Programmer's Reference

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For Safety information, Warranties, and Regulatory information, see the pages behind the index.

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HP 54710 and HP 54720
Oscilloscopes
The HP 54710 and HP 54720 Oscilloscope Programming Command Set
<table>
<thead>
<tr>
<th>MEASURE</th>
<th>NTESI</th>
<th>TIMEBASE</th>
<th>TRIGGER</th>
<th>TRIGGER&lt;-&gt;</th>
<th>PMEMORY</th>
<th>WMEMORY&lt;-&gt;</th>
<th>WAVEFORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINe</td>
<td>AMAsk</td>
<td>DELay</td>
<td>DENVis</td>
<td>BKLimit</td>
<td>ADD</td>
<td>DISPlay</td>
<td>BANDpass</td>
</tr>
<tr>
<td>DELTtime</td>
<td>COUNI</td>
<td>POSItion</td>
<td>DTMe</td>
<td>PROBDe</td>
<td>CLEAR</td>
<td>SAVe</td>
<td>BYTExander</td>
</tr>
<tr>
<td>DUTycycle</td>
<td>MASK</td>
<td>RANGE</td>
<td>EDGE</td>
<td>DISPlay</td>
<td>XOFFset</td>
<td>COMPlete</td>
<td>COMPling</td>
</tr>
<tr>
<td>FALLtime</td>
<td>POLYgon</td>
<td>Reference</td>
<td>Glitch</td>
<td>ERASe</td>
<td>XRANGE</td>
<td>COLNt</td>
<td>COLPing</td>
</tr>
<tr>
<td>FFT</td>
<td>RUNmode</td>
<td>SCALE</td>
<td>mOLdolf</td>
<td>MERGe</td>
<td>YOFFset</td>
<td>YRANGE</td>
<td>DATA</td>
</tr>
<tr>
<td>FREQuency</td>
<td>SCALe</td>
<td>VIEW</td>
<td>HYSTeresis</td>
<td></td>
<td></td>
<td></td>
<td>FORmat</td>
</tr>
<tr>
<td>HISTgram</td>
<td>SSLReen</td>
<td>WINDow</td>
<td>LEVEL</td>
<td></td>
<td></td>
<td></td>
<td>PoinTs</td>
</tr>
<tr>
<td>NWIDTH</td>
<td>SSUltary</td>
<td></td>
<td>MODE</td>
<td></td>
<td></td>
<td></td>
<td>PRECable</td>
</tr>
<tr>
<td>OVERSShot</td>
<td>Swwaveform</td>
<td></td>
<td>PATTERN</td>
<td></td>
<td></td>
<td></td>
<td>SOURCe</td>
</tr>
<tr>
<td>PERod</td>
<td>TEST</td>
<td></td>
<td>SLOPe</td>
<td></td>
<td></td>
<td></td>
<td>SOURCe</td>
</tr>
<tr>
<td>PRESsHoot</td>
<td></td>
<td></td>
<td>SOURCe</td>
<td></td>
<td></td>
<td></td>
<td>VIEW</td>
</tr>
<tr>
<td>PWidtth</td>
<td></td>
<td></td>
<td>STAtE</td>
<td></td>
<td></td>
<td></td>
<td>XDISPLAY</td>
</tr>
<tr>
<td>RESults?</td>
<td></td>
<td></td>
<td>SWEp</td>
<td></td>
<td></td>
<td></td>
<td>XINCRement</td>
</tr>
<tr>
<td>RESline</td>
<td></td>
<td></td>
<td>STV</td>
<td></td>
<td></td>
<td></td>
<td>XORiga</td>
</tr>
<tr>
<td>SECHatch</td>
<td></td>
<td></td>
<td>SWEp</td>
<td></td>
<td></td>
<td></td>
<td>X RANGE</td>
</tr>
<tr>
<td>SENDvoid</td>
<td></td>
<td></td>
<td>UDTv</td>
<td></td>
<td></td>
<td></td>
<td>XREFERence</td>
</tr>
<tr>
<td>SOURCe</td>
<td></td>
<td></td>
<td>XUVnts</td>
<td></td>
<td></td>
<td></td>
<td>YDISPLAY</td>
</tr>
<tr>
<td>STATistics</td>
<td></td>
<td></td>
<td>XNCREnt</td>
<td></td>
<td></td>
<td></td>
<td>YORight</td>
</tr>
<tr>
<td>TEDGE</td>
<td></td>
<td></td>
<td>XRANGE</td>
<td></td>
<td></td>
<td></td>
<td>YRFERENCE</td>
</tr>
<tr>
<td>TMAX</td>
<td></td>
<td></td>
<td>YUNits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THN</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>TVOLT</td>
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<td>VAMPlitude</td>
<td></td>
<td></td>
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<tr>
<td>VAVerage</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>VBASex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VLDWer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>VMAX</td>
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<tr>
<td>VRMS</td>
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<td>VTMe</td>
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<tr>
<td>VTOP</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>VUPper</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
In This Book

This book is your guide to programming the HP 54710 and HP 54720 Digitizing Oscilloscopes using the HP-IB command set.

Part One, "Introduction to Programming the HP 54710/HP 54720 Oscilloscopes," gives you the conceptual information needed to start programming the oscilloscope. This part includes information about basic program communications, interface, syntax, data types, and status reporting. It also has a set of sample programs that show you some typical applications.

Part Two, "HP 54710/HP 54720 HP-IB Command Reference," describes all the commands used to program the oscilloscope. Each chapter lists the commands that belong to an individual subsystem, and explains the function of each command.
Contents

Part 1 Introduction to Programming the HP 54710/HP 54720 Oscilloscopes

1 Introduction to Programming

Introduction to Programming  1–2
Talking to the Instrument  1–3
Program Syntax  1–4
Output Command  1–4
Device Address  1–5
Instructions  1–5
Instruction Header  1–6
White Space (Separator)  1–6
Program Data  1–6
Header Types  1–7
Duplicate Mnemonics  1–8
Query Headers  1–9
Program Header Options  1–10
Program Data Syntax Rules  1–10
Character Program Data  1–11
Numeric Program Data  1–11
Embedded Strings  1–12
Program Message Terminator  1–12
Selecting Multiple Subsystems  1–12
Programming Getting Started  1–13
Initialization  1–13
Example Program  1–14
Using the Digitize Command  1–15
Receiving Information from the Instrument  1–17
String Variable Example  1–18
Numeric Variable Example  1–18
Definite-Length Block Response Data  1–19
Multiple Queries  1–19
Instrument Status  1–20
2 Interface Functions
   HP-IB Interface Connector  2-3
   HP-IB Default Startup Conditions  2-3
   Interface Capabilities  2-4
   Command and Data Concepts  2-5
   Addressing  2-5
   Communicating Over the Bus  2-6
   Remote, Local, and Local Lockout  2-7
   Bus Commands  2-8
   Status Messages  2-8

3 Message Communication and System Functions
   Protocols  3-3
   Syntax Diagrams  3-5
   Syntax Overview  3-8

4 Status Reporting
   Status Reporting Data Structures  4-5
   Status Byte Register  4-8
   Service Request Enable Register  4-10
   Trigger Event Register (TRG)  4-10
   Standard Event Status Register  4-11
   Standard Event Status Enable Register  4-12
   User Event Register (UER)  4-13
   Local Event Register (LCL)  4-13
   Operation Status Register (OPR)  4-13
   Limit Test Event Register (LTER)  4-14
   Mask Test Event Register  4-14
   Histogram Event Register  4-15
   Arm Event Register (ARM)  4-15
   Error Queue  4-16
   Output Queue  4-17
   Message Queue  4-17
   Key Queue  4-17
   Clearing Registers and Queues  4-17

Contents-2
5 Programming Syntax

HP BASIC Output Statement 5-3
HP BASIC Enter Statement 5-3
Device Address 5-4
Instructions 5-4
Instruction Header 5-5
Queries 5-7
Program Data 5-8
Multiple Subsystems 5-10
Multiple Functions within a Subsystem 5-11
Common Commands within a Subsystem 5-12
Instruction Terminator 5-13

6 Programming Conventions

Data Flow 6-3
Truncation Rule 6-5
The Command Tree 6-6
Infinity Representation 6-11
Sequential and Overlapped Commands 6-11
Response Generation 6-11
EOI 6-11

7 Example Programs

Example Programs 7-2
Digitize Example Program 7-3
Measurement Example Program 7-11
Results? Measurement Example 7-18
Learn String Example Program 7-22
Service Request Example Program 7-27
Configuration Example Program 7-31
Limit Test Example Program 7-32
Part 2 HP 54710/HP 54720 HP-IB Command Reference

8 Common Commands

*CLS  (Clear Status) 8-5
*ESE  (Event Status Enable) 8-6
*ESR? (Event Status Register) 8-8
*IDN? (Identification Number) 8-10
*LRN? (Learn) 8-11
*OPC  (Operation Complete) 8-12
*OPT  (Option) 8-13
*RCL  (Recall) 8-14
*RST  (Reset) 8-15
*SAV  (Save) 8-20
*SRE  (Service Request Enable) 8-21
*STB? (Status Byte) 8-23
*TRG  (Trigger) 8-25
*TST? (Test) 8-26
*WAI  (Wait-to-Continue) 8-27

9 Root Level Commands

Status Reporting Data Structures 9-7
AER? (Arm Event Register) 9-10
AUToscale 9-11
BLANK 9-13
CDISplay 9-14
DIGitize 9-15
ERASE 9-17
HEEN 9-18
HER? 9-19
LER? (Local Event Register) 9-20
LTEE 9-21
LTER? 9-22
MENU 9-23
MERGe 9-24
MODel? 9-25
10 System Commands

DATE 10-4
DSP 10-5
ERRor? 10-7
HEADer 10-10
KEY 10-11
LONGform 10-17
SETup 10-19
TIME 10-21

11 Acquire Commands

BWLimit 11-5
COMPLETE 11-6
COMPLETE:STATe 11-8
COUNT 11-9
INTERpolate 11-10
MODE 11-11
POINts 11-12
SRATe (Sample RATE) 11-14
Contents

12 Calibration Commands

Mainframe Calibration  12-3
Plug-in Calibration  12-4
Normal Accuracy Calibration Level  12-5
Best Accuracy Calibration Level  12-6
Probe Calibration  12-8

Calibration Commands  12-9
BEST:CANcel  12-12
BEST:CONTinue  12-12
BEST:DATA  12-12
BEST:STARe  12-13
BEST:STATUs  12-13
FRAME:CANcel  12-14
FRAME:CONTinue  12-14
FRAME:DATA  12-15
FRAME:DONE?  12-15
FRAME:LABel  12-16
FRAME:MEMory?  12-16
FRAME:STARe  12-16
FRAME:TIME?  12-17
OUTPut  12-18
PLUGin:CANcel  12-19
PLUGin:CONTinue  12-19
PLUGin:DONE?  12-19
PLUGin:MEMory?  12-20
PLUGin:STARe  12-20
PLUGin:TIME?  12-20
SKEW  12-21
STATus?  12-22

13 Channel Commands

BWLimit  13-5
DISPlay  13-7

Contents-6
INPut 13–8
OFFSet 13–10
OUTPut 13–12
PROBe 13–13
PROBe:CALibrate 13–15
PROBe:INPut 13–16
PROTection:CLEar 13–17
PROTection? 13–18
RANGE 13–19
SCALE 13–21
SENSitivity 13–22
UNITs 13–23
UNITs:ATTenuation 13–24
UNITs:OFFSet 13–25

14 Disk Commands

DELete 14–4
DIRectory? 14–4
FORMat 14–5
LOAD 14–5
STORE 14–6

15 Display Commands

ASSign 15–7
CGRade 15–8
CGRade:LEVeLs? 15–10
COLumn 15–11
DATA 15–12
DCOLor (Default COLor) 15–14
DWAVeform (Draw WAVeform) 15–15
FORMat 15–16
GRATitule 15–17
INVerse 15–18
LINE 15–19
MASK 15–20
PERSistance 15–22
Contents

ROW  15–23
S Colo  r  15–24
SOURce  15–28
STRIng  15–29
TEXT  15–30

16 Function Commands

ADD  16–8
DIFFerentiate  16–9
DISPlay  16–10
DIVide  16–11
FFT:FREQuency  16–12
FFT:MAGNify  16–12
FFT:MSPan  16–13
FFT:RESolution  16–13
FFT:SPAN  16–14
FFT:WINDow  16–14
FPTMagnitude  16–16
HORizontal  16–17
HORizontal:POSition  16–18
HORizontal:RANGE  16–19
INTEGRate  16–20
INVert  16–21
MAGNify  16–22
MAXimum  16–23
MINimum  16–24
MULTiplay  16–25
OFFSet  16–26
ONLY  16–27
RANGE  16–28
SUBTract  16–29
VERSUs  16–30
VERTical  16–31
VERTical:OFFSet  16–32
VERTical:RANGE  16–33
17 Hardcopy Commands

ADDRess 17-5
AREA 17-6
BACKground 17-7
DESTination 17-8
DEVICE 17-9
FACTors 17-10
FFEed (Form FEed) 17-11
FILENAME 17-12
LENGTH 17-13
MEDIA 17-14

18 Marker Commands

CURSor? 18-6
MEASurement:READout 18-7
MODE 18-8
TDELta? 18-9
TSTArt 18-10
TSTOp 18-12
VDELta? 18-14
VSTArt 18-15
VSTOp 18-17
X1Position 18-19
X2Position 18-20
X1Y1source 18-21
X2Y2source 18-22
XDELta? 18-23
Y1Position 18-24
Y2Position 18-25
YDELta? 18-26

19 Measure Commands

DEFine 19-14
DELTatime 19-18
DUTycycle 19-20
20 **Pixel Memory Commands**

Pixel Memory Commands 20-2
ADD 20-3
CLEar 20-3
DISPlay 20-3
ERASe 20-3
MERGe 20-4

21 **Timebase Commands**

DELay 21-4
POSition 21-6
RANGe 21-7
REFERence 21-8
SCALE 21-9
VIEW 21-10
WINDow:DELay 21-11
WINDow:POSition 21-13
WINDow:RANGe 21-14
WINDow:SOURce 21-15

22 **Trigger Commands**

Trigger Commands 22-2
DEVents 22-8
DEVents:ARM 22-9
DEVents:EVENt 22-11
DEVents:TRIGger 22-13
DTIME 22-15
DTIME:ARM 22-16
DTIME:DELay 22-18
DTIME:TRIGger 22-19
EDGE 22-21
EDGE:SLOPe 22-22
EDGE:SOURce 22-23
GLITch 22-24
GLITch:POLarity 22-25
GLITch:SOURce 22-26
GLITch:WIDTH 22-27
HOLDoff 22-28
HYSTeresis 22-29
LEVEL 22-30
MODE 22-31
PATTERN 22-33
PATTERN:CONDition 22-34
PATTERN:LOGic 22-35
SLOPe 22-36
SOURce 22-37
STATE 22-38
STATE:CLOCK 22-39
STATE:CONDition 22-40
STATE:LOGic 22-41
STATE:SLOPe 22-42
STV 22-43
STV:FIELD 22-44
STV:LINE 22-45
STV:SOURce 22-46
STV:POLarity 22-47
STV:STANdard 22-48
SWEep 22-49
23 TriggerN Commands

TriggerN Commands 23-2
BWLimit 23-3
PROBe 23-4
TRIGger:STV:FIELD Command/Query 23-5
FIELD 23-5
:TRIGger:STV:LINE Command/Query 23-7
LINE command/query 23-7
:TRIGger:STV:SOURce Command/Query 23-9
SOURce command/query 23-9
:TRIGger:STV:SPOLarity Command/Query 23-10
POLarity command/query 23-10
TRIGger:STV:STANdard Command/Query 23-11
STANdard command/query 23-11
TRIGger:UDTV:ENUMber Command/Query 23-12
CONDITION command/query 23-12
TRIGger:UDTV:SLOPe Command/Query 23-14
OCCurrentce:SLOPe command/query 23-14
TRIGger:UDTV:SOURce Command/Query 23-15
OCCurrentce:SOURce command/query 23-15
TRIGger:UDTV:STATe Command/Query 23-17
LOGic command/query 23-17

24 Waveform Commands

BANDpass? 24-8
BYTeorder 24-9
COMPlete? 24-11
25 Waveform Memory Commands

Waveform Memory Commands 25–2
Display 25–4
SAVE 25–4
XOFFSET 25–5
XRANGE 25–5
YOFFSET 25–6
YRANGE 25–6

26 FFT Commands

FFT Commands 26–2
Display 26–4
FREQUENCY 26–5
27 Limit Test Commands

Limit Test Commands 27-2
FAIL 27-9
LIMIt 27-11
MNFound 27-12
RUN (RUNode) 27-14
SOURce 27-17
SSCREen 27-18
SSCREen:DDISk 27-20
SSCREen:DDISk:BACKground 27-21
SSCREen:DDISk:MEDia 27-22
SSCREen:DDISk:PFORmat 27-23
SSCREen:DPRinter 27-24
SSCREen:DPRinter:ADDRes 27-25
SSCREen:DPRinter:BACKground 27-26
SSCREen:DPRinter:MEDia 27-27
SSCREen:DPRinter:PFORmat 27-28
SSCREen:DPRinter:PORT 27-29
SSUMmary 27-30
SSUMmary:ADDRes 27-32
SSUMmary:FORMat 27-33
SSUMmary:MEDia 27-34
SSUMmary:PFORmat 27-35
SSUMmary:PORT 27-36
SVAVeform 27-37
TEST 27-39
ULIMit 27–41

28 Mask Test Commands

Mask Test Commands 28–2
AMASK:CREate 28–14
AMASK:SOURce 28–15
AMASK:UNITs 28–17
AMASK:XDELta 28–19
AMASK:YLEtta 28–21
COUNT:FAILures? 28–23
COUNT:FSAMPles? 28–24
COUNT:FWAVEforms? 28–25
COUNT:SAMPLEs? 28–26
COUNT:WAVEforms? 28–27
MASK:DEFine 28–28
POLYgon:DEFine 28–30
RUMode 28–32
SCALe:DEFault 28–35
SCALe:SOURce 28–36
SCALe:X1 28–38
SCALe:XDELTa 28–40
SCALe:Y1 28–42
SCALe:Y2 28–43
SSCreEn 28–44
SSCreEn:DISk 28–46
SSCreEn:DISk:BACKground 28–47
SSCreEn:DISk:MEDia 28–48
SSCreEn:DISk:PRINTFmat 28–49
SSCreEn:DRINTER 28–50
SSCreEn:DRINTER:ADDRESS 28–51
SSCreEn:DRINTER:BACKground 28–52
SSCreEn:DRINTER:MEDIA 28–53
SSCreEn:DRINTER:PRINTFmat 28–54
SSCreEn:DRINTER:PORT 28–55
SSSUMmary 28–56
29 Histogram Subsystem

Histogram Commands 29–2
Histograms and the Database 29–3
AXIS 29–6
MODE 29–7
RUNTIl 29–8
SCALE 29–9
SCALE:OFFSET 29–10
SCALE:RANGE 29–12
SCALE:SCALE 29–14
SCALE:TYPE 29–16
WINDOW:SOURce 29–17
WINDOW:X1Position 29–18
WINDOW:X2Position 29–19
WINDOW:Y1Position 29–20
WINDOW:Y2Position 29–21

30 Error Messages

Error Queue 30–3
Error Numbers 30–4
Command Error 30–4
Execution Error 30–5
Device- or Oscilloscope-Specific Error 30–5
Query Error 30–6
List of Error Messages 30–6

31 Algorithms
Part 1

1 Introduction to Programming
2 Interface Functions
3 Message Communication and System Functions
4 Status Reporting
5 Programming Syntax
6 Programming Conventions
7 Example Programs

Introduction to Programming the HP 54710/HP 54720 Oscilloscopes
Introduction to Programming
Introduction to Programming

This chapter introduces the basics for remote programming of an oscilloscope. The programming instructions in this manual conform to the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation. The programming instructions provide the means of remote control.

There are basic operations that can be done with a controller and an oscilloscope:

- Set up the instrument.
- Make measurements.
- Get data (waveform, measurements, configuration) from oscilloscope.
- Send information (pixel image, configurations) to oscilloscope.

Other tasks are accomplished by combining these basic functions.

The programming examples for individual commands in this manual are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller.
Talking to the Instrument

Computers acting as controllers communicate with the instrument by sending and receiving messages over a remote interface. Instructions for programming normally appear as ASCII character strings embedded inside the output statements of a "host" language available on your controller. The input statements of the host language are used to read in responses from the oscilloscope.

For example, HP 9000 Series 200/300 BASIC uses the OUTPUT statement for sending commands and queries. After a query is sent, the response is usually read in using the ENTER statement.

Messages are placed on the bus using an output command and passing the device address, program message, and terminator. Passing the device address ensures that the program message is sent to the correct interface and instrument.

The following HP BASIC OUTPUT statement sends a command that sets the bandwidth limit of channel 1 to on:

```
OUTPUT < device address > ;";CHANNEL1:BLIMIT ON"<terminator>
```

The < device address > represents the address of the device being programmed. Each of the other parts of the above statement are explained in the following pages.
Program Syntax

To program the instrument remotely, you must have an understanding of the command format and structure expected by the instrument. The IEEE 488.2 syntax rules govern how individual elements such as headers, separators, program data, and terminators may be grouped together to form complete instructions. Syntax definitions are also given to show how query responses are formatted. Figure 1-1 shows the main syntactical parts of a typical program statement.

Figure 1-1

Output Command

The output command is entirely dependent on the programming language. Throughout this manual HP 9000 Series 200/300 BASIC 5.0 is used in the examples of individual commands. If you are using other languages, you will need to find the equivalents of HP BASIC commands like OUTPUT, ENTER, and CLEAR in order to convert the examples. The instructions listed in this manual are always shown between quotes in the example programs.
Device Address

The location where the device address must be specified is also dependent on the programming language you are using. In some languages, this may be specified outside the output command. In HP BASIC, this is always specified after the keyword OUTPUT. The examples in this manual assume the oscilloscope is at device address 707. When writing programs, the address varies according to how the bus is configured.

Instructions

Instructions (both commands and queries) normally appear as a string embedded in a statement of your host language, such as BASIC, Pascal, or C. The only time a parameter is not meant to be expressed as a string is when the instruction's syntax definition specifies <block data>, such as learnstring. There are only a few instructions that use block data.

Instructions are composed of two main parts:

- The header, which specifies the command or query to be sent.
- The program data, which provide additional information needed to clarify the meaning of the instruction.
Introduction to Programming

Instruction Header

The instruction header is one or more mnemonics separated by colons (:) that represent the operation to be performed by the instrument. The command tree in figure 5-1 illustrates how all the mnemonics can be joined together to form a complete header (see the “Programming Conventions” chapter).

The example in figure 1-1 is a command. Queries are indicated by adding a question mark (?) to the end of the header. Many instructions can be used as either commands or queries, depending on whether or not you have included the question mark. The command and query forms of an instruction usually have different program data. Many queries do not use any program data.

White Space (Separator)

White space is used to separate the instruction header from the program data. If the instruction does not require any program data parameters, you do not need to include any white space. In this manual, white space is defined as one or more spaces. ASCII defines a space to be character 32 (in decimal).

Program Data

Program data are used to clarify the meaning of the command or query. They provide necessary information, such as whether a function should be on or off, or which waveform is to be displayed. Each instruction’s syntax definition shows the program data, as well as the values they accept. The section “Program Data Syntax Rules” in this chapter has all of the general rules about acceptable values.

When there is more than one data parameter, they are separated by commas (,). Spaces can be added around the commas to improve readability.
Header Types

There are three types of headers:

- Simple Command headers.
- Compound Command headers
- Common Command headers.

Simple Command Header
Simple command headers contain a single mnemonic. AUTOSCALE and DIGITIZE are examples of simple command headers typically used in this instrument. The syntax is:

<program mnemonic><terminator>

When program data must be included with the simple command header (for example, .DIGITIZE CHAN1), white space is added to separate the data from the header. The syntax is:

<program mnemonic><separator><program data><terminator>

Compound Command Header
Compound command headers are a combination of two program mnemonics. The first mnemonic selects the subsystem, and the second mnemonic selects the function within that subsystem. The mnemonics within the compound message are separated by colons. For example:
To execute a single function within a subsystem:

:<subsystem>:<function><separator><program data><terminator>
(For example :CHANNEL1:BWLIMIT ON)

Combining Commands in the Same Subsystem
To execute more than one function within the same subsystem a semi-colon (;) is used to separate the functions:

:<subsystem>:<function><separator><data>;<function><separator><data>
<terminator>
(For example :CHANNEL1:COUPLING DC;BWLIMIT ON)
Common Command Header
Common command headers control IEEE 488.2 functions within the instrument (such as clear status). Their syntax is:

*<command header><terminator>

No space or separator is allowed between the asterisk (*) and the command header. *CLS is an example of a common command header.

Duplicate Mnemonics

Identical function mnemonics can be used for more than one subsystem. For example, the function mnemonic RANGE may be used to change the vertical range or to change the horizontal range:

:CHANNEL1:RANGE .4
sets the vertical range of channel 1 to 0.4 volts full scale.

:TIMEBASE:RANGE 1
sets the horizontal time base to 1 second full scale.

CHANNEL1 and TIMEBASE are subsystem selectors and determine which range is being modified.
Query Headers

Command headers immediately followed by a question mark (?) are queries. After receiving a query, the instrument interrogates the requested function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the answer is transmitted across the bus to the designated listener (typically a controller). For example, the query:

TIMEBASE:RANGE?

places the current time base setting in the output queue. In HP BASIC, the controller input statement:

ENTER < device address > ;Range

passes the value across the bus to the controller and places it in the variable Range.

Query commands are used to find out how the instrument is currently configured. They are also used to get results of measurements made by the instrument. For example, the command:

:MEASURE:RISE TIME?

instructs the instrument to measure the rise time of your waveform and place the result in the output queue.

The output queue must be read before the next program message is sent. For example, when you send the query :MEASURE:RISE TIME? you must follow that query with an input statement. In HP BASIC, this is usually done with an ENTER statement immediately followed by a variable name. This statement reads the result of the query and places the result in a specified variable.

Sending another command or query before reading the result of a query causes the output buffer to be cleared and the current response to be lost. This also generates a query interrupted error in the error queue.
Program Header Options

Program headers can be sent using any combination of uppercase or lowercase ASCII characters. Instrument responses, however, are always returned in uppercase.

Program command and query headers may be sent in either long form (complete spelling), short form (abbreviated spelling), or any combination of long form and short form.

TIMEBASE:DELAY 1US - long form
TIM:DEL 1US - short form

Programs written in long form are easily read and are almost self-documenting. The short form syntax conserves the amount of controller memory needed for program storage and reduces the amount of I/O activity.

The rules for the short form syntax are shown in the chapter, "Programming Conventions."

Program Data Syntax Rules

Program data is used to convey a variety of types of parameter information related to the command header. At least one space must separate the command header or query header from the program data.

<program mnemonic><separator><data><terminator>

When a program mnemonic or query has multiple program data a comma separates sequential program data.

<program mnemonic><separator><data>,<data><terminator>

For example, :MEASURE:TVOLT 1.0V,2 has two program data: 1.0V and 2.
There are two main types of program data that are used in commands: character and numeric program data.
Character Program Data

Character program data is used to convey parameter information as alpha or alphanumeric strings. For example, the :TIMEBASE:REFERENCE command can be set to left, center, or right. The character program data in this case may be LEFT, CENTER, or RIGHT. :TIMEBASE:REFERENCE RIGHT sets the time base reference to right.

