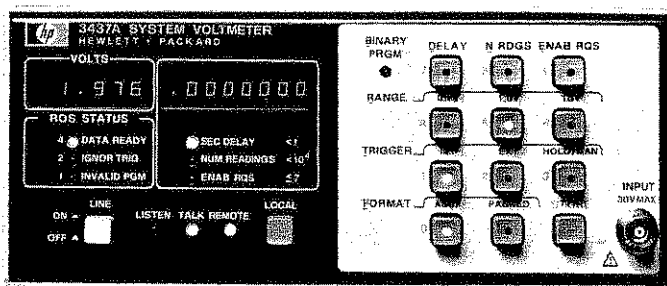


# OPERATING MANUAL

# SYSTEM VOLTMETER

## 3437A





**OPERATING MANUAL**

**MODEL 3437A**

**SYSTEM VOLTMETER**

Serial Numbers: 1630A00101 and greater

**IMPORTANT NOTICE**

This manual applies to instruments with serial numbers indicated on this page. If the instrument has been changed since this manual was printed, a yellow "Manual Change Sheet" (containing updating information) will be supplied with this manual.

**WARNING**

*To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.*

Manual Part No. 03437-90012

Revision A

©Copyright Hewlett-Packard Company 1976  
P.O. Box 301, Loveland, Colorado 80537 U.S.A.

Printed: December 1978



### **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 [ ,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . 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-. 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.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

### **LIMITATION OF WARRANTY**

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance 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. HEWLETT-PACKARD 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. HEWLETT-PACKARD 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.*



## **SAFETY SUMMARY**

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

### **GROUND THE INSTRUMENT**

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

### **DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE**

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

### **KEEP AWAY FROM LIVE CIRCUITS**

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

### **DO NOT SERVICE OR ADJUST ALONE**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

### **DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

### **DANGEROUS PROCEDURE WARNINGS**

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

#### **WARNING**

**Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.**

## SAFETY SYMBOLS

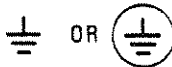
### General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



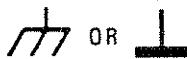
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

**WARNING**

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

**CAUTION**

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

**NOTE :**

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

## SECTION I

### GENERAL INFORMATION

#### 1-1. INTRODUCTION.

1-2. This section contains general information concerning the -hp- Model 3437A System DVM. Included is an instrument description, specifications, information concerning instrument and accessory information, and safety considerations.

#### 1-3. DESCRIPTION.

1-4. The Model 3437A is a Microprocessor controlled 3½ digit, successive approximation system voltmeter, capable of sampling voltages at rates up to 5700 samples per second.

1-5. Chassis isolated input terminals, a wideband input amplifier, auto-zero, auto-polarity, sample and hold, and 100% overrange on each of the input voltage ranges (.1 volt, 1 volt, and 10 volts) provide floating measurement capability ( $\pm 20$  V) over the frequency range of DC through 1.0 MHz.

1-6. Hewlett-Packard Interface Bus is standard. All front panel functions are programmable. The output data format is selectable between an ASCII (8 byte) and Packed (2 byte) format. The packed data format allows the controller additional data storage as well as allowing the input voltage to be sampled at rates up to 5700 samples per second.

1-7. The 3437A digital delay logic is capable of delaying an external trigger from 0 to 1 second (100 ns steps), and of generating up to 9999 triggers (for each trigger received) at rates of 1 Hz through 5700 Hz. The internally generated triggers provide a burst sampling capability (up to 9999 samples) at a maximum rate of 5700 sampled per second. Figures 1-1 and 1-2 illustrate the delayed measurement and burst sampling capabilities of the 3437A.

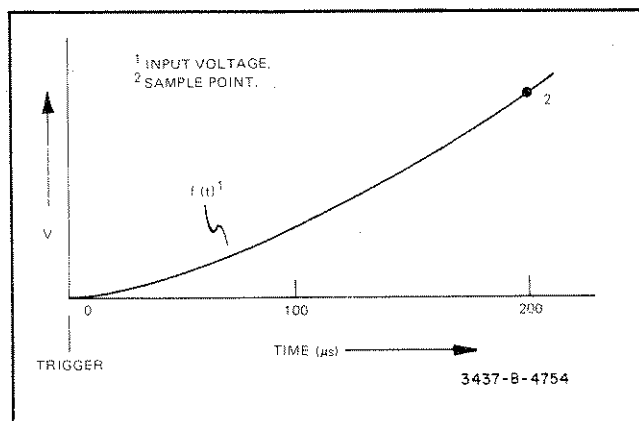


Figure 1-1. NRDGS = 1 DELAY = 200  $\mu$ s.

1-8. (Figure 1-1) 200  $\mu$ s after being triggered, the 3437A will sample and (after conversion) display the instantaneous value of the input voltage. If the 3437A is addressed to talk, the sampled input voltage will be output onto the HP-IB.

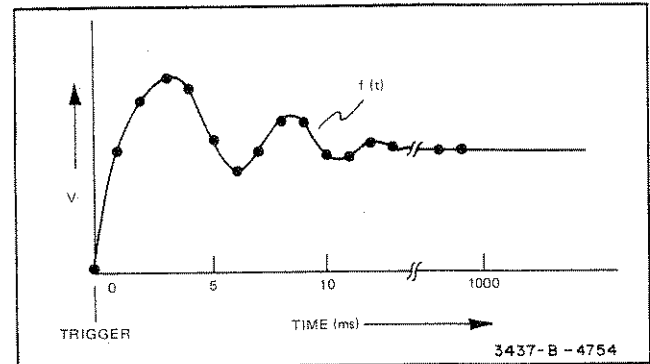


Figure 1-2. NRDGS = 1000 DELAY = 1 ms.

1-9. (Figure 1-2) When triggered, the 3437A will sample the input voltage 1000 times at 1 ms intervals. Between samples, the instantaneous value of the sampled input voltage is converted and output onto the HP-IB.

1-10. The Binary Program mode provides a means of programming the 3437A using an abbreviated program code. When interrogated in the Binary Program mode. The 3437A responds by writing 7 bytes (completely describing the programmed state of the instrument) onto the HP-IB. The controller can use these 7 bytes as an abbreviated program code to reprogram the 3437A to its previous configuration.

1-11. Model 3437A applications include:

- a. Fast multipoint data-acquisition.
- b. Repetitive-waveform analysis.
- c. Low frequency transient characterization.
- d. Low frequency True RMS measurements.

#### 1-12. SPECIFICATIONS.

1-13. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Any change in the specifications due to manufacturing, design, or traceability to the U.S. National Bureau of Standards will be covered by revised pages, a change sheet, or both, to this manual. Addi-



Table 1-1. Specifications.

| VOLTAGE MEASUREMENT CHARACTERISTICS.                  |                          |                     |                 |
|---|--------------------------|---------------------|-----------------|
| Range   | Bandwidth (3dB)          | Display*            |                 |
| 10 Volt   | 1.0 MHz                  | ± 19.98 (max)       | ± 99.99 (ovrld) |
| 1 Volt  | 1.1 MHz                  | ± 1.998             | ± 9.999         |
| .1 Volt   | 40 kHz                   | ± .1998             | ± .9999         |
| Static Accuracy (90 days, 23°C ± 5°C)                 |                          |                     |                 |
| 10 Volt Range   |                          | ± 0.05% of Reading  | ± 1.6 Digits    |
| 1 Volt Range  |                          | ± 0.03% of Reading  | ± 1.6 Digits    |
| .1 Volt Range   |                          | ± 0.06% of Reading  | ± 1.8 Digits    |
| Static Accuracy (1 year, 23°C ± 5°C)                  |                          |                     |                 |
| 10 Volt Range   |                          | ± 0.05% of Reading  | ± 2.0 Digits    |
| 1 Volt Range  |                          | ± 0.03% of Reading  | ± 2.0 Digits    |
| .1 Volt Range   |                          | ± 0.06% of Reading  | ± 2.2 Digits    |
| Static Accuracy Temperature Coefficient (0°C to 50°C) |                          |                     |                 |
| ± 0.002% reading/°C ± 0.05 digits/°C                  |                          |                     |                 |
| Dynamic Accuracy                                      |                          |                     |                 |
|   |                          | mV within           |                 |
| Range   | Step Input               | Final Value         | Time            |
| 10 Volt   | 10 V                     | ± 200 mV            | 700 ns          |
| 10 Volt   | 10 V                     | ± 30 mV             | 7.5 μs          |
| 1 Volt  | 1 V                      | ± 20 mV             | 700 ns          |
| 1 Volt  | 1 V                      | ± 3 mV              | 1.5 μs          |
| .1 Volt   | .1 V                     | ± 200 μV            | 25 μs           |
| DELAY CHARACTERISTICS.                                |                          |                     |                 |
| Delay   |                          |                     |                 |
| For NRDGS equal to 0 or 1                             |                          |                     |                 |
| 0 to .9999999 sec in 100 ns steps                     |                          |                     |                 |
| For NRDGS > 1   |                          |                     |                 |
| Data Format   | Delay between readings   |                     |                 |
| ASCII   | 277.8 μs to .9999999 sec |                     |                 |
| Packed  | 175.4 μs to .9999999 sec |                     |                 |
| Offset (actual delay with 0 delay programmed)         |                          |                     |                 |
| 100 ns ± 25 ns  |                          |                     |                 |
| Accuracy  |                          |                     |                 |
| ± 0.008% Delay + Delay offset                         |                          |                     |                 |
| Repeatability (Jitter)                                |                          |                     |                 |
| For NRDGS equal to 0 or 1                             |                          |                     |                 |
| Delay   | Jitter                   |                     |                 |
| 0 or 100 ns   | 2 ns                     |                     |                 |
| 200 ns to 50 ms                                       | 10 ns + .002% of Delay   |                     |                 |
| > 50 ms   | 110 ns                   |                     |                 |
| NUMBER OF READINGS. (For each trigger received.)      |                          |                     |                 |
| From 0 to 9999  |                          |                     |                 |
| INPUT CHARACTERISTICS.                                |                          |                     |                 |
| Input Impedance                                       |                          |                     |                 |
|   | Range                    | Impedance           |                 |
|   | 10 Volt                  | 1 MΩ (± 20%)        | < 75 pF         |
|   | 1 Volt                   | > 10 <sup>8</sup> Ω | < 75 pF         |
|   | .1 Volt                  | > 10 <sup>8</sup> Ω | < 75 pF         |
| Maximum Input Voltage (All ranges)                    |                          |                     |                 |
| HI to LO  | < ± 30 V Peak            |                     |                 |
| LO to CHASSIS   | < ± 42 V Peak            |                     |                 |
| PROGRAMMABILITY.                                      |                          |                     |                 |
| (In accordance with IEEE - 488-1975)                  |                          |                     |                 |
| AH1   | Acceptor                 | PP0                 | Parallel Poll   |
| C0  | Controller               | RL1                 | Remote/Local    |
| DC1   | Device Clear             | SR1                 | Service Request |
| DT1   | Device Trigger           | SH1                 | Source          |
| L4  | Listener                 | T5                  | Talker          |
| COMMON MODE REJECTION RATIO.                          |                          |                     |                 |
| ≥ 75 dB (1 kΩ unbalance in low input lead at 60 Hz)   |                          |                     |                 |

\*Display will indicate overload if input is unterminated (.1 volt range).

Table 1-2. Supplemental Characteristics.

| MAXIMUM READING RATE. <sup>1</sup>                   |  |
|--|--|
| ASCII  | 3600 Readings per second   |
| Packed   | 5700 Readings per second   |
| <sup>1</sup> Actual reading rate is given by:        |  |
| ASCII  | $\frac{3600 \times 7 \text{ Byte Listen Rate}}{3600 + 7 \text{ Byte Listen Rate}}$ |
| Packed   | $\frac{5700 \times 2 \text{ Byte Listen Rate}}{5700 + 2 \text{ Byte Listen Rate}}$ |
| Where Listen Rate = Data acceptance rate of listener |  |
| GENERAL.   |  |
| Power Requirements                                   |  |
| 100 V, 120 V, 220 V, 240 V (+ 5% -10%, 48-440 Hz)    |  |
| ≤ 42 VA  |  |
| Operating Temperature                                |  |
| 0°C to 50°C  |  |
| Storage Temperature                                  |  |
| -40°C to 75°C  |  |
| Humidity Range                                       |  |
| < 95% RH (0°C to 40°C)                               |  |
| Dimensions   |  |
| 212.7 mm wide x 88.9 mm high x 527.1 mm deep         |  |
| Weight   |  |
| Net  | 5.6 kg   |
| Shipping   | 7.6 kg   |
| Model Number and Name                                |  |
| 3437A System Voltmeter                               |  |

tional information describing the operating characteristics (Table 1-2) are not specifications but are supplemental information for the user.

