signals will be used as the triggering slope.
40 48		Input BNC connectors for the START and STOP channel signal inputs.
41 45		Input impedance switches used to select an input impedance of 50Ω or 1 MegΩ shunted by less than 30 pF.
42 46		Selects attenuation for input signal. Used in conjunction with LEVEL control to set trigger point. Input level is not affected in ÷1 position. Input signal amplitude is reduced by a factor of 10 in ÷10 position.
43 47		Coupling switches used to select direct or capacitor coupling for input signal.
44		Input Amplifier Control switch.

a. **START COM** — Operationally connects START and STOP channels in parallel. Used for single source time interval measurement. STOP channel jack is not active. START and STOP input impedance switches must be set to same position.

b. **SEP** — Allows independent operation of START and STOP channels.

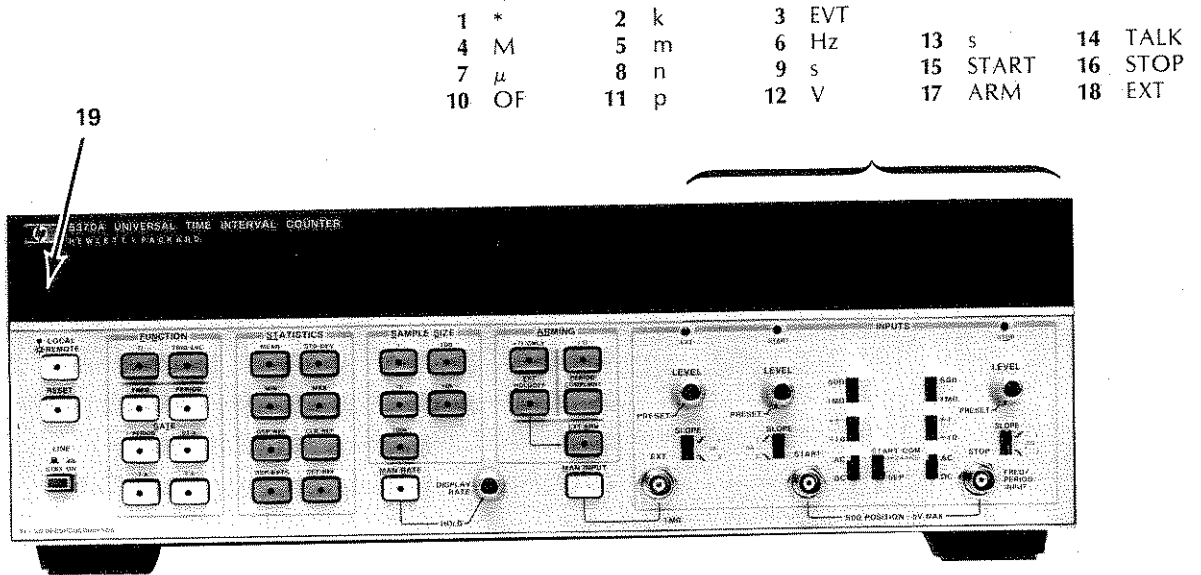*Figure 3-1. Front Panel Controls, Indicators, and Connectors (Continued)*
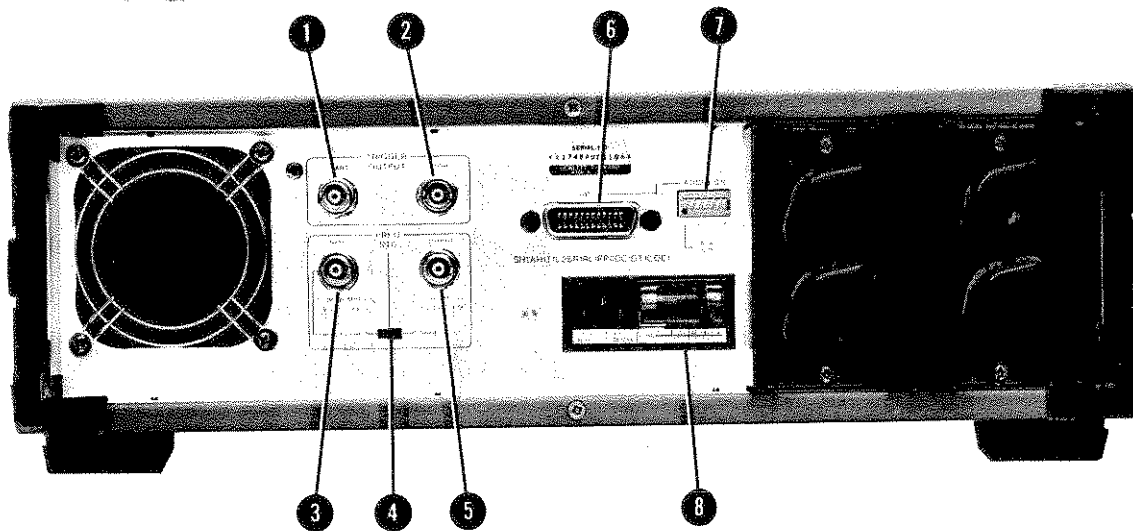
- **TRIGGER OUTPUT START** jack. Edge going from 0 to –0.7 volt nominal into 50Ω in sync with the opening of the START channel.

- **TRIGGER OUTPUT STOP** jack. Edge going from 0 to –0.7 volt nominal into 50Ω in sync with the closing of the STOP channel.

- **FREQ STD INPUT** jack. Allows 5370A to be operated synchronous with an external standard of either 5 or 10 megahertz with drive of 1 volt rms across 1 kilohms. FREQ STD select switch **4** must be set to EXT position.

- **FREQ STD** select switch.

    a. **INT** allows the 5370A to operate with the internal time base standard.
    b. **EXT** allows the 5370A to operate with an external time base standard.

- **FREQ STD OUTPUT** jack. Provides 10 megahertz internal standard signal for external use. Amplitude is 1 volt rms into 50 ohms. FREQ STD select switch **4** must be set to INT position.

- Interface connector for 5370A connection to HP-IB remote interface.

- **ADDRESS** switch cluster containing address switches A1 through A5 and TALK ONLY switch A7. Switch A6 is not internally connected. See programming in this section for detailed explanation.

- AC power input module permits 5370A operation from 100, 120, 220, or 240 volts ac. The number visible in the window indicates nominal line voltage to which instrument must be connected (see *Figure 2-1*). Protective ground conductor connects to the instrument through this module.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUND-ING) CONDUCTOR INSIDE OR OUTSIDE THE INSTRU-MENT OR DISCONNECTING OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. (See Section II.)

Figure 3-2. Rear Panel Features

1	*	2	k	3	EVT			13	s	14	TALK
4	M	5	m	6	Hz			15	START	16	STOP
7	μ	8	n	9	s			17	ARM	18	EXT
10	OF	11	p	12	V						

Number	Symbol	Description
1	*	ASTERISK — Indicates crystal oscillator oven (Option 001) is below operating temperature (cold), as is the case when the 5370A is first plugged into the line supply.
2	k	kilo (10^3)
3	EVT	Events
4	M	Mega (10^6)
5	m	milli (10^{-3})
6	Hz	Hertz
7	μ	Micro (10^{-6})
8	n	nano (10^{-9})
9	s	seconds
10	OF	Overflow
11	p	pico (10^{-12})
12	V	Volts
13	LSTN	Listen — Active when 5370A is programmed to listen.
14	TALK	Active when 5370A is programmed to talk.
15	START	Active when Time Interval measurement is armed by START channel signal input in the ±T.I. mode.
16	STOP	Active when Time Interval measurement is armed by STOP channel signal input in the ±T.I. mode.
17	ARM	Indicates 5370A is armed (ready to measure input signal). ARM light is actually flickering while measuring N samples but so fast as to appear to be continually on. ARM light may not appear lit for single samples of narrow events. Light stays on during measurement time.
18	EXT	Indicates machine is in the EXTernal ARM mode.
19		Oscillator clock loss indicator. Indicates loss of internal clock signal, possibly due to setting of rear panel FREQ STD switch. Once clock signal is returned, the 5370A power may need to be turned off and on again before internal circuits can operate properly.