The available mnemonics for character program data are always included with the instruction's syntax definition. When sending commands, either the long form or short form (if one exists) may be used. Upper-case and lower-case letters may be mixed freely. When receiving responses, upper-case letters are used exclusively.

Numeric Program Data

Some command headers require program data to be expressed numerically. For example, :TIMEBASE:RANGE requires the desired full scale range to be expressed numerically.

For numeric program data, you have the option of using exponential notation or using suffix multipliers to indicate the numeric value. The following numbers are all equal:

\[ 28 = 0.28E2 = 280E-1 = 28000m = 0.028K = 28E-3K. \]

When a syntax definition specifies that a number is an integer, that means that the number should be whole. Any fractional part would be ignored, truncating the number. Numeric data parameters that accept fractional values are called real numbers. For more information see the chapter, "Interface Functions."

All numbers are expected to be strings of ASCII characters. Thus, when sending the number 9, you would send a byte representing the ASCII code for the character "9" (which is 57). A three-digit number like 102 would take up three bytes (ASCII codes 49, 48, and 50). This is taken care of automatically when you include the entire instruction in a string.
Embedded Strings

Embedded strings contain groups of alphanumeric characters which are treated as a unit of data by the oscilloscope. For example, the line of text written to the advisory line of the instrument with the :SYSTEM:DSP command:

:SYSTEM:DSP "This is a message."

Embedded strings may be delimited with either single (' ) or double (" ) quotes. These strings are case-sensitive and spaces act as legal characters just like any other character.

Program Message Terminator

The program instructions within a data message are executed after the program message terminator is received. The terminator may be either an NL (New Line) character, an EOI (End-Or-Identify) asserted in the HP-IB interface, or a combination of the two. All three ways are equivalent. Asserting the EOI sets the EOI control line low on the last byte of the data message. The NL character is an ASCII linefeed (decimal 10).

The NL (New Line) terminator has the same function as an EOS (End Of String) and EOT (End Of Text) terminator.

Selecting Multiple Subsystems

You can send multiple program commands and program queries for different subsystems on the same line by separating each command with a semicolon. The colon following the semicolon enables you to enter a new subsystem. For example:

<program mnemonic><data>;<program mnemonic><data><terminator>

:CHANNEL1:RANGE 0.4; TIMEBASE:RANGE 1

Multiple commands may be any combination of compound and simple commands.
Programming Getting Started

The remainder of this chapter deals mainly with how to set up the instrument, how to retrieve setup information and measurement results, how to digitize a waveform, and how to pass data to the controller. Refer to the chapter, "Measure Subsystem" for information on sending measurement data to the instrument.

The programming examples in this manual are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller.

Initialization

To make sure the bus and all appropriate interfaces are in a known state, begin every program with an initialization statement. For example, HP BASIC provides a CLEAR command which clears the interface buffer:

CLEAR 707! initializes the interface of the instrument

When you are using HP-IB, CLEAR also resets the oscilloscope's parser. The parser is the program that reads in the instructions that you send.

After clearing the interface, initialize the instrument to a preset state:

OUTPUT 707;"**RST"! initializes the instrument to a preset state.

The actual commands and syntax for initializing the instrument are discussed in the chapter, "Common Commands."

Refer to your controller manual and programming language reference manual for information on initializing the interface.

Autoscale

The AUTOSCALE feature of Hewlett-Packard digitizing oscilloscopes performs a very useful function on unknown waveforms by setting up the vertical channel, time base, and trigger level of the instrument.

The syntax for the autoscale function is:

:AUTOSCALE<terminator>
Setting Up the Instrument
A typical oscilloscope setup would set the vertical range and offset voltage, the horizontal range, delay time, delay reference, trigger mode, trigger level, and slope.

A typical example of the commands sent to the oscilloscope are:

```
:CHANNEL1:PROBE 10; RANGE 16;OFFSET 1.00<terminator>
:TIMEBASE:MODE NORMAL; RANGE 1E-3;DELAY 100E-6<terminator>
```

This example sets the timebase at 1 ms full-scale (100 $\mu$s/div) with delay of 100 $\mu$s. Vertical is set to 16 V full-scale (2 V/div) with center of screen at 1 V and probe attenuation of 10.

Example Program
This program demonstrates the basic command structure used to program the oscilloscope.

```
10 CLEAR 707 ; Initialize instrument interface
20 OUTPUT 707;"*RST" ;Initialize instrument to preset state
30 OUTPUT 707;"*:TIMEBASE:_RANGE 5E-4" ; Time base to 500 us
      ; full scale
40 OUTPUT 707;"*:TIMEBASE:DELAY 0" ; Delay to zero
50 OUTPUT 707;"*:TIMEBASE:REFERENCE CENTER" ; Display
      ; reference at center
60 OUTPUT 707;"*:CHANNEL1:PROBE 10" ; Probe attenuation to 10:1
70 OUTPUT 707;"*:CHANNEL1: RANGE 1.6" ; Vertical range to 1.6 V full scale
80 OUTPUT 707;"*:CHANNEL1:OFFSET -.4" ; Offset to -0.4
90 OUTPUT 707;"*:CHANNEL1:INPUT DC" ; Coupling to DC
100 OUTPUT 707;"*:TRIGGER:MODE EDGE" ; Edge triggering
110 OUTPUT 707;"*:TRIGGER:LEVEL chan1,-.4" ; Trigger level to -0.4
120 OUTPUT 707;"*:TRIGGER:SLOPE POSITIVE" ; Trigger on positive slope
130 OUTPUT 707;"*:ACQUIRE:TYPE NORMAL" ; Normal acquisition
140 OUTPUT 707;"*:DISPLAY:GRATICULE FRAME" ; Grid off
150 END
```
Program Overview
Line 10 initializes the instrument interface to a known state.
Line 20 initializes the instrument to a preset state.
Lines 30 through 50 set the time base mode to normal with the horizontal time at 500 μs full scale with 0 s of delay referenced at the center of the graticule.
Lines 60 through 90 set the vertical range to 1.6 volts full scale with center screen at −0.4 volts with 10:1 probe attenuation and DC coupling.
Lines 100 through 120 configures the instrument to trigger at −0.4 volts with normal triggering.
Line 130 configures the instrument for normal acquisition.
Line 140 turns the grid off.

Using the Digitize Command
The Digitize command is a macro that captures data satisfying the specifications set up by the acquire subsystem. When the digitize process is complete, the acquisition is stopped. The captured data can then be measured by the instrument or transferred to the controller for further analysis. The captured data consists of two parts: the waveform data record and the preamble.

After changing the oscilloscope configuration, the waveform buffers are cleared. Before doing a measurement, the Digitize command should be sent to ensure new data has been collected.

The DIGITIZE command can be sent without parameters for a higher throughput. Refer to the DIGITIZE command in the Root Level Commands chapter for details.

When the DIGITIZE command is sent to an instrument, the specified channel signal is digitized with the current ACQUIRE parameters. To obtain waveform data, you must specify the WAVEFORM parameters for the waveform data prior to sending the :WAVEFORM:DATA? query.
Introduction to Programming
Using the Digitize Command

The number of data points comprising a waveform varies according to the number requested in the ACQUIRE subsystem. The ACQUIRE subsystem determines the number of data points, type of acquisition, and number of averages used by the DIGITIZE command. This allows you to specify exactly what the digitized information contains. The following program example shows a typical setup:

```
OUTPUT 707;":ACQUIRE:TYPE AVERAGE"<terminator>
OUTPUT 707;":ACQUIRE:COMPLETE 100"<terminator>
OUTPUT 707;":WAVEFORM:SOURCE CHANNEL1"<terminator>
OUTPUT 707;":WAVEFORM:FORMAT BYTE"<terminator>
OUTPUT 707;":ACQUIRE:COUNT 8"<terminator>
OUTPUT 707;":ACQUIRE:POINTS 500"<terminator>
OUTPUT 707;":DIGITIZE CHANNEL1"<terminator>
OUTPUT 707;":WAVEFORM:DATA?"<terminator>
```

This setup places the instrument into the averaged mode with eight averages. This means that when the DIGITIZE command is received, the command will execute until the signal has been averaged at least eight times.

After receiving the :WAVEFORM:DATA? query, the instrument will start passing the waveform information when addressed to talk.

Digitized waveforms are passed from the instrument to the controller by sending a numerical representation of each digitized point. The format of the numerical representation is controlled with the :WAVEFORM:FORMAT command and may be selected as BYTE, WORD, or ASCII.

The easiest method of entering a digitized waveform depends on data structures, available formatting and I/O capabilities. You must scale the integers to determine the voltage value of each point. These integers are passed starting with the leftmost point on the instrument’s display. For more information, refer to chapter 18, “Waveform Subsystem.”

When using HP-IB, a digitize operation may be aborted by sending a Device Clear over the bus (CLEAR 707).
Receiving Information from the Instrument

After receiving a query (command header followed by a question mark), the instrument interrogates the requested function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the answer is transmitted across the interface to the designated listener (typically a controller). The input statement for receiving a response message from an instrument's output queue typically has two parameters; the device address, and a format specification for handling the response message. For example, to read the result of the query command :CHANNEL1:COUPLING? you would execute the HP BASIC statement:

```
ENTER <device address> ;Setting$
```

where <device address> represents the address of your device. This would enter the current setting for the channel one coupling in the string variable Setting$.

All results for queries sent in a program message must be read before another program message is sent. For example, when you send the query :MEASURE:RISETIME?, you must follow that query with an input statement. In HP BASIC, this is usually done with an ENTER statement.

Sending another command before reading the result of the query causes the output buffer to be cleared and the current response to be lost. This also causes an error to be placed in the error queue.

Executing an input statement before sending a query causes the controller to wait indefinitely.

The format specification for handling response messages is dependent on both the controller and the programming language.
String Variable Example

The output of the instrument may be numeric or character data depending on what is queried. Refer to the specific commands for the formats and types of data returned from queries.

For the example programs, assume that the device being programmed is at device address 707. The actual address varies according to how you have configured the bus for your own application.

In HP BASIC 5.0, string variables are case sensitive and must be expressed exactly the same each time they are used. The following example shows the data being returned to a string variable:

```
10 DIM Rang$[30]
20 OUTPUT 707;";CHANNEL1:RANGE?"
30 ENTER 707;Rang$
40 PRINT Rang$
50 END
```

After running this program, the controller displays:

```
+8.000000E-01
```

In this example, the oscilloscope is set to 100 mV/division given this output value.

---

Numeric Variable Example

The following example shows the data being returned to a numeric variable:

```
10 OUTPUT 707;";CHANNEL1:RANGE?"
20 ENTER 707;Rang
30 PRINT Rang
40 END
```

After running this program, the controller displays:

```
.8
```
Definite-Length Block Response Data

Definite-length block response data allows any type of device-dependent data to be transmitted over the system interface as a series of 8-bit binary data bytes. This is particularly useful for sending large quantities of data or 8-bit extended ASCII codes. The syntax is a pound sign ( # ) followed by a non-zero digit representing the number of digits in the decimal integer. After the non-zero digit is the decimal integer that states the number of 8-bit data bytes being sent. This is followed by the actual data.

For example, for transmitting 4000 bytes of data, the syntax would be:

#44000 <4000 bytes of data> <terminator>

The "4" represents the number of digits that follow, and "4000" represents the number of bytes to be transmitted.

Multiple Queries

You can send multiple queries to the instrument within a single program message, but you must also read them back within a single program message. This can be accomplished by either reading them back into a string variable or into multiple numeric variables. For example, you could read the result of the query :TIMEBASE:RANGE?;DELAY? into the string variable Results$ with the command:

ENTER 707;Results$

When you read the result of multiple queries into string variables, each response is separated by a semicolon. For example, the response of the query :TIMEBASE:RANGE?;DELAY? would be:

<range_value> ; <delay_value>

Use the following program message to read the query :TIMEBASE:RANGE?;DELAY? into multiple numeric variables:

ENTER 707;Result1,Result2
Instrument Status

Status registers track the current status of the instrument. By checking the instrument status, you can find out whether an operation has been completed, whether the instrument is receiving triggers, and more. The chapter on "Status Reporting" explains how to check the status of the instrument.
Interface Functions
Interface Functions

The interface functions deal with general bus management issues, as well as messages which can be sent over the bus as bus commands. In general, these functions are defined by IEEE 488.1.
HP-IB Interface Connector

The oscilloscope is equipped with an HP-IB interface connector on the rear panel. This allows direct connection to an HP-IB compatible printer or external controller. An external HP-IB compatible device can be connected to the oscilloscope by installing an HP-IB cable between the two units.

Finger tighten the captive screws on both ends of the HP-IB cable to avoid accidentally disconnecting the cable during operation.

Up to fifteen HP-IB compatible instruments (including a controller) can be interconnected in a system by stacking (piggy-backing) connectors. This allows the instruments to be connected in virtually any configuration desired, as long as there is a path from the controller to every device operating on the bus.

Avoid stacking more than three or four cables on any one connector. Multiple connectors produce leverage that can damage a connector mounting.

CAUTION

HP-IB Default Startup Conditions

The following default HP-IB conditions are established during power-up.

- HP-IB local mode is active.
- Local lockout is cleared.
- The Request Service (RQS) bit in the status byte register is set to zero.
- All event registers, the Standard Event Status Enable Register, Service Request Enable Register, and the Status Byte Register are cleared.
Interface Functions

Interface Capabilities

The interface capabilities of this oscilloscope, as defined by IEEE 488.1, are listed in the following table.

<table>
<thead>
<tr>
<th>Code</th>
<th>Interface Function</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH1</td>
<td>Source Handshake</td>
<td>Full Capability</td>
</tr>
<tr>
<td>AH1</td>
<td>Acceptor Handshake</td>
<td>Full Capability</td>
</tr>
<tr>
<td>T5</td>
<td>Talker</td>
<td>Basic Talker/Serial Poll/Talk Only Mode/Unaddress if Listen Address (MLA)</td>
</tr>
<tr>
<td>L4</td>
<td>Listener</td>
<td>Basic Listener/Unaddresses if Talk Address (MTA)</td>
</tr>
<tr>
<td>SR1</td>
<td>Service Request</td>
<td>Full Capability</td>
</tr>
<tr>
<td>RL1</td>
<td>Remote Local</td>
<td>Complete Capability</td>
</tr>
<tr>
<td>PP1</td>
<td>Parallel Poll</td>
<td>Remote Configuration</td>
</tr>
<tr>
<td>DC1</td>
<td>Device Clear</td>
<td>Full Capability</td>
</tr>
<tr>
<td>DT1</td>
<td>Device Trigger</td>
<td>Full Capability</td>
</tr>
<tr>
<td>C0</td>
<td>Controller</td>
<td>No Capability</td>
</tr>
<tr>
<td>E2</td>
<td>Driver Electronics</td>
<td>Tri State (1 MB/SEC MAX)</td>
</tr>
</tbody>
</table>
Command and Data Concepts

The HP-IB has two modes of operation: command mode and data mode. The bus is in the command mode when the Attention (ATN) control line is true. The command mode is used to send talk and listen addresses and various bus commands such as group execute trigger (GET).

The bus is in the data mode when the ATN line is false. The data mode is used to convey device-dependent messages across the bus. The device-dependent messages include all of the oscilloscope specific commands, queries, and responses found in this manual including instrument status information.

Addressing

The oscilloscope is always in the addressed (talk/listen) mode from the HP-IB menu of the front panel of the oscilloscope. The HP-IB menu is selected by pressing the Utility key on the front panel, then selecting the HP-IB softkey.

Addressed mode is used when the instrument operates in conjunction with a controller. When the instrument is in the addressed mode, the following is true:

- Each device on the HP-IB resides at a particular address, ranging from 0 to 30.
- The active controller specifies which devices talk and which listen.
- An instrument may be talk addressed, listen addressed, or unaddressed by the controller.

If the controller addresses an instrument to talk, the instrument remains configured to talk until it receives an interface clear message (IFC), another instrument's talk address (OTA), its own listen message (MLA), or a universal untalk command (UNT).

If the controller addresses an instrument to listen, the instrument remains configured to listen until it receives an interface clear message (IFC), its own talk address (MTA), or a universal unlisten command (UNL).
Communicating Over the Bus

Device addresses are sent by the controller in the command mode to specify who talks and who listens. Since HP-IB can address multiple devices through the same interface card, the device address passed with the program message must include not only the correct interface select code, but also the correct instrument address.

Device Address = (Interface Select Code * 100) + (Instrument Address)

The examples in this manual assume that the oscilloscope is at device address 707.

Interface Select Code

Each interface card has a unique interface select code. This code is used by the controller to direct commands and communications to the proper interface. The default is typically "7" for HP-IB controllers.

Instrument Address

Each instrument on the HP-IB must have a unique instrument address between decimal 0 and 30. This instrument address is used by the controller to direct commands and communications to the proper instrument on an interface. The default is typically "7" for this oscilloscope. This address can be changed in the HP-IB menu of the Utility menu of the oscilloscope.

Address 21 is usually reserved for the Computer interface Talk/Listen address and should not be used as an instrument address.
Remote, Local, and Local Lockout

The remote, local, and local lockout modes are used for various degrees of front-panel control while a program is running.

The instrument accepts and executes bus commands while in the local mode with all front-panel controls active.

The instrument is placed in the remote mode when the controller sets the Remote Enable (REN) bus control line true and addresses the instrument to listen. In the remote mode, all controls except the power switch and the front-panel LOCAL key are entirely locked out. Local control can only be restored by the controller or by pressing the front-panel LOCAL key.

* Cycling the power also restores all front-panel controls (local mode), but this also resets certain HP-IB states. *

The Local Lockout command (LLO) disables all front-panel controls including the LOCAL key. The only active control is the power switch. This prevents undesired or accidental front-panel control which could result in data or settings being changed. The instrument accepts the Local Lockout command whether the instrument is addressed in the remote or local mode. The instrument is returned to the local mode by either setting the REN line false, or by sending the go-to-local command (GTL) to the instrument.
Bus Commands

The following commands are IEEE 488.1 bus commands (ATN true). IEEE 488.2 defines many of the actions that are taken when these commands are received by the instrument.

**Device Clear**
The device clear (DCL) and selected device clear (SDC) commands clear the input buffer and output queue, reset the parser, and clear any pending commands. If either of these commands is sent during a digitize operation, the digitize operation is aborted.

**Group Execute Trigger**
The group execute trigger (GET) command arms the trigger. This is the same action produced by sending the RUN command.

**Interface Clear**
The interface clear (IFC) command halts all bus activity. This includes unaddressing all listeners and the talker, disabling serial poll on all devices, and returning control to the system controller.

---

**Status Messages**

When the instrument is in the remote mode, the Remote message is displayed on the oscilloscope screen.
Message Communication and System Functions

This chapter describes the operation of instruments that operate in compliance with the IEEE 488.2 (syntax) standard. It is intended to give you enough basic information about the IEEE 488.2 Standard to successfully program the instrument. You can find additional detailed information about the IEEE 488.2 Standard in ANSI/IEEE Std 488.2-1987, "IEEE Standard Codes, Formats, Protocols, and Common Commands."

This instrument series is designed to be compatible with other Hewlett-Packard IEEE 488.2 compatible instruments. Instruments that are compatible with IEEE 488.2 must also be compatible with IEEE 488.1 (HP-IB bus standard); however, IEEE 488.1 compatible instruments may or may not conform to the IEEE 488.2 standard. The IEEE 488.2 standard defines the message exchange protocols by which the instrument and the controller will communicate. It also defines some common capabilities that are found in all IEEE 488.2 instruments. This chapter also contains a few items which are not specifically defined by IEEE 488.2, but which deal with message communication or system functions.
Protocols

The message exchange protocols of IEEE 488.2 define the overall scheme used by the controller and the instrument to communicate. This includes defining when it is appropriate for devices to talk or listen, and what happens when the protocol is not followed.

Functional Elements

Before proceeding with the description of the protocol, a few system components should be understood.

Input Buffer  The input buffer of the instrument is the memory area where commands and queries are stored prior to being parsed and executed. It allows a controller to send a string of commands, which could take some time to execute, to the instrument, and then proceed to talk to another instrument while the first instrument is parsing and executing commands.

Output Queue  The output queue of the instrument is the memory area where all output data (<response messages>) are stored until read by the controller.

Parser  The instrument's parser is the component that interprets the commands sent to the instrument and decides what actions should be taken. "Parsing" refers to the action taken by the parser to achieve this goal. Parsing and executing of commands begins when either the instrument recognizes a <program message terminator> (defined later in this chapter) or the input buffer becomes full. If you wish to send a long sequence of commands to be executed and then talk to another instrument while they are executing, you should send all the commands before sending the <program message terminator>.

Protocol Overview

The instrument and controller communicate using <program message>s and <response message>s. These messages serve as the containers into which sets of program commands or instrument responses are placed. <program message>s are sent by the controller to the instrument, and <response message>s are sent from the instrument to the controller in response to a query message. A <query message> is defined as being a <program message> that contains one or more queries. The instrument will only talk when it has received a valid query message, and therefore has something to
say. The controller should only attempt to read a response after sending a complete query message, but before sending another <program message>. The basic rule to remember is that the instrument will only talk when prompted to, and it then expects to talk before being told to do something else.

Protocol Operation

When the instrument is turned on, the input buffer and output queue are cleared, and the parser is reset to the root level of the command tree.

The instrument and the controller communicate by exchanging complete <program message>s and <response message>s. This means that the controller should always terminate a <program message> before attempting to read a response. The instrument will terminate <response message>s except during a hardcopy output.

If a query message is sent, the next message passing over the bus should be the <response message>. The controller should always read the complete <response message> associated with a query message before sending another <program message> to the same instrument.

The instrument allows the controller to send multiple queries in one query message. This is referred to as sending a “compound query.” As noted later in this chapter, multiple queries in a query message are separated by semicolons. The responses to each of the queries in a compound query will also be separated by semicolons.

Commands are executed in the order they are received.

Protocol Exceptions

If an error occurs during the information exchange, the exchange may not be completed in a normal manner. The following are some of the protocol exceptions.

Command Error A command error is reported if the instrument detects a syntax error or an unrecognized command header.

Execution Error An execution error is reported if a parameter is found to be out of range, or if the current settings do not allow execution of a requested command or query.

Device-specific Error A device-specific error is reported if the instrument is unable to execute a command for a strictly device dependent reason.
Query Error  A query error is reported if the proper protocol for reading a query is not followed. This includes the interrupted and unterminated conditions described in the following paragraphs.

Syntax Diagrams

The example syntax diagrams in this chapter are similar to the syntax diagrams in the IEEE 488.2 specification. Commands and queries are sent to the instrument as a sequence of data bytes. The allowable byte sequence for each functional element is defined by the syntax diagram that is shown.

The allowable byte sequence can be determined by following a path in the syntax diagram. The proper path through the syntax diagram is any path that follows the direction of the arrows. If there is a path around an element, that element is optional. If there is a path from right to left around one or more elements, that element or those elements may be repeated as many times as desired.
Figure 3-2

Message Communication and System Functions
Syntax Diagrams

<program message unit>
:TWAVEFORM:OSEARCH 30,TRIGGER ; DELAY 3.8 ns <NL>

<command program header>
:TWAVEFORM:OSEARCH

<program header separator>
SP

<program data>
30 ; TRIGGER

<decimal numeric program data>
30

<program data separator>
SP

<program data>
TRIGGER

<program message unit separator>
SP ; SP

<white space>
;

<white space>
; DELAY 3.8 ns

<program header>
DELAY 3.8 ns

<program header separator>
SP

<program data>
3.0 SP ns

<decimal program data>
3.0

<suffix program data>
SP ns

<white space>
<suffix multiplier>
<suffix unit>

<program message> Parse Tree

HP 54710 and HP 54720
Programmer's Reference
3-7
Syntax Overview

This overview is intended to give a quick glance at the syntax defined by IEEE 488.2. It will help you understand many of the things about the syntax you need to know.

IEEE 488.2 defines the blocks used to build messages that are sent to the instrument. A whole string of commands can therefore be broken up into individual components.

Figure 3-1 is an example syntax diagram and figure 3-2 shows a breakdown of an example <program message> in the parse tree. There are a few key items to notice:

- A semicolon separates commands from one another. Each <program message unit> serves as a container for one command. The <program message unit>s are separated by a semicolon.
- A <program message> is terminated by a <NL> (new line). The recognition of the <program message terminator>, or <PMT>, by the parser serves as a signal for the parser to begin execution of commands. The <PMT> also affects instrument command tree traversal.
- Multiple data parameters are separated by a comma.
- The first data parameter is separated from the header with one or more spaces.
- The header MACHINE1:ASSIGN 2,3 is an example of a compound header. It places the parser in the machine subsystem until the <NL> is encountered.
- A colon preceding the command header returns you to the top of the parser tree.
Upper/Lower Case Equivalence
Upper and lower case letters are equivalent. The mnemonic `SINGLE` has the same semantics as the mnemonic `single`.

<white space>
<white space> is defined to be one or more characters from the ASCII set of 0 - 32 decimal, excluding 10 decimal (NL). <white space> is used by several instrument listening components of the syntax. It is usually optional, and can be used to increase the readability of a program.

Suffix Multiplier The suffix multipliers that the instrument will accept are shown in table 3-1.

<table>
<thead>
<tr>
<th>Value</th>
<th>Mnemonic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E18</td>
<td>EX</td>
</tr>
<tr>
<td>1E15</td>
<td>PE</td>
</tr>
<tr>
<td>1E12</td>
<td>T</td>
</tr>
<tr>
<td>1E9</td>
<td>G</td>
</tr>
<tr>
<td>1E6</td>
<td>MA</td>
</tr>
<tr>
<td>1E3</td>
<td>K</td>
</tr>
<tr>
<td>1E-3</td>
<td>M</td>
</tr>
<tr>
<td>1E-6</td>
<td>U</td>
</tr>
<tr>
<td>1E-9</td>
<td>N</td>
</tr>
<tr>
<td>1E-12</td>
<td>P</td>
</tr>
<tr>
<td>1E-15</td>
<td>F</td>
</tr>
<tr>
<td>1E-18</td>
<td>A</td>
</tr>
</tbody>
</table>
**Suffix Unit** The suffix units that the instrument will accept are shown in table 3-2.

<table>
<thead>
<tr>
<th>Suffix</th>
<th>Referenced Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>S</td>
<td>Second</td>
</tr>
</tbody>
</table>

- HP 54710 and HP 54720
  Programmer's Reference
Status Reporting
Status Reporting

Figure 4-1 is an overview of the oscilloscope's status reporting structure. The status reporting structure allows monitoring specified events in the oscilloscope. The ability to monitor and report these events allows determination of such things as the status of an operation, the availability and reliability of the measured data, and more.

- To monitor an event, first clear the event, then enable the event. All of the events are cleared when you initialize the instrument.
- To generate a service request (SRQ) interrupt to an external controller, enable at least one bit in the Status Byte Register.

The Status Byte Register, the Standard Event Status Register group, and the Output Queue are defined as the Standard Status Data Structure Model in IEEE 488.2-1987.

IEEE 488.2 defines data structures, commands, and common bit definitions for status reporting. There are also instrument-defined structures and bits.
Status Reporting Overview Block Diagram

The status reporting structure consists of the registers in figure 4-1.

