Table 3-4. Optimizing Reading Rate (Cont'd).

as you could. Why? Because you have not optimally handled the transfer of data over the bus from the 3456A to your computer.

Let's take a closer look at the reasons for fast reading rates:

- High speed scanning
- Data Throughput
- Waveform Characterization

HIGH SPEED SCANNING

Typical applications of high speed scanning include temperature and strain profiling where a large number of measurements must be taken very quickly to "freeze" the phenomenon at some point in time. For this type measurement, data transfer from the voltmeter to the computer is not really required to go fast. As long as the scanner data does not exceed 350 measurements, the built-in memory can store all the measurements for one scanned sequence and transfer the data at the end of acquisition. In conjunction with Reading Storage, three other 3456A features make high speed scanning particularily easy to do:

- Program Memory
- Voltmeter Complete
- External Trigger

Program Memory can be used to store a series of measurement sequences and operate on the acquired data. For example, in a high speed scanning situation you could acquire the measurements as fast as possible in the Reading Store mode. Flag the computer and then output the data, perhaps already scaled, in ASCII format. It is almost a 10 to 1 savings in time during acquisition and the results are just as easy to use as if you load, acquire, and transfer individual readings. Voltmeter Complete can be used to increment the scanner sequentially without software interaction between the voltmeter, the scanner, and the computer.

To close the loop, the scanner can output a signal to the 3456A's internal trigger. The result is that once the measurements are initiated by your computer there is no additional need for computer interaction until the measurement sequence is complete.

The fastest possible reading rate for any integration time is achieved when:

- Autorange, Auto Zero, Math, Display and Filter are off.
- Measurements are stored in the built-in memory using internal trigger and the packed format mode.

Since the packed mode and Display off are functions only available over the HP-IB, the maximum reading rate is achievable only with remote operation. If your trigger source is fast enough, external triggering is just as fast as internal triggering.

Transferring the measurements in packed format over the bus to a 9825A Calculator using a Fast Read/Write Buffer transfer reduces the maximum reading rate by 10% and you have to unpack the stored data. But, you can store many more measurements using the computer's memory.

DATA THROUGHPUT

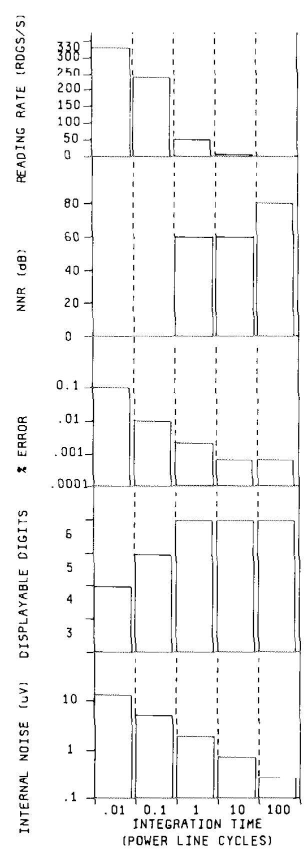
The 3456A solves many of the data throughput problems because Reading Store and Program Memory remove the constant control necessity from the computer. The ability to flag the computer from the front panel of the 3456A, store measurement sequences in its memory, and flag the computer when it is done, lets you use both the 3456A and the computer to their best advantage. To avoid overrunning the computer with data from the 3456A, you can select the Systems Output mode which updates the output only after handshake.

WAVEFORM CHARACTERIZATION

The 3456A can digitize sinewaves up to about 100 Hz with fairly good accuracy. All the high speed modes must be used to acquire at least two samples per cycle. The Delay generator gives you about 1% timing accuracy.

Waveform characterization should be performed with a System Voltmeter. These voltmeters use a sample and hold technique which allows the waveform to be "frozen" at a well-defined point in time. An integrating-type voltmeter, like the 3456A, will always average the waveform over its integration period giving less accurate results. System voltmeters also typically have higher speed, greater bandwidth, and much more precise delay generation.

To summarize, let's look at the fastest reading rate set up again. Note that all convenience and accuracy features are eliminated and that the data is stored internally in the packed mode. This may not be right for your use. You may want a final answer which the Math functions could provide without computer interaction.



3456 TABLE 3-4

(read Paragraph 3-56). Figure 3-8, the Numbered Keyboard figure may also be helpful for the following discussion of the math operation. They are:

- %Error
- Scale
- Pass/Fail (Limit Test)
- dB
- dBm
- Null
- Thermistor
  - in Degrees C
  - in Degrees F
- Statistics
  - Mean
  - Variance
  - Count
  - Limits

3-73. Math operations can only be done on instrument acquired measurement data.

3-74. A Math operation is selected by first pressing the front panel's blue MATH button and then pressing the desired math key. The blue label below the front panel's numbered keys shows the various math operations. An LED, located to the center and below the display also lights when a math operation is selected. The registers used in the math operations are identified by the white labels above the numbered keys. The range of numbers you can store into the registers or use in math is from $\pm$ 0.000000 x 10^{-9} to 1999999 x 10^9. The 3456A does, however, do internal calculations using 9 digit floating point numbers. If any of the math calculations are out of range, an "LL" is displayed. The following describes the 3456A's math operations.

3-75. %Error.

3-76. The %Error math feature of the 3456A can best be described by the formula:

$$\text{Results in percent} = \frac{X - Y}{Y} \times 100$$

where "X" is the present measurement value and "Y" is the value in register Y. This formula gives the percent difference between the reading taken by the 3456A and the value in register Y. The default (Turn-On or Reset)) value in register Y is 1. The %Error feature is selected by the "8" [100 (X - Y/Y)] key. Refer to Table 1-1 for the %Error accuracy specifications.

3-77. You can use the %Error function to determine the percent difference between an ideal voltage and a measured voltage. For example, you may wish to know the %Error of a 10 V dc measurement. The first thing to do is to store 10 into register Y. Then set the 3456A to the %Error math function and take a 10 V measurement. If the reading is exactly 10 V a "0" is displayed. If the reading is, for example, 10.1 V, the result becomes:

$$\text{Result} = \frac{X - Y}{Y} \times 100 = \frac{10.1 - 10}{10} \times 100 = .01 \times 100 = 1$$

showing that the measured value is 1% higher than the ideal value. The number displayed on the front panel would be "1".

3-78. Scale.

3-79. The Scale feature of the -hp- Model 3456A lets you modify a measurement value by a selected value. The modification can be done either by addition, subtraction, multiplication, or division, depending on how the Scale function is used. The Scale mode is represented by the formula:

$$\text{Results} = \frac{X - Z}{Y}$$

where "X" is the present measurement value, "Y" is the value in register Y and "Z" is the value in register Z. The default (Turn-On/Reset) values in register Y and Z are 1 and 0, respectively. The Scale math feature is selected by the "7" [(X - Z)/Y] key. Refer to Table 1-1 for Scale accuracy specifications.

3-80. To do an addition or a subtraction, first enter a "1" into register Y. If you wish to perform an addition, enter a negative number into register Z. If a subtraction is desired, enter a positive number into register Z. The Scale formula then becomes:

$$\text{Results} = \frac{X - (\pm Z)}{1} = X - (\pm Z)$$

To perform a division, enter a "0" into register Z and the divisor value into register Y. The Scale formula then becomes:

$$\text{Results} = \frac{X - 0}{Y} = \frac{X}{Y}$$

Multiplication is performed by dividing the measured value by the inverse of the multiplier value (a fraction). Here again, a "0" is to be entered into register Z with the inverse value going into register Y.

3-81. Pass/Fail (Limit Test).

3-82. The Pass/Fail math operation can be used to make a voltage or ohms measurement and then determine if the reading falls within certain limits. The limits are selectable from the 3456A's front panel and should be stored into the instrument's UPPER and LOWER registers. Once the limits are stored and the Pass/Fail math operation is selected, the 3456A can then be set for a regular volts or ohms measurement. If the measured reading is within the selected limits, the reading will be displayed. If the reading is above the upper limit, "HI" will be displayed. If the reading is below the lower limit, "LO" will be displayed. The default (Turn-On/Reset) values of the UPPER and LOWER registers are +1999999+9 and −1999999+9, respectively. The Pass/Fail feature is selected by the "1" (PASS/FAIL) key. Refer to Table 1-1 for the Pass/Fail accuracy specificaitons.

3-83. A way to use the Pass/Fail feature, is to make sure that a certain number of 1 K ohm resistors are within a 1% tolerance. To do this, you first should store the upper and lower accuracy limits into the 3456A's respective registers. In this case "1010" is stored into the UPPER register and a "990" is stored into the LOWER register. The next step is to select the ohms function and the 1 K ohms range. After you have done this, select the Pass/Fail math feature and start to measure the resistors one at a time. If the resistor value is within the 1% tolerance, in other words between 1.01 K ohms and .99 K ohms, the actual value of the resistor will be displayed on the front panel. "HI" will be displayed for any readings above 1.01 K ohms and "LO" will be displayed for any readings below .99 K ohms.

3-84. dB.

3-85. This feature of the 3456A is a Ratio Measurement of two voltages which is calculated and displayed in Decibels (dB). The dB formula is:

$$dB = 20 \text{ Log} \left| \frac{X}{Y} \right|$$

where "X" is the present measurement value and "Y" is the value in register Y. The default (Turn-On/Reset) value in register Y is 1. The dB feature is selected by the "9" (20 LOG X/Y) key. Refer to Table 1-1 for the dB accuracy specifications.

3-86. You can use the dB feature to measure the voltage gain of an amplifier. First measure the input voltage to the amplifier and store it into register Y. (You can store the reading directly into Y without re-entering the reading from the keyboard.) For this example a voltage reading of .1 V is assumed. The next step is to measure the amplifier's output voltage and set the 3456A to the dB math operation. The gain of the amplifier is then displayed in decibels. Assuming that the amplifier's output voltage is 10 V, the dB equation becomes:

$$dB = 20 \text{ Log } \frac{X}{Y} = 20 \text{ Log } \frac{10}{.1} = 20 \text{ Log } 100 = 40$$

giving you a gain of 40 decibles.

3-87. dBm.

3-88. The dBm feature of the 3456A is used to calculate a power ratio using a resistance as the reference. The dBm equation is:

$$dBm = 10 \text{ Log} \left| \frac{X^2/R}{1 \text{ mW}} \right|$$

where "X" is the present measured value, "1 mW" is the power reference, and "R" is the resistance reference value to be entered by you. The default (Turn-On/Reset) value in register R is 600 ohms. The dBm math feature is selected by the "4" [dBm (R)] key. Refer to Table 1-1 for the dBm accuracy specifications.

3-89. The dBm feature can be used to measure the input power of a speaker. In this example we assume an 8 ohm speaker load and an input voltage of 10 volts. The formula now becomes:

$$dBm = 10 \text{ Log} \left| \frac{100/8}{.001} \right| = 40.97$$

giving you a value of 40.97 dBm.

3-90. Null.

3-91. The Null feature of the 3456A is described by the formula:

$$\text{Displayed Results} = X - X_1$$

where "X_1" is the first measurement taken after the Null feature has been selected and where "X" is the reading(s) after the first reading. When the "X_1" reading is first taken it is stored into register Z. That reading is then subtracted from the following reading(s) with the net present result displayed on the front panel. Since the first reading is stored in register Z, you can recall its value by recalling the register. The Null math feature is selected by the "3" (NULL) key.

3-92. The Null feature can be used to make more accurate 2-Wire Ohms measurements. To do this, short the input leads together at the measuring point and place the 3456A into the Null and 2-Wire Ohms mode. The first reading taken, which is the lead resistance, is stored into register Z. Remove the short from the input leads and take the unknown resistance measurement. The displayed reading is the total resistance measurement minus the lead resistance, giving you an accurate 2-Wire Ohms Measurement. The Null formula becomes.

$$\text{Unknown Resistance} = X - X_1 = X - R$$

where "X" is the total unknown resistance (including "R") and where "R" is the lead resistance.

3-93. Thermistor.

3-94. The 3456A makes temperature measurements using an externally connected thermistor, when selecting this mode. To correctly do this operation, set the 3456A to the ohms function. It is advisable to first select an ohms range which corresponds closely to the resistance value of the thermistor for the temperature to be measured. When the Thermistor operation is selected, the ohms reading (thermistor resistance) is then calculated by the instrument and can be displayed either in degrees C or degrees F dependent on which math feature is selected. The Thermistor math operation with the results displayed in degrees C is selected by the "6" (°C) key. The "5" (°F) key is used for degrees F. Refer to Table 1-1 for the Thermistor accuracy specifications. The recommended Thermistor can be ordered by -hp Part Number 0837-0164. A package of 4 thermistors is also available under Accessory Number 44414A. The thermistor's corresponding resistor value at high and low temperature limits and at nominal room temperature is:

Temperature	Resistance
150°C	92.7 Ohms
25°C	5000 Ohms
-80°C	3684 K Ohms

3-95. Keep a couple of things in mind when using the Thermistor mode. Choosing an optimum ohms range for the termperature measurement has been mentioned in the preceding paragraph. This is important for a stable reading. You can use other ranges or autorange, but the reading may be unstable. To demonstrate this, choose a high ohms range for the thermistor. An ohms reading is still taken and the temperature is still calculated; but since a higher range is more sensitive for low ohms values, the reading is not as stable. Autorange may have the same effects, since there may be a difference from range to range. Another thing to keep in mind is lead resistance. If 2-Wire Ohms is used, any lead resistance is added to the thermistor resistance causing an inaccurate temperature reading.

3-96. Statistics.

3-97. The Statistics math feature of the -hp- Model 3456A is used to make a Mean and Variance calculation of reading(s) taken in any function. These calculations are made when the instrument is set to the Statistics (STAT) mode and after a measurement cycle is completed. The Mean value is then stored into the MEAN register with the number of readings taken stored into the COUNT register. The Variance value is stored into the VARIANCE register with highest reading taken stored into the UPPER register and the lowest reading into the LOWER register. In addition, the first reading taken is also stored into register Z. Except for the Variance calculation, all other statistics calculations are done after the first measurement cycle is completed. The Variance calculation needs at least two readings to calculate its value. The default values of the MEAN, VARIANCE, COUNT, UPPER, LOWER, and Z registers are 199999 +9, −00.000 −3 (0), 0, 1999999 +9, −1999999 +9, and 0 respecitvely. The Statistic mode is selected by the "2" (STAT) key. To reset the registers to their default values without pressing the 3456A's RESET button or cycling power, select the statistics function again by pressing the MATH button and STAT key. Refer to Table 1-1 for the Statistics Accuracy Specifications.

NOTE

Since the math calculations are made to 9 digits, certain accuracy limitations as shown in Table 1-1 should be kept in mind.

3-98. Mean. The Mean (Average) value is calculated by *the formula:*

$$\text{Mean (M)} = X_1 + \frac{1}{C}\sum_{i=1}^{C}(X_i - X_1) = \overline{X}$$

Where "X_i is the "ith" reading taken after enabling statistics, "X_1" is the first reading taken after enabling Statistics, and "C" is the total number of readings taken with the present reading (X) displayed on the front panel. The present Mean value is in the MEAN register and it, along with the other registers used in the Statistics mode, can be recalled at any time by recalling the appropriate register.

3-99. Variance. The Variance value is calculated by the formula:

Variance (V) =

$$\frac{\sum_{i=1}^{C}(X_i - X)^2 - \frac{1}{C}\left[\sum_{i=1}^{C}(X_i - X_1)\right]^2}{C - 1}$$

Where "X_i" is the "ith" reading taken after enabling statistics, "X_I" is the first reading taken after enabling Statistics and "C" is the total number of readings taken with the present reading (X) displayed on the front panel. The present Variance value is in the VARIANCE register and it, along with the value(s) in the other register(s), can be recalled at any time by recalling the appropriate register.

3-100. Statistics Example. One way to use the Statistics feature is to calculate the average value of a number of resistors. Start by setting the 3456A to the ohms function and Single Trigger mode. Then select the Statistics Math mode. Next connect the first resistor to the input terminals and trigger the instrument (push the SINGLE trigger button). Do the same for the other resistors after the measurement cycle is completed. When all of the resistors are measured, you can determine the average value of the resistors by recalling the MEAN register. The Variance of the register values can be recalled by the VARIANCE register. To doublecheck the number of resistors you have measured, recall the COUNT register. For the lowest value, recall the LOWER register and the UPPER register for the highest value.

3-101. READING STORAGE.

3-102. The Reading Storage feature of the 3456A allows you to store into the instrument's internal memory a certain number of readings. The memory size is 1400 bytes and since each reading takes 4 bytes of memory up to 350 readings can be stored, depending on available memory space. This is because the Program Memory Operation of the 3456A (see Paragraph 3-200) also uses the internal memory and, if used, reduces memory space allowing fewer readings to be stored. The number of storable readings can be determined by this formula:

Memory Size - Memory Used = Memory Available (rounded off to the lowest value)

For example, if you use 85 bytes of memory for the Program Memory operation the total number of readings you can store is:

$$\frac{1400 - 85}{4} = 328.75$$

allowing you enough space for 328 readings.

3-103. The Reading Storage feature is enabled by pressing the front panel's RDGS STORE button. The LED next to the button then lights and the instrument starts storing a reading when triggered. The LED turns off when the feature is disabled or when the 3456A's internal memory is full. To turn the Reading Storage feature off, press the RDGS STORE button a second time. The readings in the memory are cleared when the Reading Storage is first turned on and the 3456A is triggered, by the Self Test mode, and at Turn-On.