Figure 3-3. Front Panel Indicators
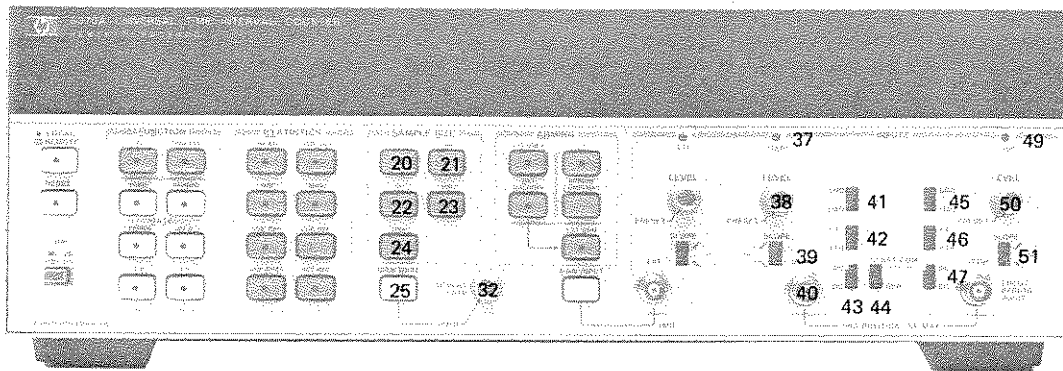
1. Before switching on the instrument, ensure that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and the safety precautions are taken. See Power Requirements, Line Voltage Selection, Power Cables, and associated warnings and cautions in Section II of this manual. Description numbers match the numbers in *Figure 3-1* and *Figure 3-2*.

2. Connect a 4-foot BNC cable, such as HP 10503A, from the rear panel FREQ STD OUTPUT jack to the front panel START input jack 40

3. Set the rear panel Frequency Select switch to INT.

4. Set the input impedance switches 41 45 to the 50Ω position.

5. Set the attenuator switches 42 46 to the ÷1 position.

6. Set the AC, DC switches 43 47 to the DC position.

7. Set the input slope switches 39 51 to the 1 (positive going slope) position.

8. Set the LEVEL controls 38 50 to the preset position.

9. Set the COM, SEP switch 44 to the START COM position.

10. Adjust DISPLAY RATE 32 to maximum (full cw).

11. Press the LINE switch 3 to turn on the 5370A.

NOTE

When instrument is first turned on, the processor performs a self-check routine on the ROM's and RAM's. If, when power is first applied, or during operation, an error message is displayed, refer to paragraph 3-22 ERROR MESSAGES in this section for error explanation.

12. For the first second after the instrument is turned on, the display will remain blank. For the next second, all segments and decimal points and all annunciator lights (except START, STOP, and ARM) in the display will be lit as well as all LED's in all the front panel switches.

13. After this initial power-up reset, the 5370A will be in the T.I. FUNCTION, MEAN STATISTICS, SAMPLE SIZE 1, and +T.I. ONLY. The display should indicate 100.00 nanoseconds ±1.0 nanosecond with both the START and STOP channel trigger LED's 37 49 flashing. Also, because of the sample size of one, the ARM light will not be visible in the display.

14. Press SAMPLE SIZE 100 switch 21 The least significant digit (LSD) will be one-digit greater (1 picosecond), the ARM light will be visible and flashing and the LED in the MAN RATE switch 25 will be flashing at approximately the same rate as the ARM light. Press SAMPLE SIZE 1K switch 22 and display will have same LSD (1 picosecond) with ARM light and MAN RATE switch flashing about twice per second. Press SAMPLE SIZE 10K 23 and display LSD will be 100 femtoseconds with ARM light flashing about once every four seconds. Press SAMPLE SIZE 100K switch 24 and the ARM light will flash about once every 40 seconds. Press SAMPLE SIZE 1 20

Figure 3-4. Operators Checks
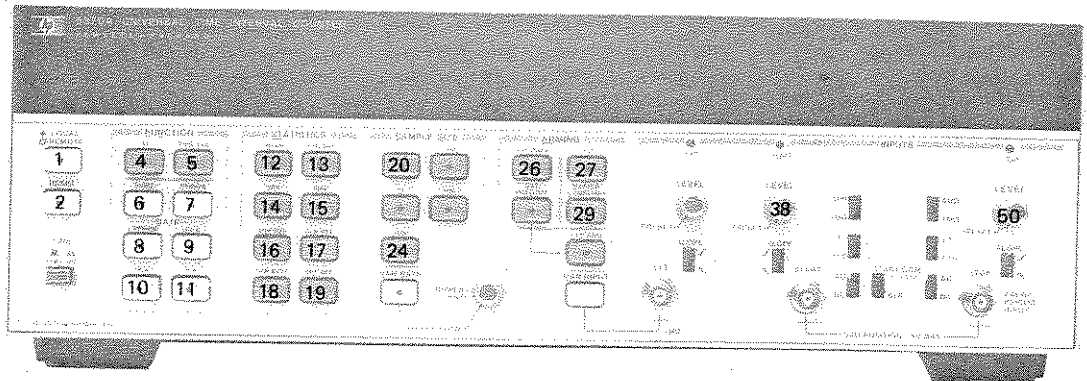
15. Press STD DEV13 and ±T.I. switch27. Display should read less than 100 ps (this reading is the instrument's jitter). Notice that SAMPLE SIZE automatically goes to 100. For STD DEV measurements, SAMPLE SIZE must be ≥100. Press MIN switch14 and minimum T.I. should be displayed. Press MAX switch15 and the maximum T.I. should be displayed. Press +T.I. ONLY26.

16. Press DSP REF switch16 and three zeros should be displayed. Press SET REF switch19 and approximately 100 nanoseconds should be displayed. This reference is the MEAN T.I. Press CLR REF switch17 and six zeros should be displayed (if 99.99X ns is displayed, CLR REF will give five zeros), three zeros on either side of the decimal point. Press DSP EVTS switch18 and 100 should be in the display. This number corresponds to the SAMPLE SIZE. Notice also EVT is displayed in the right hand side of the window.

17. Press MEAN switch12 and SAMPLE SIZE 1 switch20. Press ±T.I. switch27 and the display should show less than 1 nanosecond. The STOP or START light in the display will also be on. Press PERIOD COMPLMNT switch29 and the display should be the same except the alternate (STOP or START) light will be on in the display. Press the PERIOD COMPLMNT switch again and the first arming channel light should come back on. This switch operation is identical to a toggle switch.

18. Press TRIG LVL5. There will be two groups displayed, three digits each, on the left and the right of the display. They indicate the DC trigger level voltage on the START and STOP channel inputs, respectively. Rotate the LEVEL controls38 50 and note the voltage should change from approximately –1.3 to +0.5 volts. Turn both LEVEL controls fully counterclockwise until they click in the preset position. The display should show zero volts for both inputs.

19. Press FREQ switch6. Press 0.01 s switch9 and display should read approximately 10.000 000X MHz. Press 0.1 s switch10 and display should read approximately 10.000 000 0X MHz. Press 1 s switch11 and display should read appoximately 10.000 000 0XX MHz. Press 1 PERIOD switch8.