Table 4-1 is a list of the bit definitions for the bit in the status reporting data structure.
### Table 4-1: Status Reporting Bit Definition

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>PON</td>
<td>Power On</td>
<td>Indicates power is turned on.</td>
</tr>
<tr>
<td>URQ</td>
<td>User Request</td>
<td>Indicates whether a front-panel key has been pressed.</td>
</tr>
<tr>
<td>CME</td>
<td>Command Error</td>
<td>Indicates whether the parser detected an error.</td>
</tr>
<tr>
<td>EXE</td>
<td>Execution Error</td>
<td>Indicates whether a parameter was out of range, or inconsistent with the current settings.</td>
</tr>
<tr>
<td>DDE</td>
<td>Device Dependent Error</td>
<td>Indicates whether the device was unable to complete an operation for device dependent reasons.</td>
</tr>
<tr>
<td>QYE</td>
<td>Query Error</td>
<td>Indicates if the protocol for queries has been violated.</td>
</tr>
<tr>
<td>ROL</td>
<td>Request Control</td>
<td>Indicates whether the device is requesting control.</td>
</tr>
<tr>
<td>OPC</td>
<td>Operation Complete</td>
<td>Indicates whether the device has completed all pending operations.</td>
</tr>
<tr>
<td>OPER</td>
<td>Operation Status Register</td>
<td>Indicates if any of the enabled conditions in the Operation Status Register have occurred.</td>
</tr>
<tr>
<td>RQS</td>
<td>Request Service</td>
<td>Indicates that the device is requesting service.</td>
</tr>
<tr>
<td>MSS</td>
<td>Master Summary Status</td>
<td>Indicates whether a device has a reason for requesting service.</td>
</tr>
<tr>
<td>ESB</td>
<td>Event Status Bit</td>
<td>Indicates if any of the enabled conditions in the Standard Event Status Register have occurred.</td>
</tr>
<tr>
<td>MAV</td>
<td>Message Available</td>
<td>Indicates if there is a response in the output queue.</td>
</tr>
<tr>
<td>MSG</td>
<td>Message</td>
<td>Indicates whether an advisory has been displayed.</td>
</tr>
<tr>
<td>USR</td>
<td>User Event Register</td>
<td>Indicates if any of the enabled conditions have occurred in the User Event Register.</td>
</tr>
<tr>
<td>TRG</td>
<td>Trigger</td>
<td>Indicates whether a trigger has been received.</td>
</tr>
<tr>
<td>LCL</td>
<td>Local</td>
<td>Indicates if a remote-to-local transition occurs.</td>
</tr>
<tr>
<td>FAIL</td>
<td>Fail</td>
<td>Indicates that the specified test has failed.</td>
</tr>
<tr>
<td>COMP</td>
<td>Complete</td>
<td>Indicates that the specified test has completed.</td>
</tr>
<tr>
<td>LTEST</td>
<td>Limit Test</td>
<td>Indicates if any of the enabled conditions have occurred in the Limit Test Register.</td>
</tr>
<tr>
<td>MTEST</td>
<td>Mask Test</td>
<td>Indicates if any of the enabled conditions have occurred in the Mask Test Register.</td>
</tr>
<tr>
<td>HIST</td>
<td>Histogram</td>
<td>Indicates if any of the enabled conditions have occurred in the Histogram Register.</td>
</tr>
<tr>
<td>WAIT TRIG</td>
<td>Wait for Trigger</td>
<td>Indicates instrument is armed and ready for trigger.</td>
</tr>
</tbody>
</table>
Status Reporting Data Structures

Figure 4-2 brings together the different status reporting data structures mentioned in this chapter and shows how they work together. To make it possible for any of the Standard Event Status Register bits to generate a summary bit, the bits must be enabled. These bits are enabled by using the *ESE common command to set the corresponding bit in the Standard Event Status Enable Register.

To generate a service request (SRQ) interrupt to an external controller, at least one bit in the Status Byte Register must be enabled. These bits are enabled by using the *SRE common command to set the corresponding bit in the Service Request Enable Register. These enabled bits can then set RQS and MSS (bit 6) in the Status Byte Register.
Status Reporting Data Structures
Status Reporting

Status Reporting Data Structures

Figure 4-2 (continued)

Status Reporting Data Structures (continued)

HP 54710 and HP 54720
Programmer's Reference
Status Reporting

Status Byte Register

Status Byte Register

The Status Byte Register is the summary-level register in the status reporting structure. It contains summary bits that monitor activity in the other status registers and queues. The Status Byte Register is a live register. That is, its summary bits are set and cleared by the presence and absence of a summary bit from other event registers or queues.

If the Status Byte Register is to be used with the Service Request Enable Register to set bit 5 (RQS/MSS) and to generate an SRQ, at least one of the summary bits must be enabled, then set. Also, event bits in all other status registers must be specifically enabled to generate the summary bit that sets the associated summary bit in the Status Byte Register.

The Status Byte Register can be read using either the *STB? Common Command or the HP-IB serial poll command. Both commands return the decimal-weighted sum of all set bits in the register. The difference between the two methods is that the serial poll command reads bit 6 as the Request Service (RQS) bit and clears the bit which clears the SRQ interrupt. The *STB? command reads bit 6 as the Master Summary Status (MSS) and does not clear the bit or have any affect on the SRQ interrupt. The value returned is the total bit weights of all of the bits that are set at the present time.

The use of bit 6 can be confusing. This bit was defined to cover all possible computer interfaces, including a computer that could not do a serial poll. The important point to remember is that, if you are using an SRQ interrupt to an external computer, the serial poll command clears bit 6. Clearing bit 6 allows the oscilloscope to generate another SRQ interrupt when another enabled event occurs.

No other bits in the Status Byte Register are cleared by either the *STB? query or the serial poll, except the Message Available bit (bit 4). If there are no other messages in the Output Queue, bit 4 (MAV) can be cleared as a result of reading the response to the *STB? command.

If bit 4 (weight = 16) and bit 5 (weight = 32) are set, the program prints the sum of the two weights. Since these bits were not enabled to generate an SRQ, bit 6 (weight = 64) is not set.
The following example uses the *STB? query to read the contents of the oscilloscopes Status Byte Register when none of the register's summary bits are enabled to generate an SRQ interrupt.

```
10  OUTPUT 707;";SYSTEM:HEADER OFF;";STB?" ;Turn headers off
20  ENTER 707;Result ;Place result in a numeric variable
30  PRINT Result ;Print the result
40  End
```

The next program prints 112 and clears bit 6 (RQS) of the Status Byte Register. The difference in the decimal value between this example and the previous one is the value of bit 6 (weight = 64). Bit 6 is set when the first enabled summary bit is set and is cleared when the Status Byte Register is read by the serial poll command.

```
Example 2
```

The following example uses the HP BASIC serial poll (SPOLL) command to read the contents of the oscilloscopes Status Byte Register.

```
10  Result = SPOLL(707)
20  PRINT Result
30  END
```

Serial polling is the preferred method to read the contents of the Status Byte Register because it resets bit 6 and allows the next enabled event that occurs to generate a new SRQ interrupt.
Status Reporting
Service Request Enable Register

---

Service Request Enable Register

Setting the Service Request Enable Register bits enable corresponding bits in the Status Byte Register. These enabled bits can then set RQS and MSS (bit 6) in the Status Byte Register.

Bits are set in the Service Request Enable Register using the *SRE command and the bits that are set are read with the *SRE? query.

Refer to figure 4-2.

---

Example

The following example sets bit 4 (MAV) and bit 5 (ESB) in the Service Request Enable Register.

```
OUTPUT 707;"*SRE 48"
```

This example uses the parameter “48” to enable the oscilloscope to generate an SRQ interrupt under the following conditions:

- When one or more bytes in the Output Queue set bit 4 (MAV).
- When an enabled event in the Standard Event Status Register generates a summary bit that sets bit 5 (ESB).

---

Trigger Event Register (TRG)

This register sets the TRG bit in the status byte when a trigger event occurs.

The TRG event register stays set until it is cleared by reading the register or using the *CLS command. If your application needs to detect multiple triggers, the TRG event register must be cleared after each one.

If you are using the Service Request to interrupt a program or controller operation when the trigger bit is set, then you must clear the event register after each time it has been set.
Standard Event Status Register

The Standard Event Status Register (SESR) monitors the following oscilloscope status events:
- PON - Power On,
- URQ - User Request,
- CME - Command Error,
- EXE - Execution Error,
- DDE - Device Dependent Error,
- QYE - Query Error,
- RQC - Request Control, and
- OPC - Operation Complete.

When one of these events occurs, the event sets the corresponding bit in the register. If the bits are enabled in the Standard Event Status Enable Register, the bits set in this register generate a summary bit to set bit 5 (ESB) in the Status Byte Register.

The contents of the Standard Event Status Register can be read and the register cleared by sending the *ESR? query. The value returned is the total bit weights of all of the bits that are set at the present time.

Example

The following example uses the *ESR query to read the contents of the Standard Event Status Register.

```
10  OUTPUT 707;"SYSTEM:HEADER OFF"  !Turn headers off
20  OUTPUT 707;"*ESR?"
30  ENTER 707;Result                   !Place result in a numeric variable
40  PRINT Result                      !Print the result
50  End
```

If bit 4 (weight = 16) and bit 5 (weight = 32) are set, the program prints the sum of the two weights.
Standard Event Status Enable Register

To make it possible for any of the Standard Event Status Register (SESR) bits to be able to generate a summary bit, first enable the bit. Enable the bit by using the *ESE (Event Status Enable) common command to set the corresponding bit in the Standard Event Status Enable Register.

Set bits are read with the *ESE? query.

Example

For example, suppose your application requires an interrupt whenever any type of error occurs. The error related bits in the Standard Event Status Register are bits 2 through 5. The sum of the decimal weights of these bits is 60. Therefore, you can enable any of these bits to generate the summary bit by sending:

**OUTPUT 707; "*ESE 60"**

Whenever an error occurs, it sets one of these bits in the Standard Event Status Register. Because the bits are all enabled, a summary bit is generated to set bit 5 (ESB) in the Status Byte Register.

If bit 5 (ESB) in the Status Byte Register is enabled (via the *SRE command), an SRQ service request interrupt is sent to the external computer.

Standard Event Status Register bits that are not enabled still respond to their corresponding conditions (that is, they are set if the corresponding event occurs). However, because they are not enabled, they do not generate a summary bit to the Status Byte Register.
User Event Register (UER)

This register hosts the LCL bit (bit 0) from the Local Event Register. The other 15 bits are reserved. You can read and clear this register using the UER? query. This register is enabled with the UEE command. For example, if you want to enable the LCL bit, you send a mask value of 1 with the UEE command; otherwise, send a mask value of 0.

Local Event Register (LCL)

This register sets the LCL bit in the User Event Register and the USR bit (bit 1) in the status byte. It indicates a remote-to-local transition has occurred. The LER? query is used to read and to clear this register.

Operation Status Register (OPR)

This register hosts the WAIT TRIG bit (bit 5), the LTEST bit (bit 8), the HIST bit (bit 9), the MASK bit (bit 10), and the PROG bit (bit 14). The WAIT TRIG bit is set by the Trigger Armed Event Register and indicates that the trigger is armed.

The LTEST bit is set when a limit test fails or is completed and sets the corresponding FAIL or COMP bits in the Limit Test Event Register.

The HIST bit is set when the COMP bit is set in the Histogram Event Register, indicating that the histogram measurement has satisfied the specified completion criteria.

The MASK bit is set when the Mask Test either fails specified conditions or satisfies its completion criteria, setting the corresponding FAIL or COMP bits in the Mask Test Event Register.

The PROG bit is reserved for future use.

If any of these bits are set, the OPER bit (bit 7) of the Status Byte Register is set. The Operation Status Register is read and cleared with the OPER? query. The register output is enabled or disabled using the mask value supplied with the OPEE command.
Status Reporting
Limit Test Event Register (LTER)

Limit Test Event Register (LTER)

Bit 0 (COMP) of the Limit Test Event Register is set when the Limit Test completes. The Limit Test completion criteria are set by the LTEST:RUN command.

Bit 1 (FAIL) of the Limit Test Event Register is set when the Limit Test fails. Failure criteria for the Limit Test are defined by the LTEST:FAIL command.

The Limit Test Event Register is read and cleared with the LTER? query. When either the COMP or FAIL bits are set, they in turn set the LTEST bit (bit 8) of the Operation Status Register. You can mask the COMP and FAIL bits, thus preventing them from setting the LTEST bit, by defining a mask using the LTEE command.

<table>
<thead>
<tr>
<th>Enable</th>
<th>Mask Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block COMP and FAIL</td>
<td>0</td>
</tr>
<tr>
<td>Enable COMP, block FAIL</td>
<td>1</td>
</tr>
<tr>
<td>Enable FAIL, block COMP</td>
<td>2</td>
</tr>
<tr>
<td>Enable COMP and FAIL</td>
<td>3</td>
</tr>
</tbody>
</table>

Mask Test Event Register

Bit 0 (COMP) of the Mask Test Event Register is set when the Mask Test completes. The Mask Test completion criteria are set by the MTEST:RUNMode command.

Bit 1 (FAIL) of the Mask Test Event Register is set when the Mask Test fails. This will occur whenever any sample is recorded within any polygon defined in the mask.

The Mask Test Event Register is read and cleared with the MTER? query.
When either the COMP or FAIL bits are set, they in turn set the MASK bit (bit 10) of the Operation Status Register. You can mask the COMP and FAIL bits, thus preventing them from setting the MASK bit, by defining a mask using the MTEE command.

<table>
<thead>
<tr>
<th>Enable</th>
<th>Mask Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block COMP and FAIL</td>
<td>0</td>
</tr>
<tr>
<td>Enable COMP, block FAIL</td>
<td>1</td>
</tr>
<tr>
<td>Enable FAIL, block COMP</td>
<td>2</td>
</tr>
<tr>
<td>Enable COMP and FAIL</td>
<td>3</td>
</tr>
</tbody>
</table>

Histogram Event Register

Bit 0 (COMP) of the Histogram Event Register is set when the Histogram completes. The Histogram completion criteria are set by the HISTogram:RUNtil command. The Histogram Event Register is read and cleared with the HER? query.

When the COMP bit is set, it in turn sets the HIIST bit (bit 9) of the Operation Status Register. Results from the Histogram Register can be masked by using the HEEN command to set the Histogram Event Enable Register to the value 0. You enable the COMP bit by setting the mask value to 1.

Arm Event Register (ARM)

This register sets bit 5 (Wait Trig bit) in the Operation Status Register and the OPER bit (bit 7) in the Status Byte Register when the instrument becomes armed.

The ARM event register stays set until it is cleared by reading the register with the AER? query or using the *CLS command. If your application needs to detect multiple triggers, the ARM event register must be cleared after each one.

If you are using the Service Request to interrupt a program or controller operation when the trigger bit is set, then you must clear the event register after each time it has been set.
Error Queue

As errors are detected, they are placed in an error queue. This queue is first in, first out. If the error queue overflows, the last error in the queue is replaced with error -350, "Queue overflow." Any time the queue overflows, the least recent errors remain in the queue, and the most recent error is discarded. The length of the oscilloscope's error queue is 30 (29 positions for the error messages, and 1 position for the "Queue overflow" message).

The error queue is read with the SYSTEM:ERROR? query. Executing this query reads and removes the oldest error from the head of the queue, which opens a position at the tail of the queue for a new error. When all the errors have been read from the queue, subsequent error queries return 0, "No error."

The error queue is cleared when any of the following items occur:

- When the instrument is powered up.
- When the instrument receives the *CLS common command.
- When the last item is read from the error queue.

For more information on reading the error queue, refer to the SYSTEM:ERROR? query in the System Commands chapter. For a complete list of error messages, refer to the chapter, "Error Messages."
Output Queue

The output queue stores the oscilloscope-to-controller responses that are generated by certain instrument commands and queries. The output queue generates the Message Available summary bit when the output queue contains one or more bytes. This summary bit sets the MAV bit (bit 4) in the Status Byte Register.

The output queue may be read with the HP Basic ENTER statement.

Message Queue

The message queue contains the text of the last message written to the advisory line on the screen of the oscilloscope. The length of the oscilloscope’s message queue is 1. The queue is read with the SYSTEM:DSP? query. Note that messages sent with the SYSTEM:DSP command do not set the MSG status bit in the Status Byte Register.

Key Queue

The key queue contains the key codes for the last 10 keys pressed on the front panel. This queue is first in, first out. If the key queue overflows, the oldest key codes are discarded as additional keys are pressed. The key queue is read with the SYSTEM:KEY? query.

Clearing Registers and Queues

The *CLS common command clears all event registers and all queues except the output queue. If *CLS is sent immediately following a program message terminator, the output queue is also cleared.
Status Reporting
Clearing Registers and Queues

Figure 4-3

Status Reporting Decision Chart

---

4-18  HP 54710 and HP 54720
Programmer's Reference
Programming Syntax
Programming Syntax

Computers acting as controllers communicate with the oscilloscope by sending and receiving program messages over a remote interface. Program messages are placed on the bus using an input or output command and passing the device address, instruction, and terminator. Passing the device address ensures that the instruction is sent to the correct interface and instrument. Instructions for programming the oscilloscope normally appear as ASCII character strings embedded inside the output statement of a "host" language available on your controller. Responses from the oscilloscope are read with the input statements of the host language.
HP BASIC Output Statement

HP 9000 Series 200/300 BASIC uses the OUTPUT statement for sending commands and queries to the oscilloscope.

**Figure 5-1**

---

HP BASIC Enter Statement

After a query is sent, the response is usually read using the HP BASIC ENTER statement. The ENTER statement passes the value across the bus to the controller and places it in the designated variable.

**Figure 5-2**

---

HP Basic Syntax for Receiving Responses
Device Address

The examples in this manual assume the oscilloscope is at device address 707. In HP BASIC, the address is specified after the keyword OUTPUT or ENTER. In actual programs, the number you use varies according to how you have configured the bus for your application.

Instructions

Instructions can be sent to the oscilloscope in either the long form (complete spelling) or the short form (abbreviated spelling). Upper-case and lower-case letters may be mixed freely. When receiving responses from the instrument, upper-case letters are used exclusively. The use of the long form or short form in a response depends on the setting you last specified with the SYSTEM:LONGFORM command.

Instructions are composed of two main parts:

- The header, which specifies the command or query to be sent.
- The program data, which provide additional information needed to clarify the meaning of the instruction.
Instruction Header

The instruction header is one or more mnemonics separated by colons (:) that represent the operation to be performed by the instrument. There are three types of headers:

- Simple Command headers.
- Compound Command headers.
- Common Command headers.

Simple Command Headers

Simple command headers contain a single mnemonic. AUTOSCALE and DIGITIZE are examples of simple command headers typically used in this oscilloscope.

Figure 5-3

Simple Command Syntax
**Compound Command Headers**

Compound command headers are a combination of two or more program mnemonics. The first mnemonic selects the subsystem, and the last mnemonic selects the function within the subsystem. Additional mnemonics may appear between the subsystem mnemonic and the function mnemonic when there are additional levels within the subsystem that must be traversed. The mnemonics within the compound header are separated by colons. An example of a compound header is :SYSTEM:LONGFORM.

**Common Command Headers**

Common command headers control IEEE 488.2 functions within the instrument such as clearing the status (*CLS). No space or separator is allowed between the asterisk (*) and the command header.
Queries

Headers immediately followed by a question mark (?) are queries. After receiving a query, the instrument interrogates the required function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the answer is transmitted across the bus to the designated listener (typically a controller). For example, the query :TIMEBASE:RANGE? places the current time base setting in the output queue.

Sending another command or query before reading the result of a query causes the output queue to be cleared and the current response to be lost. This also generates an error in the error queue.

Figure 5-6

Query Syntax

Queries can be used to find out how the instrument is currently configured. They are also used to get results of measurements made by the oscilloscope, with the query actually activating the measurement.
Program Data

Program data are used to clarify the meaning of a command or query. They provide necessary information such as whether a function should be on or off, which waveform is to be displayed, and more.

Spaces and Commas

A space separates the header from the data. When there is more than one data parameter, the data parameters are separated by commas (,).

Character Program Data

Character program data is used to convey parameter information as alpha or alphanumeric strings. The available mnemonics for program data are listed with the individual commands in this manual.

Numeric Program Data

With numeric program data, you have the option of using exponential notation or using suffix multipliers to indicate a numeric value. The following numbers are all equal:

$$28 = 0.28E2 = 280E-1 = 28000m = 0.028K = 28E-3K$$

When a syntax definition specifies that a number is an integer, that means the number should be whole without any fractional part or decimal point.

Embedded Strings

Embedded strings contain groups of alphanumeric characters that are treated as a unit of data by the oscilloscope. For example, the line of text written to the advisory line of the oscilloscope with the :SYSTEM:DSP command. Embedded strings may be delimited with either single (') or double (") quotes. These strings are case-sensitive and spaces act as legal characters just like any other character.
Block Data

Definite-length block response data (block data) allows any type of device-dependent data to be transmitted over the bus as a series of 8-bit binary data bytes. This is particularly useful for sending large quantities of data or 8-bit extended ASCII codes. The syntax is a pound sign (#) followed by a non-zero digit representing the number of digits in the decimal integer. After the non-zero digit is a decimal integer that states the number of 8-bit data bytes being sent. This is followed by the actual data.

Figure 5-7

Block Data Syntax

For example, for transmitting 500 bytes of data, the syntax would be: #3500<500 bytes of data><terminator>

The "3" states the number of digits that follow, and the "500" states the number of bytes to be transmitted.
Multiple Subsystems

You can send multiple instructions (commands and queries) for different subsystems on the same line by separating each instruction with a semi-colon (;). The colon following the semi-colon enables you to enter a new subsystem (for example: CHANNEL1: RANGE 0.4; TIMEBASE: RANGE 1).

Multiple instructions may be any combination of compound and simple commands.

Selecting Multiple Subsystems
Multiple Functions within a Subsystem

To execute more than one function within the same subsystem, separate each function with a semi-colon (;). For example: SYSTEM:LONGFORM ON;HEADER ON turns the long form on and the headers on.

Selecting Multiple Functions within a Subsystem
Common Commands within a Subsystem

Common commands can be received and processed by the oscilloscope whether they are sent over the bus as separate program messages or within other program messages. If a subsystem has been selected and a common command is received by the oscilloscope, the instrument remains in the selected subsystem. For example, if the program message

```
*:ACQUIRE:TYPE AVERAGE:*CLS;COUNT 1024
```

is received by the oscilloscope, the oscilloscope sets the acquire type and count, then clears the status information without leaving the selected subsystem.

If some other type of command is received within a program message, you must reenter the original subsystem after the command. For example, the program message

```
*:ACQUIRE:TYPE AVERAGE:*AUTOSCALE;ACQUIRE:COUNT 1024
```

sets the acquire type, completes the autoscale operation, then sets the acquire count. In this example, :ACQUIRE must be sent again after the AUTOSCALE command in order to reenter the acquire subsystem and set count.

**Figure 5-10**

Selecting Common Commands within a Subsystem
Instruction Terminator

The instructions within the program message are executed after the instruction terminator is received. The terminator may be either a New Line (NL) character, and End-Or-Identify (EOI) asserted, or a combination of the two. All three ways are equivalent. Asserting the EOI sets the EOI control line low on the last byte of the data message. The NL character is an ASCII linefeed (decimal 10).

Figure 5-11
Programming Conventions
Programming Conventions

This chapter covers conventions used in programming the oscilloscope, as well as conventions used throughout this manual. A block diagram and description of data flow is included for understanding oscilloscope operations. A detailed description of the command tree and command tree traversal is also included in this chapter.
Data Flow

The data flow gives you an idea of where the measurements are made on the acquired data, and when the post-signal processing is applied to the data. Figure 6-1 is a data flow diagram of the oscilloscope. The diagram is laid out serially for a visual perception of how the data is affected by the oscilloscope.
The digitizer samples the applied signal and converts it to a digital signal. The FISO holds the data until the system bus is ready for the data. The output of the FISO is raw data, and it is used as an address to the calibration read-through table (cal table).

The cal table automatically applies the calibration factors to the raw data, so that the output of the cal table is calibrated data.

In the real-time sampling mode, the calibrated data is stored in the channel memories before any of the postprocessing is performed. Postprocessing includes turning on or off the digital bandwidth limit filter or the interpolator, calculating functions, storing data to the waveform memories, transferring data over the HP-IB bus, or transferring data to and from the disk. Notice that the measurements are performed on the real-time data after it has gone through postprocessing.

Therefore, you can make measurements on the data, and you can turn on or off digital bandwidth limit or interpolation without having to reacquire the data. This is important because the real-time sampling mode is primarily used on events that happen either once or infrequently, and reacquiring the data may not be one of your options. Also, turning on interpolation usually improves the repeatability of your measurements.

The equivalent-time sampling mode is slightly different. Notice that averaging is turned on or off before the data is stored in the channel memories. That means once the data is acquired, if you need to turn averaging on or off before making any measurements, you must reacquire the data. However, because the equivalent-time sampling mode is primarily used on repetitive signals, you should be able to reacquire the data.

Also, you may notice that postprocessing the data in the equivalent-time signal path includes calculating functions, storing data to the waveform memories, transferring data over the HP-IB bus, or transferring data to and from the disk.

After the measurements are performed, the data is sent through the display portion of the oscilloscope. Notice that connected dots is a display feature, and that it has no influence on the measurement results. The pixel memory is also part of the video RAM, which is past the point where the measurements are performed on the data. Therefore, you cannot make measurements on data in the pixel memory. But, you can make measurements on data stored to the waveform memories.
Truncation Rule

The following truncation rule is used to produce the short form (abbreviated spelling) for the mnemonics used in the programming headers and alpha arguments.

The mnemonic is the first four characters of the keyword, unless the fourth character is a vowel. Then the mnemonic is the first three characters of the keyword.

If the length of the keyword is four characters or less, this rule does not apply and the short form is the same as the long form.

The following table shows how the truncation rule is applied to various commands.

<table>
<thead>
<tr>
<th>Long Form</th>
<th>Short Form</th>
<th>How The Rule is Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANGE</td>
<td>RANG</td>
<td>Short form is the first four characters of the keyword.</td>
</tr>
<tr>
<td>PATTERN</td>
<td>PATT</td>
<td>Short form is the first four characters of the keyword.</td>
</tr>
<tr>
<td>TIME</td>
<td>TIME</td>
<td>Short form is the same as the long form.</td>
</tr>
<tr>
<td>DELAY</td>
<td>DEL</td>
<td>Fourth character is a vowel, short form is the first three characters.</td>
</tr>
</tbody>
</table>
The Command Tree

The command tree in figure 6-2 shows all of the commands in this oscilloscope and the relationship of the commands to each other. The IEEE 488.2 common commands are not listed as part of the command tree since they do not affect the position of the parser within the tree.

When a program message terminator (<NL>, linefeed - ASCII decimal 10) or a leading colon (:) is sent to the instrument, the parser is set to the "root" of the command tree.

Command Types

The commands in this instrument can be placed into three types: Common commands, root level commands, and subsystem commands.

- Common commands are commands defined by IEEE 488.2 and control some functions that are common to all IEEE 488.2 instruments. These commands are independent of the tree and do not affect the position of the parser within the tree. *RST is an example of a common command.

