

**HP 82000 IC Evaluation System**  
**HP-IB Command Reference**

**Models D50, D100, D200 and D400**

**SERIAL NUMBERS**

This manual affects all systems with software revisions up to 2.0.0



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**Revision 2.0**

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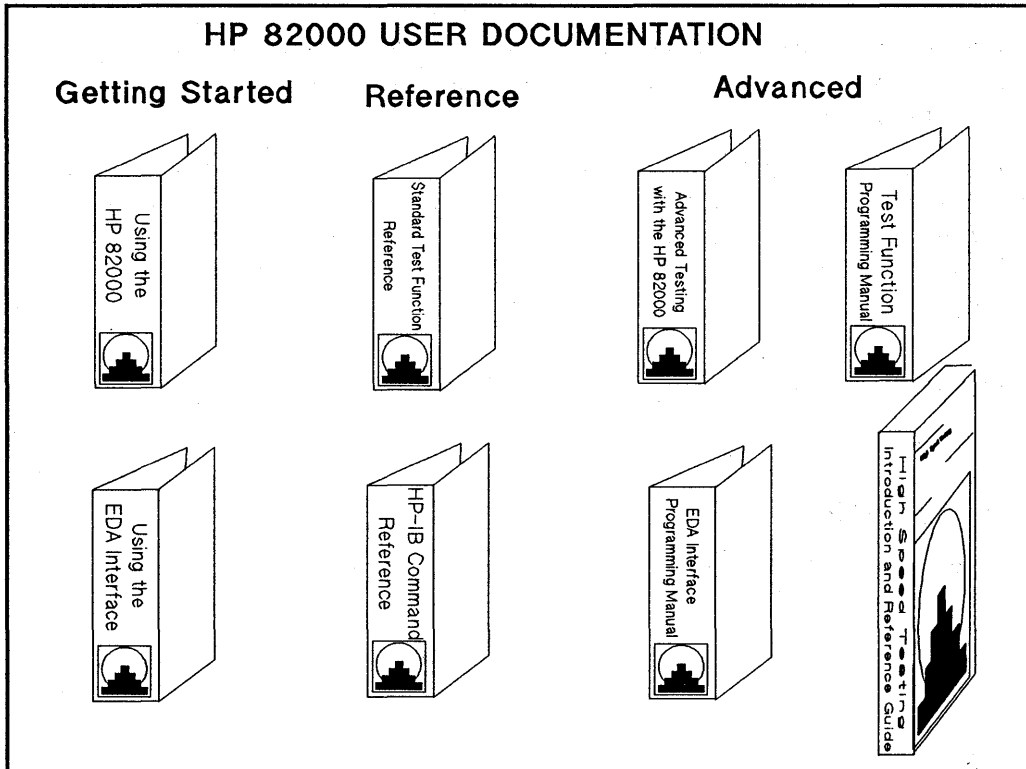
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### **October 1990**

**Revision 2.0 (Software versions up to 2.0.0)**

# Documentation Map

The following figure shows the User manuals available for the HP 82000 IC Evaluation System.





**Installation and Service Documentation:**

**Site Preparation and Planning Guide**

**Installing the HP 82000**

**Maintaining the HP 82000**

**Servicing the HP 82000**

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## Preface

### Purpose

The purpose of this manual is to describe how to use HP-IB commands to program the HP 82000 IC Evaluation System. The manual does not aim to provide a description of HP-IB programming or the theory of the HP-IB interface.

### Audience

This manual is intended for experienced users of the HP 82000, who want to develop test programs in BASIC or C, or write test functions in C.

The subject of using the HP-IB commands from a BASIC or C program is described in the manual *Advanced Testing with the HP 82000*.

# Contents

---

<b>1. Introduction</b>	
Hardware - Software Interaction . . . . .	1-2
Interpreting Firmware Instructions . . . . .	1-2
Notation of HP-IB Commands . . . . .	1-3
Queries . . . . .	1-4
Syntax . . . . .	1-4
Using the hpt Utility . . . . .	1-4
<b>2. Configuration Setup Commands</b>	
Listing Installed Boards . . . . .	2-2
Defining Pin Names . . . . .	2-4
Syntax . . . . .	2-4
Power-On Defaults . . . . .	2-5
Removing Pin Name Definitions . . . . .	2-5
Setting Pin Capabilities . . . . .	2-6
Syntax . . . . .	2-6
io-mode . . . . .	2-6
operation-mode . . . . .	2-7
scan-path-mode . . . . .	2-8
pin-list . . . . .	2-9
Setting up Power Supply Pins . . . . .	2-9
Power-On Defaults . . . . .	2-10
Errors . . . . .	2-11
Examples . . . . .	2-11
Example 1 . . . . .	2-11
Example 2 . . . . .	2-12

<b>3. Level Setup Commands</b>	
Level Commands . . . . .	3-1
Specifying the Timing Reference . . . . .	3-2
Syntax . . . . .	3-2
Driver Level Settings . . . . .	3-2
Syntax . . . . .	3-2
Errors . . . . .	3-4
Warnings . . . . .	3-4
Driver Level Settings . . . . .	3-4
Syntax . . . . .	3-4
Errors . . . . .	3-5
Warnings . . . . .	3-5
Receiver Threshold Commands . . . . .	3-6
Syntax . . . . .	3-6
Errors . . . . .	3-7
Warnings . . . . .	3-7
Setting Power Supply Levels . . . . .	3-7
Defaults . . . . .	3-8
Errors . . . . .	3-8
Examples . . . . .	3-9
<b>4. Format and Timing Setup Commands</b>	
Setting Up the System Clock . . . . .	4-2
Setting the System Clock Period . . . . .	4-2
Synchronizing the System Clock . . . . .	4-4
Checking the System Clock Setting . . . . .	4-5
Power-On Defaults . . . . .	4-6
Errors . . . . .	4-6
Setting Driver Format and Timing . . . . .	4-6
Syntax . . . . .	4-6
Leading Edge Delays . . . . .	4-7
Trailing Edge Delays . . . . .	4-10
Power-On Defaults . . . . .	4-12
Errors . . . . .	4-12
Setting Receiver Format and Timing . . . . .	4-12
Syntax . . . . .	4-13
Power-On Defaults . . . . .	4-14
Errors . . . . .	4-14

Example . . . . .	4-15
<b>5. Vector Setup</b>	
Static Vector Setup Commands . . . . .	5-2
Syntax . . . . .	5-2
Setting Driver Channel Static Vectors . . . . .	5-2
Setting Receiver Channel Static Vectors . . . . .	5-3
Power-On Defaults . . . . .	5-3
Autocorrection Rules . . . . .	5-4
Errors . . . . .	5-4
Warnings . . . . .	5-4
Example . . . . .	5-4
Vector Transfer Commands . . . . .	5-5
Syntax . . . . .	5-5
Transferring Driver and Receiver Vector Data . . . . .	5-6
Power-On Defaults . . . . .	5-7
Errors . . . . .	5-8
Warnings . . . . .	5-8
Example . . . . .	5-8
Vector Data Format . . . . .	5-9
Calculating the Data Transfer Block Size . . . . .	5-9
Data Formats . . . . .	5-12
STD Mode . . . . .	5-12
Word Mask Pins . . . . .	5-13
FD Mode . . . . .	5-14
MUX Mode and FQ2 mode . . . . .	5-15
Drive Data . . . . .	5-15
Expected Data . . . . .	5-15
FQ Mode . . . . .	5-16
Drive Data . . . . .	5-16
Expected Data . . . . .	5-16
FQM Mode . . . . .	5-17
Expected Data . . . . .	5-17

<b>6. Vector Sequencer Commands</b>	
Programming the Vector Sequencer . . . . .	6-1
Syntax . . . . .	6-2
Setting and Reading Sequencer States . . . . .	6-2
Writing a Sequencer Instruction . . . . .	6-3
The DEFAULT Sequencer Program . . . . .	6-6
Setting the First Free Sequencer Address . . . . .	6-6
Setting the Sequencer Start Address . . . . .	6-6
Clearing Sequencer Labels . . . . .	6-6
Setting Sequencer Global Conditions . . . . .	6-6
Setting the Sequencer External Input . . . . .	6-7
Power-On Defaults . . . . .	6-8
Errors . . . . .	6-9
Warnings . . . . .	6-9
Example . . . . .	6-9
<b>7. Test Function Commands</b>	
Setting the Tester States . . . . .	7-1
Examples . . . . .	7-2
Switching from DISCONNECT to CONNECT . . . . .	7-2
Switching from CONNECT to DISCONNECT . . . . .	7-2
Functional Test Commands . . . . .	7-2
Syntax . . . . .	7-3
Sequencer Start Label . . . . .	7-4
Receive Mode . . . . .	7-4
Sequencer States . . . . .	7-5
Performing a Functional Test . . . . .	7-5
Reloading the Pattern Memory during a Functional Test . . . . .	7-6
Example . . . . .	7-7
Power-On Defaults . . . . .	7-7
Errors . . . . .	7-8
AC Measurement Commands . . . . .	7-8
Syntax . . . . .	7-10
Defining Edge Search Parameters . . . . .	7-12
Measuring Propagation Delay and Data Hold Time . . . . .	7-12
Pass/Fail Test for 100 MHz and 200 MHz MUX-mode Pins . . . . .	7-12
Value Test Data Hold Time for 100 MHz and 200 MHz MUX-mode Pins . . . . .	7-13

Value Test Propagation Delay for 100 MHz and 200	
MUX-mode Pins . . . . .	7-14
Testing 200 MHz FD, FQ2, FQ and FQM mode pins . . . . .	7-14
Example . . . . .	7-15
Setup / Hold Time Measurement . . . . .	7-17
Setup Time Pass/Fail and Value Test . . . . .	7-17
Hold Time Pass/Fail and Value Test . . . . .	7-18
Example . . . . .	7-19
Pulse / Pause Width Measurement . . . . .	7-20
Input / Output Level Measurement . . . . .	7-21
$V_{IH}$ , $V_{IL}$ Pass/Fail and Value Test . . . . .	7-21
$V_{OH}$ , $V_{OL}$ Pass/Fail and Value Test . . . . .	7-22
Example . . . . .	7-23
High Resolution Timing Diagram . . . . .	7-24
Syntax . . . . .	7-25
Finding the Limitations Imposed by the Hardware . . . . .	7-26
Defining the Test Function Parameters . . . . .	7-26
Running the Test Function . . . . .	7-27
Getting the Test Results . . . . .	7-27
Examples . . . . .	7-28
DC Measurement Commands using the PMU . . . . .	7-29
Syntax . . . . .	7-29
Setting the Parameters for a DC Measurement . . . . .	7-30
Retrieving Measurement Results from a DTST Command . . . . .	7-32
Performing a DC Measurement . . . . .	7-33
DC Measurement Details . . . . .	7-34
Relay Setting . . . . .	7-34
Measurement Sequence . . . . .	7-34
PMU Usage . . . . .	7-34
PMU Ranges . . . . .	7-34
DC Measurement Commands using the DPS . . . . .	7-35
Errors . . . . .	7-35
Low Level Test Commands . . . . .	7-36
General Considerations . . . . .	7-36
Relay Commands . . . . .	7-37
Syntax: . . . . .	7-38
Power Supply Relay Commands . . . . .	7-39
Errors . . . . .	7-40

Warnings . . . . .	7-40
Examples . . . . .	7-40
PMU measurement in parallel mode: . . . . .	7-40
PMU measurement in serial mode: . . . . .	7-40
Sequencer Commands . . . . .	7-41
Syntax . . . . .	7-41
Errors . . . . .	7-41
PMU Commands . . . . .	7-41
Syntax . . . . .	7-41
Setting up the PMU . . . . .	7-41
Making a PMU Measurement . . . . .	7-43
Errors . . . . .	7-45
Utility Lines . . . . .	7-45
Syntax . . . . .	7-45
Setting the Utility Output Lines . . . . .	7-45
Reading the Utility Output Lines . . . . .	7-45
Reading the Utility Input Lines . . . . .	7-45
Power-On Defaults . . . . .	7-46
Example . . . . .	7-46
High Throughput Commands . . . . .	7-46
Performing AC Functional Tests . . . . .	7-47
Saving a Parameter Set . . . . .	7-47
Example . . . . .	7-48
Loading a Parameter Set . . . . .	7-48
Example . . . . .	7-49
Executing a Functional Test . . . . .	7-49
Example . . . . .	7-50
Performing DC tests . . . . .	7-50
Setting Up a PMU Voltage Measurement . . . . .	7-50
Example . . . . .	7-51
Setting Up a PMU Current Measurement . . . . .	7-52
Example . . . . .	7-52
Reading Pre-saved DC Parameters . . . . .	7-53
Executing a DC Test . . . . .	7-53
Setting the Relay Switching Method . . . . .	7-54



<b>8. Test Result Commands</b>	
Commands and their Modes . . . . .	8-1
Syntax . . . . .	8-2
Reading the Error Map . . . . .	8-3
Getting Pass/Fail Information for a Pin . . . . .	8-3
Getting the Number of Errors Detected in the Last Test . . . . .	8-3
Getting pass/fail information for the last test . . . . .	8-3
Reading the Data Acquisition Memory . . . . .	8-4
Reading the amount of data in the Error Map/ Received Data RAM . . . . .	8-4
Reading how many cycles there were between the event address and acquisition stop . . . . .	8-4
Mapping Machine Cycles to Sequencer Instructions . . . . .	8-5
Errors . . . . .	8-6
Examples . . . . .	8-6
Result Data Storage . . . . .	8-7
<b>9. Status and Error Commands</b>	
Status Byte . . . . .	9-2
Event Status Register . . . . .	9-4
Event Summary Register . . . . .	9-5
Tester Status Registers . . . . .	9-6
Status Register . . . . .	9-6
Transition Filter . . . . .	9-7
Event Register . . . . .	9-7
Event Enable Register . . . . .	9-7
Hardware Status . . . . .	9-9
Test Function Status . . . . .	9-9
Error Handling . . . . .	9-10
Introduction . . . . .	9-10
Error Categories . . . . .	9-10
Error Queue . . . . .	9-11
SELF TEST . . . . .	9-12
Command Synchronization . . . . .	9-12
Introduction . . . . .	9-12
Handshake Holdoff . . . . .	9-13
Example . . . . .	9-13
Operation Complete Message . . . . .	9-14

Protocol Re-synchronization . . . . .	9-14
System Reset . . . . .	9-15

**10. Calibration Commands**

Level Calibration . . . . .	10-1
Syntax . . . . .	10-2
Calibrating the ADC . . . . .	10-2
Calibrating the Mainframe . . . . .	10-3
Calibrating Driver Outputs and Receiver Thresholds . . . . .	10-3
AC Calibration Commands . . . . .	10-4
Syntax . . . . .	10-4
Calibrating the Cal Probe . . . . .	10-6
Calibration Period . . . . .	10-6
Determining which Channel is being Calibrated . . . . .	10-6
Performing a Driver Timing Calibration . . . . .	10-7
Performing a Receiver Timing Calibration . . . . .	10-7
User Calibration . . . . .	10-7
Stopping the Calibration Routine . . . . .	10-7
Calibration Data Transfer . . . . .	10-8
Syntax . . . . .	10-9
Additional Calibration Data Information . . . . .	10-13
Reading the Calibration State . . . . .	10-14
Power-On Defaults . . . . .	10-14
D100, D200 and D400 . . . . .	10-14
50 MHz . . . . .	10-15
User Calibration . . . . .	10-15
Notes . . . . .	10-15
Errors . . . . .	10-15
Warnings . . . . .	10-15
D400 Calibration Commands . . . . .	10-15
HSWG Calibration: . . . . .	10-16
Syntax . . . . .	10-16
Width Generator Calibration Data . . . . .	10-17
Width Generator Calibration Setup . . . . .	10-17
Executing the Width Generator Calibration . . . . .	10-18
400 MHz Channel AC Calibration . . . . .	10-19
Syntax . . . . .	10-19
400 MHz Channel Calibration Data . . . . .	10-19

400 MHz Channel Calibration . . . . .	10-20
400 MHz User Calibration . . . . .	10-20
Syntax . . . . .	10-20
Performing 400 MHz User Calibration . . . . .	10-21
PMU Calibration . . . . .	10-21
Errors . . . . .	10-25
Diagnostic Commands . . . . .	10-25
Performing System Diagnostics . . . . .	10-25
Syntax . . . . .	10-25
<b>11. Pin and System Attribute Commands</b>	
Pin Attribute Commands . . . . .	11-1
Syntax . . . . .	11-1
Description . . . . .	11-2
Threshold Correction without active termination . . . . .	11-2
Threshold Correction for active termination (TERM, IOH, IOL) pins . . . . .	11-2
Power-On Defaults . . . . .	11-3
Errors . . . . .	11-4
Warnings . . . . .	11-4
Setting System Attributes . . . . .	11-4
Syntax . . . . .	11-4
Description . . . . .	11-4
Power-On Defaults . . . . .	11-5
Errors . . . . .	11-5
<b>12. HP-IB Command Syntax</b>	
Introduction . . . . .	12-1
General Information . . . . .	12-1
System HP-IB Commands . . . . .	12-2
Global definitions . . . . .	12-2
ADCM? . . . . .	12-5
AQST? . . . . .	12-6
CALI, CALI? . . . . .	12-7
CALP, CALP? . . . . .	12-9
CALS? . . . . .	12-10
CHER? . . . . .	12-11
CMNT, CMNT? . . . . .	12-12

CONF, CONF?	12-13
DCGB, DCGB?	12-15
DCL	12-17
DCPR?	12-18
DCSR?	12-19
DFCM	12-20
DFPM?	12-22
DFPN, DFPN?	12-23
DFPS, DFPS?	12-25
DFVM	12-26
DIAG	12-28
DLCD, DLCD?	12-29
DPAR, DPAR?	12-31
DRLC?	12-32
DRLM, DRLM?	12-33
DRLS?	12-34
DRLV, DRLV?	12-35
DRLX, DRLX?	12-37
DRTM, DRTM?	12-39
DRVD, DRVD?	12-42
DTCD, DTCD?	12-45
DTMC?	12-47
DTST	12-49
DTUC?	12-50
DTUD, DTUD?	12-51
ERCT?	12-52
ERMP?	12-53
ERRS?	12-55
ESGB, ESGB?	12-56
EXPD, EXPD?	12-57
FTCK?	12-60
FTST?	12-61
GETV?	12-62
HRTL?	12-64
HRTM	12-65
H RTP, H RTP?	12-66
HRTR?	12-67
HWEN, HWEN?	12-68

HWET? . . . . .	12-69
HWFL, HWFL? . . . . .	12-70
HWRS, HWRS? . . . . .	12-71
HWST? . . . . .	12-72
IFC . . . . .	12-73
ITMC? . . . . .	12-74
IXMD? . . . . .	12-75
LDHW, LDHW? . . . . .	12-76
MFLC? . . . . .	12-77
MLCD, MLCD? . . . . .	12-78
MTCB, MTCB? . . . . .	12-79
PASS? . . . . .	12-80
PATR, PATR? . . . . .	12-81
PDFT? . . . . .	12-82
PMUM? . . . . .	12-83
PMUS . . . . .	12-84
PSAV . . . . .	12-85
PSCF? . . . . .	12-86
PSLV, PSLV? . . . . .	12-87
PSME? . . . . .	12-89
PSST, PSST? . . . . .	12-90
PTST? . . . . .	12-91
PULL, PULL? . . . . .	12-92
RCES? . . . . .	12-93
RCLC? . . . . .	12-94
RCLS? . . . . .	12-95
RCLV, RCLV? . . . . .	12-96
RCMD, RCMD? . . . . .	12-98
RCTM, RCTM? . . . . .	12-99
RECD? . . . . .	12-101
RLCD, RLCD? . . . . .	12-103
RLYC . . . . .	12-105
RSWM . . . . .	12-106
RTCD, RTCD? . . . . .	12-107
RTMC? . . . . .	12-109
RTUC? . . . . .	12-111
RTUD, RTUD? . . . . .	12-112
SATR, SATR? . . . . .	12-113

## Figures

---

1-1. HP 82000 System Model . . . . .	1-3
4-1. Example of DNRZ Format in 200 MHz Mode . . . . .	4-10
4-2. Example of Different Formats with Tristate . . . . .	4-11
4-3. Example of RZ Format in 200MUX Mode . . . . .	4-11
5-1. Data Alignment (STD and FD mode) . . . . .	5-10
5-2. Transfer Data / Vector RAM alignment (MUX mode) . . . . .	5-11
7-1. DC Wiring Schematics . . . . .	7-37
7-2. Relay Switching Matrix . . . . .	7-39
7-3. PMU I/U Characteristics . . . . .	7-44
9-1. Status Model . . . . .	9-2
9-2. Standard Event Status Model . . . . .	9-4
9-3. Tester Status Model . . . . .	9-6
12-1. Downloaded Strings . . . . .	12-3
12-2. Uploaded Strings . . . . .	12-4

*ESE, *ESE?	12-158
*ESR?	12-159
*IDN?	12-160
*OPC, *OPC?	12-161
*OPT?	12-162
*SRE, *SRE?	12-163
*STB?	12-164
*WAI	12-165

**A. ERRS? Error Codes**

**B. Test Function Error Codes**

Status Messages	B-1
MCD Errors	B-1
BASIC Errors	B-2
Test Function Process Errors	B-2
Break Key	B-2

**Index**

SCCH?	12-114
SCLK, SCLK?	12-115
SDRV, SDRV?	12-117
SELF?	12-119
SNCC, SNCC?	12-120
SPOLL	12-121
SQCL	12-122
SQFA?	12-123
SQGB, SQGB?	12-124
SQPG, SQPG?	12-126
SQSA, SQSA?	12-129
SQSL, SQSL?	12-130
SQSS, SQSS?	12-131
SQST, SQST?	12-132
SQXI, SQXI?	12-133
SREC, SREC?	12-134
STST?	12-136
SYNC, SYNC?	12-137
TDHM?	12-138
TEMP?	12-139
TFEN, TFEN?	12-140
TFET?	12-141
TFFL, TFFL?	12-142
TFRS, TFRS?	12-143
TFST?	12-144
THLD?	12-145
TPDM?	12-146
TPWM?	12-147
TSUP?	12-148
TTMC	12-149
UDEF	12-150
UDPS	12-151
UTIN?	12-152
UTOT, UTOT?	12-153
VALD?	12-154
VCLK?	12-155
VEFA, VEFA?	12-156
VESA, VESA?	12-157



## Tables

---

2-1. ID Code Definitions Bits 0 and 1 . . . . .	2-2
2-2. ID Code Definitions Bits 2 and 3 . . . . .	2-3
2-3. ID Code Definitions Bits 4 to 7 . . . . .	2-3
2-4. ID Code Definitions Bits 8 and 9 . . . . .	2-4
2-5. Availability of Operating Modes and IO Modes . . . . .	2-7
3-1. Drive Level Settings . . . . .	3-3
3-2. Drive Level Settings . . . . .	3-5
3-3. Receiver Threshold Settings . . . . .	3-6
3-4. Receiver Logic Levels . . . . .	3-7
4-1. System Clock Period Settings . . . . .	4-3
4-2. System Clock Period Settings for External Source . . . . .	4-3
4-3. Driver Format and Timing Settings—D50 Systems . . . . .	4-8
4-4. Driver Format and Timing Settings—D100 and D200 Systems . . . . .	4-9
4-5. Driver Format and Timing Settings—D400 Systems . . . . .	4-9
4-6. Trailing Edge Delays—Driver Channels . . . . .	4-10
4-7. Trailing Edge Delays—Receiver Channels . . . . .	4-13
7-1. AC Test Function Timing Resolution (D100, D200 and D400) . . . . .	7-9
7-2. AC Test Function Timing Resolution (D50) . . . . .	7-9
7-3. Driver Formats for Hold Time Tests . . . . .	7-19
7-4. PMU Voltage Range Coding . . . . .	7-42
7-5. PMU Current Range Coding . . . . .	7-43
7-6. PMU Limit Detection Coding . . . . .	7-44
9-1. Status Byte Organization . . . . .	9-3
9-2. Event Status Register Organization . . . . .	9-5
9-3. Hardware Status . . . . .	9-9
9-4. Test Function Status . . . . .	9-10
10-1. . . . .	10-24
10-2. . . . .	10-24
12-1. Drive Level Settings . . . . .	12-35
12-2. Drive Level Settings . . . . .	12-37

12-3. Receiver Threshold Settings . . . . . 12-96  
12-4. System Clock Ranges and Resolutions . . . . . 12-115  
12-5. System Clock Period Settings for External Source . . . . . 12-116

## Introduction

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The HP-IB commands are the firmware instructions used by the Programming Work Station (PWS) to control the HP 82000 hardware.

You can include these commands as instructions within programs written in C or BASIC. In this way, you can combine sequences of HP-IB commands to form your own tests.

The HP-IB commands provide firmware level instructions for:

- configuring pins;
- setting the timing and signal formats;
- setting the levels;
- setting up vector data;
- controlling and programming the vector sequencer;
- programming the utility lines;
- setting up and executing test measurements;
- determining test results;
- performing diagnostics;
- calibrating the system;
- operating the Device Power Supply (DPS);
- handling errors;
- reporting the hardware status;
- and synchronizing commands.

The HP-IB commands for performing all of these tasks are described in this manual.

---

## Hardware - Software Interaction

While you are using the HP 82000 from its interactive software, the interface between the Programming Workstation (PWS) and the hardware operates transparently. The test data and setup data that you enter in the software windows is downloaded to the hardware by interactive software, and you see the test results either as result values, or as an error message in the Report Window (if you have tried to do something that the software will not allow).

What actually happens when you use the interactive software, is that a series of HP-IB commands is sent from the PWS to the hardware. This series of commands may either cause a specific action in the hardware, or they may be sent in the contents of a setup file (such as level or timing setup files, or calibration files). Further HP-IB commands are used to interrogate the hardware, and this information is used to update the software windows.

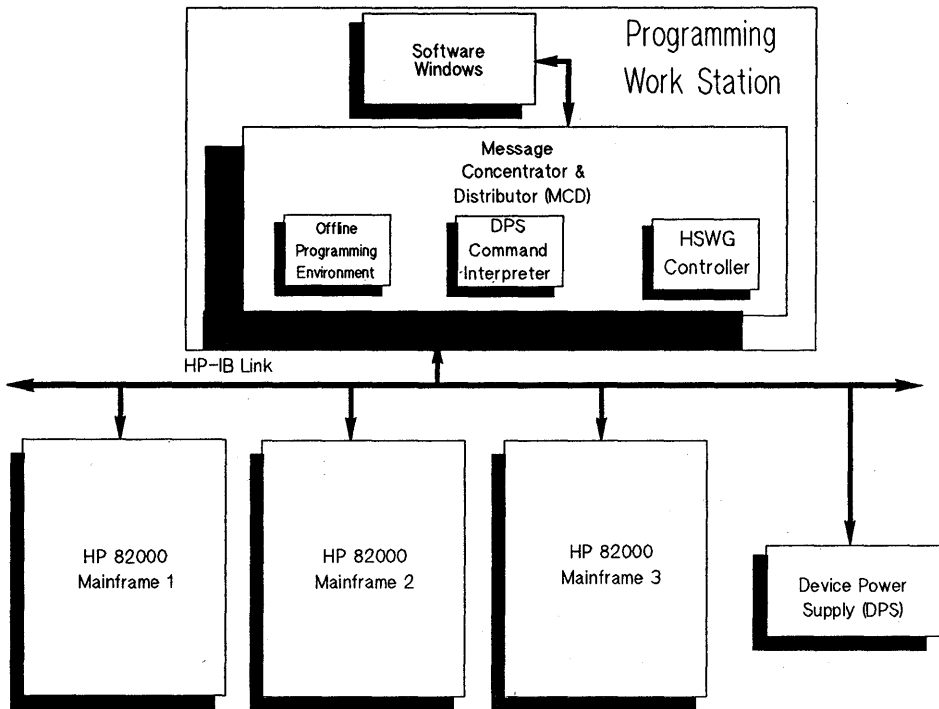
### Interpreting Firmware Instructions

An HP-UX process, running within the PWS, converts the commands that you enter in the software windows, into firmware level instructions which are transmitted via the HP-IB link to the hardware. Similarly, electrical data signals received from the HP-IB link are interpreted for the software windows by this same process.

This software process is called the *Message Concentrator and Distributor* (MCD).

As well as communicating with the tester hardware, the MCD process is also responsible for controlling the Device Power Supply (DPS) and High Speed Width Generator (HSWG) units, and for offline programming.

Figure 1-1 illustrates the interaction between the HP 82000 hardware and the PWS.



**Figure 1-1. HP 82000 System Model**

## Notation of HP-IB Commands

Each HP-IB command is represented by a mnemonic, comprising up to four upper-case letters. When you enter an HP-IB command (either in a C or BASIC program, or by using the hpt utility to execute commands directly), the PWS expects:

- the mnemonic name of the HP-IB command;  
followed by
- a string of parameters, each separated by a comma (,).

## Queries

HP-IB Commands which retrieve information from the hardware, are called *Queries*. You can identify an HP-IB Query by the question mark (?) at the end of the mnemonic name.

Some of the HP-IB commands form complementary pairs, comprising an instruction for setting the hardware state, and a corresponding query for finding the present hardware state.

For example, the command VEFA sets the first free vector address; the query VEFA? reads the present first free vector address.

## Syntax

The second half of this manual lists all the HP-IB commands used by the HP 82000, in alphabetical order, and gives a complete syntax description, with a full list of parameters, for each command.

---

## Using the hpt Utility

This is a utility program, provided as part of the HP 82000 software, which allows you to execute HP-IB commands *directly* from an HP-UX shell window, while the sytem software is running.

To start the hpt utility, at the HP-UX command line on the PWS, type in:

```
$ /hp82000/pws/bin/hpt
```

The PWS responds with the prompt:

```
@
```

To execute an HP-IB command, type in the command mnemonic and its parameters, followed by **Return**. The PWS displays any values returned by the HP-IB command, and then gives the @ prompt again.

To exit the hpt utility, press **Break** on the keyboard. This returns you to the HP-UX command line.

## Configuration Setup Commands

---

In the HP 82000 software, these commands are used in the Pin Configuration Setup window. Configuration setup files are stored in the configuration directory of the device in use. There are six commands for setting up tester channels and four commands for setting up device power supply pins. The commands are:

*OPT?	lists installed tester hardware.
DFPN	sets a pin name to a system channel.
DFPN?	lists all the pins defined with DFPN commands.
UDEF	removes a defined channel from the current configuration. This is the opposite of the DFPN command.
CONF	sets up the operation mode for a pin.
CONF?	lists the operation mode for a pin.
DFPS	sets a pin name to a power supply.
DFPS?	lists all the pins defined as power supply pins.
UDPS	removes a defined power supply from the current configuration. This is the opposite of the DFPS command.
PSCF?	reports the availability of power supplies

---

## Listing Installed Boards

The \*OPT? command lists all the boards installed in the specified mainframe. The mainframe can be either 0, 1, or 2 for the master, slave1 and slave2 respectively.

The command returns a string consisting of 18 fields separated by commas. These fields, which correspond to slot numbers 1 to 18 in a mainframe, contain either the ID code of an installed board or zero (0) for an empty slot.

The ID code is a decimal representation of an eight bit code (11 bit for slot 2).

---

### Note



The first two bits (D0 and D1) indicate the hardware revision letter of the board. You can confirm the revision letter by checking the legend printed on the board.

---

**Table 2-1. ID Code Definitions Bits 0 and 1**

D1	D0	Representation
0	0	Not Used
0	1	Revision C
1	1	Revision D or E
1	0	Not Used



**Table 2-2. ID Code Definitions Bits 2 and 3**

D3	D2	D100, D200 or D400	D50
0	0	32K I/O Board	16K I/O board
0	1	128K I/O Board	64K I/O board
1	0	512K I/O Board	256K I/O Board
1	1	1M I/O Board	not used
0	0	PMU Board	PMU Board
0	1	512K Clock Board	512K Clock Board
1	0	2M Clock Board	2M Clock Board
0	0	64K Sequencer Board	32K Sequencer Board
0	1	256K Sequencer Board	128K Sequencer Board

**Table 2-3. ID Code Definitions Bits 4 to 7**

D7	D6	D5	D4	Representation
0	0	0	0	Clock/Microprocessor Board
0	0	0	1	Sequencer Board
0	0	1	0	100 MHz I/O Board
0	0	1	1	200 MHz I/O Board
0	1	0	0	50 MHz I/O Board
0	1	0	1	PMU Board
0	1	1	0	400 MHz I/O Board
0	1	1	1	Master Only Sequencer Board

The code for slot 2 is extended by two bits (D9, D8) which are used to describe the function of the sequencer in multi-mainframe mode. The meanings of these bits are:

**Table 2-4. ID Code Definitions Bits 8 and 9**

D10	D9	D8	Representation
0	0	0	Master
0	0	1	Slave 1
0	1	0	Slave 2
0	1	1	Slave 3
1	0	0	Slave 4

An example output for this command is:

```
*OPT 5,273,49,49,49,49,49,49,49,49,49,49,49,49,49,81
```

which indicates:

5	Revision C Clock Board
273	Revision C Sequencer Board in slave 1 mode
49	15 Revision C 200 MHz IO Boards
81	Revision C PMU Board

---

## Defining Pin Names

The DFPN command is used to assign a pin name to a system channel. Normally that system software refers to system channels using these pin names and not actual channel numbers. The DFPN? command returns a list of system channels that have been assigned pin names.

### Syntax

```
DFPN channel, [pin-number], pin-list
```

```
DFPN? pin-list
```

**channel** is a five digit number, which describes the channel to be used for a pin. The five digits of the number fall into three groups in the format *mbbcc*.

- *m* - the first digit specifies the mainframe.

## 2-4 Configuration Setup Commands

- **bb** - the second and third digits specify the channel board. A channel board is identified by the logical slot in which it is installed. Slots for channel boards are numbered from 01 to 16.
- **cc** - the fourth and fifth digits specify the channel on the board. A board may have 8 or 16 channels. They are numbered from 01 to 16.

These numbers are also printed on the DUT Board.

**pin-number** is the physical pin number of the DUT and is included for comment purpose only. It is required by the system software.

**pin-list** contains the name of one signal that is to be mapped to the system channel. This command can only take one pin name as its argument.

The DFPN? commands returns a list of defined pin names.

## Power-On Defaults

At Power-On there are no pins defined.

---

## Removing Pin Name Definitions

The UDEF command removes a definition made with the DFPN command. All the setups for the pin remain in memory and will come into effect again if the channel is redefined by another DFPN command. However, if the environment has changed between the UDEF and the DFPN commands in such a way that current settings are invalid, they will be silently adjusted to make them correct.

The pin configuration will always be forgotten after a UDEF command. If the pin channel is configured again, the operation mode for the pin will be set to OFF (see CONF below).

---

## Setting Pin Capabilities

The CONF command is used to set the direction and termination, operating mode and scan path mode of pins that have been previously defined with a DFPN command, and also allows the definition of a global word mask. The CONF? query command returns mode information for the required pins.

### Syntax

```
CONF [io-mode], [operation-mode], [scan-path-mode], pin-list
```

```
CONF? pin-list
```

#### io-mode

This parameter determines the io capabilities of the pin. Table 2-5 shows the availability of the io modes with each operating mode.

- I The pin is considered to be a DUT input pin. Only the resources related to the channel driver are enabled (drive data, drive level, drive formats, and so on). All resources related to the channel receiver are not accessible and are disabled. The receiver will not contribute to any test results.
- IX (D400 only). The pin is a DUT input pin, but is driven by a High Speed Width Generator (HSWG) channel. The driver side of the I/O board is routed through the HSWG, and the receiver resources are disconnected. This io mode corresponds to the `ih` pin type, in the interactive software windows.
- 0 The pin is considered to be a DUT output pin. Only the resources related to the channel receiver are enabled (expected data, receive data, compare edges, receive threshold, and so on). All resources related to the channel driver are not accessible and are disabled. The driver will be in high impedance state all the time.
- IO The pin is considered to be a DUT bidirectional pin. Both driver and receiver resources are enabled. This mode is not available with 400 MHz I/O boards.
- IO\_L This is the same as IO but threshold adjustments are made assuming that the DUT output is terminated by the low level of the driver. This mode is not available with 400 MHz I/O boards.

## 2-6 Configuration Setup Commands

- IOH** This is the same as IO but threshold adjustments are made assuming that the DUT output is terminated by the high level of the driver. This mode is not available with 400 MHz I/O boards.
- TERM** The pin is considered to be a DUT output pin, but in contrast to the output mode (0), it is terminated by an active load. The behaviour of the receiver resources are the same as in output mode but the driver will force a constant voltage level. The driver setup is also accessible. This io mode corresponds to the `ot` pin type, in the interactive software windows.
- NC** The pin is temporarily considered to be disconnected from the DUT. The resources of both driver and receiver are accessible, but the DUT pin is always physically disconnected from the resources (the final relay will not be closed). The receiver will not contribute to test results. This mode is not available with 400 MHz I/O boards.
- DC** The pin is considered to be available for DC-measurements only. No AC-resources (driver/receiver) are accessible.
- OFF** The pin is not configured at all. It is not available for any measurements.

#### operation-mode

This determines the internal operation mode of the channel logic. Table 2-5 shows the operating modes that are available for each I/O board type, and the io modes that can be used.