20. Press PERIOD switch7. Display should indicate approximately 100 nanoseconds.

21. Press Function switch T.I4, 100K SAMPLE SIZE24, rotate DISPLAY RATE control maximum cw and check the *rear panel* START and STOP outputs1 and2 using an oscilloscope. Both signals should be ≥–0.7V (into 50Ω) and approximately 320 µs wide as shown below.
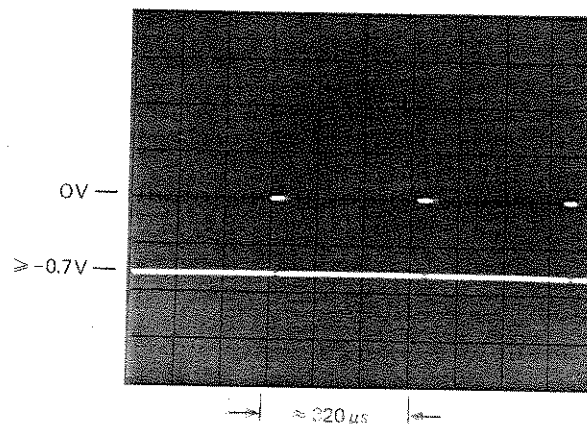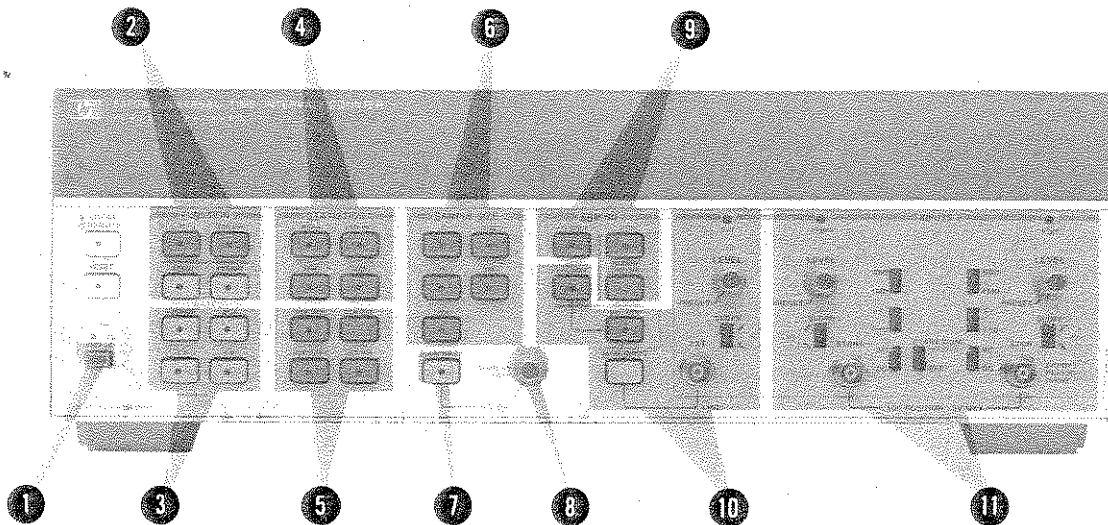

Figure 3-4. Operators Checks (Continued)

NOTE

See *Table 1-1* for specifications on all input signals concerning bandwidth, accuracy, and amplitude.
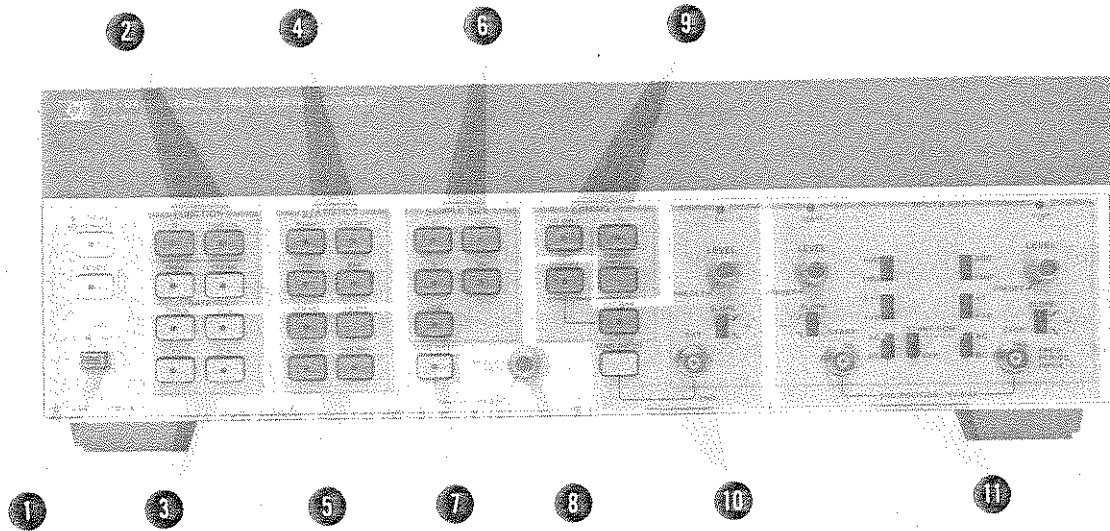
1. Set LINE switch ❶ to ON position.

NOTE

All GATE switches are disabled when 5370A is in T.I. FUNCTION.

2. Set START and STOP input impedance, attenuation, and coupling switches to desired position; see specifications in *Table 1-1*.

3. Set START COM/SEP switch ⓫ to COM position. When COM/SEP switch is set to COM, impedance switches must be set to the same impedance.

4. Connect input signal to START channel input jack.

5. Set START channel slope switch SA ⓫ to 1 for triggering on positive slope or to 2 for triggering on negative slope.

6. Set STOP channel slope switch SO ⓫ to 1 for triggering on positive slope or to 2 for triggering on negative slope.

7. Set START LEVEL control to start mesurement at desired voltage level. Press TRIG LVL (trigger level) to display triggering voltage (if desired).

8. Set STOP LEVEL control to stop measurement at desired voltage level. Press T.I. FUNCTION.

9. Press desired STATISTICS ❹ . When STD DEV is pressed in T.I. FUNCTION, the 5370A automatically goes to SAMPLE SIZE of 100 (unless SAMPLE SIZE is greater than 100). EXT HOLDOFF ❿ and DSP EVT ❺ will not operate when 5370A is set for ±T.I. ARMING ❾ .

10. Press desired SAMPLE SIZE ❻ .

11. Press desired ARMING mode ❾ . See *Table 1-1* for specifications on EXT input signal used for EXT HOLDOFF and/or EXT ARM.

12. Adjust DISPLAY RATE control ❽ for a convenient interval between measurements.

13. If more than one piece of information is desired for a sample, turn DISPLAY RATE control ❽ fully counterclockwise until it clicks in the HOLD position. Then press the MAN RATE (manual rate) switch ❼ to start measurement. At the end, different statistical information for that one sample can be obtained by pressing the appropriate switches. Press ❼ again for a new sample. For measurement of single-shot signal, set input conditioning as desired. Press T.I., MEAN, SAMPLE SIZE 1, EXT ARM MAN INPUT (or use external arming signal via EXT input) and DISPLAY RATE to HOLD. The instrument is now ready for the single-shot signal.