- Root level commands control many of the basic functions of the instrument. These commands reside at the root of the command tree. They are always parsable if they occur at the beginning of a program message, or are preceded by a colon. Unlike common commands, root level commands place the parser back at the root of the command tree. AUTOSCALE is an example of a root level command.

- Subsystem commands are grouped together under a common node of the command tree, such as the TIMEBASE commands. Only one subsystem may be selected at a given time. When the instrument is initially turned on, the command parser is set to the root of the command tree and no subsystem is selected.
Tree Traversal Rules

Command headers are created by traversing down the command tree. A legal command header from the command tree in figure 6-2 would be .TIMEBASE:RANGE. This is referred to as a compound header. A compound header is a header made up of two or more mnemonics separated by colons. The mnemonic created contains no spaces. The following rules apply to traversing the tree.

A leading colon or a program message terminator (either an <NL> or EOI true on the last byte) places the parser at the root of the command tree. A leading colon is a colon that is the first character of a program header.

Executing a subsystem command places you in that subsystem until a leading colon or a program message terminator is found.

In the command tree of figure 6-2, use the last mnemonic in the compound header as a reference point (for example, RANGE). Then find the last colon above that mnemonic (TIMEBASE:). That is the point where the parser resides. Any command below this point can be sent within the current program message without sending the mnemonics which appear above them (for example, REFERENCE).
Programming Conventions
The Command Tree

Figure 6-2

Common Commands
-CLS
-ESRC
-ESR?
-EXI?
-LEP?
-OPC?
-OP?
-RC?
-RST
-SAV
-SRE
-STD?
-TRG
-TST?
-WAI

Command Tree

HP 54710 and HP 54720
Programmer's Reference
### Figure 6-2 (continued)

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>MTEST</th>
<th>TIMEbase</th>
<th>TRIGGER</th>
<th>TRIGGER&lt;N&gt;</th>
<th>PHMErey</th>
<th>WMEMory&lt;N&gt;</th>
<th>WAVEform</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINE</td>
<td>AMASK</td>
<td>DELoy</td>
<td>DEVENTs</td>
<td>BWLAW</td>
<td>ADD</td>
<td>DISPLAY</td>
<td>BANDpass?</td>
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<tr>
<td>DEL:Time</td>
<td>CUONI</td>
<td>POS:ion</td>
<td>OTIME</td>
<td>PROBE</td>
<td>CLEAR</td>
<td>SAVE</td>
<td>BYTeorder</td>
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<tr>
<td>DUTycycle</td>
<td>MASK</td>
<td>RANGE</td>
<td>EDGE</td>
<td>DISPLAY</td>
<td>XOFFset</td>
<td>COMplete?</td>
<td></td>
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<tr>
<td>FALLime</td>
<td>POLYGON</td>
<td>REFERENCE</td>
<td>GLITCH</td>
<td>ERASE</td>
<td>XRANGE</td>
<td>COUNT?</td>
<td></td>
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<tr>
<td>FFT</td>
<td>RUN:ode</td>
<td>SCALE</td>
<td>HOLDoff</td>
<td>MERGE</td>
<td>YOFFset</td>
<td>COUPling?</td>
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<td>FREQUENCY</td>
<td>SCAlE</td>
<td>VIEW</td>
<td>HYSTeresis</td>
<td>DATA</td>
<td>FORMat?</td>
<td></td>
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<tr>
<td>HISTogram</td>
<td>SC:Ren</td>
<td>WINDow</td>
<td>LEVEL</td>
<td>FORMat</td>
<td>FONNi?</td>
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<td>SWAVEform</td>
<td>SLOPe</td>
<td>VIEW</td>
<td>TYPE?</td>
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<td>TEST</td>
<td>SOURCE</td>
<td>XDISPlay?</td>
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</tbody>
</table>

---

**Command Tree (continued)**
Programming Conventions
The Command Tree

Tree Traversal Examples
The OUTPUT statements in the following examples are written using HP BASIC 5.0 on an HP 9000 Series 200/300 controller. The quoted string is placed on the bus, followed by a carriage return and linefeed (CRLF).

Example 1

OUTPUT 707;":CHANNEL1:RANGE 0.5;OFFSET 0"

In the previous example, the colon between CHANNEL1 and RANGE is necessary because CHANNEL1:RANGE is a compound command. The semicolon between the RANGE command and the OFFSET command is required to separate the two functions. The OFFSET command does not need CHANNEL1 preceding it since the CHANNEL1:RANGE command sets the parser to the CHANNEL1 node in the tree.

Example 2

OUTPUT 707;":TIMEBASE:REFERENCE CENTER;POSITION 0.00001"

or

OUTPUT 707;":TIMEBASE:REFERENCE CENTER"
OUTPUT 707;":TIMEBASE:POSITION 0.00001"

In the first line of example 2, the "subsystem selector" is implied for the POSITION command in the compound command.

A second way to send these commands is shown in the second part of the example. Since the program message terminator places the parser back at the root of the command tree, TIMEBASE must be re-selected to re-enter the TIMEBASE node before sending the POSITION command.
Example 3

OUTPUT 707;*:TIMEBASE:REFERENCE CENTER;:CHANNEL1:OFFSET 0*

In example 3, the leading colon before CHANNEL1 tells the parser to go back to the root of the command tree. The parser can then recognize the CHANNEL1:OFFSET command and enter the correct node.

Infinity Representation

The representation for infinity for this oscilloscope is 9.99999E+37. This is also the value returned when a measurement cannot be made.

Sequential and Overlapped Commands

IEEE 488.2 makes a distinction between sequential and overlapped commands. Sequential commands finish their task before the execution of the next command starts. Overlapped commands run concurrently. Commands following an overlapped command may be started before the overlapped command is completed.

Response Generation

As defined by IEEE 488.2, query responses may be buffered for the following reasons:

- When the query is parsed by the instrument.
- When the controller addresses the instrument to talk so that it may read the response.

This oscilloscope buffers responses to a query when the query is parsed.

EOI

The EOI bus control line follows the IEEE 488.2 standard without exception.
Example Programs
Example Programs

The programs listed in this chapter are the same as those on the disks provided with this programmer's reference. The disks are provided in both LIF and DOS formats. The disks contain some interactive files, i.e., additional files are created while running the programs. To preserve the original quality of the example programs disks, make a copy of the originals and use the copy for running the programs.
Digitize Example Program

10 "DIG_7XX.ibw"
20
30 Copyright: (c) 1993, Hewlett-Packard Co. All rights reserved.
40 Contributor: Colorado Springs Division
41 Product: Example Program
42
43 $Revision: 3.0$
44 $Date$ 6.9.93
45 $Author$ Ed Mierzejewski
46
47 Description: DIG_7XX.ibw autoscales to get a waveform on screen and
digitizes the waveform. Then the operator can reposition
before transferring the data to the computer. Then the
computer will draw the waveform as repositioned on the
computer screen. It also save the data to a record and
recalls that data before drawing it.

54 Main Routine: Begin_main.
55 Sub routines: none.
56 Sub programs: Get_waveform, Graph, Initscope, Readme, Readme2,
57 Retrieve_wave, Save_waveform.
59 Functions: none.
60 Variable List: Preamble & Waveform, $Path$, & $Scope$
61
62 Preamble = Real array for the first 15 parameters of the
63 preamble, they are numerics and the remaining 3
64 parameters are alphas and are not used.
66 Waveform = Integer array to store the waveform data.
67 $Path$ = the path for saving/recalling data to/from media.
68 $Scope$ = The scope's complete HPIB address.
70
71 REAL Preamble(1:15)
130 INTEGER Waveform(1:32000)
140 Begin_main: 1
185 CALL Readme
186 CALL Initscope($Scope$)
190 CALL Get_waveform($Scope$,Waveform(*),Preamble(*))
220 CALL Save_waveform($Path$,Waveform(*),Preamble(*))
240 CALL Readme2
260 CALL Retrieve_wave($Path$,Waveform(*),Preamble(*))
290 CALL Graph(Waveform(*),Preamble(*))

HIP 54710 and HP 54720
Programmer's Reference
Example Programs
Digitize Example Program

291 PRINT TABXY(15,30);"Program has Ended."
292 LOCAL 707
300 END_main:
310   END
320 BEGIN_sub1:
321   
330 SUB Readme
340 ! Description: Readme prints program explanation to the computer
341 ! screen.
342 ! Parameters: none.
343 !
350   CLEAR SCREEN
360   PRINT "DIG_7XX.ibw does the following tasks:"
370   PRINT
380   PRINT "a. initialize interface and scope"
390   PRINT "b. digitize and acquire data"
400   PRINT "c. store data to disk"
410   PRINT "d. retrieve data from disk"
420   PRINT "e. draw signal on computer"
430   PRINT
440   PRINT "Assumed system configuration is:"
450   PRINT
460   PRINT "HP-IB address = 7"
470   PRINT "Scope address = 7"
480   PRINT "signal attached to channel 1"
490   PRINT
500   PRINT "If the addresses are not correct, change the ASSIGN "
510   PRINT "statements in sub program 'Initscope'."
520   PRINT
530   PRINT "Press Continue when ready to start"
540   PAUSE
550   CLEAR SCREEN
560 SUBEND
570   
580 SUB Readme2
590   ! Description: Readme2 is user information and status.
600   ! Parameters: none.
610   !
620   CLEAR SCREEN
623   PRINT
630   PRINT "The waveform data and preamble information have now been"
640   PRINT "read from the scope and stored in the computer's disk."
641   PRINT

7-4 HP 54710 and HP 54720
Programmer's Reference
Example Programs
Digitize Example Program

642 PRINT "When you press continue that information will be retrieved."
650 PRINT "from the disk, and plotted to the computer screen."
660 PRINT
670 PRINT "Press CONTINUE to continue."
680 PAUSE
690 CLEAR SCREEN
700 SUBEND
710 SUB InitScope(@Scope)
720 i
730 ! Description: InitScope assigns the path to the scope, initializes
740 ! the scope, autoscales, and sets up the acquisition
750 ! parameters.
760 ! Parameters:
770 ! Passed: @Scope = the HPIB address of the scope.
780 ! Internal: @Isc = interface select code of the HPIB interface.
790 ! Modified Variables: @Scope and @Isc
800 CLEAR SCREEN
810 PRINT "INITIALIZE"
820 ASSIGN @Isc TO 7 i Interface Select Code = 7
830 ASSIGN @Scope TO 707 i scope address
840 Init_sys: i_
850 CLEAR @Isc i clear HP-IB interface
860 OUTPUT @Scope;"*RST;*CLS" i set scope to default config
870 OUTPUT @Scope;":AUTOScale"
880 OUTPUT @Scope;":SYSTEM:HEADER OFF"
890 Acq_setup: i
900 OUTPUT @Scope;":ACquire:COMPLETE 100;POINTS 500"
910 OUTPUT @Scope;":WAVEform:FORMAT BYTE;SOURCE CHAnnell"
920 i
930 ! Normally WORD data would be recommended because it allows better
940 ! use of the full resolution of the scope, especially in ET MODE.
950 ! Byte data is shown because HPBasic doesn't recognize signed bytes
960 ! and requires a conversion. FNFind will do the conversion.
970 i
980 CLEAR SCREEN
990 SUBEND
1000 i
1010 SUB Get_waveform(@Scope,INTEGER Waveform(*),REAL Preamble(*))
1020 i
1021 ! Description: Get_waveform digitizes the autoscaled waveform,
1022 ! gets waveform data and preamble after the operator
1023 ! adjusts the display to show the data as desired.
Example Programs
Digitize Example Program

1050 I
1051 I There are 2 forms of digitize: 1. 'with parameters'
1052 I will digitize the specified channel/function, screen
1053 I is blanked, then place the data in associated channel/
1054 I function memory. 2. 'without parameters' digitizes
1055 I all 'on' channels/functions and places data in the
1056 I associated channel/function memory, and leaves them on
1057 I but stopped.
1058 I
1059 I Both digitizes are here and on adjacent lines. One of
1060 I the lines must be commented out or only the last one
1061 I will be used.
1062 I
1063 I Parameters:
1064 I Passed: $Scope, Waveform, Preamble
1065 I Internal: Digits = this is the length of the data header.
1066 I Length = the number of bytes of data from the scope.
1067 I End$ = empties output buffer of linefeed.
1068 I One_char$ = used to find the '#' character.
1069 I
1070 I Modified Variables: Waveform, Preamble, Digits, Length, End$, and
1071 I One_char$.
1072 I
1073 I CLEAR SCREEN
1074 I PRINT "Get waveform"
1075 I OUTPUT $Scope;"DIGitize CHAN1"
1076 I OUTPUT $Scope;"DIGitize"
1077 I User_sets_disp: 1
1078 I LOCAL 707
1079 I PRINT "Adjust Display as you want it. Press continue when ready."
1080 I PAUSE
1081 I Read_data: 1
1082 I OUTPUT $Scope;"WAVEform:DATA?"
1083 I ENTER $Scope USING ";,1A,";One_char$
1084 I IF One_char$="#" THEN
1085 I ENTER $Scope USING ";,1D";Digits
1086 I ENTER $Scope USING ";,"&VAL$(Digits)&"D";Length
1087 I CLEAR SCREEN
1088 I PRINT
1089 I PRINT "reading ";Length;" bytes from scope"
1090 I
1091 I Redimension the array for the waveform data. After data is
1092 I read in, one extra byte read to clear the line feed (10)
1093 I attached to the end of the scope's output buffer.
Example Programs
Digitize Example Program

1300       REDIM Waveform (1:Length)
1310       ENTER Scope USING "#,B":Waveform(*)
1320       ENTER Scope USING ",K,B":End$  
1330       OUTPUT Scope; "WAVEFORM:PREAMBLE?"
1340       ENTER Scope; Preamble(*)
1370       ELSE
1380       PRINT "BAD DATA"
1390       END IF
1400       END
1410       SUB Save_waveform (@Path, INTEGER Waveform(*), REAL Preamble(*))
1430       // Description: Save_waveform sends acquired data and preamble to the
1440       // computer's disk. It is stored in 'WAVESAMPLE'. If
1450       // 'WAVESAMPLE' already exist, it will be purged then a
1460       // new one created.
1436       // Parameters:
1437       // Passed: @Path, Waveform, Preamble
1438       // Internal: none
1439       // Modified Variables: none
1440       // Sub programs: Ertrap
1442       // ON ERROR CALL Ertrap
1490       CREATE BDAT "WAVESAMPLE", 1, 4080
1510       ASSIGN @Path TO "WAVESAMPLE"
1520       OUTPUT @Path; Waveform(*), Preamble(*)
1530       END
1540       SUB Retrieve_wave (@Path, INTEGER Waveform(*), REAL Preamble(*))
1551       // Description: Retrieve_wave reads data and preamble stored in
1552       // 'WAVESAMPLE'.
1551       // Parameters:
1552       // Passed: @Path, Waveform, Preamble
1553       // Internal: Con = indexing variable
1554       // Functions: FN8con = converts from signed bytes.
1555       // ASSIGN @Path TO "WAVESAMPLE"
1590       ENTER @Path; Waveform(*), Preamble(*)
1600       FOR Con=1 TO Preamble(3)
1620       Waveform(Con)=FN8con(Waveform(Con))
1630       NEXT Con
1640       END

HP 54710 and HP 54720
Programmer's Reference
Example Programs
Digitize Example Program

1650 SUB Graph(INTEGER Waveform(*),REAL Preamble(*))
1670
1680 Description: Graph takes the converted data and plots it on screen.
1690 It uses the 'Y Display Range' to show the data as seen
1700 on screen vertically, and 'X Display Range' to show
1710 as seen horizontally (pre(14 and 12 respectively).
1720
1730 Parameters: Waveform(*) = array of data values. Enters as q levels
1740 leaves as voltages.
1750 Preamble(*) = the preamble for the data.
1760
1770 Internal: Vrange = preamble(14), y-axis duration of waveform displayed.
1780 Srange = preamble(12), x-axis duration of waveform displayed.
1790 Offset = preamble(15), center of screen vertically.
1800 vmin = lower limit vertically.
1810 vmax = upper limit vertically.
1820 hmin = lower limit horizontally (preamble(13)).
1830 hmax = upper limit horizontally.
1840 Hdata(*) = Horizontal values in proper units.
1850 Vdata(*) = Vertical values in proper units.
1851 I = indexing variable.
1860
1870 Modified variables: Hdata(*), Vdata(*), and I
1880
1890 Subprogram calls: V_convert and H_convert.
1900
1910 ALLOCATE REAL Hdata(1:Preamble(3))
1920 ALLOCATE REAL Vdata(1:Preamble(3))
1930 CALL V_convert(Waveform(*),Preamble(*),Vdata(*))
1940 CALL H_convert(Hdata(*),Preamble(*))
1950 Vrange=Preamble(14)
1960 Srange=Preamble(12)
1970 Offset=Preamble(15)
1980 Vmin=Offset-Vrange/2
1990 Vmax=Vrange/2+Offset
2000 Hmin=Preamble(13)
2010 Hmax=Hmin+Srange
2020 GCLEAR !initialize graphics
2030 CLEAR SCREEN
2040 GINIT
2050 GRAPHICS ON
2060 VIEWPORT 0,130,35,100
2070 WINDOW Hmin,Hmax,Vmin,Vmax
2080 FRAME
Example Programs
Digitize Example Program

2090 PEN 4
2100 MOVE Hdata(1),Vdata(1)
2110 FOR I=1 TO Preamble(3)
2115 plot data points
2120 DRAW Hdata(I),Vdata(I)
2130 NEXT I
2140 PRINT TABXY(0,18),"Vertical=";Vrange/8;" V/div";TAB(50),"Offset = ";Offset;"V"
2150 PRINT TABXY(0,19),"Time=";Srange/10;" s/div"
2160 DEALLOCATE Hdata(*)
2170 DEALLOCATE Vdata(*)
2180 SUBEND
2190
2200 DEF FNBcon(INTEGER B)
2201!
2202 ! Description: FN Bcon takes the signed byte value from the scope and
2203 ! converts it to a positive integer of the proper value.
2204 ! Parameters:
2205 ! Passed: B
2206 ! Internal: Or param = value to OR with the passed value, B, when the
2207 ! MSB is set.
2208 ! Modified Variables: B
2209!
2210 Orparam=-256
2211 IF BIT(B,7) THEN B=BINOR(Orparam,B)
2212 RETURN B
2213!
2214 FNEND
2215
2230 SUB Ertrap
2231!
2232 ! Description: Ertrap is called by an error interrupt. It checks for
2233 ! error #54 which will occur when there is a duplicate
2234 ! file name. The existing file will be purged.
2235 ! Parameters: none
2236!
2237 IF ERRN=54 THEN PURGE "WAVESAMPLE"
2238 OFF ERROR
2239 SUBEND
2240
2240 SUB V_convert(INTEGER Wav(*),REAL Pre(*),Vdata(*))
2241!
2242 ! Description: V_convert takes the data from the scope and converts it
2243 ! into voltage values using the equation from the manual.
2244 ! Parameters: Wav(*) = array of data values. Enters as q levels
2245 ! leaves as voltages.

HP 54710 and HP 54720
Programmer's Reference 7-9
Example Programs
Digitize Example Program

2460 ! Pre(*) = the preamble for the data.
2470 ! Vdata(*) = array of vertical values, volts.
2480 !
2490 ! Internal: yref = pre(10), level associated with y origin.
2500 ! yinc = pre(8), duration between y-axis levels.
2510 ! yorg = pre(9), y-axis value at level zero.
2511 !
2520 ! C = indexing variable.
2530 ! Modified variables: Vdata(*)
2540 !
2550 Yref=Pre(10)
2560 Yinc=Pre(8)
2570 Yorg=Pre(9)
2580 FOR C=1 TO Pre(3)
2590 Vdata(C)=(Yav(C)-Yref)*Yinc+Yorg
2600 NEXT C
2610 SUBEND

2620 !
2630 SUB H_convert(Hdata(*),Pre(*))
2640 !
2650 ! Description: H_convert creates horizontal axis values using the
2660 ! equation from the manual.
2670 !
2680 ! Parameters: Hdata(*) = Horizontal values.
2690 ! Pre(*) = the preamble for the data.
2700 !
2710 ! Internal: xref = pre(7), data point associated with the x origin.
2720 ! xinc = pre(5), duration between x-axis data points.
2730 ! xorg = pre(6), x-axis value of first point in record.
2740 !
2750 ! Modified variables: Hdata(*)
2760 !
2770 Xref=Pre(7)
2780 Xinc=Pre(5)
2790 Xorg=Pre(6)
2800 FOR C=1 TO Pre(3)
2810 Hdata(C)=((C-1)-Xref)*Xinc+Xorg
2820 NEXT C
2830 SUBEND
Example Programs
Measurement Example Program

Measurement Example Program

10  \ RE-SAVE "MEAS_7XX"  \Observing True Representation of signal.Rev. 1.18
20  
30  \******************************************************************************
40  \************  Main Program  **********************************************
50  
60  Readme
70  InitScope(Scope)
80  True_rep(Scope)
90  Measure(Scope)
100 Rt_4g(Scope)
110 Measure(Scope)
120 Rt_2g(Scope)
130 Measure(Scope)
140 PRINT  " The program has completed!  "
150 BEEP
160  \******************************************************************************
170 END  \*  End of Main Program  *
180  \******************************************************************************
190  
200  \******************************************************************************
210 \*  Begin Sub Programs  *
220  \******************************************************************************
230 SUB Readme
240  \******************************************************************************
250 \*  This sub program writes user program information to the screen.  *
260  \******************************************************************************
270 CLEAR SCREEN
280 PRINT "This example program will setup and measure the cal."
290 PRINT "signal from the 54721A with different sampling rates"
300 PRINT "and statistics. It shows the difference sampling rate"
310 PRINT "makes when measuring a fast pulse."
320 PRINT
330 PRINT "The program assumes that the system is configured such that:"
340 PRINT  " HP-IB interface is at address 7."
350 PRINT  " Scope is at address 7."
360 PRINT  " A 54721A is installed into slots 1 & 2."
370 PRINT
380 PRINT "If these addresses are incorrect, break program and set addresses"
390 PRINT "as needed in the ASSIGN statements."
400 PRINT
410 PRINT "PRESS continue to run program"
Example Programs

Measurement Example Program

420 PAUSE
430 CLEAR SCREEN
440 SUBEND
450 I
460 SUB Initscope(@Scope)
470 !********************************************************************************
480 ! This sub program initializes the I/O and scope.  *
490 !********************************************************************************
500 ASSIGN @Scope TO 707
510 CLEAR @Scope            ! clear HP-IB interface
520 OUTPUT @Scope;"*cls"
530 OUTPUT @Scope;"*rst"   ! reset scope to default config
540 OUTPUT @Scope;" :system:header off"! turn off header
550 CLEAR SCREEN
560 SUBEND
570 SUB True_rep(@Scope)
580 !********************************************************************************
590 ! The first step of this demonstration is to show the true     *
600 ! signal in the equivalent time mode.       *
610 !********************************************************************************
620 PRINT " First see the true signal in the Equivalent Time mode."  
630 PRINT
640 PRINT " !********************************************************************************
650 PRINT " Connect the HP 54721A Calibrator Output to the Input 
660 PRINT " of the 54721A.     
670 PRINT " !********************************************************************************
680 PRINT
690 PRINT " Press continue when ready to continue.  "
700 PAUSE
710 CLEAR SCREEN
720 OUTPUT @Scope;":channel1;display on"
730 I******** Turn on the calibrator signal on the 21 plug-in.
740 OUTPUT @Scope;":channel1;output on"
750 OUTPUT @Scope;":acquire;mode ETIME"
760 OUTPUT @Scope;":autoscale"  
770 OUTPUT @Scope;":display;persistence infinite"
780 I This completes the first setup.  FTE26
790 OUTPUT @Scope;":menu acquire"
800 PRINT "Waiting 5 seconds for Autoscale to complete and to "
810 PRINT "acquire a waveform."  
820 WAIT 5
830 CLEAR SCREEN
840 PRINT " The displayed waveform on the 54720A is the true   
850 PRINT " representation of the signal."
860 PRINT
Example Programs
Measurement Example Program

870 PRINT " The HP 54720A is in equivalent time mode;"
880 PRINT " Sampling rate is 500 MSa/s,"
890 PRINT " Analog Bandwidth is 1.1 GHz"
900 PRINT
910 PRINT " Press Continue to Continue"
920 : Save the True Waveform to a Pixel memory for later
930 : comparison.
940 PAUSE
950 CLEAR SCREEN
960 OUTPUT @Scope;:"pmemory1:clear"
970 OUTPUT @Scope;:"pmemory1:display on"
980 OUTPUT @Scope;:"pmemory1:display on"
990 BEEP
1000 INPUT "Do you want to leave the saved waveform on? <Y or N>",Y$
1010 IF UPC$(Y$[1,1])="Y" THEN
1020 ELSE
1030 OUTPUT @Scope;:"pmemory1:display off"
1040 END IF
1050 SUBEND
1060 :
1070 SUB Rt_4g(@Scope)
1080 :******************************************************************************
1090 :* This sub program will reacquire the 54721A calibration *:
1100 :* output in the real time mode with 4GSa/s. *:
1110 :******************************************************************************
1120 CLEAR SCREEN
1130 PRINT "Setting up for 4GSa/sec."
1140 OUTPUT @Scope;:"acquire:mode rtime"
1150 OUTPUT @Scope;:"acquire:rate 4E+9"
1160 OUTPUT @Scope;:"acquire:interpolate on"
1170 PRINT
1180 PRINT " When ready to make some measurements press continue."
1190 PAUSE
1200 CLEAR SCREEN
1210 SUBEND
1220 :
1230 SUB Measure(@Scope)
1240 :******************************************************************************
1250 :* This sub program will make a +width and Vpp measurement. *:
1260 :* It will also report the mean and standard deviations. *:
1270 :******************************************************************************
1280 CLEAR SCREEN
1290 REAL R(1:14),A(1:14)
1300 DIM Ex$(1:14)[1],M$(32)
1310 :

HP 54710 and HP 54720
Programmer's Reference
Example Programs
Measurement Example Program

1320 I Normally when making measurements they should be preceded
1330 I by a DIGITIZE. But, because I have the scope setup like I
1340 I want it from previous sub programs and I will be using the
1350 I statistics, I will not use the DIGITIZE command.
1360 I
1370 PRINT " Making measurements on Channel 1. "
1380 PRINT " Measuring for 5 seconds."
1390 OUTPUT @Scope;"measure:source channel1"
1400 OUTPUT @Scope;"measure:statistics on;sendvalid on"
1410 OUTPUT @Scope;"measure:width;vpp"
1420 WAIT 5  ! Give the measurements a chance to build up values
1430 OUTPUT @Scope;"stop" ! Stop; match on screen values with returned.
1440 OUTPUT @Scope;"measure:results?"
1450 ENTER @Scope USING "%,X";A(*)
1460 Exp(A(*),R(*),Ex$(*)) ! Convert to Engineering Notation
1470 CLEAR SCREEN
1480 PRINT " The results of the positive pulse width measurement are;"
1490 PRINT
1500 Result_state(R(2),M$) ! Interpret the Result State value
1510 PRINT "The current value is ";R(1);Ex$1)
1520 PRINT "The state value is ";R(2);"It means, ";M$
1530 PRINT "The minimum value is ";R(3);Ex$3)
1540 PRINT "The maximum value is ";R(4);Ex$4)
1550 PRINT "The average value is ";R(5);Ex$5)
1560 PRINT "The standard deviation is ";R(6);Ex$6)
1570 PRINT "The number of measurements is ";R(7);Ex$7)
1580 PRINT " The results of the peak to peak measurement are;"
1590 PRINT
1600 Result_state(R(9),M$) ! Interpret the Result State Value.
1610 PRINT "The current values is ";R(8);Ex$8)
1620 PRINT "The state value is ";R(9);"It means, ";M$
1630 PRINT "The minimum value is ";R(10);Ex$10)
1640 PRINT "The maximum value is ";R(11);Ex$11)
1650 PRINT "The average value is ";R(12);Ex$12)
1660 PRINT "The standard deviation is ";R(13);Ex$13)
1670 PRINT "The number of measurements is ";R(14);Ex$14)
1680 PRINT
1690 PRINT " Press continue when ready to continue."
1700 PAUSE
1710 CLEAR SCREEN
1720 OUTPUT @Scope;"run"
1730 SUBEND
1740 !
1750 SUB Rt_2q(@Scope)
1760 !******************************************************************************************************************
Example Programs
Measurement Example Program

1770  !* This sub program is just like "Rt_4g" except it samples at *!
1780  !* 2 GSa/s.                                *!
1790  !********************************************************************!
1800  CLEAR SCREEN
1810  PRINT "Setup Scope for 2 GSa/Sec."
1820  OUTPUT @Scope;";acquire;rate 2E+9"
1830  OUTPUT @Scope;";acquire;interpolate on"
1840  PRINT
1850  PRINT "When ready to make the measurements press continue."
1860  PAUSE
1870  CLEAR SCREEN
1880  SUBEND
1890  !
1900  SUB Eng(N(*),A(*),Ex$(*))
1910  !********************************************************************!
1920  !* This sub program converts a # to engineering notation *!
1930  !********************************************************************!
1940  S=SIZE(N,1)
1950  FOR C=1 TO S
1960  SELECT N(C)
1970  CASE >.999
1980  A(C)=N(C)
1990  CASE >9.99E-4
2000  A(C)=N(C)/1.E-3
2010  Ex$="m"
2020  CASE >9.99E-7
2030  A(C)=N(C)/1.E-6
2040  Ex$="u"
2050  CASE >9.99E-10
2060  A(C)=N(C)/1.E-9
2070  Ex$="n"
2080  CASE >9.99E-13
2090  A(C)=N(C)/1.E-12
2100  Ex$="p"
2110  CASE >9.99E-16
2120  A(C)=N(C)/1.E-15
2130  Ex$="f"
2140  CASE ELSE
2150  A(C)=N(C)
2160  END SELECT
2170  NEXT C
2180  SUBEND
2190  !
2200  SUB Result_state(N,MS)
2210  !********************************************************************!