**Table 2-5. Availability of Operating Modes and IO Modes**

Operating Mode	I/O Board	IO Modes available
STD	50 MHz, 100 MHz and 200 MHz	I, O, IO, TERM, IOH, IOL, DC, NC, OFF
FD	50 MHz and 200 MHz	I, O, IO, TERM, IOH, IOL, DC, NC, OFF
MUX	50 MHz and 200 MHz	I, O, IO, TERM, IOH, IOL, DC, NC, OFF
FQ2	400 MHz	I, IX, O, TERM, DC, OFF
FQ	400 MHz	I, IX, O, TERM, DC, OFF
FQM	400 MHz	O, TERM, DC, OFF

- STD** This is the standard mode of operation for D50, D100 and D200 systems and provides a full range of signal formats. In the driver part, even bits determine data and odd bits determine high impedance (tristate). This mode corresponds to:
- 25 mode in D50 systems
  - 100 mode in D100 and D200 systems
- FD** This mode doubles the frequency but reduces the available formats. In this case, even and odd bits in the driver determine DNRZ. This mode corresponds to:
- 50 mode in D50 systems
  - 200 mode in D200 systems
- MUX** This mode doubles the frequency by combining the resources of two consecutive channels. If a pin is configured in this mode, its co-channel cannot be accessed directly. The co-channel is automatically set up by setting up the master channel. This mode corresponds to:
- 50MUX mode in D50 systems
  - 200MUX mode in D200 systems
- FQ2** This mode provides the maximum no of signal format types for 400 MHz I/O boards. This mode corresponds to 200COM mode in the Setup window.
- FQ** This mode provides 400 MHz drive and receive signals from a 400 MHz I/O board. This channel can be routed through an HSWG channel to provide an enhanced range of signal formats. This mode corresponds to 400 mode in the Setup window.
- FQM** This mode combines the receiver resources of two 400 MHz channels to provide a dual threshold edge compare facility at 400 MHz operating frequency. This mode allows the channel to operate as an output pin only, and corresponds to 400MUX mode in the Setup window.

#### **scan-path-mode**

This determines the behavior of the pin during a serial scan vector and allows the definition of a global word mask. This parameter can be set independently of all other parameters.

- P A channel in this mode keeps its data during a serial scan. Its vector memory may be used for a channel in serial mode.

- S A channel in this mode serializes data from the vector memory of other channels during a serial scan. (Serial scan mode is not available with 400 MHz I/O boards.)
- W A channel in this mode is used as a global word mask. Serializing is broken at this channel.

### **pin-list**

This is the name of the pin or pins to be configured or listed. The wildcard symbol @ can be used to configure or list all pins defined with a DFPN command

The CONF? query lists the current io-mode, operation-mode and scan-path-mode for all the pins in pin-list.

---

## **Setting up Power Supply Pins**

The DFPS and DFPS? commands are used to setup and list the names used for the available power supply outputs. UDPS is used to undefine a power supply. PSCF? is a special command to read the type and channel count of an installed power supply.

DFPS channel, sign, pin

DFPS? pinlist

UDPS pinlist

PSCF?

where

**channel** is a two digit figure which indicates the Device Power Supply (DPS) number and the DPS output channel used. For example, DPS1 output channel 3 is indicated by the number 13 in this parameter.

**sign** is the polarity of the power supply output. It can be either POS or NEG.

**pin** is the name to be used for the power supply channel.  
and for the DFPS? and UDPS? queries:  
**pinlist** is the name to be used for the power supply being defined or undefined. For UDPS, the wildcard symbol '@' is used to mean all power supply pins.

The PSCF? query command returns the string

**PSCF dps-name, nr-of-channels**

where

**dps\_name** is the model number of the power supply (for example, HP6624A). Power supplies supported by the system software, are

- HP 6621A to HP 6626A
- HP 6628A and HP 6629A
- and HP 6632A to HP 6634A

**nr\_of\_channels** is the number of outputs that can be used

## **Power-On Defaults**

At power-on the following default settings are made:

**io-mode** is OFF.  
**operation-mode** is STD (for 50 MHz, 100 MHz and 200 MHz boards) or FQ (for 400 MHz boards).  
**scan-path-mode** is P.  
no power supply pins are defined



---

## Errors

An error will be generated if:

- pin-list in the DFPN command contains more than one pin.
- there are parameter range errors
- the tester is not idle
- a Channel is not available.
- the channel to be defined is in use.
- the pin to be defined is already in use.
- the resources that are being programmed are not installed.
- the resources being programmed are already in use.
- there is no device power supply installed in the system

---

## Examples

### Example 1

```
UDEF ( @ )
DFPN 10101, "001", ( reset )
CONF IO, MUX, P, ( reset )
```

In this example, the first line ensures that no pins are already defined. The second line defines channel 1 on board 1 in mainframe 1 to be the pin RESET. The third line configures RESET as an I/O multiplex pin with parallel scan behaviour.

```
UDPS ( @ )
DFPS 11, POS, ( VCC )
```

The first line undefines all power supply pins. Channel 1 of the DPS1 is defined to output a positive voltage that can be referenced by the name VCC.

## Example 2

This is the configuration file configuration/c\_d200 in the device directory of the MC10H136 demo device.

```
hp82000,configuration,0.1
DFPN 10104,"13", (Clock)
DFPN 10201,"12", (D0)
DFPN 10202,"11", (D1)
DFPN 10206,"6", (D2)
DFPN 10205,"5", (D3)
DFPN 10203,"10", (NCin)
DFPN 10108,"4", (NCout)
DFPN 10101,"14", (Q0)
DFPN 10102,"15", (Q1)
DFPN 10106,"2", (Q2)
DFPN 10107,"3", (Q3)
DFPN 10204,"9", (S1)
DFPN 10207,"7", (S2)
DFPN 10105,"1", (Vcc1)
CONF I,STD,P, (Clock)
CONF I,STD,P, (D0)
CONF I,STD,P, (D1)
CONF I,STD,P, (D2)
CONF I,STD,P, (D3)
CONF I,STD,P, (NCin)
CONF TERM,STD,P, (NCout)
CONF TERM,STD,P, (Q0)
CONF TERM,STD,P, (Q1)
CONF TERM,STD,P, (Q2)
CONF TERM,STD,P, (Q3)
CONF I,STD,P, (S1)
CONF I,STD,P, (S2)
CONF DC,STD,P, (Vcc1)
DFPS 11,neg, (Vee)
```

## Level Setup Commands

---

This chapter describes the HP-IB commands that are used to set driver and receiver levels, and power supply output levels.

---

### Level Commands

A tester channel consists of a driver and receiver part. The driver part needs to know the drive signal low and high levels that are to be output for a 0 and 1 vector and the receivers require the compare high and low thresholds that are to be used when making measurements on DUT outputs.

To specify whether the Level Setup Screen sets the timing reference automatically, the DRLM and DRLM? queries are provided.

There are two commands to specify the driver levels and receiver thresholds, DRLX and RCLV respectively. Two query commands DRLX? and RCLV? can be used to read the current settings from the hardware.

If a device power supply is installed in the system, it is possible to program and read the output levels using the PSLV and PSLV? commands.

Default values are set after power on and after an HP-IB “reset” (\*RST) command and remain valid until they are overwritten by downloading a Level Setup or Pin Configuration file. In the PWS software, these levels are set in the “Level Setup” window.

---

## Specifying the Timing Reference

### Syntax

```
DRLM [ L50 ]  
      [ FRZN ]
```

DRLM?

This command specifies that the Level Setup screen sets the timing reference to the 50% swing point (L50) or to a fixed level (FRZN).

Using L50 sets the reference to the difference of the programmed high and low levels, FRZN makes this setting dependent on the nominal-swing setting of the DRLX command.

---

### Note



Setting the nominal-swing parameter in the DRLX command to anything other than -1 will result in FRZN mode being selected.

---

---

## Driver Level Settings

### Syntax

```
DRLX [ logic-0-level ], [ logic-1-level ], [ nominal-swing ], pinlist
```

DRLX? pinlist

The following table shows the value ranges and default (power-on) values for the driver level settings.

**Table 3-1. Drive Level Settings**

Parameter	Implicit Unit	Range (D100, D200 & D400)	Range (D50)	Range (ihs pins)	Default
logic-0-level	mV	-4000..7800	-2000..6500	-4000..4800	-1700
logic-1-level	mV	-3800..8000	-2500..7000	-3800..5000	-800

There are swing limitations which mean that the minimum swing between logic-0-level and logic-1-level is 200 mV (500 mV for 50 MHz boards) and the maximum permitted swing is :

- 7000 mV for the 50 MHz boards;
- 5000 mV for IX channels (400 MHz channels connected to the HSWG)
- 8000 mV for 100 MHz boards, 200 MHz boards and 400 MHz boards (without HSWG)

Violations of these minimum or maximum swing values will cause a semantic error.

The optional parameters, logic-0-level or logic-1-level can be omitted. If this occurs, the firmware can auto-correct this parameter if necessary. This may be needed to ensure that programmed values are valid.

When a channel is configured to active termination (**TERM**), the drive part of the channel is forced to a static low level. The single level is programmed via the first parameter (**logic-0-level**). The second parameter is ignored and will be forced to an auto-corrected value depending on the required termination level. Querying the settings of such a channel returns the single level as the first parameter, the second parameter will be omitted.

The parameter **nominal-swing** specifies the level swing to be used for determining the 50% reference point for driver timing. The special value -1 automatically sets the swing to the difference between the logic-1 and logic-0 levels.

## Errors

Errors will be generated for:

- low level out of range
- high level out of range
- swing violation
- attempting to program a non-applicable pin (configured as O, DC, or OFF)

## Warnings

Warnings will be generated if:

- Auto correction occurs
- Level programming exceeds the hardware specs

---

### Note



Setting the **nominal-swing** parameter in the DRLX command to anything other than -1 will result in FRZN mode being selected in the DRLM command..

---

---

## Driver Level Settings

---

### Note



This command is only documented to support older software releases. The use of this command to set up driver levels is discouraged.

---

## Syntax

```
DRLV [logic-0-level], [logic-1-level], pinlist
```

```
DRLV? pinlist
```

The following table shows the value ranges and default (power-on) values for the driver level settings.

**Table 3-2. Drive Level Settings**

Parameter	Implicit Unit	Range (200 MHz)	Range (50 MHz)	Default Value
logic-0-level	mV	-4000..7800	-2000..6500	-1700
logic-1-level	mV	-3800..8000	-2500..7000	- 800

There are swing limitations which mean that the minimum swing between `logic-0-level` and `logic-1-level` is 200 mV (500 mV for 50 MHz boards) and the maximum permitted swing is 8000 mV (7000 mV for the 50 MHz boards). Violations of these minimum or maximum swing values will cause a semantic error.

The optional parameters, `logic-0-level` or `logic-1-level` can be omitted. If this occurs, the firmware can auto-correct this parameter if it needs to. This may be necessary to ensure that programmed values are valid.

When a channel is configured to active termination (`TERM`), the drive part of the channel is forced to a static low level. The single level is programmed via the first parameter (`logic-0-level`). The second parameter is ignored and will be forced to an auto-corrected value depending on the required termination level. Querying the settings of such a channel returns the single level as the first parameter, the second parameter will be omitted.

## Errors

Errors will be generated for:

- low level out of range
- high level out of range
- swing violation
- attempting to program a non-applicable pin (configured as O, DC, or OFF)

## Warnings

Warnings will be generated if:

- Auto correction occurs
- Level programming exceeds the hardware specs

---

## Receiver Threshold Commands

### Syntax

RCLV [logic-0-threshold], [logic-1-threshold], pinlist

RCLV? pinlist

**Table 3-3. Receiver Threshold Settings**

Parameter	Implicit Unit	Range (D100,D200,D400)	Range (D50)	Default Value
logic-0-threshold	mV	-4000..7994	-2000..6950	-1.470
logic-1-threshold	mV	-3994..8000	-2010..7000	-1110

As in the driver level commands, there is a swing limitation such that there must be a minimum swing between `logic-0-threshold` and `logic-1-threshold`. The minimum swing limitation depends on the type of pin defined. The minimum threshold swing is

- 6000 mV for 100 MHz, 200 MHz and 400 MHz boards, and
- 10000 mV for 50 MHz boards.

In the case of a channel in FD or FQ operating mode, the required single threshold is set by the `logic-1-threshold` parameter. The first parameter, `logic-0-threshold` is ignored and silently auto-corrected to a value dependent on the given threshold. Querying such a pin will return the single threshold in the `logic-1-threshold` parameter and the first parameter `logic-0-threshold` will be omitted. Table 3-4 shows the logic levels that can be set for each Operating Mode.



**Table 3-4. Receiver Logic Levels**

<b>Operating Mode</b>	<b>Low Level</b>	<b>High Level</b>
FD, FQ	not programmable	threshold for single level compare
STD, MUX, FQ2, FQM	lower threshold for dual level compare	upper threshold for dual level compare

## **Errors**

Errors will be generated for:

- low level out of range
- high level out of range
- swing violations
- attempting to program non-applicable pins (configured as I, DC, OFF)

## **Warnings**

A warning will be generated if:

- auto-correction has occurred
- level programming exceeds the hardware specifications

---

## **Setting Power Supply Levels**

The PSLV and PSLV? commands are used to set and query the current device power supply (DPS) output voltage and current limit settings. Additionally, it is also possible to specify a setup time, which causes the system to wait until the next command is executed, and an off-state impedance. The off-state impedance is used to set the DPS outputs when the system is in the disconnected state.

PSLV [volt], [off-imp], [setup-time], pinlist

## PSLV? pinlist

where

**volt** is a real number in the range 0 to 40 to specify the output voltage. The sign (positive or negative) of the volt parameter must be the same as that in the DFPS command used to define the power supply channel.

---

### Note



If the installed power supply is capable of supplying more than 40 Volt, the system will limit its output to 40 Volt.

---

**off-imp** either HIZ or LOZ to specify high or low impedance in disconnect state. If HIZ is selected, the channel will be programmed to the minimum possible current limit for the power supply. If LOZ is used, the power supply current limit will remain at the same level as in the active state.

**setup-time** is an integer with the implied units milliseconds. It specifies the delay between setting the power supply and starting a test.

## Defaults

At power-on and after a reset, all power supply outputs will be set to zero (0) Volt, the minimum current limit programmable for the power supply (0.004 .. 0.15 A), HIZ, and a zero (0) millisecond setup time.

## Errors

An error will be generated if

- there are any syntax errors
- the polarity of the voltage level is different from that in the DFPS command for the pin
- the programmed voltage is higher than the maximum output voltage of the power supply.
- the programmed current limit is greater than the power supply maximum output current

- the range combination `volt` and `curr` is not allowed by the installed DPS

---

## Examples

`DRLX 0, 5000,, (A0, A1)`

This example forces the address channels `A0` and `A1` (`I` type pins) to output 0 V if a digital 0 (low) and 5.0 V if a digital 1 (high) must be provided to the DUT.

`DRLX 0,,, (TC)`

If the DUT pin `TC` is configured as `TERM` (active termination), logic-1-level would be ignored anyway so it's a good idea to omit this parameter, only the logic-0-level is of interest.

`RCLV 400, 4800, (D0, D1)`

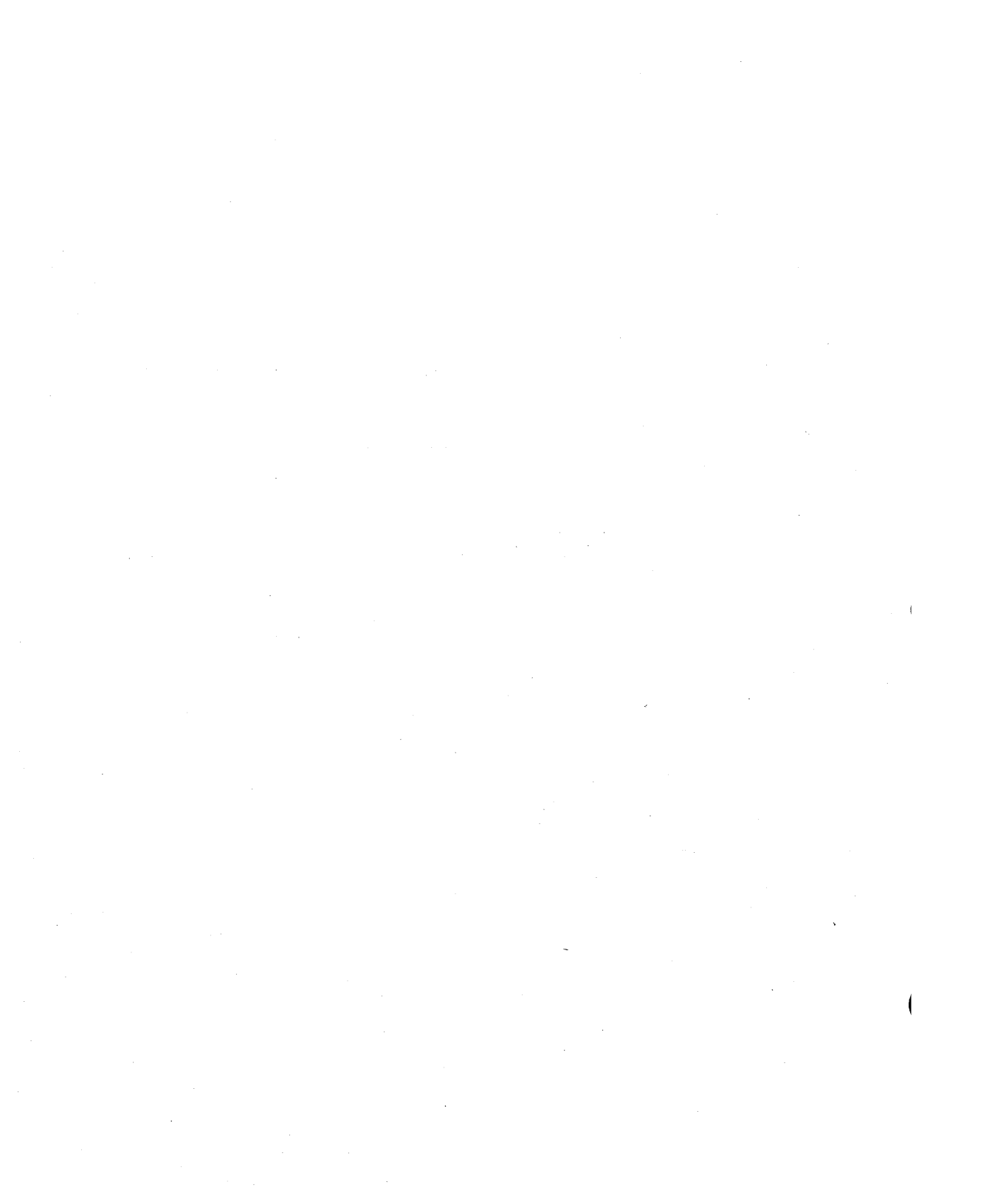
All levels received at `D0` and `D1` (`O` pins) lower than 0.4 Volt will be recognized as a digital 0 (low) and those greater than 4.8 Volt as a logical 1 (high). A stable level between these two values will be treated as intermediate.

`PSLV 5, 1, 100, (VCC)`

The power supply defined with the name `VCC` is set to output 5 Volt at a maximum current of 1 Amp. The test will be started 100 milliseconds after this command is executed.

The following listing is the level setup file used for the 10H136 demo device.

```
hp82000,level,0.1
PSLV -5.200,0.500000,hiz,15,(Vee)
PSLV -2.000,1.000000,hiz,15,(LPS)
DRLX -1800,-900,900,(Clock,D0,D1,D2,D3)
DRLX -1800,-900,2000,(NCin)
DRLX -2000,,, (NCout,Q0,Q1,Q2,Q3)
DRLX -1800,-900,900,(S1,S2,WORDMASK)
DRLM FRZN
RCLV -1260,-1250,(NCout,Q0,Q1,Q2,Q3)
RCLV 1990,2000,(WORDMASK)
```



## Format and Timing Setup Commands

---

The commands covered in this section allow the system clock and driver and receiver timing and format to be set up. These can also be set up using the Timing Setup window of the PWS.

There are seven commands for setting up the system clock:

SCLK	set up system clock reference and period
SCLK?	retrieve system clock reference and period
SNCC	setup synchronization input behavior
SNCC?	retrieve synchronization input behavior
SYNC	enable or disable synchronization
SYNC?	retrieve synchronization mode
VCLK?	check setting of clock period for possible auto-corrections

---

### Note



In multiple mainframe configurations, only the master mainframe responds to the queries SNCC?, SYNC?, and SCLK?.

---

There are four commands used for setting channel format and timing:

DRTM	sets the timing and format of driver outputs.
DRTM?	reads back the current timing and format settings of driver outputs.
RCTM	sets the timing and format of receiver inputs.
RCTM?	reads back the current timing and format settings of receiver inputs.

---

**Note**

All timing setup commands temporarily change the state of the sequencer to OFF, if it is not already in this state.

---



---

## Setting Up the System Clock

The SCLK command is used to set the system vector rate and optionally synchronize this to an external input.

The SNCC command defines the synchronization circuitry behavior. It allows setting of the synchronization comparator slope sensitivity, threshold, and input impedance. Additionally, a delay can be specified which defines the time, the internal clock will be delayed against the external clock input signal.

The SYNC command allows the internal clock to be synchronized to an external signal. Synchronization takes place each time the internal clock is turned on.

The VCLK? query is used to check whether a period setting will cause edge delay auto-corrections to occur.

---

## Setting the System Clock Period

SCLK [clock-source], [period], [fraction] SCLK?

clock-source	can be INT or EXT to select between the internal reference clock or an external clock connected to the Ext Clock input.
period	is a real number indicating the clock period in the ranges shown in the table below. This is in the implied units nanoseconds, so setting SCLK INT, 80 , will result in a vector rate of 12.5 MHz.
fraction	If you have specified an external clock, this parameter is used to multiply or divide the external clock signal by a fixed value.

Allowed values for fraction are F1T8, F1T4, F1T2, F1T1, F2T1, F4T1, F8T1 which result in ratios from 1/8 to 8x.

Period can be programmed as shown in the table below:

**Table 4-1. System Clock Period Settings**

Range	Parameter	Resolution
10ns .. 99.9ns	10 .. 99.9	100ps
100ns .. 999ns	100 .. 999	1ns
1us .. 9.99us	1000 .. 9990	10ns
10us .. 99.9us	10000 .. 99900	100ns

For an external clock source, period is restricted to the following ranges :

**Table 4-2. System Clock Period Settings for External Source**

Fraction	Range
F1T8	10ns .. 720ns
F1T4	10ns .. 1.44μs
F1T2	10ns .. 2.88μs
F1T1	10ns .. 5.76μs
F2T1	10ns .. 11.5μs
F4T1	10ns .. 23μs
F8T1	13.3ns .. 46μs

The system clock is available at the BNC connector J11 located on the clock board. It is a 50% duty cycle square wave with ECL levels (-1.7 V low and +0.8 V high), if properly terminated (50 Ω).

Each time you modify the system clock, you should verify, and, if necessary, modify all programmed channel edge delays. If an edge becomes incompatible with a newly programmed period this edge will be silently autocorrected.

The VCLK? query can be used to verify the clock period setting.

The fraction parameter will be ignored if clock-source is set to internal.

To synchronize the clock, either the internal reference oscillator (**clock-source = INT**) or an external reference signal (**clock-source = EXT**) may be used. If an external reference has been chosen, the frequency of the external clock source has to be specified by passing the external to pattern clock frequency ratio as one of the command parameters (**fraction**). This parameter will be ignored for internal clock programming. It comes from the formula

$$\langle \textit{fraction} \rangle = \frac{\langle \textit{period} \rangle}{T_{ext}} = \frac{f_{ext}}{f_{per}}$$

---

## Synchronizing the System Clock

SNCC [delay], [slope], [level], [impedance]

SNCC?

SYNC mode

SYNC?

<b>delay</b>	is a positive real number used to set a delay between the internal clock and the external phase synchronization signal. This has the implied units nanoseconds and can be set to a maximum of 1 millisecond.
<b>slope</b>	sets the active edge of the external phase synchronization signal and can be either POS or NEG
<b>level</b>	sets the threshold level of the external phase sync. input in the range $\pm 10$ V. It has the implied units millivolts.
<b>impedance</b>	sets the impedance of the external phase synch. input to 10 k $\Omega$ (R10K) or 50 $\Omega$ (R50). Note that selecting a 50 $\Omega$ input impedance implies a restricted level range of $\pm 5$ V.
<b>mode</b>	can be ON or OFF depending on whether the internal clock should be synchronized



Using an external clock allows phase synchronization of the system clock to a second external signal (normally delivered by the DUT).

The SNCC command affects only the synchronization parameters. It does not affect the mode selected by the SYNC command. If, however, synchronization is active (“SYNC ON”), the passed parameters are in effect immediately after sending the command.

Synchronization is only supported, if used in conjunction with an external clock source. Any other value than OFF for the mode parameter will therefore cause an error if used in internal clock mode. Selecting the internal clock source while synchronization is in effect, causes synchronization to be turned off. While system clock synchronization stays in effect, the system clock will be synchronized each time it has to be turned on. An error will be reported, if synchronization fails. This condition is also reported in the Hardware Status Register.

The external clock delay in the SNCC command can be set to a maximum of 1 millisecond with a three-digit  $\pm 50$  picosecond resolution.

The query commands SCLK?, SNCC?, and SYNC? respond with the current settings of the appropriate commands.

---

## Checking the System Clock Setting

### VCLK? period

System responds with VCLK flag, where,

<b>period</b>	see Setting the System Clock Period
<b>flag</b>	Set to 0 or 1 to indicate whether auto-correction will occur for the desired period setting.

Each time you modify the system clock, you should verify, and, if necessary, modify all programmed channel edge delays. If an edge becomes incompatible with a newly programmed period this edge will be silently autocorrected.

If **flag** is set to 1, at least one timing edge needs to be corrected if the clock period setting is used. This command is used in the User Interface to avoid

erroneous period changes which will cause an entire timing setup to become invalid.

Each mainframe will answer this query with the results of the pins in that mainframe.

## Power-On Defaults

At power-on, the following settings are made:

```
SCLK INT,10,  
fraction = F1T1  
SNCC 0,POS,0,R10K  
SYNC OFF
```

## Errors

Errors will be generated if:

- programmed values contain value range errors
- there is a mismatch of period and fraction parameter (external clock)
- Synchronization is set and the clock source is internal
- Synchronization failed

---

## Setting Driver Format and Timing

The DRTM command is used to set the format of a signal and the timing of the leading and trailing edges.

### Syntax

```
DRTM [drive-format], [leading-edge], [trailing-edge], pinlist
```

```
DRTM? pinlist
```

Drive-format can be one of:

- DNRZ for delayed non-return to zero format

- RZ for return-to-zero format
  - R1 for return-to-one format
  - RC for return-to-complement format
  - RI for return-to-inhibit format (50MHz only)
- leading-edge** this is the time delay for the leading edge of the signal. It is a real number with the implied units nanoseconds.
- trailing-edge** this is the time delay for the trailing edge of the signal. It is a real number with the implied units nanoseconds.

Allowed settings for different system operating modes are shown in the tables below. All edges are programmed with the implicit unit nanoseconds, for example, DRTM RZ, 0, 5.05, (Pin) will set the machine channel signal Pin so that the leading edge is at 0 ns delay and the trailing edge at 5050 ps.

### **Leading Edge Delays**

The values given in the following tables give the *minimum* guaranteed range of values accepted by the system before an error message is given. In certain circumstances, the system will accept a leading edge delay greater than these values.

**Table 4-3. Driver Format and Timing Settings—D50 Systems**

Operating Mode	Signal Formats	Period	Maximum Leading Edge Delay
STD	DNRZ, RZ, R1, RC, RI	40 ns to 41.7 ns 41.7 ns to 181.3 ns 181.3 ns to 600 ns over 600 ns	1 cycle period (4 cycle periods)—125 ns 600 ns 1 cycle period
FD	DNRZ	40 ns to 41.7 ns 41.7 ns to 181.3 ns 181.3 ns to 600 ns over 600 ns	1 cycle period (4 cycle periods)—125 ns 600 ns 1 cycle period
MUX	DNRZ, RZ R1	40 ns to 50 ns 50 ns to 207.1 ns 207.1 ns to 600 ns over 600 ns	1 cycle period (3.5 cycle periods)—125 ns 600 ns 1 cycle period

**Table 4-4.  
Driver Format and Timing Settings—D100 and D200 Systems**

<b>Operating Mode</b>	<b>Signal Formats</b>	<b>Period</b>	<b>Maximum Leading Edge Delay</b>
STD	DNRZ, RZ, R1, RC,	10 ns to 24.7 ns 24.7 ns to 168.5 ns 168.5 ns to 600 ns over 600 ns	1 cycle period (4 cycle periods)—74 ns 600 ns 1 cycle period
FD	DNRZ	10 ns to 24.7 ns 24.7 ns to 168.5 ns 168.5 ns to 600 ns over 600 ns	1 cycle period (4 cycle periods)—74 ns 600 ns 1 cycle period
MUX	DNRZ, RZ R1	10 ns to 29.6 ns 29.6 ns to 192.6 ns 192.6 ns to 600 ns over 600 ns	1 cycle period (3.5 cycle periods)—74 ns 600 ns 1 cycle period

**Table 4-5. Driver Format and Timing Settings—D400 Systems**

<b>Operating Mode</b>	<b>Signal Formats</b>	<b>Period</b>	<b>Maximum Leading Edge Delay</b>
FQ2	DNRZ, RZ R1	10 ns to 27.6 ns 27.6 ns to 190.6 ns 190.6 ns to 600 ns over 600 ns	0.5 cycle period (3.5 cycle periods)—76 ns 600 ns 1 cycle period
FQ	DNRZ, (and RZ, if HSWG fitted)	10 ns to 27.6 ns 27.6 ns to 190.6 ns 190.6 ns to 600 ns over 600 ns	0.5 cycle period (3.5 cycle periods)—76 ns 600 ns 1 cycle period

## Trailing Edge Delays

**Table 4-6. Trailing Edge Delays—Driver Channels**

Trailing Edge Limits	D50	D100, D200 and D400 (except IX pins)	IX type pins (see note)
Minimum Delay	LE + 3 ns	LE + 1 ns	LE + 1 ns
Maximum Delay	LE + (cycle - 3 ns)	LE + (cycle - 1 ns)	LE + (cycle - 9.95 ns)

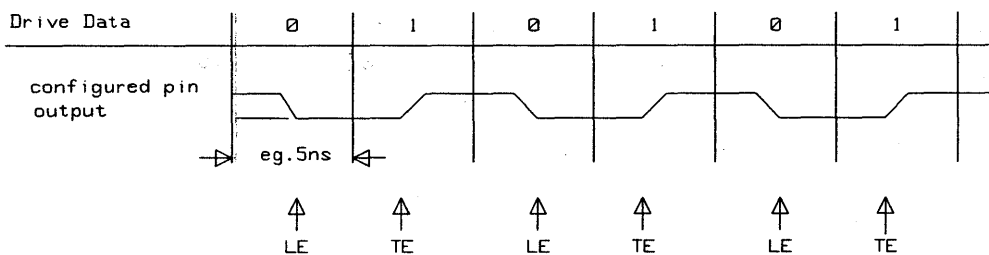
(where: LE = Leading Edge delay)

### Note

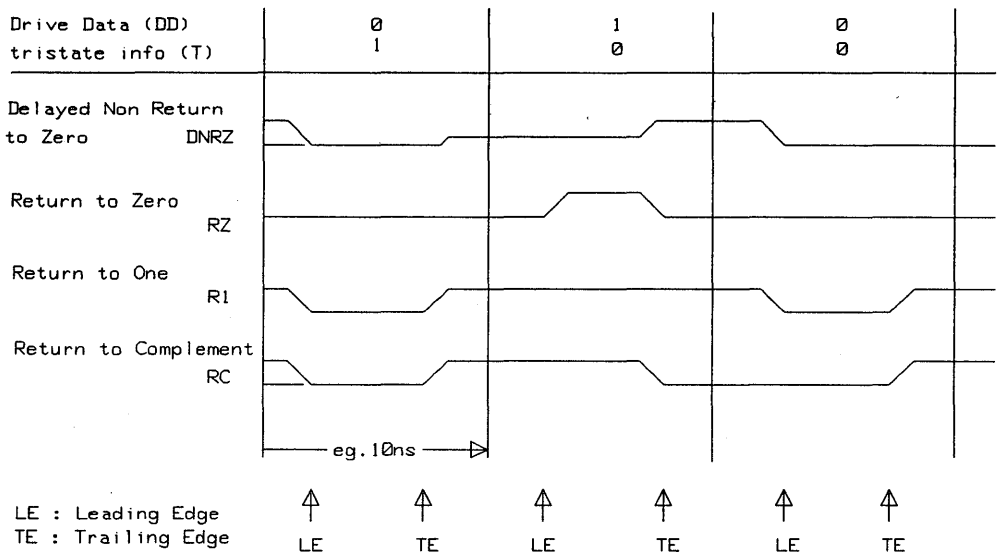


You can further reduce the pulse width produced by the HSWG channels (IX pins), by entering a trailing edge value of 0.5 ns. However, the tester is then outside its calibrated operating range and the true width of this pulse may be nearer 700 ps.

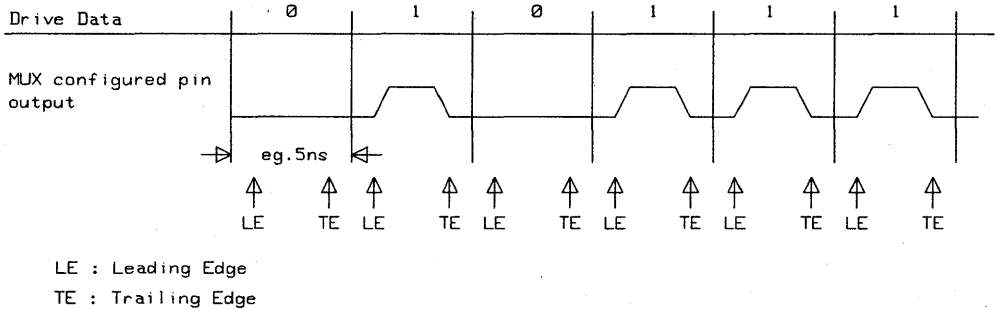
The following figures show the possible formats and their resulting states.



**Figure 4-1. Example of DNRZ Format in 200 MHz Mode**



**Figure 4-2. Example of Different Formats with Tristate**



**Figure 4-3. Example of RZ Format in 200MUX Mode**

Programmed edges that do not have the necessary HW resources, for example, no tristate edge (TE) in the case of “FD” or “MUX” configured pins and DNRZ format are ignored and no warning message is generated.

All edge delays are rounded to the hardware resolution (50 ps for 200 MHz boards, 200 ps for 50 MHz boards).

Pins that are configured for serial scan are handled in the same way but you should remember that LSSD execution is possible only up to a frequency of 25MHz.

Contextual edge mismatching generated by using optional edge parameters is autocorrected in the following manner: If the value of a programmed edge exceeds the allowed range, the optional parameter is set to the maximum possible value. On the other hand, if a programmed value goes below the minimum, the optional parameter is autocorrected to the minimum possible value.

The DRTM? query command returns the format and timing setups of all the signal names in pinlist.

## **Power-On Defaults**

At power-on, the following settings are made:

DRTM DNRZ, 0, 0, all-pins

## **Errors**

An error will be generated if:

- there are any value range errors
- attempting to program non-applicable pins (configured as O, DC, OFF, or TERM)

---

## **Setting Receiver Format and Timing**

The RCTM command is used to select the compare mode of receiver channels and program the delays for measurements.



## Syntax

RCTM [receive-format], [leading-edge], [trailing-edge], pinlist

RCTM? pinlist

**receive-format** can be either WIDW for window compare mode or EDGE for edge compare mode.

**leading-edge** this is the time delay to the start of a window in window compare mode or the delay for the measurement in edge compare mode. It is a real number with the implied units nanoseconds.

**trailing-edge** this is the time delay to the end of a window in window compare mode. It is a real number with the implied units nanoseconds.

Allowed settings for different system operating modes are shown in the table below. All edges are programmed with the implicit unit ns, for example, RCTM WIDW, 1, 5.05, (Pin) will set the receiver of the machine channel with signal name Pin so that the window compare will start after 1 ns and stop after 5050 picoseconds.

The limits on leading edge delays for receiver channels are the same as those available for driver channels. These limits are shown in Table 4-3 to Table 4-5.

The limits on trailing edge delays for receiver channels are shown in Table 4-7 below.

**Table 4-7. Trailing Edge Delays—Receiver Channels**

<b>Trailing Edge Limits</b>	<b>D50</b>	<b>D100 and D200</b>	<b>D400</b>
Minimum Delay	LE + 3 ns	LE + 2.5 ns	N/A
Maximum Delay	LE + (cycle - 3 ns)	LE + (cycle - 2.5 ns)	N/A

(where: LE = Leading Edge delay)

Programmed edges that do not have the necessary HW resources are ignored and no warning message is generated.

All edge delays are rounded to the hardware resolution (50 ps for 200 MHz boards, 200 ps for 50 MHz boards).

Contextual edge mismatching generated by using optional edge parameters is autocorrected in the following manner: If the value of a programmed edge exceeds the allowed range, the optional parameter is set to the maximum possible value. On the other hand, if a programmed value goes below the minimum, the optional parameter is autocorrected to the minimum possible value.

The RCTM? query command returns the receiver format and timing setups of all the signal names in pinlist.