3-104. Readings are stored into memory with the most recent reading as reading #1 and the preceding readings as #2, #3, and so on. For example if you take 350 readings, the reading taken after enabling the feature is #350 and the last reading taken is #1. The reading order is important to keep in mind when recalling the reading(s). Any or all of the readings can be recalled either one at a time or they can be scrolled. These two methods operate as follows.

a. Recalling Single Readings. To recall a single reading from memory

1. Set the 3456A to Trigger Hold and then turn Reading Storage on. The Trigger is set to Hold because a trigger restarts the Reading Storage, when enabled, and the previously stored readings are cleared.
2. Next store the number corresponding to the reading you wish to recall into register R (use store method in Paragraph 3-60).
3. Then recall the R register (by pressing the RECALL button and key "4").

The reading is then displayed on the front panel. When you press the RECALL button again without pressing the "4" key, the following reading is then displayed. Press the button again and the next reading is displayed, and so on. Try the following example in which reading #3 through #1 are recalled.

1. Press the HOLD trigger button and then press the RDGS STORE button.
2. Store "3" into register R by pressing the STORE button and then key 4.
3. Recall the register by pressing the RECALL button and key 4. Reading #3 is now displayed on the front panel.
4. Press the RECALL button again and reading #2 is displayed.
5. Reading #1 is next displayed when the RECALL button is again pressed.

b. Scroll Readings. This procedure is very similar in recalling a single reading. The only difference is that the reading number is entered into register R as a negative number. When that register is then recalled the reading which corresponds to the stored number is then displayed. The display time is determined by the DELAY register value. The next reading is then displayed and then the next reading and so on. Since the time between readings is very short and makes it impossible to see the readings, store a delay into the DELAY register. A 1 second delay, for example, will display each reading for 1 second. The last reading to be displayed is reading #1 and remains until the 3456A's operation is changed.

3-105. The 3456A can also perform other operations while recalling readings. When recalling a single reading, the reading number is displayed before displaying the actual reading. But since the display time is determined by the value in the DELAY register, the reading number may not be seen. Here again, a delay has to be stored into the DELAY register. The reading number is then displayed for a time determined by the delay. Another operation you can do is to select a math operation while the recalled readings are scrolled. For instance, select the Statistics math operation to find the Mean, Variance, Upper, Lower, and Count values of the stored readings. An example on how to use this feature with 350 stored readings is as follows.

a. Press the HOLD trigger button and then the RDGS STORE button.

b. Enter "-350" into the R register to scroll the readings starting with reading #350.

c. Select the Statistics math operation by pressing the MATH button and then the "2" (STAT) key.

d. Recall the R register by pressing the RECALL button and then the "4" (R register) key. The scrolled readings should now be displayed.

e. When the scrolling is completed (no updating of the display), the reading's Mean, Variance, and Count values can now be determined by recalling register MEAN, VARIANCE, and COUNT respectively.

3-106. VOLTMETER COMPLETE.

3-107. The voltmeter complete connector is a BNC connector which outputs a sync signal during the measurement cycle . The signal itself is composed of an approximately 330 nanosecond wide negative going TTL level pulse. One way to use the sync signal is to advance a scanner, like the -hp- Model 3497A. To do this, connect the 3456A's voltmeter complete output to the scanner's channel advance input. Once the connection is made, the scanner advances to the next channel during the 3456A's measurement cycle. The voltmeter complete output is designed to drive at least one TTL input.

3-108. GUARDING.

3-109. General.

3-110. The Guarding Terminals on the -hp- Model 3456A can be used to reduce or cancel error causing common-mode voltages. Figure 3-9 gives three methods of making guard connections. A Guard Terminal on the 3456A is used to make the connections. Both the front panel and the rear panel have a Guard Terminal. For most measurements the terminal should be connected to the common (Low) input terminal. This is done internally in the instrument when the Guard Switch is in the IN position. Each of the Guard Terminals use a separate switch for a connection to each of the common terminals, with the switches located above their respective Guard Terminals.

3-111. Guarding Information.

3-112. Detailed information on guarding methods and the purpose of guarding can be found in -hp- Application Note Number 123, "Floating Measurements and Guarding". This application note is available through your nearest -hp- Sales and Service Office.

3-113. FRONT/REAR SWITCH LOCKOUT.

3-114. The Model 3456A is provided with an interlock for the Front/Rear Switch. This has been provided for you to lock the switch either for the front or rear terminals, preventing any quick changes from front to rear. The switch is locked in the front position when the arrow marked on the lock is pointing toward the FRONT lettering. In the rear position the arrow is point to the REAR lettering. A procedure to install and remove the lock is given in Appendix B.

3-115. REMOTE OPERATION.

3-116. General.

3-117. The following gives instrument dependent information necessary to remotely operate the -hp- Model 3456A over the Hewlett-Packard Interface Bus (HP-IB). Directions for mechanical interface connections to the HP-IB are given in Section II (see Paragraph 2-18) of this Manual. You should be familiar with the front panel (local) operation of the instrument before attempting to use the 3456A in the remote (HP-IB) operating mode. The front panel operational information is located in the Operating Characteristics paragraphs (starting with Paragraph 3-10) in this section of the Manual.

NOTE

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

3-118. HP-IB Description (in Appendix A).

3-119. A general description of the HP-IB is in this Manual's Appendix A. Refer to it for any non-3456A related HP-IB information. Included in the appendix is a worksheet you can use to tabulate the 3456A's HP-IB capabilities and of other Bus compatible devices. It is assumed, in the following paragraphs, that you are knowledgeable about the HP-IB.

3-120. 3456A Response to Bus Messages.

3-121. The following paragraphs deal with the implementation of the HP-IB using the 3456A. The instrument's Bus capabilities are listed in Table 3-5. The following also explains the 3456A's response to Bus Messages, also known as Meta Messages.

Table 3-5. Interface Functions.

Mnemonic	Interface Function Name
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (Basic Talker, Serial Poll, Talk Only Model, Unaddressed to Talk if Addressed to Listen)
L4	Listener (Basic Listener, Unaddressed to Listen if Addressed to Talk)
SR1	Service Request Capability
RL1	Remote/Local Capability
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger Capability
C0	No Controller Capability
E1	Open Collector Bus Drivers

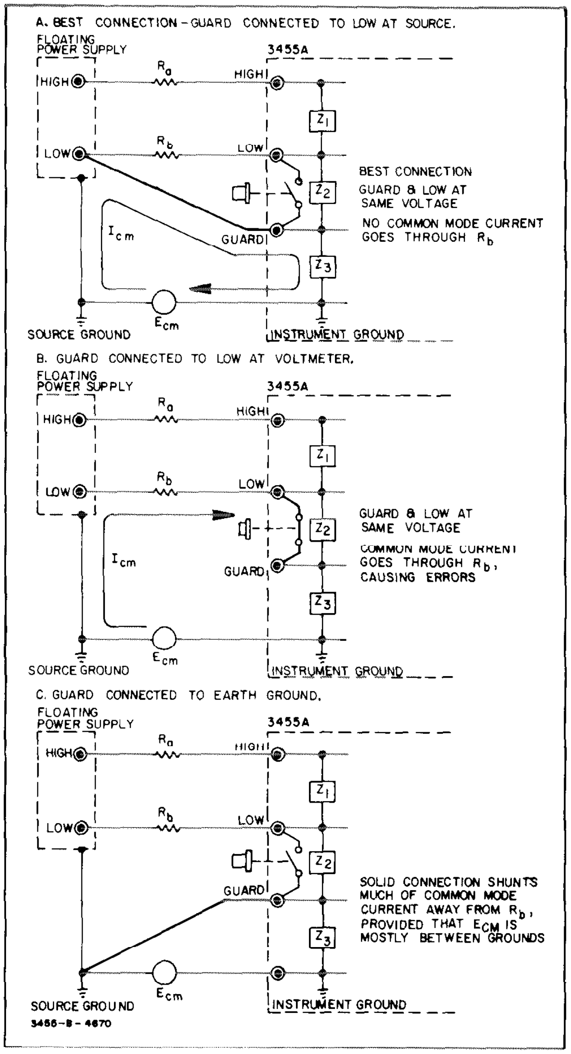


Figure 3-9. Guard Connection.

3-122. Data.

3-123. The Data Message is used to transfer information between the 3456A and the controller. It is used either to send data or receive data. A description is as follows.

a. Send Data is the 3456A's set up information (set to DCV, etc.). The instrument has to be in Remote and Listen (a listener) and the controller a Talker.

b. Receive Data is the 3456A's output. This includes readings and instrument status. To send the data, the 3456A is the talker and the controller is a listener.

3-124. Trigger.

3-125. The Trigger Message causes the 3456A to initiate a measurement cycle. It is an HP-IB Trigger and triggers the instrument in any front panel Trigger mode, since it has priority over other trigger conditions. If the 3456A is triggered during a measurement cycle, the cycle is aborted. If the instrument is executing a measurement cycle, it will be aborted upon receipt of a Bus Trigger. The 3456A has to be programmed to "listen" to execute the trigger.

3-126. Clear.

3-127. The Clear Message sets the 3456A to the turn-on state. This action is similar to pressing the RESET button on the instrument's front panel. The Clear, Turn-On, and Reset differences are listed in Table 3-6.

Table 3-6. 3456A Clear, Home, and Reset Differences.

	Status Byte Byte Reset	HP-IB Address Reset	Hardware Reset	Program Memory and Reading Storage Clear	Time
Power-On	Y	Y	Y	Y	= 3 sec
Reset	Y	Y	N	N	< .5 sec
Clear	Y	N	N	N	< 5 msec
Home	Y	N	N	N	< 5 msec
Note: Y = YES, N = NO					

3-128. Remote.

3-129. The 3456A is in the local front panel mode when first turned on. A Remote Message allow the 3456A to be controlled over the HP-IB. In Remote, the front panel controls are disabled (except the LOCAL button) and are then controllable over the HP-IB. The instrument's initial set up is determined by the front panel setting before being placed in remote.

3-130. Local.

3-131. This message clears the remote operation of the 3456A and enables the front panel operation. Pressing the front panel LOCAL button also sets the instrument to local, provided the button has not been disabled by the Local Lockout Message (see next paragraph).

3-132. Local Lockout.

3-133. This message disables the 3456A's Local Front Panel controls, including the LOCAL button. The message is in effect until the message is cleared over the HP-IB or power is cycled.

3-134. Clear Lockout and Set Local.

3-135. This message places the 3456A to local and clears the Lockout.

3-136. Require Service (SRQ).

3-137. The Require Service Message (SRQ) is independent of all other HP-IB activity and is sent on a single line called the SRQ line. Its state is either true or false, with low being true and high being false. When the Require Service Message is sent and more than one device on the HP-IB has the capability to send this message, the user must decide which device is sending the message. This is done by conducting a "Serial Poll" for the device(s) on the Bus. The device polled responds by sending a Status Byte. The Status Byte indicates whether the device has requested service and if so, for what reason. If the device polled shows that it did not send the Require Service Message, the other devices would typically be polled. Paragraph 3-140 describes the 3456A's Status Byte.

3-138. When the 3456A sends a Require Service Message, the front panel SRQ LED is on. The message and LED are cleared when the 3456A is polled, although some of the messages are cleared by the instrument (i.e. Front Panel SRQ, Program Memory Complete, and Data Ready). The following are the conditions that can cause a Require Service Message.

Front Panel SRQ (can be cleared by the 3456A)
Program Memory Execution Complete (can be cleared by the 3456A)
Data Ready (can be cleared by the 3456A)
Trigger Too Fast
Illegal Instrument State/Internal Error/Syntax Error
Program Memory Error
Limits Failure

3-139. The 3456A requires service only if told to do so. It has to be programmed to output the Require Service Message for the previously listed conditions. This is done by setting the Service Request Mask. The mask is set by sending certain program codes to the 3456A and is explained in Paragraph 3-169.

3-140. Status Byte.

3-141. The Status Byte Message is output by the 3456A in response to a Serial Poll. Each bit represents a message. Table 3-7 lists the bits which are defined as follows.

NOTE

Remember to set the SRQ mask to output the Require Service Message.

a. Front Panel SRQ. A Require Service Message can be output when pressing the 3456A's front panel SRQ button. The button is only enabled in Local operation.

b. Program Memory Execution Complete. A Require Message is output when the 3456A's internally programmed operation, called Program Memory, is completed. Information on the Program Memory Operation is in Paragraph 3-200.

Table 3-7. Status Byte Definition.

Octal Code	Decimal Code	Bit	Definition
101	65	0	Front Panel SRQ - When the front panel SRQ button is pressed, this Require Service is output. Pressing the button a second time will clear the Service Request.
102	66	1	Program Memory Execution Complete -Indicates to the controller that all the program codes in the 3456A's internal memory are executed. The Require Service condition is cleared when the Program Memory is executed again.
104	68	2	Data Ready - Indicates to the controller that measurement data is ready to be output. The Require Service is cleared when a new measurement cycle is initiated.
110	72	3	Trigger Too Fast - Indicates that the 3456A was triggered while executing a measurement cycle. This only occurs in External Trigger.
120	80	4	Illegal Instrument State - Indicates that the 3456A is unable to do an operation because of an invalid set-up (e.g. 10 M ohm range in DCV) Internal Error - Indicates a failure in the 3456A Syntax Error - Indicates to the controller that invalid Program Code(s) where sent to the 3456A (e.g. code F9)
140	96	5	Program Memory Error - Indicates that the Program Memory Execution command or the Test function was stored in memory, or an overflow of memory occurred while loading into memory.
300	192	7	Limits Failure - Indicates that the Pass/Fail measurement made is out of the selected limits.

Note: Bit 6 is not in this table, because it is the SRQ bit.

c. Data Ready. A Require Service Message is output when the 3456A's measurement cycle is completed (e.g. a DCV reading is taken). More information on Data Ready is in Paragraph 3-206.

d. Trigger Too Fast. This Require Service Message is output if the 3456A is triggered while outputting data over the HP-IB. This can only be caused by the External Trigger.

e. Illegal Instrument State/Internal Error/Syntax Error. This Message is output for the following conditions:

1. Illegal Instrument State. An Illegal Instrument State is when the 3456A is, for example, unable to complete internal operations. An example is programming the instrument to the 10 M ohm range while in the DCV function. This range is invalid in the DCV function.

2. Internal Error. An Internal Error occurs is when a digital failure occurs in the 3456A. If this may happen, refer the instrument to a Service Trained Person.

3. Syntax Error. A Syntax Error is when invalid programs codes are sent to the 3456A. An invalid program code is F9.

f. Program Memory Error. This error occurs under the following two conditions.

1. When trying to execute the program memory from memory (program codes X1 in program memory) and when enabling the Internal Test from memory (program codes TE1 in memory). Both conditions terminate the Program Memory Operation.

2. When exceeding internal memory space during program memory loading (storing more than 1400 bytes into memory).

g. Limits Failure. A Limits Failure occurs when a limit is exceeded in the 3456A's Pass/Fail math operation. More information on the Pass/Fail feature is in Paragraph 3-81.

3-142. The Status Byte Message in Figure 3-10 is represented in octal code. Each bit, except for bit 6, indicates a particular Require Service condition. Bit 6 (seventh bit) is the Service Request bit and is true when service is required. The bit lets the controller know that a Require Service condition exists. Remember, set the SRQ mask to output the Require Service Message.

3-143. If the SRQ mask has been set for more than one condition, more than one bit of the Status Byte Message may be true. For example:

a. A Require Service condition sets bits 1, 2, and 6 true. (Remember, bit 6 is true for any Require Service.) The conditions are caused by Program Memory Execution Complete and Data Ready.

b. The Status Byte looks like:

b_7							b_0
0	1	0	0	0	1	1	0

NOTE

A "1" in this example indicates a true condition.

c. The byte is output in octal code and the corresponding octal number is:

01 000 110 → 106

The resultant decimal number of octal 106 is 70.

3-144. Status Bit.

3-145. The 3456A does not respond to a Parallel Poll.

NOTE

The Status Bit is not part of the Status Byte Message and should not be confused with the bits in the Status Byte Message.

3-146. Pass Control.

3-147. The 3456A does not have controller capabilities.

3-148. Abort (Interface Clear).

3-149. All HP-IB communication is terminated, including the 3456A's Bus communication. Control is returned to the system controller. The Abort Message does not remove the 3456A from remote control.

3-150. 3456A Addressing.

3-151. HP-IB requires that a device on the Bus needs to be identified as a Listener or a Talker, in order to execute the Bus Messages and commands. Because of this requirement, each device on the HP-IB has a unique "listen" and "talk"address to distinguish themselves from each other. The device is then able to receive programming instructions when addressed to listen or sent data when addressed to talk.

3-152. The 3456A's address is set by the address switch located at the instrument's rear panel. The switch is a seven section "DIP" switch with five switches used for

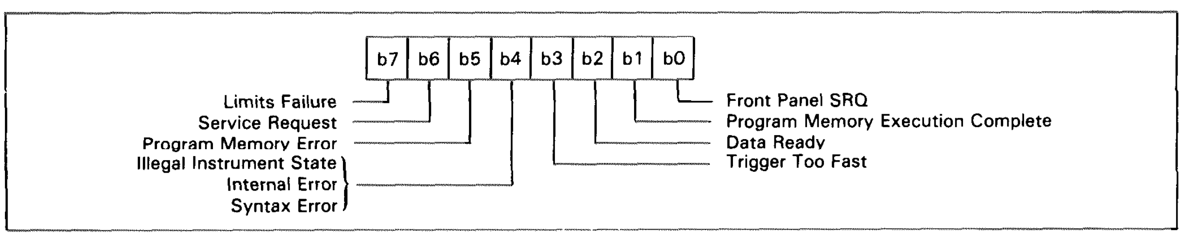


Figure 3-10. Status Byte.

address selection, as shown in Table 3-8. The sixth switch is not used and the seventh switch sets the instrument to the "Talk-Only" mode (see Paragraph 3-154). The 3456A's allowable address settings are listed in Table 3-8. Its factory address setting is a listen address of 22 decimal (ASCII character "6") and a talk address of 54 decimal (character "V").