Figure 3-5. One Source Time Interval Measurement

NOTE

See *Table 1-1* for specifications on all input signals concerning bandwidth, accuracy, and amplitude.
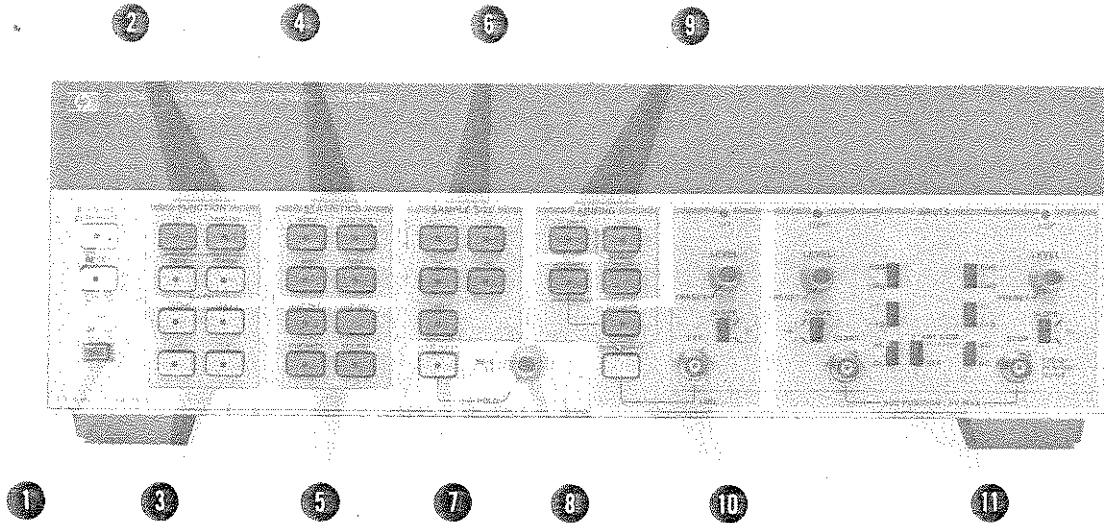
1. Set LINE SWITCH ① to ON position.

NOTE

All GATE switches are disabled when the 5370A is in T.I. FUNCTION.

2. Set START and STOP input impedance, attenuation, and coupling switches ⑪ to desired position; see specifications in *Table 1-1*.

3. Set START COM/SEP switch ⑪ to SEP position.

4. Connect START signal to START input jack and STOP signal to STOP input jack.

5. Set START channel slope switch SA ⑪ to 1 for triggering on positive slope or to 2 for triggering on negative slope.

6. Set STOP channel slope switch SO ⑪ to 1 for triggering on positive slope or to 2 for triggering on negative slope.

7. Set START LEVEL control to start measurement at desired voltage level. Press TRIG LVL to display triggering voltage (if desired).

8. Set STOP LEVEL control to stop measurement at desired voltage level. Press T.I. FUNCTION.

9. Press desired STATISTICS ④. When STD DEV is pressed in T.I. FUNCTION, the 5370A automatically goes to SAMPLE SIZE of at least 100. EXT HOLDOFF ⑩ and DSP EVT ⑤ will not operate when 5370A is set for ±T.I. ARMING ⑨.

10. Press desired SAMPLE SIZE ⑥.

11. Press desired ARMING mode ⑨. See *Table 1-1* for specifications on EXT input signal used for EXT HOLDOFF and/or EXT ARM. See also paragraphs 3-17 through 3-21.

12. Adjust DISPLAY RATE control ⑧ for a convenient interval between measurement.

13. For one-shot measurements, see step 13 in *Figure 3-5*.

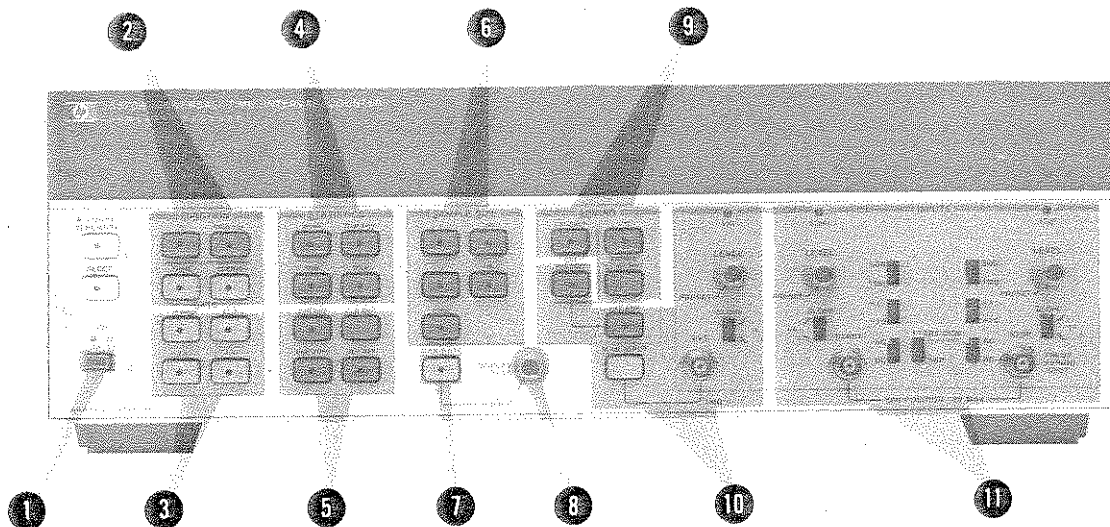*Figure 3-6. Two Source Time Interval Measurement*

NOTE

See *Table 1-1* for specifications on all input signals con-
cerning bandwidth, accuracy, and amplitude.

1. Set LINE switch ① to ON position.

2. Set STOP LEVEL control to trigger measurement at desired voltage level. Press TRIG LVL ② to display actual DC voltage of trigger level. Use PRESET for sine waves.

3. Set START COM/SEP switch ⑪ to SEP position.

4. Set STOP impedance, attenuation, and coupling switches ⑪ to desired position; see specifications in *Table 1-1* for details.

5. Connect input signal to STOP channel input jack ⑪ .

6. Press FREQ switch in FUNCTION group ② .

7. Press GATE switch, group ③ , for desired integration time or press desired SAMPLE SIZE ⑥ .

8. Press desired STATISTICS switch ④ .

9. Adjust DISPLAY RATE control ⑧ for a convenient interval between measurements. If one-
shot measurements are desired, see step 13 in *Figure 3-5*.

Figure 3-7. Frequency Measurements

NOTE

See *Table 1-1* for specifications on all input signals con-
cerning bandwidth, accuracy, and amplitude.

1. Set LINE switch ① to ON position.

2. Press PERIOD switch in FUNCTION group ② .

3. Set STOP impedance, attenuation, and coupling switches ⑪ to desired position; see
    specifications in *Table 1-1* for details.

4. Set STOP LEVEL control to trigger measurement at desired voltage level. Press TRIG LVL, group
    ② , to display actual DC voltage of trigger level; press PERIOD again. Use PRESET for sine
    waves.

5. Set START COM/SEP switch ⑪ to SEP position.

6. Connect input signal to STOP channel input jack ⑪ .

7. Press desired SAMPLE SIZE switch ⑥ or GATE time switch ③ . If STD DEV (standard deviation)
    is to be displayed, SAMPLE SIZE must be ≥100.

8. Press desired STATISTICS switch ④ ; statistics can only be performed while machine is in the
    1 PERIOD ③ mode.

9. +T.I. is the only ARMING mode ⑨ usable in the PERIOD function.

10. Press desired switch for EXT ARM and/or EXT HOLDOFF ⑩ . See *Table 1-1* for specifications
    for External Gate input signal. See also paragraphs 3-17 through 3-21.