## **Power-On Defaults**

At power-on, the following settings are made:

RCTM WIDW, 0, 2, std-pins, mux-pins

RCTM EDGE, 0, , fd-pins

## **Errors**

An error will be generated if:

- there are any value range errors
- attempting to program non-applicable pins (configured as I, DC, or OFF)

---

## Example

The following listing shows the format and timing setup for the MC10H136 demo device.

```
hp82000,timing,0.1
SCLK INT,20,
SNCC 0,POS,0,R10K
SYNC OFF
DRTM RZ,9,19,(Clock)
DRTM RZ,2,15,(D0)
DRTM RZ,2,15,(D1)
DRTM RZ,2,15,(D2)
DRTM RZ,2,15,(D3)
DRTM DNRZ,2,2,(NCin)
DRTM DNRZ,2,2,(S1)
DRTM DNRZ,2,2,(S2)
RCTM EDGE,18,,(NCout)
RCTM EDGE,18,,(Q0)
RCTM EDGE,18,,(Q1)
RCTM EDGE,18,,(Q2)
RCTM EDGE,18,,(Q3)
```



## Vector Setup

---

The vector setup commands fall into two categories:

- static vector setup commands, and
- vector transfer commands.

The vector setup commands temporarily change the sequencer to the Break state if it is already running.

The static vector setup commands include commands to define driver channel static vectors such as masks and break vectors, and static receiver data vectors such as mask and expected data pattern vectors when the tester is in data acquisition (DA) mode.

The vector transfer commands are used to transfer large amounts of vector data via HP-IB, utilizing the DMA capabilities implemented on the tester's local microprocessor board. These commands differ from the general HP 82000 commands. Refer to the command descriptions for a details of these differences.

---

### Note



It is not possible to create vector setup files using the vi editor in HP-UX. The representation of data in these files uses characters that cannot be edited or displayed by the vi editor.

---

---

## Static Vector Setup Commands

There are four commands to set and read the channel static vectors. These are:

SDRV	defines the driver channel's pin mask and break vector.
SDRV?	reads the current settings of driver channel mask and break vectors
SREC	defines the receiver channel's pin mask and the expected data vector used in data acquisition (DA) mode.
SREC?	reads the current settings of receiver pin mask and expected data vectors to be used in data acquisition (DA) mode.

### Syntax

SDRV [dr-mask], [break-vec], pin-list

SDRV? pin-list

SREC [rec-mask], [aqi-exp-data], pin-list

SREC? pin-list

Both commands affect the channel's behavior without modifying the contents of the vector memory.

### Setting Driver Channel Static Vectors

It is possible to set `dr-mask` to ACT for active or TT for tristate. (Tristate mode for IX type pins is simulated by opening the HSWG output relays)

Masking a driver pin forces the output driver to tristate mode (`dr-mask = TT`).

`break-vec` can be set to one of LO, HI, LZ, HZ, or HOLD (LZ and HZ are not available with channels on 400 MHz I/O boards).

This parameter modifies the pin's behavior during break cycles. The pin may be programmed to output the signal passed as parameter (LO, HI, LZ or HZ) or to repeat the last active vector (HOLD). This vector is valid for the entire

machine cycle (i.e. two vectors in FD and MUX modes, or four vectors in FQ mode).

### Setting Receiver Channel Static Vectors

**rec-mask** can be either **ACT** to activate it or **X** to change the pin to a “Don’t Care” pin in real-time compare mode. The receiver pin mask has no effect in DA mode. Word mask pins are always masked. Attempting to unmask a word mask pin results in a warning.

The **aqi-exp-data** parameter of the SREC command is valid for DA mode only. This parameter allows you to define a vector which will be compared against the incoming data in acquisition mode, to trigger a sequencer jump when a *match condition* is found.

It can be set to:

<b>IM</b>	for an intermediate level
<b>LO</b>	for a low level
<b>HI</b>	for a high level, or
<b>X</b>	for a “Don’t Care” condition

As with the break vector, this vector will be valid for an entire machine cycle. For 200 MHz pins, an error is generated if the test fails in either of the two vectors; for 400 MHz, an error is generated for a fail in any of the four vectors which are output during that machine cycle.

### Power-On Defaults

After power-on, the static vector setup is defined as follows:

- All driver channels are set to tristate, the break vector is set to LOW.
- All receiver channels are masked (set to Don’t Care mode), the expected data vector (valid in DA mode only) is set to Don’t Care.

## Autocorrection Rules

If the configuration of an already defined pin is changed, the following autocorrection rules apply. Note that no warnings will be generated for the corrections noted below.

Invalid break vector and expected data setups are changed from:

- LZ to LO, and HZ to HI
- IM to LO and X to HI (FD mode only)

## Errors

- Badly positioned mnemonic
- Execution conflicts with current configuration
- LZ | HZ for 200 MHz pins
- IM | X for 200 MHz double frequency pins

## Warnings

A warning will be generated if you attempt to unmask a word mask pin.

## Example

```
CONF I, STD, P, (A0)
CONF I, FD, P, (A1)
CONF O, STD, P, (D0)
CONF O, MUX, P, (D1)
SDRV ACT, HOLD, (A0, A1)
SREC ACT, LOW, (D0, D1)
```

In the above example, the DUT input pins A0 and A1 are active. Both pins will repeat the last machine cycle vector in break mode. The DUT output pins D0 and D1 will be monitored. In data acquisition mode, the failure condition becomes false, if the output signal of both pins is LOW for an entire machine cycle.



---

## Vector Transfer Commands

There are eight commands used for transferring vector data to and from the hardware. These are:

DRVD	transfers driver vector data to the hardware using a packed binary data format.
DRVD?	transfers driver vector data from the hardware using a packed binary data format.
EXPD	transfers receiver vector data to the hardware using a packed binary data format.
EXPD?	transfers receiver vector data from the hardware using a packed binary data format.
VESA	defines the vector start address. This address is used as the base address for all subsequent vector data transfers.
VESA?	reports the current value of the vector start address
VEFA	modifies the first free vector address. This address is updated after each vector data transfer to show the first unused location in the vector data memory.
VEFA?	reports the current setting of the first free vector address.

### Syntax

DRVD rel-start-addr, vector-length, pin-list, #spec(binary-data)

DRVD? rel-start-addr, vector-length, pin-list

EXPD rel-start-addr, vector-length, pin-list, #spec(binary-data)

EXPD? rel-start-addr, vector-length, pin-list

VESA start-addr

VESA?

VEFA ffvad

VEFA?

## Transferring Driver and Receiver Vector Data

`rel-start-addr = V-LAST = 0 .. highest vector memory address`

`vector-length = V-MEM = 1 .. size of vector memory`

`spec = digit{digit}`

`start-addr = 0 .. V-LAST`

`ffvad = 0 .. V-MEM`

The vector data transfer commands DRVD and DRVD? are used to transfer large amounts of driver vectors via HP-IB. The data itself is transferred in a non ASCII format and will be transferred as an entire block for the specified pin.

The `pin-list` parameter must specify exactly one pin for the vector setup commands DRVD and EXPD, while `pin-list` for the DRVD? and EXPD? commands may hold any number of pins. Transferring data from the hardware results in a string of data being sent to the host in the same format as the DRVD and EXPD commands.

The `#` marks the start of the binary data block to transfer. It is immediately followed by the `spec` parameter, which defines the number of bytes to transfer. This parameter follows the following rules:

1. The first digit specifies the number of digits the length specifier consists of.
2. The specifier itself has to be transferred immediately after the first `spec` digit.
3. The vector bytes are sent immediately after the length specifier and terminated with a linefeed character (`\n`).

---

### Note



The number of bytes has to match the length specifier value. No white space is allowed between the elements of the length specifier described above.

---

The vector data block will be loaded to the vector RAM unchanged. Therefore, the contents of the data stream depends on the hardware vector RAM organization.

If the number of vectors to be downloaded exceeds the vector memory size, the remaining bytes are ignored and a warning message will be issued.

The vector transfer starts at the byte location of the vector specified by the previously defined vector start address and the `rel-start-addr` parameter (which is regarded as an offset value, added to the vector start address). The vector base address can be altered by the VESA command.

---

**Note**

All vectors affected by the bytes sent will be overwritten. To avoid erroneous vector RAM contents, you should set the vector start address, the `rel-start-addr`, and the vector length to multiples of 4 (because one byte specifies four vectors).

---

If the requested download operation was successful, the first free vector address will be updated to show the first unused vector RAM location. This address can be altered by the VEFA command.

### Power-On Defaults

After power-on, the entire vector memory contents will be initialized to

- L0 (no tristate) for driver channels
- 'X' for receiver channels

In addition, the vector start address and the first free vector address are both set to 0.

## Errors

- Parameter out of range
- Address exceeds vector memory limits (VESA, VEFA)
- Vector length exceeds data block size (DRVD, EXPD)
- Invalid vector length (DRVD?, EXPD?)
- Vector start address exceeds vector memory limits (DRVD, EXPD)
- More than one pin in pin-list (DRVD, EXPD)
- Tester is not in real-time compare mode (EXPD, EXPD?)
- Execution conflicts with current configuration for pin-list (DRVD, EXPD)
- Vector data transfer failed or aborted (DRVD, EXPD, DRVD?, EXPD?)

Note, that the vector memory contents may be partially overwritten if this error occurs.

## Warnings

- Vector data truncated (DRVD, EXPD)

## Example

```
CONF I, MUX, P, (A0)
```

```
VESA 2
```

```
DRVD 0, 12, (A0), #42048(2 KByte binary data)
```

VEFA? now responds with VEFA 14

In the above example, the vector RAM of the 200 MHz (MUX) input pin A0 is loaded from vector address 0 through 15 with the first 4 bytes of each binary 1K data block. Bytes 1 through 4 are loaded to the master channel's vector RAM, bytes 1025 through 1028 are loaded to the slave channel's vector RAM. All other bytes are discarded and will have no effect. The vectors 0, 1, 14 and 15 will be overwritten. The first free vector address `ffvad` will be set to 14.

---

## Vector Data Format

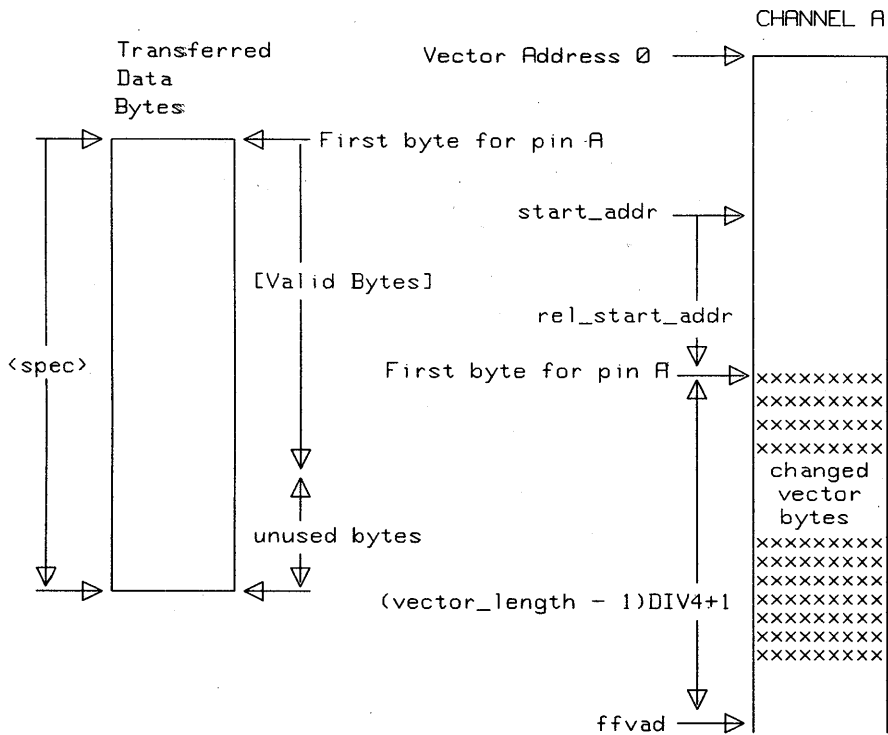
### Calculating the Data Transfer Block Size

You can use the following equation to calculate the minimum number of data bytes to be transferred for a given **vector-length**, **start-addr** and **rel-start-addr**.

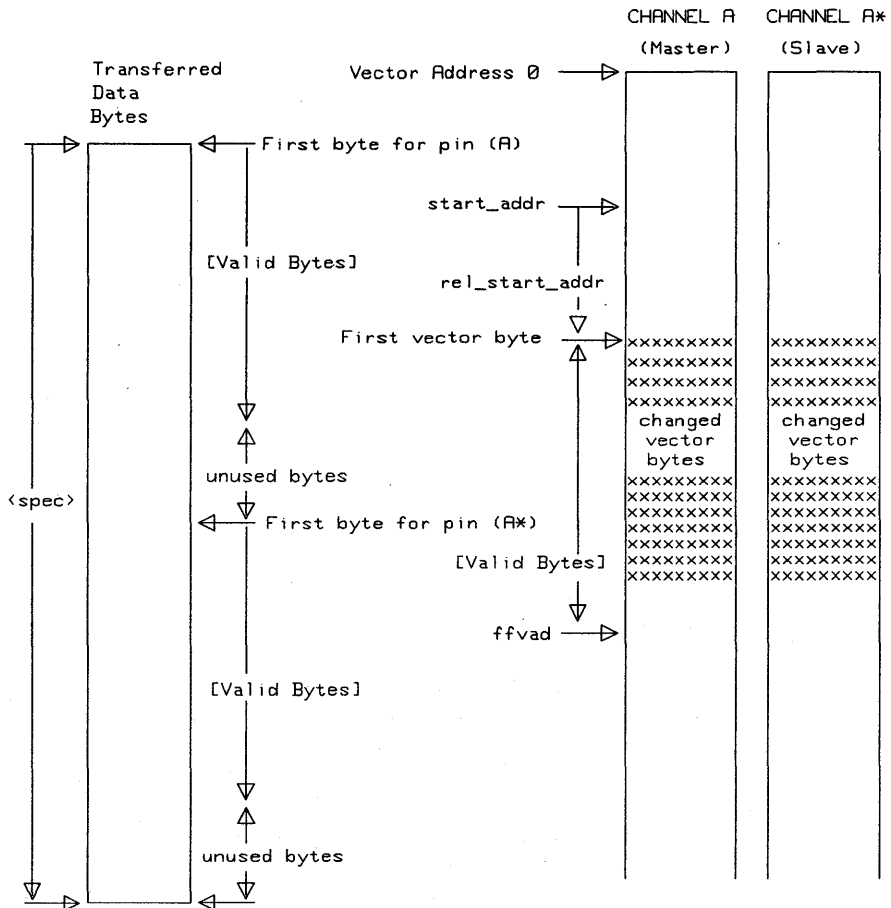
$$ValidBytes = \frac{(StartAddr + RelStartAddr)MOD4 + (VecLength - 1)}{4} + 1$$

**Where:**

- ValidBytes** = Minimum size for data block  
**StartAddr** = Base address for vector transfer (**start-addr** parameter of **VESA** command).  
**RelStartAddr** = Offset relative to base address (**rel-start-addr** parameter of **DRVD** or **EXPD** command).  
**VecLength** = Vector Length (specified by **DRVD** or **EXPD** command).



**Figure 5-1. Data Alignment (STD and FD mode)**



**Figure 5-2. Transfer Data / Vector RAM alignment (MUX mode)**

Note that an odd length specifier **spec** causes the size of the gap between the valid data blocks to be one less than the number of bytes ignored at the end of the entire data block.

---

## Data Formats

The following tables show the data bit alignment for the different operating modes.

### STD Mode

In this mode, data contains data and tristate bits.

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	D7	D6	D5	D4	D3	D2	D1	D0
	D0	T0	D1	T1	D2	T2	D3	T3
	E0/0	E0/1	E1/0	E1/1	E2/0	E2/1	E3/0	E3/1

where

Dn            drive data  
Tn            tristate on (1) or off (0)  
En/0, En/1    compare mode (as shown below)

#### Compare Modes for STD Mode

En/0	En/1	compare mode
0	0	intermediate
0	1	low
1	0	high
1	1	don't care



---

## Word Mask Pins

These are only valid for expected data.

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	D7	D6	D5	D4	D3	D2	D1	D0
	M0	X	M1	X	M2	X	M3	X

where

Mn            mask bit for vector n  
0 = word mask not active  
1 = vector masked

## FD Mode

In this mode, there are no tristate bits.

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	D7	D6	D5	D4	D3	D2	D1	D0
	D0.0	D0.1	D1.0	D1.1	D2.0	D2.1	D3.0	D3.1
	E0.0	E0.1	E1.0	E1.1	E2.0	E2.1	E3.0	E3.1

where

Dn.0            drive data (first half-cycle)  
En.0            expected data (first half-cycle)  
Dn.1            drive data (second half-cycle)  
En.1            expected data (second half-cycle)

## MUX Mode and FQ2 mode

### Drive Data

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	D7	D6	D5	D4	D3	D2	D1	D0
	D0.0	"0"	D1.0	"0"	D2.0	"0"	D3.0	"0"
	...	...	...	...	...	...	...	...
	Dw.0	"0"	Dx.0	"0"	Dy.0	"0"	Dz.0	"0"
	D0.1	"0"	D1.1	"0"	D2.1	"0"	D3.1	"0"
	...	...	...	...	...	...	...	...
	Dw.1	"0"	Dx.1	"0"	Dy.1	"0"	Dz.1	"0"

### Expected Data

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	D7	D6	D5	D4	D3	D2	D1	D0
	E0.0/0	E0.0/1	E1.0/0	E1.0/1	E2.0/0	E2.0/1	E3.0/0	E3.0/1
	...	...	...	...	...	...	...	...
	Ew.0/0	Ew.0/1	Ex.0/0	Ex.0/1	Ey.0/0	Ey.0/1	Ez.0/0	Ez.0/1
	E0.1/0	E0.1/1	E1.1/0	E1.1/1	E2.1/0	E2.1/1	E3.1/0	E3.1/1
	...	...	...	...	...	...	...	...
	Ew.1/0	Ew.1/1	Ex.1/0	Ex.1/1	Ey.1/0	Ey.1/1	Ez.1/0	Ez.1/1

where

Dn.0                      drive data (first half-cycle)  
Dn.1                      drive data (second half-cycle)  
En.0/0, En.0/1        expected data (first half-cycle)  
En.1/0, En.1/1        expected data (second half-cycle)

## FQ Mode

In this mode, there are no tristate bits.

### Drive Data

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	<b>D7</b>	<b>D6</b>	<b>D5</b>	<b>D4</b>	<b>D3</b>	<b>D2</b>	<b>D1</b>	<b>D0</b>
	D0.0	D0.1	D1.0	D1.1	D2.0	D2.1	D3.0	D3.1
	...	...	...	...	...	...	...	...
	Dw.0	Dw.1	Dx.0	Dx.1	Dy.0	Dy.1	Dz.0	Dz.1
	D0.2	D0.3	D1.2	D1.3	D2.2	D2.3	D3.2	D3.3
	...	...	...	...	...	...	...	...
	Dw.2	Dw.3	Dx.2	Dx.3	Dy.2	Dy.3	Dz.2	Dz.3

### Expected Data

Vector	Vector 0		Vector 1		Vector 2		Vector 3	
Bit Pos.	<b>D7</b>	<b>D6</b>	<b>D5</b>	<b>D4</b>	<b>D3</b>	<b>D2</b>	<b>D1</b>	<b>D0</b>
	E0.0	E0.1	E1.0	E1.1	E2.0	E2.1	E3.0	E3.1
	...	...	...	...	...	...	...	...
	Ew.0	Ew.1	Ex.0	Ex.1	Ey.0	Ey.1	Ez.0	Ez.1
	E0.2	E0.3	E1.2	E1.3	E2.2	E2.3	E3.2	E3.3
	...	...	...	...	...	...	...	...
	Ew.2	Ew.3	Ex.2	Ex.3	Ey.2	Ey.3	Ez.2	Ez.3

where

- Dn.0 drive data (first quarter-cycle)
- Dn.1 drive data (second quarter-cycle)
- Dn.2 drive data (third quarter-cycle)
- Dn.3 drive data (fourth quarter-cycle)
- En.0 expected data (first quarter-cycle)
- En.1 expected data (second quarter-cycle)





## Vector Sequencer Commands

---

The vector sequencer allows you to modify the order in which vectors are sent to the DUT. Conditional jumping and looping statements allow the generation of complex vector sequences dependent on the results of tests.

---

### Programming the Vector Sequencer

Sequencer programming can be very involved, and for this reason, there are two sequencer programming windows provided in the PWS software; the Sequencer Control Screen and the Sequencer Programming Screen. The instructions that are programmed in these windows are converted to the commands described in this section.

The commands in this section are:

SQST	set sequencer state
SQST	read sequencer state
SQPG	write sequencer instructions
SQPG?	read sequencer instructions
SQCL	clear sequencer label
SQFA	set first free sequencer instruction
SQFA?	retrieve first free sequencer instruction
SQSA	set start address of next sequencer instruction line
SQSA?	retrieve start address of next sequencer instruction line
SQGB	define global sequencer parameter
SQGB?	get global sequencer parameter
SQXI	define sequencer external input
SQXI?	get sequencer external input definition

## Syntax

SQST sequencer\_state

SQST?

SQPG inst-no, [label], [state], [vector-type], [vector-start]  
, [vector-length], [instruction-count], [jump-destination]  
, [jump-condition], [analyzer-stop], [failure-reset-flag],  
[apg-on-flag], [flag-2], [flag-1], [flag-0]

SQPG? inst-no

SQFA inst-no

SQFA?

SQSA inst-no

SQSA?

SQCL

SQGB [start-mode], [trigger-vector], [analyze-stop-delay]  
, [serial-word-length], [break-on-fail/full]

SQGB?

SQXI input-id, [purpose], [active], [threshold], [impedance]

SQXI? input-id

### Setting and Reading Sequencer States

The SQST command puts the sequencer into the specified sequencer-state.  
The possible states are:



OFF	(sequencer and clock off) The clock (and therefore the entire timing system) will be stopped. Only static signals are available at the connected DUT pins.
BRK	(sequencer in break) The clock and the timing system are fully functional. The input signals at the connected DUT pins match the defined break vector. On entering the “BRK” state, a test currently in process will be aborted.
RUN	(sequencer running) This command parameter causes a sequencer program to be executed starting at the currently defined start label. Depending on the global sequencer settings (SQGB), the sequencer will either be armed (waiting for an external condition) or active (generating test vectors). The sequence of test vectors generated depends on the previously downloaded sequencer program.

Selecting the sequencer RUN state results in a temporary change to the BRK state, if the sequencer was in either the RUN or OFF states.

Selecting the sequencer OFF state results in a temporary change to the BRK state, if the sequencer was in the RUN state.

Changing the sequencer state from RUN to BRK may also be forced by the sequencer program. In this case, the SQST? query reports the sequencer state entered under hardware control.

### Writing a Sequencer Instruction

The SQPG command defines one instruction for the sequencer. While inst-no is mandatory, all other fields of the sequencer are optional. If they are omitted, they will retain their previous values.

**inst-no** is an integer in the range 0 .. 999 that defines the instruction number to write. It is given relative to the sequencer-start-instruction given in the SQSA command. The resulting absolute instruction number must not exceed 0999. The resulting absolute instruction number will update the first free sequencer instruction automatically, if it is greater.

<b>label</b>	is a string of max 8 characters. Labels can be used later for specifying the start of a test. Giving a label with is currently defined in another instruction will remove the old definition and will generate a warning. Specifying a null string will remove a label. The number of labels concurrently defined is limited. The firmware can hold up to 15 labels concurrently.
<b>state</b>	controls the state of the sequencer. It can be either <ul style="list-style-type: none"> <li>■ CONT - continue in processing instructions</li> <li>■ BRK - go to break state (finish sequence)</li> <li>■ ARM - go to arm state and wait for trigger condition before processing instruction</li> </ul>
<b>vector-type</b>	controls the way in which vectors will be output during this instruction. It can be either <ul style="list-style-type: none"> <li>■ LIN - output a linear sequence of <b>vector-length</b> vectors starting at address <b>vector-start</b></li> <li>■ REP - output vector at address <b>vector-start</b> the number of times defined by <b>vector-length</b>.</li> <li>■ SCAN - output <b>vector-length</b> vectors in serial scan mode starting at address <b>vector-start</b> and using <b>serializing-word-length</b>.</li> </ul>
<b>vector-start</b>	defines the start address of the vectors to use in this instruction. The address is given relative to the <b>vector-start-address</b> set by the VESA command. The resulting absolute address must not exceed the highest address of vector memory installed. The value (-1) will specify the vector address after the last vector address used in the last instruction executed.
<b>vector-length</b>	defines the number of vectors to output. The minimum vector length is 32 except for jump source EVER or NEV when the minimum is 8. The maximum vector length is 1048575 ( $2^{20} - 1$ ).
<b>instruction-count</b>	specifies how often this instruction is executed. It must be an integer in the range 1 .. 2048. The value (-1) specifies an infinite repetition of this instruction. If the jump condition occurs, this repetition will be stopped independently of the <b>instruction-count</b> .

#### 6-4 Vector Sequencer Commands

**jump-destination** specifies the instruction to process when the jump condition has been detected. The **inst-no** is given relative to the **sequencer-start-instruction** given in the SQSA command. The resulting absolute instruction number must not exceed 999.

**jump-condition** specifies the condition which selects whether the next instruction processed is the following instruction or the instruction specified in **jump-destination**. The jump conditions can be derived from :

<b>NEV</b>	<i>NEVER</i> jump (default) - this causes the next consecutive sequencer instruction to be processed.
<b>SS</b>	Software Signal - a condition arbitrarily defined by the HP-IB command SQSS
<b>NSS</b>	(equivalent to $\overline{SS}$ )
<b>APG</b>	APG ready
<b>NAPG</b>	(equivalent to $\overline{APG}$ )
<b>FAIL</b>	Compare Failed
<b>NFL</b>	(equivalent to $\overline{FAIL}$ )
<b>XA</b>	External Input A Active
<b>NXA</b>	(equivalent to $\overline{XA}$ )
<b>XB</b>	External Input B Active
<b>NXB</b>	(equivalent to $\overline{XB}$ )
<b>EVER</b>	Unconditional jump to the <b>jump-instr</b>

**analyzer-stop** the first occurrence of this flag will trigger the end of data analysis after **analyze-delay** vectors.

**failure-reset-flag** resets the test failed condition at the start of this instruction, otherwise a jump on **FAIL** may be taken after a failure in a previous instruction

**apg-on-flag, flag-2, flag-1, flag-0** are boolean (1|0) flags for later use. They are not currently used.

The query command SQPG? returns the sequencer instruction specified by **inst-no**. The special value (-1) will define all sequencer instruction in the range from **sequencer-start** to **first-free-sequencer-instruction-1**. The query is not defined if **vector-start** and **sequencer-start** are set to anything other than zero.

**The DEFAULT Sequencer Program.** The firmware automatically installs and maintains a default sequencer program. This program outputs vectors from vector 0 to the last transferred vector (FFVAD-1) in a linear sequence. It can be referred to under the label "DEFAULT". Neither the Default sequencer program nor its label can be altered by the user.

### **Setting the First Free Sequencer Address**

The SQFA command sets the first free sequencer instruction to `inst-no`. `inst-no` is given absolute and must be in the range from 0 to 999. The first free sequencer instruction will also be updated by the SQPG command, if it is above the `inst-no` specified by an SQFA command.

The SQFA? query returns the current first free sequencer instruction.

### **Setting the Sequencer Start Address**

The SQSA command sets the start sequencer instruction to `inst-no`. `inst-no` is given absolute and must be an integer in the range 0 .. 999. All instruction numbers given in the SQPG command are treated relative to the current start sequencer instruction.

The SQSA? query retrieves the current start sequencer instruction.

### **Clearing Sequencer Labels**

The SQCL command removes the definition of all labels defined by SQPG commands.

### **Setting Sequencer Global Conditions**

The SQGB command specifies global parameters for the sequencer. They are:

<code>start-mode</code>	specifies how the sequencer will be started at a sequencer start command. It can be either <ul style="list-style-type: none"><li>■ ARM the sequencer will start only after a external run signal has received.</li><li>■ RUN the sequencer will start immediately after the sequencer start command.</li></ul>
-------------------------	--

**trigger-vector** specifies the vector-address, which should activate the trigger output of the tester when applied. It must be a valid vector address (0..V-MEM).

**analyze-stop-delay** specifies how many cycles the analyze memory full event will occur after a instruction with the **analyze-stop** flag set was executed. This event may put the sequencer into break mode. The last 64k vector are available at stop. The value of the **analyze-stop-delay** must be in the range 1 to 16777000.

**serial-word-length** specifies the word-length which is to use during instructions with **vector-type** "SCAN". It must be in the range from 4 to the total number of pins installed.

**break-on-fail / end** if set, the tester will go into break if a compare error occurs or the analyze memory is full. If reset, the tester will continue testing even if a compare error occurs or the analyze memory is full.

The SQGB? query retrieves the sequencer global setting

### Setting the Sequencer External Input

The sequencer can be made to react to an external input which could come from the DUT or any other source.

Two external inputs with identical capabilities are available. They are named XA and XB and are located on the Sequencer Board. The parameter **input-id** selects the external input to set. It is mandatory, while all other parameter are optional. Omitting a parameter leaves it value unchanged. The parameters are:

**input-id** can be either XA or XB. This selects the external input to to be modified. This parameter is mandatory.

**purpose** selects the task the input is used for. It can be

- BRK - to put the sequencer from active into break state (the external input must not be used for instruction jumps)
- CONT - to put the sequencer from arm into active state (the external input is available for instruction jumps also)

- JUMP - to cause jumps in appropriate sequencer instructions (the external input is available for instruction jumps only)
- slope defines what is treated as active for this input. This can be
  - H - high level
  - L - low level
  - R - rising edge
  - F - falling edge
- threshold defines the threshold of the input. The integer given is treated as millivolts and must be in the range -10000 (mV) to +10000 (mV). A warning will be generated, if the value is outside the range  $\pm 5000$  and low impedance is selected, because applying voltages out of this range may damage the tester. However, the input will be programmed accordingly.
- impedance specifies how the external input is terminated. It must be either
  - H high = 10 k $\Omega$
  - L low = 50  $\Omega$

## Power-On Defaults

At power-on, only the default label is defined and the following settings are made:

SQPG all-instructions, "", BRK, LIN, 0, 8, 1, 0, NEV, 0, 0, 0, 0, 0, 0

SQFA 0

SQSA 0

SQGB RUN, 0, 16777000, 8, 0

SQXI XA, JUMP, H, 0, H

SQXI XB, JUMP, H, 0, H

## **Errors**

- Value out of Range
- Bad label
- Too many labels

## **Warnings**

- External Input Threshold out of spec for low impedance
- Label redefined

## **Example**

```
SQPG 999,"Harry",CONT,LIN,64000,64000,2000,1000,NEV,1,1,1,1,1,1
SQCL
SQGB RUN,64000,16000000,126,1
SQXI XA,BRK,H,-10000,H
```





## Test Function Commands

---

This chapter describes the commands used to:

- set the tester state
- perform functional tests
- perform ac measurements
- perform dc measurements using the DC Measurement Unit
- perform dc measurements using the DPS

Additional low level commands in this chapter are used to:

- switch relays
- control the PMU
- set the sequencer software signal
- set and read the system utility lines

---

## Setting the Tester States

In the PWS software, there are tester states such as CONNECT, DISCONNECT, and TESTING. These states are not explicitly reflected by any HP-IB commands. However, the firmware supports these states by providing some primitives to handle tester states.

These primitives consist of:

- relay control commands to allow DUT pins to be connected and disconnected
- clock/sequencer commands that control clock and sequencer states

## Examples

### Switching from DISCONNECT to CONNECT

```
<report-message> "CONNECT"  
PSST ON  
RLYC AC, X, (<all-ac-pins>)  
SQST BRK
```

The RLYC command closes all the ac relays, the PSST command the power supply relays, and the SQST command sets the sequencer to the BRK state. The RLYC, PSST, and SQST commands are described in the following sections.

### Switching from CONNECT to DISCONNECT

```
SQST OFF  
RLYC IDLE,OFF,(0)  
PSST OFF  
<report-message> "DISCONNECT"
```

In this example, the sequencer is stopped, all relays are opened, the DPS is switched off and the "DISCONNECT" message is sent to the display.

---

## Functional Test Commands

A functional test consists of sending vectors to the DUT and checking that the resultant outputs are as expected. No ac or dc measurements are made during a functional test, the result is simply PASSED or FAILED.

To perform a functional test, the following requirements need to be fulfilled:

- Vector, timing, level and other setups must be loaded in the hardware - these commands are described in other parts of this manual.
- A sequencer start label must be defined to determine the order in which vectors must be sent to the DUT
- The comparators must be set to either acquire incoming data or compare it to expected data.
- The sequencer must be started

- When the sequencer stops, the test result needs to be read.

There are eight commands that are used for functional testing:

<b>SQSL</b>	defines the sequencer start label
<b>SQSL?</b>	retrieves the sequencer start label
<b>RCMD</b>	defines the receive mode
<b>RCMD?</b>	retrieves the receive mode
<b>SQST</b>	changes the sequencer state
<b>SQST?</b>	retrieves the sequencer state
<b>FTST?</b>	runs a functional test and returns the result of the test (PASSED/FAILED).
<b>FTCK?</b>	runs a functional test and keeps the system clock running.

## Syntax

**SQSL** label

**SQSL?**

**RCMD** receive-mode

**RCMD?**

**SQST** sequencer-state

**SQST?**

**FTST?**

**FTCK?**

**label** is a string of  $\leq 8$  characters indicating a sequencer start label. This label must have been previously defined either by using the Vector Sequencer window or the SQPG command (refer to the Vector Sequencer chapter).

**receive- mode** is either DA for data acquisition mode or RTC for real-time compare mode.

**sequencer-** can be either OFF, BRK, or RUN which sets the sequencer to  
**state** the OFF, BREAK, and RUN states respectively.  
**test- result** returns either P or F depending on whether the test passed  
or failed.

### **Sequencer Start Label**

The start label defined by the SSQL command is used to identify the first instruction (and therefore the first test vector) executed by subsequent tests.

If the defined start label is no longer valid (this could be caused by downloading a different sequencer program or by clearing the previously declared labels), the start label used by subsequent tests (and reported by the SSQL? query) will be changed to the "DEFAULT" label.

Starting a test at the "DEFAULT" start label causes the default sequencer program to be executed. This is described in the Vector Sequencer chapter.

Specifying a start label while the sequencer is running will interrupt the test being executed. When the sequencer is subsequently restarted, the first vector to be output will be the vector at label.

### **Receive Mode**

The **receive-mode** defined by the RCMD command specifies the way in which the tester will process the incoming data of subsequent tests. If the tester is set up for real-time compare mode (RTC), the DUT response will be compared against the expected data downloaded previously using the EXPD command.

If the system is set up in data acquisition mode (DA), the DUT response will be stored in the received data memory. The RECD? query may be used to examine the sampled data.

The query commands described in the Test Results chapter are provided to allow further interpretation of the test results obtained. These queries depend on the currently selected received data processing mode.

Sending the RCMD command while the sequencer is running will interrupt the test being executed. The test will be restarted at the specified start label, with the current **receive-mode**.

## Sequencer States

The SQST command puts the sequencer into the specified sequencer-state. The possible states are:

OFF	(sequencer and clock off) The clock (and therefore the entire timing system) will be stopped. Only static signals are available at the connected DUT pins.
BRK	(sequencer in break) The clock and the timing system are fully functional. The input signals at the connected DUT pins match the defined break vector. On entering the "BRK" state, a test currently in process will be aborted.
RUN	(sequencer running) This command parameter causes a sequencer program to be executed starting at the currently defined start label. Depending on the global sequencer settings (SQGB), the sequencer will either be armed (waiting for an external condition) or active (generating test vectors). The sequence of test vectors generated depends on the previously downloaded sequencer program.

Selecting the sequencer RUN state results in a temporary change to the BRK state, if the sequencer was in either the RUN or OFF states.

Selecting the sequencer OFF state results in a temporary change to the BRK state, if the sequencer was in the RUN state.

Changing the sequencer state from RUN to BRK may also be forced by the sequencer program. In this case, the SQST? query reports the sequencer state entered under hardware control.

## Performing a Functional Test

The FTST? query starts a functional test and returns the test result after the sequencer has stopped. The pattern used for the functional test is selected by the current sequencer start label, defined with the SSQL command. The received data processing mode has to be selected prior to a functional test by sending the RCMD command.

If the sequencer is already running, the functional test query aborts the test in process and restarts the sequencer at the defined start label.

A functional test running in data acquisition mode always returns P (passed), reflecting that data comparison has been disabled.

The `test-result` returned by a functional test in real-time compare mode will be F (failed), if any of the unmasked DUT output signals did not match the expected data for at least one test vector.

The Device Clear command (DCL) may be used to abort a functional test currently in process.

The following example performs a functional test and returns the number of failed cycles.

```
RCMD RTC      Set to real-time compare mode
SQSL "TEST"   Select the pattern to be used
FTST?        Perform the functional test
ERCT?        Read the number of errors
```

The following sequence of low level commands may be used to simulate the FTST? query.

```
SQST RUN      Start sequencer
...          wait until SQST? returns BRK
PASS?        read test results
```

## Reloading the Pattern Memory during a Functional Test

The FTCK? query allows you to execute functional tests in a similar way to FTST?, but unlike the FTST? query, FTCK? does not stop the system clock before starting the sequencer.

This facility is useful if your test vector pattern exceeds the length of the pattern memory, because in this case, you have to reload the pattern memory during your test. If the clock is stopped during the reload, a reset signal is issued in the hardware and, instead of staying in the Break state, the sequencer is turned off.

You can reload the pattern memory during a functional test by:

- downloading your first set of test vectors;
- performing your test with the FTST?;
- reload the pattern memory with the second set of vectors;
- perform the test again, but using FTCK?.

Because the clock is not stopped between vectors, the tester supplies your DUT with the break vector while the pattern memory is being reloaded. This means that your device is in a known logic condition when the test restarts.

