HEWLETT PACKARD

PCInstruments

Owner's Guide

HP 61013A Digital Multimeter

HP Part No. 61013-90001
Microfiche No. 61013-90002

Printed in U.S.A.
April, 1985

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■ Is the organization logical?	Yes	No
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Printing History

New editions of this manual will incorporate all material since the previous edition. Update packages, which may be issued between editions, contain replacement and additional pages to be merged into the manual by the user.

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.)

The instrument prefix number alongside the date refers to the first part of the serial number on the bottom of the instrument. This number indicates the version of the instrument that was available at the time that this manual was issued. However, note that, many instrument updates do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between instrument changes and manual updates.

Edition 1....April 1985....Instrument Prefix 2506A

Safety Summary

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

Ground the Instrument

Establish a complete safety ground before connecting user's circuits. Connect the output cable from the power pack to the instrument and then connect the line cord from the power pack to the ac line. Detailed instructions are in the PC Instruments System Owner's Manual.

Do Not Exceed Input Ratings

To avoid possible damage to the Digital Multimeter, do not connect more than 250 Vdc or 250 Vac between the Digital Multimeter's HI and LO INPUT jacks or more than 350 V peak between either input jack and earth ground.

Safety Symbols

Instruction manual symbol: the product will be marked with this symbol when it is necessary for you to refer to the manual (see What's In This Manual).

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

What's in this Manual?

This manual is a supplement to the HP PC Instruments System Owner's Manual. It contains specific information about your HP PC Instruments Digital Multimeter, Model 61013A. You must read the System Owner's Manual before you read this manual. Warranty and service information is included in the Support Guide in front of your System Owner's Manual.

The System Owner's Manual discusses system related information that is common to all instruments. It also contains specific information about your computer and PC Instruments System. If you are a first time user, refer to Table 3 in your System Owner's Manual for the proper reading sequence of your computer and PC Instruments manuals. If your are an experienced user and already have an operating system, you need only read this manual to learn how to operate and program your Digital Multimeter.

Please insert this manual in the same hardcover binder as your System Owner's Manual. Here is a brief description of the contents of each chapter in this manual.

Chapter 1 - Product Description
Briefly describes the Digital Multimeter, gives its specifications, and lists the items that you receive with it.

Chapter 2 - Trying Out Your Instrument
Gives simple step-by-step instructions that let you quickly perform some operations with nothing connected to the instrument's front panel.

Chapter 3 - Manual Instrument Control
Gives detailed operating information not covered in the simplified instructions of Chapter 2.

Chapter 4 · Front Panel Connections
Explains how to connect the Digital Multimeter to your application.

Chapter 5 · Programming With BASIC
Describes how to control the Digital Multimeter with a program. All programming statements for the Digital Multimeter are explained. Simple programming examples are included.

Appendix A · Programming Statement Summary
Lists all programming statements that apply to the Digital Multimeter.

Appendix B · Verification and Calibration
Contains verification and calibration procedures that you may use to verify the proper operation of the Digital Multimeter if you suspect an instrument malfunction. Includes an easy to use instrument calibration sequence.

Appendix C · Error Status Messages
Lists all error messages that apply to the Digital Multimeter.

1 Product Description

Introducing the PC Instruments Digital Multimeter

The HP PC Instruments Digital Multimeter, hereafter referred to as the "DMM" in this manual, will measure ± dc voltages, ac voltages, and ohms. It performs these measurements under the control of a computer that is equipped with the PC Instruments software and interface card. The System Owner's Manual tells you all you need to know about the required software and computer interface card for your PC Instruments System. Chapters 2 and 3 in this manual explain how to operate the DMM "manually" from the Soft Front Panel (computer display) while Chapter 5 describes the programming statements that you can use to control it from BASIC.

Figure 1-1 shows the basic functions of the DMM. It will measure ± dc voltages on four ranges from 0.2 V to 200 V and make true RMS ac measurements over the same ranges. The DMM can also make resistance measurements on six ranges from 200 ohms to 20 megohms and can be "zeroed" to ensure accurate measurements. In order to measure resistance, the DMM injects a precision current into the resistance under test and measures the resulting voltage drop. In addition to the ranges mentioned, the DMM has an auto range feature that applies to all functions. In auto range, the DMM selects the optimal range for the signal that is being measured.

The DMM uses a 4-1/2 digit A/D (analog-to-digital) converter to make these measurements. The measurements can be taken continuously (2.5 or 12.5 readings/sec) or triggered one at at time. The readings taken at the 2.5 per second rate have greater accuracy than those taken at 12.5 readings/sec; see the Specifications table in this chapter. The DMM can be used with a PC Instruments Relay/Multiplexer Model 61011A to take voltage and/or resistance readings of up to eight different inputs. Meter

leads are connected to the HI and LO INPUT jacks on the DMM's front panel. The DMM's input jacks are isolated from digital ground and can be floated at up to 350 V from either terminal to earth ground (see Isolation Voltage Rating Specification in Table 1-1).

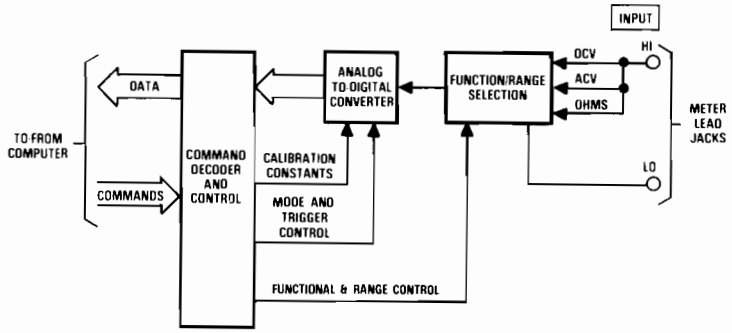


Figure 1-1. Digital Multimeter Block Diagram

Calibration constants are stored in a non-volatile memory device inside the DMM. These constants are used in the calibration procedures described in Appendix B. To assure measurement accuracy, it is recommended that the DMM be calibrated every six months.

Items Supplied with the Digital Multimeter

In addition to this manual, the following items are supplied with the DMM.

Power Pack - consists of an ac power transformer with an attached one metre cable. The transformer type that you received was determined by the available ac voltage in your country. Chapter 2 in the System Owner's Manual lists the different types and their HP part numbers.

Power Cord - connects the power pack to an ac source. The plug type was determined by the country of destination. Chapter 2 in the System Owner's Manual lists the different types and their HP part numbers.

Instrument Interconnect Cable - connects your instrument to the system interface. Refer to Chapter 2 in the System Owner's Manual.

Meter Leads ( ) - connect your DMM to the application. They consist of one pair (one red and one black) of each of the following:

- Banana Plug meter leads
- Test Probes
- Grabber Test Clips

Manual Update Pages - if applicable, updated pages are included. Replace the obsolete pages with the new ones before you use this manual.

Table 1-1 Specifications

Digits:
4-1/2

Functions:
± DC, AC (true RMS), Ohms

Programmable Ranges:
DC (+ or −) or AC Volts (RMS)

Range	Max Display (4 1/2 Digit)	Resolution
200 mV	199.99 mV	.01 mV
2 V	1.9999 V	.0001 V (.1 mV)
20 V	19.999 V	.001 V (1 mV)
200 V	199.99 V	.01 V (10 mV)
*Auto		

Ohms

Range	Max Display (4 1/2 Digit)	Resolution
200 Ω	199.99 Ω	.01 Ω
2 KΩ	1.9999 KΩ	.0001 KΩ (.1 Ω)
20 KΩ	19.999 KΩ	.001 KΩ(1 Ω)
200 KΩ	199.99 KΩ	.01 KΩ (10 Ω)
2 MΩ	1.9999 MΩ	.0001 MΩ (100 Ω)
20 MΩ	19.999 MΩ	.001 MΩ(1 KΩ)
* Auto		

* In autorange, the optimal range is selected.

Maximum Measurement Rate:
12.5 readings/sec (System limit with a MEASURE statement)

Programmable Measurement Rates:
2.5 readings/sec or 12.5 readings/sec

Input Impedance:
10 M ohms minimum all dc ranges
1 M ohms in parallel with < 60 pF on all ac ranges

Table 1-1. Specifications (continued)

Maximum Source Current (Resistance Measurements):
1 mA

Maximum AC Frequency:
1 kHz

Input Overvoltage Protection:
350 V Peak (non-destructive)

NMR:
>60 db at 50/60 Hz (at 2.5 readings/sec on dc ranges)

ECMRR:
>120 db at 50 Hz, 60 Hz, dc (with 1 k ohms imbalance at 2.5 readings/sec on dc ranges)

CMMR (ac ranges):
>60 db at dc to 60 Hz on ac ranges.