11. Adjust DISPLAY RATE control ⑧ for a convenient interval between measurements. If one-
    shot measurements are desired, see step 13 in *Figure 3-5*.

Figure 3-8. Period Measurements

3-29. PROGRAMMING

3-30. Introduction

3-31. The 5370A Universal Time Interval 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 5370A 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 5370A to perform a specific type of measurement, trigger the measurement, and read the results.

NOTE

HP-IB is Hewlett-Packard's implementation of IEEE Standard 488-1975, "Standard Digital Interface for Programmable Instrumentation".

3-32. This section describes how to use the HP 9825A and HP 9830A Calculators on the HP-IB bus as computing controllers to program the 5370A. Before starting to operate a system, it is helpful to be familiar with the selected calculator, the capabilities of the HP-IB, and the manual operation and capabilities of the 5370A. The following HP manuals provide useful background information:

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

3-33. The capability of a device connected to the bus is specified by its interface functions. Table 3-1 lists the 5370A Interface Functions using the terminology of the IEEE Std. 488-1975. These functions are also listed below the rear panel HP-IB connector. The number following the interface function code indicates the particular capability of that function as listed in Appendix C of IEEE Std. 488-1975. Interface functions provide the means for a device to receive, process, and send messages over the bus.

3-34. Messages are the means by which devices exchange control and measurement information. These messages permit communication and/or control between: 1) controller and device(s); 2) device and device(s); and 3) controller and controller(s). Table 3-2 lists the Bus Messages and gives a brief description of each.

Table 3-1. HP-IB Interface Capability

CODE	INTERFACE FUNCTION
SH1	Source Handshake capability
AH1	Acceptor Handshake capability
T1	Talker (basic talker, serial poll, talk only mode)
L2	Listener (basic listener)
SR1	Service Request capability
RL1	Remote/Local capability
PPØ	No Parallel Poll capability
DC1	Device Clear capability
DT1	Device Trigger capability
CØ	No Controller capability
E1	One Unit Load

Message	Description	5370A Use	Sample 9825A Statements (5370A Set to Address 03)
Data	Transfers device-dependent information from one device to one or more devices on the Bus.	Input: Accepts program codes. See *Table 3–4* for program code set Output: Sends measurement data. Output format is TI = SD.DDDDDDDDDDESDD	wrt 703, "SS3AR2" red 703, A
Trigger	Causes a group of selected devices to simultaneously initiate a set of device-dependent actions.	Starts a new measurement. Equivalent to the "MR" (manual rate) remote command.	trg 7 or trg 703
Clear	Causes an instrument to be set to a predefined state (a certain range, function, etc.).	Same as front panel reset. Generates lamp test, clears status byte, followed by "MR". Does not set counter to predefined function.	clr 7 or clr 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 absense 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 (RTL).	rem 703
Local	Causes selected devices to return to local (front panel) operation.	Returns 5370A to front panel control.	lcl 703
Local Lockout	Disables local (front panel) controls of selected devices	Disables local (RTL) pushbutton.	llo7
Clear Lockout and Local	Returns all devices to local (front panel) control and simultaneously clears the Local Lockout Message.	Returns counter to local (front panel) control and clears the local lockout message.	lcl7
Require Service	Indicates a device's need for interaction with the controller.	Used to flag an error condition or to indicate that measurement is complete. Error message is coded in status byte.	rds (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 8 is set if device is running debug monitor (diagnostic tool). Bit 7 is set if service is requested. Bit 6 is set if oven heater is on. Bit 5 is set if an external time base is used. Bits 1–4 indicate error message if bit 7 is used. Error 0: Measurement is complete and counter is ready to output. Error 1: Illegal remote command. Error 2: Overrange (TI is too long or statistics overflow). Error 3: Undefined routine. Error 4: Out of lock (refers to internal phase lock loop). Error 5: Undefined key (indicates a hardware problem). Error 6: Fault in RAM storage. Error 7: Fault in ROM storage.	rds (703)→A ↕ rds (703)→A
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 can assume the Bus supervisory role.	Does not use	—
Abort	Unconditionally terminates Bus communications and returns control to the system controller.	Clears Talk, Listen, and Serial Poll Enable registers on 5370A HP-IB Interface. Front panel setup does not change.	cli 7

3-18

3-35. Setting the Address Switches

3-36.   To use the 5370A in an HP-IB system, the first step is to set the rear panel address switches as shown in *Table 3-3*. 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 within 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.

3-37.   The five right-hand switches, A5 through A1, set the talk and listen addresses of the 5370A when it is used in the ADDRESSABLE mode. *Table 3-3* shows the possible address settings and the corresponding ASCII codes for talk and listen.

3-38.   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 calculator, since the calculator addresses the 5370A to talk and listen by using the code 703. (The "03" being the 5370A 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.

3-39.   Program Codes

3-40.   There are effectively three types of program codes that are used to remotely program the counter's functions. The first type uses two letters of the particular function, e.g., FN for FuNction, and a number associated with the specific function, see *Figure 3-9*. For example, selecting FN3 as the program code programs the frequency function. Notice that for commands such as FN, the front panel controls are numbered 1-N, left to right and then top to bottom.

3-41.   Other codes have only two functions, coded 0 and 1. The "0" indicates the selected function is **off** or disabled and the "1" indicates **on** or enabled. For example, EA0 is the code for EXT ARM disable.

3-42.   The third type of function selection places portions of the front panel to either remote or local operation. For example, program code SR sets the slope switches to remote programming control. Program code SA1 or SA2 must now be programmed to choose the particular slope, positive or negative, for the START channel. These are the basic types of function codes for remote programming. Those that require special consideration are described in *Table 3-4*, Program Code Set.
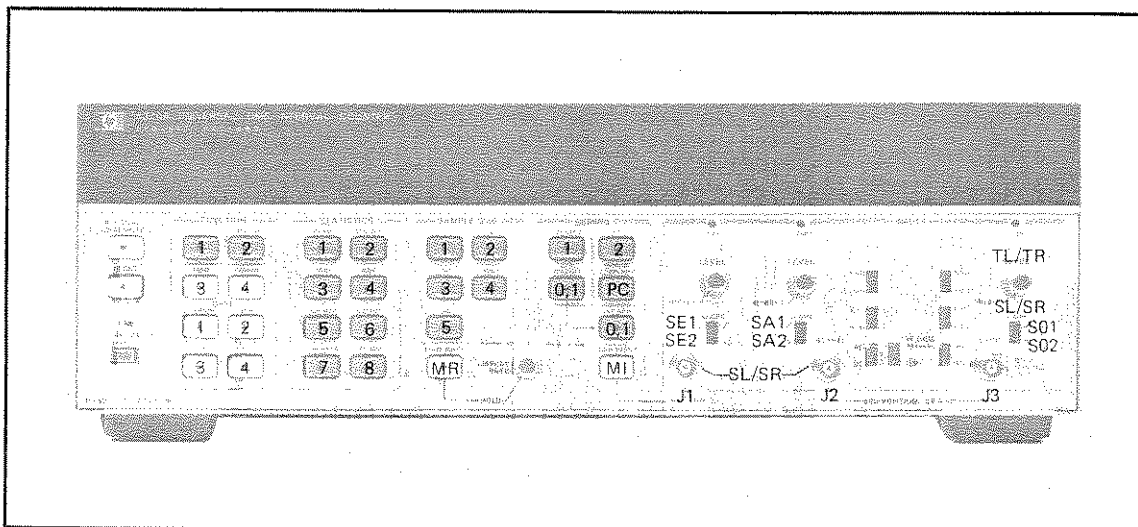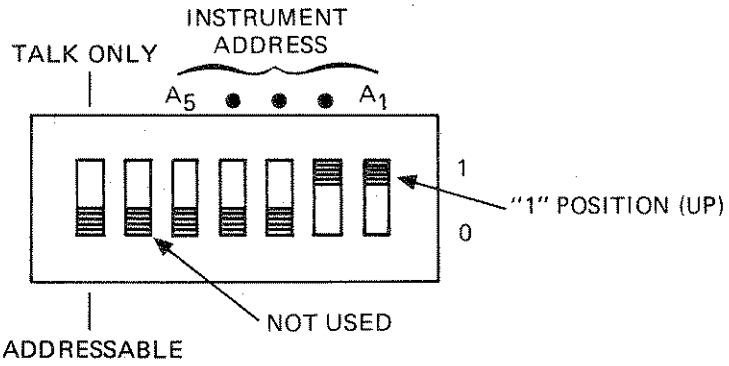