In addition, the error flags (accessible with the `CHER?` command) are not reset, and will hold the total number of errors when the test finishes.

Although the error flags remain valid until the end of the test, the value in the error counter (read using `ERCT?`), is reset each time the sequencer is started, so you must read the value of this counter between tests, if you need this information.

---

**Note**

Use the `FTCK?` command in real-time compare mode. If it is used in data acquisition mode, the acquired data may be invalid.

---

**Example**

The following example illustrates the use of the `FTCK?` command.

```
DRVD 0,65536,(Din),#516384....
EXPD 0,65536,(Dout),#516384....   Load first part of vectors
SQL "DEFAULT"
FTST?                               Perform functional test
ERCT?                               Count errors in first part of test
DRVD 0,65536,(Din),#516384....   Load second part of vectors
EXPD 0,65536,(Dout),#516384....
                                     Perform functional test,
                                     without stopping the clock
FTCK?                               Count errors in second part of test
ERCT?                               Read channel error flags
CHER?                               for complete test
```

**Power-On Defaults**

At power-on, the following settings are valid:

```
SQL "DEFAULT"
```

```
RCMD RTC
```

SQST OFF

## Errors

Errors will be generated by:

- Trying to define an undeclared label.

---

## AC Measurement Commands

The commands described in this section are provided to support the various AC test functions. Most of them need more than one test to be run. Therefore, the sequencer may be restarted several times (at the defined start label). It is up to the user to ensure that all external conditions affecting the sequencer program flow behave the same during all tests.

The following commands are described in this section:

PDFT?	performs a combined propagation delay and data hold time measurement and returns a PASS/FAIL indication
TPDM?	performs a propagation delay measurement and returns a value.
TDHM?	performs a data hold time measurement and returns a value.
ESGB	sets up the step width settings for searches - used by RCES?, TSUP?, and THLD? and the minimum pulse width settings for input timing measurements - TSUP? and THLD?
ESGB?	reports the current settings of ESGB.
RCES?	sets the limits and search mode for output pin measurements.
TSUP?	performs a setup time measurement and returns a PASS/FAIL indication
THLD?	performs a hold time measurement and returns a PASS/FAIL indication
TPWM?	measures the minimum pulse and pause width for any number of input pins
DRLS?	performs a $V_{IL \max}$ and $V_{IH \min}$ test and returns a PASS/FAIL indication
RCLS?	performs a $V_{OL \max}$ and $V_{OH \min}$ test and returns a PASS/FAIL indication



All commands will modify the tester setup (format, timing or levels) during execution. However, the original settings will be restored upon termination. Aborting the command by sending a Device Clear message (SDC) aborts the test currently executing and restores all modified setups. For all commands modifying the timing setup, an unstable (or entirely missing) external phase sync signal will cause the system clock to run out of phase if external phase synchronization has been selected (see SCLK, SYNC and SNCC). No warnings or error messages will be sent in this case.

For all test function commands it is recommended that the operation modes of all pins specified in the passed pinlist are the same (either MUX, STD, FD, FQ2, FQ or FQM).

The resolution of timing measurement results depends on the programmed tester period as shown in the table below.

**Note**



This is the smallest discrete increment that the tester can use for presenting results; this does not affect the *accuracy* of the tester.

**Table 7-1.  
AC Test Function Timing Resolution (D100, D200 and D400)**

Clock Period	Resolution
$\leq 900$ ns	50 ps
$< 10$ $\mu$ s	1 ns
$< 100$ $\mu$ s	10 ns

**Table 7-2. AC Test Function Timing Resolution (D50)**

Clock Period	Resolution
$\leq 900$ ns	200 ps
$< 10$ $\mu$ s	1 ns
$< 100$ $\mu$ s	10 ns

## Syntax

PDFT? tpd, tdh, pinlist

returns

PDFT test-result

TPDM? pinlist

returns

TPDM rel-op, meas-val

TDHM? pinlist

returns

TDHM rel-op, meas-val

ESGB [pure\_lin\_step], [lin\_bin\_step], [min\_pulse\_width]

ESGB?

RCES? start, stop, mode, pinlist

returns

RCES rel-op, meas-val

TSUP? start, [limit], pinlist

returns

TSUP res-spec, meas-val

THLD? start, [limit], pinlist

returns

THLD res-spec, meas-val

TPWM? le\_delay, te\_delay, pinlist

returns

TPWM res-spec, min-pulse-width, res-spec, min-pause-width

DRLS? level\_select, pass\_value, [limit], pinlist

returns

DRLS res-spec, meas-value

RCLS? level\_select, pass\_value, [limit], pinlist

returns

RCLS res-spec, meas-value

where

**tpd** is a real number with the implied units nanoseconds used for the propagation delay time

**tdh** is a real number with the implied units nanoseconds used for the data hold time

**test\_result** can be either P or F to indicate passed or failed

**rel\_op** is a relational operator that can be one of:

LT - less than

LE - less than or equal to

EQ - equal to

GE - greater than or equal to

GT - greater than

**meas\_value** is a real number with the implied units nanoseconds or millivolts used for the measured value

**pure\_lin\_step** is a real number with implied units nanoseconds used to define a linear step

**lin\_bin\_step** is a real number with implied units nanoseconds used to define a linear/binary step

**start** is a real number with implied units nanoseconds used to define the start of a window

**stop** is a real number with implied units nanoseconds used to define the end of a window

**mode** either L or LB to specify a linear or linear/binary search sequence

<b>limit</b>	is a real number with implied units nanoseconds or millivolts used to define the limit for a measurement
<b>res_spec</b>	can be a relational operator of type <b>rel_op</b> , or P or F to indicate a pass or fail
<b>level_select</b>	can be H or L to indicate a high or low level
<b>min_pulse_width</b>	'is a real number with implied units nanoseconds giving the minimum measured pulse width.
<b>min_pause_width</b>	is a real number with implied units nanoseconds giving the maximum measure pause width.
<b>le_delay</b>	is a real number with implied units nanoseconds used to define a leading edge delay
<b>te_delay</b>	is a real number with implied units nanoseconds used to define a trailing edge delay

### Defining Edge Search Parameters

The ESGB command is used to setup the step width required for a linear edge search (RCES?, TSUP?, THLD?) and the minimum pulse width required for all input pin timing measurements (TSUP?, THLD?). Refer to the description of the commands in parentheses to understand how the values setup by the ESGB command are actually used.

A negative value for **pure\_lin\_step** or **lin\_bin\_step** is used to specify an infinite step width (see RCES?).

**Min\_pulse\_width** must not be negative.

At power-on the following default values are active

ESGB -1,2,2.5	<i>For D100, D200 and D400</i>
ESGB -1,4,5	<i>For D50</i>

### Measuring Propagation Delay and Data Hold Time

Three commands are available to measure the propagation delay and/or data hold time of a DUT output pin.

**Pass/Fail Test for 100 MHz and 200 MHz MUX-mode Pins.** The PDFDT? command returns a passed/failed result of a combined propagation delay/data hold time test. The test is done in window compare mode, setting the compare window of all selected pins to

$tpd \dots t_{dh} + \text{period}$  (STD pins)  
 $tpd \dots t_{dh} + \text{period}/2$  (MUX pins)

If the required window exceeds the maximum tester window width (period - 3 ns), two tests with overlapping windows are performed.

**Test\_result** will be either P (test passed) or F (test failed).

The allowed value ranges depend on the configuration of the pins passed in **pinlist**. If no MUX pins are specified,  $pin\_period = \text{tester\_period}$ . If at least one MUX pin is specified,  $pin\_period = \text{tester\_period} / 2$

**tpd** and **tdh** must be in the following ranges:

For a propagation delay measurement,

$tpd \geq 0$   
 $tpd \leq pin\_period$

For a data hold time measurement,

$tdh \geq 0$   
 $tdh \geq tpd - pin\_period + 2 \text{ ns}$   
 $tdh \leq tpd$   
 $tdh \leq \text{tester\_period} - 3 \text{ ns}$

In a multiple mainframe configuration, only the master mainframe responds to the PDFT? query. Pins in **pinlist** must be configured as O, IO, IOL, IOH, TERM, or NC pins. FD, FQ2, FQ and FQM pins are not allowed to be part of **pinlist**. Exceeding the value ranges for the **start** and **stop** parameters causes an error message to be sent to the host and no test to be run.

**Value Test Data Hold Time for 100 MHz and 200 MHz MUX-mode Pins.** The TPDM? command returns the measured (maximum) propagation delay of any number of DUT output pins.

A binary search algorithm is used to measure the propagation delay. Measurement is done in window compare mode, varying the leading edge to find the minimum delay at which a functional test passes. The trailing edge will be initially set to

period - 2 ns (STD pins only)  
period/2 - 2 ns (at least one MUX pin)

but may be auto-corrected during the search in the range

period - 3 ns .. period + 2 ns (STD pins only)  
period/2 .. period/2 + 2 ns (at least one MUX pin)

The returned `rel_op` will be

- EQ if a passed/failed transition could be detected
- LE if all tests passed
- GT if all tests failed

In a multiple mainframe configuration, only the master mainframe responds to the `TPDM?` query. Pins in `pinlist` must be configured as O, IO, IOL, IOH, TERM, or NC pins. FD, FQ2, FQ and FQM pins are not allowed to be part of `pinlist`.

**Value Test Propagation Delay for 100 MHz and 200 MUX-mode Pins.** The `TDHM?` command returns the measured (minimum) data hold time of any number of DUT output pins.

A binary search algorithm is used to measure the data hold time. Measurement is done in window compare mode, varying the trailing edge to find the maximum delay at which a functional test passes. The leading edge will be initially set to

period (STD pins only)  
period/2 (at least one MUX pin)

but may be auto-corrected during the search in the range

period - 2 ns .. period (STD pins only)  
period/2 - 2 ns .. period/2 (at least one MUX pin)

The returned `rel_op` will be

- EQ if the maximum data hold time could be measured
- GE if all tests passed
- LT if all tests failed

Pins in `pinlist` must be configured as O, IO, IOL, IOH, TERM, or NC pins. FD, FQ2, FQ and FQM pins are not allowed to be part of `pinlist`.

**Testing 200 MHz FD, FQ2, FQ and FQM mode pins.** The `RCES?` command is used for both value and pass-fail tests of any number of DUT output pins. The command performs a linear search, varying the leading edge, starting at `start` and terminating after the first test fails or after the search limit specified

by **stop** has been reached. If a linear-binary search has been selected (mode = LB), an additional binary search in the interval between the last passed and the first failed test will be done, to improve the measurement resolution. The trailing edge may be auto- corrected, if the command is used for window compare mode pins.

Both, **start** and **stop** must be in the range

0 .. period (no MUX pin)

0 .. period/2 (at least one MUX pin)

An increasing search will be performed, if **start** is less than or equal to **stop**, otherwise a decreasing search will be used.

The step width used for the linear search depends on the selected mode and will be

**pure\_lin\_step** (if mode = L)

**lin\_bin\_step** (if mode = LB)

In either case, an infinite step width results in performing no more than two tests, one at the specified **start** and the other at the specified **stop** value.

The returned **rel\_op** depends on the search direction and will be

EQ if the maximum data hold time could be measured

GT if the first test failed (decreasing search)

GE if all tests passed (increasing search)

LE if all tests passed (decreasing search)

LT if the first test failed (increasing search)

In a multiple mainframe configuration, only the master mainframe responds to the RCES? query. Pins in **pinlist** must be configured as O, IO, IOL, IOH, TERM, or NC pins. Exceeding the value ranges for the **start** and **stop** parameters causes an error message to be sent to the host and no test to be run.

### Example

The following example shows how to use these queries to measure the propagation delay and data hold time of a DUT output pin. Assuming a tester period of 100 ns and expected pass values of 2 ns (**tpd**) and 0 ns (**tdh**) and a reference signal (**tref**) at 10 ns.

PDFT? 12,10,(pin)

Propagation Delay and Data Hold Time Test. The command returns "PDFT P" if the test passed, otherwise "PDFT F" will be returned.

TPDM? (pin)

Propagation Delay Measurement. If the returned `rel_op` is EQ, the propagation delay can be derived from the returned value :  $tpd = return\_value - tref$

TDHM? (pin)

Data Hold Time Measurement. If the returned `rel_op` is EQ, the data hold time can be derived from the returned value :  $tdh = return\_value - tref$

If the pin to be measured is configured as a 200 MHz FD-mode pin, the same example would read:

RCES? 50,12,L,(pin)

Propagation Delay Pass/Fail Test. We expect the output signal to be stable in the interval  $tref + tpd .. period/2$ . Therefore, a passed test will return the LE `rel_op`. All other return values indicate a failed test.

RCES? 50,60,L,(pin)

Data Hold Time Pass/Fail Test. We expect the output signal to be stable in the interval  $period/2 .. tref + tdh + period/2$ . Therefore, a passed test will return the GE `rel_op`. All other return values indicate a failed test.

RCES? 50,0,LB,(pin)

Propagation Delay Measurement. The pass/fail transition is expected to be in the interval  $0 .. period/2$ . If the returned `rel_op` is EQ, the propagation delay can be derived from the returned value :  $tpd = return\_value - tref$

RCES? 50,100,LB,(pin)

Data Hold Time Measurement. The pass/fail transition is expected to be in the interval  $period/2 .. period$ . If the returned `rel_op` is EQ, the data hold time can be derived from the returned value :  $tdh = return\_value - tref - period/2$



## Setup / Hold Time Measurement

Two commands (TSUP?, THLD?) are available, to measure the setup and/or hold time of a DUT input pin. Both commands are used for pass/fail and value tests.

**Setup Time Pass/Fail and Value Test.** The TSUP? command returns a passed/failed result of a setup time test, if **limit** has been omitted. The test is done by a single functional test, setting the driver leading edge of all pins in **pinlist** to the expected pass value, passed as **start**. The trailing edge may be auto-corrected (for Rx format pins only) to ensure the **min\_pulse\_width** specified (see ESGB). The passed/failed test returns a **res\_spec** of either P (pass) or F (fail). The returned value will be the passed **start** value.

A value test is done by varying the driver leading edge of all pins passed in **pinlist**. The first measurement, done at the expected pass value **start**, is used to select either a binary search (test failed) or linear search (test passed) algorithm to measure the DUT pins setup time. The linear search will be done, increasing the edge delay by **lin\_bin\_step** until the first test fails (or the hardware programming limit, period or period/2, is reached). An additional binary search improves the resolution of the returned result value. The binary search will be done in the interval **limit** through **start** to measure the setup time. For Rx format pins, the trailing edge may be auto-corrected during the search, to ensure the **min\_pulse\_width** specified (see ESGB). The returned **res\_spec** will be

- EQ if the setup time could be measured
- GE if all tests passed
- LT if all tests failed

The allowed value range for the **start** parameter depends on the configuration of the pins passed in **pinlist**

- 0 .. period (no MUX pins)
- 0 .. period/2 (at least one MUX pin)

The **limit** parameter, if specified, must be in the range

- 0 .. **start**

In addition, the **min\_pulse\_width** specified prior to this command must not exceed the hardware limits and has to be in the range

0 .. period - 0.5 ns (no MUX pins)  
0 .. period/2 (at least one MUX pin)

In a multiple mainframe configuration, only the master mainframe responds to the TSUP? query. Pins in `pinlist` must be configured as I, IO, IOL, IOH, or NC pins; IX pins must not be included in the pinlist. Exceeding the value ranges for the `start` and `limit` parameters causes an error message to be sent to the host and no test to be run.

**Hold Time Pass/Fail and Value Test.** The THLD? command returns a passed/failed result of a hold time test, if `limit` has been omitted. The test is done by one or two functional tests, depending on the operation mode of the pins passed in `pinlist`. The driver trailing edge will be set to the expected pass value `start`, while the format will be set up according to the table given below. The leading edge may be auto-corrected to ensure the `min_pulse_width` specified (see ESGB). The passed/failed test returns a `res_spec` of either P (pass) or F (fail). The returned value will be the passed `start` value.

A value test is done by varying the driver trailing edge of all pins passed in `pinlist`. The first measurement, done at the expected pass value `start` is used to select either a binary search (test failed) or linear search (test passed) algorithm to measure the DUT pins hold time. Again, each test done may consist of two functional tests (see table below). The linear search will be done, decreasing the edge delay by `lin_bin_step` until the first test fails or the hardware programming limit (0) is reached. An additional binary search improves the resolution of the returned result value. The binary search will be done in the interval `limit` through `start` to measure the hold time. The leading edge may be auto-corrected during the search, to ensure the `min_pulse_width` specified (see ESGB). The returned `res_spec` will be one of:

- EQ if the hold time could be measured
- LE if all tests passed
- GT if all tests failed

The allowed value range for the `start` parameter depends on the configuration of the pins passed in `pinlist`

`min_pulse_width` ..  $2 * \text{period} - 1 \text{ ns}$  (no MUX pins)  
`min_pulse_width` .. `period` (at least one MUX pin)

The `limit` parameter, if specified, must be in the range

start .. 2 \* period - 1 ns (no MUX pins)  
start .. period (at least one MUX pin)

**Table 7-3. Driver Formats for Hold Time Tests**

Pin Mode	Pin Type	Format	1st pass	2nd pass
STD	i,i/o	DNRZ,R1,RZ	RC	
	i,i/o	RI	unchanged	
	ioh,iol	R1,RZ,RI	unchanged	
	ioh	DNRZ	R1	
	iol	DNRZ	RZ	
MUX	i,i/o	DNRZ,R1,RZ	RZ	R1
	ioh,iol	R1,RZ,RI	unchanged	
	ioh	DNRZ	R1	
	iol	DNRZ	RZ	
FQ2	i	DNRZ,RZ,R1	RZ	R1

In a multiple mainframe configuration, only the master mainframe responds to the THLD? query. Pins in pinlist must be configured as I, IO, IOL, IOH, or NC pins. IX pins must not be included in the pinlist. Exceeding the value ranges for the start and limit parameters causes an error message to be sent to the host and no test to be run. FD, and FQ pins are not allowed to be part of pinlist.

**Example.** The following example shows how to use these queries to measure the setup and hold time of a 100 MHz DUT input pin (DNRZ), assuming a tester period of 100 ns and expected pass values of 2 ns (tsu) and 3 ns (thld). We further assume a reference signal (tref) at 10 ns.

TSUP? 8,,(pin)

Setup Time Pass/Fail Test. The expected pass value is (tref - tsu). The command returns "TSUP P,8" if the test passed, otherwise "TSUP F,8" will be returned.

THLD? 13,,(pin)

Hold Time Pass/Fail Test. The expected pass value is (thld - tref). The command returns "THLD P,13" if the test passed, otherwise "THLD F,13" will be returned.

TSUP? 8,0,(pin)

Setup Time Value Test. We assume that (pin) is a DNRZ pin, so limit can be set to 0. For Rx format pins, limit should be set to the programmed trailing edge value minus the actual period if the programmed delay is greater than the period. If the returned rel\_op is EQ, the setup time can be derived from the returned value :  $tsu = tref - return\_value$

THLD? 13,108,(pin)

Hold Time Value Test. Limit is set to period plus the programmed leading edge delay. If the returned rel\_op is EQ, the hold time can be derived from the returned value :  $thld = return\_value - tref$

### **Pulse / Pause Width Measurement**

TPWM? le\_delay, te\_delay, pinlist

Return string:

TPWM rel\_op, min\_pulse\_width, rel\_op, min\_pause\_width

The TPWM? command is used to measure the minimum pulse- and pause-width of any number of DUT input pins.

The value test is done by varying the driver trailing edge of all pins passed in pinlist, using a binary search algorithm. The binary search is performed in the interval te\_delay through (le\_delay + 0.5 ns) to measure the minimum pulse width and in the interval te\_delay through le\_delay + pin\_period to measure the minimum pause width.

Only R1, RZ, RI or RC format pins are allowed to be part of pinlist. The passed le\_delay and te\_delay setups must be in the range described in the timing setup section (see the description of the DRTM command). Note that the value ranges for MUX pins are used if one or more pins pinlist are configured as MUX mode pins.

The returned rel\_op will be one of

EQ if the min. pulse (or pause) width could be measured  
LE if all tests passed  
GT if all tests failed

In a multiple mainframe configuration, only the master mainframe responds to the TPWM? query. Pins in `pinlist` must be configured as I, IO, IOL, IOH, or NC pins. Exceeding the value ranges for the `le_delay` and `te_delay` parameters causes an error message to be sent to the host and no test to be run.

### Input / Output Level Measurement

Two commands (DRLS?, RCLS?) are available to measure the input level sensitivity of a DUT input pin and the min./max. output levels of a DUT output pin. Both commands are used for pass/fail and value tests.

**V<sub>IH</sub>, V<sub>IL</sub> Pass/Fail and Value Test.** The DRLS? command returns a passed/failed result of a V<sub>IHmin</sub> or V<sub>ILmax</sub> test, if `limit` has been omitted. The test is done by a single functional test, setting the driver high (`level_select = H`) or low (`level_select = L`) level of all pins in `pinlist` to the expected `pass_value`. The corresponding high or low level may be auto-corrected to avoid violating the driver swing limitations (see DRLV). The passed/failed test returns a `res_spec` of either P (pass) or F (fail). The returned value will be the passed `pass_value`.

A value test is done by varying the driver high (`level_select = H`) or low (`level_select = L`) level of all pins passed in `pinlist`. For value tests, `pass_value` gives the high level (or low level) at which a functional test is expected to pass. In general, the value passed will be the programmed value.

`Limit` specifies the binary search limit which will in general be the programmed low level (`level_select = H`) or the programmed high level (`level_select = L`). The binary search will be done in the interval `limit` through `pass_value`. During the search, the corresponding high or low level may be auto-corrected to avoid violating the driver swing limitations (see DRLV). The returned `res_spec` will be one of:

EQ if V<sub>IHmin</sub> or V<sub>ILmax</sub> could be measured  
GT if all tests failed (`level_select = H`)  
GE if all tests passed (`level_select = L`)  
LE if all tests passed (`level_select = H`)

LT if all tests failed (`level_select = L`)

The allowed value ranges are

`pass_value` : -4000 mV .. +8000 mV

`limit` : -4000 mV .. `pass_value` (H) and `pass_value` .. +8000 mV (L)

In a multiple mainframe configuration, only the master mainframe responds to the DRLS? query. Pins in `pinlist` must be configured as I, IO, IOL, IOH, or NC pins. IX pins must not be included in the `pinlist`. Exceeding the value ranges for the `pass_value` and `limit` parameters causes an error message to be sent to the host and no test to be run.

**V<sub>OH</sub>, V<sub>OL</sub> Pass/Fail and Value Test.** The RCLS? command returns a passed/failed result of a V<sub>OHmin</sub> or V<sub>OLmax</sub> test, if `limit` has been omitted. The test is done by a single functional test, setting the receiver high (`level_select = H`) or low (`level_select = L`) level of all pins in `pinlist` to the expected `pass_value`. The corresponding high or low level may be auto-corrected to avoid violating the receiver swing limitations (see RCLV). The passed/failed test returns a `res_spec` of either P (pass) or F (fail). The returned value will be the passed `pass_value`.

A value test is done by varying the receiver high (`level_select = H`) or low (`level_select = L`) level of all pins passed in `pinlist`. For value tests, `pass_value` gives the high level (or low level) at which a functional test is expected to pass. In general, the value passed will be the programmed value. `Limit` specifies the binary search limit which will in general be the programmed low level (`level_select = H`) or the programmed high level (`level_select = L`). The binary search will be done in the interval `hardware_limit` through `limit`. During the search, the corresponding high or low level may be auto-corrected to avoid violating the receiver swing limitations (see RCLV). The returned `res_spec` will be one of:

EQ if V<sub>OHmin</sub> or V<sub>OLmax</sub> could be measured

GT if all tests failed (`level_select = L`)

GE if all tests passed (`level_select = H`)

LE if all tests passed (`level_select = L`)

LT if all tests failed (`level_select = H`)

The allowed value ranges are

**pass\_value** : -4000 mV .. +8000 mV

**limit** : -4000 mV .. **pass\_value** (H) and **pass\_value** .. +8000 mV (L)

In a multiple mainframe configuration, only the master mainframe responds to the RCLS? query. Pins in **pinlist** must be configured as O, IO, IOL, IOH, TERM, or NC pins. Exceeding the value ranges for the **pass\_value** and **limit** parameters causes an error message to be sent to the host and no test to be run.

### Example

Assuming a DUT with one input (Din) and one output (Dout) pin, we want to measure the input level sensitivity and the maximum and minimum output levels. We further assume that the tester configuration and vector setup has been already done, such that a functional test will pass.

The (hypothetical) specs of the device are as follows :

Parameter	Value
Vil (Din)	≤1.13 V
Vih (Din)	≥1.48 V
Vol (Dout)	≤0.98 V
Voh (Dout)	≥1.63 V

The following firmware command sequence is used to measure the DUT parameters :

DRLV -1700,-800,(Din)

RCLV -1300,-1250,(Dout)

Setup pin levels such that a functional test will pass.

DRLS? H,-1130,,(Din)      *Vih*

DRLS? L,-1480,,(Din)      *Vil*

RCLS? H,-980,,(Dout)      *Voh*

RCLS? L,-1630,,(Dout)      *Vol*

All queries shown above will return P,value if the functional test passed, otherwise F,value will be returned.

DRLS? H, -800, -1700, (Din)	<i>V<sub>ih</sub></i>
DRLS? L, -1700, -800, (Din)	<i>V<sub>il</sub></i>
RCLS? H, -1250, -1300, (Dout)	<i>V<sub>oh</sub></i>
RCLS? L, -1300, -1250, (Dout)	<i>V<sub>ol</sub></i>

If the returned `rel_spec` is EQ, the returned value of each test gives the requested level ( $V_{ih}$ ,  $V_{il}$ ,  $V_{oh}$ , or  $V_{ol}$ ) without any further conversions.

---

## High Resolution Timing Diagram


The commands described in this section are provided to support the High Resolution Timing Diagram. There are four commands in this section:

H RTP	sets up the parameters for the high resolution timing diagram
H RTP?	reads the current parameters set for the high resolution timing diagram
H RTM	starts a high resolution timing diagram measurement
H RTR?	gets the results of the last H RTM measurement
H RTL?	reports the limitations imposed on the high resolution timing diagram by the hardware.

A high resolution timing diagram test is done by collecting the DUT data sampled at various sampling points distributed evenly over the tester period. The number of sampling points depends on the required resolution. The samples are taken in edge compare mode, varying the comparator leading edge.

Because the test requires that more than one test be run, the sequencer will be restarted several times at the defined start label. You should ensure that all external conditions affecting sequencer program flow behave the same way for all tests.

---

**Note**  An unstable or missing external phase sync signal will cause the system clock to run out of phase, if external phase synchronization has been selected (see SCLK, SYNC, and SNCC). No error messages or warnings will be issued if this occurs.

---



During the test, the tester timing setup will be modified. When the test terminates, the original values will be restored. The last activity of the HRTM command is to perform a functional test in DA mode, with the original settings.

Aborting the command using a Device Clear message (SDC) aborts the test currently running and restores the original setup values. In this case, no functional test will be performed.

## Syntax

```
H RTP cycles, cycle-offset, samples-per-cycle, samples,  
sample-offset
```

```
H RTP?
```

```
H RTM pin-list
```

```
H RTR?
```

returns

```
H RTR pin, #spec result
```

where

```
spec = digit {digit}
```

```
result = resultchar {resultchar}
```

```
resultchar = 0 | 1 | I | ?
```

```
H RTL?
```

returns

```
H RTL no_of_pins, no_of_samples
```

## Finding the Limitations Imposed by the Hardware

The HRTL? query reports the maximum number of pins, and the maximum number of samples which may be measured in parallel by a single HRTM command, and also the maximum number that can be specified in the H RTP command.

While the number of samples is fixed at 1024, the number of pins depends on the clock board revision and the tester model. With the 512 Kbyte firmware memory clock board, the maximum number of pins is 32 pins for the D200; and 4 pins for the D50. With the 2 Mbyte clock board, 32 pins are available for all models (D50, D100, D200 and D400)

## Defining the Test Function Parameters

The test function parameters are defined with the H RTP command. The current settings can be read using H RTP?. This query will only be answered by the master mainframe.

H RTP *cycles, cycle-offset, samples-per-cycle, samples, sample-offset*

<b>cycles</b>	specifies the number of cycles to be examined in high resolution mode. It may be any integer value greater than zero taking the sampling limits, given below, into consideration. Regardless of the current operating modes for the pins in <i>pin-list</i> , the term <i>cycles</i> always refers to sequencer cycles (100 MHz).
<b>cycle-offset</b>	specifies the first cycle to be examined. It is given relative to the start of the analyzer delay counter and may be negative.
<b>samples-per- cycle</b>	specifies the timing resolution by defining the number of samples (> 0) to be taken in each cycle.
<b>samples</b>	specifies the number of samples to take for the next HRTM command
<b>sample- offset</b>	specifies the first sample. It is given relative to the first sample in the cycle and can be in the range 0 .. ( <i>samples_per_cycle</i> - <i>samples</i> ).

Value range errors will occur if:

```
cycles < 1  
(cycles × samples) > 1024  
samples > (samples_per_cycle - sample_offset)
```

## Running the Test Function

The test function is started for the pins in **pin-list** using the **HRTM** command. The number of tests that is actually performed is determined by the **samples** variable specified in the last **HRTM** command. If an error occurs, no results will be available and the number of tests actually performed is not specified.

Errors will occur if:

- The tester is not in acquisition mode (see **RCMD**)
- The requested number of cycles after **cycle-offset** are not available
- The number of pins in **pin-list** > 32
- **pin-list** contains non-applicable pins (**I**, **DC**, or **OFF**)

In this case, the results will still be available for all applicable pins.

## Getting the Test Results

The **HRTR?** query returns the results of the last **HRTM** executed. A blank line (line-feed only) will be sent if no test has yet been performed since power-on or the last **HRTM** command. No response will be sent for a pin whose configuration has been changed since the last measurement.

The values of **resultchar** have the following meanings:

- |          |   |
|----------|---|
| <b>0</b> | a level below the lower threshold was detected  |
| <b>1</b> | a level above the upper threshold was detected  |
| <b>I</b> | an intermediate level was detected (not returned for 200 MHz pins)  |
| <b>?</b> | the level detected was below the pin's lower threshold and above the upper threshold. This can only occur if the pin is not calibrated correctly (not returned for 200 MHz pins). |

## Examples

If the period has been set to 100 ns, the following set of commands can be used to obtain a high resolution timing diagram for 10 cycles starting at cycle 0, with a resolution of 1 ns.

```
HRTP 10,0,100,100,0
HRTM (Q0,Q1,Q2,Q3)
HRTR?
```

To perform a test without initialization cycles, the following set of commands can be used (assuming a test length of 1000 cycles).

```
HRTP 10,-1000,100,100,0
HRTM (Q0,Q1,Q2,Q3)
HRTR?
```

To run a test with a resolution exceeding the maximum number of samples (say 100 picoseconds), it has to be split as in the following example.

```
SCLK ,300, first part
HRTP 1,10,3000,100,0
HRTM (Q0,Q1,Q2,Q3)
HRTR?
HRTP 1,10,3000,100,100 second part
HRTM (Q0,Q1,Q2,Q3)
HRTR?
HRTP 1,10,3000,100,200 third part
HRTM (Q0,Q1,Q2,Q3)
HRTR?
```

---

## DC Measurement Commands using the PMU

There are six commands for performing dc measurements using the PMU. These are:

DCGB	sets the global dc measurement modes
DCGB?	retrieves the global dc measurement modes
DPAR	defines a set of dc measurement parameters
DPAR?	retrieves a set of dc measurement parameters
DTST	performs a dc measurement
DCPR?	retrieves the result of pin-related dc measurements
DCSR?	retrieves the result of non-pin-related dc measurements

### Syntax

DCGB [meas-mode], [connect-mode], [pre-action]

DCGB?

DPAR set-id, [connect-u], [force-u], [force-i], [time]

DPAR? set-id

DTST set-id, pinlist

DCPR? id

DCSR? id

The DCGB command defines the global parameters for the next dc measurement. The parameters:

<b>meas-mode</b>	specifies whether the measurement will be performed in parallel or serial. It can be <ul style="list-style-type: none"><li>■ P - parallel. Only one measurement per mainframe is performed. All pins of one mainframe are connected simultaneously to a PMU and the combined current and voltage is measured. The result is available using DCSR?</li></ul>
------------------	---

- S - serial. Every pin is measured alone. The result is available using DCPR?. It is calculated taking the value of the Rs parameter of the PATR command into consideration.
- D - direct. Every pin is measure separately. The result is available via the DCPR? query. It is calculated at the tester pin.

This parameter greatly influences the speed of the measurement and the quality of the results available after the measurement. Parallel measurements, of course, will not generate individual per-pin results.

**connect-mode** specifies how the PMU is connected to the pin. It can be one of

- A - additional. The PMU is also connected to the IO channel during the measurement. In this case, any AC electronics on the IO board can affect the measurement and can be used to measure the DUT pins under loaded conditions.
- E - exclusive. The PMU is connected to the DUT only. The IO board is disconnected from the DUT for the duration of the measurement.

**pre-action** specifies the actions, to put the DUT into a state desired for the measurement. It can be

- NONE - nothing is done.
- FTST - a functional test, as described by the FTST command, is performed before the dc measurement.

At Power On it is defined as: DCGB S,E,NONE

### Setting the Parameters for a DC Measurement

The DPAR commands specifies the parameter sets for the dc measurements. Multiple parameter sets can be held simultaneously in the firmware.

The parameters of this command are:

**set-id** this integer selects the set to specify. This parameter is mandatory. It must be in the range 0 .. 1.

**connect\_u** is a fixed point number specifying the force voltage of the PMU in millivolts. It must be in the range -20000 (mV) .. +20000 (mV). If the value given exceeds this range, it will be set to

the limit. This voltage will be applied before the PMU is connected to the pin. The parameter allows reduction of the current required to charge the DC rail to the level of the DUT pin. Only devices that are sensitive to current peaks caused by this charging effect need this parameter to be set. Other devices will normally set this value to `force_u`.

**force-u** is a fixed point number specifying the force voltage of the PMU in millivolts. It must be in the range -20000 (mV) .. +20000 (mV). If the value given exceeds this range, it will be set to the limit. The PMU will force this voltage as long as current specified by the `force-i` parameter is not exceeded. The voltage range of the PMU is automatically selected for best fit. If the dc measurement aims to a voltage measurement, this parameter should be specified to the highest absolute voltage expected to prevent PMU overflow conditions.

**force-i** is a fixed point number specifying the force current of the PMU in microamperes. It must be in the range 0 ( $\mu\text{A}$ ) .. 500000 ( $\mu\text{A}$ ). If the value given exceeds this range, it will be set to the limit. The current range of the PMU is automatically selected for best fit. The PMU will never generate a absolute current above this value. If the dc measurement aims to a current measurement, this parameter should be treated as clamp current, the current is limited by the PMU.

**time** is a fixed point number specifying the wait time used before a dc measurement in milliseconds. This time is measured from the point the DUT is connected to the PMU till the PMU read out. It is to allow charging of capacitive loads on the DUT wiring without influencing the measurement results. The firmware takes care for any internal capacitive loads, so the user need not compensate for them.

All values in this command can be given in an arbitrary precision. However, the firmware will map them to the accuracy of the available hardware.

At Power On all sets are defined as: DPAR x,0,0,0

## Retrieving Measurement Results from a DTST Command

Two commands are available for retrieving DC test results. The DCPR query retrieves the measured values of the last DTST command for each pin (if the test was performed per pin), and DCSR? gives the result per pinlist. The parameter

**set-id** selects, which pins are reported. All pins measured for this set since the most recent DPAR command for this set will be reported.

The DCPR? query responds with the syntax:

DCPR id, valid-code, measured-u, measured-i, pin-list

and the DCSR? query responds with the syntax:

DCSR id, valid-code, measured-u, measured-i

where

**valid-code** This integer describes the condition of the PMU during the measurement. It is in the range 0 .. 63. If **valid-code** is coded binary it has the format OFGppppp where

- ppppp is the **pmu-state** as described in the PMUM? query.
- G is the **force-i** overflow flag. It is set when the PMU could not be set to the necessary force current.
- F is the **functional fail** flag. It is set if preceding functional test result in a fail.

**measured-u** is the measured voltage given in millivolts. It is only valid, if the **valid-code** indicates neither unstable nor voltage overflow.

**measured-i** is the measured current given in microamperes. It is only valid, if the **valid-code** indicates neither unstable nor current overflow.

**pinlist** specifies the pins the former parameters are related to.

After Power On no DTST command has been executed and the query will not respond for any pin.



## Performing a DC Measurement

The DTST command will perform a dc measurement according to the current setup. The parameters of the command are

**set-id** specifies the parameter set to use for result generation. The parameter set is specified by the DPAR command.

**pinlist** specifies the pins to measure.

The following pseudo “C” should clarify how the different DCGB parameters will influence the DTST command.

```
switch (pre-action){
case NONE:
    break;
case FTST:
    perform-functional-test;
    break;
}
PMU.voltage=force-u[set-id];
PMU.current=force-i[set-id];
switch mode{
case S /* serial */
    for (pin in pins-to-measure){
        connect pin to PMU;
        wait time;
        pin.valid-code=PMU.state | FTST-result ;
        pin.measured-i=PMU.i;
        pin.measured-u=PMU.u;
        restore-connectivity-of-pin;
    }
    break;
case P /* parallel */
    connect all pins-to-measure to PMU;
    wait time;
    valid-code=PMU.state | FTST-result | PMU-current-overflow;
    measured-i=PMU.i;
    measured-u=PMU.u;
}
```

---

**Note**

Before executing DTST?, the relays of the IX pins included in the pin list must be switched to DC DCB or DCC using the RLYC command.