Isolation Voltage Ratings:
250 VDC, 250 Vac rms, or 350 Vac peak between any input jack and earth ground.

AC Crest Factor:
Maximum 3:1 at full scale.

As-Shipped Default Settings:
Label: DMM.01
Function: dcV
Range: Auto
Trigger: Internal
Readings/Sec: 2.5

Weight:
1.02 kg (2.25 lbs)

Table 1-1. Specifications (continued)

Accuracy at 23° C ±5° C, 80% RH (all ac specifications are given for a sine wave)

2.5 readings/sec:

DC Volts: ± 0.05% of reading ± 3 counts

AC Volts (45 Hz to 500 Hz): ± 0.5% of reading ± 50 counts

AC Volts(30 Hz to 45 Hz and 500 Hz to 1 kHz): ± 1% of reading ± 50 counts

Ohms:

± 0.1% of reading ± 2 counts (200, 2 k, 20 k, 200 k, 2 M ohm ranges)

± 0.35% of reading ± 2 counts (20 M ohm range)

12.5 readings/sec:

DC Volts: ± 0.05% of reading ± 7 counts

AC Volts (45 Hz to 500 Hz): ± 0.5% of reading ± 54 counts

AC Volts (30 Hz to 45 Hz and 500 Hz to 1 kHz): ± 1% of reading ± 54 counts)

Ohms:

± 0.1% of reading ± 6 counts (200, 2 k, 20 k, 200 k 2 M ohm ranges)

± 0.35% of reading ± 6 counts on 20 M ohm range

Table 1-1. Specifications (continued)

Accuracy at 0° C to 40 ° C, 80% RH: (all ac specifications are given for a sine wave):

2.5 readings/sec:

DC Volts: ± 0.1% of reading ± 8 counts

AC Volts (45 Hz to 500 Hz): ± 0.75% of reading ± 100 counts

AC Volts (30 Hz to 45 Hz and 500 Hz to 1 kHz): ± 1.5% of reading ± 100 counts)

Ohms:

± 0.2% of reading ± 7 counts (200, 2 k, 20 k, 200 k, 2 M ohm ranges)

± 0.5% of reading ± 12 counts (20 M ohm range)

12.5 readings/sec:

DC Volts: ± 0.1% of reading ± 12 counts

AC Volts (45 Hz to 500 Hz): ± 0.75% of reading ± 104 counts

AC Volts (30 Hz to 45 Hz and 500 Hz to 1 kHz): ± 1.5% of reading ± 104 counts)

Ohms:

± 0.2% of reading ± 11 counts (200, 2 k, 20 k, 200 k, 2 M ohm ranges)

± 0.5% of reading ± 16 counts (20 M ohm range)

2 Trying Out Your Instrument

Introduction

The following step-by-step procedure allows you to perform some simple instrument operations. The procedure is especially suitable for first time users who want to quickly become familiar with the basic operation of the DMM. Chapter 3 contains all of the operating details for the DMM.

The Procedure

Trying out the DMM consists of pointing to and selecting various interactive fields on DMM's Soft Front Panel. Before you go ahead and try out your DMM, you should already have connected it to the interface, applied power, loaded the operating sytem, renamed (or erased) "HPSTATE.HPC" to return the DMM to its factory default settings, and run PANELS as explained in Chapters 2 and 3 of your System Owner's Manual. In order to perform the procedure that follows, your meter leads do not have to be connected.

Step #1 - If your DMM does not already appear in the Interactive Instrument Window, point to and select DMM.01 from the label(s) listed in the System View Window (see Figure 2-1). If you have many instruments in your system, you may have to use the ROLL UP SYS VIEW and ROLL DWN SYS VIEW softkeys to view them all. When you select an instrument from the list, the ACTIVE indicator on the front panel of the instrument will light.

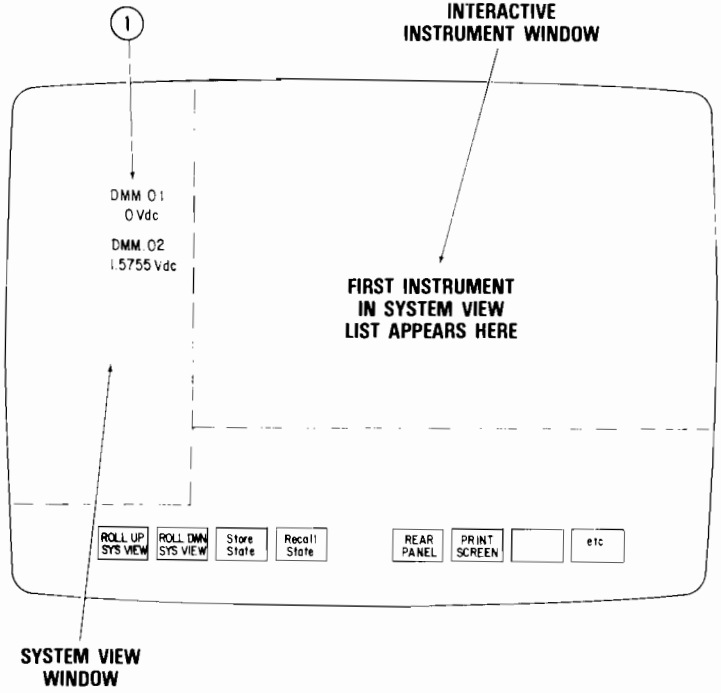


Figure 2-1. Select the Instrument

DMM.01 is the factory default label for the first Digital Multimeter in the system. If you are using more than one DMM in your system, each additional DMM is assigned a sequentially numbered default label (i.e., DMM.02, DMM.03, etc.). The line directly below the label indicates the latest DMM measurement (e.g. 1.5755 Vdc). If you

have many instruments in your system, you may have to use the ROLL UP SYS VIEW softkey to view them all. When you select an instrument from the list, the active indicator on the front of the instrument will light.

Step #2 · Once you select DMM.01, the DMM.01 area in the System View Window turns bright and your instrument appears in the Interactive Instrument Window. Figure 2-2 shows that the factory default settings (Function= dcV, Range= Auto, etc.) are in effect (bright backgrounds) when the DMM Soft Front Panel appears in the Interactive Instrument Window. To operate DMM.01, first point to and select the acV Function.

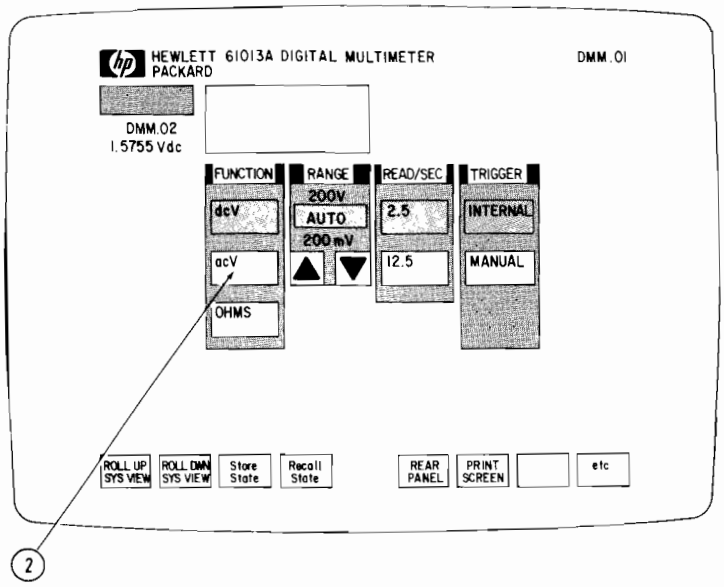


Figure 2-2. Select acV Function

Step #3 - Now that the acV function is selected (see Figure 2-3), use the UP arrow or DOWN arrow to move 200 mV into the range select field. Each time that you point to and select the UP arrow field, the next choice appears in the select field. Each time that you point to and select the DOWN arrow field, the previous choice appears in the select field.