**1-14. OPTIONS.**

1-15. The following options are available for the -hp- Model 3437A System Voltmeter:


| Option | -hp- Part Number | Description      |
|--------|------------------|------------------|
| 907    | 5061-0088        | Front Handle Kit |
| 908    | 5061-0072        | Cabinet Assembly |
| 909    | 5061-0075        | Cabinet Assembly |

**1-16. ACCESSORIES.**

1-17. The following accessories are available and can be ordered from your nearest -hp- Sales and Service Office:

1. DSA Test ROM -hp- 34115A
2. Performance Test Source Interface -hp- 34114A
3. Performance Test Trigger Interface -hp- 34113A

**1-18. SAFETY CONSIDERATIONS.**

1-19. If, to preserve the apparatus from damage, it is necessary for the user to refer to the instruction manual, the apparatus will be marked with the symbol .

**1-20. INSTRUMENT IDENTIFICATION.**

1-21. A three-section serial number (XXXXAXXXXX) is used to identify the Model 3437A. Figure 1-3 illustrates the meaning of the three parts of the number.

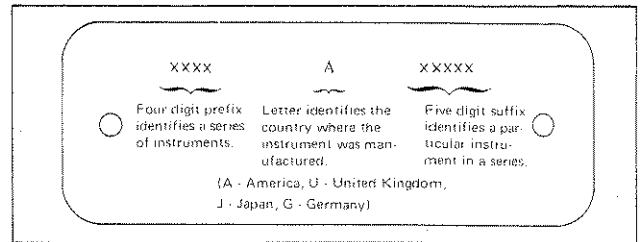


Figure 1-3. Instrument Serial Number.

Table 1-3. Message Transfer Rates (Listen).

| Listen                      | Handshake ( $\mu$ s/Byte) <sup>A</sup> |
|-----------------------------|--|
| Commands (ATN True)         |  |
| Addressed to Listen (ATL)   | 58                                     |
| Addressed to Talk (ATT)     | 38                                     |
| Group Execute Trigger (GET) | 160                                    |
| Local Lockout (LLO)         | 37                                     |
| Selected Device Clear (SDC) | 124                                    |
| Serial Poll Enable (SPE)    | 35                                     |
| Serial Poll Disable (SPD)   | 36                                     |
| Unlisten (UNL)              | 36                                     |
| Untalk (UNT)                | 36                                     |
| Program Code (ATN False)    |  |
| Delay                       | 100                                    |
| "  "                        | 92                                     |
| 0                           | 64                                     |
| 1                           | 69                                     |
| 2                           | 74                                     |
| 3                           | 79                                     |
| 4                           | 84                                     |
| 5                           | 89                                     |
| 6                           | 94                                     |
| Store                       | 176                                    |
| NRDGS                       | 112                                    |
| 1                           | 94                                     |
| 2                           | 68                                     |
| 3                           | 68                                     |
| 4                           | 68                                     |
| Store                       | 112                                    |
| Enab RQS                    | 108                                    |
| 7                           | 59                                     |
| Store                       | 90                                     |

| Listen                   | Handshake ( $\mu$ s/Byte) <sup>A</sup> |
|--------------------------|--|
| Program Code (ATN False) |  |
| Cont'd                   |  |
| Range                    | 56                                     |
| 1                        | 88                                     |
| Range                    | 56                                     |
| 2                        | 89                                     |
| Range                    | 56                                     |
| 3                        | 90                                     |
| Trigger                  | 56                                     |
| 1                        | 97                                     |
| Trigger                  | 56                                     |
| 2                        | 98                                     |
| Trigger                  | 56                                     |
| 3 <sup>B</sup>           | 90                                     |
| Trigger                  | 56                                     |
| 3 <sup>C</sup>           | 74                                     |
| Format                   | 56                                     |
| 1                        | 98                                     |
| Format                   | 56                                     |
| 2                        | 99                                     |
| Binary Prgm              | 83                                     |
| 1st Byte                 | 95                                     |
| 2nd Byte                 | 78                                     |
| 3rd Byte                 | 66                                     |
| 4th Byte                 | 75                                     |
| 5th Byte                 | 42                                     |
| 6th Byte                 | 42                                     |
| 7th Byte                 | 140                                    |

Table 1-4. Message Transfer Rates (Talk).

| Talk                     | Handshake ( $\mu$ s/Byte) <sup>A</sup> |
|--------------------------|--|
| Data Formats (ATN False) |  |
| ASCII                    | 22 $\mu$ s                             |
| Packed                   | 20 $\mu$ s                             |

<sup>A</sup>Typical

<sup>B</sup>Initial

<sup>C</sup>Subsequent—maximum rate (due to conversion time)  $\cong$  240  $\mu$ s.

## SECTION II INSTALLATION

### 2-1. INTRODUCTION.

2-2. This section contains information and instructions pertaining to initial instrument set-up. Included are initial inspection procedures, power and grounding requirements, environmental information, bench and rack mounting instructions, a description of interface connectors, and repackaging instructions.

### 2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage that might have occurred in transit, and the electrical performance should be tested using the performance tests outlined in Section V. If there is damage or deficiency, refer to the warranty inside the front cover of this manual.

### 2-5. POWER REQUIREMENTS.

2-6. This instrument can be operated from ac line voltages of 100 V, 120 V, 220 V, 240 V, at corresponding line frequencies of 48 through 440 Hz.



*Verify that the 110 V/220 V Line Voltage Selection switch, (Figure 2-1) located on the rear panel of Model 3437A, is set to the ac source voltage to be used before inserting the power cord and turning the instrument on. Also insure that the proper fuse is installed.*

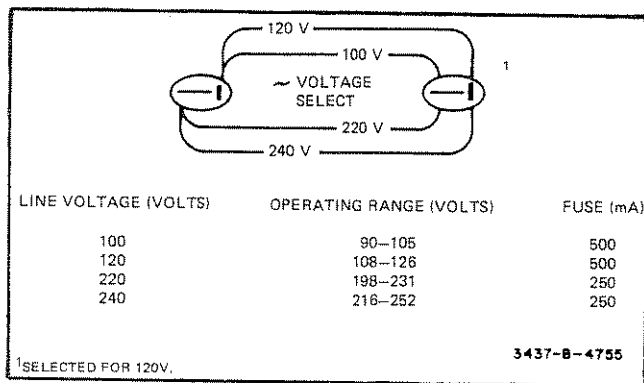


Figure 2-1. Line Voltage Selection.

### 2-7. Power Cords and Receptacles.

2-8. Figure 2-2 illustrates the various -hp- power cord configurations. If the appropriate power cord is not included with the instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.

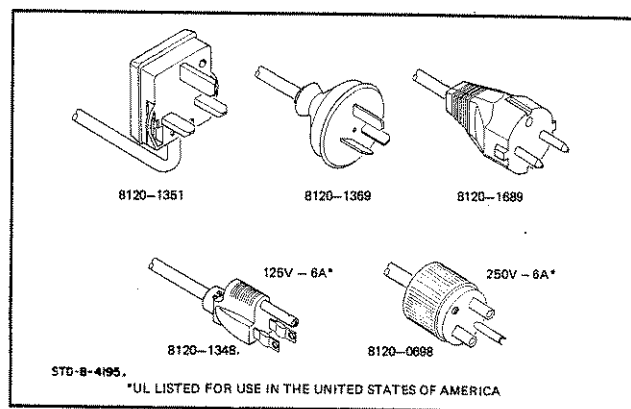


Figure 2-2. -hp- Power Cords.

### 2-9. Grounding Requirements.

2-10. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Model 3437A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-11. To preserve the protection feature when operating from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to power line ground.

### 2-12. ENVIRONMENTAL REQUIREMENTS.

2-13. The 3437A should not be operated where the ambient temperature exceeds 0°C to 50°C or stored where the ambient temperature exceeds -40°C to +75°C.

### 2-14. Humidity.

2-15. The instrument may be operated in environments with relative humidity of up to 95%. However, the instrument must be protected from temperature extremes which cause condensation within the instrument.

**2-16. Altitude.**

2-17. The instrument may be operated at altitudes up to 4573 meters (15,000 feet).

**WARNING**

*To prevent potential electrical or fire hazard, do not expose equipment to rain or moisture.*

**2-18. INSTRUMENT MOUNTING.**

2-19. The Model 3437A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument. The front of the instrument may be elevated for convenience of operating and viewing by extending the tilt stand. The plastic feet are shaped to permit placing the instrument on top of other half-module Hewlett-Packard instruments.

**2-20. Rack Mounting.**

2-21. The Model 3437A is housed in a -hp- standard (½

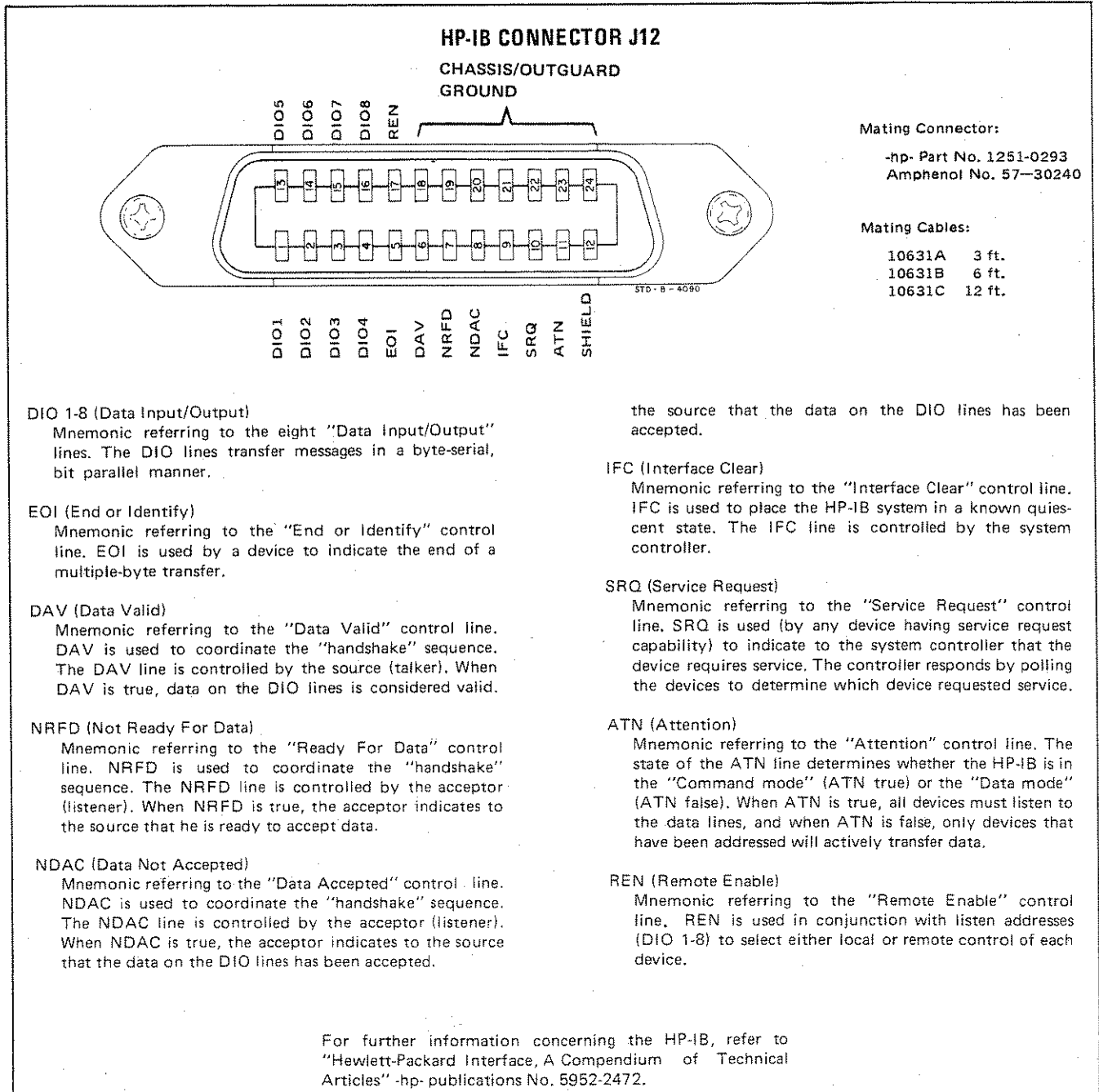


Figure 2-3. Hewlett-Packard Interface Bus Connector.

module) System II enclosure. Refer to the -hp- catalog for rack mounting accessories.

## 2-22. Interface Connectors.

**2-23. Input.** The voltage to be measured is applied to either the front or rear panel mounted (parallel connected) triax connector labeled INPUT.

**2-24. Ext Trig and Delay Out.** A standard (negative edge) TTL input applied to the rear panel mounted BNC connector labeled EXT TRIG causes the instrument to initiate one or more measurements and provide one or more corresponding delayed triggers at the rear panel mounted BNC connector labeled DELAY OUT.

**2-25. Hewlett-Packard Interface Bus (HP-IB).** Figure 2-3 illustrates the rear panel HP-IB connector, along with a brief description of each signal line.