---

## DC Measurement Details

For a detailed understanding of things going on during a dc measurement the following notes will give some hints. Every detail not defined here should be treated as undefined and even if a specific behavior seems to be stable it should not be relied on. A non documented behavior may be observed not in all case and/or may change without notice.

### Relay Setting

When a DTST command is accepted the pin-mode (see RLYC command) of all pins of the system must be either IDLE or AC. These pin-modes will have been restored when the command has finished. Any other pin-mode of any pin in the system may result in an inaccurate measurement or even in damage of the DUT.

### Measurement Sequence

The sequence, the pins of DTST command are measured, is arbitrary. The firmware will neither define any particular sequence nor that two identical DTST commands will measure in the same sequence. Any measurement, sensitive to a specific measurement sequence, should be performed by separate DTST commands.

### PMU Usage

The firmware will neither specify which of the available PMUs is used for a specific pin nor that two identical DTST command will use the same PMU for a specific pin. Any measurement, sensitive to the use of a specific PMU, should be performed by low level PMU commands (PMUS, PMUM?).

### PMU Ranges

The DTST command will select a PMU range for voltage and current which fits best for specified force values. During a measurement the ranges of the

PMU will be adjusted to achieve the best resolution available or to prevent an overflow condition. This method assumes that the signal of the measured pin is stable over the whole measurement sequence, and may result in marginal current drops. Any measurement sensitive to the use of a specific range or not satisfying the stated assumptions, should be performed by low level PMU commands (PMUS, PMUM?).

---

## DC Measurement Commands using the DPS

The supported power supplies have the capability of reporting the actual voltage and current being supplied. The accuracy of this measurement is not very high, but it may be useful in some applications.

`PSME? pin-list`

This command returns the following string

`PSME status, voltage, current, pin`

where

<code>status</code>	reports the output state of the power supply. It can be either CV or CC for constant voltage and current respectively.
<code>voltage</code>	is a real number indicating the voltage at the DPS output. The polarity of the voltage is taken from the relevant DFPS command.
<code>current</code>	is a real number indicating the current flowing at the DPS output.
<code>pin</code>	specifies the DPS output to be read

### Errors

An error will be generated if there are no power supplies defined.

---

## Low Level Test Commands

The low-level HP-IB commands allow you to design test functions with increased flexibility.

The other, high-level HP-IB test commands combine the operations of several low-level commands, to improve programming convenience. However, under some circumstances, your test application may require additional manipulation of the tester hardware, which can only be carried out using these low-level operations.

Low-level commands are provided for:

- setting the pin connection relays;
- setting the DPS relays;
- setting the PMU relays;
- controlling the vector sequencer;
- setting the utility lines.

### General Considerations

If you do use low-level commands, you must be aware of the following considerations:

- Low-level commands interfere with the operation of high-level commands in many ways. You must have a detailed understanding of the operations being carried out in the tester hardware, *before* you combine high-level and low-level commands.
- Low-level commands perform only a rudimentary check of the parameters that you enter, and they do not warn you if the system is put into a state which could cause damage to the tester or DUT.
- Some low-level commands do not have corresponding queries associated with them. (so you might not be able to check the present hardware state).
- Values for low-level commands are not defined at power-up. The power-up states are controlled by the high level commands implicitly.

## Relay Commands

RLYC controls relays connected to pins and resources on the DC rail. Relays are in the tester for mainly two purposes:

- connect the pin electronics to the DUT (AC-relay)
- connect the DC measurement equipment (internal or external) to the DUT

PSST controls the relays that connect the DPS to the DUT.

While the AC connections can be made for each pin independently from other connections, DC connections share common resources. There is only one common DC line on each channel board and there are only two DC rail on a mainframe.

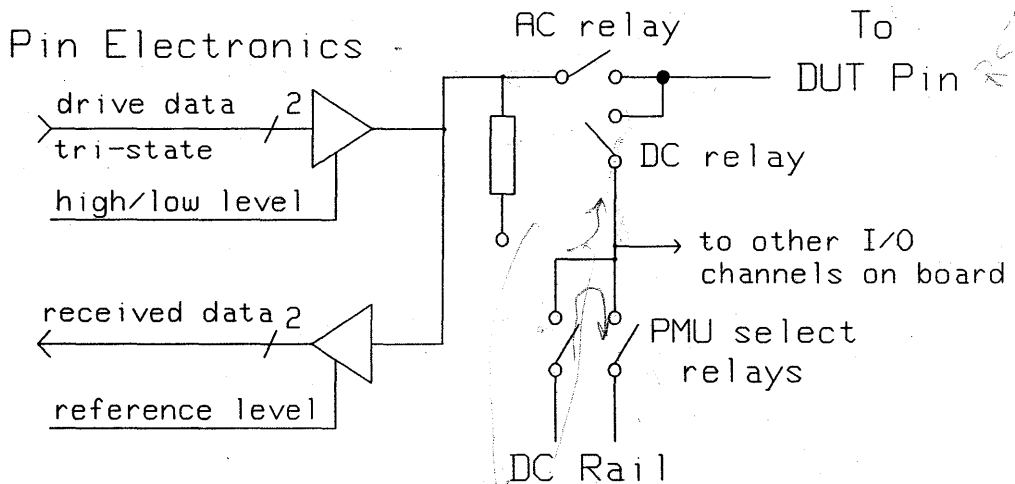


Figure 7-1. DC Wiring Schematics

These impose that

- the pins of any one I/O board may only be connected to the same DC equipment
- external DC equipment can only be used as an alternative to PMU1
- pins can only be connected to DC equipment on the same mainframe

With these restrictions in mind we come to a command that is based on the idea of connecting a pin to the DC equipment by specifying the setting of

- the pin relays and
- the Common DC relays

independently.

## Syntax:

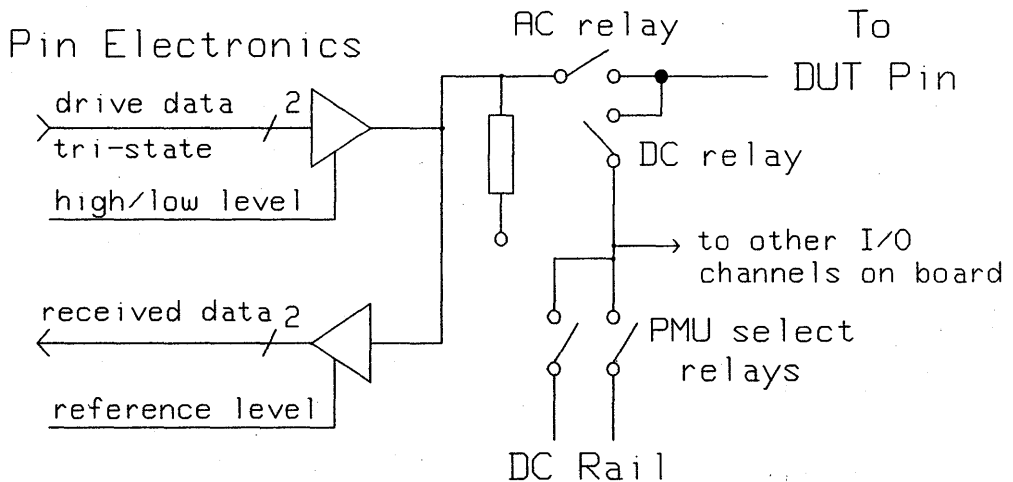
`RLYC [pin-mode], [dc-target], pinlist`

The parameters:

<b>pin-mode</b>	<p>how a pin is connected to the tester The token</p> <ul style="list-style-type: none"> <li>■ IDLE will disconnect the pin from any tester electronics.</li> <li>■ AC will connect the pin to the pin electronics only.</li> <li>■ DC will connect the pin to the specified <code>dc-target</code> only. With IX pins, the non-inverted output channel of the HSWG is connected.</li> <li>■ BOTH will connect the pin to the pin electronics and the specified <code>dc-resource</code>.</li> <li>■ DCC connects the inverted (complementary) output of an HSWG channel to <code>dc-target</code>, when measuring an IX pin.</li> <li>■ DCB connects both the inverted and non-inverted outputs of an HSWG channel (in parallel) to <code>dc-target</code>, when measuring an IX pin.</li> </ul>
<b>dc-target</b>	<p>specifies to what dc resource the pin should be connected. The token</p> <ul style="list-style-type: none"> <li>■ PMU1 will connect the boards affected by the given pins to PMU1.</li> <li>■ PMU2 will connect the boards affected by the given pins to PMU2.</li> <li>■ EXT will connect the boards affected by the given pins to the external input at the clock board.</li> <li>■ OFF will disconnect the board specified by the given pins from the both dc rails.</li> <li>■ X will not change the relays associate with dc resources at all.</li> </ul>
<b>pinlist</b>	<p>The setting of <code>pin-relay</code> will only occur on the pins specified by here. The setting of dc resource related relays will be done</p>

an all mainframes, if the command is send to all mainframes (as usual). However the computation of “affected” and “unaffected” boards is done on the basis of the pinlist.

This command will support either the setting of only pin relays or Performing your own connection routine, so that you can either route a signal path from a dc-target to one or more pins with or without simultaneous setting of pin relays for normal serial or parallel DC measurement, or for precharging the rails. A definition of all relay settings is given below.



**Figure 7-2. Relay Switching Matrix**

**Note**



You should use this command with care as some relay settings may lead to unwanted side effects.

**Power Supply Relay Commands**

The PSST command is used to connect and disconnect the DPS to/from the DUT, the PSST? query reports the current state of the DPS outputs.

PSST status PSST?

where

**status** can be either ON or OFF to indicate whether the DPS is connected or not.

The PSST command changes the state of the defined DPS outputs to the states defined in the relevant PSLV commands. If the state is changed to OFF, the setup time is used as a delay. The power supply outputs are switched in the reverse order to that used when they were switched on.

### Errors

- Parameter error
- No power supplies connected

### Warnings

Warnings will be issued if

- PSST OFF is executed and a power supply output is in the CC mode.
- PSST OFF is executed and the power supply is in the power on state.

### Examples

#### PMU measurement in parallel mode:

```
PMUS P11, ...
RLYC PMU1,DC,(Pin1,Pin2, ...)
/* wait for charging parasitic Capacities, if necessary */
PMUM? 1
RLYC IDLE,DC,(Pin1,Pin2, ...)
```

#### PMU measurement in serial mode:

```
for Pin-i in (Pin1,Pin2, ...)
do
  PMUS P11, ...
  RLYC PMU1,DC,(Pin-i)
  /* wait for charging parasitic capacities, if necessary */
  PMUM? 1
  RLYC AC,X,(Pin-i)
done
```



---

## Sequencer Commands

The SQSS command sets a software signal to the sequencer according to its parameter. A sequencer program can test for this condition and branch on it.

The SQSS?-query retrieves the state of the software signal.

### Syntax

SQSS boolean

SQSS?

### Errors

- Value out of range

---

## PMU Commands

There are two commands used to control the PMU. These are:

PMUS            Puts PMU into specified setup  
PMUM?          Measures state of PMU

### Syntax

PMUS pmu-id, u-force, [u-range], i-force, [i-range]

PMUM? pmu-id

### Setting up the PMU

The PMUS command setups a parametric measurement unit installed in the test system. The PMU is put into the specified setup during the execution of the command. It stays in this setup as long as it is not needed by other commands such as dc measurement or calibration commands. The parameter:

- pmu-id** specifies the PMU to setup. It has the form Pmp where m specifies the mainframe the PMU is installed in and p the PMU inside the mainframe. m must be in the range 1 .. 3 and p must be in the range 1 .. 2.
- u-force** specifies the voltage to force by the PMU. It is given in millivolts. It must be in the range -20000.000 (mV) .. +20000.000(mV). The value can be given in any precision, but it will be rounded according to the resolution of the PMU in the specified range. PMU resolution is 1/2000 of the specified range.
- u-range** specifies the the voltage range to use. The meaning of the ranges are:

**Table 7-4. PMU Voltage Range Coding**

Range	Meaning
U2E3	-2000 mV .. +2000 mV
U1E4	-10000 mV .. +10000 mV
U2E4	-20000 mV .. +20000 mV
AUTO	autoranging: the smallest range to force u-force

- i-force** specifies the current to be forced by the PMU. It is given in microamperes. It must be in the range 0.000 ( $\mu A$ ) .. 200000.000 ( $\mu A$ ). The value can be given in any precision, but it will be rounded according to the resolution of the PMU in the specified range. PMU resolution is 1/4000 of the specified range.

**Table 7-5. PMU Current Range Coding**

Range	Meaning
I2E0	0.001 $\mu\text{A}$ .. 2 $\mu\text{A}$
I2E1	0.01 $\mu\text{A}$ .. 20 $\mu\text{A}$
I2E2	0.1 $\mu\text{A}$ .. 200 $\mu\text{A}$
I2E3	1 $\mu\text{A}$ .. 2000 $\mu\text{A}$
I2E4	10 $\mu\text{A}$ .. 20000 $\mu\text{A}$
I2E5	100 $\mu\text{A}$ .. 200000 $\mu\text{A}$
I5E5	200 $\mu\text{A}$ .. 500000 $\mu\text{A}$
AUTO	autoranging: the smallest range to force <b>i-force</b>

This command has no query associated, because it interferes with internal dc measurement commands and the a query response cannot be guaranteed to be valid.

### Making a PMU Measurement

The PMUM? query measures a PMU and give the result of the measurement. The parameter

**pmu-id** specifies the PMU to setup. It has the form Pmp where m specifies the mainframe the PMU is installed in and p the PMU inside the mainframe. m must be in the range 1 .. 3 and p must be in the range 1 .. 2.

The query has the following syntax:

PMUM pmu-id, pmu-state, u-read, i-read

where

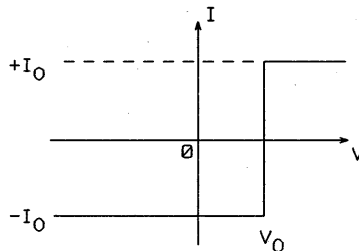
**pmu-id** to specify the PMU measured. This parameter is identical to the query given.

- pmu-state** is an integer which specifies the state of the PMU. It is in the range 1 .. 31. If **pmu-mode** is coded binary it has the form **Ovismm** where
- **v** is voltage overflow flag. It is set when the PMU is in an overflow condition during the voltage measurement.
  - **i** is current overflow flag. It is set when the PMU run in a overflow condition during the current measurement. (NOTE: Will not occur with current PMU)
  - **s** is the stability flag. It is cleared when the PMU is stable, set otherwise.
  - **mm** is limit detection code.

**Table 7-6. PMU Limit Detection Coding**

<b>mm</b>	<b>Meaning</b>
00	not used
01	negative current limit
10	positive current limit
11	voltage limit

It gives the section of the I/U characteristics in which the PMU is operating.



**Figure 7-3. PMU I/U Characteristics**

- u-read** gives the measured voltage in millivolts.  
**i-read** gives the measured current in microamperes.

## Errors

- Value out of range
- Resource not available

---

## Utility Lines

There are three commands to set and read the state of the system utility lines. These commands are:

UTOT	define state of utility output
UTOT?	get state of utility output
UTIN?	get state of utility input

### Syntax

UTOT utility-data

UTOT?

UTIN?

### Setting the Utility Output Lines

The UTOT command will set the seven utility output to the value specified by utility-data. utility-data must be in the range 0..127.

### Reading the Utility Output Lines

The UTOT? query will retrieve the current state of the utility output port.

### Reading the Utility Input Lines

The UTIN? query will read the current state of the utility input port. The state of the port is given/read as binary coded integer.

## Power-On Defaults

At Power On the utility output port will set to:

UTOT 0

## Example

UTOT 127

This command sets all the output utility lines to logic high.

---

## High Throughput Commands

These commands allow you to write test routines for applications where you need to perform the same sequence of tests on a number of devices of the same type. By using the high throughput commands, you can minimize the amount of time taken for each device to be tested. Incoming inspection, and quality control testing are typical of these applications.

By preloading several sets of test parameters into RAM (local to the hardware), you can rapidly execute a sequence of different tests on your DUT, simply by switching between sets of parameters. In this way, the High Throughput commands reduce the amount of data transferred between the PWS and the tester hardware during your test routine.

A full description of how to use these commands to optimize the tester throughput, is given in the manual *Advanced Testing with the HP 82000*.

The High Throughput commands are:

PSAV	to save the hardware state as a set of ac test parameters (a <i>parameter set</i> ) in RAM;
LDHW	to reload a pre-saved parameter set to hardware;
LDHW?	to read parameter sets already loaded in hardware;
STST?	to perform a functional test using a parameter set;
DFVM	to define a set of dc parameters for a PMU voltage measurement;
DFCM	to define a set of dc parameters for a PMU current measurement;
DFPM?	to read pre-saved dc parameters;
PTST?	to execute a PMU test from pre-saved dc parameters.
RSWM	to set the switching methods of the AC and DC relays.
RSWM?	to examine the relay switching method that has been set.

## Performing AC Functional Tests

### Saving a Parameter Set

The PSAV command saves the *foreground* settings of the tester hardware, into RAM, and assigns an id number (between 1 and 64) to enable these settings to be quickly reloaded during a test.

The foreground settings are the values that you enter using the interactive windows, or via the other HP-IB commands.

When you execute a PSAV command, with the instruction:

PSAV *id*

the status of the following hardware settings are saved:

- Pin Configuration
  - pin operating mode (STD, FD, MUX, etc ... )
  - pin type (I, IO, IX, etc ... )
  - scan mode (parallel or serial)
  - channel relay setting
  - DPS status (on or off)
- Level Setup

- driver low level
- driver high level
- receiver low level
- receiver high level
- DPS voltage
- DPS current
- Channel Timing
  - driver signal format (DNRZ, RZ, etc ... )
  - receiver compare format (Edge, Window, etc ... )
  - leading edge delay
  - trailing edge delay
- Clock Timing
  - period
  - clock source (internal/external)
  - sync mode
- Vector Information
  - break vector
  - sequencer start label

---

**Note**

After a system reset, all 64 parameter sets are loaded with the foreground values.



---

**Example.** To save the present foreground settings as a parameter set with the id number 24, you can enter the instruction:

PSAV 24

### Loading a Parameter Set

The command LDHW loads the hardware with a parameter set which you previously saved with PSAV. The id number which you specify (1 to 64) determines which parameter set is loaded. The id number "0" used in conjunction with LDHW, loads the hardware with the *foreground* settings.



The values loaded by the LDHW command are used by the hardware, until either:

- you perform another LDHW command (a new parameter set is loaded);
- you perform an STST command (a new parameter set is loaded);
- you perform an HP-IB measurement command which changes any configuration settings (the foreground settings, id = 0, are reloaded);
- you change the hardware settings explicitly, using HP-IB setup commands (the foreground settings are reloaded).
- or you use any of the windows in the interactive software. (the foreground settings are reloaded).

When the foreground settings are reloaded into the hardware, the interactive windows of the PWS are immediately updated.

The query LDHW? returns the id number of the parameter set which is presently loaded in the hardware.

**Example.** To load the parameter set with the id number 24 into the hardware, you enter:

```
LDHW 24
```

To find out the id of the parameter set which is presently loaded in the hardware, you can enter the query:

```
LDHW?
```

If parameter set 24 is still loaded, the returned string would be:

```
LDHW 24
```

### **Executing a Functional Test**

The command:

```
STST? id
```

performs a functional test using a presaved parameter set (saved with PSAV). The STST? command is functionally the same as:

```
LDHW id  
FTST?
```

The return string from the STST? command contains the id number of the parameter set that has been used, and a pass (P) or fail (F) result.

**Example.** To perform a functional test with the parameter set id 24, you can enter the command string:

```
STST? 24
```

If the test result is a pass, the returned string is:

```
STST 24,P
```

## Performing DC tests

The high throughput commands for performing dc tests allow you to store up to 64 different sets of dc parameters in RAM. These parameters can be used to perform either voltage measurements or current measurements with the PMU. The dc parameters are identified with an id number *id\_dc* (which can be in the range 1 to 64).

---

**Note** There is no foreground set for dc parameters.



---

## Setting Up a PMU Voltage Measurement

The command DFVM allows you to define a set of dc parameters for a voltage measurement test with the PMU, and assign an id number *id\_dc* to it.

The DFVM command allows you to define:

**the identification number *id\_dc*** for the dc parameters (in the range 1 to 64);

**the force-current** to specify the PMU current to be used to simulate a load on the pin (in  $\mu\text{A}$ );

**the clamp-voltage** to specify the output voltage limit of the PMU during the measurement (in mV);

**the max. and min. pass values** to specify the pass voltage limits (in mV);

**the connect voltage** to specify the voltage forced by the PMU while the DC relay is connected. If this parameter is omitted, then the mean value between the max. and min. pass values is used.

**the settling time** to specify how long to wait between the connection of the PMU, and performing the measurement (in milliseconds);

and **the measurement mode**, which can be:

- **TRM** (terminated)—the pin is connected to the PMU and the pin electronics;
- **NTRM** (not terminated)—the pin is connected to the PMU only;
- **SPOL** (specified polarity)—the measurement is taken with the polarity specified by the clamp voltage;
- **BPOL** (both polarities)—measurements are taken with both polarities (a pass result is given if the pin passes the test in *either* direction).

---

**Note**

SPOL and NTRM are synonymous.



---

**Example.** To define the dc parameters for a PMU voltage measurement test, on pins Q1, Q2 and Q3 of your device, with

- the id number (*id\_dc*) “3”;
- a force current of 5 milliamps;
- a clamp voltage of 5.5 Volts;
- a minimum pass value of 4.5 Volts;
- a maximum pass value of 5.0 Volts;
- the default connect voltage (in this case, 4.75 V)
- a settling time of 1.5 milliseconds;
- with the PMU measurement carried out while the pin electronics are still connected;

you enter the following string:

```
DFVM 3,5000,5500,4500,5000,,1.5,TRM,(Q1,Q2,Q3)
```

## Setting Up a PMU Current Measurement

The command DFCM allows you to define a set of dc parameters for a current measurement test with the PMU, and assign an id number *id\_dc* to it.

With the DFCM command, you can set:

- the **identification number** *id\_dc* for the dc parameters (in the range 1 to 64);
- the **force-voltage** to specify the PMU voltage to be used during the measurement (in mV);
- the **maximum current** to specify the maximum current allowed during the measurement (in  $\mu\text{A}$ );
- the **max. and min. pass values** to specify the pass current limits (in  $\mu\text{A}$ );
- the **connect voltage** to specify the voltage forced by the PMU while the DC relay is connected. If this parameter is omitted, then the force-voltage value is used.
- the **settling time** to specify how long to wait between the connection of the PMU, and performing the measurement (in milliseconds);
- and the **measurement mode** which can be:

- **GNG (ganged)**—measurements are taken while all the pins are connected to the PMU;
- **NGNG (not ganged)**—each pin is measured individually.

**Example.** To define the dc parameters for a PMU current measurement test, on pins Q1, Q2 and Q3 of your device, with

- the id number (*id\_dc*) "4";
- a force of voltage -1.7 Volts;
- a maximum current of 0.1 milliamps ;
- a minimum pass value of 20 microamps;
- a maximum pass value of 80 microamps;
- the default connect voltage (in this case, -1.7 V)
- a settling time of 1 millisecond;
- with the PMU measurement carried out on all three pins together;

you enter the string:

```
DFCM 4, -1700, 100, 20, 80, , 1, GNG, (Q1, Q2, Q3)
```

## Reading Pre-saved DC Parameters

You can check the dc measurement settings already stored in RAM, with the DFPM? query:

DFPM? *id\_dc*

If a voltage measurement has been defined for the *id\_dc* number that you enter, the return string begins with DFVM, followed by a string of parameters which follow the syntax of the DFVM command.

For example, to check the dc parameters with the *id\_dc* number “3”, you enter the command string:

DFPM? 3

If *id\_dc* “3” was defined as in the DFVM example above, you get the returned string:

DFVM 3, 5000, 5500, 4500, 5000, , 1.5, TRM, (Q1, Q2, Q3)

Similarly, if a current measurement was previously defined for the *id\_dc* number, the returned string begins with DFCM, and follows the syntax of the DFCM command. So, if the DFCM example above, was entered, the the command:

DFPM? 4

would give the return string:

DFCM 4, -1700, 100, 20, 80, , 1, GNG, (Q1, Q2, Q3)

## Executing a DC Test

The command PTST? allows you to execute a test, using the dc parameters that you have previously entered with the DFVM and DFCM commands. The syntax for the command is:

PTST? *id\_dc*, *level*

As well as specifying the *id\_dc* of the dc parameter set to be executed, the syntax for PTST? allows a choice of test method. You can enter the test mode as:

- **gpf** (global pass/fail)—for a single pass/fail result;
- **ppf** (per pin pass/fail)—for a pass/fail result per pin;

- *pval* (per pin value)—for a value result per pin.

After you have executed the dc test, this is the string that is returned:

PTST *id\_dc*, *result*, (*pin list*)

where:

- *id\_dc* is the id number of the dc parameter set that has been used in the test;
- *result* is either P for a passed test, F for a failed test, or the measured value;
- *pin list* is a list of the pins to which *result* applies. If the test mode *gpf* was chosen for the test, then *result* applies to all the pins, and *pin list* is returned empty.

## Setting the Relay Switching Method

The command:

RSWM method

allows you to specify the order in which the AC and DC relays are switched, when you perform a measurement using PTST? or DTST?. The method parameter can be either

- *bbm* - Break Before Make, i.e.
  1. all relays are opened,
  2. the relays needed for the measurement are closed.
- *mbb* - Make Before Break, i.e.
  1. the relays needed for the measurement are closed.
  2. the relays not needed for the measurement are opened.

## Test Result Commands

---

The test result commands are used to load the results of one test into the host.

---

### Commands and their Modes

The commands that are available depend on the measurement mode. The commands and their valid modes are listed below:

#### Commands valid for compare mode

ERMP?	returns the contents of the error map in a binary format.
CHER?	returns passed / failed information for every given pin.
ERCT?	returns the number of errors in the error map.
PASS?	returns a quick passed / failed information for the last test.

#### Commands valid for acquisition mode

RECD?	returns the contents of the data acquisition memory in a binary format.
-------	---

#### Commands valid for both modes

VALD?	returns the number of valid data in the error map / received data ram.
AQST?	returns the number of cycle between the event address and the found acquisition stop, and returns a -1 if no event was found before stop.

**GETV?** returns the vector and sequencer instruction number for the given cycles. Although the number of cycles to the logical 0 address is reported.

Except for the **PASS?** and **CHER?** commands, the commands return the results of a test of zero cycles length after changing the analyze mode or before at least one test has been started.

---

**Note** RECD? and ERMP? work on byte boundaries.



In the following descriptions, the term “cycle” is related to tester periods.

---

## Syntax

**ERMP?** sample-start-cycle-#, #-of-cycles

**CHER?** pin-list

**ERCT?**

**PASS?**

**RECD?** sample-start-cycle-#, #-of-cycles, pin-list

**VALD?**

**AQST?**

**GETV?** cycle-#, #-of-cycles



## Reading the Error Map

Sending the ERMP? command will result in the specified contents of the Error Map being transferred to the host. The data returned is in the format:

```
ERMP sample-start-cycle-#, #-of-cycles, #spec(binary-data)
```

where

**sample-start-cycle-#** is an integer in the range 1 .. **size-of-error-map - 8** indicating the first cycle

**#-of-cycles** is an integer in the range 1 .. **size-of-error-map - 8** indicating the number of cycles to be read.

The actual test date is transmitted in an unreadable binary format.

Note that the error map will report only one error per machine cycle. Due to this cycle oriented error map, two errors occurring in the same machine cycle (but in distinct user cycles) are sampled as a single error and the error count (accessible using the ERCT command) is incremented by one (instead of two).

## Getting Pass/Fail Information for a Pin

The CHER? query returns passed / failed information for **pin-list**. The value returned will be either P (passed) or F (failed) for every pin name in **pin-list**.

The CHER? query causes a temporary change to the sequencer OFF state to read the hardware channel error flags.

## Getting the Number of Errors Detected in the Last Test

ERCT? returns the number of errors currently in the error map. The returned value will be an integer in the range 0 .. **size-of-error-map - 4**.

The reported error number returns only the number of errors sampled in the error map.

## Getting pass/fail information for the last test

PASS? returns either P or F to indicate whether the last test passed or failed.

## Reading the Data Acquisition Memory

RECD? returns the contents of the data acquisition memory in binary format.

---

**Note** This command is only valid in data acquisition mode.



---

**sample-start-cycle-#** is an integer in the range (1 .. vector-memory-size - 8) indicating the first cycle

**#-of-cycles** is an integer in the range (1 .. vector-memory-size - 8) indicating the number of cycles to be read.

**pin-list** contains a list of pin names for which data should be read

The system replies in the format:

RECD sample-start-cycle-#, #-of-cycles, #spec(binary data)

for each pin in pin-list.

Data transfer is performed in a by pin oriented manner, each byte containing information of 4 cycles for one pin. The contents of the data stream reflects the hardware RAM organization and will not be altered by the transfer commands.

sample-start-cycle-# and (sample-start-cycle-# + #-of-cycles) will be rounded to the next byte boundaries for binary transfers.

## Reading the amount of data in the Error Map/ Received Data RAM

VALD? returns the number of valid logged data cycles in the error map / received data ram.

## Reading how many cycles there were between the event address and acquisition stop

AQST? returns the number of cycles between the event address and the found acquisition stop, and returns a -1 if no event was found before stop. The returned value is an integer between -1 and  $2^{24}$ .

From the start of the test, error map (in compare mode) and received data (in acquisition mode) will be monitored. After the event address is reached, the stop delay counter will be counted down and stop monitoring after the counter reaches the value 0. The firmware performs the conversion between the logical acquisition start address 0 and the sampling offset in the memory map and the received data memory. All reported values refer to the logical start address 0.

### Mapping Machine Cycles to Sequencer Instructions

The GETV? query returns the cycle - vector relationship in a compressed form. It reports the cycle number after the logical 0 address, the vector number, the sequencer instruction number and gives the information how the next cycle was generated and how often (see examples).

Sending the command to the hardware will result in the hardware responding with:

```
GETV cycle-#, [vector-#], [instr-#], [instr-type], rep-factor
```

where

<b>cycle-#</b>	the actual cycle number in the range (0 .. last-cycle-number - 4)
<b>vector-#</b>	the actual vector number in the range (-1 .. size-of-vector-memory)
<b>instr-#</b>	an integer in the range 0 .. 2 <sup>11</sup> indicating the actual the actual instruction number.
<b>instr-type</b>	the type of the current instruction, one of INC, HOLD, SCAN or DEAD.
<b>rep-factor</b>	the repeat factor of the current instruction in the range 1 .. V-MEM - 4

Note that under some circumstances, the vector and instruction for a given cycle may be not available. In this case, the related parameters are omitted in the answer string. The break vector, which will be output during dead cycles, is shown by returning a vector number of -1.

## Errors

- Parameter range errors
- Command not allowed in compare mode
- Command not allowed in acquisition mode
- Insufficient data available
- Asking for compare results in acquisition mode will cause an error, asking for received data in compare mode will also generate an error.

## Examples

In this example of part of a vector sequence, the cycle-vector relationship will be reported as shown below.

cycle #	vector #	sequ	instr #	instr	type
800	??	??		??	
more lines					
900	??	0		inc	
more lines					
1000	2	1		hold	
1001	2	1		hold	
1002	2	1		hold	
1003	2	1		hold	
1004	BREAK		2		dead cycle
1005	4	2		inc	
1006	5	2		inc	
1007	6	2		inc	
1008	7	2		inc	
1009	8	2		inc	
1010	9	2		inc	
1011	10	2		inc	

Sending GETV? 800, 210

will result in

```
GETV      800,,,100
GETV      900,,0,INC,100
GETV      1000,2,1,HOLD,4
GETV      1004,-1,2,DEAD,1
```

## Result Data Storage

The following section describes the data storage format used in the Error Map and Received Data memories.

Figure 13. Error Map / Received Data RAM alignment

### Error Map Data Bit Alignment

D7	D6	D5	D4	D3	D2	D1	D0
(not used)				Cycle 1	Cycle 2	Cycle 3	Cycle 4
X	X	X	X	E0	E1	E2	E3

### Received Data Bit Alignment (STD mode)

Cycle 0		Cycle 1		Cycle 2		Cycle 3	
D7	D6	D5	D4	D3	D2	D1	D0
E0/0	E0/1	E1/0	E1/1	E2/0	E2/1	E3/0	E3/1

where

$E_n/0, E_n/1$  is received data (as shown below)

### Received Data States

$E_n/0$	$E_n/1$	received data
0	0	intermediate
0	1	low
1	0	high
1	1	don't care

**Received Data Bits alignment (FD mode)**

Cycle 0		Cycle 1		Cycle 2		Cycle 3	
D7	D6	D5	D4	D3	D2	D1	D0
E0.0	E0.1	E1.0	E1.1	E2.0	E2.1	E3.0	E3.1

where

En.0            received data (first user-cycle)  
 En.1            received data (second user-cycle)

**Received Data Bit Alignment (MUX and FQ2 modes)**

Cycle 0		Cycle 1		Cycle 2		Cycle 3	
D7	D6	D5	D4	D3	D2	D1	D0
E0.0/0	E0.0/1	E1.0/0	E1.0/1	E2.0/0	E2.0/1	E3.0/0	E3.0/1
...							
Ew.0/0	Ew.0/1	Ex.0/0	Ex.0/1	Ey.0/0	Ey.0/1	Ez.0/0	Ez.0/1
...							
E0.1/0	E0.1/1	E1.1/0	E1.1/1	E2.1/0	E2.1/1	E3.1/0	E3.1/1

where

En.0/0, En.0/1    received data (first user-cycle)  
 En.0/0, En.0/1    received data (second user-cycle)

### Received Data Bit Alignment (FQ mode)

Cycle 0		Cycle 1		Cycle 2		Cycle 3	
D7	D6	D5	D4	D3	D2	D1	D0
E0.0	E0.1	E1.0	E1.1	E2.0	E2.1	E3.0	E3.1
...	...	...	...	...	...	...	...
Ew.0	Ew.1	Ex.0	Ex.1	Ey.0	Ey.1	Ez.0	Ez.1
E0.2	E0.3	E1.2	E1.3	E2.2	E2.3	E3.2	E3.3
...	...	...	...	...	...	...	...
Ew.2	Ew.3	Ex.2	Ex.3	Ey.2	Ey.3	Ez.2	Ez.3

Where:

- En.0 = received data (first user-cycle)
- En.1 = received data (second user-cycle)
- En.2 = received data (third user-cycle)
- En.3 = received data (fourth user-cycle)

### Received Data Bit Alignment (FQM mode)

Cycle 0		Cycle 1		Cycle 2		Cycle 3	
D7	D6	D5	D4	D3	D2	D1	D0
E0.0/0	E0.0/1	E1.0/0	E1.0/1	E2.0/0	E2.0/1	E3.0/0	E3.0/1
...	...	...	...	...	...	...	...
Ew.0/0	Ew.0/1	Ex.0/0	Ex.0/1	Ey.0/0	Ey.0/1	Ez.0/0	Ez.0/1
E0.1/0	E0.1/1	E1.1/0	E1.1/1	E2.1/0	E2.1/1	E3.1/0	E3.1/1
...	...	...	...	...	...	...	...
Ew.1/0	Ew.1/1	Ex.1/0	Ex.1/1	Ey.1/0	Ey.1/1	Ez.1/0	Ez.1/1
E0.2/0	E0.2/1	E1.2/0	E1.2/1	E2.2/0	E2.2/1	E3.2/0	E3.2/1
...	...	...	...	...	...	...	...
Ew.2/0	Ew.2/1	Ex.2/0	Ex.2/1	Ey.2/0	Ey.2/1	Ez.2/0	Ez.2/1
E0.3/0	E0.3/1	E1.3/0	E1.3/1	E2.3/0	E2.3/1	E3.3/0	E3.3/1
...	...	...	...	...	...	...	...
Ew.3/0	Ew.3/1	Ex.3/0	Ex.3/1	Ey.3/0	Ey.3/1	Ez.3/0	Ez.3/1

Where:

- En.0/0, En.0/1 = received data (first user-cycle)
- En.1/0, En.1/1 = received data (second user-cycle)
- En.2/0, En.2/1 = received data (third user-cycle)
- En.3/0, En.3/1 = received data (fourth user-cycle)



## Status and Error Commands

---

There are a number of HP-IB commands that are used to check the status of the system hardware and to detect when any errors have occurred. This chapter describes the use of these commands.

The chapter is divided into the following parts:

- Status Byte - contains a summary of the current system status.
- Standard Event Status Register - contains a summary of any command-related errors and status information.
- Hardware Status Register - contains a summary of the current state of the hardware.
- Test Function Status Register - contains a summary of test function-related status information.
- Error Handling - contains a description of the commands that are used to handle any errors that may occur.

Other registers are available that control the output states of the status registers. These are described in the relevant sections below.

---

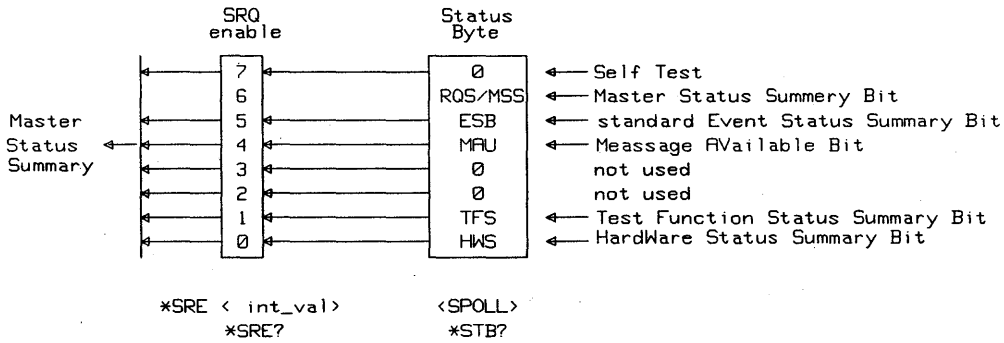
### Note



Status reports generated by the hardware conform to the definitions in IEEE Standard 488.2 Section 11, Status Reporting Model. Refer to this standard for a more formal discussion of this topic.