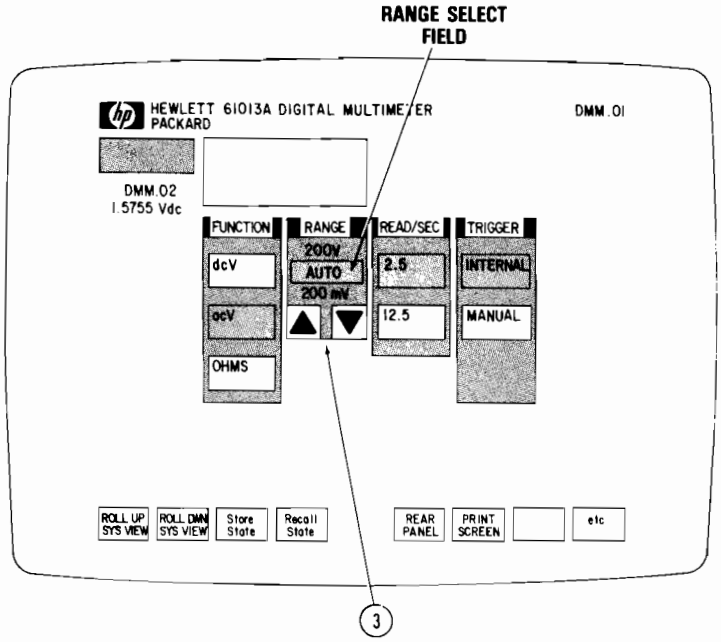


Figure 2-3. Move 200 mV into the Range Select Field

Step #4 - Now that the desired Range, 200 mV, appears in the select field (see Figure 2-4), point to it and select it to set the DMM to this range.

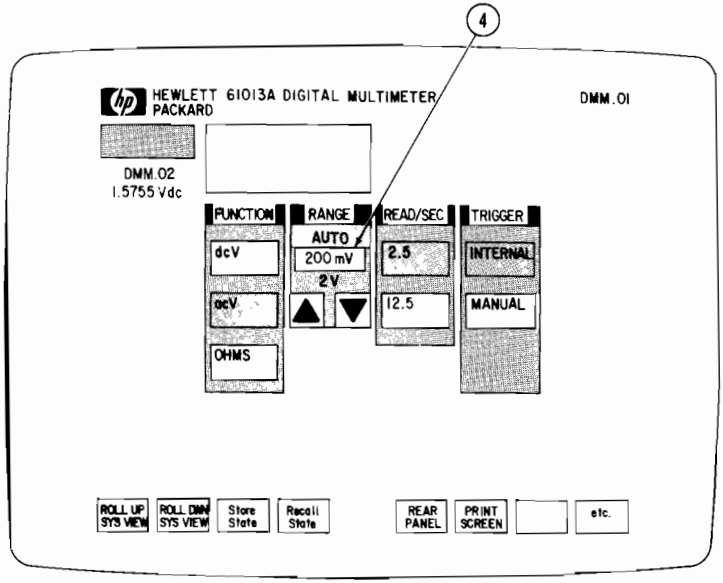


Figure 2-4. Point to and Select the 200 mV Range

The Result · After completing Steps 1 through 4 above, DMM.01 is set up to measure ac volts in the 200 mV range (see Figure 2-5). The remaining settings for TRIGGER and READ/SEC were not changed. To try out a different instrument at this time, go to Chapter 2 in its manual; otherwise, exit the Soft Front Panel by pressing the **etc.** softkey and then the **EXIT** softkey.

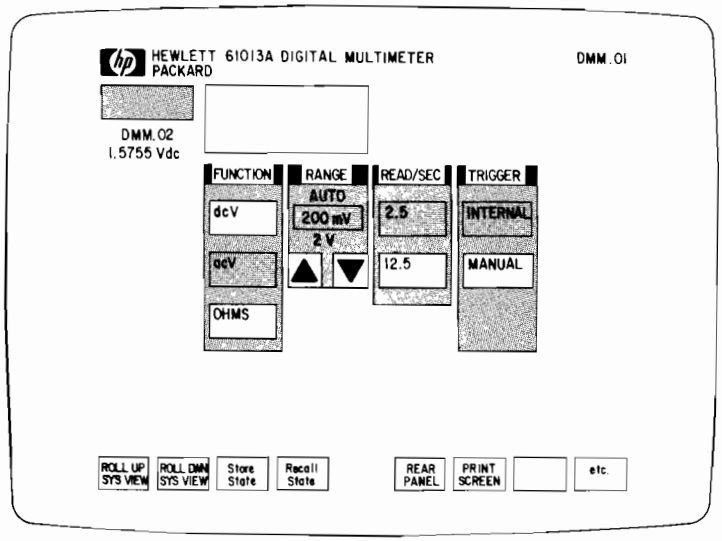


Figure 2-5. acV Function/200 mV Range Activated

What To Do Next

Now that you have finished trying out your instrument, the next thing you do depends upon the type of user you are. If you are an experienced PC Instruments user and are already familiar with your System Owner's Manual, read the remaining chapters in this manual. If you are a first time PC Instruments user, read Chapter 4 in the System Owner's Manual and Chapter 3 in this manual to learn all about controlling your DMM "manually". Table 3 in the System Owner's Manual specifies the reading sequence for first time users.

3 Manual Instrument Control

Introduction

The basics of selecting a Function and a Range have already been discussed in Chapter 2 of this manual to help you become familiar with the DMM. This chapter describes how to use all of the DMM's Soft Front Panel features. Chapter 4 of the System Owner's Manual describes the Soft Front Panel features (including softkeys) that are common to all instruments.

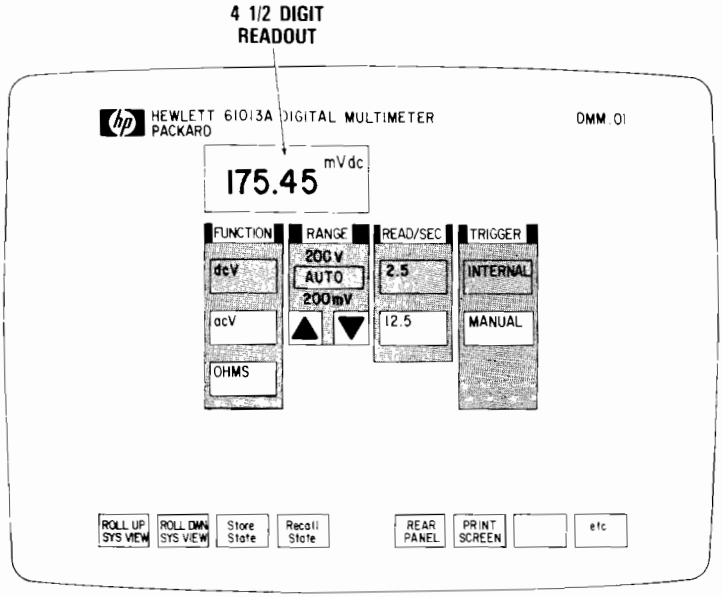


Figure 3-1. DMM Soft Front Panel, dcV Selected

Figure 3-1 shows the DMM's Soft Front Panel settings which are in effect when the DMM is shipped from the factory; these are also referred to as default settings: Function = dcV, Range = Auto, Trigger = Internal, and

Read/Sec = 2.5. The figure also shows the default label (DMM.01) in the upper right hand corner ot the Interactive Instrument Window. If your computer display does not look like this, it means that a previous user has changed the default settings and/or label. The Interactive Instrument Window can display either the front panel or the rear panel of your instrument. Use the FRONT PANEL softkey to get the front panel to appear. This is the panel that lets you operate the instrument.

As shown in Figure 3-1, the DMM's Soft Front Panel provides a 4-1/2 digit readout. The unit of measure (e.g. mV, V, Ohms, etc.) and negative polarity (for dc measurements) are indicated along with the reading. If INTERNAL trigger is selected, the display is updated continuously (every 2.5 or 12.5 seconds). If MANUAL trigger is selected, the display is updated each time a reading is taken by selecting START. These features are described later in this chapter. Note that the reading (e.g. 175.45 mVdc) will appear in the System View window under the DMM.01 label when another instrument is being controlled manually in the Interactive Instrument Window. This allows you to monitor the DMM readings while you are operating another instrument. If you are using the DMM in this manner, the INTERNAL trigger (continuous readings) must be selected so that the most recent DMM reading will always appear in the System View Window. You can tell which DMM trigger mode is in effect by looking at the label in the System View Window. If the letter "M" appears next to the label, the Manual Trigger Mode is in effect. If there is no letter after the label, the Internal Trigger Mode is in effect. The letter "E" appearing next to the label indicates an error condition. A description of the error will appear in the Status window the next time the the instrument is brought into the Interactive Instrument Window.

The following paragraphs describe how to operate the DMM to take dc voltage, ac voltage, and resistance measurements.