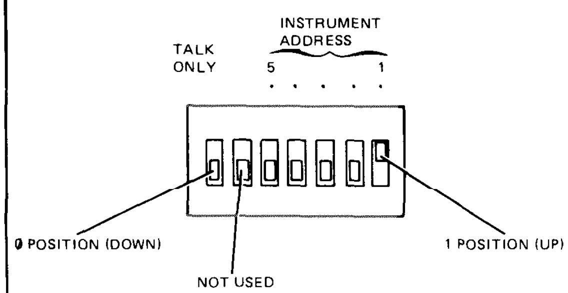
NOTE

Setting the 3456A's Address Switch to the Listen Address' corresponding decimal code will also set the Talk Address.

3-153. Instrument address commands are usually in this form:

universal unlisten, device talk, device listen.

Table 3-8. 3456A Address Codes.



ASCII Code Character		Address Switches					5-bit
Listen	Talk	A5	A4	A3	A2	A1	Decimal Code
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
0	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 ← 3456A FACTORY Setting
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

The universal unlisten command removes all listeners from the HP-IB to allow only the addressed listener to receive information. The information is sent by a talker which is designated by the device talk code.

3-154. Talk-Only (No Controller).

3-155. Setting the 3456A to the "Talk-Only" mode can provide measurement data to another device, like a printer, without a Bus controller. The 3456A is placed to the "Talk-Only" mode by setting the rear "DIP" switch to the mode (set the seventh switch to "1"). Once this is done measurement data is output after each trigger. Instrument set up (function, range, etc.) is done from the front panel.

3-156. 3456A HP-IB Programming.

3-157. Now that the basic HP-IB operation is known, the next thing is to program and use the 3456A over the Bus. First, determine the measurement or instrument operation you want. Then determine the 3456A's program codes. The codes are ASCII characters transmitted over the HP-IB to the instrument.

3-158. Once you have defined the instrument criteria and program codes, next write an algorithm on how to make the measurement. When you have done this, convert the Algorithm to controller language. Refer to your controller's operating manual for the language.

3-159. Algorithm.

3-160. The algorithm should show exactly how to set up and use the instrument in a certain function. To simplify the algorithm, use the twelve Bus Messages as key words in the algorithm. The messages are repeated here for your reference.

1. DATA
2. TRIGGER
3. CLEAR
4. REMOTE
5. LOCAL
6. LOCAL LOCKOUT
7. CLEAR LOCKOUT AND SET LOCAL
8. REQUIRE SERVICE
9. STATUS BYTE
10. STATUS BIT
11. PASS CONTROL
12. ABORT

3-161. The definitions of the Bus Messages are given in this manual's Appendix A, Paragraph A-11. Remember, refer to your controller manual to convert the messages. If you have an -hp- Model 9825A Controller, the controller's Extended I/O Manual (-hp- Part Number 09825-90025) has a listing of the codes. For the 9835A/B, refer to the I/O Programming Manual (-hp- Part Number 09835-90060). If your controller manual does not have a code conversion chart, you may be able to use the technical description of the messages located in Appendix A.

3-162. Here is an example Algorithm for the 3456A. Note that only the key words are used, not the codes.

a. In this algorithm, the 3456A is set up to make a DCV measurement, output it over the HP-IB and print the reading. The program ends if the 3456A sends a Require Service Message. The algorithm is as follows.

1. ABORT all previous operations
2. Set the 3456A to REMOTE
3. CLEAR the 3456A
4. LOCAL LOCKOUT the Instrument
5. Send DATA to set up the 3456A to
   a) the dc function
   b) autorange
   c) hold trigger
   d) set SRQ mask to Illegal Instrument State, Internal Error, and Syntax Error.
6. TRIGGER the 3456A
7. Send the measurement DATA to the controller and store in a variable
8. Check the 3456A to see if it REQUIRE's SERVICE
9. If REQUIRE SERVICE, check the STATUS BYTE; otherwise skip the next step
10. If the 3456A sent the STATUS BYTE, it did REQUIRE SERVICE and the program is ended
11. Print out the DATA from the variable
12. CLEAR LOCKOUT AND SET LOCAL
13. End program

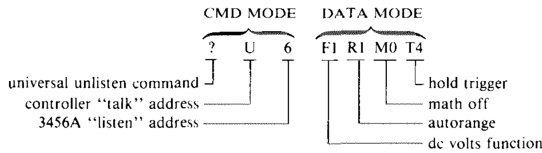
3-163. Programming the 3456A over the HP-IB.

3-164. Programming the 3456A is done by DATA messages. Remember, DATA is sent or received. The DATA received by the 3456A is for instrument set up (function, range, etc.). The DATA sent by the 3456A is output data. Included in the following paragraph are programming examples of the Bus Messages and the algorithm. They are given in the HP-IB format, HPL (9825A Controller Language), and Enhanced Basic (9835A/B and 9845B Controller Language).

3-165. Program Codes (Data received by the 3456A).

3-166. Program codes are used for the 3456A's set up information. A listing of the codes is in Table 3-9. The instrument must be in "remote" and "listen" to receive the codes. An example is as follows.

a. HP-IB Format:



b. HPL (9825A Controller Language).

wrt 722,"F1 R1 M0 T4"

c. Enhanced Basic (9835A/B, 9845B Controller Language).

OUTPUT 722;"F1 R1 M0 T4"

NOTE

The "7" in the "722" address code is the 9825A, 9835A/B and 9845B Controllers I/O Card select code.

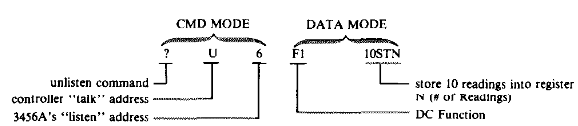
NOTE

The spaces between the program codes (F1spaceR1, etc.) shown in the example are not necessary. They are only included to separate the different program codes.

3-167. Storing into Registers (Y, Z, Delay, etc.) over the HP-IB.

3-168. Storing into register is similar to the front panel method. First enter the number to be stored and then store it into the register. The following examples shows how to do it, by storing "10" into the Number of Readings/Trigger register. The DCV function's program codes is also included in the example to show that other than register program codes can be in the same string.

a. HP-IB Format.



b. HPL (9825A Controller Language).

wrt 722,"F1 10STN"

Table 3-9A. 3456A Program Codes.

	Control	Program Code
FUNCTION	Shift Function Off (Unshifted)	S0
	DCV	F1
	ACV	F2
	ACV + DCV	F3
	2 Wire K Ohms	F4
	4 Wire K Ohms	F5
	Shift Function On (Shifted)	*S1*
	DCV/DCV Ratio	F1
	ACV/DCV Ratio	F2
	ACV + DCV/DCV Ratio	F3
	O.C. 2 Wire K Ohms	F4
	O.C. 4 Wire K Ohms	F5
RANGE	Auto	R1
	100 mV or .1 K Ohms	R2
	1000 mV or 1 K Ohms	R3
	10 V or 10 K Ohms	R4
	100 V or 100 K Ohms	R5
	1000 V or 1 M Ohms	R6
	10 M Ohms	R7
	100 M Ohms	R8
	1000 M Ohms	R9
TRIGGER	Internal	T1
	External	T2
	Single	*T3*
	Hold	T4
AUTOZERO	On	Z1
	Off	Z0
FILTER	On	FL1
	Off	FL0
TEST	On	TE1
	Off	TE0
REGISTERS	Storing into Registers	ST
	Recalling Registers	RE
	Number of Readings	N
	Number of Digits Displayed	G
	Number of Power Line Cyc. Int.	I
	Delay	D
	Mean Register (Read only)	M
	Varience Register (Read only)	V
	Count Register (Read only)	C
	Lower Register	L
	R Register	R
	Upper Register	U
	Y Register	Y
	Z Register	Z
MATH	Off	M0
	Pass/Fail	M1
	Statistic (Mean, Variance, Count)	M2
	Null	M3
	dBm	M4
	Thermistor (°F)	M5
	Thermistor (°C)	M6
	Scale [(X - Z)/Y]	M7
	%Error [(X - Y)/Y x 100]	M8
	dB (20 Log X/Y)	M9
READING STORAGE	On	RS1
	Off	RS0
SYSTEM OUTPUT MODE	On	SO1
	Off	SO0
DISPLAY	On	D1
	Off	D0
OUTPUT FORMAT	Packed Format On	P1
	Packed Format Off (ASCII Format)	P0
CLEAR-CONTINUE	Active	CL1
NUMERIC SEPARATOR	Separates Numbers (e.g. F1W10STN)	W
HOME COMMAND	Software Reset	H
FRONT/REAR SWITCH SENSE	1 = Front, 0 = Rear	SW1
EOI	Enable	O1
	Disable	O0
PROGRAM MEMORY	*Load Program (Syntax) On*	*L1*
	Load Program (Syntax) Off	Q
	Execute Program Memory	X1

c. Enhanced Basic (9835A/B, 9845B Controller Language).

OUTPUT 722;"F1 10STN"

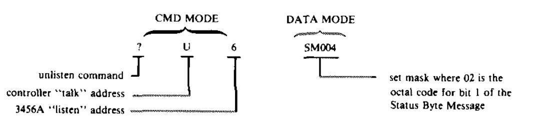
In the example, "F1" and "10STN" is separated by a space to keep the numbers apart. This is not necessary but may be less confusing. You can, however, enter a "W" instead of a space. The "W" is ignored by the 3456A but can be used to separate numerical entries from commands. The same program string with "W" looks like this:

"F1W10STN"

3-169. Programming the SRQ Mask.

3-170. Program codes are used to set the SRQ Mask. Use the programming procedure in Paragraph 3-165 to send the codes. Remember, the 3456A has to be in "remote" and "listen" to receive the codes. Since the Status Byte Message is in octal, the mask is programmed in octal by using the corresponding octal codes of the message. For example, bit 2 (Data Ready) is to be set and is done by sending its octal code, 004. The following example illustrates this.

a. HP-IB Format.



b. HPL (9825A Controller Language).

wrt 722, "SM004"

c. Enhanced Basic (9835A/B, 9845B Controller Language).

OUTPUT 722; "SM004"

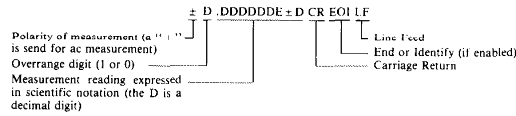
3-171. Any, all, or combinations of the Require Service conditions can be set by programming the SRQ mask. All the bits can be disabled by programming the mask to "000".

3-172. 3456A's Measurement DATA (Data sent by the 3456A).

3-173. 3456A measurement data can be sent to the controller in two different formats, ASCII or Packed Format. The following explains the formats.

3-174. ASCII Format.

3-175. **Output Statement.** The 3456A's output data in the ASCII Format consists of 14 bytes and is in this form:

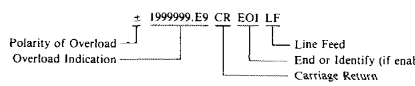


NOTE

The decimal point in the output statement is "free field" and can move to any place on the left side of the "E" and the right of the overrange digit.

Each character in the output statement is one byte and adds up to 14 bytes (the Carriage Return and Line Feed are one character each). The first digit (D) is the overrange digit and is either "1" or "0". The decimal point can be anywhere between the right of the overrange digit (shown in this example) and the left of the exponent ("E"). The Carriage Return and Line Feed are used to terminate the output statement. The End or Identify (EOI) line is normally set by the 3456A prior to the Line Feed if enabled. The EOI statement can be disabled over the HP-IB (see Paragraph 3-186).

3-176. **Overload Output Statement.** The output statement from an overload condition is in this form:



The overload polarlity depends on the type of overload condition. A "+" is normally output when a measurement overload is present. A "-" can be output when a math overload condition is present.

3-177. **Multiple Reading Output.** The output statement for multiple readings (Number of Readings per Trigger feature) is similar to the normal output statement. The only difference is that no Carriage Return (CR), Line Feed (LF), and End or Identify (EOI) is output until all readings are taken. A comma (,) is used in their place to separate the readings. An example for 3 multiple readings is as follows:

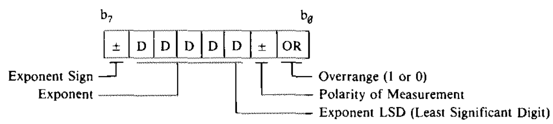
+D.DDDDDDE+D,-DD.DDDDE+D,
+DDD.DDDDE-D CR EOI LF

3-178. Packed Format.

3-179. Unlike the ASCII Format, the Packed Format outputs 4 bytes instead of 14. A faster reading transfer is possible using the Packed Format. Before the 3456A can output readings in the packed mode, it must be remotely programmed. The codes are "P1" (see Table 3-9) to enable and "P0" to disable the Packed Format. The ASCII Format is automatically selected at turn-on.

3-180. Output Statement. Once the 3456A is programmed to output data in the Packed Format, each measurement is output in 4 bytes. Each byte shows a certain part of the measurement data. Here is a graphic description of the packed mode.

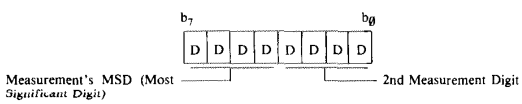
First Byte



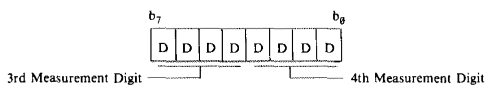
NOTE

The decimal point in the Packed Format is implied to the Overrange Digit's left.

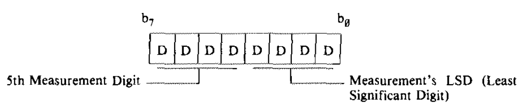
Second Byte



Third Byte



Fourth Byte



The sign (polarity) is indicated with "+" as a "0" and "-" as a "1". The exponent and the measurement digits are in packed Binary Coded Decimal (BCD). The decimal point is implied to the overrange digit's left. The End or Identify (EOI) line is normally set prior to the 4th byte.

3-181. Overload Output Statement. The Overload Output Statement in the Packed Format follows the same number convention as the ASCII overload statement. The difference is that the numbers representing the overload condition is output in the Packed mode.

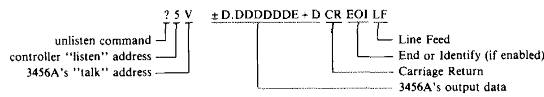
3-182. Multiple Reading Output. No delimiters are used between the readings with the End or Identify (EOI) being suppressed. The EOI will not be activated until all readings are output.

3-183. Unpacking the Packed Output. Since only four bytes of data is output in the Packed Format, some sort of unpacking should be done for the reading(s) to make sense. This is done simply by converting each 8 bit binary number to a decimal number. An unpacking program using Enhanced Basic (9835A/B, 9845B Controller Language) is in Appendix A.

3-184. Reading the 3456A's Output Data.

3-185. First choose the output format you wish to use. The ASCII Format is chosen in this example. To output data, the 3456A has to be addressed to "talk" and the device receiving the data is the listener. Here is an example.

a. HP-IB Format.



b. HPL (9825A Controller Language).

red 722,A

c. Enhanced Basic (9835A/B, 9845B Controller Language).

ENTER 722;A

NOTE

Although it is not specified in the HP-IB Format, the output of the 3456A is normally stored in a variable. This is the reason why variable "A" is used in the controller language examples.

3-186. Disabling the End or Identify (EOI) Statement.

3-187. The End or Identify (EOI) statement can be disabled over the HP-IB for a faster transfer of readings. This is done by sending program codes "O0" to the 3456A using the programming procedure in Paragraph 3-165. Disabling the EOI statement and using the 3456A's Internal Trigger mode allows the faster possible reading transfer. The EOI statement is enabled by sending codes "O1" and at turn-on.

3-188. System Output Mode.

3-190. With the 3456A's System Output Mode enabled, a new measurement cycle is not initiated until the present reading is output by the instrument. The reading is output by addressing the 3456A to "talk". Once this is done, a new measurement cycle is started. As long as the System Output mode is enabled and no reading is output, the instrument does not take any new readings. The mode is an advantage when using controllers slower than the 3456A. For example, if the Number of

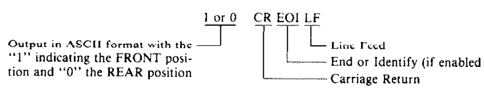
Readings per Trigger operation is selected to output readings, the readings are output one after another. A slow controller may not be able to accept the readings at the 3456A's output speed and loose some or all readings. The System Output mode prevents this from happening. The 3456A waits until the controller is able to receive data. The mode is enabled by sending program codes "SO1" and disabled by codes "SO0". Use the programming procedure in Paragraph 3-165 to send the codes.

3-191. Home Command.

3-192. The Home Command is used to reset the 3456A to the same conditions as sending the CLEAR message, except faster. The differences between Home, Clear, Reset, and Turn-On are listed in Table 3-6. The Home Command is sent by program code "H" using the programming procedure in Paragraph 3-165.

3-193. Front/Rear Switch Position.

3-194. The Front/Rear Switch position can be remotely determined over the HP-IB. This is done by sending program codes "SW1" to the 3456A and then reading its output. If "0" is output, the switch is set to REAR and "1" indicates FRONT. Use the programming procedure in Paragraph 3-165 to send the codes and the procedure in Paragraph 3-184 to read the output data (switch position). The output is as follows:



3-195. Complete Program Example.

3-196. After you know how to program the 3456A using the HP-IB, the next step is to write a program of the algorithm in Paragraph 3-162. Again, the program is given in the HP-IB Format, HPL (9825A Controller Language), and Enhanced Basic (9835A/B, 9845B Controller Language).

a. HP-IB Format.