---

# Status Byte



**Figure 9-1. Status Model**

The Status Byte is the summary of the tester status. It is eight-bits wide. Due to the fact that the number of tester states cannot fit into one byte, each bit in the Status Byte is the summary of a more detailed status in another status byte. The Status Byte can be read with the `*STB?` command or an HP-IB serial poll bus cycle. This can be performed by sending `SPOLL (@dev)` from BASIC.

The Status Byte bits and their meaning are listed below:

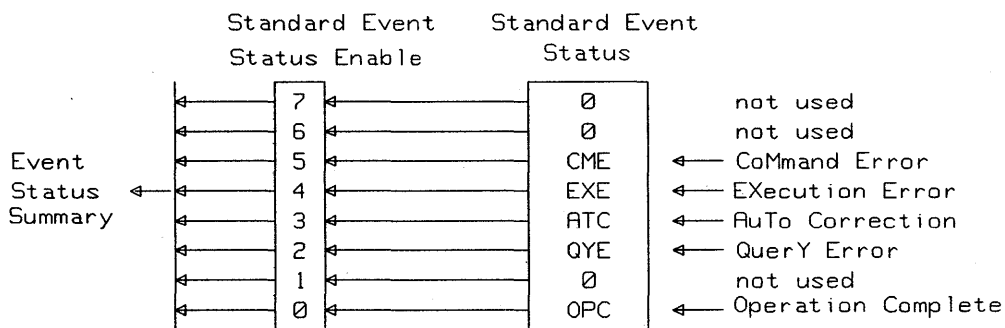
**Table 9-1. Status Byte Organization**

Bit	Meaning
7	SELF TEST report available.
6	Request Service / Master Status Summary (RQS/MSS) - indicates that the tester has a pending service request or is the summary of the Status Byte itself.
5	Standard Event Summary Bit (ESB) - the summary of the Standard Event Status Register.
4	Message Available (MAV) - indicates that the tester has data to send.
3	Unused, always set to 0.
2	Unused, always set to 0.
1	Test function Status Summary (TFS) - the summary of the Test Function Status Register.
0	Hardware Status Summary (HWS) - the summary of the Hardware Status Register.

The Master Status Summary Bit (MSS) is controlled by the Service Request Enable Register (SRE). Each bit in the Status Byte can be enabled individually by setting the corresponding bit in the SRE. The enabled bits together will form the MSS so that MSS is true if one of the enabled bits of the Status Byte is true. The MSS, which is also part of the Status Byte, cannot be set. The SRE can be set and read with the \*SRE and \*SRE? commands respectively. The content of the SRE also defines the generation of interrupts (Service Request (SRQ)). If MSS becomes true, a Service Request will be generated. The Service Request will go to false again after it has been acknowledged by the controller via a SPOLL or the \*STB? command. The MSS however will stay true as long as long as the cause has not disappeared.

## Event Status Register

The Standard Event Status Register (ESR) reflects a status which can be found on many HP-IB devices and is therefore standardized. Not all of the standardized meanings of the bit are applicable to firmware; those that are not used will always be set to zero.



\*ESE < int\_val >

\*ESE?

\*ESR?

**Figure 9-2. Standard Event Status Model**

**Table 9-2. Event Status Register Organization**

<b>Bit</b>	<b>Meaning</b>
7	Not used, always set to 0.
6	Not used, always set to 0.
5	Command Error (CME) - indicates that a command error has occurred.
4	Execution Error (EXE) - indicates that an execution error has occurred.
3	Autocorrection (ATC) - indicates that an autocorrection has occurred.
2	Query Error (QYE) - indicates a problem in reading a response from the tester. The will occur either: 1. When the controller attempts to read from the system, without having sent a query. 2. Data relating to pending queries have been lost (possibly due to memory restrictions).
0	Operation Complete (OPC) - this bit is generated in response to a *OPC command. It is used for synchronization purposes. See the Command Synchronization chapter for more details.

---

## **Event Summary Register**

The Standard Event Summary Bit (ESB) of the Status Byte is controlled by the Standard Event Status Enable register (ESE). Each bit in the ESR can be enabled to set the ESB by setting the corresponding bit in the ESE. The ESB will become true if one of the enabled bits in the ESR is true. This allows the propagation of selected standard events to the Status Byte, and together with the SRE, the generation of a Service Request.

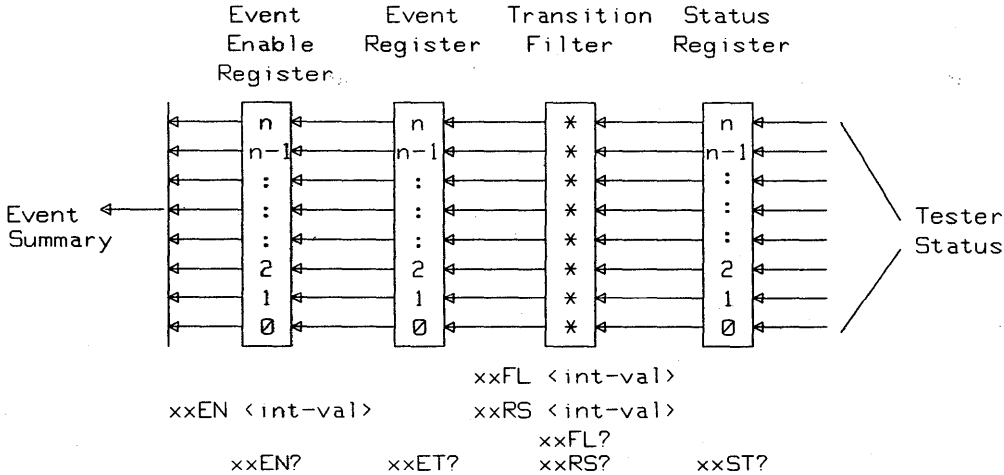
Related commands are:

\*ESR?            to read the current state of the ESR

\*ESE            to set the ESE

\*ESE?            to read the current setting of the ESE

### Tester Status Registers



**Figure 9-3. Tester Status Model**

Tester status is reported by two registers. These are the Hardware and Test Function Status Registers. They both operate in the same manner as described below.

In the following descriptions the abbreviation xx relates to both the HW—and TF—commands.

### Status Register

Every bit in a Status Register reflects the state of part of the tester. Every bit has a meaning of its own and its interpretation does not depend on the state of other bits.

The Status Register can be read by the xxST?-query. The response will be the decimal coded value of the register. The content of the Status Register can not be changed directly. It always reflects the underlying tester state and will change only if the tester state changes.

## **Transition Filter**

This controls the changes of the Status Register that are considered to be an event. For every bit of the Status Register you can specify whether a transition from 0 to 1 or from 1 to 0, both transitions, or no transition are to be considered as an event. If the specified transition occurs for a bit that has been selected, the corresponding bit in the Event Register will be set. The contents of the Transition Filter can be specified by the `xxFL` and the `xxRS` commands.

Every bit set in the `int_val` of the `xxFL` command, will result the corresponding bit in the Event Register being set, if the corresponding bit in the Status Register changes from 1 to 0. Similarly, the `int_val` of the `xxRS` command, will result in setting the corresponding bit in the Event Register, if the corresponding bit in the Status Register changes from 0 to 1. These two commands in combination these command allow you to specify all the possible conditions. The current settings of the transition filter can be read with the `xxRS?` and `xxFL?` queries.

## **Event Register**

This holds the events specified by the Transition Filter. The bits in the Event Register are sticky in the sense that a bit once set (to 1) will not be changed by any transitions in the Status Register. This may lead to the situation that the Event Register does not reflect the current status (which is the purpose of the status register), but it ensures that no event can be missed between successive reads of the event register. The Event Register can be read with the `xxET?` query command.

The Event Register is cleared when read with the `xxET?` query. All Event Registers are cleared with the `*CLS`-command, the DCL HP-IB message, and at power up.

## **Event Enable Register**

This controls how the Summary bit for the Event Register is generated. Setting a bit in the Event Enable Register enables the corresponding bit in the Event Register. The Summary Bit will become true, if one of the enabled bits of the Event Register becomes true. The Summary Bit has a place in the Status Byte.

The Event Register can be written with the xxEN-command and read with the xxEN?-query.

The whole model is to ensure that every tester status change can be reflected in the Status Byte (STB) and generate an IRQ in a controller defined manner. This should become clear in the following example.

Situation:

Suppose the controller wants to receive an SRQ when bit 0 of the tester Status xx changes from 0 to 1 or bit 2 of the tester Status xx changes in either direction. Nothing else should cause a SRQ. The summary bit of Status xx is bit 0 in the STB.

Actions:

To setup the desired SRQ generation the controller has to send:

- xxRS 5 *This enables event generation for transitions from 0 to 1 for bits 0 and 2 of the Status Register xx.*
- xxFL 4 *This enables event generation for a transition from 1 to 0 for bit 2 but not for bit 0 of the Status Register xx.*
- xxEN 5 *Enables the summary bit generation for bits 0 and 2 of the Event Register xx.*
- \*SRE 1 *Enables the generation of SRQ for the summary bit xx, which is bit 0 of the STB.*

If the controller has received a SRQ, it should perform:

- SPOLL - *goes to all connected instruments. The mainframe which has caused the SRQ will be the only one with RQS-bit set. The SPOLL clears the RQS-bit after reading the STB. This ensure that each SRQ will only be serviced once. If the SRQ was caused by the mainframe in our example, bit 0 will also be set indicating that an event has occurred in Status Register xx.*
- xxET? *This transfers the content of the Event Register xx to the controller. The controller can now decide whether bit 0 or bit 2 of Status Register xx has caused the event. This also clears the Event Register xx, allowing new events to generate a new SRQ.*
- xxST? *Reads the Status Register xx to the controller to allow status specific actions. It does not change the register.*



## Hardware Status

The available hardware status commands are:

HWEN	defines the Status Enable Register of the Hardware Status
HWFL	defines the falling transition event generation of Hardware Status
HWRS	defines the rising transition event generation of Hardware Status
HWEN?	reads the Status Enable Register of the Hardware Status
HWET?	read the Event Register of the Hardware Status
HWFL?	read the falling transition event generation of Hardware Status
HWRS?	read the rising transition event generation of Hardware Status
HWST?	reads the Status Register of the Hardware Status

The bits in the Hardware Status Register have the following meaning: (This is the meaning when the bit is set)

**Table 9-3. Hardware Status**

Bit	Meaning
1	Clock out of sync
2	Channel drivers active they drive the programmed levels.
3	clock active (running)
4	Sequencer busy (not BREAK) armed or active, test has not finished
5	Sequencer active (not ARMED and not BREAK))

## Test Function Status

The available test function status commands are:

TFEN	defines the Status Enable Register of the Hardware Status
TFFL	defines the falling transition event generation of Test Function Status
TFRS	defines the rising transition event generation of Test Function Status
TFEN?	reads the Status Enable Register of the Hardware Status
TFET?	read the Event Register of the Test Function Status

**TFFL?** read the falling transition event generation of Test Function Status  
**TFRS?** read the rising transition event generation of Test Function Status  
**TFST?** read the Status Register of the Test Function Status

The bits in the Test Function Status Register have following meaning: (This is the meaning when the bit is set).

**Table 9-4. Test Function Status**

Bit	Meaning
1	Last test FAILED

---

## Error Handling

### Introduction

This section describes the error handling strategy of the system firmware. The ERRS? command is used to check whether any errors have occurred.

### Error Categories

When the firmware reads commands from the HP-IB, several errors may occur. Because commands are interpreted in several stages, the firmware reacts differently to certain errors. These errors are classified as follows:

- CME** Command Error - is caused by a violation of the command syntax. The command will be completely ignored and all data will be ignored until the next semicolon (;), new line or EOI.
- EXE** Execution Error - A command has been received with correct syntax, but it can not be executed. Reasons for this may be:
1. A command parameter is outside the defined range

2. Command parameters does not satisfy command specific restrictions, for example;  $high\_level - low\_level < min\_swing$ .
3. The command can not be applied with the hardware in its current state,for example; an attempt to define pins while the system is not idle.

The command descriptions at the back of this manual contain a list of the restrictions for each command.

---

**Note**

If a restriction applies only to some of the pins specified in a command, the command will be executed on all or some of the good pins.

---

**ATC**

Auto correction - The state of the tester was in conflict with a parameter. In order to execute this command, this state will also be changed. This is called a Side Effect. It is up to the user to retrieve the changed state from the firmware.

The errors classified here will be reported in the Standard Event Register (see below).

---

**Note**

The firmware will accept settings as long as the hardware can be programmed reasonably even if this is 'out of spec'! Programming 'out of spec' will not cause any errors, but hardware may fail to achieve the desired settings.

---

**Error Queue**

The occurrence of any error will be logged in the error queue. The queue can contain 10 errors. If the error queue overflows, the last error in the queue will be replaced by the 'Error-Queue-Overflow' error.

The error queue is cleared by reading its contents, using the \*CLS-command and the DCL HP-IB message.

The contents of the error queue can be read by the 'ERRS?'-query. The mainframe responds with all the errors queued so far and then clears the error queue.

The response of the ERRS? query is

ERRS? error-code, token, (Pins)

where

error-code is an integer indicating the problem.

token is the mnemonic of the command that caused the error, or zero (0) if the error is not related to a command.

pins are the pins that are affected by the command causing the error. This list may be empty.

## SELF TEST

The firmware performs checks to detect anomalies in the hardware or firmware at power-on and download and during command execution. Any anomalies that are found are recorded and can be queried using the SELF? query. The presence of any self test reports is indicated by bit 7 of the Status Byte.

The response of the SELF? query is

SELF? major, minor

where major and minor are integers indicating the problem. They are intended for the HP service personnel.

---

## Command Synchronization

### Introduction

The problem of command synchronization arises because the firmware can accept data faster than it can be processed. This is done to release the HP-IB as quickly as possible and to allow parallel operation of the controller and firmware. However, at some times, that the controller needs to know when the firmware has reached a certain point in the processing of a data stream on the HP-IB. There are two ways of doing this - by using handshake holdoff, or the OPC and WAI commands.

At other times, the communications between the PWS and the hardware may be disturbed, or may need to be stopped. If this occurs, the hardware has to be brought to a known state before any other commands can be processed. This is also described in the following pages.

## Handshake Holdoff

The firmware will change from parallel to serial processing if a data byte is sent with the EOI line true. The physical acceptor handshake AH1 or source handshake SH1 for the next byte of data is held off for the time required to process any pending data. This results in having this and all previous data processed, before the next data byte is accepted or transferred by the firmware.

### Example

The controller sends a file of commands to the firmware and wants to check whether an error has occurred during the processing of these commands. It does this by reading the Status Register with the SPOLL command. It then needs to know when the command has been processed.

If the controller performs the SPOLL just after the last byte of the commands, there is a chance that not all of the commands have been processed and the value returned by SPOLL reflects a state in the middle of processing rather than at the end.

If the last byte of the commands is sent with EOI true, the SPOLL will not be executed completely before all the commands have been executed. So it ensures that the returned value reflects the state of the firmware after completely processing all the commands.

---

### Caution



Using this way of synchronizing may inhibit all traffic on the HP-IB until the firmware has processed all pending commands. The firmware cannot guarantee that this is done in a certain time!

---

## Operation Complete Message

These commands provide a synchronization method which does not rely on HP-IB holdoff.

The \*OPC command is used to set an OPC event in the Standard Event Register. Refer to the chapter on status and error reporting for more information on the status registers.

The OPC event is generated after processing all previously received commands. By configuring status reporting appropriately, this can generate a SRQ which can be detected by SPOLL.

The OPC query will respond with a "1" after it and all previously sent commands are processed.

The \*WAI command will wait until all pending overlapping commands are complete. Because the firmware has no overlapping commands, \*WAI degenerates to a NOP.

There are three HP-IB commands that allow this type of synchronization:

- \*OPC                sets an OPC message in the Standard Event register.
- \*OPC?            responds with "1", when the command has been processed.
- \*WAI              waits for completion of overlapping operations.

## Protocol Re-synchronization

Sometimes the communication between controller and firmware is disturbed or the controller needs to abort a currently active message. Therefore, it is necessary to have a way of forcing the firmware to a known state. Because there are three levels of protocol (or handshake), there are also three levels of re-synchronization:

---

### Note



Re-synchronization of one level is always done at the next lower lever. The three levels are handshake, message, and command level. So resynchronizing the command level must be performed at the message level.

---

- IFC**            Interface Clear - There is an extra line on the HP-IB called Interface Clear or IFC. If it is activated, the firmware will abort any pending physical handshake for the current HP-IB bus message (data or command byte). This ensures that the firmware will be able to physically accept the next bus message sent (for example, DCL).
- DCL**            Device Clear - This is an HP-IB bus command. It is sent with the ATN-line held true. It will reset all internal parsers, so that the next data byte sent will be treated as a program\_message\_header. It will also clear all the status registers, except the output queue. This ensures that the firmware will be able to accept the next program\_message (for example \*RST).
- \*RST**           RESET command - This is a global command, sent as data, which will place the tester in its Power Up state. (See the System Reset section, below.)

---

## System Reset

The \*RST command brings the tester hardware into a state caused by a power up, however *the original firmware remains loaded*. All registers in the hardware contain system defaults.

---

### Caution



The RESET command should only be sent when the tester is in the disconnected state, since it may result in 'hot switching' of the relays (which may reduce the lifetime of the relays.)

---

If this command is used, the tester will be in an uncalibrated state. You must download base, dc, ac, and any user calibration files before performing any more tests. Failure to do this will result in unpredictable test results.

The files that need to be downloaded are:

/hp82000/fw/data/bc\_cal\_dXX  
/hp82000/fw/data/dc\_cal\_dXX

*base calibration data*  
*dc calibration data*

`/hp82000/dev_tech/YYY/ac_cal_dXX` *ac calibration data*

where **XX** is 50, 100, 200 or 400 depending on the system, and **YYY** could be either the supplied technologies `ec1` or `cmos`, or a user generated device technology.

Additionally, if you have any user calibration setting files, these must also be downloaded.



## Calibration Commands

---

This section describes the commands used to calibrate the system, load calibration settings into the hardware and perform system diagnostics. The chapter is divided into the following parts:

- level calibration
- ac calibration
- 400 MHz calibration commands
- transfer of calibration data
- PMU calibration
- system diagnostics

---

### Level Calibration

This section describes the firmware commands that support the level calibration of both driver and receiver levels. There are four commands used to perform a level calibration:

ADCM?	return ADC conversion result
MFLC?	mainframe level calibration
DRLC?	driver channel level calibration
RCLC?	receiver channel level calibration

---

#### Note



Performing a level or timing calibration may destroy the receiver vector memory contents. You should reload expected data before running a functional test after calibration.

---

## Syntax

ADCM? multi-mainframe-id

ADCM multi-mainframe-id, adc-value

MFLC multi-mainframe-id, lol-offset, lol-gain, hil-offset,  
hil-gain, drv-lol-adjust, drv-hil-adjust, thr-offset, thr-gain

MFLC? multi-mainframe-id

DRLC channel, lol-offset, lol-gain, hil-offset, hil-gain,  
lol-adjust, hil-adjust

DRLC? query-channel

RCLC channel, lol-offset, lol-gain, hil-offset, hil-gain

RCLC? query-channel

where

multi-main	is 1, 2, 3, or ALL
frame-id	
adc-value	is an integer between -1 and 4095
channel	see DFPN syntax
query-channel	channel or ALL

All other parameters are floating point numbers.

### Calibrating the ADC

The ADC, located on the clock board is used for all measurements during the level calibration process. It has therefore to be calibrated prior to all subsequent calibration steps.

With a multiple mainframe system, an ADC calibration must be performed for each installed mainframe.

The ADC calibration is part of the basic calibration procedure. To calibrate the ADC, an external reference supply and voltage measurement unit is required.

ADCM? measures the level seen at the external PMU rail connection and returns the conversion result in ADC scaling units. In practice, the calibration process requires at least two measurements. Note, that any number of measurements is allowed. This may be used to compute the average values, which will in general lead to higher accuracy.

Assuming the measurements have been done applying the voltages U2 and U1 (causing the ADC values X2 and X1), the ADC gain to be downloaded (see MLCD) can be obtained from

$$Gain = \frac{(U2[uV] - U1[uV])}{(X2 - X1)}$$

---

**Note** ADCM? returns -1 for `adc_value` if the measurement failed.



---

### Calibrating the Mainframe

The mainframe level calibration command MFLC? returns the clock driver and cal-receiver calibration values. These values must be downloaded (see MLCD) prior to a subsequent timing calibration.

### Calibrating Driver Outputs and Receiver Thresholds

Two commands are provided to calibrate the driver output levels (DRLC?) and the receiver thresholds (RCLC?).

The values returned must be downloaded using the DLCD and RLCD commands.

---

## AC Calibration Commands

The AC calibration commands are used with a program running on the PWS to generate calibration values to be downloaded into the HW. The AC calibration commands do not alter any calibration values in the HW. The main functions of the calibration commands are to

- initiate the calibration process (ITMC?),
- to find the pin actually connected to the calibration probe, which is to be connected by the user to the pin to be calibrated (SCCH?),
- to perform driver and receiver AC calibration (DTMC?, RTMC?),
- to perform a user calibration (DTUC?, RTUC?),
- and to terminate the calibration process (TTMC).

The controller software calculates the actual driver and receiver offsets to be downloaded into the hardware by the appropriate command (DTCD, RTCD). The commands DTUD and RTUD perform the same function for the user calibration settings.

All calibration commands are channel oriented, so no configuration is required for AC calibration. However, user calibration uses the current pin configuration and timing settings.

For best timing accuracy a DC calibration must have been performed before starting an ac calibration.

### Syntax

Initialize Calibration Process

```
ITMC? [period | u]
```

The u option is used to start user calibration.

```
ITMC error, #-of-probe-channels, period, round-trip  
{ [ ,1e-bpoints, te-bpoints ] }
```

```
CALP cal-period, cal-mclk
```

```
CALP?
```

Generate Standard Calibration Values

DTMC? channel, [probe-channel-nr]

DTMC error, channel, probe-channel-nr, period, [le-rx]  
, [le-rxslave] { , [le-bpoints] }, [te-rx], [te-hz], [te-rxslave]  
{ , [te-bpoints] }

RTMC? channel, [probe-channel-nr]

RTMC error, channel, probe-channel-nr, period, le-wc, le-wcslave,  
le-ec, le-ecslave, { [le-bpoints] }, te-wc, te-wcslave, te-ec,  
{ [te-bpoints] }

#### Generate User Calibration Values

DTUC? channel, [probe-channel-nr], driver-base-delay

DTUC error, channel, probe-channel-nr, period, base-delay, [le],  
[le\_slave], [te], [te\_slave]

RTUC? channel, [probe-channel-nr], receiver-base-delay

RTUC error, channel, probe-channel-nr, period, base-delay, [le],  
[le\_slave], [te], [te\_slave]

#### Search Channel

SCCH? [probe-channel-nr]

SCCH channel, probe-channel-nr, [pin-name]

#### Terminate Calibration Process

TTC

#### Read Temperature

TEMP?

TEMP mainframe, temperature

where

<b>#-of-probe-channels</b>	1 or 16 for the number of calibration channels in the calprobe.
<b>probe-channel-nr</b>	an integer between 1 and 16 indicating the cal probe channel in use
<b>channel</b>	the channel to be calibrated.
<b>cal-period</b>	the calibration period in ns.
<b>error-code</b>	an integer in the range 0 .. 999999 indicating the calibration error code, 0 = no error.
<b>-offset</b>	found channel delays in ns for leading and trailing edges.
<b>-bp</b>	0 .. 4095 calibration probe fine delay dac values (up to 10) for leading and trailing edges.
<b>-basepoints</b>	0 .. 255 driver / receiver fine delay dac values (up to 10) for leading and trailing edges.
<b>le-</b>	leading edge
<b>te-</b>	trailing edge
<b>wc-</b>	window compare
<b>ec-</b>	edge compare

## Calibrating the Cal Probe

ITMC? performs timing calibration of calibration probe and sets the system into a mode called calibration mode. In this mode, only calibration commands (except ITMC?) are allowed. The given calibration period is used for all subsequent calibration commands.

This command also returns the number of usable calibration probe channels. This is done when the probe is connected to any valid channel.

## Calibration Period

The CALP command and CALP? query are used to set and query the period and mclk values corresponding to the downloaded AC calibration values.

In calibration mode, CALP? returns the actual calibration period and mclk value being used.

## Determining which Channel is being Calibrated

SCCH? returns the channel, which is currently connected to the specified calibration probe channel (default is probe channel 1)

## **Performing a Driver Timing Calibration**

DTMC? performs timing driver calibration of the specified pin using the given calibration probe channel (default is channel 1).

## **Performing a Receiver Timing Calibration**

RTMC? performs timing receiver calibration of the specified pin using the given calibration probe channel (default is channel 1).

## **User Calibration**

The commands for this function are used by the User Calibration part of the system Calibration software.

User calibration consists of calculating additional offsets to the standard calibration values for a fixed set of pin configuration, calibration, timing, and level setups.

These files are first downloaded into the hardware and the User Calibration routine then produces a set of additional offsets that are later stored in a user\_cal file. The calibration probe is used to measure the actual timing at the DUT pins. Any differences that are found between the actual timing and the expected timing are offset by the user calibration offsets.

For more details on user calibration, refer to Maintaining the HP 82000 and Servicing the HP 82000.

## **Stopping the Calibration Routine**

TTMC terminates the calibration process

---

### **Note**



TACC restores the user settings, destroys received and expected data, and sets the system into the disconnected state.

Calibration does not change any loaded cal values.

---

---

## Calibration Data Transfer

The calibration values obtained by running the system calibration, are used throughout all timing and level setup commands to ensure that the tester signals meet their specified accuracy. The commands described in this section are provided to read or modify the calibration values. Downloading a new set of calibration data causes the timing and levels to be updated, utilizing the new calibration values.

These are the commands that are used to transfer calibration data to the hardware:

MLCD	modifies mainframe level calibration data
MLCD?	obtains mainframe level calibration data
MTCDC	modifies mainframe timing calibration data
MTCDC?	obtains mainframe timing calibration data
DLCD	modifies driver level calibration data
DLCD?	obtains driver level calibration data
DTCD	modifies driver timing calibration data
DTCD?	obtains driver timing calibration data
RLCD	modifies receiver level calibration data
RLCD?	obtains receiver level calibration data
RTCD	modifies receiver timing calibration data
RTCD?	obtains receiver timing calibration data
DTUD	modifies driver calibration data at user setting
DTUD?	obtains driver calibration data at user setting
RTUD	modifies receiver calibration data at user setting
RTUD?	obtains receiver calibration data at user setting
CALP	sets the period and MCLK value corresponding to the downloaded AC calibration values
CALP?	in calibration mode, returns the current period and MCLK value
CALI	sets calibration data information
CALI?	reads calibration data information
CALS?	reads tester calibration state



## Syntax

MLCD multi-mainframe-id, [adc-gain], [drv-lol-offset],  
[drv-lol-gain], [drv-hil-offset], [drv-hil-gain], [drv-lol-adj],  
[drv-hil-adj], [cmp-offset], [cmp-gain]

MLCD? multi-mainframe-id

MTCB multi-mainframe-id, [rec-basic-offset] { , [le-basepoints] }  
{ , [te-basepoints] }

MTCB? multi-mainframe-id

DLCD channel, [lol-offset], [lol-gain], [hil-offset], [hil-gain]  
, [lol-adj], [hil-adj]

DLCD? query-channel

DTCD channel, [le-offset], [le-mux-offset] { , [le-basepoints] }  
, [te-offset], [te-hiz-offset], [te-mux-offset]  
{ , [te-basepoints] }

DTCD? query-channel

RLCD channel, [lol-offset], [lol-gain], [hil-offset], [hil-gain]

RLCD? query-channel

RTCD channel, [le-wc-offset], [le-wc-mux-offset], [le-ec-offset]  
, [le-ec-mux-offset] { , [le-basepoints] }, [te-wc-offset],  
[te-wc-mux-offset], [te-ec-offset] { , [te-basepoints] }

RTCD? query-channel

## Load User Calibration Values

DTUD? channel

DTUD channel, [le], [le-slave], [te], [te-slave]

RTUD? channel

RTUD channel, [le], [le-slave], [te], [te-slave]

CALP cal-period, cal-mclk

CALP?

CALS?

CALS state

CALI mainframe-id, cal-data-set, [cal-date], [cal-temperature]

CALI? mainframe-id, cald-data-set

CALI mainframe-id, cal-data-set, cal-date, cal-temperature

multi-mainframe-id	can be 1, 2, 3, or ALL
channel	(see DFPN syntax)
query-channel	channel   ALL

All other parameters are floating point numbers.

The parameters passed for the level calibration download commands (xLCD) must not exceed the following ranges:

### Level Value Ranges (D100, D200 and D400)

		min	max	unit
Driver	Offset	- 300	+ 300	[mV]
	Gain	3.09236	3.28346	[mV/LSB]
	Adjust	0	7	[mV/V]
Receiver	Offset	- 500	+ 500	[mV]
	Gain	3.44040	3.87960	[mV/LSB]
Cal. Comp.	Offset	- 900	+ 900	[mV]
	Gain	5494.50	6715.50	[ $\mu$ V/LSB]
ADC	Gain	2500	4000	[ $\mu$ V/LSB]

### Level Value Ranges (D50)

		min	max	unit
Driver	Offset	- 300	+ 300	[mV]
	Gain	2.0	2.5	[mV/LSB]
	Adjust	0	0	[mV/V]
Receiver	Offset	- 500	+ 500	[mV]
	Gain	4.3	5.4	[mV/LSB]
Cal. Comp.	Offset	- 900	+ 900	[mV]
	Gain	5494.50	6715.50	[ $\mu$ V/LSB]
ADC	Gain	2500	4000	[ $\mu$ V/LSB]

The parameters passed for the timing calibration download commands (xTCD) must not exceed the following ranges:

### Timing Value Ranges (D100, D200 and D400)

		min	max	unit
Base-points	Channel	0	255	
	Clock Driver	0	4095	
Offset User cal offsets	All Edges	- 10.0	+31.0	[ns]
		±32		[ns]
<b>Round Trip Delay</b>		0.0	+50.0	[ns]

### Timing Value Ranges (D50)

			min	max	unit	
Base-points	Channel		-32.768	+32.767		
	Clock Driver		0	4095		
Offset	Leading Edge	Standard	0.0	+31.0	[ns]	
		MUX mode	- 5.0	+31.0	[ns]	
	Trailing Edge	Standard	- 1.0	+31.0	[ns]	
		MUX mode	- 6.0	+31.0	[ns]	
	Tristate Edge			0.0	+31.0	[ns]
	<b>Round Trip Delay</b>			0.0	+50.0	[ns]

The mainframe level calibration values are accessible with the MLCD command. One set of calibration data is held for each mainframe. The calibration values include the clock driver data (drv-lol-offset, drv-lol-gain, drv-hil-offset, drv-hil-gain, drv-lol-adj, drv-hil-adj),

the calibration comparator data (`cmp-offset`, `cmp-gain`), and the clock board ADC gain (`adc-gain`).

The mainframe timing calibration values are accessible with the MTCDC command. One set of calibration data is held for each mainframe. The calibration values include the clock driver/calibration comparator data (`le-offset`, `le-gain`, `te-offset`, `te-gain`) and the system roundtrip delay (`rec-basic-offset`).

The channel level calibration values are accessible with the DLCD (driver) or RLCD (receiver) command. One set of calibration data is held for each channel. The calibration values include the driver (`drv-lol-offset`, `drv-lol-gain`, `drv-hil-offset`, `drv-hil-gain`, `drv-lol-adj`, `drv-hil-adj`) and receiver data (`rec-lol-offset`, `rec-lol-gain`, `rec-hil-offset`, `rec-hil-gain`).

The channel timing calibration values are accessible with the DTCD (driver) or RTCD (receiver) command. One set of calibration data is held for each channel. The calibration values include the driver (`le-offset`, `te-offset`, `le-mux-offset`, `te-mux-offset`, `te-hiz-offset`) and receiver (`le-wc-offset`, `te-wc-offset`, `le-ec-offset`, `te-ec-offset`, `le-wc-mux-offset`, `te-wc-mux-offset`, `le-ec-mux-offset`) offsets, and the driver and receiver fine timing basepoints (`le-basepoints`, `te-basepoints`).

### **Additional Calibration Data Information**

The CALI command is used to store additional information about the currently active set of calibration values in the HP 82000 firmware.

One data set is available on each connected mainframe. A single mainframe can be selected by specifying the `mainframe-id`, which may be in the range 1 through 5. Additionally, ALL may be used to alter or retrieve the calibration information of all mainframes at once.

The firmware distinguishes between four sets of calibration values, which may be accessed independently of each other specifying the proper `cal-data-set value`: The basic calibration data (BC), the level calibration data (DC), the standard timing calibration data (AC), and the timing calibration data for a given user setting (UC). Again, ALL may be used to alter or retrieve all data sets at once.

The cal-date is passed as a string (enclosed in double quotes ") and is given as MM/DD/YY.

The cal-temperature passed for each mainframe is given in Kelvin. Downloading a cal-temperature value more than 5 K away from the actual temperature results in a warning message sent by the affected mainframe(s). The power-on default for the cal-temperature is 0. Therefor no warning message will be sent if this value is downloaded.

After power-on (or after processing the \*RST command), the cal-temperature is set to 0, and the cal-date is set to an empty string ("")

### **Reading the Calibration State**

The CALS query returns 1 if the tester is in its calibration state. This state will be entered after a successful ITMC query and left after the corresponding TTMC command has been received by the tester. If the tester is not in its calibration state, 0 will be returned.

### **Power-On Defaults**

#### **D100, D200 and D400**

MLCD mfid,3207.75,0,3188.48,0,3188.48,5.2,1.2,0,7024.74

MTCD mfid,13,327,654,981,1308,1635,1962,2289,2616,2943,  
3270,327,654,981,1308,1635,1962,2289,2616,2943,3270

DLCD chan,0,3188.48,0,3188.48,5.2,1.2

DTCD chan,0,0,20.4,40.8,61.2,81.6,102,122.4,142.8,163.2,  
183.6,204,0,0,0, 20.4,40.8,61.2,81.6,102,122.4,142.8,163.2,  
183.6,204

RLCD chan,0,3662.11,0,3662.11

RTCD chan,0,0,0,0,20.4,40.8,61.2,81.6,102,122.4,142.8,163.2,  
183.6,204,0,0,0,20.4, 40.8,61.2,81.6,102,122.4,142.8,163.2,  
183.6,204,0,0,0,

## 50 MHz

MLCD mfid,4884,0,3188.48,0,3188.48

## User Calibration

DTUD 0, 0, 0, 0

RTUD 0, 0, 0, 0

## Notes

Commands specifying invalid channels or invalid mainframe IDs are silently ignored.

The sequencer must be in the OFF state.

## Errors

Sequencer not in OFF state.

Value range errors

## Warnings

Level/Timing setup out of specification (for the download commands).

---

## D400 Calibration Commands

ILCD, ITCD	width generator calibration data
IXCM	width generator calibration setup
IXTC	width generator calibration
XTCD	400 MHz channel calibration data
XTMC	400 MHz channel calibration
XTUC	perform 400 MHz user calibration
XTUD	get or set 400 MHz user calibration data

## HSWG Calibration:

### Syntax

ILCD channel, [low-ft], [high-ft], [low-wd], [high-wd],  
[a, b, c]

ILCD? channel

### Query Response:

ILCD channel, low-ft, high-ft, low-wd, high-wd, a, b, c

ITCD channel, edge, [offset]

ITCD? channel, edge

### Query Response:

ITCD channel, edge, offset

IXCM pulse-width, low-level, high-level, connect-code,  
channel-id

IXCM?

### Query Response:

IXCM pulse-width, low-level, high-level, connect-code,  
channel-id

IXTC? channel, op-code, [probe-channel]

### Query Response:

IXTC error, probe-channel, period, channel, 0, low-level,  
high-level

IXTC error, probe-channel, period, channel, 1, low-level,  
high-level

IXTC error, probe-channel, period, channel, 2, edge, basepoints



**IXTC error, probe-channel, period, channel, 3 , edge, offset**

**IXTC error, probe-channel, period, channel, 4 .. 7 , edge, offset**

### **Width Generator Calibration Data**

The ILCD and ITCD commands are used to define a new set of calibration values for high speed width generator (HSWG) channels. The currently active values may be read by using the corresponding queries.

Both queries may be used to read either the calibration values of a dedicated channel or of all installed 400 MHz channels (with channel set to ALL ).

The edge parameter of the ITCD command is used to specify one of the four available edges and must therefore be in the range 1 through 4 . For the ITCD query ALL may be specified to read the calibration offsets of all edges.

The ILCD command defines the driver levels, setup to stimulate the high speed width generator. Low-ft and high-ft are the driver levels used in 'feed-through' mode, while low-wd and high-wd are used in 'width' mode. Additionally the three parameters a , b , and c are setup to minimize the delay variation, depending on the width generator's pulse width.