DC Voltage Measurements

The DMM can measure dc voltages of either polarity on four ranges from 200 mV to 200 V. To measure dc voltage, you must select the dcV FUNCTION and set the RANGE, READ/SEC, and TRIGGER fields as desired. Figure 3-1 shows the dcV FUNCTION selected (bright background). If dcV is not selected, you must point to it and select it. Selecting a function cancels the previously selected function and then sets the new function. The last RANGE, READ/SEC, and TRIGGER settings for this new function are also selected (i.e., they will become the bright fields on the screen). If you want to change these settings, proceed as follows:

Range Selections

Use the UP ARROW or DOWN ARROW field to move the desired range value into the range select field. Then you must point to and select this field to set the DMM to the specified range. Range selection is shown graphically in Steps 3 and 4 in "Trying Out Your Instrument" in Chapter 2. The range choices for the dcV function are 200 mV, 2 V, 20 V, 200 V, and Autorange. The maximum 4-1/2 digit display (readout) and the resolution for each of the range choices for the dcV function are as follows:

Range	Max. Readout (+ or −)	Resolution
200 mV	199.99 mVdc	.01 mVdc
2 V	1.9999 Vdc	.0001 Vdc
20 V	19.999 Vdc	.001 Vdc
200 V	199.99 Vdc	.01 Vdc
Auto	*	*

* In autorange, the optimal range is selected.

When autorange is selected, the DMM searches for the proper range. Autorange is most useful when you are taking measurements over a wide range of values. However, if you know that the values that you are going to measure will fall within a specific range, you should select that range before you start taking measurements.

For example, if you know that the measurements will fall within the range from 200 mV to 1.9999 Vdc, you should select the 2 V range before you start taking measurements. With a specific range selected, the DMM does not search for the proper range before it displays a measurement; consequently, the measurements are generally performed more rapidly when a specific range is selected.

If the reading exceeds the limits of the selected range, a message indicating "OVERLOAD" will appear.

If the reading is in a range lower than the selected range, the reading will appear in the readout area and a status message will appear to notify you that you will get better resolution if you select a lower range.

Readings/Second Selection

You can select the number of readings per second the DMM will take. You can select either 2.5 or 12.5 readings/second by pointing to and selecting the desired READ/SEC field. Figure 3-1 shows 2.5 READ/SEC selected.

Trigger Selection

You can select either INTERNAL or MANUAL trigger by pointing to and selecting the desired TRIGGER field. Figure 3-1 shows INTERNAL (bright background) selected. With INTERNAL selected, the DMM will take readings continuously at the selected rate (either 2.5 or 12.5 readings/second). In most applications, you will set the DMM to INTERNAL trigger so that you can continously monitor the output of the device under test in the System View Window while you operate another instrument.

MANUAL trigger allows you to take one reading at a time. When you point to and select MANUAL, the DMM stops taking readings and the START field appears as shown in Figure 3-2. Now you can point to and select the START field to cause the DMM to take a single reading. While the reading is in progress, the START field stays

bright and will not respond to additional selections until the present reading is completed.

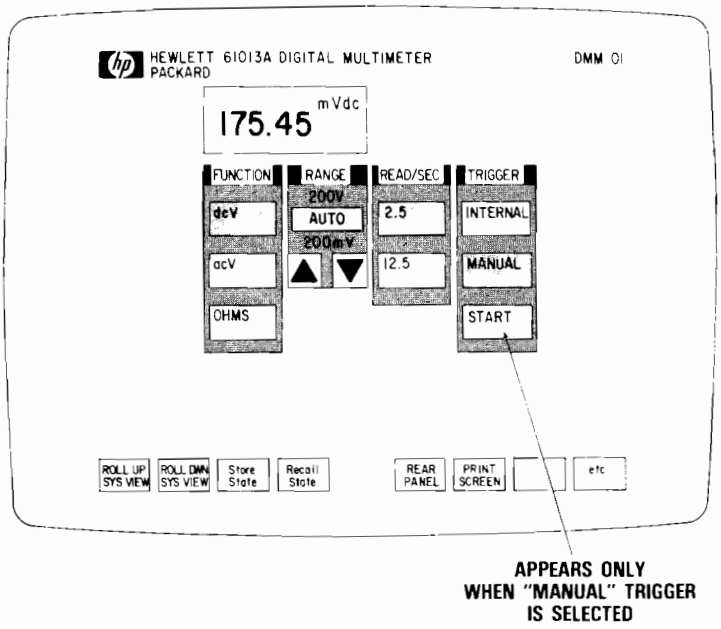


Figure 3-2. DMM Soft Front Panel, Manual Trigger Selected

AC Voltage Measurements

Manual operations for making ac voltage measurements are identical to those just described for the dcV function. The DMM can make true RMS ac voltage measurements on four ranges from 200 mV to 200 V. To measure ac voltage, you must point to and select the acV FUNCTION. Remember that when you select the acV function, the last range, readings/sec, and trigger settings for acV are also recalled. If you want to change them, set the RANGE, READ/SEC, and TRIGGER fields as desired. Figure 3-3 shows the acV FUNCTION selected (bright background).

The maximum 4-1/2 digit display (readout) and the resolution for each of the range choices for the acV Function are as follows:

Range	Max. Readout (true RMS)	Resolution
200 mV	199.99 mVac	.01 mVac
2 V	1.9999 Vac	.0001 Vac
20 V	19.999 Vac	.001 Vac
200 V	199.99 Vac	.01 Vac
Auto	*	*

* In autorange, the optimal range is selected.

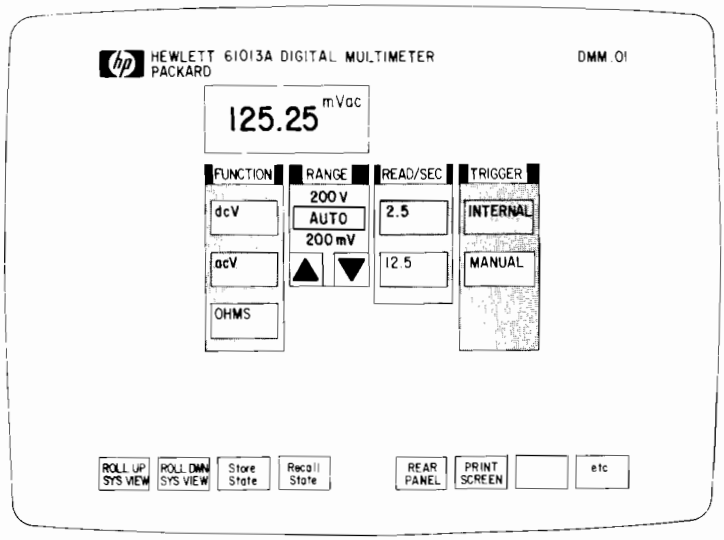


Figure 3-3. DMM Soft Front Panel, acV Selected

Resistance Measurements

Manual operations for making resistance measurements are identical to those just described for the voltage measurements except that you can "zero" the DMM before taking resistance measurements.

The DMM can make resistance measurements over six ranges from 200 ohms to 20 megohms. To measure resistance, you must point to and select the OHMS FUNCTION and set the RANGE, READ/SEC, and TRIGGER fields as desired. Figure 3-4 shows the OHMS FUNCTION selected (bright background). Note that with OHMS selected, the ZERO OHMS field appears beneath the RANGE choices.

"Zeroing" the DMM

To "zero" the DMM, you short the meter leads together and point to and select the ZERO OHMS field. This causes the DMM to self calibrate for a zero ohms reading by taking into account any resistance in the meter leads. ZERO OHMS automatically calibrates in the DMM's lowest resistance range (200 ohms). The ZERO OHMS field will be bright while the calibration is in progress.

The maximum 4-1/2 digit display (readout) and the resolution for each of the range choices for the OHMS Function are as follows:

Range	Max. Readout	Resolution
200 Ω	199.99 Ω	.01 Ω
2 kΩ	1.9999 kΩ	.0001 kΩ
20 kΩ	19.999 kΩ	.001 kΩ
200 kΩ	199.99 kΩ	.01 kΩ
2 MΩ	1.9999 MΩ	.0001 MΩ
20 MΩ	19.999 MΩ	.001 MΩ
Auto	*	*

* In autorange, the optimal range is selected.

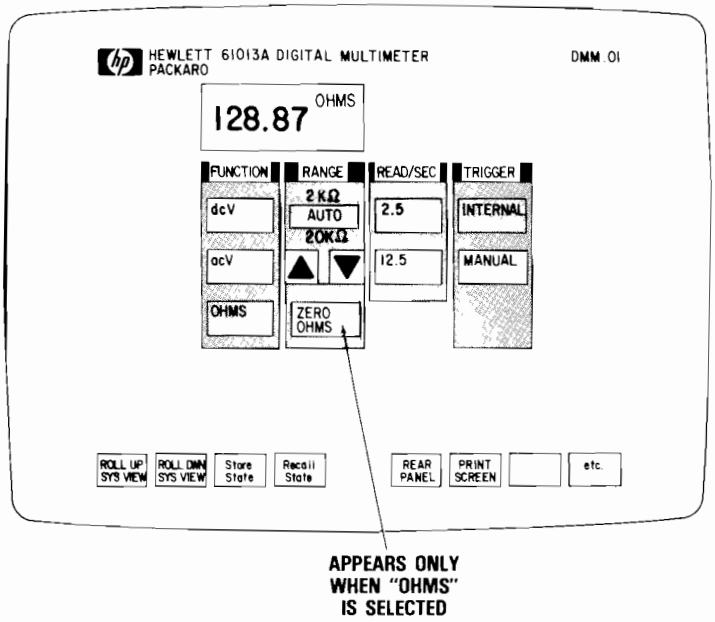


Figure 3-4. DMM Soft Front Panel, Ohms Selected

4 Front Panel Connections

Introduction

The following paragraphs describe how to make the meter lead connections to the DMM's front panel and to the application. You should become familiar with the operation of the DMM as described in the preceding two Chapters before you connect it to an application and start taking measurements. You may also want to learn how to program it as described in Chapter 5 before you connect it to an application.