HP 54710 and HP 54720
Programmer's Reference 7-15
Example Programs
Measurement Example Program

2220  * This sub program interprets the Result State Value *
2230  ***********************************************
2240  SELECT N
2250  CASE 0
2260     M$="Result Correct"
2270  CASE 1
2280     M$="Result Questionable"
2290  CASE 2
2300     M$="Result Less than or Equal to"
2310  CASE 3
2320     M$="Result Greater than or Equal to"
2330  CASE 4
2340     M$="Result Invalid"
2350  CASE 5
2360     M$="Edge Not Found"
2370  CASE 6
2380     M$="Max. q level not found"
2390  CASE 7
2400     M$="Min. q level not found"
2410  CASE 8
2420     M$="Requested Time not found"
2430  CASE 9
2440     M$="Voltage not found"
2450  CASE 10
2460     M$="Top and Base are equal"
2470  CASE 11
2480     M$="Measurement zone too small"
2490  CASE 12
2500     M$="Lower Threshold"
2510  CASE 13
2520     M$="Upper Threshold"
2530  CASE 14
2540     M$="Bad Upper/Lower combination"
2550  CASE 15
2560     M$="Top not on waveform"
2570  CASE 16
2580     M$="Base not on waveform"
2590  CASE 17
2600     M$="Completion Criteria not reached"
2610  CASE 18
2620     M$="Invalid Signal for measurement"
2630  CASE 19
2640     M$="Source Signal not displayed"
2650  CASE 20
2660     M$="Clipped High"
Example Programs
Measurement Example Program

2670 CASE 21
2680 M$="Clipped Low"
2690 CASE 22
2700 M$="Clipped High and Low"
2710 CASE 23
2720 M$="All Holes"
2730 CASE 24
2740 M$="No Data on Screen"
2750 CASE 25
2760 M$="Cursor not on screen"
2770 CASE 26
2780 M$="Measurement Aborted"
2790 CASE 27
2800 M$="Measurement timed out"
2810 CASE 28
2820 M$="No measurement to track"
2830 CASE ELSE
2840 END SELECT
2850 SUBEND
Example Programs
Results? Measurement Example

---

Results? Measurement Example

10 ! RE-SAVE "RESU_7XX": Operation of SENDValid & STATisics on RESULTS?
20 !
30 !********************************************************************************
40 !******************* Main Program, Rev. 1.18 ****************************
50 !********************************************************************************
60 !
60 Readme
70 !
70 Initscope($Scope)
80 !
80 True_rep($Scope)
90 !
90 Measure($Scope)
100 PRINT "End of Program -- Results are on your printer."
110 BEEP 15,2
120 !********************************************************************************
130 END
140 !* End of Main Program *
150 !
160 !********************************************************************************
170 !* Begin Sub Programs *
180 !********************************************************************************
190 SUB Readme
200 !********************************************************************************
210 !*This sub program writes user program information to the screen.*!
220 !********************************************************************************
230 CLEAR SCREEN
240 PRINT "This example program will setup and measure the cal."
250 PRINT "signal from the 54721A in the ET mode."
260 PRINT
270 PRINT "It measures the Positive Pulse Width with Statistics."
280 PRINT "Then uses the *RESULTS?* to report over the HPIB."
290 PRINT
300 PRINT "The report from the RESULTS? varies depending on the status"
310 PRINT "of STATISTICS ON|OFF and SENDValid ON|OFF."
320 PRINT
330 PRINT "This program will print the results for each of the cases."
340 PRINT
350 PRINT "The program assumes that the system is configured such that:
360 PRINT
370 PRINT " HP-IB interface is at address 7."
380 PRINT " Scope is at address 7."
390 PRINT " A 54721A is installed into slots 1 & 2."
400 PRINT " Printer at 701"
410 PRINT
Example Programs
Results? Measurement Example

PRINT "If these addresses are incorrect, break program and set addresses."
PRINT "as needed in the ASSIGN statements."
PRINT
PRINT "PRESS continue to run program"
PAUSE
CLEAR SCREEN
SUBEND

500 SUB Initscope(@Scope)
510 "***********************************************************************"
520 ! This sub program initializes the I/O and scope. !
530 "***********************************************************************"
540 ASSIGN @Scope TO 707
550 CLEAR @Scope !clear EP-IB interface
560 OUTPUT @Scope;"cls"
570 OUTPUT @Scope;"RST" !reset scope to default config
580 OUTPUT @Scope;"SYSTEM:HEADER OFF";turn off header
590 CLEAR SCREEN
600 SUBEND
610 !
620 SUB True_rep(@Scope)
630 "***********************************************************************"
640 ! This sets up the scope to look at the calibration signal of *!
650 ! the 54721A in the ET (equivalent time mode). !
660 "***********************************************************************"
670 PRINT " Connect the HP 54721A Calibrator Output to the Input "
680 PRINT " of the 54721A."
690 PRINT
700 PRINT " Press continue when ready to continue. "
710 PAUSE
720 CLEAR SCREEN
730 OUTPUT @Scope;":channel1:display on"
740 "******** Turn on the calibrator signal on the 21 plug-in.
750 OUTPUT @Scope;":channel1:output on"
760 OUTPUT @Scope;":acquire:mode etime"
770 OUTPUT @Scope;":autoscale"
780 OUTPUT @Scope;":display:persistence infinite"
790 WAIT 5
800 PRINT " The displayed waveform on the 54720A is the true "
810 PRINT " representation of the 54721A cal. signal."
820 PRINT
830 PRINT " The HP 54720A is in equivalent time mode:"
840 PRINT " Sampling rate is 500 MSa/s,"
850 PRINT " Analog Bandwidth is 1.1 GHz"
Example Programs
Results? Measurement Example

870 SUBEND
880 1
890 SUB Measure(@Scope)
900 ******************************
910 /* This sub program will make a *length measurement. */
920 /* It will also report the mean and standard deviations. */
930 ******************************
940 CLEAR SCREEN
950 PRINT " Measuring Waveform and Reporting Results. 
960 REAL R(1:12)
970 ******************************
980 /* Normally when making measurements, they should be preceded by a DIGITIZE. But, because I have the scope setup like I want it from previous sub programs and I will be using the statistics, I will not use the DIGITIZE command. */
990 ******************************
1030 OUTPUT @Scope;"measure:source channel1"
1040 PRINTER IS 701
1050 FOR C=1 TO 4
1060 OUTPUT @Scope;"run"
1070 MAT R= (0)
1080 OUTPUT @Scope;"measure:statistics ";INT(C/3)
1090 OUTPUT @Scope;"measure:sendvalid ";C MOD 2
1100 OUTPUT @Scope;"measure:statistics?"
1110 ENTER @Scope;St$
1120 OUTPUT @Scope;"measure:sendvalid?"
1130 ENTER @Scope;Tv$
1140 OUTPUT @Scope;"measure:width"
1150 OUTPUT CRT;"Measuring for 20 seconds to get good stats."
1160 WAIT 20 /* Give the measurements a chance to build up values */
1170 OUTPUT @Scope;"stop"!* See that values match ON SCREEN & OVER HPIB !*
1180 OUTPUT @Scope;"measure:results?"
1190 ENTER @Scope USING "%K";R(*)
1200 OUTPUT CRT;"Printing Results to your printer"
1210 PRINT
1220 PRINT "Statistics is ";St$,"SendValid is ";Tv$
1230 PRINT
1240 PRINT "First value is ";R(1)
1250 PRINT "Second value is ";R(2)
1260 PRINT "Third value is ";R(3)
1270 PRINT "Fourth value is ";R(4)
1280 PRINT "Fifth value is ";R(5)
1290 PRINT "Sixth value is ";R(6)
1300 PRINT "Seventh value is ";R(7)
1310 WAIT 5
Example Programs
Results? Measurement Example

1320 CLEAR SCREEN
1330 NEXT C
1340 PRINTER IS CRT
1350 SUBEND
Example Programs
Learn String Example Program

Learn String Example Program

10 REM SAVE "LSTG7XX2" HP Basic for HP-IB interface, rev 2.0
20 ******************************************************************************
30 /* This program reads and returns the learn string from and to a */
40 /* 547XX Oscilloscope. */
50 /* ***************************************************************************/
60 /* ***************************************************************************/
70 /* Begin MAIN PROGRAM */
80 /* ***************************************************************************/
90 COM /Io/ #:Scope,Bpib
100 readme "Description of the program"
110 initscope "initialize interface and scope"
120 length=fnstsize "find setup string size."
130 get_learnstr(length) "save 3 configurations on disk"
140 recall_learnstr(length) "select & recall 1 of 3 setups"
150 print
160 beep 15,1
170 print "program done"
180 ******************************************************************************
190 /* End of Main Programs */
200 ******************************************************************************
210 end
220 ******************************************************************************
230 /* Begin Sub Programs */
240 ******************************************************************************
250 sub initscope
260 ******************************************************************************
270 /* This sub program initializes the INTERFACE AND SCOPE */
280 ******************************************************************************
290 com /io/ #:scope,bpib
300 bpib=7
310 scope=7
320 assign #:scope to bpib*100+scope "scope address"
330 clear bpib "clear FPB interface"
340 output #:scope;"*RST" "set scope to default config"
350 output #:scope;":AUTOSCALE" "AUTOSCALE"
360 output #:scope;":SYST:HEAD OFF" "wait for scope to finish auto"
370 output #:scope;"*OFC?" "wait for scope to finish auto"
380 enter #:scope;opc
390 subend
400 ""
410 sub readme

7-22
HP 54710 and HP 54720
Programmer's Reference
Example Programs
Learn String Example Program

420 !**********************************************************************
430 ! This sub program displays a message about the program for the *
440 ! user.
450 !**********************************************************************
460 CLEAR SCREEN
470 PRINT "This sample program will prompt the user to set up the"
480 PRINT "scope in three different configurations and will store"
490 PRINT "them to the computer disk. Any of the three configurations"
500 PRINT "may then be recalled from the disk and sent to the scope"
510 PRINT
520 PRINT "The program assumes that the system is configured such that:";
530 PRINT "HP-IB interface is at address 7"
540 PRINT "scope is at address 7"
550 PRINT "a signal is attached to channel 1"
560 PRINT
570 PRINT "If these addresses are incorrect, break program and set addresses"
580 PRINT "as needed in the Initialize in the ASSIGN statements."
590 PRINT
600 PRINT "Press CONTINUE when ready to start. Scope will first autoscale"
610 PRINT "on signal on channel 1 and will then prompt for user to setup"
620 PRINT "scope as desired before saving configurations in computer."
630 PRINT
640 PAUSE
650 CLEAR SCREEN
660 SUBEND
670 i
680 SUB Get_learnstr(Length)
690 !**********************************************************************
700 ! This sub program will get the learn string from the 547XX *
710 ! and place it in SETS$. Then it will create a BDAT file *
720 ! called "JSETUPS" which holds 3 records. If this file is *
730 ! already created it will be PURGED! *
740 !**********************************************************************
750 COM /I/O/ $Scope,Hpib
760 ON ERROR CALL Ertrap
770 CREATE BDAT "JSETUPS",3,Length !create 3 files for 3 different
780 !setups.
790 ALLOCATE Set$(Length) !temp variable to hold string.
800 ASSIGN &Path TO "JSETUPS" !open file
810 FOR I=1 TO 3
820 CLEAR SCREEN
830 LOCAL $Scope
840 PRINT "PLEASE HAVE SETUP "$;I;" READY AND PRESS RETURN"
850 INPUT A$
860 OUTPUT $Scope;"$SYSTEM:SETUP?" !query learnstring from scope
Example Programs
Learn String Example Program

870 ENTER @Scope USING "-K"; Set$ ; read learn string from scope
880 IF Set$[1;1]="F" THEN
890 OUTPUT @Path,I; Set$ ; store setup string to disk
900 ELSE
910 CLEAR SCREEN
920 PRINT "Received bad data. No setup saved."
930 END IF
940 NEXT I
950 ASSIGN @Path TO * ; close file
960 DEALLOCATE Set$
970 SUBEND
980 ;
990 SUB Ertrap
1000 ;*******************************************************************************************
1010 ;* The program will branch to this Error Trap if the *
1020 ;* ON ERROR is ON and an error occurs. It reset the *
1030 ;* ON ERROR to OFF the return to where it was called. *
1040 ;*******************************************************************************************
1050 IF ERRN=54 THEN ; Error 54 is Duplicate File Name
1060 PURGE "JSETUPS"
1070 OFF ERROR
1080 ELSE
1090 CLEAR SCREEN
1100 PRINT ERRM$
1110 BEEP
1120 PAUSE
1130 END IF
1140 SUBEND
1150 ;
1160 SUB Recall_learnstr(Length)
1170 ;
1180 ; This sub program lets the user select which of the 3 setups
1190 ; that have been stored on the disk in "JSETUPS1, 2, or 3 to
1200 ; use to setup the scope. It will loop until the user selects
1210 ; (E) to exit.
1220 ;
1230 COM /Io/ @Scope,Hpib
1240 ASSIGN @Path TO "JSETUPS" ; open file
1250 ALLOCATE Set$[Length] ; create temp variable.
1260 Done=0
1270 REPEAT
1280 CLEAR SCREEN
1290 PRINT "Please enter (1) to recall setup 1"
1300 PRINT " (2) to recall setup 2"
1310 PRINT " (3) to recall setup 3"

7-24
HP 54710 and HP 54720
Programmer's Reference
Example Programs
Learn String Example Program

1320 PRINT "(E) to exit"
1330 INPUT A$
1340 SELECT UPC$(A$)
1350 CASE "1","2","3"
1360 ENTER $(Path,VAL(A$));Set$
1370 IF Set[1;1]=";" THEN
1380 !read data from disk.
1390 !Have good data.
1400 !Add command header to setup string and send entire string to scope.
1410 !
1420 OUTPUT $Scope USING "$,X";";SYSTEM:SETUP ";Set$
1430 ELSE
1440 CLEAR SCREEN
1450 PRINT "Received bad data, no string entered."
1460 END IF
1470 CASE "E"
1480 Done=1
1490 END SELECT
1500 UNTIL Done
1510 DEALLOCATE Set$
1520 ASSIGN $(Path TO * SUBEND
1530 !
1540 DEF FNStsize
1550 !The setup string size can vary dependant upon operating system
1560 !revision. Must read the header to determine the proper lengths.
1570 !The format of the data is $NX...X<setup data string>. Then I
1580 !add 5 for the bdat file management headers.
1590 !
1600 !COM /Io/ $Scope,Hplb
1610 DIM Psign$(1]
1620 INTEGER Length,Cnt,L
1630 ON TIMEOUT Hplb,3 CALL Tout
1640 !Set the bus timeout so if there is no/bad data, can't find
1650 !the $ sign, we will stop and let the operator know.
1660 OUTPUT $Scope:";";SYSTEM:SETUP?"
1670 !Query scope for the setup string.
1680 Cnt=0
1690 REPEAT
1700 ENTER $Scope USING "$,A";Psign$
1710 !Enter a character at a time until find the $ sign. It
1720 !indicates the beginning of the block header.
1730 !FM must keep track of the number of characters before the $
1740 !sign for cases where the system headers are ON.
1750 Cnt=Cnt+1
1760
Example Programs
Learn String Example Program

1770   UNTIL Psign$="#"
1780   ENTER @Scope USING "#,#A";Psign$
1790       "Next character tells the number of digits in the header."
1800   ENTER @Scope USING "#,#Psign$#D";Length
1810       "Length is the number of data values to follow before the NL."
1820   ALLOCATE Temp$[Length+1]
1830   ENTER @Scope USING "#,#K";Temp$
1840   L=7+Cnt+VAL(Psign$)+Length
1850   DEALLOCATE Temp$
1860   RETURN L
1870   FEND
1880   :
1890   SUB Tout
1900       "Branching here says that the HP18 bus was idle for 3 seconds."
1910       "This would be cause by reaching the end of the setup data without"
1920         "finding a $ sign."
1930   CLEAR SCREEN
1940   PRINT "Bad Data, query aborted."
1950   BEEP
1960   PAUSE
1970   SUBEND
Example Programs

Service Request Example Program

10 1 RE-SAVE "SRQ_7XX"
20 1 This program sets the Event Status Enable Register and the
30 1 Service Request Enable Register so that an error will cause
40 1 a service request. It also saves a setup to a setup memory
50 1 and recalls that setup.
60 DIM Query$[15],Command$[15],Q$[9000]
70 COM /Err/ Hpib,Scope
80 COM /S/ #S
90 Hpib=7
100 CLEAR Hpib
110 Scope=7
120 Saddr=Hpib*100+Scope  !Sets the I/O address.
130 Readme
140 ASSIGN #5 TO Saddr
150 ON INTR Hpib,15 CALL Ermsg  !Tells computer where to go on an error
160 CLEAR Saddr
170 OUTPUT #5;"*ESE 60;*SRE 32;*CLS"
180 1 *ESE XX sets the Event Status Enable Register.
190 1 32 => CME or Command Error
200 1 16 => EXE or Execution Error
210 1 8 => DDE or Device Dependent Error
220 1 4 => QYE or Query Error
230 1 --------------------------------------
240 1 60
250 1 *SRE XX sets the Service Request Enable Register.
260 1 32 => ESB or Event Status Bit
270 ENABLE INTR Hpib;2  !Allows the HPIB to interrupt the computer.
280 Saveset$="*SAV "  !This command is missing the parameter, 1.
290 Recallset$="*RCL 1"  !This recalls setup #1.
300 1
310 OUTPUT #5;Saveset$  !Send the command, causes CME until the 1 is added.
320 WAIT 1
330 LOCAL Saddr
340 Readme1
350 OUTPUT #5;Recallset$  !Recalls setup #1.
360 LOCAL Saddr
370 Readme2
380 END
390 1
400 SUB Ermsg  !Error Trap
410 COM /S/ #S

HP 54710 and HP 54720
Programmer's Reference
Example Programs
Service Request Example Program

420 COM /Err/ HpiB,Scope
430 DIM R$(50)
440 PRINT "An error occurred."
450 Sp=SPOOL(707)
460 IF BIT(Sp,6) THEN
470 ! Testing bit 6 will tell us if the scope is the source of the interrupt.
480 OUTPUT $S;"ESR":Reads then clears the Standard Event Status Register
490 ENTER $S;J
500 Srq_type(J)   !Call to the SRQ interpreter subprogram.
510 Done=0
520 REPEAT
530 ! Read the Error Queue to determine the specific error. Repeat reading
540 ! until the Queue is empty. Each time the queue is read the error will
550 ! be reported or the message 'THERE ARE NO MORE ERRORS' will be returned.
560 OUTPUT $S;"SYSTEM ERROR STRING"
570 ENTER $S;E$
580 IF E$(1;1)="0" THEN
590 PRINT "THERE ARE NO MORE ERRORS."
600 OUTPUT $S;"CLS"  !Clears all event registers and queues except
610 ! the output queue.
620 ENABLE INTR HpiB;2
630 Done=1
640 Readme3
650 ELSE
660 PRINT E$
670 END IF
680 UNTIL Done
690 ELSE
700 CLEAR SCREEN
710 PRINT "An interrupt on the HPIB has occurred but it is not the "
720 PRINT "scope. Please clear the other source of interrupt before"
730 PRINT "restarting this program."
740 PAUSE
750 END IF
760 SUBEND
770 !
780 SUB Readme
790 PRINT "This program sets the Event Status Enable Register and the"
800 PRINT "Service Request Enable Register so that an error will cause"
810 PRINT "a service request."
820 PRINT
830 PRINT "The second function of this program is to save and then recall"
840 PRINT "the current scope setup to and from setup memory 1. However,"
850 PRINT "there is a bug in this program. The save command is missing a"
860 PRINT "parameter. It needs a 1 after the space or "SAV 1"."
Example Programs
Service Request Example Program

870 PRINT
880 PRINT " After you have seen how the SRQ's work you may edit line 280."
890 PRINT " to save the setup."
900 PRINT
910 PRINT " Once you have fixed the bug the program will run and save the"
920 PRINT " current setup to setup memory 1 then pause and allow you to "
930 PRINT " change the setup. When you continue, the original setup will"
940 PRINT " be restored."
950 PRINT
960 PRINT " The expected configuration is;"
970 PRINT " The scope is at address 7"
980 PRINT " The SPI is at address 7"
990 PRINT
1000 PRINT " If the configuration is different break program and set "
1010 PRINT " the addresses as required using the variables Spib and "
1020 PRINT " Scope. Then run again."
1030 PRINT
1040 PRINT " Press Continue when ready to resume operation."
1050 PRINT
1060 PAUSE
1070 CLEAR SCREEN
1080 SUBEND
1090"
1100 SUB Readmel
1110 PRINT
1120 PRINT " The current setup has been saved in setup memory #1."
1130 PRINT
1140 PRINT " Change the scopes setup from the front panel. When you"
1150 PRINT " press continue the original setup will be restored."
1160 PRINT
1170 BEEP
1180 PAUSE
1190 CLEAR SCREEN
1200 SUBEND
1210"
1220 SUB Readme2
1230 PRINT " The program has ended. Thanks for trying our Save "
1240 PRINT " and Recall setup memories."
1250 PRINT
1260 PRINT " Now would you have the opportunity to edit the program"
1270 PRINT " to generate and error and see how the interrupt masking"
1280 PRINT " works."
1290 PRINT 1300 PRINT " GOODBYE. "
1310 SUBEND
Example Programs
Service Request Example Program

1320 i
1330 SUB Readme
1340 PRINT
1350 PRINT " Break the program at this time and determine the cause of "
1360 PRINT " the error."
1370 PRINT
1380 PRINT " Once you have fixed the cause of the error described by"
1390 PRINT " the error code and message, rerun the program by pressing"
1400 PRINT " RUN."
1410 PAUSE
1420 CLEAR SCREEN
1430 SUBEND
1440 i
1450 SUB Src_type(J)
1460 i The scope has interrupted the computer and we have read the
1470 i Standard Event Status Register. Now the value, J, that was
1480 i read by the *ESR? will be evaluated to determine why the
1490 i SRQ was generated.
1500 PRINT "ESR value is ";J
1510 SELECT J
1520 CASE 32
1530 PRINT "32 => CME or Command Error."
1540 CASE 16
1550 PRINT "16 => EKE or Execution Error."
1560 CASE 8
1570 PRINT "8 => DDE or Device Dependent Error."
1580 CASE 4
1590 PRINT "4 => QME or Query Error."
1600 END SELECT
1610 SUBEND
Configuration Example Program

10 !RE-SAVE "CONFIG" !This is an RMB and IBasic Program.
20 !It queries the scope to determine the configuration and then
30 !prints it to the crt. It assumes that the scope is at HPIB
40 !
50 DIM Mframe$(13),Slot$(1:4)[13]
60 OUTPUT 707;";SYSTEM:HEADER ON"
70 OUTPUT 707;";SYSTEM:LONGFORM ON"
80 !
90 !***** DETERMINE THE FRAME MODEL NUMBER *****!
100 !
110 OUTPUT 707;";MODEL? FRAME"
120 ENTER 707;Mframe$
130 !
140 !***** DETERMINE THE PLUG-INS AND THEIR LOCATIONS *******!
150 !
160 FOR I=1 TO 4
170 OUTPUT 707 USING "K";";MODEL? PLUGIN";I
180 ENTER 707;Slot$(I)
190 NEXT I
200 !
210 !***** REPORT THE MAINFRAME MODEL # AND PLUG-INS *******!
220 !
230 CLEAR SCREEN
240 PRINT "The Main frame is ";Mframe$
250 PRINT
260 PRINT "The plug-in in slot 1 is ";Slot$(1)
270 PRINT "The plug-in in slot 2 is ";Slot$(2)
280 PRINT "The plug-in in slot 3 is ";Slot$(3)
290 PRINT "The plug-in in slot 4 is ";Slot$(4)
300 PRINT
310 PRINT
320 PRINT "End of Program"
330 END
Limit Test Example Program

10 | MLIM.ILW
20 |
30 | Copyright: (c) 1993, Hewlett-Packard Co. All rights reserved.
40 | Contributor: Colorado Springs Division
50 | Product: Throughput Application
60 |
70 | $Revision$ 3.0
80 | $Date$ 6-14-93
90 | $Author$ Ed Hiezewski
100 |
110 | Structure Chart: None
120 | Description: This uses Measure Limit Testing to make 3 measurements
130 | on 10 successive pulses at a 10 Hz rate.
140 |
180 | Considerations: None
200 | Main routine: Begin_main
210 | Sub-routines: None
220 | Functions: None
230 | Sub-programs: Readme, Set_paths, Set_scope, Meas, Tcount
240 |
250 Variable_list:
280 Begin_main:
290 | CALL Readme
300 | CALL Set_paths($Scope,Isc)
310 | CALL Set_scope($Scope)
320 | CALL Meas($Scope,Isc)
330 End_of_main:
340 |
350 |
360 Begin_sub:
370 |
380 | SUB Readme
390 |
400 | Description: Readme writes instructions and information at the
410 | beginning of the program for the user to ensure
420 | proper setup prior to continuing the program.
430 |
440 | Parameters: None
450 |
460 | CLEAR SCREEN
461 | PRINT TABXY(5,5)
Example Programs
Limit Test Example Program