The ITCD command defines offset values for all edges. These offset values are used, if the high speed width generator is used in 'width' mode (400 MHz RZ). The offsets used in 'feed-through' mode are specified using the XTCD command.

### **Width Generator Calibration Setup**

The IXCM command is used to define the width generator setup required to calibrate the channel selected by channel-id. The setup defined will be used by the next calibration command (see IXTC).

The IXCM query returns the required width generator settings together with the channel-id to perform the next step in the width generator calibration process. Nothing will be returned, if the tester is not in its calibration state (see CALS) or if no IXCM command has been sent since the last ITMC query.

Pulse-width is the required pulse width, given in ns units. A value of -1 shows that the width generator will be used in its 'feed-through' mode.

Low-level and high-level are the required output levels of the high speed width generator. The levels are returned in mV and are specified into open.

The connect-code specifies the required relay setting of the E1215 width generator. The meaning of the values 0 through 3 is the same as documented for the IXMD query response. In addition to these states 4 or 5 may be specified to connect either the width generators normal or complement path to the DUT board.

### **Executing the Width Generator Calibration**

The IXTC query performs a timing calibration step, specified in op-code for the selected channel . The response to the IXTC query depends on the measurement selected by op-code.

Calibration measurements are done using the width generator settings specified by the IXCM command, sent most recently. If the passed channel number doesn't match the channel-id specified (see IXCM), an error message will be generated and no measurements are performed.

For multiplex calibration probes, the specified probe-channel will be used. If no probe-channel is specified, channel 1 is used, which is also appropriate for a standard calibration probe.

An op-code of 0 or 1 is used to obtain the driver levels required to stimulate the high speed width generator in either 'feed-through' or 'width' mode. The query therefor returns the required low-level and high-level values to be setup. These values must be downloaded using the ILCD command.

An op-code of 2 selects the fine timing linearity measurement. The measurement depends on the level calibration values, obtained in step 0 and 1 , which must be downloaded prior to this calibration step. The values returned are the delay DAC values used to obtain delay steps of 750 ps. These values must be downloaded using the XTCD command and are required for the following calibration steps.

An op-code of 3 or 4 selects an offset measurement in either feed-through or 'width' mode. In 'width' mode, the pulse width used must be setup by the IXCM command. The offset values determined in 'feed-through' mode are downloaded using the XTCD command, while the offset adjust values for 'width' mode are downloaded using the ITCD command. The op-codes 5 through 7 have the same functionality as op-code 4 . These codes are

required by the calibration program on the PWS to perform additional offset measurements in 'width' mode, used to calculate the coefficients for the delay-width dependency compensation (see ILCD).

## 400 MHz Channel AC Calibration

### Syntax

```
XTCD channel, edge { , [basepoint] }, [driver-offset],  
[single-threshold-offset], [dual-threshold-offset]
```

```
XTCD? channel, edge
```

### Query Response:

```
XTCD channel, edge { , basepoint }, driver-offset,  
single-threshold-offset, dual-threshold-offset
```

```
XTMC? channel, [probe-channel]
```

### Query Response:

```
XTMC error-code, probe-channel, period, channel, edge  
{ , basepoint }, driver-offset, single-threshold-offset,  
dual-threshold-offset
```

## 400 MHz Channel Calibration Data

The XTCD command defines a new set of basepoints and driver offsets for standard 400 MHz and high speed width generator channels. Additionally the receiver offsets for standard 400 MHz channels are defined with this command. The currently active values may be read by using the corresponding query.

The query may be used to read either the calibration values of a dedicated channel or of all installed 400 MHz channels (with channel set to ALL).

The edge parameter of the XTCD command is used to specify one of the four available edges and must therefor be in the range 1 through 4. For the XTCD query ALL may be specified to read the calibration values of all edges.

As for the 200 MHz channels, ten basepoints are available to describe the edge generator linearity. Depending on the period, some of the basepoints may be

unused. The basepoints are given as offset values (in ns ) for fixed fine delay DAC programming values (0, 16, 34, 54, 76, 100, 126, 154, 184, 216, and 250).

The driver-offset parameter specifies the edge offset (in ns) used for 400 MHz I pins or the offset in 'feed-through' mode for IX pins.

The single-threshold-offset (in ns) is used for FQ pins configured as O pins. The dual-threshold-offset (in ns) for edge 1 and 3 is used for FQ2 output pins and for the master channel of an FQM output pin. For FQM pins, the corresponding co-channel edge offsets are specified as the dual-threshold-offset parameters of edge 2 and 4 .

### **400 MHz Channel Calibration**

The XTMC command returns the calibration values for a 400 MHz channel using the calibration probe-channel specified. If no probe-channel is given, a single probe calibration probe will be assumed.

If the calibration measurement fails for any reason, an error-code will be returned, describing the failure. Note, that in this case all other values returned are invalid.

The period returned is the calibration period, selected by the ITMC command.

### **400 MHz User Calibration**

#### **Syntax**

```
XTUC? channel, [probe-channel-nr], driver-base-delay,  
receiver-base-delay
```

#### **Query Response:**

```
XTUC error, channel, probe-channel-nr, driver-base-delay,  
receiver-base-delay, period, drive-edge1, drive-edge2,  
drive-edge3, drive-edge4, receive-edge1, receive-edge2,  
receive-edge3, receive-edge4
```

```
XTUD channel, [drive-edge1], [drive-edge2], [drive-edge3]  
, [drive-edge4], [receive-edge1], [receive-edge2],  
[receive-edge3], [receive-edge4]
```

**XTUD? channel**

Query Response:

**XTUD channel, drive-edge1, drive-edge2, drive-edge3, drive-edge4,  
receive-edge1, receive-edge2, receive-edge3, receive-edge4**

### **Performing 400 MHz User Calibration**

The user calibration offsets are obtained for all edges at once. Not all edges are required for a particular pin configuration. Therefor the unused edge offsets are returned as 0 . The edge offsets are given in ns .

The probe-channel-nr selects a MUX-probe channel to be used for calibration. Omitting this parameter selects channel 1 , which is also used for a standard (single channel) calibration probe.

The driver-base-delay and receiver-base-delay are calculated by the standard calibration and are found in the calibration raw-data file as DRMA and RCMI values.

The user calibration offsets are downloaded for all edges at once. Because not all edges are used for a particular pin configuration, the unused edge offsets should be set to 0 . The edge offsets are given in ns .

---

## **PMU Calibration**

There are six commands used for calibrating any installed PMUs. These are:

<b>PMBC?</b>	perform pmu basic calibration results
<b>PMAC?</b>	perform pmu auto calibration results
<b>PBCD</b>	downloads a new set of calibration values for the PMU board measurement unit.
<b>PBCD?</b>	reads the current setting of the calibration values
<b>PACD</b>	downloads a new set of calibration values for the PMU board voltage and current force units.
<b>PACD?</b>	reads the current setting of the voltage and current force units

**PMBC? pmu-id**

returns

PMBC pmu-id, adcval, offset-2V, offset-10V, offset-20V,  
offset-200nA, offset-2uA, offset-20uA, offset-200uA, offset-2mA,  
offset-20mA, offset-200mA, offset-500mA

PMAC? pmu-id

returns

PMAC pmu-id, gain-u, offset-2V, offset-20V, offset-20V,  
gain-i-pos, offset-ip-200nA, offset-ip-2uA, offset-ip-20uA,  
offset-ip-200uA, offset-ip-2mA, offset-ip-20mA, offset-ip-200mA,  
offset-ip-500mA, gain-i-neg, offset-in-200nA, offset-in-2uA,  
offset-in-20uA, offset-in-200uA, offset-in-2mA, offset-in-20mA,  
offset-in-200mA, offset-in-500mA, leakage, leakage-per-V

PBCD? pmu-id

PBCD pmu-id, [gain], [offset-2V], [offset-20V], [offset-20V],  
[offset-200nA], [offset-2uA], [offset-20uA], [offset-200uA],  
[offset-2mA], [offset-20mA], [offset-200mA], [offset-500mA]

PACD? pmu-id

PACD pmu-id, [gain-u], [offset-2V], [offset-20V], [offset-20V]  
, [gain-i-pos], [offset-ip-200nA], [offset-ip-2uA],  
[offset-ip-20uA], [offset-ip-200uA], [offset-ip-2mA],  
[offset-ip-20mA], [offset-ip-200mA], [offset-ip-500mA]  
, [gain-i-neg], [offset-in-200nA], [offset-in-2uA],  
[offset-in-20uA], [offset-in-200uA], [offset-in-2mA],  
[offset-in-20mA], [offset-in-200mA], [offset-in-500mA],  
[leakage], [leakage-per-V]\$

where

pmu-id is one of P11 | P12 | P21 | P22 | P31 | P32 (see test functions  
section)  
adcval an int-val (-1 .. 4095 )  
all others fix-point-val

Adjustment of the system PMU boards requires two steps.

At first a “Basic Calibration” has to be done to adjust the on-board ADC, which will be used for all further measurements. The Basic Calibration is supported by the PMBC firmware command.

After downloading the ADC calibration values, PMAC may be used to return the calibration values for the voltage and current force DACs on the PMU board.

Note, that both calibration commands require at least one installed channel board.

Up- and downloading the PMU calibration values is supported by the PBCD and PACD commands.

The PMBC? returns the ADC offset values together with the binary conversion result achieved by measuring an external voltage source. While the offset values can be downloaded without any modification, the gain has to be calculated (using the returned ADC readouts). To calculate the ADC gain two measurements must be done, applying two different voltages of approximately  $\pm 18V$ . The gain to download will be

$$gain = \frac{U_2(+18V) - U_1(-18V)}{adcval[1] - adcval[2]}$$

*Adcval* is the ADC conversion result after measuring the external voltage (0 .. 4095). The measurement will be done in the  $\pm 20 V$  range.

---

**Note**

A value of -1 will be returned if the external voltage cannot be measured.



---

The offset values are returned as ADC binary readouts and are obtained by performing ten measurement cycles.

The PMAC? command is used to adjust an installed PMU and to transmit the calibration values to the host.

The gain calibration values (*gain-u*, *gain-i-pos*, *gain-i-neg*) are returned as fix point values using an implicit unit of  $1 \mu V$  (or  $1nA$ ). Gain calibration is done using the  $\pm 20V$  (or  $\pm 20mA$ ) range.

The units for the offset calibration values are range dependent as shown below:

**Table 10-1.**

Range	Unit
2 V .. 20 V	1 $\mu$ V
200 nA .. 200 $\mu$ A	1 fA
2 mA .. 200 mA	1 nA
500 mA	1 $\mu$ A

**Leakage** and **Leakage-per-V** are the measured leakage current at (approx.) 0 V (passed in nA) and the leakage current voltage dependency (passed in nA / V).

The PBCD command is used to download a new set of calibration values for the PMU board measurement unit.

Gain is the ADC gain for the 20 V measurement range, passed as a fix point value using an implicit unit of 1  $\mu$ V. Gain may be in the range 7 mV .. 13 mV.

The offset values are passed as binary ADC values. The valid range is 1500 .. 2500 for all voltage and current ranges.

The PACD command is used to download a new set of calibration values for the PMU board voltage and current force units.

The gain calibration values (**gain-u**, **gain-i-pos**, **gain-i-neg**) are passed as fix point values using an implicit unit of 1  $\mu$ V (or 1nA). The valid ranges for the gain values are 7 mV .. 13 mV and 3.5  $\mu$ A .. 6.5  $\mu$ A.

The units of the offset calibration values are range dependent as shown below :

**Table 10-2.**

Range	Unit	Range Limits
2 V .. 20 V	1 uV	$\pm$ 2 V
200 nA .. 200 $\mu$ A	1 fA	$\pm$ 2 $\mu$ A
2 mA .. 200 mA	1 nA	$\pm$ 2 mA
500 mA	1 $\mu$ A	$\pm$ 2 A



**Leakage** and **Leakage-per-V** are the expected leakage current at (approx.) 0 V (passed in nA) and the leakage current voltage dependency. The leakage current may be in the range  $\pm 2$  mA while the voltage dependency must not exceed  $\pm 100 \mu\text{A} / \text{V}$ .

## **Errors**

Tester not in DISCONNECT state

Selected PMU not installed

Value range error

---

## **Diagnostic Commands**

Diagnostics are performed with a standard query command. The DIAG? command is used by the Diagnostics User Interface.

### **Performing System Diagnostics**

There is one command DIAG used for performing diagnostics. It is used from the Diagnostics User Interface. Refer to Servicing the HP 82000 manual for more information on system diagnostics.

### **Syntax**

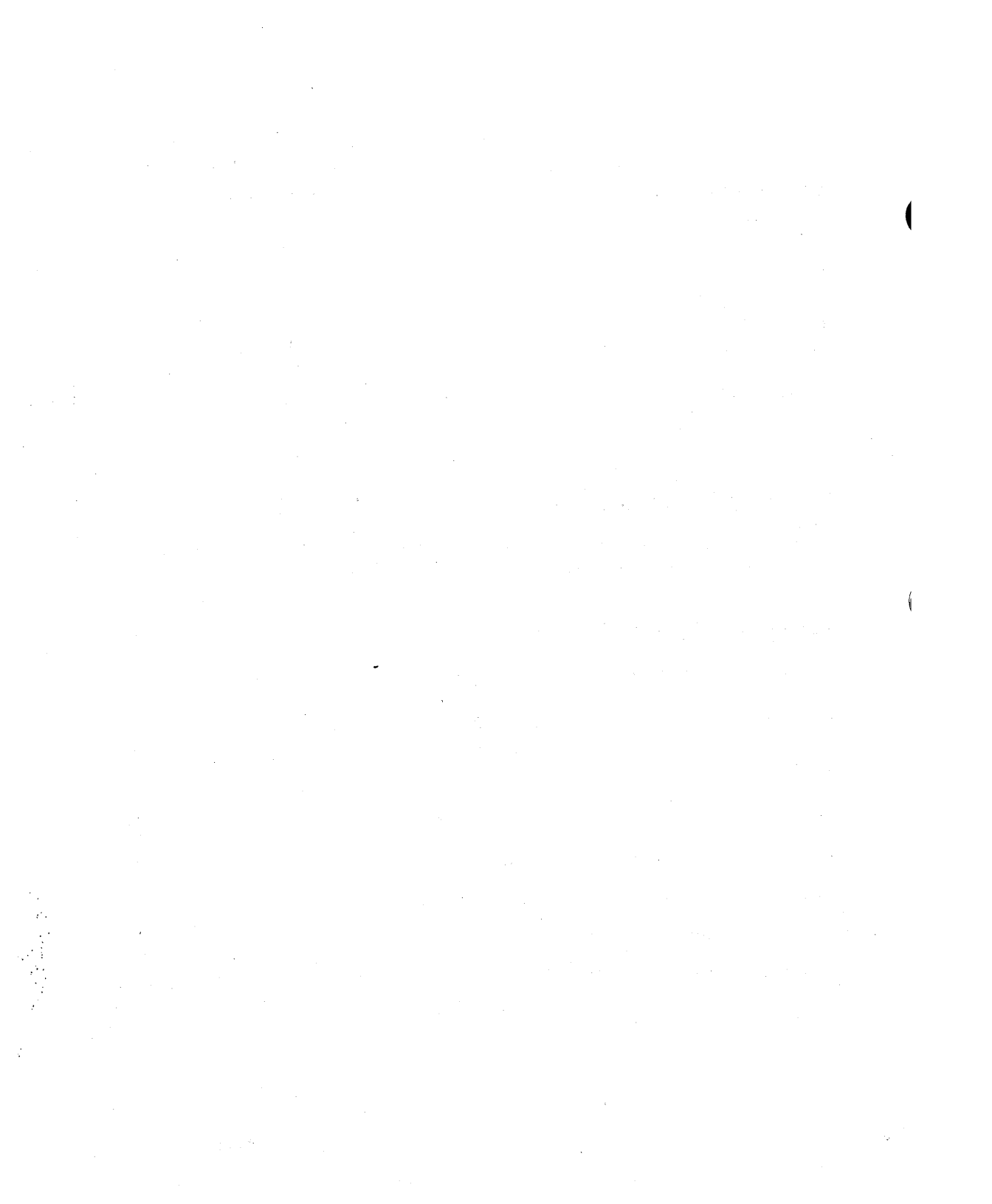
DIAG? code

code            tests to be performed.

When this command is sent, the system responds with:

DIAG code, arbitrary-data

where arbitrary-data indicates the results of the test specified in code.



## Pin and System Attribute Commands

---

These commands are used to set or read pin and system attributes. A pin is a system channel which is referenced by a pin name (see DFPN command in the Configuration Commands chapter). The attributes are:

- Pin attributes
  - the series resistor wired on the DUT board
  - the output resistor of the DUT
  - an additional timing offset for driver/receiver edges.
- System attributes
  - a round trip adjust value

These attributes are used to correct the comparator thresholds and timing setup automatically.

The PATR command is used to set individual pin attributes. The query command PATR? can be used to read the current settings. The SATR and SATR? commands are used to set round trip adjust values for all pins.

---

### Pin Attribute Commands

#### Syntax

```
PATR [Rs], [Rout-source], [Rout-sink], [t-drive], [t-rec],
pinlist
```

```
PATR? pinlist
```

where

Rs is a real in the range 0 .. 6553.5 with the implied units Ohm

**Rout-source** is a real in the range 0 .. 6553.5 with the implied units Ohm  
**Rout-sink** is a real in the range 0 .. 6553.5 with the implied units Ohm  
**t-drive** is a real in the range -32.767 .. +32.767 with the implied units nanoseconds  
**t-rec** is a real in the range -32.767 .. +32.767 with the implied units nanoseconds

## Description

$R_s$  is the series resistor wired on the DUT board in order to increase the signal fidelity.  $R_{out\_source}$  and  $R_{out\_sink}$  are the DUT output source and sink resistors respectively.

Defining these resistor values by executing the command, results in an automatic comparator threshold adjustment according to the following formulae:

### Threshold Correction without active termination

$$U_{th} = U_x \times \frac{R_c}{R_c + R_{out\_source} + R_s} \quad (1)$$

### Threshold Correction for active termination (TERM, IOH, IOL) pins

$$U_{th} = \frac{(U_x \times R_t) + U_t \times (R_{out} + R_s)}{R_t + R_{out} + R_s} \quad (2)$$

where

$U_{th}$  is the actual level programmed in the hardware  
 $R_c$  is the comparator input impedance (10k  $\pm$  1% for a 50 Ohm system and 32k  $\pm$  20% for a 100 Ohm system)  
 $R_t$  is the termination resistor (50 Ohm  $\pm$  3 Ohm for a 50 Ohm system and 100 Ohm for a 100 Ohm system)  
 $U_x$  is the level programmed as a result of downloading a Level Setup or by using the Level Setup commands.  
 $U_t$  is the termination level (low level for TERM and IOL and high level for IOH pins)  
 $R_{out}$  DUT output resistor. Either  $R_{out\_source}$  or  $R_{out\_sink}$ , depending on  $U_x$  and  $U_t$ .

If  $U_x > U_t$  then

```
Rout = Rout_source
else
Rout = Rout_sink
```

Using this adjustment formula ensures that comparator thresholds are programmed so that the user programmed thresholds are seen by the DUT output in case the output is not loaded.

This adjustment always takes place each time the comparator thresholds or the resistor values are changed by the appropriate commands.

T<sub>drive</sub> and t<sub>rec</sub> are timing offsets that are used to adjust the timing settings and are always added when programming timing edges. T<sub>drive</sub> will be added to all the driver edges of the specified pin(s), while t<sub>rec</sub> is added to all the receiver edges of the specified pin(s).

The timing offsets can be used to adjust the calibration values, for example, in the case of a longer DUT interface cable being used for connecting a prober, and the calibration was performed at the DUT Board with the Calibration Matrix.

The ranges of t<sub>drive</sub> and t<sub>rec</sub> specified above are theoretical, you should ensure that the sum of t<sub>programmed</sub>, t<sub>calibration</sub>, and t<sub>drive</sub>/t<sub>rec</sub> does not exceed the allowed range.

---

**Note**

Changing the pin attributes results in a temporary change to the sequencer OFF state, if it is not already in this state.

---

## Power-On Defaults

At power-on, the pin attribute settings are:

```
PATR 0,0,0,0,0,all-installed_pins
```

## Errors

An error will be generated for:

- any value range errors.
- attempting to program a non-applicable pin (configured as DC or OFF)

## Warnings

Warnings will be generated by this command if:

- Level programming exceeds hardware specifications
- Timing programming exceeds hardware specifications
- Comparator threshold(s) auto-corrected

---

## Setting System Attributes

### Syntax

```
SATR [round-trip-adjust]
```

```
SATR?
```

where

`round-trip-adjust` is a fixed point value with the implied units nanoseconds.

### Description

The `round-trip-adjust` defined in the SATR command is used to alter the common receiver delay calculated by the calibration routines. The value will be used for all the receivers in all mainframes.

The total value of `round-trip-adjust` and the round trip time calculated by calibration (see MTCB command) must not exceed 50 nanoseconds, otherwise an error will be generated and the setting will be ignored.

The SATR? query will be answered by the master mainframe only.

---

**Note**



Changing the system attributes results in a temporary change to the sequencer OFF state, if it is not already in this state.

---

**Power-On Defaults**

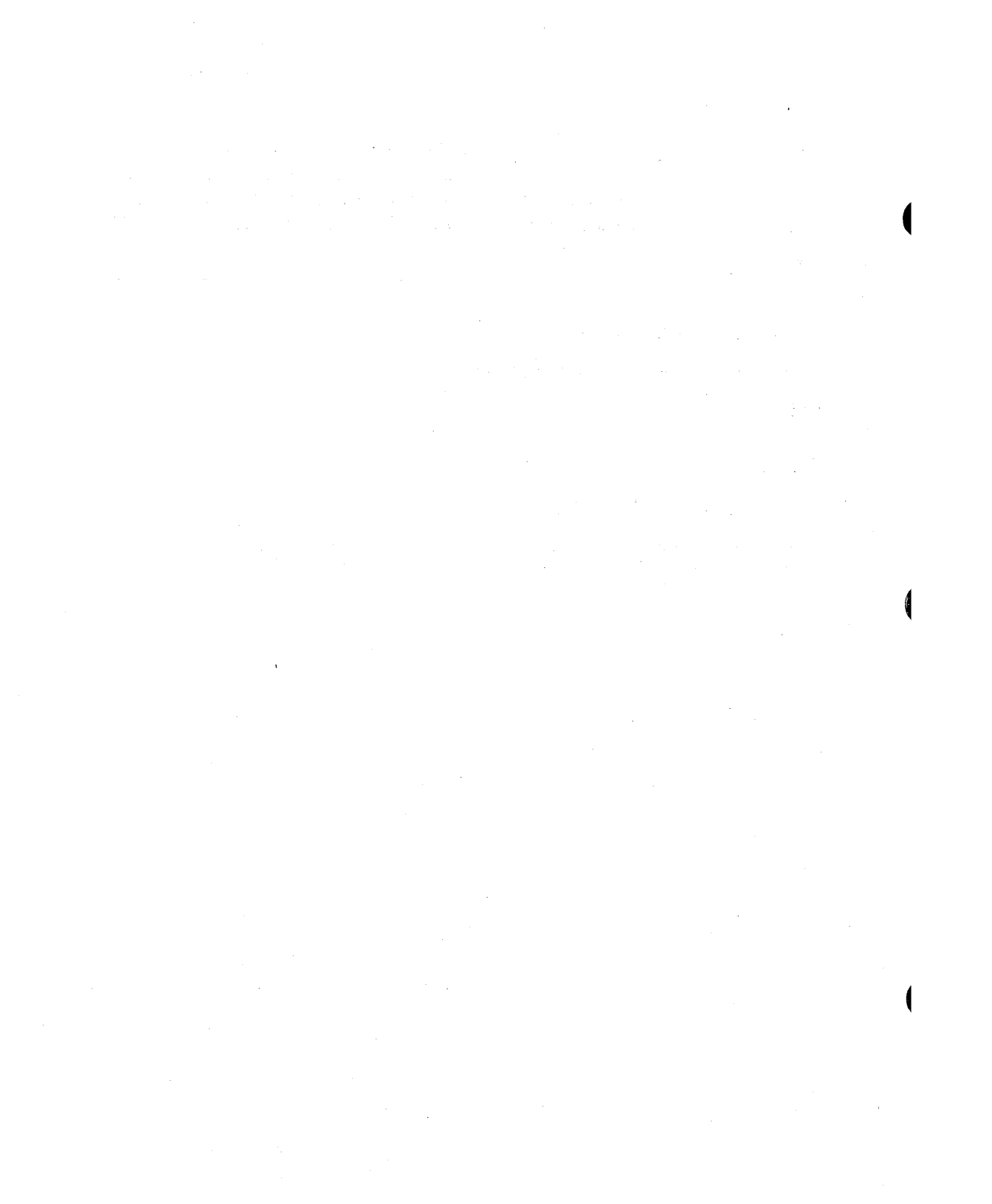
At power-on, the system attribute settings are:

SATR 0

**Errors**

An error will be generated for:

- any value range errors (combined round trip delay value greater than 50 nanoseconds).





## HP-IB Command Syntax

---

### Introduction

This chapter contains general information on the HP-IB commands followed by an alphabetical list of all the commands used in the hardware.

Each command description consists of a short description, the required syntax, possible error and warning messages and a short example. For more information on specific topics refer to the relevant section in the following chapters.

---

### General Information

The system HP-IB command language conforms to IEEE Standard 488.2 Draft 18 with the exception of the optional parameters.

All commands sent via HP-IB consist of ASCII strings except the vectors, which are transferred in a binary format. The DMA used in the system allows a vector transfer rate of approximately 250 kbyte/sec.

Hardware channels can only be accessed by their user defined name, as specified in the pin configuration setup menu.

Exceptions to this rule are the calibration and diagnostics routines, which act directly on machine channels. During calibration, the channel is selected manually by probing the DUT board pin (returning the pin name if set up). Diagnostics may check channels which are not connected to the DUT board or used for the current application. The Input and Output part of the same channel must have the same name. The wildcard symbol (@) can be used to access all applicable channels.

All settings can be read by the controller via queries, the responses to queries have the same format as the corresponding setup commands. Exceptions are noted in the command description.

Example:

```
DRLV? (RESET)      leads to the response  
DRLV 0, 5, (RESET)
```

The above example returns the high and low level of the pin called RESET.

Hardware programming is contextually independent which means that, for example, MUX pin vectors will be downloaded to the hardware as if there were two independent pins.

---

**Note**

The only exceptions to this rule are that pin naming must precede all other pin commands and clock programming should precede edge programming.

---

Command headers consist of four letters with no upper/lower case significance. The corresponding query command uses the same name followed by a question mark (?).

For optional parameters, the current value will remain set in the hardware if it is not affected by subsequent use of the command. In the case of a parameter mismatch, optional parameters may be autocorrected and generate a warning. Mismatched parameters in a command generate an error.

---

## System HP-IB Commands

### Global definitions

Spaces are not explicitly shown in the syntax definitions. They are always allowed between “none terminal symbols”, which means that you can insert any number of spaces (ASCII 255) between any “none terminal symbol”.

Except for pin names, there is no significance between upper and lower case letters.

The general form of strings downloaded to the system is shown in the figure below.

```

{<d2_command>}
d2_command ::= [program_message]
                <program_message_terminator>

program_message_terminator ::= [
    EOI
    NL + EOI
    NL
]

program_message ::= <program_message_unit>
program_message_unit ::= <program_header>
                        <program_data>, <program_data>
program_header ::= <char><char><char><char>

program_data ::= [
    <int_val>
    <fix_point_val>
    <enumerated>
    <pin_list>
]

int_val ::= (<digit>)
fix_point_val ::= [<sign>] [<digit>.<digit>]

sign ::= [
    +
    -
]

enumerated ::= <char><char><char><char>
pin_list ::= <pin_name>, [<pin_name>]
pin_name ::= <pin_char>{<pin_char>} <= 15
pin_char ::= ASCII 21H thru 7EH except " # ' ( ) , ;

```

**Figure 12-1. Downloaded Strings**

## Note



- CR is allowed and will be taken as a white space.
- Value parameters (eg. edge delays, level voltages, etc.) are represented in fixed point format and take advantage of implicit units (eg. implicit unit of edge delays is ns). Which implicit unit is taken for what value parameter is explained in the particular chapters.
- the at character (@) is the 'all pins' wildcard and will be expanded by the firmware to a list of all applicable pins.

The general form of the query responses is shown in the figure below.

```
<d2_response>
d2_response ::= [response_message]
                <response_message_terminator>
response_message_terminator ::= NL + EOI
response_message ::= <response_message_unit>
response_message_unit ::= <response_header>
                        <response_data>, <response_data>
response_header ::= <char><char><char><char>
response_data ::= [
    <int_val>
    <fix_point_val>
    <enumerated>
    <pin_list>
]
int_val ::= {<digit>}
fix_point_val ::= [<sign>] [<digit>.<digit>]
sign ::= -
enumerated ::= <char><char><char><char>
pin_list ::= <pin_name>, [<pin_name>]
pin_name ::= <pin_char>(<pin_char>) <= 15
pin_char ::= ASCII 21H thru 7EH except " # ' ( ) , ;
```

**Figure 12-2. Uploaded Strings**

---

**Note**



CR NL+ EOI may be an alternate response message terminator, configured by a special HP-IB command.

---

---

## ADCM?

### Calibration ADC Calibration

ADCM? returns the ADC level measured at the PMU rail external connection in ADC scaling units.

```
ADCM? mainframe_id
```

where `mainframe_id` is either 1, 2, 3, 4, 5 or ALL.

This returns the following string:

```
ADCM adc-value
```

where `adc-value` is the ADC conversion result

### Errors

An error will be generated for the following reasons:

- error
- error

### Example

Sending ADCM? 1 will return a string similar to

```
ADCM 1,1519
```

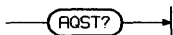
Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

---

## AQST?

**Test Results** Number of cycles

AQST? returns the number of cycles between the **event address** and any detected stop condition, and returns a -1 if no event was found before the vector sequence was completed.



Sending this command causes the system to return **cycles\_after\_event\_addr** which is an integer between -1 and  $2^{24}$  indicating the number of cycles of data acquired by the last test.

The command is valid for acquisition and compare modes.

### Errors

An error will be generated for the following reasons:

- Parameter range errors

### Example

Sending **aqst?** without previously performing a test returns -1.

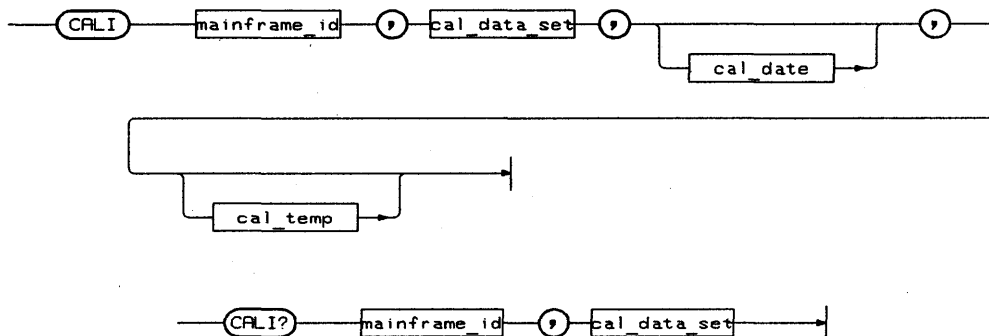
Sending it after performing a test will return the number of cycles acquired in the last test

<b>ftst?</b>	<i>Perform functional test</i>
<b>FTST F</b>	<i>returned by system if test fails</i>
<b>aqst?</b>	<i>Query number of cycles</i>
<b>AQST 1001</b>	<i>1001 cycles were acquired since the delay counter was started</i>

## CALI, CALI?

### Calibration Set and read calibration data information

The CALI command stores additional information about the currently active set of calibration values in the HP 82000 hardware.



where:

mainframe_id	can be 1, 2, 3, 4, 5 or ALL
cal_data_set	can be: BC (base calibration) DC (level calibration) AC (standard calibration) UC (calibration at user settings)
cal_date	is the calibration date—a character sting enclosed in double-quotes (") in the form "MM/DD/YY" (i.e. Month/Day/Year).
cal_temp	is the temperature at calibration time, in units of Kelvin (K). (default=0)

## **CALI, CALI?**

### **Errors**

- `cal_temp` more than  $\pm 5\text{K}$  from actual temperature.

### **Example**

```
CALI 1,AC,"10/03/90",293
```

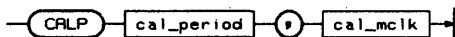
means that the standard calibration for mainframe 1 was performed on 3rd October 1990, at an ambient temperature of 293k (20°C)  $\pm 5\text{K}$ .



---

## CALP, CALP?

**Calibration** Set/read period and MCLK value



This command sets/returns the period and MCLK value corresponding to the downloaded AC calibration values.

In calibration mode, CALP? returns the current value of calibration period and MCLK.

### Example

Refer to Chapter 10 for more information on system calibration.

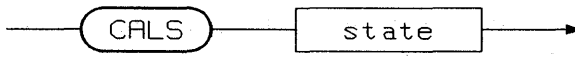
---

## CALS?

Calibration Read tester calibration state



Returns the string:



where:

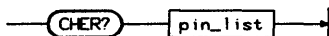
**state** can be either:

- 1 indicating that the system is calibrated; or
- 0 indicating that the system is not calibrated.

## CHER?

**Test Results** Get pass/fail information per pin

CHER? returns passed / failed information for every given pin.



Sending the command returns **passed/failed** which can be either P or F depending on whether an error was detected in the last test.

The command is only valid in RTC mode.

### Note



Each time the CHER? query is executed, the PASS/FAIL flag is reset to PASS. So if you execute CHER? twice in succession, without performing a test between executions, the second execution of CHER? will always return pass.

### Errors

An error will be generated for the following reasons:

- Parameter range errors
- Command used in acquisition mode
- No data available - no test has been performed

### Example

After performing a test in RTC mode, sending CHER? will return the pass./fail for each pin in pinlist.

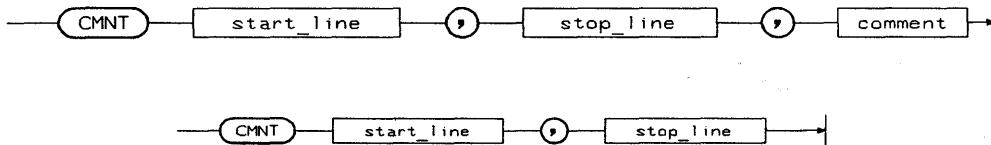
```

ftst?           Perfrom functional test
FTST F         Test failed
cher? (@)      Q0 caused fail
CHER F, (Q0)
CHER P, (Q1)
CHER P, (Q2)
CHER P, (Q3)
  
```

---

## CMNT, CMNT?

**Vector Setup** Add or read comments in vector table



where:

**start\_line** is the first line to be commented;  
**stop\_line** is the last line to be commented;  
**comment** is the comment text.

The comment text must be enclosed in double quotes ("). A vertical bar (|) in the comment text acts as a separator between lines.

Alternatively, you can designate lines without comments by entering an empty comment string.

### Example

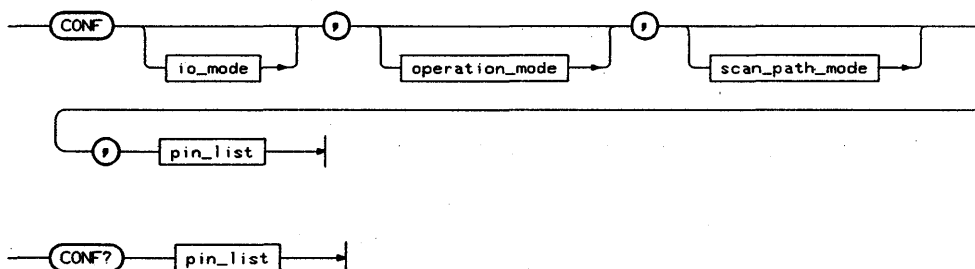
```
CMNT 0,1,"Comment for line 0|Comment for line 1"
```

```
CMNT 10,100,"" (lines 10 to 100 have no comments)
```

## CONF, CONF?

### Configuration Pin operating modes

The CONF command sets up the operating modes for a pin and checks for sufficient calibration data for those modes. The related CONF? query command returns the mode settings of the named pins.



The parameter `io_mode` determines the io capabilities of the pin. `io_mode` can consist of one of:

I	input
IX	high speed (400 MHz) input (HSWG channel)
O	output
IO	bidirectional
TERM	DUT output pin, but in contrast to output (O) mode, it is terminated by an active load.
NC	The pin is considered to be disconnected from the DUT.
DC	The pin is considered available for DC (PMU) measurements only. No AC-resources are accessible.

The parameter `operation_mode` determines the internal operation mode of the channel logic and consists of one of:

STD	This is the standard mode of operation for D50, D100 and D200 boards.
FD	This mode doubles the STD mode frequency of D50 and D200 I/O boards by reducing the available formats.

## CONF, CONF?

MUX	This mode doubles the STD mode frequency of D50 and D200 I/O boards, by combining the resources of two consecutive channels.
FQ2	This mode provides the maximum number of signal formats for D400 I/O boards, at a frequency of 200 MHz.
FQ	This mode provides DNRZ signals at 400 MHz. Additional signal formats are available if this channel is routed through a High Speed Width Generator (HSWG).
FQM	This mode combines the receiver resources of two channels, to provide dual threshold edge compare at 400 MHz. No driver resources are available.

The parameter `scan_path_mode` determines the behavior of the pin during a serial scan vector.

P	The channel keeps its data during a serial scan. Its vector memory may be used for a channel in serial mode.
S	The channel serializes data from the vector memory of other channels during a serial scan.