**2-26. Interface Cable Length.** The maximum accumulative length of an HP-IB cable in any system must not exceed more than 2 meters of cable per device (up to 15 devices) or 20 meters, whichever is less.

## 2-27. REPACKAGING FOR SHIPMENT.

2-28. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropri-

ate packing material and seal with strong tape or metal bands. If the original container is not available, proceed as follows:

a. Wrap the instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of the instrument and protect panel face with cardboard strips or plastic foam.

c. Place the instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark shipping container "DELICATE INSTRUMENT." "FRAGILE." etc.

### NOTE

*If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.*

## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION.

3-2. This section contains complete operating instructions (both bench and system) for the Model 3437A Systems Voltmeter. Included is a description of the front and rear panel controls and indicators, programming instructions, and application examples.

#### 3-3. Controls and Indicators.

3-4. Figure 3-1 identifies the 3437A displays, annunciators, controls, and connectors. The identification of each item is keyed to the drawing within the figure.

#### 3-5. Front Panel Description.

3-6. **KEYBOARD.** The 3437A keyboard functions in two modes:

- a. Key per function.
- b. Numeric entry.

3-7. **Key Per Function.** The Key Per Function mode (each key representing instrument functions) occurs when the instrument is turned on.

3-8. **Numeric Entry.** The Numeric Entry mode (announced by blinking DELAY, NRDGS, or ENAB RQS annunciators) is a subset of the Key Per Function mode, and occurs when either the DELAY, N RDGS, or ENAB RQS keys are pressed.



ed while the keyboard is in the Key Per Function mode. Subsequent entries (displayed by the numeric entry display) correspond to the blue labeled numeric symbols 0-9 and decimal point . The Numeric Entry mode is terminated when  <sup>STOR</sup> is pressed.

3-9. **VOLTS DISPLAY.** Displays the sign and magnitude of the sampled input voltage (“+” is implied). The overload indication is ± 99.99 (Decimal point position corresponds to voltage range selected).

3-10. **NUMERIC ENTRY DISPLAY.** The contents of the numeric entry display are announced directly below the display.

3-11. **RQS STATUS.** The RQS STATUS annunciators announce the instrument status.

3-12. **Data Ready.** The DATA READY annunciator notifies the operator that the sampled input voltage has

been converted, displayed, and is ready to be output onto the HP-IB. The DATA READY annunciator remains on until the measurement data has been output onto the HP-IB, or until a new function is programmed.

3-13. **Ignore Trig.** The IGNORE TRIG annunciator notifies the operator that a second trigger occurred prior to completion of the measurement sequence/data transfer initiated by the first trigger, and that the second trigger was ignored. The IGNORE TRIG annunciator remains on until a new function is programmed.

3-14. **Invalid Prgm.** The INVALID PRGM annunciator notifies the operator that an invalid program condition has occurred. The annunciator becomes illuminated during the Remote and Local modes of operation, for the following reasons:

#### LOCAL:

a. **DELAY (0–9999999).** The first entry into the delay field must be a decimal point. Any entry other than a decimal point (leading zeros ignored) results in an invalid program condition. When this occurs, the last valid delay entry is stored and the numeric entry mode is terminated. The INVALID PGM annunciator remains on until the key causing the invalid entry is released.

b. **NRDGS (0–9999).** A decimal point entry into the number of readings field results in an invalid program condition. When this occurs, the last valid NRDGS entry is stored and the numeric entry mode is terminated. The INVALID PGM annunciator remains on until the key causing the invalid entry is released.

c. **ENAB RQS (0–7).** Any entry other than 0–7 results in an invalid program condition. When this occurs, the last valid ENAB RQS entry is stored and the numeric entry mode is terminated. The INVALID PGM annunciator remains on until the key causing the invalid entry is released.

d. **STORE.** If the  <sup>STORE</sup> key is pressed while the

keyboard is not in the Numeric Entry mode, an invalid program condition occurs. The INVALID PGM annunciator remains on until the key causing the invalid entry is released.

#### REMOTE:

An invalid entry while in the Numeric Entry mode, or the use of an invalid program code, will result in an invalid

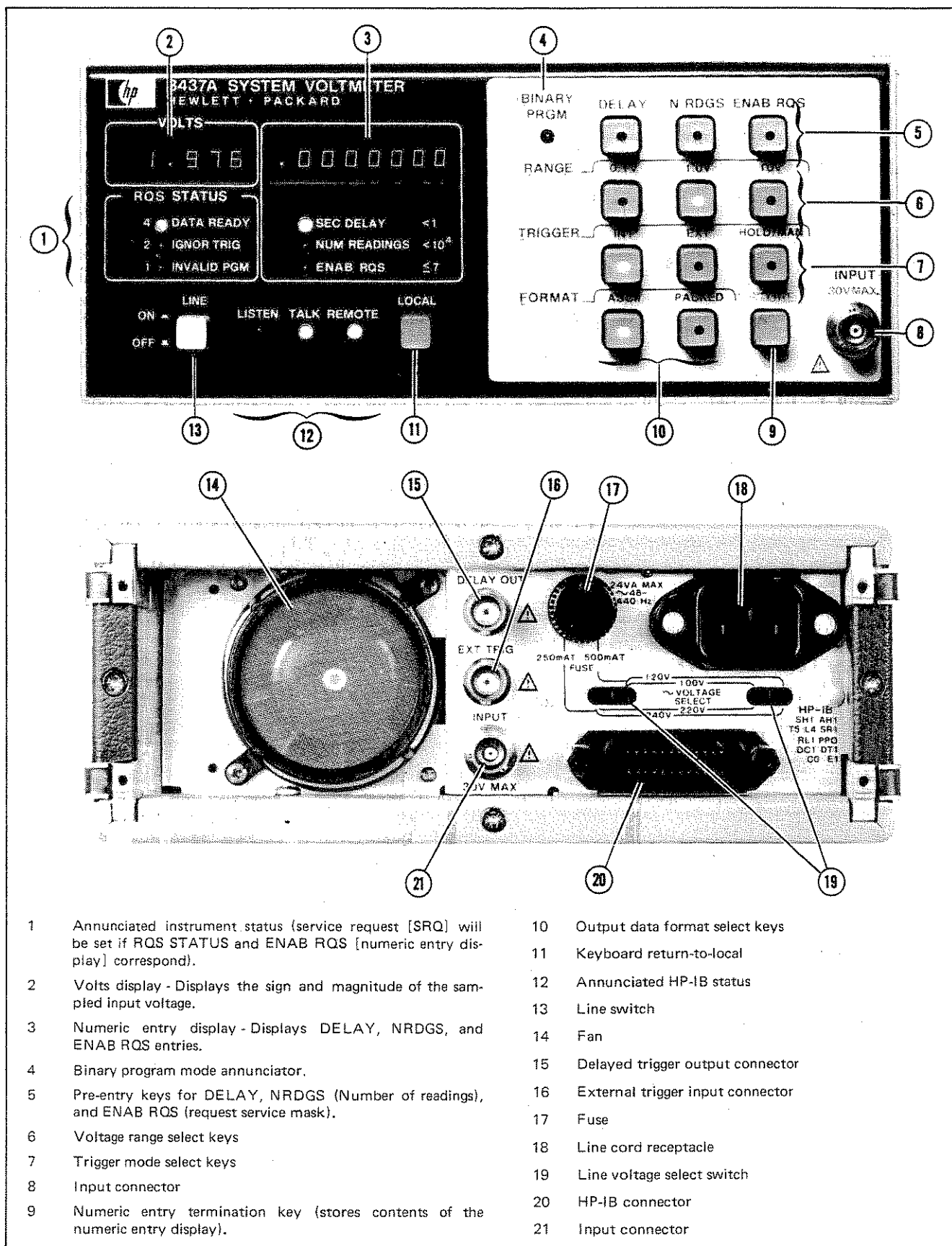








Figure 3-1. 3437A Front and Rear Panel Description.

program condition to occur. The INVALID PGM annunciator remains on until the 3437A is readdressed to listen.



3-15. . The DELAY key (delay pre-entry) is used when entering either the delay between readings (NRDGS > 1) or the delay that occurs prior to sampling the input voltage after the 3437A is triggered (NRDGS=1).


EXAMPLE:

1. Press 
  - a. The Numeric Entry mode is annunciated by the (Flashing) DELAY annunciator.
  - b. The numeric entry display (annunciated by SEC DELAY) displays the previously stored delay.
2. Press  (Any entry other than a decimal point (leading zeros ignored) results in an invalid program condition.
3. Enter up to 7 integers corresponding to the specified delay (additional inputs are ignored). A partial delay field can be set to zeros by pressing .
4. Terminate DELAY entry (Numeric Entry mode) by pressing .

3-16. . The NRDGS key (number of readings pre-entry) is used when entering the number of readings to be taken after the 3437A is triggered.

EXAMPLE:

1. Press 
  - a. The Numeric Entry mode is annunciated by the (Flashing) NRDGS annunciator.
  - b. The numeric entry display (annunciated by NUM READINGS) displays the previously stored number of readings.
2. Enter a 4 digit integer (0-9999) corresponding to the number of readings to be taken after the 3437A is triggered. (If a decimal point is entered into the number of readings field, an invalid program condition results.) Additional entries into a completed NRDGS field, cause previous entries to be shifted left.
3. Terminate NRDGS entry (Numeric Entry mode) by pressing .

3-17. . The ENAB RQS key (enable request pre-entry) is used when entering the request service mask. (The request service mask is an octal number (0-7) identifying the conditions for which service request (SRQ) is initiated.) Table 3-1 shows the request service mask and corresponding conditions for which the 3437A will initiate a service request.

EXAMPLE:



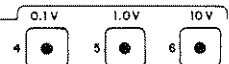



1. Press 
  - a. The Numeric Entry mode is annunciated by the (Flashing) ENAB RQS annunciator.
  - b. The numeric entry display (annunciated by ENAB RQS) displays the previously stored request service mask.
2. Enter the request service mask (0-7). An invalid entry results in an invalid program condition to occur. (Additional entries override previous entries.)
3. Terminate ENAB RQS entry (numeric entry mode) by pressing .

Table 3-1. SRQ Conditions.

| RQS Mask <sup>1</sup> |         | Conditions for Initiating SRQ                   |
|-----------------------|---------|---|
| (4 2 1)               | (Octal) |   |
| 0 0 0                 | 0       | No SRQ Capabilities                             |
| 0 0 1                 | 1       | Invalid Program                                 |
| 0 1 0                 | 2       | Trigger Ignore                                  |
| 0 1 1                 | 3       | Trigger Ignore or Invalid Program               |
| 1 0 0                 | 4       | Data Ready                                      |
| 1 0 1                 | 5       | Data Ready or Invalid Program                   |
| 1 1 0                 | 6       | Data Ready or Trigger Ignore                    |
| 1 1 1                 | 7       | Data Ready or Trigger Ignore or Invalid Program |

<sup>1</sup> a. Invalid PGM  
 b. Trig Ignore  
 c. Data Ready

3-18. RANGE  The three voltage ranges (annunciated by the range select keys) are selected by pressing either the    key. (Each range has 100% overrange capability.) The displayed decimal point position will not correspond to the selected voltage range until the 3437A has sampled the input voltage.



INT.

a. Local - With zero delay programmed, the sample rate is approximately 10 samples per second.

b. Remote - To generate an internal trigger while in remote, the following conditions must exist:

1. Remote
2. Internal Trigger
3. Addressed to Talk
4. Not in Binary Prgm Mode
5. Not in Serial Poll Mode
6. Not in Numeric Entry Mode

With these conditions satisfied, the 3437A will generate an internal trigger on the transition of ATN false.

EXT.

The 3437A will sample the input voltage when triggered (TTL negative edge) at the external trigger input connector.



*External trigger inputs exceeding TTL levels (0 to 5 V) may cause damage to the 3437A's external trigger input circuitry. The Performance Test trigger interface (-hp- 34113A) is useful for clamping bipolar triggers to within TTL levels. Refer to page 5-85 for more information on this interface.*

HOLD/MAN. (LOCAL & REMOTE)

The first time the key is pressed, the 3437A holds the volts display of the last sampled voltage constant. The second time the key is pressed (and each time thereafter), a manual trigger is generated. Manual triggers can be generated in this manner until a new function is programmed.

GROUP EXECUTE TRIGGER.

(Addressed HP-IB Command.) Each time the 3437A receives group execute trigger (GET) while addressed to listen, it will generate a trigger (regardless of trigger mode selected).

**3-20. FORMAT** The output data format is selectable between an ASCII (8-byte) and PACKED (2-byte) format.

**3-21.** Each data transfer is output as 6 ASCII characters, followed by a carriage return (CR) and line feed (LF) concurrent with EOI true.