1. Interface clear	ABORT all previous operation
2. ?U6	REMOTE the 3456A
3. ?U6 *004*	CLEAR the instrument
4. *021*	LOCAL LOCKOUT the 3456A (including the other devices on the controller's select code)
5. ?U6 F1R1T4SM020 *15 12*	Send DATA to set up the instrument to the dc function, autorange, hold trigger, and set SRQ bit 4 mask (15 is CR and 12 is LF)
6. ?U6 *010*	TRIGGER the 3456A
7. ?U5V +D.DDDDDDE+D *015* EOI *012*	Send the measurement DATA to the controller and store in a variable
8. ?5V *030*	If REQUIRE SERVICE, check the STATUS BYTE; otherwise skip the next step (the 030 is the Serial Poll enable)
9, 10. *031*	No STATUS BYTE is sent by the 3456A (the 031 is the Serial Poll disable)
11. Controller Language	Print out the DATA in variable A
12. ?U, *001*	CLEAR LOCKOUT AND SET LOCAL (in this case, only for the 3456A)
13. Controller Language	Ends the program

b. HPL (9825A Controller Language).

0: cli 7	ABORT
1: rem 722	REMOTE 3456A
2: clr 722	CLEAR 3456A
3: llo 7	LOCAL LOCKOUT
4: wrt 722, "F1R1T4SM020"	DATA. Set up instrument
5: trg 722	TRIGGER 3456A
6: red 722,A	DATA.Output of 3456A into variable
7: rds (722) → S	REQUIRE SERVICE?
8: if S=0; gto 10	If no STATUS BIT, skip the next line
9: stp	Stop the program
10: prt A	Print output DATA in variable
11: lcl 722	CLEAR LOCKOUT AND SET LOCAL (3456A)
12: end	Ends the program

c. Enhanced Basic (9835A/B, 9845B Controller Language).

10 ABORTIO 7	ABORT
20 REMOTE 722	REMOTE 3456A
30 CLEAR 722	CLEAR 3456A
40 LOCAL LOCKOUT 7	LOCAL LOCKOUT
50 OUTPUT 722; "F1R1T4SM020"	DATA. Set up instrument
60 TRIGGER 722	TRIGGER 3456A
70 ENTER 722;A	DATA. Output of 3456A into variable
80 STATUS 722;S	REQUIRE SERVICE?
90 IF S=0 THEN GOTO 110	If no STATUS BIT, skip the next line
100 STOP	Stop the program
110 PRINT A	Print output DATA in variable

120 LOCAL 722	CLEAR LOCKOUT AND SET LOCAL
130 END	Ends the program

3-197. The information you have received in the preceding paragraphs should give you a good start in programming the 3456A over the HP-IB. The following paragraphs explain some more unique remote operations.

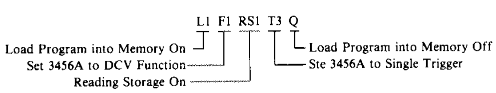
3-198. Front Panel SRQ.

3-199. The Front Panel SRQ feature of the 3456A outputs a Require Service Message when the Front Panel SRQ button is pressed. Before this can take place, set bit 0 on the SRQ mask (refer to Paragraph 3-169 to set the mask). Once this is done, press the SRQ button. The front panel SRQ LED will turn on and the Require Service Message is output. This condition will remain until the SRQ button is pressed a second time or a Serial Poll is done by the controller.

3-200. Instrument Program memory Operation.

3-201. With this feature, you can store into the 3456A's internal memory any valid remote operations (excluding Test and Program Memory Execution) using program codes. Total available memory size is 1400 bytes. Because a program code takes one byte of memory you can store 1400 codes. The memory is also used with Reading Storage and any stored codes takes space away for storing readings.

3-202. Storing Program Codes. The 3456A has to be told to store into its internal memory. The program used are "L1" to enable the storage and "Q" to disables the storage. This is illustrated in the following example.



Program codes "L1" and "Q" are not stored into memory. The total memory used is 7 bytes. The codes remain in memory until the 3456A is turned off (Reset, Clear, and Home do not clear the memory). The memory can be cleared by sending codes "L1Q".

NOTE

Unlike regular remote operation, program memory only ignores blanks. Other invalid characters can produce a Syntax Error during program memory execution.

3-203. Program Execution. Once the program codes are stored in memory they can be executed. This is done by sending program codes "X1" to the 3456A. The instrument then performs the operation. In the previous example, when Program Memory is executed, a dc reading is taken and stored into memory.

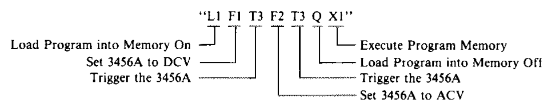
NOTE

The Execute (X1) and Internal Test (TE1) codes can cause a program memory execution error.

NOTE

With Home (H) command stored in program memory while executing the memory the 3456A is reset to the Turn-On state and stops the program memory operation.

3-204. Multiple Operations. You can store and execute more than one remote operation into memory. For example, the 3456A can be programmed to do a DCV measurement, Trigger it, do an ACV measurement, Trigger it, and so on. The next example illustrates this.



3-205. Recall of Readings from Memory. Readings are remotely recalled and output from memroy similar to the front panel recall operation (see Paragraph 3-104). This is done by storing into register R the corresponding number of the reading you wish to recall. Then recall the register and output the reading. The following procedure illustrates this operation. In the procedure, reading #1 and #2 are to be recalled.

a. Set the 3456A to listen. Sent the program codes for Hold Trigger, Reading Storage On, and store a "1" (reading #1) into register R.

"T4 RS1 1STR"

b. Sent program codes to recall the R register.

"RER"

c. Set the 3456A to talk. Output the reading (#1) over the HP-IB.

d. Set the 3456A to listen. Sent the program codes to store a "2" (reading #2) into register R.

"2STR"

e. Sent program codes to recall the R register.

"RER"

f. Set the 3456A to talk. Output the reading (#2) over the HP-IB.

NOTE

Make sure the 3456A is programmed to Hold or Single Trigger when recalling readings.

The remote recall operation is similar to the front panel operation. Scrolling is also done similar to front panel operation. An example to scroll the readings, starting with #10, is as follows.

a. Set the 3456A to listen. Sent program codes for Hold Trigger, Reading Storage On, and store "-10" into register R. (The -10 is used to scroll the readings starting with reading #10.)

"T4 RS1 -10STR"

b. Sent program codes to recall the R register.

"RER"

c. Set the 3456A to talk. The readings are now output over the HP-IB starting with reading #10 and ending with #1.

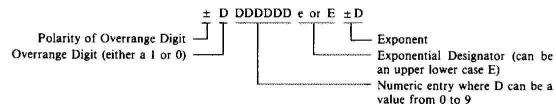
In the example, multiple readings are output the same as explained in paragraph 3-177. A program example using HPL (9825A Controller Language) and Enhanced Basic (9835A/B and 9845B Controller Language) is given in Appendix A.

3-206. Data Ready.

3-207. The Data Ready feature, when enabled, outputs a Require Service Message for a completed measurement cycle. The SRQ mask has to be set before the message is output. Set the mask by sending program codes "SM004" (for bit 2 of the Status Byte). When the Require Service message is sent, the front panel SRQ LED is on. The LED remains on until a new measurement cycle is started (the 3456A is triggered), when the present reading is output over the HP-IB, or when the 3456A is polled (Serial Poll). If the 3456A is set up to take a number of readings per trigger, the require service condition will be true, at the end of each reading, for about 320μs. The condition will remain true and the SRQ LED turns on, after all the readings are taken.

3-208. 3456A's Numeric Entry Format and other Input Considerations.

3-209. The 3456A's Numeric Entry Format (used in program codes) are in this form:



The decimal point is optional and ranges from the right of the overrange digit to the Exponential Designator's left.

3-210. When sending data to the 3456A in remote, all lower case (except "e") alpha characters, spaces, carrage return, and line feed are ignored. All other invalid ASCII characters are illegal. The optional "W" character can be used as a prefix to a numeric string like this"

F1W10STN

3-211. OPERATOR'S CHECK.

3-212. The following is an Operator's Check you can perform to check the major DCV, ACV, Ohms, and Digital circuitry. The checks are not used to verify performance accuracy. They are only used to check the operating capabilities of the 3456A. The following can be used as the Operator's Check.

a. Remove everything from the 3456A's input terminals.

b. press the TEST button. The display should go blank while doing an internal test. When the test passes and is completed, +1.8.8.8.8.8.8.+8. is displayed including all of the front panel LEDs. The cycle will then be repeated. If a negative integer is displayed, refer the 3456A to a service trained person. Press the TEST button a second time.

APPENDIX A

A-1. INTRODUCTION.

A-2. The following chapters in this appendix contain certain general and specific HP-IB information. The general information is non-controller dependent but may be dependent on the 3456A. The specific information is controller and/or instrument dependent.

A-3. GENERAL HP-IB DESCRIPTION.

A-4. The Hewlett-Packard Interface Bus (HP-IB) is a carefully defined interface which simplifies the integration of various instruments, calculators, and computers into systems. The interface provides for messages in digital form to be transferred between two or more HP-IB compatible devices. A compatible device can be an instrument, calculator, computer, or peripheral device that is designed to be interfaced using the HP-IB.

A-5. The HP-IB is a parallel bus of 16 active signal lines grouped into three sets, according to function, to interconnect up to 15 instruments. A diagram of the Interface Connections and Bus Structure is in Figure A-1.

A-6. Eight signal lines, termed as DATA lines, are in the first set. The Data lines are used to transmit data in the form of coded messages. These messages are used to program instrument function, transfer measurement data, coordinate instrument operation, and to manage the system. This allows you to set-up the instrument and read its measurement data. Input and output of messages in bit-parallel, byte-serial form are also transferred in the Data lines. A 7-bit ASCII code normally represents each piece of DATA.

A-7. Data is transferred by means of an interlocking "handshake" technique which permits data transfer (asynchronously) at the rate of the slowest active device used in that particular transfer. The three DATA BYTE CONTROL lines coordinate the transfer and form the second set of lines.

A-8. The remaining five GENERAL INTERFACE MANAGEMENT lines are used to manage the devices on the HP-IB. This includes activating all connected devices at once, clearing the interface, and others. A condensed description of the HP-IB is available in the

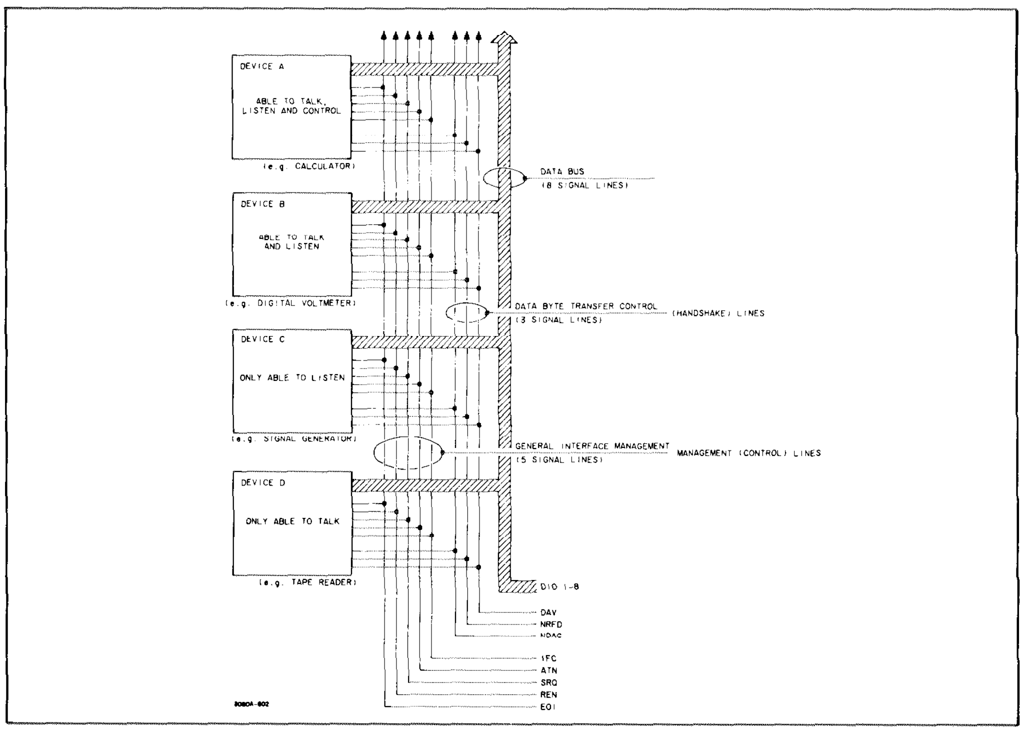


Figure A-1. Interface Connection and Bus Structure.

Condensed Description of the Hewlett-Packard Interface Bus Manual, -hp- Part Number 59401-90030. The manual is available through your nearest -hp- Sales and Service Office.

A-9. HP-IB SYSTEM OVERVIEW.

A-10. The following chapters define the terms and concepts used to describe HP-IB (Bus) system operations.

A-11. HP-IB System Terms.

a. Address: The characters sent by a controlling device to specify which device will send information on the HP-IB and which device(s) will receive that information. Addressing may also be accomplished by hardwiring a device to only send information or only receive information.

b. Byte: A unit of information consisting of 8 binary digits (bits).

c. Device: A unit that is compatible with the IEEE Standard 488-1975.

d. Device Dependent: An action a device performs in response to information sent over the HP-IB. The action is characteristic of an individual device and may vary from device to device.

e. Polling: This process typically is used by a controller to locate a device that needs to interact with the controller. There are two types of polling, as follows:

1. Serial Poll: This method obtains one byte of operational information about an individual device in the system. The process must be repeated for each device from which information is desired.
2. Parallel Poll: This method obtains information about a group of devices simultaneously.

A-12. Basic Device Communication Capabilities.

A-13. Devices which communicate along the interface bus can be classified into three basic categories:

a. Talker: Any device that is able to send information over the HP-IB, when it has been addressed. Only one talker may be active at a time; usually the one that is currently directed to send data. All HP-IB type calculators and computers are generally talkers.

b. Listener: Devices which receive information over the HP-IB, when they have been addressed. A device may or may not be both a talker and a listener. Calculators or computers are generally both a talker and a listener (at different times).

c. Controller: The device that can specify which devices(s) on the Bus is a talker or a listener. There can be two types of controllers, an Active Controller and a System Controller. The Active Controller is the current controlling device. The System Controller can, however, take control of the HP-IB even if it is not the active controller. There can also be only one controller at a time, even if several controllers are on the Bus.

A-14. HP-IB Messages.

A-15. Different types of information can be passed over the HP-IB to one or more devices. Some of this information is in the form of messages, most of which can be separated into two parts. One part can be classified as the address portion specified by the controller and the information that comprises the messages. The second part can be classified as HP-IB management messages. These messages are comprised of twelve messages and are called meta messages. In this manual they are referred to as Bus Messages and are defined as follow.

a. Data: The actual information (binary bytes) sent by a talker to one or more listener. The information (data) can either be in a numeric form or a character string.

b. Trigger: The trigger message causes the listening device or devices to perform a device dependent action when addressed.

c. Clear: The clear message causes the listening device(s) or all of the devices on the HP-IB to return to their predefined device-dependent state.

d. Remote: This message causes the listening device(s) to switch from local front panel control to remote program control when addressed to listen.

e. Local: This message clears the REMOTE message from the listening device(s) and returns the device(s) to local front panel control.

f. Local Lockout: This message prevents a device operator from manually inhibitating remote program control.

g. Clear Lockout and Set Local: With this mesage, all devices are removed from the local lockout mode and revert to local. The remote message is also cleared for all devices.

h. Require Service: A device can send this message at any time to signify the device needs some type of interaction with this controller. The message is cleared by the device's STATUS BYTE message if the device no longer requires service.

i. Status Byte: A byte that represents the status of a single device on the HP-IB. One bit indicates whether the device sent the required service message and the remaining seven bits indicate operational conditions defined by the device. This byte is sent from the talking device in response to a "Serial Poll" operation performed by the controller.

j. Status Bit: A byte that represents the operational conditions of a group of devices on the HP-IB. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a parallel poll operation.

k. Pass Control: The bus management responsibility is transferred from the active controller to another controller by this message.

l. Abort: The system controller sends this message to unconditionally assume control of the HP-IB from the active controller. The message will terminate all bus comunication but does not implement the CLEAR message.

A-16. HP-IB WORKSHEET.

A-17. The HP-IB Worksheet (Table A-1) can be used to determine the HP-IB capabilities of the other HP-IB compatible instruments may have. The sheet may be filled in with the Bus messages applicability for your controller and each HP-IB device. The Bus capability of the 3456A has already been filled in. Refer to your controller manual and the manual(s) of your other device(s) for their Bus Messages capabilities. Once the sheet is filled out, you should then have the HP-IB capabilities of your device(s).

Table A-1. HP-IB Worksheet.

MESSAGE	HP-IB BUS IMPLEMENTATION WORKSHEET DEVICE									
INSTRUMENT IDENTIFICATION AND HP-IB ADDRESS	MODEL 3456A					MODEL				
	LISTEN YES					LISTEN				
	TALK YES					TALK				
	5 BIT VALUE 22					5 BIT VALUE				
DATA	S & R									
TRIGGER	R									
CLEAR	R									
LOCAL	R									
REMOTE	R									
LOCAL LOCKOUT	R									
CLEAR LO & SET LOCKOUT	R									
REQUIRE SERVICE	S									
STATUS BYTE	S									
STATUS BIT	N									
PASS CONTROL	N									
ABORT	N									

S = SEND ONLY R = RECEIVE ONLY S & R = SEND AND RECEIVE N = NOT IMPLEMENTED

A-18. UNPACKING PROGRAM.

A-19. The following is an unpacking program used to unpack the 3456A's readings taken in the Packed mode. The program is given in the Enchanced Basic (9835A/B and 9845B Controller) Language.