Figure 3-9. Program Codes Relating to Switch Functions

Table 3-3. Address Selection

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

3-43.   Output Formats

3-44.   The 5370A can output data in three different formats. Two of the formats are described in detail, in the back of this section, in Examples 2 and 5. Example 2 describes the Display All output format which outputs not only the resultant measurement but all related statistics. Example 5 describes in detail, the Binary Output or Computer Dump format. The third format is the Standard Output format and is described in the following paragraph.

3-45.   The standard output byte contains 22 characters per measurement. The characters are arranged as follows:

$$AAAASD.DDDDDDDDDDDESDD$$

where

A =	TI	= for Time Interval
	FREQ	= for Frequency
	PER	= for Period

S =   Sign of measurement or exponent (space for positive and – for negative)
D =   Digits
E =   Exponent

The output byte is followed by a CR (carriage return) and LF (line feed).

Table 3-4. Program Code Set

Codes shown in **bold face** are start-up conditions. These conditions are set when the instrument powers up on turn-on. They cannot be selected by using the bus commands of Device Clear or Selected Device Clear.

1. **FUNCTION**
   FN1 **Time interval**
   FN2   Trigger Levels
   FN3   Frequency
   FN4   Period

2. **GATE TIME** (for FREQUENCY or PERIOD mode)
   GT1 **Single Period**
   GT2   0.01 second
   GT3   0.1 second
   GT4   1 second

3. **STATISTICS**
   ST1 **Mean**
   ST2   Standard Deviation (requires ≥100 sample size)
   ST3   Minimum
   ST4   Maximum
   ST5   Display Reference
   ST6   Clear Reference (immediate execution)
   ST7   Display Events
   ST8   Set Reference (immediate execution)
   ST9   Display All (In the TIME INTERVAL mode, counter displays and outputs mean, standard deviation, minimum, maximum, reference, and events. In frequency or period and with a gate time selected, counter displays and outputs mean and events. In frequency or period with a sample size selected, counter displays and outputs mean, standard deviation, minimum, maximum, and events. See Example 2 in this section).

4. **SAMPLE SIZE**
   SS1 **Sample Size = 1**
   SS2   Sample Size = 100
   SS3   Sample Size = 1K   See also "SB", Sample Size Binary in this table.
   SS4   Sample Size = 10K
   SS5   Sample Size = 100K

5. **MODE**
   MD1 **Front Panel Display Rate Control is Functional.** Output only if addressed.
   MD2   Display Rate Hold Until "MR" command (or GET) (Display Rate control is locked out). Wait until addressed. Changing functions while in MD2 mode causes the first measurement output data to be invalid. With the new function programmed, the first data output will be the previous measurement data in terms of the new function. For example, with 5370A in frequency and a measurement of 1 MHz taken, if a new function was programmed, say Period, then the first output data will be 1 μs (which is the previous Frequency measurement of 1 MHz converted to the new function of Period).
   MD3   Display Rate Fast (Display Rate control is locked out). Only if addressed.
   MD4   Display Rate Fast (Display Rate control is locked out). Wait until addressed.

6. **INPUT SELECTION** (see Example 3)
   IN1 **Input selection for normal time interval operation.** START event = START channel input, STOP event = STOP channel input.

INTERNAL
SWITCH CIRCUIT

START CHANNEL ══════════════ START EVENT

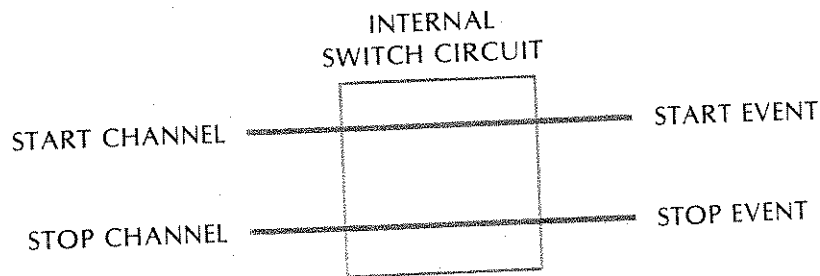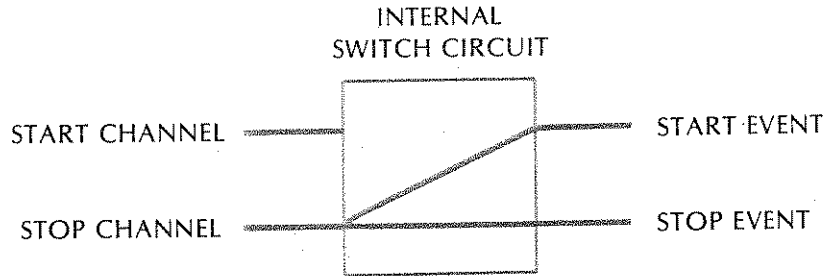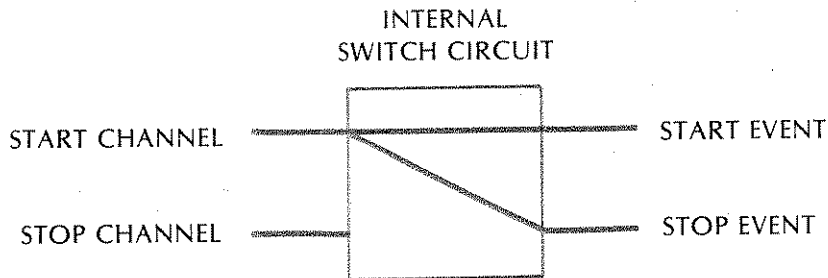STOP CHANNEL ══════════════ STOP EVENT

Table 3–4. Program Code Set (Continued)

IN2   Normal input selection for frequency or period measurement. START event = STOP channel input, STOP event = STOP channel input.

INTERNAL
SWITCH CIRCUIT

START CHANNEL   START EVENT

STOP CHANNEL   STOP EVENT

IN3   Input selection for operator convenience in switching input to different channels. START event = START channel input, STOP event = START channel input.

INTERNAL
SWITCH CIRCUIT

START CHANNEL   START EVENT

STOP CHANNEL   STOP EVENT

IN4   Input selection for operator convenience in switching input to different channels. START event = STOP channel input, STOP event = START channel input.