470 PRINT "MLIM.ibw uses a HP8131 in the burst mode to manually start a "
471 PRINT "burst of 10, 2ns pulses with a 99.9 ms period, 1 V amp."
472 PRINT
473 PRINT "It will work with any similar signal, including the "
474 PRINT "front panel cal."
475 PRINT
480 PRINT "It makes a Vpp, Risetime, and Positive pulse width measurement"
490 PRINT "on each and reports the mean after all 10 measurement sets are"
491 PRINT "complete."
500 PRINT
510 PRINT "There are NO specific plug-ins required, except a suitable 1"
520 PRINT "must be in channel 1. (Program was developed using a '13A"
521 PRINT "installed in slot 1 of a 54710A."
530 PRINT
540 PRINT "The HPIB card is assumed to be at interface select code 7 and"
550 PRINT "the scope is at address 7."
560 PRINT
570 PRINT "Ensure all of this is correct before continuing."
580 PRINT
590 PAUSE
600 CLEAR SCREEN
610 SUBEND
620 |
960 SUB Set_scope($s)
970 |
980 ! Description: Set_scope has 2 parts:
990 ! 1 -- initialize the scope and i/o.
1010 ! 2 -- set for RT acqires and measurement of the pulses.
1020 |
1030 ! Parameters:
1040 ! Passed: ($s) $Scope = specific scope's address,
1050 ! Internal:
1060 |
1070 ! Modified Variables: None
1080 |
1090 Part_1: ! Initialize for RT to measure pulses.
1100 OUTPUT $s;"*rst;*cls"
1101 OUTPUT $s;"opee 256" : Unmasks the Lim.Tst. Comp. bit.
1104 OUTPUT $s;"*are 128" : Unmasks the oper bit, see Ltest.
1105 OUTPUT $s;":"disp:grat fram"
1110 OUTPUT $s;"blan chan2;view chan1" : 54710 only has 2 chan's avail.
1120 OUTPUT $s;"acq:mode rtim;rat 2E9;poin 512"
1130 OUTPUT $s;"chani:bwl off;disp on;inp dc50;offs 0;prob 1;rat;scal .5"
1140 OUTPUT $s;"tim:pos 10K-9;scal 2.5K-9"
Example Programs
Limit Test Example Program

1150  OUTPUT $:"trig:swe trig; sour trig1; lev trig1, .5"
1190  Part 2:                        ! Set Measurements
1200  OUTPUT $:"meas: send off; stat on; sour chani"
1201  |
1202  : Turn off sendvalid, on statistics, and sets source to channel 1
1203  |
1210  OUTPUT $:"meas: vpp; ris; gwid"
1220  SUBEND
1230  |
1240  SUB Set_paths($Scope, Isc)
1250  |
1260  Description: Set paths simply assigns HPIB select code to be 7 and
1261  the scope address to be 7.
1270  |
1280  Parameters:
1310  Passed: $Scope = I/O path 707
1320  scope = the HPIB address that the scope is selected to.
1330  Internal: Isc = the interface select code for the HPIB card.
1350  Modified Variables: $Scope
1360  |
1400  CLEAR SCREEN
1420  Isc=7
1430  Scope=7
1580  ASSIGN $Scope TO Isc*100+Scope
1610  SUBEND
1620  |
1630  SUB Meas($S, Isc)
1640  |
1641  Description: The scope is setup and waiting to make continuous meas.'s.
1642  |
1643  1 -- Setup On interrupt so Lim. Test. Comp. gives SRQ.
1644  2 -- Setup Limit test.
1645  3 -- Set RUN Limit Tests.
1646  4 -- Report results.
1647  |
1648  Parameters:
1649  Passed: ($S) $Scope = specific scope's address,
1650  COM_For_cnt/ INTEGER num_acq, M
1651  |
1652  Internal: Results(*) = array of values returned from a RESULTS?
1653  Value 4 of each set is the mean. Therefore,
1654  Results(4), (13), and (22) are the ones of
1655  interest.
1656  |
1657  M = measurement sets requested.
1658  Num_acq = the termination variable.
1661  |

7-34     HP 54710 and HP 54720
Programmer's Reference
Example Programs
Limit Test Example Program

1662 1 Modified Variables: Num_acq
1663 1
1664 1 Calls sub programs: Tcount
1665 1
1871 1 COM /For_cnt/ INTEGER Num_acq,M,S 1 need to pass num_acq on intr.
1872 1 REAL Results(1:27) 1 9 parameters per measurement.
1900 1 M=10
1901 1 Num_acq=0
1910 1 CLEAR SCREEN
1920 1 Part1: 1 Setup interrupt
1930 1 ON INTR Isc;9 CALL Tcount
2000 1 Part2: 1
2001 1 OUTPUT $S;";ltes;scour 1;fail nev;mnf pass;run wav,";M
2002 1 OUTPUT $S;";ltes;scour 2;fail nev;mnf pass;run wav,";M
2003 1 OUTPUT $S;";ltes;scour 3;fail nev;mnf pass;run wav,";M
2010 1 OUTPUT $S;";stop;cdis"
2020 1 OUTPUT $S;";ltes;test on"
2060 1 Part3: 1
2068 1 ENABLE INTR Isc;2
2069 1 OUTPUT $S;";run" 1 scope will wait for triggers.
2070 1 PRINT "If using the 8131A, Start Generator NOW."
2071 1 REPEAT 1 wait for limit test complet.
2076 1 UNTIL Num_acq=M
2077 1 Part4: 1
2080 1 OUTPUT $S;";meas;res?" 1 read summary of measurements.
2081 1 ENTER $S;Results(*)
2082 1 CLEAR SCREEN
2083 1 PRINT " _ The results are;"
2085 1 PRINT "the vpp mean is ";Results(4);",";
2086 1 PRINT "the rise time mean is ";Results(13);",";and"
2087 1 PRINT "the +width mean is ";Results(22);"."
2088 1 PRINT
2089 1 PRINT Results(*),
2091 1 SUBEND
2100 1
2110 1 SUB Tcount
2111 1
2112 1 Description: Tcount will set Num_acq to the stop value when the Lim.
2113 1 Test Complete interrupt occurs.
2118 1 Parameters:
2119 1 Passed:
2120 1 COM /For_cnt/ INTEGER Num_acq,M
2121 1 Num_acq = the variable used to terminate at proper number.
2122 1 M = the number of acquisitions wanted, termination value.
2124 1 Internal: None
Example Programs
Limit Test Example Program

2129  |
2130  Modified Variables: num_acq
2131  |
2132  Calls sub programs: None
2133  |
2134  COM /For_cnt/ INTEGER Num_acq,M,S
2135  PRINT "hello"
2136  Num_acq=M
2138  SUBEND
Index

A
abbreviated spelling of instructions, 5-4
aborted a digitize command, 1-16
aborted a digitize operation, 2-8
absolute maximum voltage, and VMAX, 19-87
absolute minimum voltage, and VMIN, 19-90
accuracy and calibration, 12-6
accuracy and probe calibration, 12-8
Acquire Commands, 11-2
BWLimit, 11-5
COMPete, 11-6
COUNT, 11-9
INTERpolate, 11-10
MODE, 11-11
POINTS, 11-12
SHAT, 11-14
TYPE, 11-16
ACQuire:TYPE and display mode, 15-2
acquired data flow, 6-3
acquisition
ACQuire:TYPE and completion, 11-6
points, 11-12
record length, 11-12
sample rate, 11-14
type, 11-16
acquisition record length, 11-12
acquisition reset conditions, 8-15
active probes and calibration, 12-8
ADD, 16-8, 20-3
ADDRESS, 17-5
ADDRESS, and SCCreen, 28-50
ADDRESS, and SUMMARY, 28-86
address, oscilloscope default, 2-9
Addressing, 2-5
advisory line, reading and writing to, 10-2
AER?, 9-10
algebraic sum of functions, 16-8
ALL, and VIEW, 24-38
alphabet characters in an embedded string, 1-12
alphabet numeric characters, 1-11
AMASK:Create, 28-14
AMASK:SOURce, 28-15 to 28-16
AMASK: UNITS, 28-17 to 28-18
AMASK:XDELia, 28-19 to 28-20
AMASK:XDELia, 28-21 to 28-22
AMPS as vertical units, 13-23
AREA, 17-6
AREA (Arm Event Register), 4-15
ARM bit, 8-24
Arm Event Register (ARM), 4-15
arming the trigger, 2-8
ASCII character, 32-1-6
ASCII linefeed, 1-12, 5-13
ASCII, and FORMAT, 24-17
ASSign, 15-7
attenuation factor for probe, 13-13
attenuation factors and probes, 12-8
attenuation factors, PROBe, 23-4
AUToscale, 9-11 to 9-12
Autoscale, during initialization, 1-13
availability and reliability of measured data, 4-2
AVERAGE acquisition type, 11-16
AVERAGE and acquisition completion, 11-6
AVERAGE and count, 11-9
AXIS, in HISTogram command, 29-6
B
BACKGROUND, 17-7
BACKGROUND, and SSSCREen, 28-50
BANDpass?, 24-8
bandwidth limit filter, 11-5
bandwidth limit, data flow, 6-4
bandwidth limits, BANDpass?, 24-8
basic command structure, 1-14
basic operations, 1-3
Best Accuracy Calibration Level, 12-6 to 12-7
BEST, in CALibrate command
CANcel, 12-12
CONTinue, 12-12
data, 12-12
START, 12-13
STATUS, 12-13
Bit Definitions in Status Reporting, 4-4
BLANK, 9-13
BLANK and VIEW, 9-40
blanking the user text area, 15-30
block data, 1-5, 1-19
block data in a learnstring, 1-5
block data, and DATA, 24-14
block Data, in Program Data, 5-9
block Diagram
Status Reporting Overview, 4-3
buffer, output, 1-9
buffered responses, 6-11
bus activity, halting, 2-8
bus Commands, 2-8
bus management issues, 2-2
bus mode, local, 2-7
BWDeskjet (HARDeopy:DEVi ce), 17-9
BWLimit, 13-5 to 13-6, 23-3
BWLimit command, 11-5
BWPaintjet (HARDeopy:DEVi ce), 17-9
BYTE, and FORMAT, 24-17
BYTEorder, 24-9 to 24-10
BYTEorder, and DATA, 24-16
C
calculating functions, and data flow, 6-4
CALe:Y1, 28-42
Calibration Commands, 12-2, 12-9
OUTPUT, 12-18
SKEW, 12-21
calibration factors, 12-4
calibration factors, and raw data, 5-4
calibration level of accuracy, 12-5
calibration protection switch, 12-3
calibration status, 12-22
CDISplay (Clear DISplay), 9-14
center screen voltage, 13-10
CENTronics (HARDeopy:DESTnation), 17-8
Channel Commands, 13-2
BWLimit, 13-5
DISPlay, 13-7
INPut, 13-8
OFFSet, 13-10
OUTPut, 13-12
PROBe, 13-13, 13-15 to 13-16
PROTection, 13-17
PROTection?, 13-18
RANGE, 13-19
SCALE, 13-21
SENSitivity, 13-22
UNITs, 13-33 to 13-35
channel reset conditions, 8-19
channel-to-channel skew factor, 12-21
Channels, and VIEW, 24-28
Character data, 1-11
character program data, 1-10 to 1-11
character Program Data, in Program Data, 5-8
CLEAR, 20-3

Index-1
Index

clearing buffers, 2-8  
error queue, 30-3  
overload protection, 13-17  
pending commands, 2-8  
Request-for-OPC flag, 8-5  
Standard Event Status Enable Register, 4-11  
Standard Event Status Register, 8-8  
datastructures, 8-5  
the error queue, 4-16  
TRG bit, 4-10, 4-15  
Clearing Registers and Queues, 4-17 to 4-18  
clipped signals, and measurement error, 19-5  
CLOCk, and STATE, 22-39  
*CLS (Clear Status), 8-5, 9-37  
CME bit, 8-7, 8-9  
colon, in syntax, 5-10  
Colons, 5-5  
COLumn, 15-11  
Combining Commands in the Same Subsystem, 1-7  
combining compound and simple commands, 1-5, 10  
combining long- and short-form headers, 1-10  
Command  
*ESE, 8-6  
ADDRess, 17-5  
AMASK: Create, 28-14  
AMASK: Source, 29-15  
AMASK: UNITS, 23-17  
AMASK: XDELta, 28-19  
AMASK: YDELta, 28-21  
AREA, 17-6  
ASSign, 15-7  
AUToscale, 9-11  
BACKGROUND, 17-7  
BWLIMIT, 11-5, 13-5, 23-3  
BYTEorder, 24-9  
CLEAR, 20-3  
Clear Status, 8-5  
*CLS, 8-5  
COLumn, 16-8, 15-11  
COMPLETE, 11-6  
COUNT, 11-9  
DATA, 15-12, 24-14  
DCORer, 15-14  
DEFINE, 19-14  
DELAY, 21-4  
DELETE, 14-4  
DELTIME, 19-18  
DESTINATION, 17-8  
DEVice, 22-8  
DEVICE, 17-9  
DIFF, 16-9  
DIGITIZE, 1-15  
DISPLAY, 13-7, 16-10, 20-3, 25-4, 26-4  
DIVide, 16-11  
DTIME, 22-15  
DUTycycle, 19-20  
DWAForm, 15-15  
EDGE, 22-21  
ERASE, 20-3  
Event Status Enable, 8-6 to 6-7  
FACTors, 17-10  
FAIL, 27-9, 29-17  
FAILtime, 19-22  
FFixed, 17-11  
FFT Magnitude, 16-16  
FILENAME, 17-12  
FORMat, 14-5, 15-16, 24-17  
FREQency, 19-29, 26-5  
GLITCH, 22-24, 22-43, 22-50  
GRAphics, 16-17  
HOLDoff, 22-28  
HORIZONTAL, 16-17  
HYS Teral, 22-29  
INPUT, 13-8  
INTEGRATE, 16-20  
INTERPOLate, 11-10  
INVERSE, 15-18  
INVERT, 16-21  
LENGth, 17-13  
LEVEL, 22-30  
LINE, 15-19  
LIMIT, 27-11, 29-13 to 29-19  
LOAD, 14-5  
MAINTENANCE, 16-22, 26-5  
MASK, 15-20  
MARK: Define, 28-28  
MAXIMUM, 16-23  
MEASurement: READout, 18-7  
MEDIA, 17-14  
MEMORY, 20-4  
MINIMUM, 16-24  
MNFOUND, 27-12, 29-20  
MODE, 11-11, 18-8, 22-31  
MSFILT, 35-7  
MULTIPLY, 16-25  
NWDRaw, 19-51  
OFFSET, 13-10, 13-13, 13-15, 16-24, 26-8  
ONLY, 16-27  
*OPC (Operation Complete), 8-12  
Operation Complete (*OPC), 8-12  
Option (*OPT), 8-13  
OUTPUT, 12-15, 13-12  
OVERshoot, 19-53  
PATern, 22-33  
PERiod, 19-56  
PER Sistance, 15-22  
POI Nts, 11-12  
POLYGON: DEFINE, 28-30  
POSITION, 21-6  
PREMamble, 24-20  
PRESHoot, 19-57  
PROBE, 23-4  
PROTECTection, 13-17  
PWIDTH, 19-59  
RANGE, 19-18, 16-28, 21-7, 26-9  
*RCL (Recall), 8-14  
Recall (*RCL), 8-14  
REFERENCE, 21-6  
RESET (*RST), 8-15  
RESOLUTION, 26-10  
RISetime, 19-65  
ROW, 15-23  
*RST (Reset), 8-15  
RUN MODE, 28-32  
RUN, 27-14, 29-21  
SAVE (*SAVE), 8-20  
SAVE, 25-4  
SCALE, 13-21, 21-9  
SCALE: DEFAULT, 28-35  
SCALE: SOURCE, 28-36  
SCALE: X, 28-38  
SCALE: XDELTA, 28-40  
SCALE: Y, 28-42  
SCALE: YZ, 28-43  
SCOLOR, 15-24  
SCRATCH, 19-67
SENData, 19-68
SESVatiy, 13-22
Service Request Enable (*SRE), 8-21
SKEW, 12-21
SLOPe, 22-38
SOURcE, 15-28, 19-69, 24-25, 25-11, 27-17, 29-6
SOURcE, and TRIGGER, 22-37
SPAN, 25-12
SRATe, 11-14
*SRE (Service Request Enable), 8-21
SSCreen, 27-18, 28-44, 29-9
SUMnary, 27-30, 28-56, 29-12
STate, 22-38
STATistics, 19-71
STORcE, 14-6
STTrig, 15-20
SUBtract, 16-29
SWAVEform, 27-37, 28-62, 29-8, 29-10, 29-14, 29-16
SWEP, 22-44 to 22-49, 22-54
to 22-55
TExt, 27-39, 28-64, 29-7
TExt, 15-30
*TRG (Trigger), 8-25
Trigger (*TRIG), 8-25
TSTArt, 18-10
TOP, 18-12
ULimit, 27-41
UNITs, 19-23
VAMPitude, 19-80
VAverage, 19-82
VBSE, 19-84
VERSus, 16-30
VERTical, 16-31
VIEW, 21-10, 24-28
VMAX, 19-87
VMIN, 19-80
VP, 19-92
VRMS, 19-94
VSTArt, 18-15
VSTOP, 18-17
VTOP, 19-97
VUPF, 19-99
*WAI (Wait-to-Continue), 8-27
Wait-to-Continue (*WAI), 8-27
WINDow, 28-13
WINDow:DElay, 21-11
WINDow:POSition, 21-13
WINDow:RANGe, 21-14
WINDow:SOURCE, 21-15
X1Position, 18-19
X1YSource, 18-21
X2Position, 18-20
X2YSource, 18-22
XOFFset, 25-5
XRANGE, 25-5
Y1Position, 18-24
Y2Position, 18-25
YOFFset, 25-6
YRANGE, 25-6
Command and Data Concepts, 2-5
Command Error, 30-4
Command Error (CME), Status Bit, 4-4
command error and protocol, 3-4
command execution and order, 3-4
callout format, 1-4
callout mode, 2-5
callout structure, 1-14
Command Tree, 6-8 to 6-9
Command Types, 5-6
commands embedded in program messages, 5-12
comms and spaces, 1-6
Common Command Header, 1-8
Common Command Headers, 5-6
Common Commands, 8-2
*CST (Test), 8-25
Clear Status (*CLS), 8-5
*CLS (Clear Status), 8-5
*ESE (Event Status Enable), 8-6
*ESR (Event Status Register), 8-8
Event Status Enable (*ESE), 8-6
Event Status Register (*ESR), 8-8
Identification Number (*IDN), 8-10
*IDN (Identification Number), 8-10
Learn (*LRN), 8-11
*LRN (Learn), 8-11
*OPC (Operation Complete), 8-12
Operation Complete (*OPC), 8-12
*OPT (Option), 8-13
Option (*OPT), 8-13
Reset (*RST), 6-15
*RST (Reset), 6-15
*SAVE (Save), 8-20
Save (*SAVE), 8-20
Service Request Enable (*SRE), 8-21
*SRE (Service Request Enable), 8-21
Status Byte (*STBY), 8-23
*STBY (Status Byte), 8-23
Text (*TST), 8-26
*TRG (Trigger), 8-25
Trigger (*TRIG), 8-25
*WAi (Wait-to-Continue), 8-27
Wait-to-Continue (*WAi), 8-27
Common Commands Syntax
Diagram, 8-3
common commands within a program message, 8-4
Communicating Over the Bus, 2-6
COMplete, 11-8
complete spelling of instructions, 5-4
COMplete?, 24-11
compound and simple commands, combining, 5-10
Compound Command Header, 1-7
Compound Command Headers, 5-6
compound queries, 3-4
concurrent commands, 6-11
CONNECT, and STAtE, 22-40
connected dots, effect on measurements, 8-4
Controller code and capability, 2-4
Controller, HP 9000 Series
209000, 1-2
controlling the front panel while programming, 2-7
conventions of programming, 6-2
Conversion from Data Value to Y Axis Units, 24-4
COUNT, 11-9
COUNT:FAILures?, 28-23
COUNT:FSAMPLEs?, 28-24
COUNT:FWAVEforms?, 28-25
COUNT:SAMPLEs?, 28-26
COUNT:WAVEforms?, 28-27
COUNT?, 24-12
coupling, input, 13-8, 13-16
COUPling?, 24-13
critical measurements and calibration, 12-6
CTIP (HARDcopy:DEVICE), 17-9
CURSOR?, 18-6

D
DATA, 15-12 to 15-13, 24-14 to 24-16
Data Acquisition, 24-3
Data Acquisition Types, 24-4
Data Conversion, 24-4
Data Flow, 6-3 to 6-4
data in alearnstring, 1-5
data in a program, 1-6
data mode, 2-5
data Structures and Status Reporting, 4-5 to 4-7, 9-7 to 9-9
data transmission mode, and FORMAT, 24-17
data, multiple program, 1-10
DATE , 10-4
dBM offset, 26-8
DCOLOR, 15-14
DDE bit, 8-7, 8-9
DECibel, PROBe, 23-4
decimal 10 (ASCII linefeed), 5-13
decimal 32 (ASCII space), 1-6
Decision Chart for Status Reporting, 4-18
default HP-IB conditions, 2-3
default oscilloscope address, 2-6
DEFINE, 19-14 to 19-17
define measure reset conditions, 8-18
defining functions, 16-2
Definite-Length Block Response Data, 1-19, 6-9
DELAY, 21-4 to 21-5
delay values and functions, 16-3
delay, and WINDOW:DELAY, 21-11
DElete, 14-4
deleting files, 14-4
delay time, and DEFINE, 19-14
DELTaime, 19-18 to 19-19
DELTaime, and DEFINE, 19-14
derivative of functions, 16-9
deskjet (HARDcopy:DEVICE), 17-9
DESTination, 17-9
DEVients, in TRIGGER command, 22-8
ARM, 22-9 to 22-10
EVENT, 22-11 to 22-12
TRIGGER, 22-13 to 22-14
DEVICE, 17-9
device address, 1-3, 1-5, 5-4
device addresses, 2-6
device clear (DCL), 2-8
Device Clear code and capability, 2-4
Device Dependent Error (DDE), Status Bit, 4-4
Device Trigger code and capability, 2-4
Device- or Oscilloscope-Specific Error, 30-5
device-dependent data, 1-19, 5-9
device-specific error and protocol, 3-4
DFREQUENCY, in MEASURE:FFT command, 19-24
DIFF, 16-9
digital bandwidth limit filter, 11-5
DIGitize, 9-15 to 9-16
DIGitize Command, 1-15
digitzing, aborting, 2-8
DIGITIZE, setting up for execution, 11-2
DIRECTory?, 14-4
disabling serial pol, 2-8
discrete derivative of functions, 16-9
DISK (HARDcopy:DESTINATION), 17-8
Disk Commands, 14-2
DElete, 14-4
DIRECTory?, 14-4
FORMat, 14-5
LOAD, 14-5
STORE, 14-6
disk reset conditions, 8-19
DISPLAY, 13-7, 16-10, 20-3, 25-4, 26-4
Display Commands, 15-2
ASSign, 15-7
COLUMN, 15-8, 15-11
DATA, 15-12
DCOLOR, 15-14
DWAVERM, 15-15
FORMat, 15-16
GRAFitcule, 15-17
INVERSE, 15-18
LINE, 15-19
MASK, 16-20
PBRobust, 15-22
ROW, 15-23
SCOLOR, 15-24
SOURce, 15-28
STRING, 15-29
TEXT, 15-30
display DISK, and MSScreen, 27-18, 28-45
display persistence, 15-22
display PRINTER, and MSScreen, 27-18, 28-45
display reset conditions, 8-17
display LINE and masking, 15-21
display STRING and masking, 15-21
DVIDe, 16-11
dividing functions, 16-11
DI500 (HARDcopy:DEVICE), 17-9
DI850 (HARDcopy:DEVICE), 17-9
DMAIDitude, in MEASURE:FFT command, 19-25
dos file compatibility, 14-2
double-wide plug-in sample rate, 11-14
Driver Electronics code and capability, 2-4
disp (display), 10-5 to 10-6
dTME, in TRIGGER command, 22-15
ARM, 22-16 to 22-17
DELAY, 22-18
TRIGGER, 22-19 to 22-20
duplicate Mnemonics, 1-8
duration between data points, and XINCement, 24-31
DUTycycle, 19-20 to 19-21
DWAVERM, 15-15