Unpacking Program

```
10    ! The following program illustrates one method for unpacking data from
20    ! the 3456A.  You can program this routine to take "any" number of readings
30    ! by changing the DIM statement in line 20 , the 3456A programming syntax
40    ! in line 30, and the buffered transfer statement in line 40.  The
50    ! numerical array Out is dimensioned to contain the number of readings that
60    ! will be taken The string variable In$ is dimensioned to 4 times the
70    ! number of readings taken.  That is, a packed reading contains 4 bytes of
80    ! data per reading.
90    !
100   ! In this particular example, the 3456A is programmed to the following
110   ! states:
120   ! Function: DCV (F1)
130   ! Data Output Format: Packed (P1)
140   ! Range: Autorange (R1)
150   ! Delay: 0 (0STD)
160   ! Integration Time: .1 Line Cycles (.1STI)
170   ! Number of Readings: 9 (9STN)
180   ! System Output Mode: On (SO1)
190   ! Trigger: Single (T3)
200   !
210   ! You can follow the comment statements on each line of the program to
220   ! understand the basic operation .  Explaining the operation of the
230   ! unpacking subprogram is beyond the scope of this manual.
240   !
250   !
260    OPTION BASE 1  ! Specifies first element in numeric array Out is Out(1).
270    DIM In$[36],Out(9)  ! Dimensions the string variable and numeric array.
280    OUTPUT 722;"P1F1R10STD.1STI9STNSO1T3"  ! Programs the 3456A.
290    ENTER 722 BFHS 36 NOFORMAT;In$ ! Enters 36 data bytes into the string In$.
300    CALL Unpk56(In$,Out(*)) ! Calls Unpacking routine; passes the packed data.
310    FOR I=1 TO 9  ! Sets up loop to print out the number of readings taken.
320    PRINT "NUMBER ";I;" VOLTAGE READING = ";Out(I)
330    NEXT I
340    END
350    SUB Unpk56(In$,Out(*))
360    INTEGER N,J,I,B1,B2,B3,B4
370    N=LEN(In$)
380    J=0
390    FOR I=1 TO N STEP 4
400    J=J+1
410    B1=NUM(In$[I])
420    B2=NUM(In$[I+1])
430    B3=NUM(In$[I+2])
440    B4=NUM(In$[I+3])
450    Out(J)=.1*BIT(B1,0)+.01*SHIFT(B2,4)+.001*BINAND(B2,15)+.0001*SHIFT(B3,4)+.
00001*BINAND(B3,15)+.000001*SHIFT(B4,4)+.0000001*BINAND(B4,15)
460    Out(J)=Out(J)*(1-2*BIT(B1,1))*10↑((1-2*BIT(B1,7))*SHIFT(BINAND(B1,124),2))
470    NEXT I
480    SUBEND
```

A-20. MULTIPLE READING TRANSFER PROGRAMS.

A-21. The following programs show how to transfer multiple readings from the 3456A to the controller. The programs are given in the HPL(9825A Controller) and Enhanced Basic (9835A/B and 9845B Controller) Language. The programs do the following.

a. The 3456A is set up to do this:

1. Clear the 3456A and set SRQ Mask to bit 1 (Program Memory Execution Complete).
2. Enter into memory to enable Reading Storage, select 10 Number of Readings per Trigger, and Single Trigger.
3. Execute Program Memory.

b. Read 3456A Status and remain in a loop until Program Memory has completed its execution.

c. Set up the 3456A to enable its System Output Mode and scroll the internally stored readings starting with #10.

d. Store readings into variables.

HPL Program.

```
0: dim A[10]
1: wrt 722,"HSM002L1RS110STNT3QX1"
2: if rds(722)#66;jmp 0
3: wrt 722,"S01-10STRRER"
4: for I=1 to 10
5: red 722,A[I]
6: next I
7: for I=1 to 10
8: prt A[I]
9: next I
10: end
*22514
```

Enhanced Basic Program

```
10   OPTION BASE 1
20   DIM A(10)
30   OUTPUT 723;"HSM002L1RS110STNT3QX1"
40   STATUS 723;S
50   IF S<>66 THEN GOTO 40
60   OUTPUT 723;"S01-10STRRER"
70   ENTER 723;A(*)
80   MAT PRINT A
90   END
```

A-22. BUS MESSAGE IMPLEMENTATION.

A-23. The following figures provide a description on the implementation of the Bus Messages using the 3456A. The codes used in the figures are:

T = True
F = False
X = Don't Care
oct = Octal Code

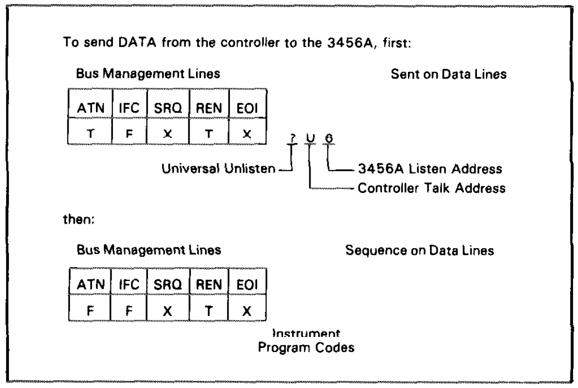


Figure A-2. Data Message (Controller to 3456A).

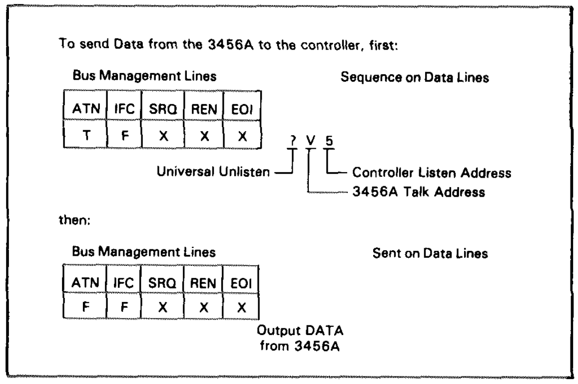


Figure A-3. Data Message (3456A to Controller or Other Device(s).

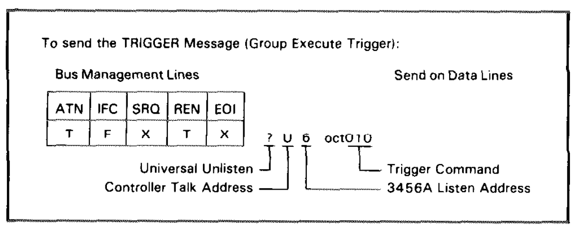


Figure A-4. Trigger Message (from Controller do Device(s)).

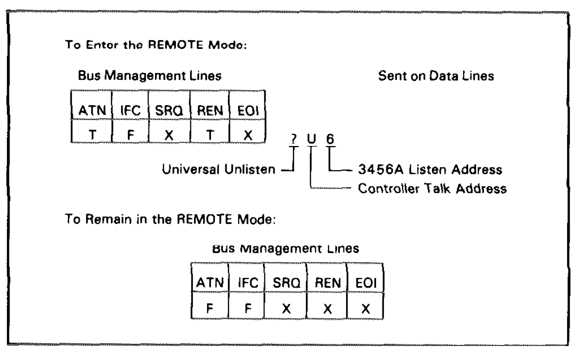


Figure A-5. Remote Message.

To enter the LOCAL Mode:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
T	F	X	T	F

? U 6 oct001

Universal Unlisten (?), Controller Talk Address (U), 3456A Listen Address (6), Go to Local instruction (oct001)

Figure A-6. Local Message.

To enable LOCAL LOCKOUT:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
T	F	X	T	F

oct 021 — Local Lockout instruction

to maintain LOCAL LOCKOUT:

Bus Management Lines

ATN	IFC	SRQ	REN	EOI
X	X	X	T	X

Figure A-7. Local Lockout Message.

To CLEAR LOCAL LOCKOUT and set LOCAL:

Bus Management Lines

ATN	IFC	SRQ	REN	EOI
X	X	X	T	X

Figure A-8. Clear Lockout/Set Local Message.

To send REQUIRE SERVICE MESSAGE:

Bus Management Lines

ATN	IFC	SRQ	REN	EOI
X	X	T	X	X

Figure A-9. Require Service Message.

To Serial POLL the 3456A (obtain Status Byte):

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
T	F	X	X	F

? 6 oct030 V 5

Universal Unlisten (?), 3456A Listen Address (6), Serial Poll Enable (oct030), 3456A Talk Address (V), Controller Listen Address (5)

then:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ*	REN	EOI
F	F	X	X	F

3456A Status Byte

*If SRQ was true, it will switch to the false state.

and finally:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
T	F	F	X	F

oct 031 — Serial Poll Disable

Figure A-10. Status Byte Message.

To send the CLEAR Message:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
T	F	X	X	X

oct004 — Clear Command

To send the CLEAR MESSAGE Only to the 3456A:

Bus Management Lines — Sent on Data Lines

ATN	IFC	SRQ	REN	EOI
F	F	X	T	X

? 6 oct 004

Universal Unlisten (?), 3456A Listen Address (6), Clear Command (oct 004)

Figure A-11. Clear Message.

To send the ABORT Message:

Bus Management Lines

ATN	IFC	SRQ	REN	EOI
X	T	X	X	X

Figure A-12. Abort Message.

APPENDIX B

B-1. FRONT/REAR SWITCH LOCK PROCEDURE.

B-2. The Front/Rear Switch can be locked in either the FRONT or REAR position by the installation of a lock. The following procedures show how to install and remove the lock.

a. Lock Installation Procedure.

1. Locate the front panel section located at the front panel's input terminals.

2. Remove the front panel section by loosening the hold down screws located to the left and right of the panel. (Note: The screws are fastened to the panel section and should not be forced out of the section.)

3. Remove the switch cap from the Front/Rear Switch. The cap can be removed by holding the cap between the index finger and thumb and pulling it away from the switch.

4. Set the Front/Rear Switch to the desired position (FRONT or REAR).

5. Locate the Locking Cap and front panel section. Install the cap into the panel section's slot marked FRONT and REAR until it snaps in place. Make sure the arrow on the cap points to the lettering which corresponds to the Front/Rear Switch position.

6. Reinstall the front panel section into the front panel and tighten the screws.

b. Lock Removal Procedure.

1. Do step a and b of the Lock Installation Procedure.

2. Remove the lock from the front panel section. Do this by squeezing the cap's locking fingers and push the lock out of the slot. A pair of needlenose pliars or something similar can be used.

3. Locate the cap which was removed from the Front/Rear Switch when the lock was installed. Reinstall it on the Front/Rear Switch.

4. Reinstall the front panel section into the front panel and tighten the screws.

SALES & SUPPORT OFFICES

Arranged alphabetically by country

Product Line Sales/Support Key

Key Product Line
A Analytical
CM Components
C Computer Systems Sales only
CH Computer Systems Hardware Sales & Services
CS Computer Systems Software Sales & Services
E Electronic Instruments & Measurement Systems
M Medical Products
MP Medical Products Primary SRO
MS Medical Products Secondary SRO
P Personal Computing Products
*** Sales only for specific product line**
**** Support only for specific product line**

IMPORTANT: These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.

HP distributors are printed in italics.

ANGOLA
Telectra
Empresa Técnica de Equipamentos
Eléctricos, S.A.R.L.
R. Barbosa Rodrigues, 41-I DT.
Caixa Postal 6487
LUANDA
Tel: 35515,35516
E,M,P

ARGENTINA
Hewlett-Packard Argentina S.A.
Avenida Santa Fe 2035
Martinez 1640 **BUENOS AIRES**
Tel: 798-5735, 792-1293
Telex: 122443 AR CIGY
Cable: HEWPACKARG
A,E,CH,CS,P

Biotron S.A.C.I.y.M
Av Paseo Colon 221, 9 Piso
*1399 **BUENOS AIRES***
Tel: 30-4846, 30-1851, 30-8384
Telex: 17595 BION/AR
M

Fate S.A. I.C.I./Electronica
Venezuela 1326
*1095 **BUENOS AIRES***
Tel: 379026, 379027
Telex: 18137, 22754 ALVAR AR
P

AUSTRALIA

Adelaide, South Australia Office
Hewlett-Packard Australia Pty.Ltd.
153 Greenhill Road
PARKSIDE, S.A. 5063
Tel: 272-5911
Telex: 82536
Cable: HEWPARD Adelaide
A*,CH,CM,,E,MS,P

Brisbane, Queensland Office
Hewlett-Packard Australia Pty.Ltd.
5th Floor
Teachers Union Building
495-499 Boundary Street
SPRING HILL, Queensland 4000
Tel: 229-1544
Telex: 42133
Cable: HEWPARD Brisbane
A,CH,CM,,E,MS,P

Canberra, Australia Capital Territory Office
Hewlett-Packard Australia Pty.Ltd.
121 Wollongong Street
FYSHWICK, A.C.T. 2609
Tel: 80 4244 Telex: 62650
Cable: HEWPARD Canberra
A*CH,CM,E,MS,P

Melbourne, Victoria Office
Hewlett-Packard Australia Pty.Ltd.
31-41 Joseph Street
BLACKBURN, Victoria 3130
Tel: 89-6351
Telex: 31-024
Cable: HEWPARD Melbourne
A,CH,CM,CS,E,MS,P

Perth, Western Australia Office
Hewlett-Packard Australia Pty.Ltd.
141 Stirling Highway
NEDLANDS, W.A. 6009
(effective 28 Sept. 1981:
261 Stirling Highway
CLAREMONT, W.A. 6010)
Tel: 386-5455
Telex: 93859
Cable: HEWPARD Perth
A,CH,CM,,E,MS,P

Sydney, New South Wales Office
Hewlett-Packard Australia Pty.Ltd.
17-23 Talavera Road
P.O. Box 308
NORTH RYDE, N.S.W. 2113
Tel: 887-1611
Telex: 21561
Cable: HEWPARD Sydney
A,CH,CM,CS,E,MS,P

AUSTRIA
Hewlett-Packard Ges.m.b.h.
Grottenhofstrasse 94
Verkaufsburo Graz
A-8052 **GRAZ**
Tel: 21-5-66
Telex: 32375
CH,CM,E*

Hewlett-Packard Ges.m.b.h.
Wehlistrasse 29
P.O. Box 7
A-1205 **VIENNA**
Tel: (222) 35-16-210
Telex: 135823/135066
A,CH,CM,CS,E,MS,P

BAHRAIN
Green Salon
P.O. Box 557
BAHRAIN
Tel: 25503-250950
Telex: 84419
P

Wael Pharmacy
P.O. Box 648
BAHRAIN
Tel: 256123
Telex: 8550 WAEL GJ
M

BELGIUM
Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 ***BRUSSELS***
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,MP,P

BRAZIL
Hewlett-Packard do Brasil I.e.C. Ltda.
Alameda Rio Negro, 750
ALPHAVILLE 06400 Barueri SP
Tel: 421-1311
Telex: 011 33872
Cable: HEWPACK Sao Paulo
A,CH,CM,CS,E,MS

Hewlett-Packard do Brasil I.e.C. Ltda.
Avenida Epitacio Pessoa, 4664
22471 **RIO DE JANEIRO**-RJ
Tel: 286-0237
Telex: 021-21905 HPBR-BR
Cable: HEWPACK Rio de Janeiro
A,CH,CM,E,MS,P*

CANADA

Alberta
Hewlett-Packard (Canada) Ltd.
210, 7220 Fisher Street S.E.
CALGARY, Alberta T2H 2H8
Tel: (403) 253-2713
A,CH,CM,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
11620A-168th Street
EDMONTON, Alberta T5M 3T9
Tel: (403) 452-3670
A,CH,CM,CS,E,MS,P*

British Columbia
Hewlett-Packard (Canada) Ltd.
10691 Shellbridge Way
RICHMOND, British Columbia V6X 2W7
Tel: (604) 270-2277
Telex: 610-922-5059
A,CH,CM,CS,E*,MS,P*

Manitoba
Hewlett-Packard (Canada) Ltd.
380-550 Century Street
WINNIPEG, Manitoba R3H 0Y1
Tel: (204) 786-6701
A,CH,CM,E,MS,P*

New Brunswick
Hewlett-Packard (Canada) Ltd.
190 Wilbur Street
MONCTON, New Brunswick E2B 2V0
Tel: (506) 386-1677
Telex: 01931470
CH**

Nova Scotia
Hewlett-Packard (Canada) Ltd.
P.O. Box 931
900 Windmill Road
DARTMOUTH, Nova Scotia B2Y 3Z6
Tel: (902) 469-7820
Telex: 01931470
CH,CM,CS,E*,MS,P*

Ontario
Hewlett-Packard (Canada) Ltd.
552 Newbold Street
LONDON, Ontario N6E 2S5
Tel: (519) 686-9181
Telex: 610-352-1201
A,CH,CM,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 610-492-4246
A,CH,CM,CS,E,MP,P

Hewlett-Packard (Canada) Ltd.
2670 Queensview Dr.
OTTAWA, Ontario K2B 8K1
Tel: (613) 820-6483
Telex: 610-563-1636
A,CH,CM,CS,E*,MS,P*

Quebec
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
KIRKLAND, Quebec H9J 2M5
Tel: (514) 697-4232
Telex: 05821521
A,CH,CM,CS,E,MP,P*

Hewlett-Packard (Canada) Ltd.
Les Galeries du Vallon
2323 Boulevard du Versant Nord
STE. FOY, Quebec G1N 4C2
Tel: (418) 687-4570
CH

CHILE
Jorge Calcagni y Cia. Ltda.
Arturo Burhle 065
Casilla 16475
SANTIAGO 9
Tel: 222-0222
Telex: Public Booth 0001
A,CM,E,M

Olympia (Chile) Ltd.
Rodrico de Araya 1045
Casilla 256-V
SANTIAGO 21
Tel: 225-5044
Telex: 40565 OLYMP CL
C,P