WARNING

Before making any front panel connections, establish a safety ground connection to your DMM by installing the Power Pack as described in the System Owner's Manual.

Meter Connections

To allow flexibility when making connections to your application, the DMM is shipped with meter leads that can accommodate test probes or grabber clips. The meter lead plugs are retractable and have protective sheaths to prevent shorting the inputs. Connect the meter leads to the DMM front panel (see Figure 4-1) as follows:

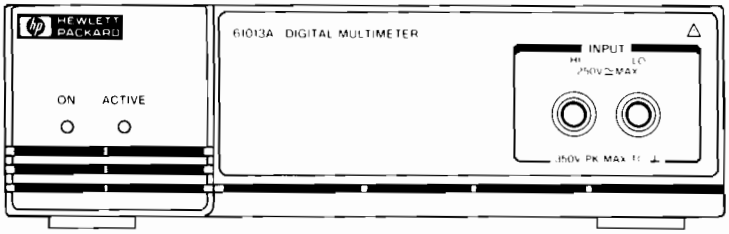


Figure 4-1. Digital Multimeter, Front View

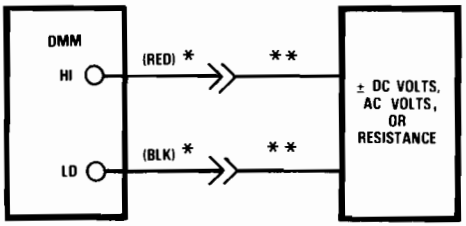
1. Connect the plug on one end of the red meter lead to the HI INPUT jack on the DMM. Connect the plug on the other end of the red meter lead to a red test probe or grabber clip.
2. Connect the plug on one end of the black meter lead to the LO INPUT jack on the DMM. Connect the plug on the other end of the black meter lead to a black test probe or grabber clip.

Application Connections

Connect the red and black (common) test probes or grabber clips between the application test points (dcV, acV, or resistance) to be measured (see Figure 4-2). The measurement can be taken "manually" from the DMM's Soft Front Panel (see Chapter 3) or by computer program (see Chapter 5).

CAUTION

To avoid possible damage to the DMM, do not connect more than 250 Vdc or 250 Vac between the DMM's HI and LO INPUT jacks or more than 350 V peak between either input jack and earth ground. The DMM is isolated from logic (computer) ground.



* METER LEADS

** TEST PROBES, GRABBER CLIPS

Figure 4-2. Measurement Connections

Voltage Measurements

The DMM can measure ± dc voltages or true RMS ac voltages from 0.01 mV to 200 V (199.99 V max. reading) in four ranges (200 mV, 2 V, 20 V, 200 V) or in autorange. All ranges are protected from input voltages up to 350 V peak, see CAUTION on page 4-3. The DMM has an input impedance of 10 Megohms for all dc ranges and 1 Megohm (across less than 60 pF) for all ac ranges (see Figure 4-3). Refer to Table 1-1 for dcV and acV measurement accuracy specifications.

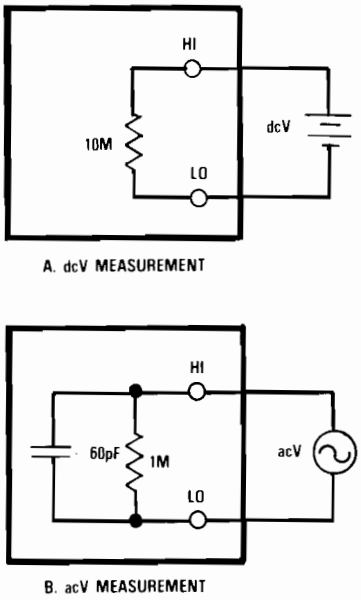


Figure 4-3. Input Impedance Equivalent Circuits for dcV and acV Measurements

Resistance Measurements

The DMM can make resistance measurements from 0.01 ohms to 20 Megohms (19.999 Megohms max. reading) in six ranges (200 ohms, 2 K, 20 K, 200 K, 2 Meg, 20 Meg) or in autorange. All ranges are protected from input voltages up to 350 V peak. Thus, you can have the DMM set up to measure resistance and inadvertently connect a voltage to the DMM's input jacks (see Caution on page 4-3) without damaging the DMM. Refer to Table 1-1 for resistance measurement accuracy specifications.

Resistance measurements are made by applying a precision current (generated by the DMM) to the unknown resistance (see Figure 4-4). The resultant voltage drop across the HI and LO INPUT jacks is then measured by the DMM. The DMM's current source (Isource) values for each resistance range are as follows:

Range	Isource
200 Ω	1 mA
2 KΩ	1 mA
20 KΩ	100 μA
200 KΩ	10 μA
2 MΩ	1 μA
20 MΩ	.1 μA

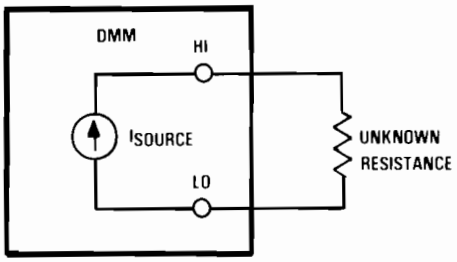


Figure 4-4. Resistance Measurement Connections

5 Programming With Basic

Introduction

You can write a BASIC program to control your DMM. Before you attempt to do this, you should familiarize yourself with controlling the instrument manually (refer to Chapters 2 and 3). Also, you must already know BASIC programming before you can write your own application program. Chapter 5 in the System Owner's Manual explains how to develop and run your application program. Before you develop your program, you must first use the Soft Front Panel to generate the program shell as explained in Chapter 4 of the System Owner's Manual. You can also use the Soft Front Panel to assign a label to the DMM and create one or more state files.

This chapter describes all of the programming statements that you can use in your program to control the DMM. These statements fall into two categories: system and instrument. System statements affect other instruments in your system while Instrument statements affect only the specified (labeled) DMM.

NOTE

If the programming statements in this chapter fail to execute, you may have a program error. Refer to Chapter 5 in the System Owner's Manual which discusses error handling methods. Appendix C of this manual lists the error messages that apply to the DMM.

How Statements Control The Digital Multimeter

Before using any of the statements described in this chapter, take some time to review Figure 5-1 below. The diagram illustrates the relationship between the statements and the functions of the DMM. From the diagram, you can see that the SET.FUNCTION and SET.RANGE statements control the analog portion of the DMM to set up the gain for the selected function (dcV, acV, or ohms). The measurements are made by a 4-1/2 digit analog-to digital (A/D) converter.The A/D converter can be programmed to take measurements continuously (ENABLE.INT.TRIGGER statement) or to take measurements one at a time (DISABLE.INT.TRIGGER statement). The START statement is used when you want to take one measurement at a time. The SET.SPEED statement allows measurements to be taken at a rate of 2.5 or 12.5 readings/second. The INITIALIZE statement simultaneously selects the function, range, speed, and trigger parameters according to a previously assigned State file.

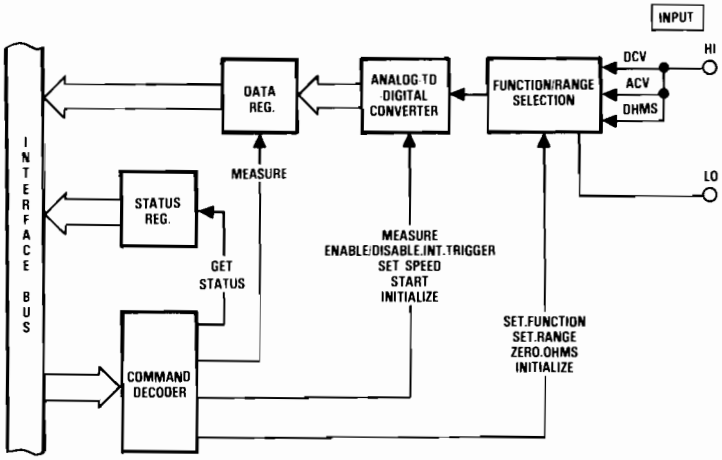


Figure 5-1. DMM Programming Statements

The measurement values are returned to the computer using the MEASURE statement. The unit of measure depends upon the function selected. For example, a reading of 152.55 can be 152.55 Vdc, 152.55 Vac, or 152.55 ohms. All of the statements that you can use to program the DMM are described in this chapter.