EXAMPLES:

a. Normal

- i. .1 volt range ± .1998 (CR) (LF and EOI)
- ii. 1 volt range ± 1.998 (CR) (LF and EOI)
- iii. 10 volt range ± 19.98 (CR) (LF and EOI)

b. Overload

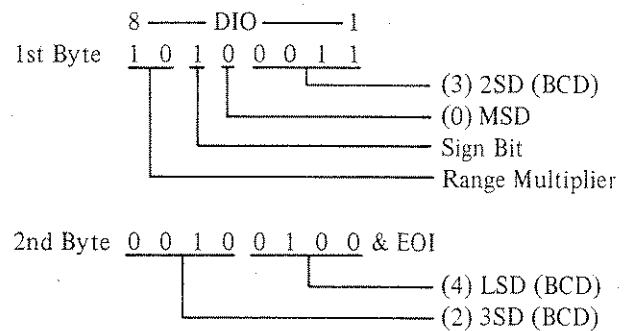
- i. .1 volt range ± .9999 (CR) (LF and EOI)
- ii. 1 volt range ± 9.999 (CR) (LF and EOI)
- iii. 10 volt range ± 99.99 (CR) (LF and EOI)

For measurement data where NRDGS > 1, the (CR) and (LF and EOI) is suppressed (between the intermediate outputs) and the data is delimited by a comma.

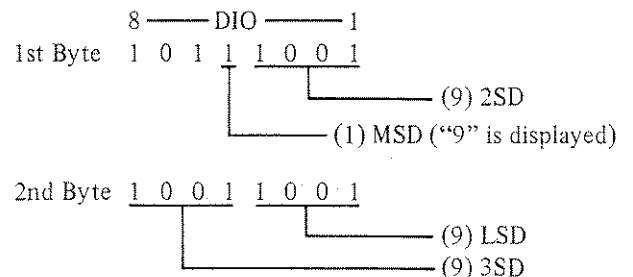
**3-22.** Each data transfer is output as 2 binary bytes. The second byte is concurrent with EOI true.

EXAMPLES:

a. Normal (+ 3.24 volts, 10 volt range)



b. Overload (+25 volts, 10 volt range)



For measurement data where NRDGS > 1, EOI is suppressed (between intermediate outputs) and the data is not delimited. EOI true is sent concurrent with the second data-byte of the last data transfer. Table 3-2 shows the packed format designators.

**3-23. LOCAL.** When the 3437A is in remote (not local lockout), pressing returns the 3437A keyboard from remote (HP-IB controlled) to local (front panel controlled).

**3-24. Programming Instructions.**

**3-25.** The 3437A is a systems instrument intended to be used with the HP-IB (IEEE STD 488-1975 or equivalent) system. The following paragraphs describe HP-IB operation.

**Table 3-2. Packed Format Designators.**

| Byte | Function         | DIO |   |   |   |   |   |   |   | Description                              |
|------|------------------|-----|---|---|---|---|---|---|---|--|
|      |                  | 8   | 7 | 6 | 5 | 4 | 3 | 2 | 1 |  |
| 1st  | Range Multiplier | 0   | 1 |   |   |   |   |   |   | 1 Volt Range                             |
|      |                  | 1   | 1 |   |   |   |   |   |   | 1 Volt Range                             |
|      |                  | 1   | 0 |   |   |   |   |   |   | 10 Volt Range                            |
|      | Sign bit         |     |   | 1 |   |   |   |   |   | Positive                                 |
|      |                  |     |   | 0 |   |   |   |   |   | Negative                                 |
|      | MSD              |     |   |   | 1 |   |   |   |   | } Numeric Value of Sampled Input Voltage |
|      |                  |     |   |   | 0 |   |   |   |   |  |
|      | 2 SD             |     |   |   |   | X | X | X | X |  |
| 2nd  | 3 SD             | X   | X | X | X |   |   |   |   |  |
|      | LSD              |     |   |   |   | X | X | X | X | }  |

3-26. The HP-IB transfers messages (data and commands) between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so that only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel.

3-27. Eight of the lines (DIO 1-8) are reserved for the transfer of messages in a byte-serial, bit-parallel manner. Message transfer is asynchronous, coordinated by the three handshake lines (DAV, NRFD, and NDAC). The remaining five lines are for control of HP-IB activity.

3-28. Devices connected to the HP-IB may be talkers, listeners, or controllers. The controller dictates the roll of each of the other devices by setting the ATN (attention) line true and sending talk or listen addresses on the data lines (DIO 1-8).

3-29. Addresses are set into each device at the time of system configuration. (The 3437A HP-IB address select switch is located on the Logic board.) While the ATN line is true, all devices must listen to the data lines. When ATN is false, only devices that have been addressed will actively send or receive data. All other devices ignore the data lines.

3-30. Several listeners can be active simultaneously but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers are automatically unaddressed.

3-31. Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed. This permits several devices to receive the same message byte concurrently.

3-32. The ATN line is one of the five control lines. When ATN is true, addresses and commands are transmitted on seven of the data lines using the ASCII code. When ATN is

false, any code of 8 bits (or less) understood by both talker and listener(s) may be used.

3-33. The other control lines are IFC, REN, SRQ, and EOI. IFC (interface clear) places the interface system in a known quiescent state (the 3437A becomes unaddressed to listen, unaddressed to talk, and the serial poll mode (SPM) is cleared). REN (remote enable) is used in conjunction with listen addresses to select either local or remote control of each device. Any device having service request capability can set service request (SRQ) true. This indicates to the system controller that a device on the bus requires attention. EOI (end or identify) is used by a device to indicate the end of a multiple-byte transfer (the 3437A sets EOI true concurrent with the last data-byte of a multiple data-byte transfer). For further information concerning the HP-IB, refer to "Hewlett-Packard Interface. A Compendium of Technical Articles" -hp- publications No. 5952-2472.

**3-34. HP-IB Address Selection.** A seven-bit binary code forms the complete TALK or LISTEN address of the 3437A. The first five bits of the code (selected by A2S1) are referred to as the instrument address. The remaining two bits (DIO 6-7) are controller originated and define the address to be either TALK or LISTEN. The seven-bit code forms an ASCII character (Table 3-3) that uniquely defines the selected TALK or LISTEN address. Figure 3-2 illustrates the address select switch and address code designators.

**3-35. Program Code Set.** Program code (an alpha-numeric code representing various instrument functions) is used to control the front panel while the 3437A is in the remote mode of operation. To implement the program code set (Table 3-4), it is necessary for the 3437A to be in remote and addressed to listen.

3-36. The 3437A front panel is designed to imply the program code set. The underlined alpha characters represent the program code alpha symbol for the corresponding instrument function.

**EXAMPLE:**

The program code string:

D.0025S, N100S, EOS, R3, T2, F1 reads:

- |    |          |          |
|----|----------|----------|
| 1. | DELAY    | 2.5 ms   |
| 2. | NRDGS    | 100      |
| 3. | ENAB RQS | 0        |
| 4. | Range    | 10 Volts |
| 5. | Trigger  | External |
| 6. | Format   | ASCII    |

It is not necessary to reprogram all functions each time a programming change is made. (The order of program code, and the use of commas is optional.)

Table 3-3. Address Codes.

| ASCII CODE CHARACTER |              | BINARY CODE                 |                |                      |                      |                      | OCTAL CODE           |                      | 5 BIT DECIMAL <sup>3</sup> EQUIVALENT |        |                 |
|----------------------|--------------|-----------------------------|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------------------------|--------|-----------------|
| Listen Address       | Talk Address | b <sub>7</sub> <sup>1</sup> | b <sub>6</sub> | A5<br>b <sub>5</sub> | A4<br>b <sub>4</sub> | A3<br>b <sub>3</sub> | A2<br>b <sub>2</sub> | A1<br>b <sub>1</sub> |                                       | Listen | Talk            |
| SP                   | @            | 0                           | 0              | 0                    | 0                    | 0                    | 0                    | 0                    | 040                                   | 100    | 0               |
| !                    | A            | 0                           | 0              | 0                    | 0                    | 0                    | 0                    | 1                    | 041                                   | 101    | 1               |
| "                    | B            | 0                           | 0              | 0                    | 0                    | 1                    | 0                    | 0                    | 042                                   | 102    | 2               |
| #                    | C            | 0                           | 0              | 0                    | 0                    | 1                    | 1                    | 0                    | 043                                   | 103    | 3               |
| \$                   | D            | 0                           | 0              | 0                    | 1                    | 0                    | 0                    | 0                    | 044                                   | 104    | 4               |
| %                    | E            | 0                           | 0              | 0                    | 1                    | 0                    | 1                    | 0                    | 045                                   | 105    | 5               |
| &                    | F            | 0                           | 0              | 0                    | 1                    | 1                    | 0                    | 0                    | 046                                   | 106    | 6               |
| '                    | G            | 0                           | 0              | 0                    | 1                    | 1                    | 1                    | 0                    | 047                                   | 107    | 7               |
| (                    | H            | 0                           | 0              | 1                    | 0                    | 0                    | 0                    | 0                    | 050                                   | 110    | 8               |
| )                    | I            | 0                           | 0              | 1                    | 0                    | 0                    | 1                    | 0                    | 051                                   | 111    | 9               |
| *                    | J            | 0                           | 0              | 1                    | 0                    | 1                    | 0                    | 0                    | 052                                   | 112    | 10              |
| +                    | K            | 0                           | 0              | 1                    | 0                    | 1                    | 1                    | 0                    | 053                                   | 113    | 11              |
| ,                    | L            | 0                           | 0              | 1                    | 1                    | 0                    | 0                    | 0                    | 054                                   | 114    | 12              |
| -                    | M            | 0                           | 0              | 1                    | 1                    | 0                    | 1                    | 0                    | 055                                   | 115    | 13              |
| .                    | N            | 0                           | 0              | 1                    | 1                    | 1                    | 0                    | 0                    | 056                                   | 116    | 14              |
| /                    | O            | 0                           | 0              | 1                    | 1                    | 1                    | 1                    | 0                    | 057                                   | 117    | 15              |
| 0                    | P            | 1                           | 0              | 0                    | 0                    | 0                    | 0                    | 0                    | 060                                   | 120    | 16              |
| 1                    | Q            | 1                           | 0              | 0                    | 0                    | 0                    | 1                    | 0                    | 061                                   | 121    | 17              |
| 2                    | R            | 1                           | 0              | 0                    | 0                    | 1                    | 0                    | 0                    | 062                                   | 122    | 18              |
| 3                    | S            | 1                           | 0              | 0                    | 0                    | 1                    | 1                    | 0                    | 063                                   | 123    | 19              |
| 4                    | T            | 1                           | 0              | 0                    | 1                    | 0                    | 0                    | 0                    | 064                                   | 124    | 20              |
| 5                    | U            | 1                           | 0              | 0                    | 1                    | 0                    | 1                    | 0                    | 065                                   | 125    | 21              |
| 6                    | V            | 1                           | 0              | 0                    | 1                    | 1                    | 0                    | 0                    | 066                                   | 126    | 22              |
| 7                    | W            | 1                           | 0              | 0                    | 1                    | 1                    | 1                    | 0                    | 067                                   | 127    | 23              |
| 8                    | X            | 1                           | 0              | 1                    | 0                    | 0                    | 0                    | 0                    | 070                                   | 130    | 24 <sup>2</sup> |
| 9                    | Y            | 1                           | 0              | 1                    | 0                    | 0                    | 1                    | 0                    | 071                                   | 131    | 25              |
| :                    | Z            | 1                           | 0              | 1                    | 0                    | 1                    | 1                    | 0                    | 072                                   | 132    | 26              |
| ;                    | [            | 1                           | 0              | 1                    | 1                    | 0                    | 1                    | 0                    | 073                                   | 133    | 27              |
| <                    | \            | 1                           | 0              | 1                    | 1                    | 0                    | 0                    | 0                    | 074                                   | 134    | 28              |
| =                    | ]            | 1                           | 0              | 1                    | 1                    | 0                    | 1                    | 1                    | 075                                   | 135    | 29              |
| >                    | ~            | 1                           | 0              | 1                    | 1                    | 1                    | 0                    | 1                    | 076                                   | 136    | 30              |

<sup>1</sup>Only the first five bits of the binary code are listed. These bits (set by A2S1) are the same for both the TALK and LISTEN address. The sixth and seventh bits (controller originated) determine whether the instrument is being addressed to TALK or LISTEN.

<sup>2</sup>3437A factory preset address.

<sup>3</sup>Derived from the sum of the binary weighted value of the first five address bits.

| Function | Bit 7 | Bit 6 |
|----------|-------|-------|
| Talk     | 1     | 0     |
| Listen   | 0     | 1     |

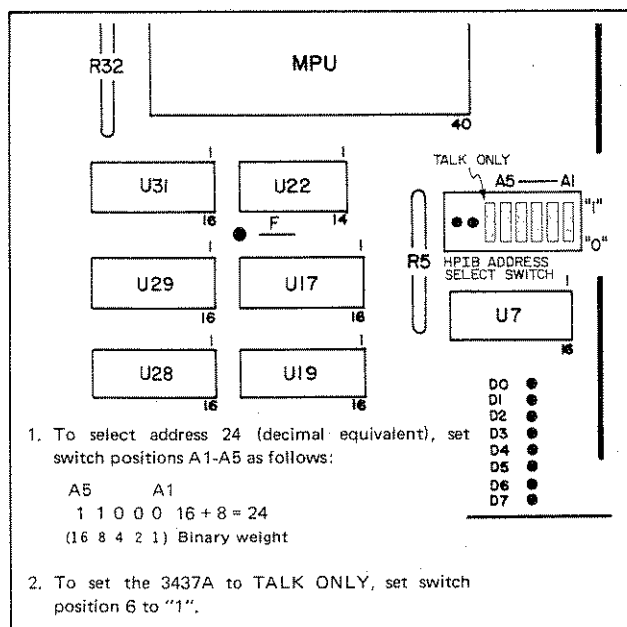


Figure 3-2. Address Select Switch and Address Code Designators.