CHINA, People's Republic of
CEIEC Inc.
44 Beiwei Rd.
***BEIJING**, China*
Telex: 22475 CEIEC CN
A,CH,CM,CS,E,P

COLOMBIA
Instrumentación
H. A. Langebaek & Kier S.A.
Apartado Aéreo 6287
***BOGOTA** 1, D.E.*
Carrera 7 No. 48-75
***BOGOTA**, 2 D.E.*
Tel: 287-8877
Telex: 44400
Cable: AARIS Bogota
A,CM,E,M,P

COSTA RICA
Cientifica Costarricense S.A.
Avenida 2, Calle 5
San Pedro de Montes de Oca
Apartado 10159
SAN JOSE
Tel: 24-38-20, 24-08-19
Telex: 2367 GALGUR
CM,E,M

CYPRUS
Telerexa Ltd.
P.O. Box 4809
14C Stassinos Avenue
NICOSIA
Tel: 62698
Telex: 2894 Levidocy
E,M,P

CZECHOSLOVAKIA
Hewlett-Packard
Obchodni Zastupitelstvi v CSSR
Post. schranka 27
*CS-118 01 **PRAHA 011***
Tel: 66-296
Telex: 121353 IHC

DENMARK
Hewlett-Packard A/S
Datavej 52
DK-3460 **BIRKEROD**
Tel: (02) 81-66-40
Telex: 37409 hpas dk
A,CH,CM,CS,E,MS,P

Hewlett-Packard A/S
Navervej 1
DK-8600 **SILKEBORG**
Tel: (06) 82-71-66
Telex: 37409 hpas dk
CH,CM,E

ECUADOR
CYEDE Cia. Ltda.
Avenida Eloy Alfaro 1749
Casilla 6423 CCI
QUITO
Tel: 450-975, 243-052
Telex: 2548 CYEDE ED
A,CM,E,P

Hospitalar S.A.
Robles 625
Casilla 3590
QUITO
Tel: 545-250, 545-122
Telex: 2485 HOSPTL ED
Cable: HOSPITALAR-Quito
M

EGYPT
International Engineering Associates
24 Hussein Hegazi Street
Kasr-el-Aini
CAIRO
Tel: 23-829
Telex: 93830
CH,CS,E,M

Informatic For Systems
22 Talaat Harb Street
CAIRO
Tel: 759006
Telex: 93938 FRANK UN
CH,CS,P

Egyptian International Office
for Foreign Trade
P.O.Box 2558
CAIRO
Tel: 984935
Telex: 93337 EGPOR
P

EL SALVADOR
IPESA de El Salvador S.A.
Boulevard de los Heroes 1148
SAN SALVADOR
Tel: 252787, 259621
Telex: Public Booth 20107
A,CH,CM,CS,E,P

FINLAND
Hewlett-Packard Oy
Revontulentie 7
SF-02100 **ESPOO** 10
Tel: (90) 455-0211
Telex: 121563 hewpa sf
A,CH,CM,CS,E,MS,P

SALES & SUPPORT OFFICES
Arranged alphabetically by country

FRANCE
Hewlett-Packard France
Le Ligoures
Bureau de Vente de Aix-en-Provence
Place Romée de Villeneuve
F-13090 **AIX-EN-PROVENCE**
Tel: (42) 59-41-02
Telex: 410770F
A,CH,CM,E,MS,P*

Hewlett-Packard France
Boite Postale No. 503
F-25026 **BESANCON**
28 Rue de la Republique
F-25000 **BESANCON**
Tel: (81) 83-16-22
CH,M

Hewlett-Packard France
Bureau de Vente de Lyon
Chemin des Mouilles
Boite Postale No. 162
F-69130 **ECULLY** Cédex
Tel: (78) 33-81-25
Telex: 310617F
A,CH,CM,CS,E,MP

Hewlett-Packard France
Immeuble France Evry
Tour Lorraine
Boulevard de France
F-91035 **EVRY** Cédex
Tel: (60) 77-96-60
Telex: 692315F
CM,E

Hewlett-Packard France
5th Avenue Raymond Chanas
F-38320 **EYBENS**
Tel: (76) 25-81-41
Telex: 980124 HP GRENOB EYBE
CH,CM

Hewlett-Packard France
Bâtiment Ampère
Rue de la Commune de Paris
Boite Postale 300
F-93153 **LE BLANC MESNIL**
Tel: (01) 865-44-52
Telex: 211032F
CH,CM,CS,E,MS

Hewlett-Packard France
Le Montesquieu
Avenue du President JF Kennedy
F-33700 **MERIGNAC**
Tel: (56) 34-00-84
Telex: 550105F
CH,CM,E,MS

Hewlett-Packard France
32 Rue Lothaire
F-57000 **METZ**
Tel: (87) 65-53-50
CH,CM

Hewlett-Packard France
3 Rue Julien Videment
F-44200 **NANTES**
Tel: (40) 48-09-44
CH**

Hewlett-Packard France
Zone Industrielle de Courtaboeuf
Avenue des Tropiques F-91947 Les Ulis Cédex **ORSAY**
Tel: (1) 907-78-25
Telex: 600048F
A,CH,CM,CS,E,MP,P

Hewlett-Packard France
Paris Porte-Maillot 13, 15 25
Boulevard De L'Amiral Bruix
F-75782 **PARIS** Cédex 16
Tel: (01) 502-12-20
Telex: 613663F
CH,CM,MS,P

Hewlett-Packard France
2 Allee de la Bourgonette
F-35100 **RENNES**
Tel: (99) 51-42-44
Telex: 740912F
CH,CM,E,MS,P*

Hewlett-Packard France
98 Avenue de Bretagne
F-76100 **ROUEN**
Tel: (35) 63-57-66 CH**,CS

Hewlett-Packard France
4 Rue Thomas Mann
Boite Postale 56
F-67200 **STRASBOURG**
Tel: (88) 28-56-46
Telex: 890141F
CH,CM,E,MS,P*

Hewlett-Packard France
20 Chemin de la Cépière
F 31081 **TOULOUSE** Cédex
Tel: (61) 40-11-12
Telex: 531639F
A,CH,CM,CS,E,P*

Hewlett-Packard France
Bureau de Vente de Lille
Immeuble Péricentre
Rue Van Gogh
F-59650 **VILLENEUVE D'ASQ**
Tel: (20) 91-41-25
Telex: 160124F
CH,CM,E,MS,P*

GERMAN FEDERAL REPUBLIC
Hewlett-Packard GmbH
Technisches Büro Berlin
Keithstrasse 2-4
D-1000 **BERLIN** 30
Tel: (030) 24-90-86
Telex: 018 3405 hpbln d
A,CH,CM,E,M,P,X

Hewlett-Packard GmbH
Technisches Büro Böblingen
Herrenberger Strasse 110
D-7030 **BÖBLINGEN**
Tel: (07031) 667-1
Telex: 07265739 bbn or 07265743
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Technisches Büro Dusseldorf
Emanuel-Leutze-Strasse 1
D-4000 **DUSSELDORF**
Tel: (0211) 5971-1
Telex: 085/86 533 hpdd d
A,CH,CM,CS,E,MS,P

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 **FRANKFURT** 56
Tel: (0611) 50-04-1
Telex: 04 13249 hpffm d
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Technisches Büro Hamburg
Kapstadtring 5
D-2000 **HAMBURG** 60
Tel: (040) 63804-1
Telex: 21 63 032 hphh d
A,CH,CM,CS,E,MS,P

Hewlett-Packard GmbH
Technisches Büro Hannover
Am Grossmarkt 6
D-3000 **HANNOVER** 91
Tel: (0511) 46-60-01
Telex: 092 3259
A,CH,CM,E,MS,P

Hewlett-Packard GmbH
Technisches Büro Mannheim
Rosslauer Weg 2-4
D-6800 **MANNHEIM**
Tel: (621) 70050
Telex: 0462105
A,C,E

Hewlett-Packard GmbH
Technisches Büro Neu Ulm
Messerschmittstrasse 7
D-7910 **NEU ULM**
Tel: 0731-70241
Telex: 712816 HP ULM-D
A,C,E*

Hewlett-Packard GmbH
Technisches Büro Nürnberg
Neumeyerstrasse 90
D-8500 **NÜRNBERG**
Tel: (0911) 56-30-83
Telex: 0623 860
CH,CM,E,MS,P

Hewlett-Packard GmbH
Technisches Büro München
Eschenstrasse 5
D-8021 **TAUFKIRCHEN**
Tel: (089) 6117-1
Telex: 0524985
A,CH,CM,E,MS,P

GREAT BRITAIN
Hewlett-Packard Ltd.
Trafalgar House
Navigation Road
ALTRINCHAM
Chesire WA14 1NU
Tel: (061) 928-6422
Telex: 668068
A,CH,CS,E,M

Hewlett-Packard Ltd.
Oakfield House, Oakfield Grove
Clifton
BRISTOL BS8 2BN
Tel: 36806
Telex: 444302
CH,CM,M,P

Hewlett-Packard Ltd.
14 Wesley Street
CASTLEFORD
Yorkshire WF10 1AE
Tel: (0977) 550016
Telex: 5557355
CH

Hewlett-Packard Ltd.
Fourier House
257-263 High Street
LONDON COLNEY
Herts., AL2 1HA
Tel: (0727) 24400
Telex: 1-8952716
CH,CS,E

Hewlett-Packard Ltd
Tradax House, St. Mary's Walk
MAIDENHEAD
Berkshire, SL6 1ST
Tel: (0628) 39151
CH,CS,E,P

Hewlett-Packard Ltd.
308/314 Kings Road
READING, Berkshire
Tel: 61022
Telex: 84-80-68
CM,P

Hewlett-Packard Ltd.
Quadrangle
106-118 Station Road
REDHILL, Surrey
Tel: (0737) 68655
Telex: 947234 CH,CS,E

Hewlett-Packard Ltd.
Westminster House
190 Stratford Road
SHIRLEY, Solihull
West Midlands B90 3BJ
Tel: (021) 7458800
Telex: 339105
CH

Hewlett-Packard Ltd.
King Street Lane
WINNERSH, Wokingham
Berkshire RG11 5AR
Tel: (0734) 784774
Telex: 847178
A,CS,E,M

GREECE
Kostas Karaynnis S.A.
8 Omirou Street
***ATHENS** 133*
Tel: 32-30-303, 32-37-371
Telex: 21 59 62 RKAR GR
A,CH,CM,CS,E,M,P

PLAISIO S.A.
G. Gerardos
24 Stournara Street
ATHENS
Tel: 36-11-160
Telex: 21 9492
P

GUATEMALA
IPESA
Avenida Reforma 3-48
GUATEMALA 9
Tel: 316627, 314786
Telex: 4192 TELETRO GU
A,CH,CM,CS,E,M,P

HONG KONG
Hewlett-Packard Hong Kong, Ltd.
G.P.O. Box 795
5th Floor, Sun Hung Kai Centre
30 Harbour Road
HONG KONG
Tel: 5-8323211
Telex: 66678 HEWPA HX
Cable: HP ASIA LTD Hong Kong
E,CH,CS,P

Schmidt & Co. (Hong Kong) Ltd.
Wing On Centre, 28th Floor
Connaught Road, C.
HONG KONG
Tel: 5-455644
Telex: 74766 SCHMX HX
A,M

ICELAND
Elding Trading Company Inc.
Hafnarnvoli-Tryggvagotu
P.O. Box 895
IS-REYKJAVIK
Tel: 1-58-20, 1-63-03
M

INDIA
Blue Star Ltd.
11 Magarath Road
***BANGALORE** 560 025*
Tel: 55668
Telex: 0845-430
Cable: BLUESTAR
A,CH,CM,CS,E

Blue Star Ltd.
Band Box House
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-3101
Telex: 011 3751
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
***BOMBAY** 400 025*
Tel: 422-6155
Telex: 011-4093
Cable: FROSTBLUE
A,CH,CM,CS,E,M

Blue Star Ltd.
Kalyan, 19 Vishwas Colony
*Alkapuri, **BORODA**, 390 005*
Tel: 65235
Cable: BLUE STAR
A

Blue Star Ltd.
7 Hare Street
***CALCUTTA** 700 001*
Tel: 12-01-31
Telex: 021-7655
Cable: BLUESTAR
A,M

Blue Star Ltd.
133 Kodambakkam High Road
***MADRAS** 600 034*
Tel: 82057
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
Bhandari House, 7th/8th Floors
91 Nehru Place
***NEW DELHI** 110 024*
Tel: 682547
Telex: 031-2463
Cable: BLUESTAR
A,CH,CM,CS,E,M

Blue Star Ltd.
15/16:C Wellesley Rd.
***PUNE** 411 011*
Tel: 22775
Cable: BLUE STAR
A

Blue Star Ltd.
1-1-117/1 Sarojini Devi Road
***SECUNDERABAD** 500 033*
Tel: 70126
Telex: 0155-459
Cable: BLUEFROST
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
***TRIVANDRUM** 695 013*
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E

INDONESIA
BERCA Indonesia P.T.
P.O.Box 496/JKT.
Jl. Abdul Muis 62
JAKARTA
Tel: 373009
Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA
P

BERCA Indonesia P.T.
Wisma Antara Bldg., 17th floor
JAKARTA
A,CS,E,M

BERCA Indonesia P.T.
P.O. Box 174/SBY.
Jl. Kutei No. 11
SURABAYA
Tel: 68172
Telex: 31146 BERSAL SB
Cable: BERSAL-SURABAYA
A,E,M,P*

IRAQ
Hewlett-Packard Trading S.A.
Mansoor City 9B/3/7
BAGHDAD
Tel: 551-49-73
Telex: 2455 HEPAIRAQ IK
CH,CS

IRELAND
Hewlett-Packard Ireland Ltd.
Kestrel House
Clanwilliam Court
Lower Mount Street
DUBLIN 2, Eire
Tel: 680424, 680426
Telex: 30439
A,CH,CM,CS,E,M,P

Cardiac Services Ltd.
Kilmore Road
Artane
***DUBLIN** 5, Eire*
Tel: (01) 351820
Telex: 30439
M

ISRAEL
Electronics Engineering Division
Motorola Israel Ltd.
16 Kremenetski Street
P.O. Box 25016
TEL-AVIV 67899
Tel: 3-338973
Telex: 33569 Motil IL
Cable: BASTEL Tel-Aviv
A,CH,CM,CS,E,M,P

ITALY
Hewlett-Packard Italiana S.p.A.
Traversa 99C
Giulio Petrone, 19
I-70124 **BARI**
Tel: (080) 41-07-44
M

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/111
I-40132 **BOLOGNA**
Tel: (051) 402394
Telex: 511630
CH,CM,E,MS

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291 C,P

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVLIGLIO**
Tel: (2) 903691
Telex: 334632
A,CH,CM,CS,E,MP,P

Hewlett-Packard Italiana S.p.A.
Via Nuova san Rocco A
Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
A,CH,CM,E

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07 E,C

Hewlett-Packard Italiana S.p.A.
Via Turazza 14
I-35100 **PADOVA**
Tel: (49) 664888
Telex: 430315
A,CH,CM,E,MS

Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA**
Tel: (06) 54831
Telex: 610514
A,CH,CM,CS,E,MS,P*

Hewlett-Packard Italiana S.p.A.
Corso Giovanni Lanza 94
I-10133 **TORINO**
Tel: (011) 682245, 659308
Telex: 221079
CH,CM,E

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Inoue Building
1-1348-3, Asahi-cho
ATSUGI, Kanagawa 243
Tel: (0462) 24-0451
CM,C*,E

Yokogawa-Hewlett-Packard Ltd.
Sannomiya Daiichi Seimei-Bldg. 5F
69 Kyo-machi Chuo-ku
KOBE 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi Yasoji Bldg 4F
3-4 Chome Tsukuba
KUMAGAYA, Saitama 360
Tel: (0485) 24-6563
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Building
1-4-73, San-no-maru
MITO, Ibaragi 310
Tel: (0292) 25-7470
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Sumitomo Seimei Nagoya Bldg.
11-2 Shimo-sasajima-cho
Nakamura-ku
NAGOYA, Aichi 450
Tel: (052) 571-5171
CH,CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg., 4th Floor
5-4-20 Nishinakajima, 5-chome
Yodogawa-ku
OSAKA, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
3-29-21 Takaido-Higashi 3-chome
Suginami-ku
TOKYO 168
Tel: (03) 331-6111
Telex: 232-2024 YHPTOK
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
3-30-4 Tsuruya-cho
Kanagawa-ku,
YOKOHAMA Kanagawa, 221
Tel: (045) 312-1252
CH,CM,E

JORDAN
Mouasher Cousins Company
P.O. Box 1387
AMMAN
Tel: 24907, 39907
Telex: 21456 SABCO JO
CH,E,M,P

KENYA
ADCOM Ltd., Inc.
City House, Wabera Street
P.O.Box 30635
NAIROBI
Tel: 331955
Telex: 22639
E,M

KOREA
Samsung Electronics
Industrial Products Div.
76-561 Yeoksam-Dong
Kangnam-Ku
C.P.O. Box 2775
SEOUL
Tel: 555-7555, 555-5447
Telex: K27364 SAMSAN
A,CH,CM,CS,E,M,P

KUWAIT
Al-Khalidya Trading & Contracting
P.O. Box 830 Safat
KUWAIT
Tel: 42-4910, 41-1726
Telex: 2481 Areeg kt
CH,E,M

Photo & Cine Equipment
P.O. Box 270 Safat
KUWAIT
Tel: 42-2846, 42-3801
Telex: 2247 Matin
P

LEBANON
G.M. Dolmadjian
Achrafieh
P.O. Box 165.167
BEIRUT
Tel: 290293
MP

LUXEMBOURG
Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 ***BRUSSELS***
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,MP,P