INTERNAL
SWITCH CIRCUIT

START CHANNEL   START EVENT

STOP CHANNEL   STOP EVENT
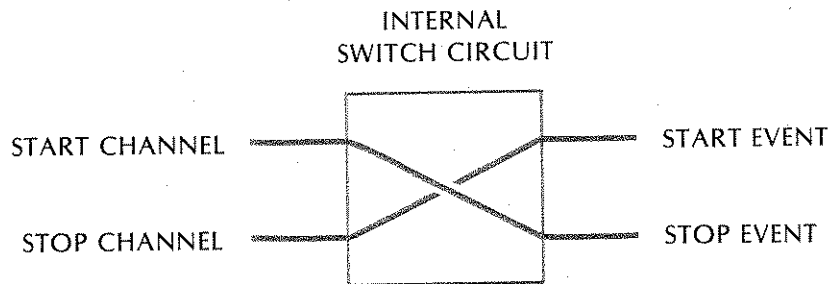
7. **START CHANNEL SLOPE SELECT**
    SA1   **Start Channel Slope: Positive**
    SA2   Start Channel Slope: Negative

8. **STOP CHANNEL SLOPE SELECT**
    SO1   **Stop Channel Slope: Positive**
    SO2   Stop Channel Slope: Negative

9. **EXTERNAL ARM SLOPE SELECT**
    SE1   **External Arm Slope: Positive**
    SE2   External Arm Slope: Negative

10. **ARM SELECT**
    AR1   **+T.I. Arming Only**
    AR2   ±T.I. Arming

Table 3–4. Program Code Set (Continued)

11. **EXTERNAL HOLDOFF**
 EHØ **External Holdoff Disable**
 EH1 External Holdoff Enable (must also use EA1 and AR1)

12. **EXTERNAL ARM**
 EAØ **External Arm Disable**
 EA1 External Arm Enable

13. **INTERNAL ARM**
 Used with ±T.I. Arm Mode only. Forces counter to arm on either START or STOP channel always, regardless of input phase relation. Disables internal phase detection circuit.
 IA1 Internal Arm Auto
 IA2 Start Channel Arm
 IA3 Stop Channel Arm

The following terse commands have also been defined.

1. MR Manual Rate. Used to initiate a sample of measurements. Typically used with MD2. MR must be sent at least 10 ms after the previous program command. For example, a typical 9825A program should be:

 a. wrt 7Ø3, "FN1ST1SS1MD2IN1SA1SO2TRSR"
 b. wait 10; wrt 7Ø3 "MR"

2. MI Manual Input. Same operation as front panel MANUAL INPUT. Used to manually arm the counter. Use wtb calculator command.

3. **SL** **Slope Local.** Set slope switches to local (front panel) operation.

4. SR Slope Remote. Sets slope switches to remote operation.

5. **TL** **Trigger Local.** Sets trigger level controls to front panel operation.

6. TR Trigger Remote. Set trigger level controls to remote operation.

7. TE Teach. When addressed to talk, the 5370A transfers all front panel information (or remotely programmed information) from its memory into the controller's memory. See Example 4.

8. PC Period Complement. Performs the same operation as the front panel switch.

9. TBØ Disable Time Interval Binary Output.

10. TB1 Time Interval Binary Output. For short time intervals of <320 μs. Counter does not perform any type of statistical measurement (mean, standard deviation, etc.). Instead, counter outputs raw data: NØ(ST), N1N2(CT1), N1N2(CT2), NØ(CT1), and NØ(CT2) in that order, and places "--------" in display. Measurements occur at up to a 6 kHz rate. See Example 5.

The following binary commands have also been defined.

1. SB Sample Size Binary. Allows a theoretical setting of sample sizes from 1 to 16,777,215. Must be entered in binary form. See Example 6. Use wtb calculator command.

2. LN Learn. Enters program information into 5370A (RAM memory) that was stored into the calculator with an earlier TEACH (TE) command. See Example 4.

The following decimal commands have also been defined.

1. TA Trigger Start. Sets the trigger level of the START channel from 0.50V to –1.30V. See Example 7.

2. TO Trigger Stop. Sets the trigger level of the STOP channel from 0.50V to –1.30V. See Example 7.

NOTE

To output the trigger level setup data from the 5370A to the controller, program the 5370A to Trigger Level function (FN2) and "red (counter talk address)". The output format is as follows:

$$STA = SD.DD, \qquad STO = SD.DD \qquad <CR\ LF>$$

where

STA = START channel Trigger level
S = Polarity of Trigger voltage
D = Digit value
STO = STOP Channel Trigger level

3-46. EXAMPLE PROGRAMS

3-47. Seven example programs are given as follows:

```
0: wrt 703,"FN3
   GT3MD2"
1: wrt 703,"MR";
   red 703,A;dsp
   A;wait 500
2: gto 1
*1132
```

EXAMPLE 1. TYPICAL MEASUREMENT FORMAT

This program forces the counter to perform a simple frequency measurement (FN3) with a 0.1 s gate time (GT3). The MD2 code prevents the counter from taking a measurement until the MR command is reached. The counter takes a measurement and reads it into the A register. The result is displayed by the calculator. After waiting 500 ms, the program loops back to the next "take a measurement" command (MR) and the process is repeated.

```
0: dim C$[80],
   D$[80]
1: wrt 703,"ST9"
2: red 703,C$,D$
3: prt C$,D$
4: stp
*2899
```

```
TI = 2.16294118
000E-04, STD= 9.
40000000000E-09,
MIN= 2.16281484
000E-04
MAX= 2.16305957
00E-04, REF= 0.0
00000000E-04,
EVT= 1.00000000
00E+02
```

EXAMPLE 2. DISPLAY ALL STATISTICS

This program allows the counter to display all statistics available for a time interval measurement. Step 0 dimensions two string variables in the calculator to accept the forthcoming data. Step 1 programs the counter to "display all" (ST9). Step 2 causes the counter to read into the two strings, and Step 3 prints the contents of the strings. The result is Mean (T.I.), standard deviation, minimum, maximum, reference and events (in this case, events is the number of samples). The counter automatically selected 100 samples because a standard deviation was programmed. The output format for a Time Interval measurement is as follows:

| T.I. = | , STD = | , MIN = | <CR LF> |
| MAX = | , REF = | , EVT = | <CR LF> |

where

T.I. =	Time Interval
STD =	Standard Deviation
MIN =	Minimum
MAX =	Maximum
REF =	Reference
EVT =	Events
<CR LF> =	Carriage Return, Line Feed

```
0: flt 6
1: wrt 703,"FN4
   IN3"
2: red 703,A;
   dsp A;wait 2000
3: wrt 703,"FN3
   IN2"
4: red 703,A;
   dsp A;wait 2000
5: gto 1
*7564
```

EXAMPLE 3. INPUT SELECTION

To demonstrate the input selection feature, connect signals of different frequencies to the input channels and set the START COM/SEP switch to SEP. Program Step 1 causes the counter to make a period measurement on the START channel signal. This is read and displayed in Step 2, along with a 2-second wait. Program Step 3 causes the counter to make a frequency measurement on the STOP channel signal. Step 4 duplicates Step 2, and Step 5 repeats the two measurements.

EXAMPLE 4. TEACH/LEARN

The following program serves as an example of the TEACH/LEARN mode. For demonstration purposes, perform the following steps:

1. Load the program into the 9825A Desk Top Computer.

2. Power up the 5370A.

3. On 5370A, push FREQ, MIN, and SAMPLE SIZE of 1K.

4. On 9825A, push RUN. The 5370A will teach the 9825A.

5. Turn 5370A power off, then on again. The counter will power up in T.I., MEAN, SAMPLE SIZE of 1, and +T.I.

6. On 9825A, push CONTINUE.

7. 5370A will learn from the 9825A and the front panel will indicate FREQ, MIN, and SAMPLE SIZE of 1K.

```
0: dim A$[50]
1: buf "BIN",A$,
   3
2: wtb 703,"te"
3: tfr 703,"BIN"
   ,21
4: if rds("BIN")
   <0;sto +0
5: wrt 703,"mr"
6: dsp "5370A→98
   25A";beep;stp
7: wrt 703,"ln",
   A$[1,21]
8: dsp "9825A→53
   70A";beep;stp
*18671
```

The program sets the dimension of the A$ string variable and names the buffer into which data will be read (BIN). It then specifies size of buffer (A$) and selects the type of buffer: 3 equals fast read/write buffer. Step 2 programs 5370A to the TEACH mode. Step 3 transfers 21 bytes of information into buffer and step 4 ensures transfer is complete before continuing. Step 5 initiates a measurement. Step 6 displays message to indicate "TEACH" is complete. Step 7 generates the "LEARN" function, and step 8 gives a display to indicate the process is complete.