Table 3-4. 3437A Program Code Summary.

| PROGRAMMING CODES <sup>1</sup> |             |            |
|--------------------------------|-------------|------------|
| Program Code (ASCII Character) | Description | Octal Code |
| D                              | Delay       | 104        |
| N                              | NRDGS       | 116        |
| E                              | ENAB RQS    | 105        |
| S                              | Store       | 123        |
| R                              | Range       | 122        |
| 1                              | .1 volt     | 061        |
| 2                              | 1 volt      | 062        |
| 3                              | 10 volts    | 063        |
| T                              | Trigger     | 124        |
| 1                              | Internal    | 061        |
| 2                              | External    | 062        |
| 3                              | Hold/Man    | 063        |
| F                              | Format      | 106        |
| 1                              | ASCII       | 061        |
| 2                              | Packed      | 062        |
| B                              | Binary Prgm | 102        |

<sup>1</sup>Program Code Handshake occurs with the 3437A in Remote, Addressed to Listen, and ATN false.

**3-37. Message Set.** Bi-directional traffic over the HP-IB (including program code) is described in terms of messages.

The controller originated messages (commands) are described in Table 3-5 and categorized as follows:

1. Addressed (Directed to bus devices previously addressed to listen)
2. Universal (Directed to all bus devices capable of responding to the command)

**EXAMPLE:**

The system controller can configure the 3437A to its

initial turn-on state by sending the universal command, Device Clear (DCL), or the addressed command, Selected Device Clear (SDC).

3-38. The 3437A originated messages allow the 3437A to communicate with the system controller, and to participate in the handshake process involved in the data-byte transfer process.

**EXAMPLE:**

The 3437A can advise the system controller that it requires service by sending the service request (SRQ) message.

**Table 3-5. 3437A Message Set Summary Sheet.**

| Message | Description           | Class           | Octal Code      | R<br>E<br>N | I<br>F<br>C | Instrument Response  |
|---------|-----------------------|-----------------|-----------------|-------------|-------------|--|
| DCL     | Device Clear          | UC <sup>2</sup> | 024             | T           |             | The 3437A configures to its initial turn-on state.<br>Volts display (sampled input voltage)<br>Numeric entry display (SEC DELAY)<br>RQS STATUS (DATA READY)<br>DELAY (0)<br>NRDGS (1)<br>ENAB RQS (0)<br>RANGE (10 volts)<br>TRIGGER (INT)<br>FORMAT (ASCII) |
| SDC     | Selected Device Clear | AC <sup>3</sup> | 004             |             |             | If addressed, the 3437A configures to its turn-on state.   |
| GET     | Group Execute Trigger | AC              | 010             | T           |             | Is triggered (regardless of trigger mode)  |
| GTL     | Go to Local           | AC              | 001             | T           |             | Returns the 3437A from remote (HP-IB Controlled) to local (front panel controlled)   |
| LLO     | Local lockout         | UC              | 021             | T           |             | Disables the Local Key<br>From LLO to GTL to TREN = Remains in LLO<br>From LLO to FREN to TREN = Exits LLO   |
| MLA     | My Listen Address     | AC              |                 |             |             | Becomes addressed to listen.   |
| MTA     | My Talk Address       | AC              |                 |             |             | Becomes addressed to talk.   |
| UNL     | Unlisten              | AC              | 077             |             |             | Becomes unaddressed to listen.   |
| UNT     | Untalk                | AC              | 137             |             |             | Becomes unaddressed to talk.   |
| SPE     | Serial Poll Enable    | UC              | 030             |             |             | Configures the 3437A into the serial poll mode.  |
| SPD     | Serial Poll Disable   | UC              | 031             |             |             | Exits serial poll mode.  |
| IFC     | Interface Clear       | }               | Single Line MSG |             | T           | Unaddress the 3437A as a talker and as a listener and clears serial poll mode.   |
| REN     | Remote Enable         |                 |                 | T           | F           | Programs the 3437A to remote (concurrent with MLA).<br>Returns the 3437A to local.   |

<sup>1</sup>All multiline (DIO 1-8) messages are sent with ATN true.  
<sup>2</sup>Universal command.  
<sup>3</sup>Addressed command.

3-39. The capability of the 3437A as a systems instrument (in accordance with IEEE - 488-1975) is as follows:

|     |                 |     |                |
|-----|-----------------|-----|----------------|
| SH1 | Source          | RL1 | Remote/Local   |
| AH1 | Acceptor        | PP0 | Parallel Poll  |
| T5  | Talker          | DC1 | Device Clear   |
| L4  | Listener        | DT1 | Device Trigger |
| SR1 | Service Request | C0  | Controller     |

**3-40. Binary Program.**

3-41. Binary Programming, consisting of a learn mode (3437A to controller) and a program mode (controller to 3437A) provides the following programming capabilities.

3-42. **Learn.** The learn mode allows the system controller to determine (learn) the programmed state of the 3437A. When interrogated in the learn mode, the 3437A responds by handshaking 7 bytes (completely describing the programmed state of the instrument) onto the HP-IB. The controller, aware of the programmed state of the instru-

ment, identifies the 7 bytes with this programmed state (Table 3-6).

3-43. **Program.** The program mode allows the system controller to program the 3437A using an abbreviated program code (identical 7 bytes received in the learn mode). Since an abbreviated program code is used (compared to the normal ASCII string of up to 25 bytes to accomplish the same function), the 3437A can be reprogrammed in a minimum amount of time.

3-44. The following example illustrates Binary Program mode operation.

**EXAMPLE:**

- The 3437A is preset as follows:

|          |             |
|----------|-------------|
| DELAY    | 500 $\mu$ s |
| NRDGS    | 9999        |
| ENAB RQS | 2           |
| RANGE    | 10 Volt     |
| TRIGGER  | External    |
| FORMAT   | ASCII       |

**Table 3-6. Binary Program Code Designators.**

| Byte        | Function | DIO |    |   |    |   |   |       | Description                         |                          |
|-------------|----------|-----|----|---|----|---|---|-------|-------------------------------------|--------------------------|
|             |          | 8   | 7  | 6 | 5  | 4 | 3 | 2     |                                     | 1                        |
| 1           | Range    |     |    |   |    |   |   | 0     | 0                                   | Invalid                  |
|             |          |     |    |   |    |   |   | 0     | 1                                   | .1 Volt                  |
|             |          |     |    |   |    |   |   | 1     | 0                                   | 10 Volt                  |
|             |          |     |    |   |    |   |   | 1     | 1                                   | 1 Volt                   |
|             | Trigger  |     |    |   |    |   | 0 | 0     | Invalid                             |                          |
|             |          |     |    |   |    |   | 0 | 1     | Internal                            |                          |
|             |          |     |    |   |    |   | 1 | 0     | External                            |                          |
|             |          |     |    |   |    |   | 1 | 1     | Hold/Man                            |                          |
|             | ENAB RQS |     | (4 | 2 | 1) |   |   |       |                                     | Does not request service |
|             |          |     | 0  | 0 | 0  |   |   |       |                                     | Invalid Prgm             |
|             |          |     | 0  | 0 | 1  |   |   |       |                                     | Ignore Trig              |
|             |          |     | 0  | 1 | 0  |   |   |       |                                     | Invalid Prgm/Ignore Trig |
|             |          | 0   | 1  | 1 |    |   |   |       | Data Ready                          |                          |
|             |          | 1   | 0  | 0 |    |   |   |       | Data Ready/Invalid Prgm             |                          |
|             |          | 1   | 0  | 1 |    |   |   |       | Data Ready/Ignore Trig              |                          |
| Data Format |          | 1   | 1  | 1 |    |   |   |       | Data Ready/Ignore Trig/Invalid Prgm |                          |
|             |          | 0   |    |   |    |   |   |       | Packed                              |                          |
|             |          | 1   |    |   |    |   |   | ASCII |                                     |                          |
| 2           | NRDGS    | (8  | 4  | 2 | 1) |   |   |       |                                     | MSD                      |
|             |          | X   | X  | X | X  |   | X | X     | X                                   | 2SD                      |
| 3           |          |     | X  | X | X  |   | X | X     | X                                   | 3SD                      |
|             |          |     |    |   |    | X | X | X     | X                                   | LSD                      |
| 4           | Delay    | X   | X  | X | X  |   |   |       |                                     | Not Used                 |
|             |          |     |    |   |    | X | X | X     | X                                   | (May or may not be set)  |
| 5           | Delay    |     |    |   |    | X | X | X     | X                                   | MSD                      |
|             |          | X   | X  | X | X  |   |   |       |                                     | 2SD                      |
| 6           | Delay    |     |    |   |    | X | X | X     | X                                   | 3SD                      |
|             |          | X   | X  | X | X  |   |   |       |                                     | 4SD                      |
| 7           | Delay    |     |    |   |    | X | X | X     | X                                   | 5SD                      |
|             |          | X   | X  | X | X  |   |   |       |                                     | 6SD                      |
|             |          |     |    |   |    | X | X | X     | X                                   | LSD                      |

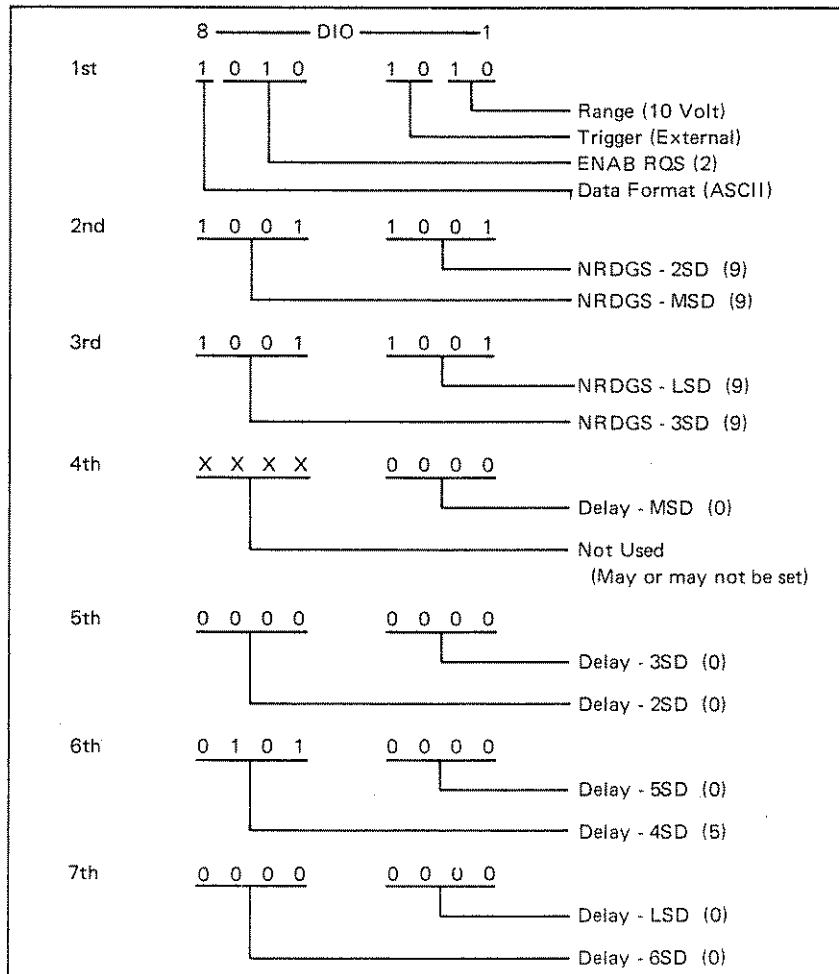
2. The system controller programs the 3437A to the Binary Program mode.
  - The 3437A is addressed to listen.
  - The controller handshakes the ASCII character B (102<sub>8</sub>) into the 3437A. The Binary Program annunciator is illuminated.
3. The system controller interrogates the 3437A, and the 3437A responds by handshaking 7 bytes (completely describing the programmed state of the instrument) onto the HP-IB (Table 3-7).
  - The 3437A is addressed to talk.
  - When ATN becomes false, the 3437A outputs the 7 bytes onto the HP-IB.
  - The 3437A terminates the Binary Program mode after the 7th byte is output onto the HP-IB.