MALAYSIA
Hewlett-Packard Sales (Malaysia)
Sdn. Bhd.
Suite 2.21/2.22
Bangunan Angkasa Raya
Jalan Ampang
KUALA LUMPUR
Tel: 483544
Telex: MA31011
A,CH,E,M,P*

Protel Engineering
Lot 319, Satok Road
P.O.Box 1917
*Kuching, **SARAWAK***
Tel: 53544
Telex: MA 70904 PROMAL
Cable: PROTELENG
A,E,M

MALTA
Philip Toledo Ltd.
Notabile Rd.
MRIEHEL
Tel: 447 47, 455 66
Telex: MW.649
P

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Avenida Periferico Sur No. 6501
Tepepan, Xochimilco
MEXICO CITY 23, D.F.
Tel: (905) 676-4600
Telex: 017-74-507
A,CH,CS,E,MS,P

Hewlett-Packard Mexicana, S.A. de C.V.
Rio Volga 600
Colonia del Valle
MONTERREY, N.L.
Tel: 78-42-93, 78-42-40, 78-42-41
Telex: 038-410
CH

MOROCCO
Dolbeau
81 rue Karatchi
CASABLANCA
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E

Gerep
2 rue d'Agadir
Boite Postale 156
CASABLANCA
Tel: 272093, 272095
Telex: 23 739
P

NETHERLANDS
Hewlett-Packard Nederland B.V.
Van Heuven Goedhartlaan 121
NL 1181KK **AMSTELVEEN**
P.O. Box 667
NL1080 AR **AMSTELVEEN**
Tel: (20) 47-20-21
Telex: 13 216
A,CH,CM,CS,E,MP,P

Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPPELLE**, A/D Ijessel
P.O. Box 41
NL2900 AA **CAPELLE**, Ijssel
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
A,CH,CM,CS

Koning en Hartman Electrotechnick B.V.
Koperwert 30
2544 En den Haag
The **NETHERLANDS**
Tel: 070-210101
Telex: 31528
CM

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
169 Manukau Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPACK Auckland
CH,CM,E,P*

Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, WELLINGTON
Tel: 877-199
Cable: HEWPACK Wellington
CH,CM,E,P

Northrop Instruments & Systems Ltd.
369 Khyber Pass Road
P.O. Box 8602
AUCKLAND
Tel: 794-091
Telex: 60605
A,M

Northrop Instruments & Systems Ltd.
110 Mandeville St.
P.O. Box 8388
CHRISTCHURCH
Tel: 486-928
Telex: 4203
A,M

Northrop Instruments & Systems Ltd.
Sturdee House
85-87 Ghuznee Street
P.O. Box 2406
WELLINGTON
Tel: 850-091
Telex: NZ 3380
A,M

NORTHERN IRELAND
Cardiac Services Company
95A Finaghy Road South
***BELFAST** BT 10 OBY*
Tel: (0232) 625-566
Telex: 747626
M

NORWAY
Hewlett-Packard Norge A/S
Folke Bernadottesvei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (BERGEN)
Tel: (05) 16-55-40
Telex: 16621 hpnas n
CH,CM,E

Hewlett-Packard Norge A/S
Oesterndalen 18
P.O. Box 34
N-1345 **OESTERAAS**
Tel: (02) 17-11-80
Telex: 16621 hpnas n
A*,CH,CM,E,MS,P

OMAN
Khimjil Ramdas
P.O. Box 19
MUSCAT
Tel: 72-22-17, 72-22-25
Telex: 3289 BROKER MB MUSCAT
P

PAKISTAN
Mushko & Company Ltd.
10, Bazar Road
Sector G-6/4
ISLAMABAD
Tel: 26875
Cable: FEMUS Rawalpindi
A,E,M

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
***KARACHI** 0302*
Tel: 511027, 512927
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
*A,E,M,P**

PANAMA
Electrónico Balboa, S.A.
Calle Samuel Lewis
Apartado 4929
Panama 5
Edificio "Alfa" No. 2
CIUDAD DE PANAMA
Tel: 64-2700
Telex: 0383 ELECTRON PG
A,CM,E,M,P

SALES & SUPPORT OFFICES

Arranged alphabetically by country

PANAMA (Con't.)
Foto Internacional, S.A.
Free Zone Colon
Apartado 2068
COLON 3
Tel: 45-2333
Telex: 379 8626, 386 8722
P

PERU
Cía Electro Médica S.A.
Los Flamencos 145, San Isidro
Casilla 1030
LIMA 1
Tel: 41-4325, 41-3703
Telex: Pub. Booth 25306
A,CM,E,M,P

PHILIPPINES
The Online Advanced Systems Corporation
Rico House, Amorsolo Cor. Herrera Street
Legaspi Village, Makati
P.O. Box 1510
*Metro **MANILA***
Tel: 85-35-81, 85-34-91, 85-32-21
Telex: 3274 ONLINE
A,CH,CS,E,M

Electronic Specialists and Proponents Inc.
690-B Epifanio de los Santos Avenue
*Cubao, **QUEZON CITY***
P.O. Box 2649 Manila
Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 40018, 42000 ITT GLOBE MACKAY BOOTH
P

POLAND
Buro Informasji Technicznej
Hewlett-Packard
Ul Stawki 2, 6P
*PL00-950 **WARSZAWA***
Tel: 39-59-62, 39-67-43
Telex: 812453 hepa pl

PORTUGAL
SOQUIMICA
Av. da Libedade 220-2
*P-1298 **LISBOA Codex***
Tel: 56 21 81, 56 21 82
Telex: 13316

Telectra-Empresa Técnica de Equipmentos Eléctricos S.a.r.l.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
***P-LISBON** 1*
Tel: (19) 68-60-72
Telex: 12598
CH,CS,E,P

Mundinter
Intercambio Mundial de Comércio S.a.r.l
P.O. Box 2761
Avenida Antonio Augusto de Aguiar 138
P-LISBON
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

PUERTO RICO
Hewlett-Packard Puerto Rico
P.O. Box 4407
CAROLINA, Puerto Rico 00630
Calle 272 Edificio 203
Urb. Country Club
RIO PIEDRAS, Puerto Rico 00924
Tel: (809) 762-7255
Telex: 345 0514
A,CH,CS

QATAR
Nasser Trading & Contracting
P.O. Box 1563
DOHA
Tel: 22170
Telex: 4439 NASSER
M

Computearabia
P.O. Box 2570
DOHA
Tel: 329515
Telex: 4806 CHPARB
P

ROMANIA
Hewlett-Packard Reprezentanta
Boulevard Nicolae Balcescu 16
BUCURESTI
Tel: 130725
Telex: 10440

SAUDI ARABIA
Modern Electronic Establishment
P.O. Box 193
AL-KHOBAR
Tel: 44-678, 44-813
Telex: 670136
Cable: ELECTA AL-KHOBAR
CH,CS,E,M,P

Modern Electronic Establishment
P.O. Box 1228, Baghdadiah Street
JEDDAH
Tel: 27-798
Telex: 401035
Cable: ELECTA JEDDAH
CH,CS,E,M,P

Modern Electronic Establishment
P.O. Box 2728
RIYADH
Tel: 62-596, 66-232
Telex: 202049
CH,CS,E,M,P

SCOTLAND
Hewlett-Packard Ltd.
Royal Bank Buildings
Swan Street
BRECHIN, Angus, Scotland
Tel: 3101, 3102
CH,CM

Hewlett-Packard Ltd.
SOUTH QUEENSFERRY
West Lothian, EH30 9GT
GB-Scotland
Tel: (031) 3311000
Telex: 72682
A,CH,CM,CS,E,M

SINGAPORE
Hewlett-Packard Singapore (Pty.) Ltd.
P.O. Box 58 Alexandra Post Office
SINGAPORE, 9115
6th Floor, Inchcape House
450-452 Alexandra Road
SINGAPORE 0511
Tel: 631788
Telex: HPSGSO RS 34209
Cable: HEWPACK, Singapore
A,CH,CS,E,MS,P

SOUTH AFRICA
Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 120
Howard Place
Pine Park Center, Forest Drive, Pinelands
CAPE PROVINCE 7450
Tel: 53-7955, 53-7956, 53-7957
Telex: 57-0006
A,CH,CM,E,MS,P

Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 37099
Overport
DURBAN 4067
Tel: 28-4178, 28-4179, 28-4110
CH,CM

Hewlett-Packard South Africa (Pty.) Ltd.
P.O. Box 33345
Glenstantia 0010 **TRANSVAAL**
1st Floor East
Constantia Park Ridge Shopping Centre
Constantia Park
PRETORIA
Tel: 01298-1126
Telex: 32163
CH,E

Hewlett-Packard South Africa (Pty.) Ltd.
Private Bag Wendywood
SANDTON 2144
Tel: 802-5111, 802-5125
Telex: 89-84782
Cable: HEWPACK Johannesburg
A,CH,CM,CS,E,MS,P

SPAIN
Hewlett-Packard Española S.A.
c/Entenza, 321
E-BARCELONA 29
Tel: (3) 322-24-51, 321-73-54
Telex: 52603 hpbee
A,CH,CM,CS,E,MS,P

Hewlett-Packard Española S.A.
c/San Vicente S/N
Edificio Albia II,7 B
E-BILBAO 1
Tel: (944) 423-8306, 423-8206
A,CH,CM,E,MS

Hewlett-Packard Española S.A.
Calle Jerez 3
E-MADRID 16
Tel: 458-2600
Telex: 23515 hpe
A,CM,E

Hewlett-Packard Española S.A.
c/o Costa Brava 13
Colonia Mirasierra
E-MADRID 34
Tel: 734-8061, 734-1162
CH,CS,M

Hewlett-Packard Española S.A.
Av Ramón y Cajal 1-9
Edificio Sevilla 1,
E-SEVILLA 5
Tel: 64-44-54, 64-44-58
Telex: 72933
A,CM,CS,MS,P

Hewlett-Packard Española S.A.
C/Ramon Gordillo, 1 (Entlo.3)
E-VALENCIA 10
Tel: 361-1354, 361-1358
CH,CM,P

SWEDEN
Hewlett-Packard Sverige AB
Enighetsvägen 3, Fack
P.O. Box 20502
S-16120 **BROMMA**
Tel: (08) 730-0550
Telex: (854) 10721 MESSAGES
Cable: MEASUREMENTS STOCKHOLM
A,CH,CM,CS,E,MS,P

Hewlett-Packard Sverige AB
Sunnanvagen 14K
S-22226 **LUND**
Tel: (46) 13-69-79
Telex: (854) 10721 (via BROMMA office)
CH,CM

Hewlett-Packard Sverige AB
Vastra Vintergatan 9
S-70344 **OREBRO**
Tel: (19) 10-48-80
Telex: (854) 10721 (via BROMMA office)
CH,CM

Hewlett-Packard Sverige AB
Frötallisgatan 30
S-42132 **VÄSTRA-FRÖLUNDA**
Tel: (031) 49-09-50
Telex: (854) 10721 (via BROMMA office)
CH,CM,E,P

SWITZERLAND
Hewlett-Packard (Schweiz) AG
Clarastrasse 12
CH-4058 **BASLE**
Tel: (61) 33-59-20
A,CM

Hewlett-Packard (Schweiz) AG
Bahnhoherweg 44
3018 **BERN**
Tel: (031) 56-24-22
CH,CM

Hewlett-Packard (Schweiz) AG
47 Avenue Blanc
CH 1202 **GENEVA**
Tel: (022) 32-30-05, 32-48-00
CH,CM,CS

Hewlett-Packard (Schweiz) AG
29 Chemin Château Bloc
CH-1219 **LE LIGNON**-Geneva
Tel: (022) 96-03-22
Telex: 27333 hpag ch
Cable: HEWPACKAG Geneva
A,CM,E,MS,P

Hewlett-Packard (Schweiz) AG
Zürcherstrasse 20
Allmend 2
CH-8967 **WIDEN**
Tel: (57) 50-111
Telex: 59933 hpag ch
Cable: HPAG CH
A,CH,CM,CS,E,MS,P

SYRIA
General Electronic Inc.
Nuri Basha-Ahnaf Ebn Kays Street
P.O. Box 5781
DAMASCUS
Tel: 33-24-87
Telex: 11215 ITIKAL
Cable: ELECTROBOR DAMASCUS
E

Middle East Electronics
Place Azmé
Boite Postale 2308
DAMASCUS
Tel: 334592
Telex: 11304 SATACO SY
M,P

TAIWAN
Hewlett-Packard Far East Ltd.
Kaohsiung Office
2/F 68-2, Chung Cheng 3rd Road
KAOHSIUNG
Tel: 241-2318, 261-3253
E,MS,P

Hewlett-Packard Far East Ltd.
Taichung Office
#33, Cheng Tr Rd.
10th Floor, Room 5
TAICHUNG
Tel: (042) 289274

Hewlett-Packard Far East Ltd.
Taiwan Office
5th Floor
205 Tun Hwa North Road
TAIPEI
Tel:(02) 751-0404
Cable:HEWPACK Taipei
A,CH,CS,E,MS,P

Ing Lih Trading Co.
3rd Floor 18, Po-Ai Road
***TAIPEI** (100)*
Tel: (02) 311-1914
Cable: INGLIH TAIPEI
A

THAILAND
Unimesa
30 Patpong Ave., Suriwong
BANGKOK 5
Tel: (234-091) (234-092)
Telex: TH 81160, TH 81038
Cable: UNIMESA Bangkok
A,C,E,M

Bangkok Business Equipment Ltd.
5/5-6 Dejo Road
BANGKOK
Tel: 234-8670, 234-8671
Telex: 87669-BEQUIPT TH
Cable: BUSIQUIPT Bangkok
P

TRINIDAD & TOBAGO
Caribbean Telecoms Ltd.
50/A Jerningham Avenue
P.O. Box 732
PORT-OF-SPAIN
Tel: 624-4213, 624-4214
Telex: 3235, 3272 HUGCO WG
A,CM,E,M,P

TUNISIA
Tunisie Electronique
31 Avenue de la Liberte
TUNIS
Tel: 280-144
E,P

Corema
1 ter. Av. de Carthage
TUNIS
Tel: 253-821
Telex: 12319 CABAM TN
M

TURKEY
Teknim Company Ltd.
Iran Caddesi No. 7
*Kavaklidere, **ANKARA***
Tel: 275800
Telex: 42155
E

E.M.A.
Medina Eldem Sokak No.41/6
Yuksel Caddesi
ANKARA
Tel: 175 622
M,P

UNITED ARAB EMIRATES
Emitac Ltd.
P.O. Box 1641
SHARJAH
Tel: 354121, 354123
Telex: 68136 Emitac SL
CH,CS,E,M,P

UNITED KINGDOM
see: GREAT BRITAIN
NORTHERN IRELAND
SCOTLAND

UNITED STATES

Alabama
Hewlett-Packard Co.
700 Century Park South
Suite 128
BIRMINGHAM, AL 35226
Tel: (205) 822-6802
CH,CM,MP

Hewlett-Packard Co.
P.O. Box 4207
8290 Whitesburg Drive, S.E.
HUNTSVILLE, AL 35802
Tel: (205) 881-4591
CH,CM,CS,E,M*

Alaska
Hewlett-Packard Co.
1577 "C" Street, Suite 252
ANCHORAGE, AK 99510
Tel: (206) 454-3971
CH*,CM

Arizona
Hewlett-Packard Co.
2336 East Magnolia Street
PHOENIX, AZ 85034
Tel: (602) 273-8000
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
2424 East Aragon Road
TUCSON, AZ 85702
Tel: (602) 889-4631
CH,CM,E,MS**

Arkansas
Hewlett-Packard Co.
P.O. Box 5646
Brady Station
LITTLE ROCK, AR 72215
Tel: (501) 376-1844, (501) 664-8773
CM,MS

California
Hewlett-Packard Co.
99 South Hill Dr.
BRISBANE, CA 94005
Tel: (415) 330-2500
CH,CM,CS

Hewlett-Packard Co.
7621 Canoga Avenue
CANOGA PARK, CA 91304
Tel: (213) 702-8300
A,CH,CM,CS,E,P

Hewlett-Packard Co.
1579 W. Shaw Avenue
FRESNO, CA 93771
Tel: (209) 224-0582
CM,MS

Hewlett-Packard Co.
1430 East Orangethorpe
FULLERTON, CA 92631
Tel: (714) 870-1000
CH,CM,CS,E,MP

Hewlett-Packard Co.
5400 W. Rosecrans Boulevard
LAWNDALE, CA 90260
P.O. Box 92105
LOS ANGELES, CA 90009
Tel. (213) 970-7500
CH,CM,CS,MP

Hewlett-Packard Co.
3939 Lankershim Blvd.
NORTH HOLLYWOOD, CA 91604
Tel: (213) 877-1282
Regional Headquarters

Hewlett-Packard Co.
3200 Hillview Avenue
PALO ALTO, CA 94304
Tel: (415) 857-8000
CH,CM,CS,E

Hewlett-Packard Co.
646 W. North Market Boulevard
SACRAMENTO, CA 95834
Tel: (916) 929-7222
A*,CH,CM,CS,E,MS

Hewlett-Packard Co.
9606 Aero Drive
P.O. Box 23333 **SAN DIEGO**, CA 92123
Tel: (714) 279-3200
CH,CM,CS,E,MP

Hewlett-Packard Co.
Suite A
5553 Hollister
SANTA BARBARA, CA 93111
Tel. (805) 964-3390

Hewlett-Packard Co.
3003 Scott Boulevard
SANTA CLARA, CA 95050
Tel: (408) 988-7000
A,CH,CM,CS,E,MP

Colorado
Hewlett-Packard Co.
24 Inverness Place, East
ENGLEWOOD, CO 80112
Tel: (303) 771-3455
A,CH,CM,CS,E,MS