System Programming Statements

All of the system programming statements are covered in the System Owner's Manual. The DMM responds to only one system statement:

INITIALIZE.SYSTEM (*statefile*) - where *statefile* is the string variable that is equal to a State filename that you assigned when operating from the Soft Front Panel as described in Chapter 4 in the System Owner's Manual.

NOTE

The Rear Panel information contained in the State file must agree with your present hardware set-up.

The INITIALIZE.SYSTEM statement sets all DMM's in your system to the settings contained in the previously created State file. All other instruments in the system are also initialized. Wherever it is used in your program, the INITIALIZE.SYSTEM statement will override the results of any previously issued program statements. If this statement is not used in your program, the instruments will be initialized with the factory default settings. The DMM's factory default settings are listed in Table 1-1.

Instrument Programming Statements

Instrument programming statements only program the instrument specified by the *label*. The *label* is either the factory default label (DMM.01 for the first Digital Multimeter in your system) or the user defined label that is assigned in the Rear Panel Mode. There are ten instrument statements that can be used to program the DMM.

INITIALIZE (*label,statefile*) · same as INITIALIZE.SYSTEM but sets only the specified Digital Multimeter to a previously defined state. Although the file contains information about the other instruments in your system, only the information that applies to the Digital Multimeter will be retrieved.

Example:

```
1010 FILE$="YOURFILE"
1020 CALL INITIALIZE(DMM.01,FILE$)
```

This example sets the Digital Multimeter to the settings contained in the file "YOURFILE". YOURFILE is a State file you created and named when operating from the Soft Front Panel. Depending upon the information in this file, DMM.01 can be initialized to measure dc volts, ac volts, or ohms in the desired range.

SET.FUNCTION (*label,function*) · Sets the labeled DMM to the specified *function*. Where *function* must be one of the following reserved variables: DCVOLTS, ACVOLTS, or OHMS.

The SET.FUNCTION statement also sets the DMM to the previously programmed RANGE, SPEED, and TRIGGER parameters for the function specified. If any of these parameters must be changed, use the SET.RANGE, SET.SPEED, and ENABLE/DISABLE.INT.TRIGGER statements as applicable.

Example:

```
1010 CALL SET.FUNCTION(DMM.01,ACVOLTS)
```

This example sets the DMM.01 to measure ac volts in the previously programmed range, speed, and trigger parameters for this function.

SET.RANGE (*label,range*) · Specifies the range of the DMM function that is presently in effect. Where *range* must be one of the reserved variables listed in Table 5-1. The table lists the reserved variables and the ranges/resolutions for each function. A reserved variable may be entered directly into the statement as shown in the following example:

Example:

```
1010 CALL SET.RANGE(DMM.01,R2)
```

This example sets the the DMM to the 2 V (1.9999 V) range if the function was set to ACVOLTS or DCVOLTS.

Table 5-1. Reserved Variables for Range

Function	Reserved Range Variable	Max Reading/Resolution
DCVOLTS	R200MILLI	±.19999 Vdc/.00001 V
	R2	±1.9999 Vdc/.0001 V
	R20	±19.999 Vdc/.001 V
	R200	±199.99 Vdc/.01 V
	AUTOM	*
ACVOLTS	R200MILLI	.19999 Vac/.00001 V
	R2	1.9999 Vac/.0001 V
	R20	19.999 Vac/.001 V
	R200	199.99 Vac/.01 V
	AUTOM	*
OHMS	R200	199.99 ohms/.01 ohm
	R2KILO	1,999.9 ohms/.1 ohm
	R20KILO	19,999 ohms/1 ohm
	R200KILO	199,990 ohms/10 ohms
	R2MEGA	1,999,900 ohms/100 ohms
	R20MEGA	19,999,000 ohms/1000 ohms
	AUTOM	*

* In AUTOM range the DMM selects the optimal range and resolution for the analog signal that is presently being measured. For example, if the measured signal is 1.5000 Vdc, the DMM selects the R2 range.

Note that the R200MILLI, R2, and R20 reserved variables are valid only for the DCVOLTS and ACVOLTS functions and will generate an error "INVALID RANGE" if specified when the OHMS function is in effect. Similarly, the ranges (R2KILO, R20KILO, R200KILO, R2MEGA, and R20MEGA) are valid only for the OHMS function and will generate an error if specified when DCVOLTS or ACVOLTS is in effect.

ZERO.OHMS(*label*) · This statement pertains only to the Ohms function. The meter leads must be shorted together when this statement is programmed. The ZERO.OHMS statement causes the DMM to self-calibrate for a zero ohms reading by taking into account any resistance in the meter leads. The following program example first prompts the user to short the meter leads together and then "zeros" the DMM before the program continues and any measurements are taken. Up to 200 ohms can be "zeroed" out.

Example:

```
1010 CALL SET.FUNCTION(DMM.01,OHMS)
1020 PRINT "Short the leads of the DMM"
1030 PRINT "Press any key once the leads are shorted"
1040 A$=INKEY$: IF A$="" THEN 1040
1050 CALL ZERO.OHMS(DMM.01)
                    .
                    .
              Continue program
                    .
                    .
                    .
```

SET.SPEED(*label,speed*) · sets the speed at which the DMM will take measurements when the Internal Trigger mode is in effect. The measurements can be taken at 2.5 or 12.5 readings/second. The 2.5 readings/second rate provides higher accuracy. The variable *speed* must be either one of two reserved variables:

Reserved Variable	Readings/Sec
R2.5	2.5
R12.5	12.5

Example:

```
1010 CALL SET.SPEED(DMM.01,R12.5)
```

This example sets DMM.01 to take 12.5 readings per second.

ENABLE.INT.TRIGGER(*label*) · Sets the DMM to the Internal Trigger mode of operation. In this mode, the DMM continually takes measurements (at the selected rate of 2.5 or 12.5 readings/sec). The latest **completed measurement** is read back to the computer when MEASURE is programmed.

Example:

```
1010 CALL ENABLE.INT.TRIGGER(DMM.01)
```

This example sets DMM.01 to the Internal Trigger mode causing the DMM to take continuous readings.

DISABLE.INT.TRIGGER(*label*) · Disables the Internal Trigger and sets the DMM to the Manual Trigger mode. In this mode, the DMM stops taking continuous measurements and will only take a measurement in response to a trigger generated by a START statement or a MEASURE statement.

Example:

```
1010 CALL DISABLE.INT.TRIGGER(DMM.01)
1020 CALL START(DMM.01)
```

This example disables the Internal Trigger mode and allows the DMM to take a measurement when a START statement (or a MEASURE statement) is programmed (described below).

MEASURE(*label,value*) · Returns a DMM reading into the variable *value*. The operations performed by the DMM when MEASURE is programmed depend upon which trigger mode is currently in effect.

If Internal Trigger mode is enabled (continuous readings), the DMM triggers the readings automatically at the selected rate (2.5 or 12.5 readings/second) and MEASURE will return the latest completed reading. The program continues after the reading has been returned.

If Internal Trigger is disabled (Manual Trigger is in effect), MEASURE can be used in two different ways:

1. You can use MEASURE to trigger the reading as well as return the reading when the Manual Mode is in effect. In order to do this, do not precede the MEASURE statement with a START statement in your program (See No. 2 below). When MEASURE is executed, the DMM is triggered to take a single reading. The program will then wait for the reading to be completed and returned before continues executing.

2. You can use MEASURE to return a reading after a START statement (described later) triggered the DMM to take the reading. Since the program will continue immediately after executing START, your program should use a GET.STATUS statement (described later) to ensure that the DMM has completed the measurement before MEASURE is programmed to return the reading.

Example:

```
1010 CALL MEASURE(DMM.01,VOLTS)
1020 IF VOLTS = 1E10 THEN 1050
1030 PRINT VOLTS;''Vdc''
1040 GOTO 1060
1050 PRINT ''OVERLOAD''
1060 END
```

This example returns a DMM.01 reading into the variable VOLTS. The resolution of the reading depends upon the range selected and the unit of measure depends upon the function selected. Assuming that the DCVOLTS function and 200 V range are in effect, a reading of 155.33 represents 155.33 Vdc. Line 1030 in the example prints out the value in ''Vdc''. If the reading exceeds the limits of the selected range, the MEASURE will return the value ''1E10'' to the variable VOLTS to indicate an overload condition (see line 1020). If this is the case, ''OVERLOAD'' is printed out.