4. The controller stores the 7 bytes, then when required, reprograms the 3437A using the identical 7 bytes. The 3437A responds by reconfiguring to its previous state.
  - The 3437A is addressed to listen.
  - The controller handshakes the ASCII character B (102<sub>8</sub>) into the 3437A. The Binary Program mode annunciator is illuminated.
  - The controller handshakes the 7 bytes into the 3437A, reconfiguring the instrument to its previous state.
  - The 3437A terminates the Binary Program mode after the 3437A handshakes the 7th byte.

**3-45. Service Request.**

3-46. The following events describe the process involving service request (SRQ), serial poll enable (SPE), and serial poll disable (SPD).

**Table 3-7. Binary Program Byte Sequence (Example).**



- a. The 3437A operator defines and programs the service request mask (ENAB RQS).
- b. The 3437A sets SRQ true when ENAB RQS (0 - 7) and RQS STATUS (0 - 7) correspond.
- c. The controller, programmed to respond to a service request, sets SPE true and conducts a serial poll. When the 3437A is in the serial poll mode and is addressed to talk, the 3437A responds by writing a serial poll status byte onto the HP-IB (Table 3-8).

When the serial poll status byte is output onto the HP-IB, the 3437A clears SRQ.

- d. The controller clears SPE by sending SPD.

**Table 3-8. Serial Poll Status Byte.**

| Function   | DIO |   |   |   |   |   |   | Description |  |
|------------|-----|---|---|---|---|---|---|-------------|--|
|            | 8   | 7 | 6 | 5 | 4 | 3 | 2 |             | 1  |
| ENAB RQS   |     |   |   |   |   | X | X | X           | Binary Code (0-7) <sup>1</sup>   |
| RQS STATUS |     |   | X | X | X |   |   |             | Binary Code (0-7)  |
| RQS Bit    |     |   | X |   |   |   |   |             | Identifies the 3437A as the instrument that set SRQ True. (1 & True and 0 & False) |
| Not Used   | X   |   |   |   |   |   |   |             | Don't care.  |

<sup>1</sup>See Table 3-6.

**3-47. APPLICATIONS.**

**3-48. Introduction.**

3-49. The 3437A, although designed as a System DVM, is capable of performing numerous bench (stand-alone) as well as systems functions. The following paragraphs describe some 3437A bench applications.

**3-50. Bench Measurements.**

**3-51. Variable Sample-Rate DVM.**

a. The 3437A can be programmed to sample voltages at rates of 100 ms to 1 second. Program the 3437A keyboard as follows:

```

DELAY. . . . . 100 ms to .9999999 second
NRDGS. . . . . 1
RANGE. . . . . As required
TRIGGER. . . . . INT
    
```

b. The 3437A will sample (and display) the instantaneous value of the input voltage at a rate specified by the programmed delay.

**3-52. Time-Selective DVM.**

3-53. Oscilloscope Accuracy Enhancement. Oscilloscope measurement accuracy can be enhanced to equal the voltage and delay accuracy of the 3437A. The technique requires that the oscilloscope main gate output (corresponding to start of sweep) externally trigger the 3437A, and that the 3437A Delay out modulate the oscilloscope Z-axis (video) input. The voltage to be measured is connected to both the oscilloscope and 3437A inputs. Each time the oscilloscope is triggered, the oscilloscope main gate output triggers the 3437A, and depending upon the programmed delay, the 3437A samples the input voltage sometime between reoccurring sweeps. Each time the 3437A samples the input voltage, the Delay out (connected to the oscilloscope Z-axis input) is forced low and intensifies the oscilloscope display for the time required to perform the conversion sequence.

3-54. The user views the oscilloscope display, then programs the 3437A delay to intensify the point of interest. The amplitude of the waveform and the lapsed time (from start of sweep to the leading edge of the intensified section) is displayed by the 3437A Volts and Numeric entry displays.

Example:

- a. Connect the equipment as illustrated in Figure 3-2.
- b. Program the 3437A keyboard as follows:

```

DELAY. . . . . 3 ms
NRDGS. . . . . 1
RANGE. . . . . 10
TRIGGER. . . . . EXT
    
```

- c. Set the 3310A controls as follows:

```

FUNCTION. . . . . SQ
RANGE. . . . . 10
DIAL. . . . . 25
DC OFFSET. . . . . OFF
OUTPUT LEVEL. . . . . MIN
    
```

- d. Set the oscilloscope controls as follows:

```

TIME/DIV. . . . . 1 ms
VOLTS/DIV. . . . . 1
TRIGGER. . . . . INTERNAL
    
```

e. Adjust the 3310A output level, and the oscilloscope trigger and intensity levels to obtain a waveform as illustrated in Figure 3-3.

f. Program the 3437A Delay so that the intensified section appears at the point of interest then read the corresponding magnitude and delay displayed by the Volts and Numeric entry display.

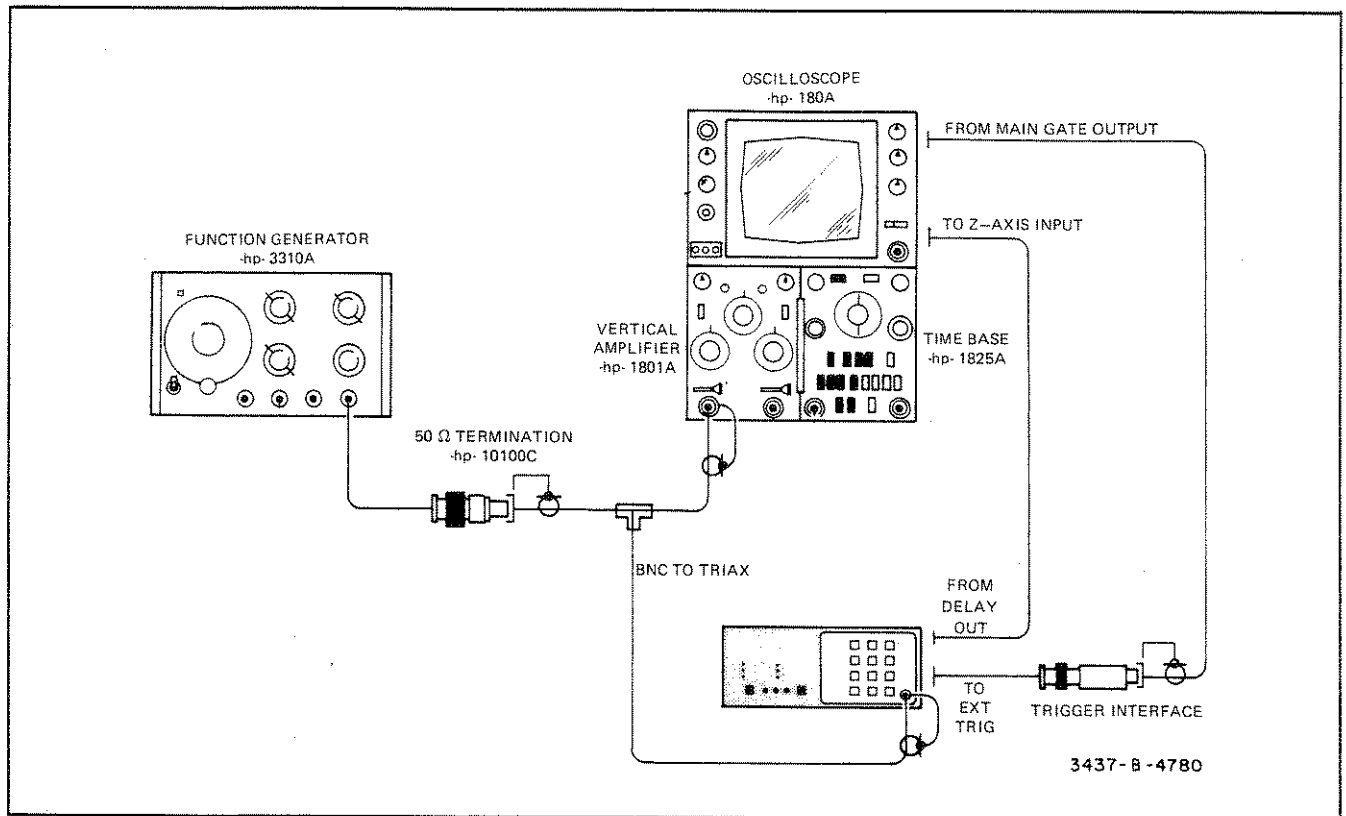


Figure 3-2. Oscilloscope Accuracy Enhancement.

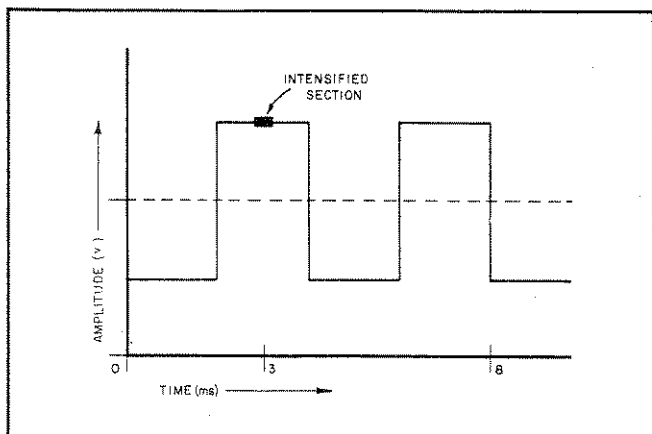


Figure 3-3. Intensified Waveform.

3-55. Delay Generator.

3-56. The 3437A can be programmed to delay an external trigger from 0 to .9999999 sec in 100 ns steps.

Example:

- a. Connect the equipment as illustrated in Figure 3-4.

- b. Program the 3437A keyboard as follows:

```

DELAY . . . . . 800 ns
NRDGS . . . . . 0
RANGE . . . . . -
TRIGGER . . . . . EXT
    
```

- c. Set the 3310A controls as follows:

```

FUNCTION . . . . . SQ
RANGE . . . . . 100
DIAL . . . . . 10
DC OFFSET . . . . . OFF
OUTPUT
LEVEL . . . . . MINIMUM
    
```

- d. Set the oscilloscope controls as follows:

```

TIME/DIV . . . . . 100 μs
VOLTS/DIV (A/B) . . . . . 5/DC
TRIGGER . . . . . EXTERNAL
    
```



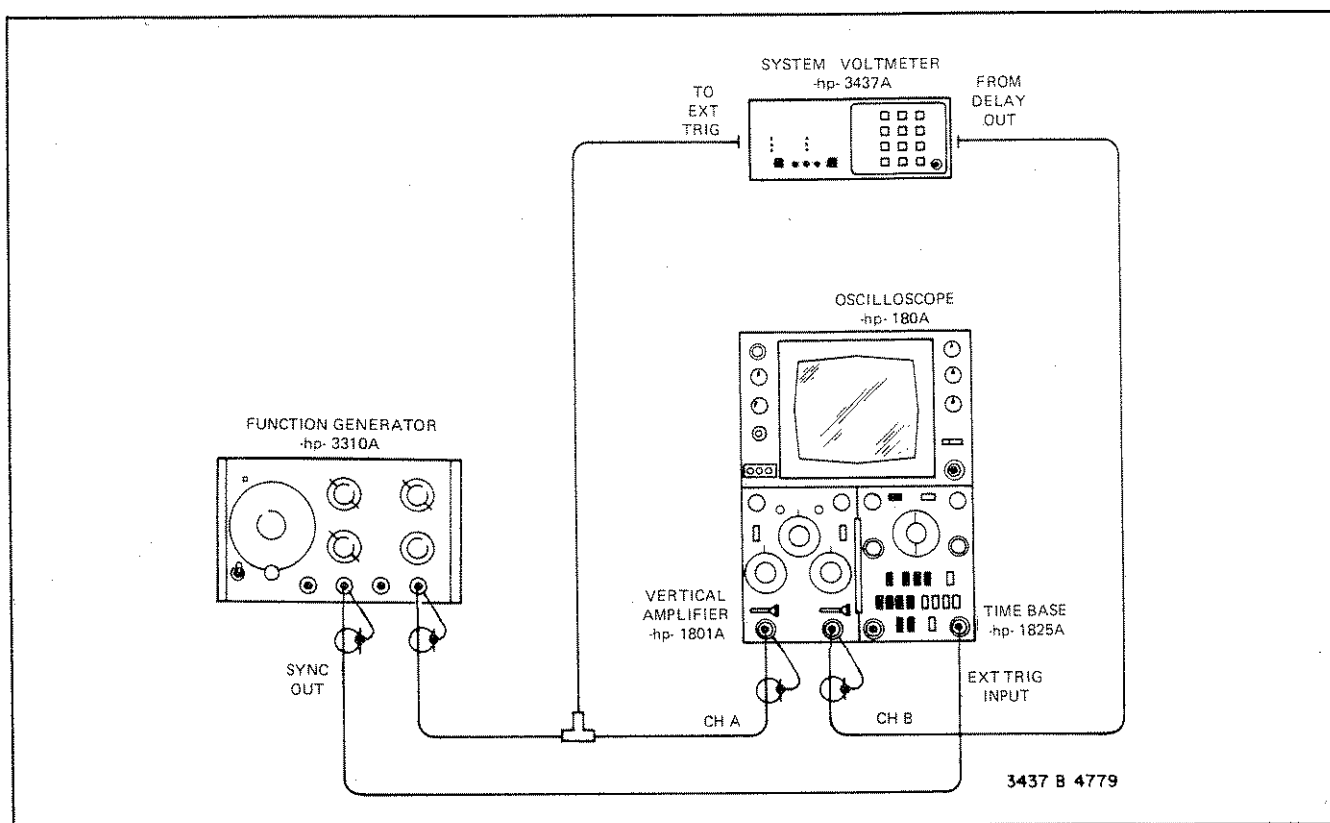


Figure 3-4. Delay Generator.

e. Adjust the 3310A output level and oscilloscope trigger level to obtain a display as illustrated in Figure 3-5. (Assure that the 3310A output is of sufficient amplitude to trigger the 3437A.)