Connecticut
Hewlett-Packard Co.
47 Barnes Industrial Road South
P.O. Box 5007
WALLINGFORD, CT 06492
Tel: (203) 265-7801
A,CH,CM,CS,E,MS

Florida
Hewlett-Packard Co.
P.O. Box 24210
2727 N.W. 62nd Street
FORT LAUDERDALE, FL 33309
Tel: (305) 973-2600
CH,CM,CS,E,MP

Hewlett-Packard Co.
4080 Woodcock Drive, #132
Brownett Building
JACKSONVILLE, FL 32207
Tel. (904) 398-0663
CM,C*,E*,MS**

Hewlett-Packard Co.
P.O. Box 13910
6177 Lake Ellenor Drive
ORLANDO, FL 32809
Tel: (305) 859-2900
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
6425 N. Pensacola Blvd.
Suite 4, Building 1
PENSACOLA, FL 32575
Tel: (904) 476-8422
A,CM,MS

Hewlett-Packard Co.
110 South Hoover, Suite 120
Vanguard Bldg.
TAMPA, FL 33609
Tel: (813) 872-0900
A*,CH,CM,CS,E*,M*

Georgia
Hewlett-Packard Co.
P.O. Box 105005
2000 South Park Place
ATLANTA, GA 30339
Tel: (404) 955-1500
Telex: 810-766-4890
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
Executive Park Suite 306
P.O. Box 816
AUGUSTA, GA 30907
Tel: (404) 736-0592
CM,MS

Hewlett-Packard Co.
P.O. Box 2103
1172 N. Davis Drive
WARNER ROBINS, GA 31098
Tel: (912) 923-8831
CM,E

Hawaii
Hewlett-Packard Co.
Kawaiahao Plaza, Suite 190
567 South King Street
HONOLULU, HI 96813
Tel: (808) 526-1555
A,CH,CM,E,MS

Idaho
Hewlett-Packard Co.
11311 Chinden Boulevard
BOISE, ID 83707
Tel: (208) 376-6000
CH,CM,M*

Illinois
Hewlett-Packard Co.
211 Prospect Road
BLOOMINGTON, IL 61701
Tel: (309) 663-0383
CH,CM,MS**

Hewlett-Packard Co.
1100 31st Street
DOWNERS GROVE, IL 60515
Tel: (312) 960-5760
CH,CM,CS

Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800
A,CH,CM,CS,E,MP

Indiana
Hewlett-Packard Co.
P.O. Box 50807
7301 No. Shadeland Avenue
INDIANAPOLIS, IN 46250
Tel: (317) 842-1000
A,CH,CM,CS,E,MS

Iowa
Hewlett-Packard Co.
5815 S.W. 5th Street
DES MOINES, IA 50315
Tel: (515) 243-5876
CH,CM,MS**

Hewlett-Packard Co.
2415 Heinz Road
IOWA CITY, IA 52240
Tel: (319) 351-1020
CH,CM,E*,MS

Kansas
Hewlett-Packard Co.
1644 S. Rock
WICHITA, KA 67207
Tel: (316) 265-5200
CH,CM

Kentucky
Hewlett-Packard Co.
10170 Linn Station Road
Suite 525
LOUISVILLE, KY 40223
Tel: (502) 426-0100
A,CH,CM,CS,MS

Louisiana
Hewlett-Packard Co.
P.O. Box 1449
3229 Williams Boulevard
KENNER, LA 70062
Tel: (504) 443-6201
A,CH,CM,CS,E,MS

Maryland
Hewlett-Packard Co.
7121 Standard Drive
HANOVER, MD 21076
Tel: (301) 796-7700
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
2 Choke Cherry Road
ROCKVILLE, MD 20850
Tel: (301) 948-6370
Telex: 710-828-9685
A,CH,CM,CS,E,MP

Massachusetts
Hewlett-Packard Co.
32 Hartwell Avenue
LEXINGTON, MA 02173
Tel: (617) 861-8960
A,CH,CM,CS,E,MP

Michigan
Hewlett-Packard Co.
23855 Research Drive
FARMINGTON HILLS, MI 48024
Tel: (313) 476-6400
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
4326 Cascade Road S.E.
GRAND RAPIDS, MI 49506
Tel: (616) 957-1970
CH,CM,CS,MS

Minnesota
Hewlett-Packard Co.
2025 W. Larpenteur Ave.
ST. PAUL, MN 55113
Tel: (612) 644-1100
A,CH,CM,CS,E,MP

Mississippi
Hewlett-Packard Co.
P.O. Box 5028
322 N. Mart Plaza
JACKSON, MS 39216
Tel: (601) 982-9363
CM,MS

Missouri
Hewlett-Packard Co.
11131 Colorado Avenue
KANSAS CITY, MO 64137
Tel: (816) 763-8000
Telex: 910-771-2087
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
1024 Executive Parkway
ST. LOUIS, MO 63141
Tel: (314) 878-0200
A,CH,CM,CS,E,MP

Nebraska
Hewlett-Packard
7101 Mercy Road
Suite 101, IBX Building
OMAHA, NE 68106
Tel: (402) 392-0948
CM,MS

Nevada
Hewlett-Packard Co.
Suite D-130
5030 Paradise Blvd.
LAS VEGAS, NV 89119
Tel: (702) 736-6610
CM,MS**

New Jersey
Hewlett-Packard Co.
Crystal Brook Professional Building
Route 35
EATONTOWN, NJ 07724
Tel: (201) 542-1384
A*,CM,C*,E*,P*

Hewlett-Packard Co.
W120 Century Road
PARAMUS, NJ 07652
Tel: (201) 265-5000
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
60 New England Av. West
PISCATAWAY, NJ 08854
Tel: (201) 981-1199
A,CH,CM,CS,E

New Mexico
Hewlett-Packard Co.
P.O. Box 11634
11300 Lomas Blvd.,N.E.
ALBUQUERQUE, NM 87123
Tel: (505) 292-1330
Telex: 910-989-1185
CH,CM,CS,E,MS

New York
Hewlett-Packard Co.
5 Computer Drive South
ALBANY, NY 12205
Tel: (518) 458-1550
Telex: 710-444-4691
A,CH,CM,E,MS

Hewlett-Packard Co.
9600 Main Street
CLARENCE, NY 14031
Tel: (716) 759-8621
Telex: 710-523-1893
CH

Hewlett-Packard Co.
200 Cross Keys Office
FAIRPORT, NY 14450
Tel: (716) 223-9950
Telex: 510-253-0092
CH,CM,CS,E,MS

Hewlett-Packard Co.
No. 1 Pennsylvania Plaza
55th Floor
34th Street & 8th Avenue
NEW YORK, NY 10119
Tel: (212) 971-0800
CH,CM,CS,E*,M*

Hewlett-Packard Co.
5858 East Molloy Road
SYRACUSE NY 13211
Tel: (315) 455-2486
A,CH,CM,E,MS

Hewlett-Packard Co.
3 Crossways Park West
WOODBURY, NY 11797
Tel: (516) 921-0300
Telex: 510-221-2183
A,CH,CM,CS,E,MS

North Carolina
Hewlett-Packard Co.
P.O. Box 15579
2905 Guess Road (27705)
DURHAM, NC 27704
Tel: (919) 471-8466
C,M

Hewlett-Packard Co.
5605 Roanne Way
GREENSBORO, NC 27409
Tel. (919) 852-1800
A,CH,CM,CS,E,MS

Ohio
Hewlett-Packard Co.
9920 Carver Road
CINCINNATI, OH 45242
Tel: (513) 891-9870
CH,CM,CS,MS

Hewlett-Packard Co.
16500 Sprague Road
CLEVELAND, OH 44130
Tel: (216) 243-7300
Telex: 810-423-9430
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
962 Crupper Ave.
COLUMBUS, OH 43229
Tel: (614) 436-1041
CH,CM,CS,E*

SALES & SUPPORT OFFICES
Arranged alphabetically by country

Ohio (Con't)
Hewlett-Packard Co.
330 Progress Rd.
DAYTON, OH 45449
Tel: (513) 859-8202
A,CH,CM,E*,MS

Oklahoma
Hewlett-Packard Co.
P.O. Box 366
1503 W. Gore Blvd., Suite #2
LAWTON, OK 73502
Tel: (405) 248-4248
C

Hewlett-Packard Co.
P.O. Box 32008
304 N. Meridan Avenue, Suite A
OKLAHOMA CITY, OK 73107
Tel: (405) 946-9499
A*,CH,CM,E*,MS

Hewlett-Packard Co.
Suite 121
9920 E. 42nd Street
TULSA, OK 74145
Tel: (918) 665-3300
A**,CH,CM,CS,M*

Oregon
Hewlett-Packard Co.
1500 Valley River Drive, Suite 330
EUGENE, OR 97401
Tel: (503) 683-8075
C

Hewlett-Packard Co.
9255 S. W. Pioneer Court
WILSONVILLE, OR 97070
Tel: (503) 682-8000
A,CH,CM,CS,E*,MS

Pennsylvania
Hewlett-Packard Co.
1021 8th Avenue
King of Prussia Industrial Park
KING OF PRUSSIA, PA 19406
Tel: (215) 265-7000
Telex: 510-660-2670
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
111 Zeta Drive
PITTSBURGH, PA 15238
Tel: (412) 782-0400
A,CH,CM,CS,E,MP

South Carolina
Hewlett-Packard Co.
P.O. Box 6442
6941-0 N. Trenholm Road
COLUMBIA, SC 29260
Tel: (803) 782-6493
CH,CM,E,MS

Hewlett-Packard Co.
814 Wade Hampton Blvd.
Suite 10
GREENVILLE, SC 29609
Tel: (803) 232-0917
C

Tennessee
Hewlett-Packard Co.
P.O. Box 22490
224 Peters Road
Suite 102
KNOXVILLE, TN 37922
Tel: (615) 691-2371
A*,CH,CM,MS

Hewlett-Packard Co.
3070 Directors Row
MEMPHIS, TN 38131
Tel: (901) 346-8370
A,CH,CM,MS

Hewlett-Packard Co.
Suite 103
478 Craighead Street
NASHVILLE, TN 37204
Tel: (615) 383-9136
CM,MS**

Texas
Hewlett-Packard Co.
Suite 310W
7800 Shoalcreek Blvd.
AUSTIN, TX 78757
Tel: (512) 459-3143
CM,E

Hewlett-Packard Co.
Suite C-110
4171 North Mesa
EL PASO, TX 79902
Tel: (915) 533-3555
CH,CM,E*,MS**

Hewlett-Packard Co.
5020 Mark IV Parkway
FORT WORTH, TX 76106
Tel: (817) 625-6361
CM,C*

Hewlett-Packard Co.
P.O. Box 42816
10535 Harwin Street
HOUSTON, TX 77036
Tel: (713) 776-6400
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
3309 67th Street
Suite 24
LUBBOCK, TX 79413
Tel: (806) 799-4472
M

Hewlett-Packard Co.
P.O. Box 1270
930 E. Campbell Rd.
RICHARDSON, TX 75081
Tel: (214) 231-6101
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
205 Billy Mitchell Road
SAN ANTONIO, TX 78226
Tel: (512) 434-8241
CH,CM,CS,E,MS

Utah
Hewlett-Packard Co.
3530 W. 2100 South Street
SALT LAKE CITY, UT 84119
Tel: (801) 974-1700
A,CH,CM,CS,E,MS

Virginia
Hewlett-Packard Co.
P.O. Box 9669
2914 Hungary Spring Road
RICHMOND, VA 23228
Tel: (804) 285-3431
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
P.O. Box 4786
3110 Peters Creek Road, N.W.
ROANOKE, VA 24015
Tel: (703) 563-2205
CH,CM,E**

Hewlett-Packard Co.
P.O. Box 12778
5700 Thurston Avenue
Suite 111
VIRGINIA BEACH, VA 23455
Tel: (804) 460-2471
CH,CM,MS

Washington
Hewlett-Packard Co.
15815 S.E. 37th Street
BELLEVUE, WA 98006
Tel: (206) 643-4000
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
Suite A
708 North Argonne Road
SPOKANE, WA 99206
Tel: (509) 922-7000
CH,CM,CS

West Virginia
Hewlett-Packard Co.
4604 MacCorkle Ave., S.E.
CHARLESTON, WV 25304
Tel: (304) 925-0492
A,CM,MS

Wisconsin
Hewlett-Packard Co.
150 S. Sunny Slope Road
BROOKFIELD, WI 53005
Tel: (414) 784-8800
A,CH,CM,CS,E*,MP

URUGUAY
Pablo Ferrando S.A.C. e.I.
Avenida Italia 2877
Casilla de Correo 370
MONTEVIDEO
Tel: 80-2586
Telex: Public Booth 901
A,CM,E,M

Guillermo Kraft del Uruguay S.A.
Av. Lib. Brig. Gral. Lavalleja 2083
MONTEVIDEO
Tel: 234588, 234808, 208830
Telex: 6245 ACTOUR UY
P

U.S.S.R.
Hewlett-Packard Co.
Representative Office
Pokrovsky Blvd. 4/17 KV12
MOSCOW 101000 Tel: 294-2024
Telex: 7825 HEWPACK SU

VENEZUELA
Hewlett-Packard de Venezuela C.A.
Apartado 50933
3A Transversal Los Ruices Norte
Edificio Segre
CARACAS 1071
Tel: 239-4133
Telex: 25146 HEWPACK
A,CH,CS,E,MS,P

YUGOSLAVIA
Iskra-Commerce-Representation of Hewlett-Packard
Sava Centar Delegacija 30
Milentija Popovica 9
11170 BEOGRAD
Tel: 638-762
Telex: 12042, 12322 YU SAV CEN

Iskra-Commerce-Representation of Hewlett-Packard
Koprska 46
61000 LJUBLJANA
Tel: 321674, 315879
Telex:

ZAIRE
Computer & Industrial Engineering
25 Avenue de la Justice
B.P. 10-976
Kinshasha I/Zaire
GOMBE
Tel: 32063
Telex: 21-457 SGEKIN ZR
CH,CS

ZIMBABWE
Field Technical Sales
45 Kelvin Road, North
P.B. 3458
SALISBURY
Tel: 705 231
Telex: 4-122 RH
C,E,M,P

FOR COUNTRIES AND AREAS NOT LISTED:

CANADA
Ontario
Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 610-492-4246

EASTERN USA
Maryland
Hewlett-Packard Co.
4 Choke Cherry Road
Rockville, MD 20850
Tel: (301) 258-2000

MIDWESTERN USA
Illinois
Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800

SOUTHERN USA
Georgia
Hewlett-Packard Co.
P.O. Box 105005
450 Interstate N. Parkway
ATLANTA, GA 30339
Tel: (404) 955-1500

WESTERN USA
California
Hewlett-Packard Co.
3939 Lankersim Blvd.
LOS ANGELES, CA 91604
Tel: (213) 877-1282

EUROPEAN AREAS NOT LISTED, CONTACT
SWITZERLAND
Hewlett-Packard S.A.
7 Rue du Bois-du-Lan
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 83-81-11
Telex: 27835 hpse
Cable: HEWPACKSA Geneve

EAST EUROPEAN AREAS NOT LISTED, CONTACT
AUSTRIA
Hewlett-Packard Ges.m.b.h.
Wehlistrasse 29
P.O. Box 7
A-1205 VIENNA
Tel: (222) 35-16-210
Telex: 135823/135066

MEDITERRANEAN AND MIDDLE EAST AREAS NOT LISTED, CONTACT
GREECE
Hewlett-Packard S.A.
Mediterranean & Middle East Operations
32 Kifisias Ave.
Atrina Center
PARADISOS, Amaroussion
Tel: 808-1741-4
Telex: 21-6588 HPAT GR
Cable: HEWPACKSA Athens

INTERNATIONAL AREAS NOT LISTED, CONTACT
OTHER AREAS
Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
Cable: HEWPACK

FOR COUNTRIES AND AREAS NOT LISTED, CONTACT:

AFRICA

NORTHERN AND CENTRAL AFRICA

SWITZERLAND
Hewlett-Packard S.A.
7 Rue du Bois-du-Lan
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 98-96-51
Telex: 27835 hpse
Cable: HEWPACKSA Geneve

ASIA

HONG KONG
Hewlett-Packard Asia Ltd.
6th Floor, Sun Hung Kai Center
30 Harbor Rd.
G.P.O. Box 795
HONG KONG
Tel: 5-832 3211
Telex: 66678 HEWPA HX
Cable: HP ASIA LTD Hong Kong

EUROPE

EASTERN EUROPE

AUSTRIA
Hewlett-Packard Ges.m.b.h.
Wehlistrasse 29
P.O.Box 7
A-1205 VIENNA
Tel: (222) 35-16-210
Telex: 135823/135066

NORTHERN EUROPE

THE NETHERLANDS
Hewlett-Packard S.A.
Uilenstede 475
NL-1183 AG AMSTELVEEN, The Netherlands
P.O.Box 999
NL-1180 AZ AMSTELVEEN, The Netherlands
Tel: 20 437771

SOUTH EASTERN EUROPE

SWITZERLAND
Hewlett-Packard S.A.
7 Rue du Bois-du-Lan
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 98-96-51
Telex: 27835 hpse
Cable: HEWPACKSA Geneve
(Offices in the World Trade Center)

MEDITERRANEAN AND MIDDLE EAST

GREECE
Hewlett-Packard S.A.
Mediterranean and Middle East Operations
Atrina Centre
32 Kifissias Ave.
Amaroussion, ATHENS, Greece
Tel: 808-0359 808-0429
Telex: 21-6588
Cable: HEWPACKSA Athens

OTHER INTERNATIONAL AREAS
Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
Cable: HEWPACK

August 1981 5952-6900

HEWLETT PACKARD

03456-90006

Printed in U.S.A.