E
EDGE, in TRIGGER command, 22-21
SLOPe, 22-22
SOURce, 22-29
EDLY, and DEVients, 22-8
EEPROM and calibration factors, 12-4
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
</table>

| embedded commands, 5-12 |
| Embedded strings, 1-3, 1-5, 1-12, 5-8 |
| Embedded Strings, in Program Data, 5-8 |
| Enable Register, 8-4 |
| End Of String (EOS), 1-12 |
| End Of Text (EOT), 1-12 |
| End-Or-Identify (EOI), 1-12 |
| End-Or-Identify (EOI) as terminator, 5-13 |
| ENGLISH (HARDoCopy:LENGth), 17-13 |
| ensemble count and type, 11-9 |
| EOI (End-Or-Identify), 1-12 |
| EOS End Of String, 1-12 |
| EOT (End Of Text), 1-12 |
| EPH (HARDoCopy:DEVICE), 17-9 |
| equipment for calibration, 12-3 |
| equivalent time mode, 11-11 |
| equivalent time mode and data flow, 6-4 |
| ERASE, 9-17, 20-3 |
| error |
| query interrupt, 1-9 |
| error in measurements, 19-3 |
| Error Messages, 30-2 |
| Error Messages table, 30-7 |
| Error Numbers, 30-4 |
| Error Queue, 30-9 |
| error queue and query results, 5-7 |
| error queue overflow, 30-3 |
| Error Queue, and Status Reporting, 4-16 |
| ERROR?, 10-7 to 10-9 |
| errors |
| exceptions to protocol, 3-4 |
| ESB (Event Status Bit), 4-4 |
| ESB (Event Summary Bit), 8-6 |
| ESB bit, 8-22, 8-24 |
| ESB (Event Status Enable), 8-6 to 8-7 |
| *ESE, 8-6 |
| *ESR (Event Status Register), 8-8 to 8-9 |
| ESR (Standard Event Status Register), 4-11 |
| ETLMe, 11-11 |
| Event Delay Triggering mode, 22-8 |
| event monitoring, 4-2 |
| event registers default, 2-3 |
| Event Status Bit (ESB), 4-4 |
| Event Status Enable (ESE), Status Reporting, 4-12 |
| Event Summary Bit (ESB), 8-6 |
| Example Program, 1-14 |
| Example Program, in initialization, 1-14 |
| Example Programs, 7-2 |
| exceptions to protocol, 3-4 |
| EXE bit, 8-7, 8-9 |
| executing DIGitize, 11-2 |
| Execution Error, 30-5 |
| Execution Error (EXE), Status Bit, 4-4 |
| execution error and protocol, 3-4 |
| execution errors, and command errors, 30-4 |
| execution of commands and order, 3-4 |
| exponential notation, 1-11 |
| exponential notation, in program data, 5-8 FORMat, and DATA, 24-16 |
| Exponents, 1-11 |
| external triggering, TRIGgerN, 23-2 |
| F |
| FACTors, 17-10 |
| FACTors (HARDoCopy:AREA), 17-6 |
| falt modes, 27-9 |
| field software, 27-9, 27-12 |
| FAIL, in Limit TEST command, 27-9 to 27-10 |
| fall time measurement setup, 19-3 |
| FFTMeas, 19-22 to 19-23 |
| FFT (XY1source), 18-21 |
| FFT (XY2source), 18-22 |
| FFT Commands, 20-2 |
| Display, 25-4 |
| FREQUENCY, 26-5 |
| MAGNIfy, 26-6 |
| MSpan, 26-7 |
| OFFSET, 26-8 |
| RANGE, 26-9 |
| RESolution, 26-10 |
| SOURCe, 26-11 |
| SPAN, 26-12 |
| WINDOW, 26-13 |
| FFT window type, 20-13 |
| FFT, and BLANK command, 9-13 |
| FFT, and DIGitize command, 9-16 |
| FFT, and DISKSTORE command, 14-6 |
| FFT, and DISPlay:ASSign command, 15-7 |
| FFT, and STORe command, 9-36 |
| FFT, and VIEW command, 9-40 |
| FFT, in MENU command, 9-23 |
| FTT, in WAVEform:SOURce command, 24-25 |
| FTT, in WME:ME:SAVE command, 25-4 |
| FTT, in WME:ME:SAVE command, 25-4 |
| FTT, in WME:ME:SAVE command, 25-4 |
| FTT, in WME:ME:SAVE command, 25-4 |
| FTT, in WME:ME:SAVE command, 25-4 |
| FILEname, 17-12 |
| filenames, 14-2 |
| filter, internal low-pass, 13-5 |
| filtering, 11-6 |
| PISO, 6-4 |
| flow of acquired data, 6-3 to 6-4 |
| forever mode, 27-14, 28-32 |
| FORMAT, 14-5, 15-16, 24-17 to 24-18 |
| format of commands, 1-4 |
| formatting disks, 14-5 |
| formatting query responses, 10-2 |
| formatfeed, 17-11 |
| Fractional values, 1-11 |
| FRAME, in CALibrate command |
| CANcel, 12-14 |
| CONTInue, 12-14 |
| DATA, 12-15 |
| DONE?, 12-15 |
| LABEL, 12-16 |
| MEMORY, 12-16 |
| START, 12-16 |
| TIME?, 12-17 |
| FREQUENCY, 19-29 to 19-30, 26-5 |
| frequency measurement setup, 19-3 |
| frequency resolution for FFT, 26-10 |
| frequency span of FFT, 26-12 |
| FREQUENCY, in FUNCtion:FFT command, 19-25 |
| FREQUENCY, in MEASURE:FFT command, 19-25 |
| front-panel control while programming, 2-7 |
| front-panel simulation, 10-2 |
| full-scale vertical axis, 13-19 |
| function and vertical scaling, 16-28 |
| Function Commands, 16-2 |
| ADD, 16-8 |
| DIFF, 16-9 |
| DISPlay, 16-10 |
| DIVide, 16-11 |
| FFT: Magnitude, 16-16 |
| HORIZontal, 16-17 |
| INTEGRate, 16-20 |
INVert, 16-21
MAGNify, 16-22
MAXimum, 16-23
MINimum, 16-24
MULTIply, 16-25
OFFSETset, 16-26
ONLY, 16-27
RANGE, 16-28
SUBTract, 16-29
VERSus, 16-30
VERTical, 16-31

Function time scale, 16-3
Functional Diagram for Limit Test, 27-3
functional elements of protocol, 3-3
functions
- calculating and data flow, 6-4
- combining in instructions, 1-7
Functions, and VIEW, 24-28

G
- GAIN and offset of a probe, 12-6
- general bus management, 2-2

GGTHan
- Definition, 22-24

GIF (HARDCopy:DEVICE), 17-9
GLITech, in TRIGger command, 22-24
POLarity, 22-25
SOURce, 22-26
WIDTH, 22-27

global reset conditions, 8-15
GLIThan
- Definition, 22-24
go-to-local command (GTL), 2-7
graphs, setting the number of, 15-16
GRATIcule, 15-17

GRATIcule (HARDCopy:AREA), 17-6
- group execute trigger (GET), 2-8

H
- halting bus activity, 2-8
- handshake code and capabilities, 2-4
HarDCopy Commands, 17-2

ADDRess, 17-5
AREA, 17-6
BACKground, 17-7
DEStInation, 17-8
DEVICE, 17-9
FACTors, 17-10

FFEEd, 17-11
FILENAME, 17-12
LENGTH, 17-13
MEDia, 17-14
- hardcopy of the screen, 17-2
- hardcopy output and message termination, 3-4
- HEADER, 10-10
- Header Types, 1-7
- header within instruction, 1-5
- Header, Instruction, 5-5 to 5-6
- Headers, 1-6
- headers in syntax, 1-4
- HEEN, 9-18
- HELP, in MENU command, 9-23
- HERR?, 9-19
- High SENsitivity, and hysteresis, 22-29
- HISTogram commands, 29-2
  - WINDOW:X2Position, 29-19
  - WINDOW:Y1Position, 29-20
  - WINDOW:Y2Position, 29-21 to 29-22
- Histogram Event Register, 4-15
- HISTogram, in MENU command, 9-23
- HITS, in MEASure:HISTogram command, 19-31 to 19-32
- HOLDoff, in TRIGger command, 22-28
- HORIZontal, 16-17
- horizontal functions, controlling, 21-2
- horizontal offset, and OFFSETset, 25-5
- horizontal range, and XRANGE, 25-5
- horizontal scaling and functions, 16-3
- Host language, 1-5
- HP 9000 Series 200000 Controller, 1-2
- HP BASIC 5.0, 1-2
- HP BASIC Enter Statement, 5-3
- HP BASIC Output Statement, 5-3
- HP PaintJet print background, 17-7
- HP:B Default Startup Conditions, 2-3
- HP:B Interface Connector, 2-3
- HP:IB menu, 2-5
- HPIB (HARDCopy:DESTImination), 17-8
- hue, 16-25
- HYSTeresis, in TRIGger command, 22-29

I
- Identification Number (*IDN), 8-10
- *IDN (Identification Number), 8-10
- IEEE 488.1, 3-2
- IEEE 488.1 and IEEE 488.2 relationship, 3-2
- IEEE 488.1 definitions for the interface, 2-2
- IEEE 488.2, 3-2
  - Standard, 1-2
  - Standard Status Data Structure Model, 4-2
- IEEE 488.2 compliance, 3-2
- IEEE 488.2 conformity, 1-2
- IEEE 488.2 syntax diagrams defined, 3-8
- Ignore softkey, 27-12
- image specifier, -K, 10-20
- image specifiers, and DATA, 24-15
- image specifiers, and PREamble, 24-21
- impedance, input, 13-8, 13-16
- individual commands language, 1-2
- Infinity Representation, 6-11
- Initialization, 1-13
- event status, 4-2
- INPut, 13-8 to 13-9
- input buffer, 3-3
- clearing, 2-6
- default condition, 3-4
- input coupling, and COUPLING?, 24-13
- Instruction Header, 1-5, 5-5 to 5-6
- Instruction headers, 1-6
- Instruction Terminators, 5-13 to 5-14
- Instructions, 1-4, 5-4
- instrument address, 2-6
- Instrument Status, 1-20
- integer definition, 1-11
- integer, in syntax definition, 5-8
- INTEGRate, 16-20
- Interface Capabilities, 2-4
- interface clear (IFC), 2-8
- interface clear message (IFC), 2-5
- Interface Functions, 2-2
- Interface Select Code, 2-6
- interface, initializing, 1-13
- internal low-pass filter, 13-5
- internal lowpass filter, BWLimit, 23-3
- INTERpolate, 11-10
- INTERPOLATE acquisition type, 11-16
Index

INTerpole and acquisition completion, 11-6
terpolator, and data flow, 6-4
interpreting commands, parser, 3-3
interrupted query, 1-9
Introduction to Programming, 1-2
INVerse, 15-18
inverse video, 15-18
INVert, 15-21
inverting functions, 16-21

K
-K, 10-20
K, and DATA, 24-15
KEY, 10-11 to 10-16
Key Queue, 4-17

L
language for programming examples, 1-2
LaSerJet (HARDeCopy:DEVice), 17-9
LCL (Local Event Register), 4-13
Learn (*LERN), 8-11
learn string, 8-11
learnstring block data, 1-5
LENGTH, 17-13
LERT, 9-20
LEVEL, in TRIGger command, 22-30
LPAF reject, input, 13-8, 13-16
Limit Test Commands, 27-2
Limit Test Event Register, 4-14
Limit Test Register (LTER), 4-14
LINE, 15-19
linefeed, 1-12
List of Error Messages, 3-6 to 30-10
Listener code and capability, 2-4
listeners, unaddressing all, 2-8
LIMIT, in Limit TEST command, 27-11
LOAD, 14-5
Local Event Register (LCL), 4-13
Local Lockout (LLO), 2-7
local lockout default, 2-3
local mode, 2-7
local mode default, 2-3
lockout mode default, 2-3
LOGic, and STATE, 22-41
Long form, 1-10
long form instructions, 5-4
LONG, and Format, 24-18
long form headers, 1-10
LONGform, 16-17 to 18-18
low-pass filter, internal, 13-5
lower test limit, 27-11
lower-case headers, 1-10
LOWERcase, 1-10
LOWpass filter, BWlimit, 23-3
*LRN (Learn), 8-11, 10-20
LSBFirst, and BYTEorder, 24-9
LITE, 9-21
LITER (Limit Test Register), 4-14
LITER*, 9-22
LITEst Commands, 27-41
FAIL, 27-9
LIMIT, 27-11
NMFound, 27-12
RUN, 27-14
SOURce, 27-17
SSCReen, 27-18
SSUMmary, 27-30
SWAVeform, 27-37
TEST, 27-39
LITES, in MENU command, 9-23
luminosity, 15-25

M
MIS, in MEASURE HISTogram command, 19-37 to 19-38
MIS, in MEASURE:HISTogram command, 19-39 to 19-40
MSS, in MEASURE:HISTogram command, 19-37 to 19-38
MSS, in MEASURE:HISTogram command, 19-39 to 19-40
MSS, in MEASURE:HISTogram command, 19-41 to 19-42
MAGNify, 16-22, 26-6
MAGNify, in FUNCTION:FFT command, 15-12
magnifying the FFT, 26-7
MAGNitude, in MEASURE:FFT command, 19-26
MAIN, and VIEW, 24-28
Mainframe Calibration, 12-3
Making Measurements, 19-4
managing bus issues, 2-2
Marker Commands, 18-2, 18-6
MEASURE:REAdOut, 18-7
MODE, 18-8
TDELta?, 18-9
TSTArt, 18-10
TSTOp, 18-12
VDELta?, 18-14
VSTArt, 18-15
VSTOp, 18-17
X1Position, 18-19
X1Ysource, 18-21
X2Position, 18-20
X2Ysource, 18-22
XDELta?, 18-23
Y1Position, 18-24
Y2Position, 18-25
YDELta?, 18-26
marker reset conditions, 8-17
mask, 15-20 to 15-21
mask parameter, 15-20
Mask Test Commands, 28-2
Mask Test Event Register, 4-14
mask, Service Request Enable Register, 5-21
MASK:DEFine, 28-28 to 28-29
Master Summary Status (MSS) and *STB, 8-23
Master Summary Status (MSS), Status Bit, 4-4
math reset conditions, 8-19
MAV (Message Available), 4-4
MAY bit, 8-22, 8-24
MAXimum, 16-33
MEAN, in MEASURE:HISTogram command, 19-33 to 19-34
Measure Commands, 19-2
DEFire, 19-14
DELtaTime, 19-18
DUTycycle, 19-20
FALLtime, 19-22
FREQuency, 19-29
NWidth, 19-51
OVERShoot, 19-53
PERiod, 19-55
PRESShoot, 19-57
PWidth, 19-59
RSMultiPly, 19-61
RIStime, 19-65
SCRatch, 19-67
SENDvalid, 19-65
SOURce, 19-69
STATistics, 19-71
TMAX, 19-74
TMIN, 19-76

Index-7
Index

TVO, 19-72, 19-78
VAMplitude, 19-80
VAVerage, 19-82
VBASe, 19-84
VLOWer, 19-86
VMAX, 19-87
VMIDdle, 19-89
VMIN, 19-90
VPP, 19-92
VRMS, 19-94
VTMe?, 19-96
VTOP, 19-97
VUPPer, 19-99
MEASure:RESults and statistics, 19-71
MEASurement Error, 19-3
MEASurement: Not Found, in Limit Test, 27-12
MEASurement Setup, 19-3
measurement source, and SOURce, 19-69
MEASurement: READout, 18-7
measurements
  effect of connected dots, 6-4
  pixel memory, 6-4
  repeatability, 6-4
  waveform memories, 6-4
MEDia, 17-14
MEDia, and SSUMmary, 28-56
MEDian, in MEASure HISTogram command, 19-35 to 19-36
Memories, and VIEW, 24-28
MENU, 9-23
MESSAGE, 9-24, 20-4
Message (MSG), Status Bit, 4-4
Message Available (MAV), Status Bit, 4-4
Message Available Bit and *OPC, 8-12
Message Communications and System Functions, 3-2
message exchange protocols of IEEE 488.2, 3-3
MESSAGE Queue, 4-17
message termination with hardcopy, 3-4
METric (HARDeopy:LENGTH), 17-13
MIN, 16-24
Mnemonic Truncation, 6-5
MPFound, in Limit TES: command, 27-12 to 27-13
MODE, 11-11, 18-8
MODE, in HISTogram command, 28-7
MODE, in TRIGger command, 22-31 to 22-32
model number, reading, 8-13
MODE?, 9-25
monitoring events, 4-2
MOSFet, and BTTeorder, 24-9
MS bit, 8-22, 8-24
MSpan, 26-7
MSPan, in FUNCtion:FFT command, 16-13
MSS bit and *STB, 8-23
MT, 9-26
MT?R, 9-27
MTEST: Commands
  AMASK:Create, 28-14
  AMASK:SOURce, 28-15
  AMASK:UNITa, 28-17
  AMASK:XDELia, 28-19
  AMASK:YDELia, 28-21
  MASK:DEFINE, 28-28
  POLYgon:DEFINE, 28-30
  RUMode, 28-32
  SCALE:DEFault, 28-35
  SCALE:SOURce, 28-36
  SCALE:X, 28-38
  SCALE:YDELia, 28-40
  SCALE:X, 28-42
  SCALE:Y, 28-43
  SSCRRe, 28-44
  SSUMmary, 28-56
  SWAVEform, 28-62
  TEST, 28-64
  MTEST, in MENU command, 9-23
  multi-slot plug-in
  best accuracy calibration, 12-6
Multiple Functions within a Subsystem, 5-11
Multiple instructions, 5-10
Multiple numeric variables, 1-19
Multiple program commands, 1-12
multiple program data, 1-10
Multiple Queries, 1-19
Multiple subsystems, 1-12, 5-10
MULTIply, 16-25
my listen address (MLA), 2-5

N
New Line, 1-12
New Line (NL) as terminator, 5-13
NL (New Line), 1-12
Noise REject, and hysteresis, 22-29
NORMAL (HARDeopy:BACKground), 17-7
Normal Accuracy Calibration Level, 12-5
NORMAL acquisition type, 11-16
NORMAL acquisition completion, 11-8
NORMAL, and hysteresis, 22-29
number of graphs, 15-16
numeric data, 1-11
numeric program data, 1-10 to 1-11
Numeric Program Data, in Program Data, 5-8
Numeric Variable Example, 1-18
Numeric variables, 1-18
NWIDth, 19-51 to 19-52

O
OFFSET, 13-10 to 13-11, 16-25, 26-8
offset and gain of a probe, 12-8
OFFSET, in MEASure HISTogram command, 19-43
ONLY, 16-27
*OPC (Operation Complete), 8-12
OPC bit, 8-7, 8-9
OPP, 9-28
OPER bit, 8-22, 8-24
OPER?, 9-29
operands and time scale, 16-3
operating the disk, 14-2
Operation Complete (*OPC), 8-12
Operation Complete (OPC), Status Bit, 4-4
operation status, 4-2
Operation Status Register (OPR), 4-13
OPR (Operation Status Register), 4-13
*OP (Option), 8-13
Option (*OPT), 8-13
Options, Program Headers, 1-10
order of commands and execution, 3-4
Oscilloscope Data Flow, 6-3
oscilloscope default address, 2-6
other talk address (OTA), 2-5
OUTPUT, 13-12
output buffer, 1-9

Index-8
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
</table>

- Output Command, 1–4
- output format, 17–9
- output queue, 1–9, 3–3, 4–17
  - clearing, 2–8
  - default condition, 3–4
  - definition, 3–3
- output queue and query results, 5–7
- OUTPUT statement, 1–3
- OUTPUT, in CALibrate command, 12–18
  - overlapped and sequential commands, 6–11
  - overload protection, 13–17
- OVERShoot, 19–53 to 19–54

P
- PAINjet (HARDecopy:DEVi ce), 17–9
- PAper (HARDecopy:MEDia), 17–14
- paper length, setting, 17–3
- Parallel Poll code and capability, 2–4
- parametric measurements, 19–2
- Parse tree, 3–7
- Parse Tree example, 3–7
- Parser, 1–13, 3–3
  - default condition, 3–4
  - definition, 3–3
  - resetting, 2–8
- passing values across the bus, 1–9
- passive probes and calibration, 12–8
- PATTer, in TRIGger command, 22–33
- CONDITION, 22–34
- LOGic, 22–35
- PCX (HARDecopy:DEVi ce), 17–9
- PEAK, in MEASure:HIStogram command, 19–44 to 19–45
- peak-to-peak voltage, and VPP, 19–92
- PEAK1, in MEASure:FPT command, 19–26
- PEAK2, in MEASure:FPT command, 19–27
  - pending commands, clearing, 2–8
- PERiod, 19–55 to 19–56
  - period measurement setup, 19–3
  - PERsistence, 15–22
- PEORmat, and SSCReen, 27–24, 28–50
- PEORmat, and SSUMmary, 27–30, 28–56
  - pixel memory and data flow, 6–4
- Pixel Memory Command s, 20–2, 20–4
  - ADD, 20–3
  - CLEAR, 20–3
  - DISPLAY, 20–3
  - ERASE, 20–9
  - pixel memory, storing, 14–6
  - Plug-In Calibration, 12–4
  - PLUGINS, in CALibrate command
    - CANcel, 12–19
    - CONTinue, 12–19
  - DONE?, 12–19
  - MEMORY?, 12–20
  - START, 12–20
  - TIME?, 12–20
  - POINTS, 11–12 to 11–13
  - points in an acquisition, 11–12
  - PRINT?, 24–16
  - POLarity, and GELTch, 22–25
  - POLYGON:DEFine, 28–30 to 28–31
  - PON bit, 8–7, 8–9
  - PORT, and SSCReen, 27–24, 28–50
  - PORT, and SSUMmary, 27–30, 28–56
  - POSition, 21–6
  - position, and WINDOW:POSition, 21–13
  - postprocessing, and data flow, 6–4
  - pound sign (#) and block data, 1–19
  - Power On (PON), Status Bit, 4–4
  - power-up condition of HP-IB, 2–3
  - PP, in MEASure:HIStogram command, 19–46 to 19–47
  - PREamble, 24–23 to 24–24
  - PREmble, and DATA, 24–16
  - PREShoot, 19–57 to 19–58
  - PRIN, 9–30
  - PRIN, in MENU command, 9–23
  - printing specific screen data, 17–5
  - printing the screen, 17–2
  - Probe, 13–13 to 13–14, 23–4
  - probe attenuation factor, 12–8
  - Probe Calibration, 12–8, 12–10 to 12–11
  - PROBE, in CHANNel command
    - CALibrate, 13–15
  - Program Data, 1–5, 5–8 to 5–9
  - program data in syntax, 1–4
  - Program Data Syntax Rules, 1–10
  - program data types, 1–10
  - program data within instruction, 1–5
  - Program example, 1–14
  - Program Header Options, 1–10
  - Program Message Terminator, 1–12
  - Program Overview, initialization example, 1–15
  - program syntax, 1–4
  - programming and front-panel control, 2–7
  - programming basics, 1–2
  - Programming Conventions, 8–2
  - programming examples language, 1–2
  - Programming Getting Started, 1–13
  - Programming Syntax, 8–2
  - PROTection, 13–17
  - protection switch, calibration, 12–3
  - Protocol, 3–3
  - Protocol exceptions, 3–4
  - protocol exceptions, 3–4
  - Protocol Operation, 3–4
  - Protocol Overview, 3–3
  - Protocols, 3–3 to 3–4
  - pulse width measurement setup, 19–3
- PWIDH, 19–59 to 19–60

Q
- Queries, defined, 5–7
- Query, 1–1, 1–9
- ADDRess, 17–5
- AER?, 9–10
- AMASK:SOURce?, 28–16
- AMASK:UNITy?, 28–18
- AMASK:XDELa, 28–20
- AMASK:YDELa, 28–22
- AREA?, 17–6
- ASSign?, 15–7
- BACKground?, 17–7
- BANDpass?, 24–8
- BWLimit?, 11–5, 13–5, 23–3
- BYTeorder?, 24–10
- COLumn?, 15–9 to 15–11
- COMPlete?, 11–7, 24–11
- COUNT:FAILures?, 28–23
- COUNT:PASSamples?, 28–24
- COUNT:FWAVEforms?, 28–25
- COUNT:SAmples?, 28–26
- COUNTr:WAVeforms?, 28–27
- COUNT?, 11–9, 24–12
- COUPLE?, 24–13
- CURSor?, 18–6
- DATA?, 15–13, 24–15
- DELay, 21–4
- DELtatime?, 19–18
- DESTination?, 17–8
- DEVent?, 22–9, 22–11, 22–51 to 22–53,
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-56</td>
</tr>
<tr>
<td>DEventa?, 22-13</td>
</tr>
<tr>
<td>DEvice?, 17-9</td>
</tr>
<tr>
<td>DIRecory?, 14-4</td>
</tr>
<tr>
<td>DISPLAY?, 13-7</td>
</tr>
<tr>
<td>DISPLAY?, 16-10, 25-4, 28-4</td>
</tr>
<tr>
<td>DTIMe?, 22-16, 22-20</td>
</tr>
<tr>
<td>DUTyCycle?, 19-21</td>
</tr>
<tr>
<td>DWAveform?, 19-15</td>
</tr>
<tr>
<td>EGE?, 22-23</td>
</tr>
<tr>
<td>EST?, 8-8</td>
</tr>
<tr>
<td>Event Status Enable, 8-6</td>
</tr>
<tr>
<td>Event Status Register, 8-8</td>
</tr>
<tr>
<td>FACTors?, 17-10</td>
</tr>
<tr>
<td>FAIL?, 27-10, 29-17</td>
</tr>
<tr>
<td>FALLtime?, 19-22</td>
</tr>
<tr>
<td>FFBed?, 17-11</td>
</tr>
<tr>
<td>FORMAT?, 15-16</td>
</tr>
<tr>
<td>FORMat?, 15-10, 24-18</td>
</tr>
<tr>
<td>FRAME?, 12-15</td>
</tr>
<tr>
<td>FREquency?, 19-30, 26-5</td>
</tr>
<tr>
<td>G1Tch?, 22-25</td>
</tr>
<tr>
<td>GRATcycle?, 15-17</td>
</tr>
<tr>
<td>HOLDoff?, 22-28</td>
</tr>
<tr>
<td>HORIZONTAL?, 16-17</td>
</tr>
<tr>
<td>HYSteresis?, 22-29</td>
</tr>
<tr>
<td>Identification Number (*IDN), 8-10</td>
</tr>
<tr>
<td>*IDN (Identification Number), 8-10</td>
</tr>
<tr>
<td>INPUT?, 13-9, 13-16</td>
</tr>
<tr>
<td>INTerpolate, 11-10</td>
</tr>
<tr>
<td>INVersed, 15-18</td>
</tr>
<tr>
<td>Learn (*LRN), 8-11</td>
</tr>
<tr>
<td>LENGTH?, 17-13</td>
</tr>
<tr>
<td>LEVEL?, 22-30</td>
</tr>
<tr>
<td>LIMIt?, 22-11, 29-18 to 29-10</td>
</tr>
<tr>
<td>*LRN (Learn), 8-11</td>
</tr>
<tr>
<td>MAGNIfy?, 26-6</td>
</tr>
<tr>
<td>MASK:DEFI ne?, 28-29</td>
</tr>
<tr>
<td>MASK?, 15-20</td>
</tr>
<tr>
<td>MEDia?, 17-14</td>
</tr>
<tr>
<td>MFFound, 27-13, 29-20</td>
</tr>
<tr>
<td>MODE, 22-32</td>
</tr>
<tr>
<td>MODE?, 11-11, 18-8</td>
</tr>
<tr>
<td>MSPan?, 26-7</td>
</tr>
<tr>
<td>OFFSet?, 13-11, 16-28, 26-8</td>
</tr>
<tr>
<td>*OPC (Operation Complete), 8-12</td>
</tr>
<tr>
<td>*OPT (Option), 8-13</td>
</tr>
<tr>
<td>Option (*OPT), 8-13</td>
</tr>
<tr>
<td>OUTPut?, 12-18, 13-12</td>
</tr>
<tr>
<td>OVEReShoot?, 19-54</td>
</tr>
<tr>
<td>PATTern?, 23-24</td>
</tr>
<tr>
<td>PERiod, 19-54</td>
</tr>
<tr>
<td>PESKavior?, 15-22</td>
</tr>
<tr>
<td>PONits?, 11-13, 24-19</td>
</tr>
<tr>
<td>POLynom:DEFI ne?, 28-31</td>
</tr>
<tr>
<td>POSITION?, 21-6</td>
</tr>
<tr>
<td>PREamble?, 24-22</td>
</tr>
<tr>
<td>PRESHoot, 19-56</td>
</tr>
<tr>
<td>PROBe?, 13-14, 24-34</td>
</tr>
<tr>
<td>PROTection?, 13-18</td>
</tr>
<tr>
<td>PWIDle?, 19-60</td>
</tr>
<tr>
<td>*SRE? (Service Request Enable), 8-21</td>
</tr>
<tr>
<td>RANGE?, 13-19</td>
</tr>
<tr>
<td>RANGe?, 13-19, 16-28, 21-7, 26-9</td>
</tr>
<tr>
<td>RESolution?, 21-8</td>
</tr>
<tr>
<td>RESolution?, 26-10</td>
</tr>
<tr>
<td>RESULT?, 19-61</td>
</tr>
<tr>
<td>RISetime?, 19-66</td>
</tr>
<tr>
<td>ROW?, 15-23</td>
</tr>
<tr>
<td>RUMode?, 28-34</td>
</tr>
<tr>
<td>RUN?, 27-16, 29-21</td>
</tr>
<tr>
<td>SCALE:SOURCE?, 28-37</td>
</tr>
<tr>
<td>SCALE:REFERENCE?, 28-37</td>
</tr>
<tr>
<td>SCALE:VOLtage?, 28-41</td>
</tr>
<tr>
<td>SCALE:Y1?, 28-42</td>
</tr>
<tr>
<td>SCALE:Y2?, 28-43</td>
</tr>
<tr>
<td>SCALE?, 13-21, 21-9</td>
</tr>
<tr>
<td>SCLOR?, 15-26</td>
</tr>
<tr>
<td>SENDvalid?, 19-58</td>
</tr>
<tr>
<td>SENSitivity?, 13-22</td>
</tr>
<tr>
<td>Service Request Enable (*SRE?), 8-21</td>
</tr>
<tr>
<td>SKEW?, 12-22</td>
</tr>
<tr>
<td>SLOPe?, 22-36</td>
</tr>
<tr>
<td>SOURCe, 24-25</td>
</tr>
<tr>
<td>SOURCe, 15-28, 19-70, 26-11, 27-17, 29-6</td>
</tr>
<tr>
<td>SOURCe, and TRIGger, 22-37</td>
</tr>
<tr>
<td>SPAN?, 25-12</td>
</tr>
<tr>
<td>SRATe, 11-15</td>
</tr>
<tr>
<td>SSCReet?, 27-19, 28-45, 29-9</td>
</tr>
<tr>
<td>SSUMmary, 27-31, 28-57, 29-13</td>
</tr>
<tr>
<td>STATistic?, 22-39</td>
</tr>
<tr>
<td>STATistics?, 19-71</td>
</tr>
<tr>
<td>Status Byte (*STB), 8-23</td>
</tr>
<tr>
<td>Status?, 12-22</td>
</tr>
<tr>
<td>*STB (Status Byte), 8-23</td>
</tr>
<tr>
<td>SWEEP?, 22-44 to 22-49, 22-54 to 22-55</td>
</tr>
<tr>
<td>TDELta?, 19-9</td>
</tr>
<tr>
<td>TEDge?, 19-72</td>
</tr>
<tr>
<td>Test (*TST), 8-26</td>
</tr>
<tr>
<td>TST?, 27-40, 28-64, 29-7</td>
</tr>
<tr>
<td>TMAX?, 19-74</td>
</tr>
<tr>
<td>TMIN?, 19-76</td>
</tr>
<tr>
<td>*TST (Test), 8-26</td>
</tr>
<tr>
<td>TSTArt?, 18-10</td>
</tr>
<tr>
<td>TSTTop?, 18-13</td>
</tr>
<tr>
<td>TVOLtage?, 19-78</td>
</tr>
<tr>
<td>TYPE?, 11-17, 24-26</td>
</tr>
<tr>
<td>ULLIMIT?, 27-41</td>
</tr>
<tr>
<td>UNITY?, 13-23</td>
</tr>
<tr>
<td>VAMPtitude?, 19-80</td>
</tr>
<tr>
<td>VAVerge?, 19-83</td>
</tr>
<tr>
<td>VBASe?, 19-84</td>
</tr>
<tr>
<td>VDEIta?, 18-14</td>
</tr>
<tr>
<td>VIEW?, 21-10, 24-29</td>
</tr>
<tr>
<td>VLOWER?, 19-86</td>
</tr>
<tr>
<td>VMAX?, 19-87</td>
</tr>
<tr>
<td>VMIDle?, 19-89</td>
</tr>
<tr>
<td>VMIN?, 19-90</td>
</tr>
<tr>
<td>VPP?, 19-92</td>
</tr>
<tr>
<td>VMRS?, 19-95</td>
</tr>
<tr>
<td>VSTArt?, 18-15</td>
</tr>
<tr>
<td>VSTTop?, 18-17</td>
</tr>
<tr>
<td>VTOP?, 19-97</td>
</tr>
<tr>
<td>VUPPer?, 19-99</td>
</tr>
<tr>
<td>WINDow:DEIta?, 21-11</td>
</tr>
<tr>
<td>WINDow:POSItion?, 21-13</td>
</tr>
<tr>
<td>WINDow:RANGE?, 21-14</td>
</tr>
<tr>
<td>WINDow:SOURCe?, 21-15</td>
</tr>
<tr>
<td>WINDow?, 26-13</td>
</tr>
<tr>
<td>XIPOsition, 18-19</td>
</tr>
<tr>
<td>XIPOsition, 18-21</td>
</tr>
<tr>
<td>XIXsource?, 18-20</td>
</tr>
<tr>
<td>XIXsource?, 18-22</td>
</tr>
<tr>
<td>XDEIta?, 18-23</td>
</tr>
<tr>
<td>XDISplay?, 24-90</td>
</tr>
<tr>
<td>XINCrement?, 24-51</td>
</tr>
<tr>
<td>XUPPre?, 25-5</td>
</tr>
<tr>
<td>XORgin?, 24-52</td>
</tr>
<tr>
<td>XSPAN?, 24-33, 25-5</td>
</tr>
<tr>
<td>XRESolution?, 24-34</td>
</tr>
<tr>
<td>XUNits?, 24-35</td>
</tr>
</tbody>
</table>