START(*label*) · Triggers the DMM to take a reading. Note that the program does not wait for the measurement to complete and thus additional statements can be executed while the reading is in progress. START is valid only in the Manual Trigger mode. START *cannot* be programmed when the Internal Trigger mode is in effect.

Example:

```
1010 CALL DISABLE.INT.TRIGGER(DMM.01)
1020 CALL START(DMM.01)
```

This example triggers the named DMM to perform a single reading. The reading must be returned to the computer using a MEASURE statement (see Sample Program No. 2).

GET.STATUS(*label,value*) · Returns the current status of the DMM to *value*. The variable *value* contains the binary-weighted represention of the DMM status as follows:

DMM Status	Value	Meaning
Data Available	1	DMM has completed a measurement.
Busy	2	DMM is currently performing a measurement.
Overrange	4	DMM has taken a measurement that is beyond the selected range.
Underrange	8	DMM can attain better resolution if a lower range is selected.

Example:

```
1010 CALL DISABLE.INT.TRIGGER(DMM.01)
1020 CALL START(DMM.01)
                    .
                    .
          continue program
                    .
                    .
1090 CALL GET.STATUS(DMM.01,VALUE)
1100 IF VALUE = 1 THEN 1150
                    .
          continue program
                    .
1150 CALL MEASURE(DMM.01,VOLTS)
                    .
                    .
```

This example uses a GET.STATUS statement to check if the DMM has completed a measurement that was triggered by a START statement. Since the program continues immediately to the next line after START is executed, processing may continue while the measurement is in progress. When GET.STATUS detects that the measurement is completed (value = 1), the reading is returned to the computer by the MEASURE statement which also resets the Data Available value to 0.

Sample Programs

The two sample programs that follow use most of the statements described in this chapter. Before you run either of these programs, you have to: use the Soft Front Panel to generate a program shell, exit the Soft Front Panel, run BASIC, load the program, and then type in the statements shown in the particular sample program starting at line 1010. When entering the programming statements, remember to use the same label that you assigned to the DMM. After you have entered the statements, save the program and run it.

Sample Program No. 1

This program controls the DMM to monitor an ac voltage source in the 0 to 2 V range. One hundred readings are printed out in about a one minute period.

Program lines (1010-1030) set up the DMM to continuously measure ac volts in the 0 to 2 V range at a rate of 2.5 readings per second. You could have used the Soft Front Panel to save a State file with these same set up conditions. Then you could have used an INITIALIZE statement at the beginning of your program instead of the statements in lines 1010-1030.

After the DMM is set up, a For/Next loop is used with MEASURE statements to return 100 readings. If a reading is above 0.2 volts, the reading (taken in the 2 V range, resolution = .0001 V) is printed out in "Vac". If a voltage reading is below 0.2 volts, another reading is taken in the 200 millivolt range (resolution = .00001 V) and the reading is printed out in "mVac"; e.g. "37.55 mVac".

Program Shell

```
.
.
.
.

1000 ' User Program starts at this line
1010 CALL SET.FUNCTION(DMM.01,ACVOLTS)
1020 CALL SET.SPEED(DMM.01,R2.5)
1030 CALL ENABLE.INT.TRIGGER(DMM.01)
```

Set up the DMM to continuously take ac voltage readings at a rate of 2.5 readings/second.

```
1040 FOR I=1 TO 100
1050 CALL SET.RANGE(DMM.01,R2)
1060 CALL MEASURE(DMM.01,VOLTS)
1070 IF ABS(VOLTS)<.2 THEN 1100
1080 PRINT VOLTS; ''Vac''
1090 GOTO 1130
```

MEASURE returns the latest reading. If it is more than .2 V, it is printed out in ''Vac''. If it is less than .2 V, program goes to line 1100.

```
1100 CALL SET.RANGE(DMM.01,R200MILLI)
1110 CALL MEASURE(DMM.01,VOLTS)
1120 PRINT VOLTS*1000;''mVac''
```

Range is changed to 200 mV and MEASURE returns the latest reading which is printed out in ''mVac''.

```
1130 NEXT I
1140 END
```

Sample Program No. 2

This program controls a Digital Multimeter to take resistance readings. A Relay/Multiplexer Model HP 61011A is used to connect 7 different resistances, one-at-a-time, to the DMM's HI and LO input terminals. The Relay Multiplexer also connects a short circuit input to allow the DMM's meter leads to be "zeroed" before the resistance measurements are taken. Figure 5-2 shows the hardware connections. The program is shown on page 5-15.

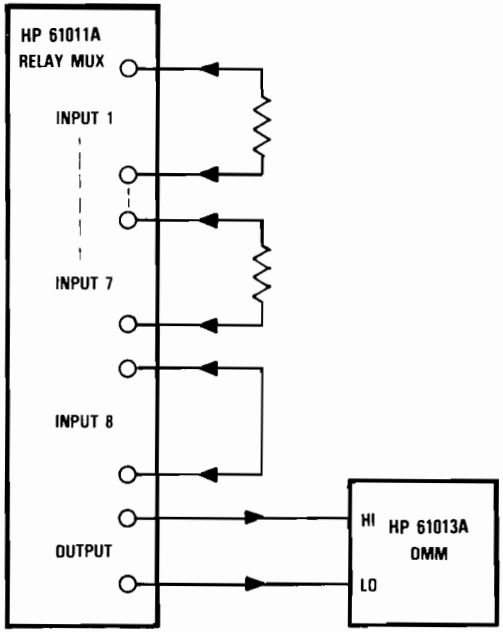


Figure 5-2. DMM/Relay Mux Application

The program first sets up the DMM to take resistance readings in the manual mode. The DMM is set to the Manual Trigger mode to insure that each reading is taken one reading at-a-time after each input is connected. Before the first reading is taken, a short circuit is connected across the DMM's input and a ZERO.OHMS statement is used to "zero" the DMM.

Next, the DMM is set to autorange and a MEASURE statement is used to trigger the DMM to take the first of seven readings and return the reading to the computer. A For/Next loop is used to connect the remaining resistors to the DMM for measurement. Each of these measurements is triggered by the START statement. While a measurement is in progress, the program prints out the previous measurement. Using the START statement in this way allows the program to continue without having to wait for each measurement to complete. After the first reading is printed out, the MEASURE statement is used only to return each remaining reading after it had been triggered by the START statement.

```
Program Shell
      .
      .

1000 ' User Program Starts at this Line
1010 CALL SET.FUNCTION(DMM.01,OHMS)
1020 CALL DISABLE.INT.TRIGGER(DMM.01)
```

Set the DMM to measure resistance in the manual trigger mode.

```
1030 ROUT = 8
1040 CALL OUTPUT(RELAY.MUX.01,ROUT)
1050 CALL ENABLE.OUTPUT(RELAY.MUX.01)
1060 CALL ZERO.OHMS(DMM.01)
```

Short circuit the DMM input and "zero" the DMM.

```
1070 CALL SET.RANGE(DMM.01,AUTOM)
1080 ROUT = 1
1090 CALL OUTPUT(RELAY.MUX.01,ROUT)
```

Set DMM to autorange and connect first resistor to DMM input.

```
1100 FOR I = 2 TO 8
1110 CALL MEASURE(DMM.01,OHMS)
1120 IF I = 8 THEN 1170
1130 CALL OUTPUT(RELAY.MUX.01,I)
```

Take seven readings and print out six of them. MEASURE triggers and returns the first reading.

```
1140 CALL START (DMM.01)
1150 PRINT OHMS;''OHMS''
1160 NEXT I
```

START triggers readings 2 thru 7 which are returned by MEASURE. The last reading is printed out in line 1170.

```
1170 PRINT OHMS;''OHMS''
1180 END
```

A Programming Statement Summary

The following is an alphabetic listing of the programming statements that can be used to control the Digital Multimeter. You can use this list as a reference guide for the spelling and syntax of each statement.

DISABLE.INT.TRIGGER(*label*)

ENABLE.INT.TRIGGER(*label*)

GET.STATUS(*label,value*)

INITIALIZE(*label,statefile*)

INITIALIZE.SYSTEM(*statefile*)

MEASURE(*label,value*)

SET.FUNCTION(*label,function*) - where *function* must be one of the following reserved variables: DCVOLTS, ACVOLTS, or OHMS

SET.RANGE(*label,range*) - where range must be one of the following reserved variables: R200MILLI, R2, R20, R200, R2KILO, R20KILO, R200KILO, R2MEGA, R20MEGA, or AUTOM

SET.SPEED(*label,speed*) - where *speed* must be one of the following reserved variables: R2.5 or R12.5

START(*label*)

ZERO.OHMS(*label*)

B Verification and Calibration Procedures

Introduction

Verification and calibration procedures for your HP 61013A PC Instruments Digital Multimeter (DMM) are included on the System Utilities and Verification Diskette. Instructions on how to load and run these procedures are given in Appendix B of your System Owner's Manual. Step-by-step instructions that guide you through each procedure appear on the computer's display when you are running the program. This appendix describes what the verification program does and lists the equipment required to perform the verification.