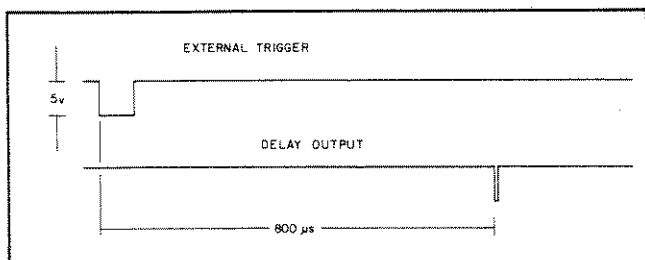


Figure 3-5. Delayed Output.

3-57. Trigger Generator.

3-58. The 3437A can be programmed to function as a trigger generator or as a burst trigger generator (up to 9999 triggers per burst).

3-59. Trigger Generator. Program the 3437A keyboard as follows:

```

DELAY.....0
NRDGS.....1
TRIGGER.....INT
    
```

a. The Delay out waveform is illustrated in Figure 3-6.

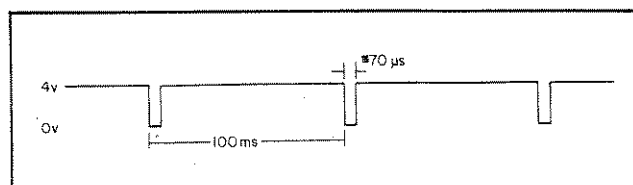


Figure 3-6. Delay Out Waveform.

b. The 3437A Delay can be programmed from 0 to .9999999 second (100 ns step) to provide continuous triggers at rates from 10 Hz to 1 Hz.

3-60. Burst Trigger Generator. Program the 3437A keyboard as follows:

```

DELAY..... 500 μs
NRDGS..... 5000
TRIGGER..... EXT/INT
    
```

a. For each trigger received, the 3437A will generate a burst of triggers (5000) at a 2000 Hz (1/500 μs) rate (Figure 3-7). Maximum Rate = 9 kHz.

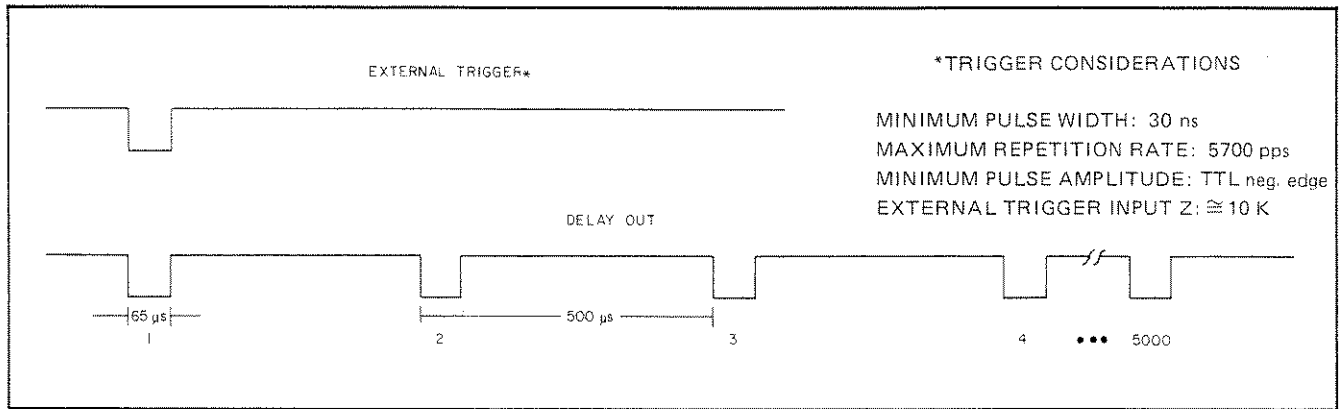


Figure 3-7. Burst Mode Delay Out.

**3-61. System Measurements.**

Systems Applications include:

- Waveform Analysis
  - Harmonic Content
  - Amplitude Characteristics

- Low Frequency True RMS Measurements
- Transient Characterization

- ANGOLA**  
Teleca  
Empresa Técnica de Equipamentos Eléctricos, S.A.R.L.  
R. Barbosa Rodrigues, 411\*DT\*  
Caixa Postal, 6487  
Luanda  
Tel: 35515/6
- ARGENTINA**  
Hewlett-Packard Argentina S.A.  
Santa Fe 2035, Martínez  
6140 Buenos Aires  
Tel: 792-1239, 798-6086  
Telex: 122443 AR OGY  
Biotron S.A.C.I.y M.  
Avda. Paseo Colon 221  
9 pmo  
1399 Buenos Aires  
Tel: 30-4848/1851/8364  
34-9356/0480/4551  
Telex: (33) 17595 BIO AR
- AUSTRALIA**  
**AUSTRALIA CAPITAL TERR.**  
Hewlett-Packard Australia Pty. Ltd.  
121 Wollongong Street  
Fyshwick, 2609  
Tel: 804244  
Telex: 62850
- NEW SOUTH WALES**  
Hewlett-Packard Australia Pty. Ltd.  
31 Bridge Street  
Pymble, 2073  
Tel: 4496566  
Telex: 21561
- QUEENSLAND**  
Hewlett-Packard Australia Pty. Ltd.  
5th Floor  
Teachers Union Building  
495-499 Boundary Street  
Spring Hill, 4000  
Tel: 2291544
- SOUTH AUSTRALIA**  
Hewlett-Packard Australia Pty. Ltd.  
153 Greenhill Road  
Parkside, 5063  
Tel: 2725911  
Telex: 82536
- VICTORIA**  
Hewlett-Packard Australia Pty. Ltd.  
31-41 Joseph Street  
Blackburn, 3130  
Tel: 89-6351  
Telex: 31024 MELB
- WESTERN AUSTRALIA**  
Hewlett-Packard Australia Pty. Ltd.  
141 Stirling Highway  
Nedlands, 6009  
Tel: 3865455  
Telex: 93859
- AUSTRIA**  
Hewlett-Packard Ges.m.b.H.  
Wehrstrasse 29  
P.O. Box 7  
A-1205 Vienna  
Tel: 35-16-21-0  
Telex: 13582/135066  
Hewlett-Packard Ges.m.b.H.  
Wehrstrasse, 29  
A-1205 Wien  
Tel: 35-16-21  
Telex: 135066
- BAHRAIN**  
Medical Only  
Wael Pharmacy  
P.O. Box 648  
Bahrain  
Tel: 54886, 56123  
Telex: 8550 WAEL GJ  
Al Hamdiya Trading and Contracting  
P.O. Box 20074  
Manama  
Tel: 259978, 259958  
Telex: 8895 KALIDA GJ
- BANGLADESH**  
The General Electric Co. of Bangladesh Ltd.  
Magna House 72  
Dhaka Commercial Area  
Mojibehi, Dacca 2  
Tel: 252415, 252419  
Telex: 734
- BELGIUM**  
Hewlett-Packard Benezux S.A./N.V.  
Avenue du Col-Vert, 1,  
(Greenkruggaan)  
B-1170 Brussels  
Tel: (02) 860 50 50  
Telex: 23-494 paibem br
- BRAZIL**  
Hewlett-Packard do Brasil  
L.E.C. Ltda.  
Alameda Rio Negro, 750  
Alphaville  
06400 Barueri SP  
Tel: 429-3222  
Hewlett-Packard do Brasil  
L.E.C. Ltda.  
Rua Padre Chagas, 32  
90000-Pórtio Alegre-RS  
Tel: 22-2998, 22-5621  
Hewlett-Packard do Brasil  
L.E.C. Ltda.  
Av. Epitácio Pessoa, 4864  
22471-Rio de Janeiro-RJ  
Tel: 286-0237  
Telex: 021-21905 HPBR-BR
- CANADA**  
**ALBERTA**  
Hewlett-Packard (Canada) Ltd.  
11620A - 168th Street  
Edmonton T5M 3T9  
Tel: (403) 452-3670  
Telex: 610-831-2431
- BRITISH COLUMBIA**  
Hewlett-Packard (Canada) Ltd.  
10691 Sheppard Way  
Richmond V6X 2W7  
Tel: (604) 270-2277  
Telex: 610-925-5059
- MANITOBA**  
Hewlett-Packard (Canada) Ltd.  
380-550 Century St.  
St. James,  
Winnipeg R3H 0Y1  
Tel: (204) 786-6701  
Telex: 610-671-3531
- NOVA SCOTIA**  
Hewlett-Packard (Canada) Ltd.  
P.O. Box 931  
800 Windmill Road  
Dartmouth B3B 1L1  
Tel: (902) 468-7820  
Telex: 610-271-4482
- ONTARIO**  
Hewlett-Packard (Canada) Ltd.  
1020 Morrison Dr.  
Ottawa K2H 8K7  
Tel: (613) 820-6483  
Telex: 610-563-1836  
Hewlett-Packard (Canada) Ltd.  
6877 Goreway Drive  
Mississauga L4V 1M8  
Tel: (416) 678-9430  
Telex: 610-492-4246
- QUEBEC**  
Hewlett-Packard (Canada) Ltd.  
275 Hymus Blvd.  
Pointe Claire H9R 1G7  
Tel: (514) 697-4232  
Telex: 610-422-3022
- FOR CANADIAN AREAS NOT LISTED:**  
Contact Hewlett-Packard (Canada) Ltd. in Mississauga.
- CHILE**  
Jorge Calcagni y Cia. Ltda.  
Arturo Buriel 065  
Casilla 16475  
Correo 9, Santiago  
Tel: 220222  
Telex: JCALCAGN
- COLOMBIA**  
Instrumentación  
Henrik A. Langebaek & Kier S.A.  
Carrera 7 No. 48-75  
Apartado Aéreo 6287  
Bogotá, 1 D.E.  
Tel: 269-8877  
Telex: 44400  
Instrumentación  
H.A. Langebaek & Kier S.A.  
Carrera 63 No. 49-A-31  
Apartado 54098  
Medellín  
Tel: 304475
- COSTA RICA**  
Clintifica Costarricense S.A.  
Avenida 2, Calle 5  
San Pedro de Montes de Oca  
Apartado 10159  
San José  
Tel: 24-38-20, 24-08-19  
Telex: 2367 GALGUR CR
- CYPRUS**  
Hewlett-Packard France  
Lypronos  
19 Georgios Xenopoulos  
Street  
P.O. Box 1152  
Nicosia  
Tel: 45828/29  
Telex: 3018
- CZECHOSLOVAKIA**  
Hewlett-Packard  
Obchodní zastupitelství v CSSR  
Plesmy stýk  
Pošt. schránka 27  
CS 118 01 Praha 011  
CSSR  
Vývojeva a Provozni Zakladna  
Výzkumných Ústavů v  
Bechovicích  
CSSR-25097 Bechovice u  
Prahy  
Tel: 89 93 41  
Telex: 12133  
Institute of Medical Bionics  
Vyskumny Ústav Lekarskej  
Bionky  
Jedlova 6  
CS-68346 Bratislava-  
Kramere  
Tel: 44-551  
Tel: (403) 253-2713  
Telex: 610-821-8141
- DENMARK**  
Hewlett-Packard A/S  
Dalavej 52  
DK-3460 Birkerød  
Tel: (02) 81 86 40  
Telex: 37409 npas dk  
Hewlett-Packard A/S  
Navervej 1  
DK-8600 Silkeborg  
Tel: (06) 82 71 66  
Telex: 37409 npas dk
- ECUADOR**  
CYEDE Cia. Ltda.  
P.O. Box 6423 CCI  
Av. Eloy Alfaro 1749  
Quito  
Tel: 450-975, 243-052  
Telex: 2548 CYEDE ED  
Medical Only  
Hospital S.A.  
Casilla 2590  
Robles 625  
Quito  
Tel: 545-250
- EGYPT**  
I.E.A.  
International Engineering Associates  
24 Hussein Hegazi Street  
Kasr-el-Ani  
Cairo  
Tel: 23 829  
Telex: 93830
- SAMTRO**  
Sami Amin Trading Office  
18 Abdel Aziz Gawish  
Abdine-Cairo  
Tel: 24932
- EL SALVADOR**  
IPESA  
Bulevar de los Heroes 11-48  
Edificio Sarah 1148  
San Salvador  
Tel: 252787
- ETHIOPIA**  
Abdelia Abdulmaik  
P.O. Box 2635  
Addis Ababa  
Tel: 11 93 40
- FINLAND**  
Hewlett-Packard Oy  
Reventankien 7  
SF-02100 Espoo 10  
Tel: (90) 455 0211  
Telex: 121563 hewpa fi
- FRANCE**  
Hewlett-Packard France  
Zone d'activités de  
Courtabœuf  
Carrera 7 No. 48-75  
Apartado Aéreo 6287  
Bogotá, 1 D.E.  
Tel: 269-8877  
Telex: 44400  
Instrumentación  
H.A. Langebaek & Kier S.A.  
Carrera 63 No. 49-A-31  
Apartado 54098  
Medellín  
Tel: 304475
- GERMANY**  
Hewlett-Packard GmbH  
Technisches Büro München  
Eschenstrasse 5  
D-8021 Taufkirchen  
Tel: (089) 6117-1  
Telex: 0524985  
Hewlett-Packard GmbH  
Technisches Büro Berlin  
Kathstrasse 2-4  
D-1000 Berlin 30  
Tel: (030) 24 90 BF  
Telex: 018 3405 hpbin d
- GREECE**  
Kostas Katayannis  
8 Omirou Street  
Athens 133  
Tel: 32 30 303/32/37 731  
31081 Toulouse  
Le Mirail-Cédex  
Tel: (61) 40 11 12
- HONG KONG**  
Hewlett-Packard France  
Licences  
Place Romée de Vienneuve  
13100 Aix-en-Provence  
Tel: (42) 59 41 02  
Telex: 410770F  
Hewlett-Packard France  
2, Allée de la Bourgonette  
35100 Rennes  
Tel: (99) 51 42 44  
Telex: 740912F  
Hewlett-Packard France  
18, rue du Canal de la Marne  
67300 Schiltigheim  
Tel: (88) 83 08 10  
Telex: 890141F  
Hewlett-Packard France  
immeuble pélicentre  
rue van Gogh  
59650 Villeneuve D'Ascq  
Tel: (20) 91 41 25  
Telex: 160124F  
Hewlett-Packard France  
Bâtiment Ampère  
Rue de la Commune de Paris  
B.P. 300  
93153 Le Blanc Meaunil-  
Cédex  
Tel: (01) 931 88 50  
Telex: 211032F  
Hewlett-Packard France  
Av. du Pt. Kennedy  
33700 Mérignac  
Tel: (56) 97 01 81  
Hewlett-Packard France  
immeuble Lorraine  
Boulevard de France  
91035 Evry-Cédex  
Tel: 077 96 90  
Telex: 692315F  
Hewlett-Packard France  
23 Rue Lohare  
57000 Metz  
Tel: (87) 65 53 50
- GERMAN FEDERAL REPUBLIC**  
Hewlett-Packard GmbH  
Vertriebszentrale Frankfurt  
Besselstrasse 117  
Postfach 560 140  
D-6000 Frankfurt 56  
Tel: (06011) 50041  
Telex: 04 13249 hpbin d  
Hewlett-Packard GmbH  
Technisches Büro Böblingen  
Herrenberger Strasse 110  
D-7030 Böblingen,  
Württemberg  
Tel: (07031) 667-1  
Telex: 07265739 bbn  
Hewlett-Packard GmbH  
Technisches Büro Düsseldorf  
Emanuel-Loebl-Str. 1  
(Seestern)  
D-4000 Düsseldorf 1  
Tel: (0211) 5971-1  
Telex: 089/86 533 hpdd d  
Hewlett-Packard GmbH  
Technisches Büro Hamburg  
Kapellstrasse 5  
D-2000 Hamburg 60  
Tel: (040) 63804-1  
Telex: 21 63 032 hpbin d  
Hewlett-Packard GmbH  
Technisches Büro Hannover  
Am Grossmarkt 6  
D-3000 Hannover 91  
Tel: (0511) 46 60 01  
Telex: 092 3259  
Hewlett-Packard GmbH  
Technisches Büro Nürnberg  
Neumeyerstrasse 90  
D-8500 Nürnberg  
Tel: (0911) 52 20 83  
Telex: 0623 860  
Hewlett-Packard GmbH  
Technisches Büro München  
Eschenstrasse 5  
D-8021 Taufkirchen  
Tel: (089) 6117-1  
Telex: 0524985  
Hewlett-Packard GmbH  
Technisches Büro Berlin  
Kathstrasse 2-4  
D-1000 Berlin 30  
Tel: (030) 24 90 BF  
Telex: 018 3405 hpbin d
- HONG KONG**  
Hewlett-Packard Hong Kong Ltd.  
11th Floor, Four Seas Bldg.  
212 Nathan Rd.  
Kowloon  
Tel: 3-697446 (5 lines)  
Telex: 36878 HK  
Medical/Analytical Only  
Schmidt & Co. (Hong Kong)  
Ltd.  
Wing On Centre, 28th Floor  
Connaught Road, C.  
Hong Kong  
Tel: 5-455644  
Telex: 74766 SCHKX HK
- INDIA**  
Blue Star Ltd.  
Sahar  
41/2 VV Savarkar Marg  
Prabhadevi  
Bombay 400 025  
Tel: 45 78 87  
Telex: 011-4093  
Blue Star Ltd.  
Band Box House  
Prabhadevi  
Bombay 400 025  
Tel: 45 73 01  
Telex: 011-3751  
Blue Star Ltd.  
Bhavesh  
Stadium Road  
Ahmedabad 380 014  
Tel: 43922  
Telex: 012-234  
Blue Star Ltd.  
7 Hal Street  
Calcutta 700 001  
Tel: 23-0131  
Telex: 921-7655  
Blue Star Ltd.  
Bhikari House  
91 Nehru Road  
New Delhi 110 024  
Tel: 892547  
Telex: 031-2463  
Blue Star Ltd.  
T.C. 7/603 'Poonima'  
Mandir  
Trivendrum 695 013  
Tel: 65799  
Telex: 0884-259  
Blue Star Ltd.  
11 Magarath Road  
Bangalore 560 025  
Tel: 55685  
Telex: 0885-430  
Blue Star Ltd.  
Measakhi Mandiram  
XXXX/1379-2 Mahala  
Gandhi Rd.  
Cochin 682 016  
Tel: 32069  
Telex: 085-514  
Blue Star Ltd.  
1-1-1171 Sarojini Devi Road  
Secunderabad 500 033  
Tel: 70126  
Telex: 0155-459  
Blue Star Ltd.  
133 Kodambakkam High Road  
Madras 600 034  
Tel: 82057  
Telex: 041-379
- ICELAND**  
Medical Only  
Elding Trading Company Inc.  
Halnarvöll - Tryggvagötu  
P.O. Box 895  
IS-Reykjavik  
Tel: 1 88 20/1 63 03  
Dokkumura-ku, Nagoya, 450  
Tel: 052 571-5171
- INDONESIA**  
BERCA Indonesia P.T.  
Jln. Abdul Muis 62  
Jakarta  
Tel: 349255, 349886  
Telex: 46748 BERSIL IA
- JAPAN**  
Yokogawa-Hewlett-Packard Ltd.  
29-21, Takaido-Higashi  
3-chome  
Suginami-ku, Tokyo 168  
Tel: 03-331-6111  
Telex: 232-2024 YHP-Tokyo  
Yokogawa-Hewlett-Packard Ltd.  
Chuo Bldg., 4th Floor  
4-20, Nishinakajima 5-chome  
Yodogawa-ku, Osaka-shi,  
Osaka, 532  
Tel: 06-304-6021  
Telex: 523-3624  
Yokogawa-Hewlett-Packard Ltd.  
Sunimoto Seimei Nagaya Bldg.  
11-2 Shimosajima-cho,  
Nakamura-ku, Nagoya, 450  
Tel: 052 571-5171
- MALAYSIA**  
Hewlett-Packard Sales (Malaysia) Sdn. Bhd.  
Suite 2.2/2.22  
Bangunan Angkasa Raya  
Jalan Ampang  
Kuala Lumpur  
Tel: 483686, 485663  
Protel Engineering  
P.O. Box 1917  
Lot 259, Satok Road  
Kuching, Sarawak  
Tel: 53544  
29-21, Takaido-Higashi  
3-chome  
Suginami-ku, Tokyo 168  
Tel: 03-331-6111  
Telex: 232-2024 YHP-Tokyo  
Yokogawa-Hewlett-Packard Ltd.  
Chuo Bldg., 4th Floor  
4-20, Nishinakajima 5-chome  
Yodogawa-ku, Osaka-shi,  
Osaka, 532  
Tel: 06-304-6021  
Telex: 523-3624  
Yokogawa-Hewlett-Packard Ltd.  
Sunimoto Seimei Nagaya Bldg.  
11-2 Shimosajima-cho,  
Nakamura-ku, Nagoya, 450  
Tel: 052 571-5171
- MEXICO**  
Hewlett-Packard Mexicana, S.A. de C.V.  
Av. Periférico Sur No. 6501  
Tepepan, Xochimilco  
Mexico 23, D.F.  
Tel: 905-676-4600  
Telex: 017-74-507  
Hewlett-Packard Mexicana, S.A. de C.V.  
Rio Volga #600  
Col. Del Valle  
Monterrey, N.L.  
Tel: 78-32-10
- MOROCCO**  
Dolbeau  
81 rue Karachi  
Casablanca  
Tel: 304182  
Telex: 23051/22822  
Gerep  
2, rue d'Agadir  
Boite Postale 156  
Casablanca  
Tel: 272093/5  
Telex: 23 739
- NETHERLANDS**  
Hewlett-Packard Benezux N.V.  
Van Heuven Goedhartlaan 121  
P.O. Box 667  
1181KX Amstelveen  
Tel: (20) 47 20 21  
Telex: 13 216
- NEW ZEALAND**  
Hewlett-Packard (N.Z.) Ltd.  
4-12 Cruckshank Street  
Kilburne, Wellington 3  
P.O. Box 9443  
Courney Place  
Wellington  
Tel: 877-199  
Hewlett-Packard (N.Z.) Ltd.  
P.O. Box 26-188  
169 Manukau Road  
Epsom, Auckland  
Tel: 687-159  
Analytical/Medical Only  
Northrop Instruments & Systems Ltd.  
Studee House  
85-87 Grunzee Street  
P.O. Box 2406  
Wellington  
Tel: 850-091  
Telex: NZ 31291  
Northrop Instruments & Systems Ltd.  
Eden House, 44 Khyber Pass  
Rd.  
P.O. Box 9682, Newmarket  
Auckland 1  
Tel: 794-091  
Northrop Instruments & Systems Ltd.  
Terrace House, 4 Oxford  
Terrace  
P.O. Box 8388  
Christchurch  
Tel: 64-165
- NIGERIA**  
The Electronics Instrumentations Ltd.  
N68/770 Oyo Road  
Obesun House  
P.M.B. 5402  
Ibadan  
Tel: 461577  
Telex: 31231 TEL NG  
The Electronics Instrumentations Ltd.  
144 Agogo Motor Road, Mushin  
P.O. Box 481  
Mushin, Lagos  
NORWAY  
Hewlett-Packard Norge A/S  
Osloveien 18  
P.O. Box 34  
1345 Osterass  
Tel: (02) 1711 80  
Telex: 166211 npas n  
Hewlett-Packard Norge A/S  
Nygardsgaten 114  
P.O. Box 4210  
5013 Nygardsgaten,  
Bergen  
Tel: (05) 21 97 33
- PANAMA**  
Electronica Balboa, S.A.  
Aparato 4929  
Panama 5  
Calle Samuel Lewis  
Edificio "Alfa", No. 2  
Ciudad de Panama  
Tel: 64-2700  
Telex: 3483103 Curundu,  
Canal Zone
- PERU**  
Compañía Electro Médica S.A.  
Los Flamencos 145  
San Isidro Casilla 1030  
Lima 1  
Tel: 41-4325  
Tel: Pub. Booth 25424  
SSIDRO
- PAKISTAN**  
Musko & Company Ltd.  
Cosman Chambers  
Abulrah Haroon Road  
Karachi-3  
Tel: 511027, 512927  
Telex: 2894



## Free Manuals Download Website

<http://myh66.com>

<http://usermanuals.us>

<http://www.somanuals.com>

<http://www.4manuals.cc>

<http://www.manual-lib.com>

<http://www.404manual.com>

<http://www.luxmanual.com>

<http://aubethermostatmanual.com>

Golf course search by state

<http://golfingnear.com>

Email search by domain

<http://emailbydomain.com>

Auto manuals search

<http://auto.somanuals.com>

TV manuals search

<http://tv.somanuals.com>