Index-10
INDEX

Y1Position, 18-24
YDElta?, 18-26
YDISPlay?, 24-36
YINCement?, 24-37
YOFFset?, 25-6
YORight?, 24-38
YRANGE?, 24-39, 25-6
YRPerceive?, 24-40
YUNIT?, 24-41
Query command, 1-9
Query Error, 30-6
Query Error (QYE), Status Bit, 4-4
query and protocol, 3-5
Query Headers, 1-9
query interrupt, 1-9
query response, 1-17
query responses, formatting, 10-2
query results and output queue, 5-7
query results and the error queue, 5-7
Question mark, 1-9
queue, output, 1-9
quoted strings, 15-19
quotes, with embedded strings, 1-12
QYE bit, 8-7, 8-9
R
RANGE, 13-19 to 13-20, 16-28, 21-7, 26-9
range, and WINDOW:RANGE, 21-14
RATIO, PROBe, 23-4
RAW acquisition type, 11-16
RAW and acquisition completion, 11-6
raw data and FISO, 6-4
*RCL (Recall), 8-14
real number definition, 1-11
real time data, and data flow, 6-4
real time data, acquisition, 7-11
real time mode, 11-11
real time mode and data flow, 6-4
real time mode and interpolation, 11-10
Recall, 9-31
Recall (*RCL), 8-14
Receiving Common Commands, 8-4
Receiving Information from the Instrument, 1-17
Receiving Responses, 5-3
REFerence, 21-8
Register
Standard Event Status Enable, 4-12
 registers, save/recall, 8-14, 8-20
Registors
Histogram Event, 4-15
Limit Test Event, 4-14
Mask Test Event, 4-14
reliability and availability of measured data, 4-2
Remote Local code and capability, 2-4
Remote Local, and Local Lockout, 2-7
remote-to-local transition, 15-21
REln, 2-7
repeatability of measurements, 6-4
representation of infinity, 6-11
reprogrammable EEPROM and calibration, 12-4
Request Control (RQC), Status Bit, 4-4
Request Service (RQS), default, 2-3
Reset (*RST), 8-15 to 8-19
resetting the parser, 2-8
RESETion, 29-10
RESETion, in FUNCTION:FFT command, 16-13
Response data, 1-19
Response Generation, 6-11
responses, buffered, 6-11
result state code, and SENDvalid, 19-68
RESULTS, 19-61 to 19-64
retrieval and storage, 14-2
returning control to system controller, 2-8
returning control to system controller, 2-16
rise time measurement setup, 19-3
RISetime, 19-65 to 19-66
RMS voltage, and VRMS, 19-94
Root Level Commands, 9-2, 9-33, 9-40
AER?, 9-10
AUToscale, 9-11
BLANK, 9-13
CDISPlay, 9-14
DIGitize, 9-15
ERE, 9-17
HER (Histogram Event Enable), 9-18
HER? (Histogram Event Register), 9-19
SAVE, 25-4
Save (*SAVE), 8-20
LTER? (Limit Test Event Register), 9-22
MENu, 9-33
MERE, 9-24
MTEE (Mask Test Event Enable), 9-25
MTER? (Mask Test Event Register), 9-27
OPES (Operation Status Event Enable), 9-28
OPER? (Operation Status Register), 9-29
PRINT, 9-30
RECall, 9-31
RUN, 9-32
SINGLe, 9-34
STOP, 9-35
STORE, 9-36
THER? (Trigger Event Register), 9-37
UEE (User Event Enable), 9-38
UER? (User Event Register), 9-39
Root Level Commands Syntax Diagram, 9-3
ROW, 15-23
RQC (Request Control) Status Bit, 4-4
RQS bit, 8-7, 8-9
RQS (Request Service) default, 2-3
RQC (Request Service) Status Bit, 4-4
RQS and *STB, 8-33
RQSMESS bit, 8-24
*RST (Reset), 8-15 to 8-19, 15-21
RTIME, 11-11
rule of truncation, 6-5
rules of traversal, 6-7
RUN, 9-32, 26-32 to 26-34
RUN and GET commands relationship, 2-8
RUN, in LIMIT TEST command, 27-14 to
RUNTHI, in HISTogram command, 29-8
S
Sample RATE, 11-14 to 11-15
sample rate and bandwidth limit, 11-5
sample rate and number of points, 11-12
Samples softkey, 28-33
sampling mode, 11-11
saturation, 15-25
Status Reporting Decision Chart, 4-18
SAVE (Save), 8-20
Save (*SAVE), 8-20
save/recall register, 8-14, 8-20
Index-11
saving limit test waveforms, 27-37
saving Mark Test waveforms, 28-62
SCALE, 13-21, 21-9
SCALE, in HISTogram command, 29-9
OFFSET, 29-10 to 29-11
RANGE, 29-12 to 29-13
SCALE, 29-14 to 29-15
TYPE, 29-16
SCALE, in MEASURE:HISTogram command, 19-48
SCALE:DEFault, 28-35
SCALE:SOURce, 28-36 to 28-37
SCALE:X1, 28-38 to 28-39
SCALE:XDELta, 28-40 to 28-41
SCALE:Y, 28-43
SCOLor, 15-24 to 15-27
SCORch, 19-67
SCREEN (HArdcopy:AREA), 17-6
selected device clear (SDC), 2-8
Selecting Multiple Subsystems, 1-12
self test, 8-26
 Semi-colon
and multiple functions, 5-11
and multiple subsystems, 5-10
semi-colon usage, 1-7
sending compound queries, 3-4
Sending Program Messages, 5-3
SENDvalid, 19-68
SENGivit, 13-22
separator, 1-6
separators in syntax, 1-4
Sequential and Overlapped Commands, 6-11
SERial (SERial number), 9-33
serial number, reading, 8-13
serial poll (SPOLL) in example, 4-9
serial poll, disabling, 2-8
serial polling of the Status Byte Register, 4-9
serial prefix, reading, 8-10
Service Request code and capability, 2-4
Service Request Enable (*SRE), 8-21 to 8-22
Service Request Enable Register (SRE), 4-10
Service Request Enable Register Bits, 8-22
Service Request Enable Register default, 2-3
setting
bits in the Service Request Enable Register, 4-10
horizontal tracking, 16-17
LCL bit, 4-13
lower test limit, 27-11
paper length, 17-13
speed of printer, 17-14
Standard Event Status Enable Register bits, 4-12
time and date, 10-21
TRG bit, 4-10
upper test limit, 27-41
voltage and time markers, 18-2
setting up for programming, 1-13
Setting Up the Instrument, 1-14
SETup, 10-19 to 10-20
setup recall, 8-14
SETup, in MENU: command, 9-23
setup, storing, 14-6
707, 1-18
Short form, 1-10
short form instructions, 5-4
short form of mnemonics, 6-5
short-form headers, 1-10
simple and compound commands, combining, 5-10
Simple command header, 1-7
Simple Command Headers, 1-7, 5-5
SINGLE, 9-34
single-wide plug-in
calibration, 12-4
sample rate, 11-14
SKEW, in CALibrate command, 12-21
SLOPe, 22-36
slope conditions, and triggering, 22-21
SLOPe, and STATe, 22-42
softkey
 FAIL, 27-9, 27-12
 Ignore, 27-12
 Samples, 28-33
 Waveforms, 27-14, 28-33
 software version, reading, 8-10
SOURCe, 15-29, 19-69 to 19-70, 24-25, 26-11
SOURCE command, and measurements, 19-5
source for FFT, 26-11
source for Limit Test, 27-17
SOURCe, and GUITrOn, 22-26
SOURCe, and TRIGger, 22-37
source, and WINDOW:SOURce, 21-15
SOURCe, in LIMIT: command, 27-17
space between header and data, 1-10
Spaces and Commas, in Program Data, 5-8
SPAN, 26-12
SPAN, in FUNCTION:FFT command, 16-14
speed of printer, 17-14
spelling of headers, 1-10
SPOLL example, 4-9
SRATe, 11-14 to 11-15
*SRE (Service Request Enable), 8-21 to 8-22
SRE (Service Request Enable Register), 4-10
SSCReen, 28-44 to 28-45
SSCReen, in LIMIT: command, 27-18 to 27-19
DDISK, 27-20
DDISK:BACKGROUND, 27-21
DDISK:MEDIA, 27-22
DDISK:PRORmat, 27-23
DPRInter, 27-24
DPRInter:ADDRess, 27-25
DPRInter:BACKground, 27-26
DPRInter:MEDIA, 27-27
DPRInter:PRORmat, 27-28
DPRInter:PORT, 27-29
SSUMmary, 28-50 to 28-57
SSUMmary, in LIMIT: command, 27-30 to 27-31
ADDRess, 27-32
FORMat, 27-33
MEDia, 27-34
PFORmat, 27-35
PORT, 27-36
Standard Event Status Enable Register (SESER), 4-12
Standard Event Status Enable Register Bits, 8-7
Standard Event Status Enable Register default, 2-3
Standard Event Status Register (ESR), 4-11

| Index-12 |
Standard Event Status Register
Bits, 8-9
Standard Status Data Structure
Model, 4-2
STATe, and ACQuire:COMPlEte
command, 11-8
STATe, in TRIGGER command,
22-38
CLOCK, 22-39
CONDition, 22-40
LOGic, 22-41
SLOPe, 22-42
STATistics, 19-71
Status, 1-20
Status Byte (*STB), 8-23 to 8-24
Status Byte Register, 4-8 to 4-9
Status Byte Register and serial
polling, 4-9
Status Byte Register Bits, 8-24
Status Byte Register default, 2-3
Status Messages, 2-8
status of an operation, 4-2
Status registers, 1-20, 8-4
Status Reporting, 4-2
Status Reporting Bit Definitions,
4-4
Status Reporting Data
Structures, 4-5 to 4-7, 9-7 to 9-9
STATus, in CALibrate command,
12-22
*STB (Status Byte), 8-23 to 8-24
STDDev, in
MEASURE:HISTORY command,
19-49 to 19-50
STOP, 9-35
storage and retrieval, 14-2
STORE, 9-36, 14-6
Store SCReen command, 27-18,
28-44
STRING, 15-29
String Variable Example, 1-18
String variables, 1-18
string, quoted, 15-19
strings:
- alphanumeric, 1-11
- structure of commands, 1-4
SUBTRACT, 15-29
Suffix Multiplier, 3-9
suffix multipliers, 1-11
suffix multipliers, in program
data, 5-8
Suffix Unit, 3-10
Suffix units, 3-10
summary bits, 4-8
SWAVEform, 26-82 to 28-63
SWAVEform, in LIMIT TEST
command, 27-37 to 27-38
SWEep, 22-49
switch:
- mainframe calibration protect,
12-3
- plug-in calibration protect, 12-4
Syntax Diagrams
Common Commands, 8-3
element, 3-6
Marker Subsystem, 18-3 to 18-4
Syntax diagrams
Hardcopy Subsystem, 17-3 to 17-
4
IEEE 488.2, 3-5
Syntax Diagrams, definition, 3-5
to 3-7
syntax error, 30-4
syntax for programming, 5-2
Syntax Overview, 3-8 to 3-10
System Commands, 10-2
DATE, 10-4
dsp, 10-5 to 10-6
ERRort, 10-7 to 10-9
HEADER, 10-10
KEY, 10-11 to 10-16
LONGformat, 10-17 to 10-18
SETup, 10-19 to 10-20
TIME, 10-21 to 10-22
System Commands Syntax
Diagram, 10-3
system controller, returning
control to, 2-8
SYSTem:DISPLAY and masking,
15-21
SYSTEM:SETUP and *LRE, 8-11
T
TALK/Listen mode, 2-5
Talker code and capability, 2-4
talker, unaddressing, 2-8
Talking to the Instrument, 1-3
TDELay, 19-9
TDLY, and DTIME, 22-15
TEDGE, in MEASURE command, 19-72 to
19-73
temperature and best accuracy
calibration, 12-7
temperature and calibration, 12-3
TERR (Trigger Event Register?), 9-37
termination of message during hardcopy,
3-4
Terminator, 1-12
Terminator, Program Message, 1-12
terminators in syntax, 1-4
TEST, 28-44
test (*TST), 8-25
test failure, 27-9, 27-12, 27-15, 28-33 to
28-34
test, in LIMIT TEST command, 27-39 to
27-40
text, 15-30
The Command Tree, 6-6 to 6-10
THINKjet (HARDcopy:DEVice), 17-9
threshold, and DEFINE, 19-14 to 19-15
THRESHold, in MEASURE:FFT command,
19-28
TIFF (HARDcopy:DEVice), 17-9
time, 10-21 to 10-22
time and date, setting, 10-2
time base reset condition, 8-15
time base scale and number of points,
11-12
time buckets, and COMPlEte?, 24-11
time buckets, and POINTs?, 24-19
time difference between markers, 19-9
time interval, and DELay, 21-4
time scale and operands, 16-3
time scale of functions, 16-3
Timebase Commands, 21-2
DELay, 21-4
POSItion, 21-6
RANGe, 21-7
REference, 21-8
SCALE, 21-9
VIEW, 21–10
WINDOW:DELAY, 21–11
WINDOW:RANGE, 21–14
WINDOW:SOURCE, 21–15
TIMEbase:POSITION, and DELAY, 21–5
TIMEbase:REFERENCE, and DELAY, 21–4
TMAX, 19–74 to 19–75
TMIN, 19–76 to 19–77
top-base, and DEFine, 19–14
TOPBase, and DEFine, 19–15
TRACKING MODE, 18–23
transferring waveform data, Waveform Commands, 24–2
transmission mode, and FORMat, 24–17
TRANSParency (HARDeCopy:MEDIA), 17–14
traversal rules, 6–7
Tree TRaversal Examples, 6–10
Tree TRaversal Rules, 6–7
**TRG (Trigger), 8–25
TRG (Trigger Event Register), 4–10
TRG bit, 8–22, 8–24
TRG bit in the status byte, 4–10
TRG Event Enable Register, 4–4
Trigger (*TRG), 8–25
Trigger (TRG), Status Bit, 4–4
Trigger Commands, 22–2
DEVent, 22–8
DTIME, 22–15
EDGe, 22–21
GLITCH, 22–24
HOLDoff, 22–28
HYSTEResis, 22–29
LEVEL, 22–30
MODE, 22–31
PAToern, 22–33
SLOpe, 22–36
SOURCE, 22–37
STATE, 22–38
STV, 22–43 to 22–48
SWEEP, 22–49
UDTV, 22–50 to 22–56
Trigger Event Register (TRG), 4–10
trigger hysteresis, 22–25
trigger reset conditions, 8–16
Trigger Commands, 23–2 to 23–3
PROBE, 23–4
truncating numbers, 1–11
Truncation Rule, 6–5
*TST (Test), 8–26
*TST (Test), 8–26
TSTArt, 18–10 to 18–11
TSTOP, 18–12 to 18–13
TVOLAT, 19–78 to 19–79
two-wide plug-in
 calibration, 12–5
TYPE, 11–16 to 11–18
TYPE?, 24–26 to 24–27
types of program data, 1–10
U
UEE, 9–98
UER (User Event Register), 4–13
UER?, 9–39
ULIMIt, in Limit TESr command, 27–41 to 27–42
unaddressing all listeners, 2–8
UNITs, 13–23
ATTenuation, 13–24
OFFSET, 13–25 to 13–26
units, vertical, 13–23
universal unital (UNT), 2–5
UNKnown vertical units, 13–23
upper test limit, 27–41
upper-case headers, 1–10
upper-case letters and responses, 1–11
Upper/Lower Case Equivalence, 3–9
Uppercase, 1–10
URQ (User Request) Bit, 8–6
URQ bit, 8–7, 8–9
User Event Register (UER), 4–13
User Request (URQ), Status Bit, 4–4
User Request Bit (URQ), 8–6
User-Defined Measurements, 19–3
Using the Digitize Command, 1–16 to 1–16
USR bit, 9–22, 9–24
Utility menu for addressing, 2–5
utility reset conditions, 8–19
UTILITY, in MENU command, 9–23
V
VAMPitude, 19–80 to 19–81
VAverage, 19–82 to 19–83
VBASE, 19–84 to 19–85
VElSet, 18–14
vertical axis, full-scale, 13–19
version of software, reading, 8–10
VERSUs, 16–30
VERTical, 16–31
vertical axis control, 13–2
vertical axis offset, and YRANge, 25–6
vertical range for FTT, 26–9
vertical scaling and functions, 16–3
vertical scaling, and YRANge, 25–6
vertical units, 13–23
video, inverse, 15–18
VIEW, 9–40, 21–10, 24–28 to 24–29
VIEW and BLANK, 9–13
VLOWER, 19–86
VMAX, 19–87 to 19–88
VMIDdle, 19–89
VMIN, 19–90 to 19–91
voltagage at center screen, 13–10
VOLTS as vertical units, 13–23
VPP, 19–92 to 19–93
VRMS, 19–94 to 19–95
VSTOP, 18–15 to 18–16
VSTOP, 18–17 to 18–18
VTIME, 19–95
VTOP, 19–97 to 19–98
VUPPER, 19–99 to 19–100
W
W, and DATA, 24–15
*WAit (Wait-to-Continue), 8–27 to 8–28
Wait-to-Continue (WATD), 8–27 to 8–28
WATTs as vertical units, 13–23
Waveform Commands, 24–2, 24–4
BYToorder, 24–9
COMPLETE?, 24–11
FORMat, 24–17
POInts?, 24–19
PREamble, 24–20
TYPE?, 24–26
VIEW, 24–28
XDISPlay?, 24–30
XINCrement?, 24–31
XORgin?, 24–32
XRANGE?, 24–33
XREFerence?, 24–34
YDISPlay?, 24–36
YINCrement?, 24–37
YORigin?, 24–38

Index-14
<table>
<thead>
<tr>
<th>Command</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YRANGE?</td>
<td>24-39</td>
</tr>
<tr>
<td>YREFERENCE?</td>
<td>24-40</td>
</tr>
<tr>
<td>YUNITS?</td>
<td>24-41</td>
</tr>
<tr>
<td>Waveform Data and Preamble</td>
<td>24-3</td>
</tr>
<tr>
<td>Waveform Memory Commands</td>
<td>25-2, 25-4</td>
</tr>
<tr>
<td>DISPLAY</td>
<td>25-4</td>
</tr>
<tr>
<td>XOFFSet</td>
<td>25-5</td>
</tr>
<tr>
<td>XTRAINe</td>
<td>25-5</td>
</tr>
<tr>
<td>YOFFSET</td>
<td>25-6</td>
</tr>
<tr>
<td>XTRAINe</td>
<td>25-6</td>
</tr>
<tr>
<td>Waveform Memory, and DATA</td>
<td>24-14</td>
</tr>
<tr>
<td>Waveform reset conditions</td>
<td>8-18</td>
</tr>
<tr>
<td>Waveform softkey</td>
<td>27-14, 28-33</td>
</tr>
<tr>
<td>waveform type, and COUNT?</td>
<td>24-12</td>
</tr>
<tr>
<td>waveform type, and TYPE?</td>
<td>24-26</td>
</tr>
<tr>
<td>waveform types, and COMPLETE?</td>
<td>24-11</td>
</tr>
<tr>
<td>Waveform View Parameters</td>
<td>24-29</td>
</tr>
<tr>
<td>waveform, storing</td>
<td>14-6</td>
</tr>
<tr>
<td>WAVEFORM:COUNT, and COMPLETE?</td>
<td>24-11</td>
</tr>
<tr>
<td>WAVEFORM:SOURCe, and DATA</td>
<td>24-14</td>
</tr>
<tr>
<td>WHITE (HARDCopy:BACKGROUND)</td>
<td>17-7</td>
</tr>
<tr>
<td>White space</td>
<td>1-6, 3-9</td>
</tr>
<tr>
<td>White Space (Separator)</td>
<td>1-5</td>
</tr>
<tr>
<td>WINDOW, and GLITCH</td>
<td>22-27</td>
</tr>
<tr>
<td>WINDOW, 25-13 to 26-14</td>
<td></td>
</tr>
<tr>
<td>window type for FFT</td>
<td>26-13</td>
</tr>
<tr>
<td>WINDOW, and VIEW</td>
<td>21-10, 24-28</td>
</tr>
<tr>
<td>WINDOW, in FUNCTION:FFT command</td>
<td>16-14 to 16-15</td>
</tr>
<tr>
<td>WINDOW, in HISTogram command</td>
<td>SOURCe, 28-17</td>
</tr>
<tr>
<td>X1Position</td>
<td>18-19</td>
</tr>
<tr>
<td>X1YSource</td>
<td>18-21</td>
</tr>
<tr>
<td>X2Position</td>
<td>18-20, 18-25</td>
</tr>
<tr>
<td>X2YSource</td>
<td>18-22</td>
</tr>
<tr>
<td>XDELTa?</td>
<td>18-23</td>
</tr>
<tr>
<td>XDISPlay?</td>
<td>24-30</td>
</tr>
<tr>
<td>XINCrement?</td>
<td>24-31</td>
</tr>
<tr>
<td>XOFFSet</td>
<td>25-6</td>
</tr>
<tr>
<td>XORigin?</td>
<td>24-32</td>
</tr>
<tr>
<td>XTRAINe</td>
<td>25-5</td>
</tr>
<tr>
<td>XTRAINe</td>
<td>24-33</td>
</tr>
<tr>
<td>XREFERENCE?</td>
<td>24-34</td>
</tr>
<tr>
<td>XUNITS?</td>
<td>24-35</td>
</tr>
</tbody>
</table>

**Y**

- Y-axis control          | 13-2    |
- Y1Position               | 18-24   |
- YDELTa?                  | 18-26   |
- YDISPlay?                | 24-36   |
- YINCrement,             | 24-37   |
- YOFFSet                  | 25-5    |
- YORigin?                 | 24-38   |
- XTRAINe                   | 25-6    |
- XTRAINe                   | 24-39   |
- YREFERENCE?              | 24-40   |
- YUNITS?                  | 24-41 to 24-42 |

**X**

- x axis duration, and XTRAINe? | 24-33 |
- x axis, controlling         | 21-2   |
- X vs Y                      | 16-30  |
- x-axis offset, and XOFFSet  | 25-5   |
- x-axis range, and XTRAINe   | 25-5   |
- x-axis units, and XUNITS    | 24-35  |