Equipment Required

You must have an installed PC instruments Interface card and a PC Instruments DMM. Since the DMM is capable of measuring DC Volts, AC Volts, and Ohms over various ranges of values, equipment to supply these stimuli is required. Also, because most of the tests involve comparing the results of a PC Instruments DMM measurement to the actual value of the input stimulus, an additional Digital Multimeter (non-PC Instruments) is required to monitor the input stimulus. The non-PC Instruments DMM is connected across the PC Instruments DMM's HI and LO input jacks along with the stimulus to be measured (see Figure B-1). The non-PC Instruments DMM must be calibrated and have the same (or better) accuracy specifications as your PC Instruments DMM. Table B-1 lists the recommended test equipment.

If you do not have a non-PC Instruments DMM to monitor the input stimulus, you can still use the verification program to check the operation of your DMM. However, the degree to which you can check the accuracy of the

DMM is limited to how accurately you know the value of the input stimulus.

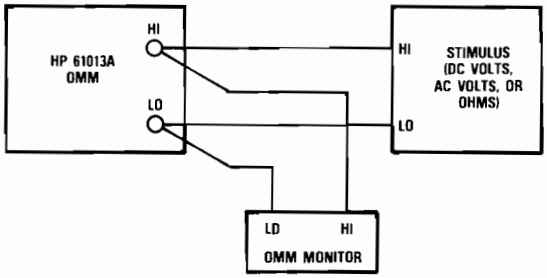


Figure B-1. Test Connections

Table B-1. Recommended Test Equipment

Type	Description
DC Voltage Source	Output Range: 100 mV to 100 V Accuracy: ± .005%
AC Voltage Source	Output Range: 100 mV to 100 V Frequency: 30 Hz to 1 kHz Accuracy: ± .1%
Resistance Standards	100 Ω, .005% 1000 Ω, .005% 10 K Ω, .005% 100 K Ω, .005% 1 M Ω, .005% 10 M Ω, .01%
Digital Multimeter	Minimum 4-1/2 digit with ACV, DCV, and resistance measurement capability. Must have the same (or better) accuracy specifications as the HP 61013A PC Instruments DMM.

The verification program allows you to use the HP 61012A PC Instruments Dual Voltage DAC (VDAC) or the HP 61014A PC Instruments Function Generator instead of the voltage sources listed above to test the voltage functions of your DMM.

When the PC Instruments VDAC or Function Generator is used, the program compares the DMM's measured value with the programmed value of the VDAC or Function Generator. The actual input to the DMM may differ slightly from the expected value due to basic accuracy and drift specifications of the source. Since the program checks the DMM's measured value against the expected input from the VDAC or Function Generator, these tests are not as accurate as the non-PC Instruments tests in which you verify the input before making the comparison. Note that the DMM's verification program does not check the accuracy of the VDAC or the Function Generator. These instruments can be verified by performing their separate verification procedures.

The ac and dc voltage measurement functions performed by your PC Instruments DMM cannot be calibrated accurately using voltages provided by the PC Instruments VDAC or Function Generator. You must use highly stable DC and AC voltage sources (see Table B-1). Also the resistors listed in Table B-1 are required to calibrate the DMM's resistance measurement function. The non-PC Instruments DMM should be connected (see Figure B-1) to measure the input stimulus.

What The Test Does

General

When you first run the verification program, it does a system level verification that partially tests all of the instruments in your system. This part of the test is described in Appendix B of your System Owner's Manual. After the system tests are completed, your DMM will appear in a menu along with all of the other instruments in the system. This menu is the starting point for instrument specific verification tests for all of your instruments. To continue testing your DMM, you must select it from the list. The instrument specific tests for the DMM consist of control tests, measurement accuracy tests, and calibration procedures.

Control Tests

The purpose of these tests is to verify that the DMM can perform voltage and resistance measurements. First the verification program checks the operation of the control circuits on the DMM. Several of the important control and status signals of the DMM are stimulated with programmed commands to verify that they changed state properly. Once these signals have been verified, the DMM is checked for the proper operation in the two trigger modes (Manual and Internal). Finally, the Auto Range feature of the DMM is tested. The Control Tests, with the exception of the Auto range test, require no user interaction. For the Auto range test, you will have to short the LO input to the HI input of the DMM (by connecting the meter leads together) and then open circuit the input (by disconnecting the meter leads) when instructed to do so on the computer screen.

Measurement Accuracy Tests

These tests are user interactive checks of the conversion accuracy of the your PC Instruments DMM. You may select any of the measurement modes (DC V, AC V, or OHMS) to test by pressing softkeys that are defined on a

menu on the computer screen. How these tests are performed depends upon whether you are using non-PC Instruments equipment or a PC Instruments Function Generator or VDAC in your system to supply the input voltage stimulus.

Using Non-PC Instruments Equipment. This mode of testing requires that you use externally controlled (non-PC Instruments) equipment to supply voltages and resistances to your DMM. When you select a function (DCV, ACV, or Ohms), your DMM is programmed to take continuous measurements of its input and the results are displayed on the computer screen. You must select the magnitude of the external input you wish to send to the DMM (based on the function and range that you wish to verify) then compare your DMM's reading to the actual input. To perform tests on all functions, a DC and an AC voltage source as well as several resistors are required. This type of testing is the most accurate if you use precise voltage and resistance inputs and compare them with the value measured by your PC Instruments DMM. Note that there is no indication on the computer display telling you if a particular test passed or failed. You must decide this for yourself based upon the input that you have supplied. In all cases, the measurement made by your PC instruments DMM should be within the accuracy specified in Table 1-1 of this manual.

Using PC Instruments VDAC and/or Function Generator. The verification program allows you to use a PC Instruments 61012A VDAC or 61014A Function Generator to supply the voltage inputs to test your DMM. The VDAC is used to supply DC voltages only; the Function Generator is used to supply both AC and DC test voltages. Note that your DMM's Ohms function cannot be verified using either of these instruments; you must use external resistors to verify the Ohms function.

NOTE

If you select to use the PC Instruments VDAC or Function Generator to test your DMM, you can change to the non-PC Instruments tests by pressing a softkey.

In order to use either the VDAC or the Function Generator to supply test inputs, it must be connected to the same PC Instruments Interface card as your DMM. The primary benefit to using the PC Instruments VDAC and/or Function Generator is that the control of the stimulus (DC or AC volts) is done automatically by the verification program. All you have to do is perform the set-up and read the test results (PASS or FAIL) on the computer screen. The one drawback is that your PC Instruments DMM is more accurate in taking a measurement than either the VDAC or Function Generator is in generating an output. This means that these tests are not a complete check of measurement accuracy. They can, however be used to do a quick operational check.

Test Results

It is important that you complete both the Control Tests and the Measurement Accuracy Tests. If your DMM does not pass the Control Tests, repeat the tests. If it fails again, consult your Support Guide for information on the PC Instruments exchange program. If your DMM fails the Measurement accuracy test, perform the calibration portion of the verification procedures (see description below). If the accuracy tests still fail, consult your Support Guide for information on the PC Instruments exchange program.

NOTE

Calibration Procedures

To assure measurement accuracy, it is recommended that you calibrate your PC Instruments DMM every six months. Calibration can only be performed using non-PC Instruments equipment (stable ac and dc voltage sources and resistors) for stimuli. You must have a non-PC Instruments DMM connected to measure the input stimuli (See Figure B-1)

When you choose to calibrate your DMM by pressing a softkey, a menu appears on the computer display that allows you to select the function (DCV, ACV, Ohms) to be calibrated. Once the desired function has been selected, any or all of the ranges for that function can be individually calibrated. The computer displays set-up instructions for each step in the calibration procedure. Once you have performed calibration on the desired functions and ranges, you can save the new calibration constants or you can cancel the new constants and continue to use the old values.

C Error Messages

The following error messages apply to the DMM. When programming your instrument from BASIC, these messages are only returned when you use the error handling routine described in Chapter 5 of the System Owner's Manual.

301 Range constant invalid

302 Functions DCVOLTS, ACVOLTS, or OHMS only

303 Speed contstants R2.5 or R12.5 only

304 Can't START (internal trigger or busy)

305 Must be in OHMS to zero leads

306 Lead resistance too high (open ?)

309 Not calibrated

399 System Error