EXAMPLE 5. TIME INTERVAL BINARY OUTPUT (COMPUTER DUMP)

The 5370A outputs raw measurement data in the following order: N0(ST), N1N2(CT1), N1N2(CT2), N0(CT1), and N0(CT2); where CT stands for count and ST stands for status. N1N2 is an 18-bit 2's complement quantity consisting of N1N2(CT1), N1N2(CT2), and the two least signicant bits of N0(ST).
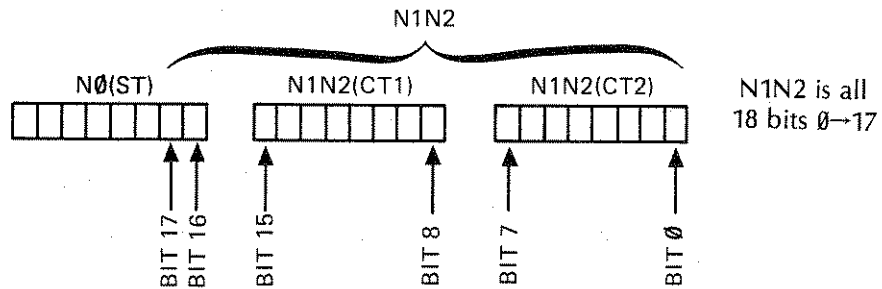

N1N2 actually represents the internal calculation of 257(N1-N2). This is done in preparation of solving the equation: T.I. 5 $[\frac{257}{256}(N1-N2) + N0]$ ns. The number 257 in 257(N1-N2) is part of the ratio 257/256.

NØ(ST) contains the following status bits:

NØ(ST)
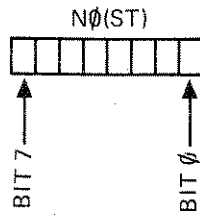
BIT 7

BIT Ø

Bit 7 = Event counter range flag
Bit 6 = End of measurement
Bit 5 = Sign of NØ (High=+)
Bit 4 = Armed flag
Bit 3 = PLL out of lock flag
Bit 2 = NØ range flag
Bit 1 = Bit 17 of N1N2
Bit Ø = Bit 16 of N1N2

NØ is a 16–bit quantity consisting of NØ(CT1) and NØ(CT2). It is expressed in sign-magnitude binary, **not** in 2's complement. To be complete, NØ requires a sign, which is contained in bit 5 of NØ(ST).

NØ

NØ(CT1)   NØ(CT2)

BIT 5 OF
NØ(S)
(SIGN OF NØ)

BIT 15   BIT 8   BIT 7   BIT Ø
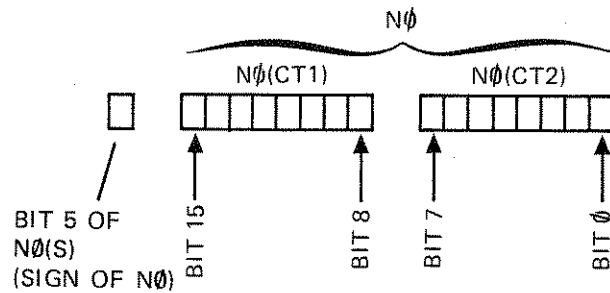
These five bytes of data will give the measured time interval when combined in the following equation:

T.I. = [N1N2/256 + NØ] 5 ns

This can be rewritten for the 9825A example shown on the next page, by letting
N1N2 = B
NØ = N
Sign of NØ = Q
∴ T.I. = (B/256 + N●Q) 5e–9

9825A EXAMPLE PROGRAM. The following program causes the counter to output in the fast binary output mode, store the five bytes of data in a buffer, perform the calculation, and display the result. Data is entered into the following string variables.

A$[1] = NØ(ST)
A$[2] = N1N2 (CT1)
A$[3] = N1N2(CT2)
A$[4] = NØ(CT1)
A$[5] = NØ(CT2)

```
0: flt 6
1: dim A$[21];
   buf "ti",A$,3
2: wrt 703,"tb1"
3: buf "ti";tfr
   703,"ti",5
4: if rds("ti")<
   0;gto +0
5: num(A$[4])*
   256+num(A$[5])*
   N
6: 1+Q
7: if bit(5,num(
   A$[1]))=0;-1+Q
8: bund(num(A$[1
   ])*31*65536+
   num(A$[2])*256+
   num(A$[3])+B
9: if B>131072;
   B-262144+B
10: (B/256+N*Q)*
   5e-9+T;dsp T
11: wait 500;
   gto 3
*25017
```

PROGRAM STEP	PURPOSE
Ø:	Sets up floating point format for 6 digits.
1:	Sets up string variable (A$) and specifies its size (21)* Names buffer into which data will be read (ti) and specifies size of buffer (A$). Selects type of buffer: 3 = fast read/write buffer.
2:	Programs 5370A to "fast binary output" mode (tb1).
3:	Initializes buffer "ti" prior to inputting data. Transfer five bytes of data from 5370A into buffer "ti".
4:	Reads status of transfer. Stays in transfer mode as long as status remains –1. When status goes to "5", program advances to next step.
5:	Sets the two NØ bytes next to each other in their proper binary order and places that value in the variable N.
6:	Assigns variable Q the value of 1.
7:	Examines the sign of NØ bit (bit 5 of NØ(ST)). If bit 5 is Ø, the variable Q is given a negative number.

*In 9825A, always allow for 16 bytes of "overhead", then allow for the number of bytes to be transferred. One sample = 16 + 5 = 21; one hundred samples = 16 + (5 x 100) = 516.

8:          Removes bits Ø and 1 from NØ(ST) and positions them and NIN2(CT1) and NIN2(CT2) in their proper binary order. Places that value in the variable B.

9:          Tests the NIN2 number to determine if it is positive or negative. If number in B is less than $(2^{18})/2$, go to step 10 If number in B is equal to or greater than $(2^{18})/2$, subtract 2^{18} from B and place result in B. This converts B into a negative number.

10:        Performs proper mathematical operation on data and displays result as time interval.

11:        Wait half a second and repeat program.

EXAMPLE 6. SAMPLE SIZE BINARY

This program permits the selection of any sample size from 1 to a theoretical maximum of 16, 777, 215. "ST7" causes the counter to display the programmed sample size, assuming the counter is taking measurements. Step 1 indicates that, for this example, 568 samples are being requested. Change this number to change the sample size. Step 2 must always be programmed to allow proper data entry to the counter.

EXAMPLE 7. REMOTE TRIGGER LEVELS

This program causes the counter to display its trigger levels (FN2) on the front panel and allows these levels to be set remotely (TR). "TA –1.29" sets the start channel trigger level (TA) to –1.29V; while "TO Ø.23" sets the stop channel trigger level (TO) to Ø.23V. Changing FN2 to FN1 will cause the counter to make a T.I. measurement at the programmed trigger levels.

This is an alternate program using a variable (T) for entering data.