The query command `CONF?` responds with the IO, operation, and scan path modes for the required pin(s).

## Errors

An error will be generated if `pin_list` contains more than one pin in the `CONF` command.

## Example

Entering

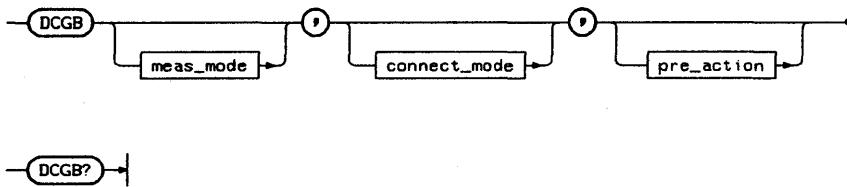
```
DFPN 0101, "", (NOT_CS)
CONF I,STD,, (NOT_CS)
```

defines `NOT_CS`, which was previously defined by the `DFPN` command, being configured as an input pin, operating in 100 MHz mode and parallel (default).

## DCGB, DCGB?

### Test Functions DC measurement globals

This command is used to set and read the global conditions for dc measurements using the PMU.



where

- meas-mode** is the measurement mode to be used. Can be:
- P parallel - all pins are measured and the combined current and voltage is measured. Read the value using DCSR?
  - S serial - each pin is measured separately taking the values in PATR into consideration for the calculation. Read the values using DCPR?
  - D direct - each pin is measured separately. The value at the DUT pin can be read using DCPR?
- connect-mode** is the connection mode used for the PMU. Can be:
- A additional - PMU is connected to the IO channel during the measurement. Any AC circuitry on the IO board can affect the measurement. Can be used to make measurements under loaded conditions.
  - E exclusive - PMU is connected only to DUT pin. The IO Board is disconnected during the measurement.
- pre-action** sets up the DUT before the measurement takes place.
- NONE - no setup is performed.
  - FTST - a functional test is performed before the measurement takes place.

**DCGB, DCGB?**

## **Power On Defaults**

At power-on the following setups are made:

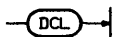
DCGB S,E,NONE

## **Example**

Sending DCGB,P,E,NONE will cause the next PMU measurement to be performed in parallel with the IO Board disconnected from the DUT pin.



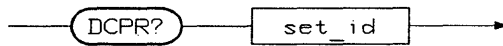
---

**DCL****HP-IB Device Clear****DCL****Refer to BASIC/UX Interfacing Techniques manual for more information.**

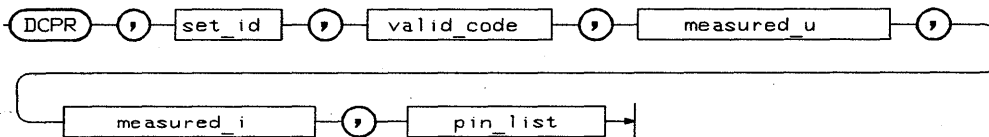
---

## DCPR?

Test Functions Retrieve results for per pinlist (parallel) dc tests.



Returns the string:



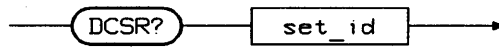
where

- valid-code** describes the condition of the PMU during the measurement. It is an integer in the range 0 .. 63. If **valid-code** is coded binary it has the format **OFGppppp** where
- **ppppp** is the **pmu-state** as described in the **PMUM?** query.
  - **G** is the force-i overflow flag. It is set when the PMU could not be set to the necessary force current.
  - **F** is the functional fail flag. It is set if preceding functional test result in a fail.
- measured-u** is the measured voltage given in millivolts. It is only valid, if the **valid-code** indicates neither unstable nor voltage overflow.
- measured-i** is the measured current given in microamperes. It is only valid, if the **valid-code** indicates neither unstable nor current overflow.
- pinlist** specifies the pins the former parameters are related to.

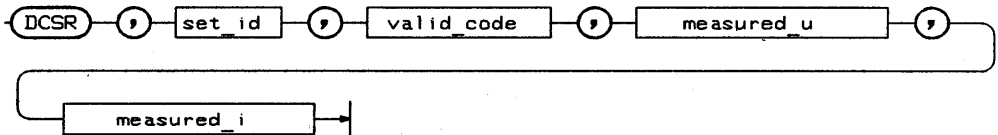
---

## DCSR?

**Test Functions** Retrieve results for per pin (series) dc tests.



Returns the string:



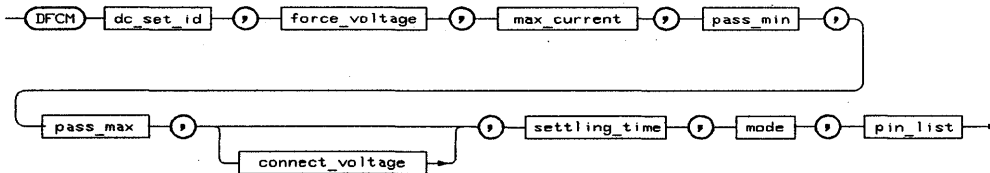
where

- valid-code** describes the condition of the PMU during the measurement. It is an integer in the range 0 .. 63. If **valid-code** is coded binary it has the format OFGppppp where
- ppppp is the pmu-state as described in the PMUM? query.
  - G is the force-i overflow flag. It is set when the PMU could not be set to the necessary force current.
  - F is the functional fail flag. It is set if preceding functional test result in a fail.
- measured-u** is the measured voltage given in millivolts. It is only valid, if the **valid-code** indicates neither unstable nor voltage overflow.
- measured-i** is the measured current given in microamperes. It is only valid, if the **valid-code** indicates neither unstable nor current overflow.

---

## DFCM

High Throughput Tests Define current measurement parameters.



where:

- dc\_set\_id** is the identification number (*id\_dc*) for the dc parameters (in the range 1 to 64);
- force\_voltage** is the PMU voltage to be used during the measurement (in mV);
- max\_current** is the maximum current allowed during the measurement (in  $\mu\text{A}$ );
- pass\_min** is the minimum pass current value (in  $\mu\text{A}$ );
- pass\_max** is the maximum pass current value (in  $\mu\text{A}$ );
- connect\_voltage** specifies the voltage forced by the PMU while the DC relay is connected. If this parameter is omitted, then the force-voltage value is used.
- settling\_time** specifies how long to wait between the connection of the PMU, and performing the measurement (in milliseconds);
- mode** can be:
- GNG (ganged)—measurements are taken while all the pins are connected to the PMU;
  - NGNG (not ganged)—each pin is measured individually.
- pin\_list** are the pins included in the test.

The dc parameter sets can be read using the DFPM? query.

## Example

To define the dc parameters for a PMU current measurement test, on pins Q1, Q2 and Q3 of your device, with

- the id number (*id\_dc*) "4";
- a force of voltage -1.7 Volts;
- a maximum current of 0.1 milliamps ;
- a minimum pass value of 20 microamps;
- a maximum pass value of 80 microamps;
- the default connect voltage (in this case, -1.7 V)
- a settling time of 1 millisecond;
- with the PMU measurement carried out on all three pins together;

you enter the string:

DFCM 4, -1700, 100, 20, 80, , 1, GNG, (Q1, Q2, Q3)

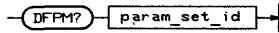
You can check the dc measurement settings already stored in RAM, with the DFPM? query:

DFPM? *id\_dc*

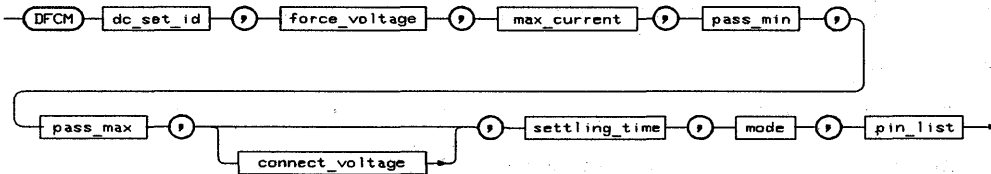
---

## DFPM?

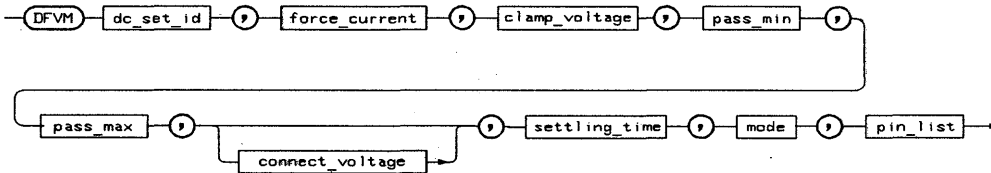
High Throughput Tests Read PMU measurement parameters, perviously defined by DFCM and DFVM.



returns either:



or:



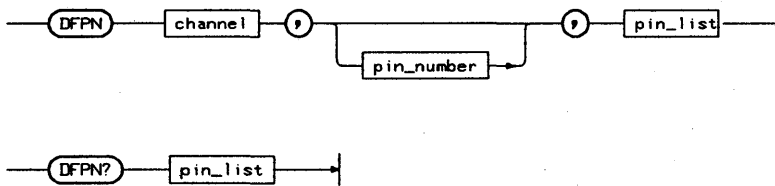
See DFVM and DFPM for the parameter descriptions.

## DFPN, DFPN?

### Configuration Setup Define pin name

The DFPN command sets up a new name for one unused channel. Later you can refer to this channel using the given name.

The corresponding DFPN? command responds with the channel number of the specified pin.



**channel** describes the channel to use. It is a five digit number that describes the channel to use for a pin. The five digits fall into three groups and the number has the format mbbcc

- m** specifies the mainframe and can be 1, 2, or 3.
- bb** specifies the slot number of the channel board in the mainframe. This can be a number between 01 and 16.
- cc** specifies the number of the channel on the board. Boards can have either eight or sixteen channels and are numbered 01 to 16.

**pin\_number** is for comment purpose only. It is required by the system software.

**pin\_list** contains one previously undefined **pin\_name** that is to be defined.

At power-up there are no pins defined.

The query command DFPN? returns the channel and pin number for the named channel.

## **DFPN, DFPN?**

### **Errors**

An error will result if `pin_list` contains more than one pin.

### **Example**

The commands

```
DFPN 10405,"", (pin1)
```

results in channel 5 on the fourth IO Board in mainframe 1 being given the name `pin1`. You must define a pin with the DFPN command before you can access it from any other commands.

Sending the command

```
DFPN? (Q)
```

will result in a list of the currently defined pins being output.



---

## DFPS, DFPS?

### DPS Define DPS pins

These commands are used to modify and read DPS settings.



where

- |                |  |
|----------------|--|
| <b>channel</b> | is a two-digit figure which indicates the DPS number and the DPS channel used. For example, DPS1, channel 3 is indicated by the number 13 in this field. on the type of DPS installed. |
| <b>sign</b>    | sets the polarity of the DPS output. Can be either POS or NEG.   |
| <b>pin</b>     | defines the pin name for the DPS channel.  |
| <b>pinlist</b> | pin names previously defined by a DFPS command.  |

### Example

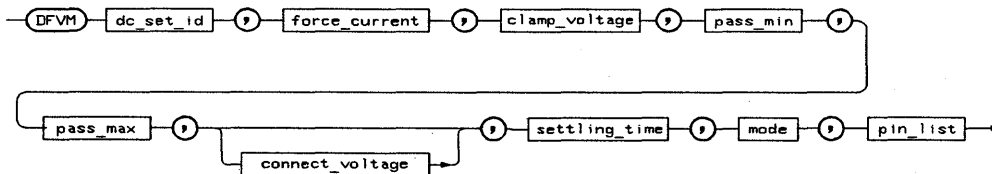
To define a DPS2, channel 2 as a positive supply to a pin called dps1:

```
DFPS 22,POS,dps1
```

---

## DFVM

High Throughput Tests Define voltage measurement parameters.



where:

<b>dc_set_id</b>	is the identification number ( <i>id_dc</i> ) for the dc parameters (in the range 1 to 64);
<b>force _current</b>	is the PMU current to be used during the measurement (in $\mu\text{A}$ );
<b>clamp_voltage</b>	is the maximum voltage allowed during the measurement (in mV);
<b>pass_min</b>	is the minimum pass voltage value (in mV)
<b>pass_max</b>	is the maximum pass voltage value (in mV)
<b>connect_voltage</b>	specifies the voltage forced by the PMU while the DC relay is connected. If this parameter is omitted, then the mean value between <b>pass_min</b> and <b>pass_max</b> is used.
<b>settling_time</b>	specifies how long to wait between the connection of the PMU, and performing the measurement (in milliseconds);

**mode**

can be:

- **TRM** (terminated)—the pin is connected to the PMU and the pin electronics;
- **NTRM** (not terminated)—the pin is connected to the PMU only;
- **SPOL** (specified polarity)—the measurement is taken with the polarity specified by the clamp voltage;
- **BPOL** (both polarities)—measurements are taken with both polarities (a pass result is given if the pin passes the test in *either* direction).

(SPOL and NTRM are synonymous.)

**pin\_list**

are the pins included in the test.

The dc parameter sets can be read using the DFPM? query.

### Example

To define the dc parameters for a PMU voltage measurement test, on pins Q1, Q2 and Q3 of your device, with

- the id number (*id\_dc*) “3”;
- a force current of 5 milliamps;
- a clamp voltage of 5.5 Volts;
- a minimum pass value of 4.5 Volts;
- a maximum pass value of 5.0 Volts;
- the default connect voltage (in this case, 4.75 V)
- a settling time of 1.5 milliseconds;
- with the PMU measurement carried out while the pin electronics are still connected;

you enter the following string:

```
DFVM 3,5000,5500,4500,5000,,1.5,TRM,(Q1,Q2,Q3)
```

You can check the dc measurement settings already stored in RAM, with the DFPM? query:

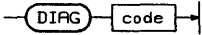
```
DFPM? id_dc
```

---

## DIAG

**Diagnostics** Perform system diagnostics

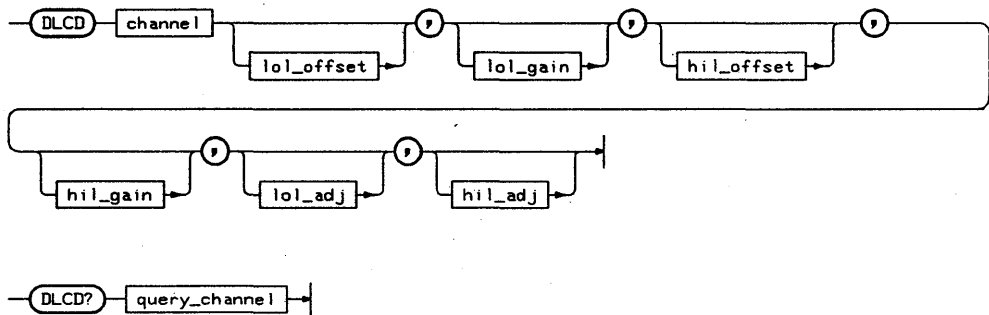
This command is used by the Diagnostics User Interface.



## DLCD, DLCD?

### Calibration Driver level data

These commands are used to modify and read driver level calibration values.



where **channel** is the sequential channel number defined with the DFPN command.

The values for the offsets and gains are shown below.

**Level Parameter Value Ranges**

		min	max	implied unit
Driver	Offset	-300	+300	mV
	Gain	3092.36	3283.46	$\mu\text{V}/\text{LSB}$

### Errors

Errors are generated for the following reasons:

- Sequencer not idle
- Gain value out of range
- Trying to set or read driver calibration data for an O channel

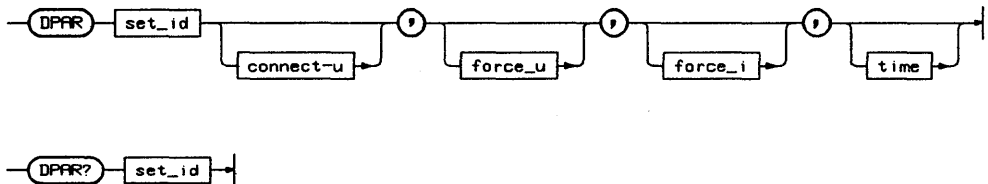
## **DLCD, DLCD?**

### **Example**

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## DPAR, DPAR?

Test Functions Define dc measurement parameters



where

**set-id**            0 or 1 for the parameter set to be defined

**connect\_u**        sets a charging voltage on the PMU pins to reduce current flow. Must be in the range  $-20000 \dots +20000$  millivolts.

**force\_u**            force voltage for PMU measurement. Must be in the range  $-20000 \dots +20000$  millivolts.

**force\_i**            force current for PMU measurement. Must be in the range  $0 \dots 500000$  ( $\mu\text{A}$ ).

**time**                additional settling time between connection of PMU and measurement taking place in milliseconds

DPAR? returns the settings for the specified parameter set.

### Power On Defaults

At power-on the following settings are made:

DPAR 0,0,0,0,0

DPAR 1,0,0,0,0

### Example

Sending DPAR 0,1000,,500,5 will precharge to 1 Volt, and force a current of  $500 \mu\text{A}$  after 5 milliseconds.

---

## DRLC?

**Calibration** Performs a driver level calibration

```
—(DRLC?)—(query_channel)—
```

where `query-channel` is the driver channel to be calibrated.

### Example

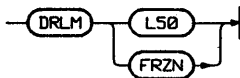
Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.



---

## DRLM,DRLM?

Level Setup Specify timing reference level



These commands specify and read the current settings for the timing reference levels. Using the setting L50 sets the level to the 50% point of the level setting. FRZN sets the reference level to the setting of nominal-swing in the DRLX command.

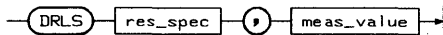
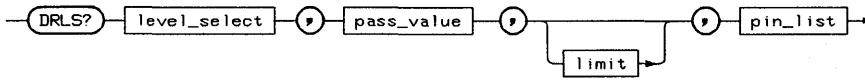
### Warnings

This command may be overridden by any settings made in DRLX commands. Any value of nominal-swing except -1 sets the mode to FRZN for that level.

---

## DRLS?

AC tests Perform an input voltage test



where

**level-select** is either H or L to specify the level to be measured  
**pass-value** is the pass limit, specified in millivolts  
**limit** either H or L to specify the limit to be used for a binary search.

The return value consists of **res-spec** which can be one of:

**EQ** The value could be measured  
**GT** if all tests failed, level select = H  
**GE** if all tests passed, level select = L  
**LE** if all tests passed, level select = H  
**LT** if all tests failed, level select = L

The **meas-value** parameter returns the actual measured value in millivolts.

## Errors

In a multi-mainframe system, only the master mainframe responds to this command.

**Pin-list** must contain pins with i, io, iol, ioh, or nc mode only.

If the value ranges are exceeded for **pass-value** or **limit**, no test will be run.

## Example

See Chapter 9 for an example of command usage.

## DRLV, DRLV?

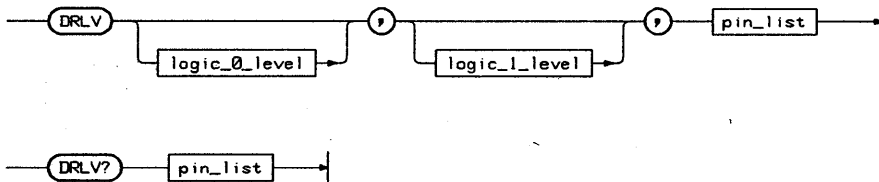
### Level Setup Driver levels

#### Note



This command is only included for compatibility with earlier software releases. Use the DRLX and DRLX? commands in place of these commands.

These commands are used to set up and query the voltage settings of the system driver channels (DUT inputs). The default values and setting ranges are shown below.



The following table shows the value ranges and default (power-on) values for the driver level settings.

**Table 12-1. Drive Level Settings**

Parameter	Unit	Range (200 MHz)	Range (50 MHz)	Default Value
logic-0-level	mV	-4000..7800	-2000..6500	-1700
logic-1-level	mV	-3800..8000	-2500..7000	- 800

There are swing limitations which mean that the minimum swing between **logic-0-level** and **logic-1-level** is 200 mV (500 mV for 50 MHz boards) and the maximum permitted swing is 8 V (7 V for the 50 MHz boards). Violations of these minimum or maximum swing values will cause a semantic error.

## **DRLV, DRLV?**

The optional parameters, `logic-0-level` or `logic-1-level` can be omitted. If this occurs, the firmware can auto-correct this parameter if it needs to. This may be necessary to ensure that programmed values are valid.

When a channel is configured to active termination (`TERM`), the drive part of the channel is forced to a static low level. The single level is programmed via the first parameter (`logic-0-level`). The second parameter is ignored and will be forced to an auto-corrected value depending on the required termination level. Querying the settings of such a channel returns the single level as the first parameter, the second parameter will be omitted.

The `DRLV?` command returns the high and low levels that have been set for the pins in `pin_list`.

## **Errors**

Errors will be generated for:

- low level out of range
- high level out of range
- swing violation
- attempting to program a non-applicable pin (configured as O, DC, or OFF)

## **Warnings**

Warnings will be generated if:

- Auto correction occurs
- Level programming exceeds the hardware specs

## **Example**

```
DRLV 0,5000,(A0,A1)
```

This example forces the 2 address channels (A0 and A1) to output 0 Volt if a digital 0 (low) and 5 Volt if a digital 1 (high) must be provided to the DUT.

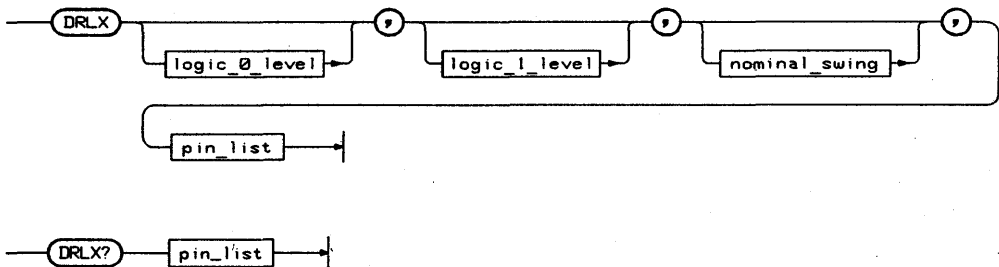
```
DRLV 0,,(TC)
```

If TC is configured as `TERM` (active termination), the `logic_1_level` would be ignored anyway so it's a good idea to omit this parameter, only the `logic_0_level` is of interest.

## DRLX, DRLX?

### Level Setup Driver levels

These commands are used to set up and query the voltage settings of the system driver channels (DUT inputs). The default values and setting ranges are shown below.



The following table shows the value ranges and default (power-on) values for the driver level settings.

**Table 12-2. Drive Level Settings**

Parameter	Implicit Unit	Range (D100, D200 & D400)	Range (D50)	Range (ihs pins)	Default
logic-0-level	mV	-4000..7800	-2000..6500	-4000..4800	-1700
logic-1-level	mV	-3800..8000	-2500..7000	-3800..5000	-800
nominal swing	mV	0..8000	0..7000	0..5000	

There are swing limitations which mean that the minimum swing between logic-0-level and logic-1-level is 200 mV (500 mV for 50 MHz boards) and the maximum permitted swing is 8 V (7 V for the 50 MHz boards). Violations of these minimum or maximum swing values will cause a semantic error.

The optional parameters, logic-0-level or logic-1-level can be omitted. If this occurs, the firmware can auto-correct this parameter if it needs to. This may be necessary to ensure that programmed values are valid.

## **DRLX, DRLX?**

When a channel is configured to active termination (**TERM**), the drive part of the channel is forced to a static low level. The single level is programmed via the first parameter (**logic-0-level**). The second parameter is ignored and will be forced to an auto-corrected value depending on the required termination level. Querying the settings of such a channel returns the single level as the first parameter, the second parameter will be omitted.

The **DRLX?** command returns the high and low levels that have been set for the pins in **pin\_list**.

## **Errors**

Errors will be generated for:

- low level out of range
- high level out of range
- swing violation
- attempting to program a non-applicable pin (configured as O, DC, or OFF)

## **Warnings**

Warnings will be generated if:

- Auto correction occurs
- Level programming exceeds the hardware specs

## **Example**

```
DRLX 0,5000,,(A0,A1)
```

This example forces the 2 address channels (A0 and A1) to output 0 Volt if a digital 0 (low) and 5 Volt if a digital 1 (high) must be provided to the DUT. The timing reference will be set to the 50% level.

```
DRLX 0,,, (TC)
```

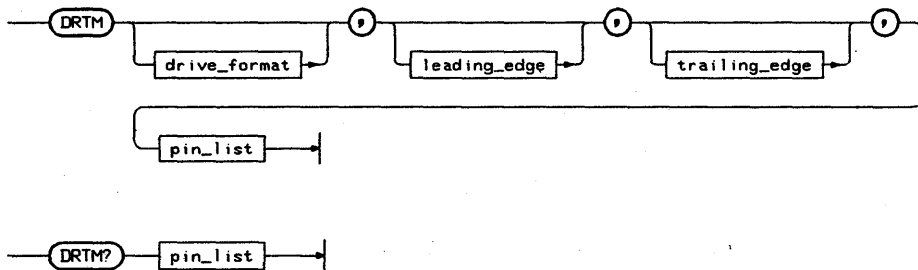
If TC is configured as **TERM** (active termination), the **logic\_1\_level** would be ignored anyway so it's a good idea to omit this parameter, only the **logic\_0\_level** is of interest.

## DRTM, DRTM?

### Timing Setup Driver timing

These commands set up and query the timing and signal formats of system driver outputs.

Each system channel can have its own individual format and edge timing settings.



`drive_format` can be one of:

- DNRZ - for delayed non-return to zero format
- RZ - for return-to-zero format
- R1 - for return-to-one format
- RC - for return-to-complement format
- RI - for return-to-inhibit format (50 MHz only)

Allowed settings for different system operating modes are shown in the table below.

All edges (driver and receiver) are programmed with the implicit unit ns, for example, `DRTM RZ, 0, 5.05, (Pin)` will set the machine channel signal Pin so that the leading edge is at 0 ns delay and the trailing edge at 5050 ps.

Programmed edges that do not have the necessary HW resources, for example, no tristate edge (TE) in the case of FD or MUX configured pins and DNRZ format or no TE in case of EDGE compare, are ignored and no warning message is generated.

## DRTM, DRTM?

Pins that are configured for serial scan are handled in the same way but you should remember that LSSD execution is possible only up to a frequency of 25MHz.

The DRTM? query returns the settings for the drive format and the leading and trailing edges for the named pins.

## Errors

Errors will be generated if:

- Edges not compatible with format and operation mode
- All range violations see table above
- Command not applicable for this channel
  - applied to O, TERM, DC, or OFF configured pin

## Autocorrection

Contextual edge mismatching generated by using optional edge parameters is autocorrected in the following manner:

If the value of a programmed edge exceeds the allowed range, the optional parameter is set to the maximum possible value. On the other hand, if a programmed value goes below the minimum, the optional parameter is autocorrected to the minimum possible value.

## Examples

Example 1

```
DFPN 1,,(NOT_CS)
CONF I,STD,,(NOT_CS)
SCLK INT,10,
DRTM RZ,6,15,(NOT_CS)
DRTM ,0,,(NOT_CS)
```

This would result in TE - LE being greater than (LE + period - 0.5 ns), so autocorrection sets TE = LE + period - 0.5 ns.

Querying the setting at this point with DRTM? (NOT\_CS)



would give DRTM RZ,0,9.5,(NOT\_CS).

**Example 2**

**DRTM DNRZ, 10, 15.50, (A0, A1)**

The above example forces the 2 address channels (tester driver channels A0 and A1) to output pattern in DNRZ format with a delay of 10ns.

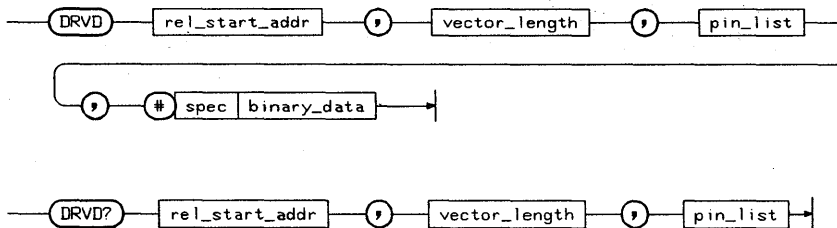
Note that the trailing edge is programmed to give timing information for the tristate data bit which could set the output to tristate at 15.50 if it is set.

---

## DRVD, DRVD?

### Vector Setup Driver data

These commands are used to transfer driver vector data for one pin from or to the host using a packed binary data format.



`rel_start_addr` is an integer in the range 0 .. highest vector memory address (65535 for 64k IO Boards) (`V_LAST`)

`vector_length` is an integer in the range 1 .. size of vector memory (65536 for 64k IO Boards) (`V_MEM`)

These commands are used to transfer vector data via the HP-IB. The data itself is transferred in an unreadable (non ASCII) format and will be transferred as an entire block for the single pin specified in `pin_list`.

The `pin_list` parameter must specify exactly one pin for the vector setup command DRVD and may hold any number of pins for DRVD?.

The # marks the start of the binary data block to transfer. This is immediately followed by the `spec` parameter, which defines the number of bytes to transfer. This parameter follows the following rules: The first digit specifies the number of digits the length specifier consists of. The specifier itself has to be transferred immediately after the first `spec` digit. The vector bytes are transferred immediately after the `spec` parameter.

Note that the number of bytes has to match the length specifier value. No white space is allowed between the elements of the length specifier.

If the number of vectors to be downloaded exceeds the vector memory size, the remaining bytes are ignored and a warning message will be issued.

The vector transfer starts at the byte location of the vector specified by the previously defined vector start address and the `rel_start_addr` parameter (which is regarded as an offset value, added to the vector start address).

The vector base address can be altered by the VESA command.

Note that all vectors affected by the bytes sent will be overwritten. To avoid erroneous vector ram contents, it is recommended to set both the vector start address and the `rel_start_addr` to multiples of 4 (because one byte specifies four vectors).

If the requested download operation was successful, the first free vector address will be updated to show the first unused vector ram location.

This address can also be altered by the VEFA command.

At power on the entire driver vector memory contents will be initialized to LO (no tristate) all channels.

In addition, the vector start address and the first free vector address are both set to 0.

## **Errors**

Errors will be generated if a parameter is out of range. This can be caused by:

- Vector length exceeds data block size
- Invalid vector length (DRVD?)
- Vector start address exceeds vector memory limits (DRVD)
- More than one pin in `pin_list` (DRVD)
- Execution conflicts with current configuration for `pin_list` (DRVD)
- DMA transfer failed or aborted (DRVD, DRVD?). If this occurs, the vector memory contents may be partially overwritten if this error occurs.

## **Warnings**

A warning will be generated if vector data has been truncated (DRVD).

## DRVD, DRVD?

### Example

In this example, the vector ram of the 200 MHz (MUX) input pin A0 is loaded from vector address 0 to 15 with the first 4 bytes of each binary 1K data block. Bytes 1 through 4 are loaded to the master channel's vector ram, bytes 1025 through 1028 are loaded to the slave channel's vector ram. All other bytes are discarded and will have no effect. The vectors 0, 1, 14 and 15 will be overwritten. The first free vector address `ffvad` will be set to 14.

```
CONF I, MUX, P, (A0)
```

```
VESA 2
```

```
DRVD 0, 12, (A0), #420481 - followed by 2 KByte of binary data
```

```
VEFA? -> VEFA 14
```

<sup>1</sup> # specifies the start of a binary block, 4 specifies the number of digits for the length specifier, 2048 is the length of data in bytes.

---

### Note



Vector data cannot be edited or generated using a text editor. Use the EDA Interface or Vector Setup editor to generate the binary data required.

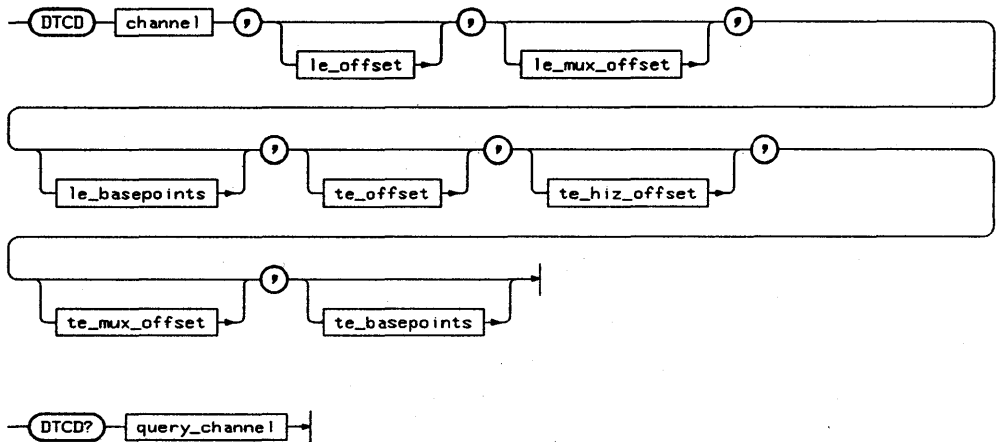
---

---

## DTCD, DTCD?

### Calibration Driver timing

These commands are used to modify and read driver timing calibration values.



where **channel** is the sequential channel number defined with the DFPN command.

---

**Note** There are ten values returned for **le\_basepoints** and **te\_basepoints**.



The values for the offsets and gains and their implied units are shown below.

## DTCD, DTCD?

Timing Parameter Value Ranges

			min	max	unit
Gain	Channel		29.41	39.22	ps/LSB
Offset	Leading Edge	Standard	0.0	+16.0	ns
		MUX Mode	-5.0	+16.0	ns
	Trailing Edge	Standard	-1.0	+16.0	ns
		MUX Mode	-6.0	+16.0	ns
Tristate Edge		0.0	+16.0	ns	

## Errors

An error will be generated for the following reasons:

- Sequencer not idle
- Gain value out of range
- Trying to set or read receiver calibration data for an I channel

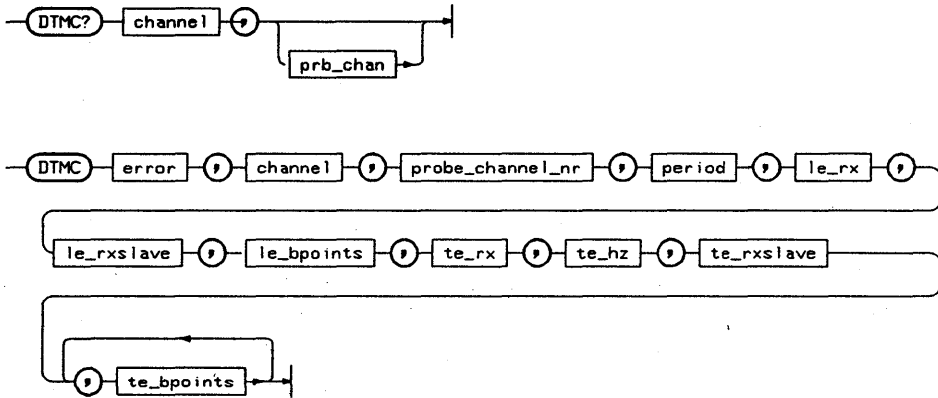
## Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## DTMC?

### Calibration Driver timing calibration

Performs driver timing calibration of the specified pin using the given calibration probe channel (default is channel 1).



where

**channel** is the channel number to be calibrated  
**prb\_chan** is the probe channel to be used. Default is 1.

The returned values for this command are:

<b>error</b>	an integer in the range 0 .. 99999 indicating a calibration error code. Value 0 indicates no error.
<b>channel</b>	the channel being calibrated
<b>probe-channel- nr</b>	the cal probe channel used for the calibration
<b>period</b>	the period used in nanoseconds
<b>le-rx</b>	Leading edge return to x format - master channel
<b>le-rxslave</b>	Leading edge return to x format - slave channel
<b>le-bpoints</b>	Leading edge fine delay basepoints (10 values)
<b>te-rx</b>	Trailing edge return to x format - master channel
<b>te-hz</b>	Trailing edge return to high impedance - master channel
<b>te-rxslave</b>	Trailing edge return to x format - slave channel

## **DTMC?**

**te-bpoints**

**Trailing edge fine delay basepoints (10 values)**

## **Example**

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.



---

## DTST

**Utility** Perform dc measurement

```
DTST set_id pin_list
```

This command performs a dc measurement on the pins in `pin_list` using the dc parameter set (set by DPAR) specified in `set_id`.

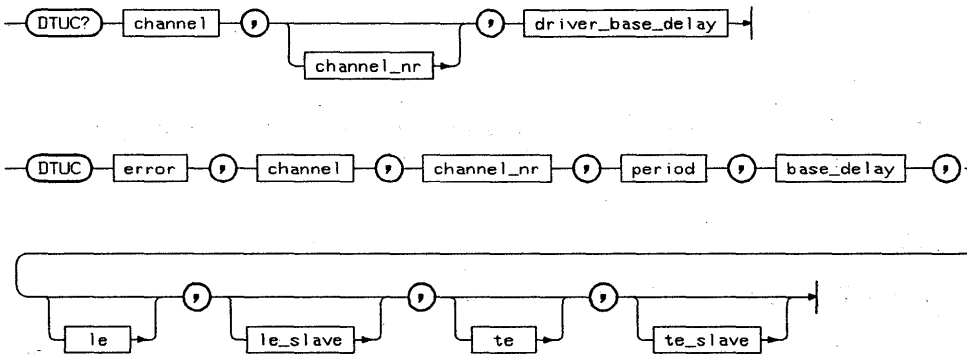
### Example

See Chapter 7 for more details of the use of this command.

---

## DTUC?

**Calibration** Generate user calibration values for a driver



where

`channel` is the channel number to be calibrated  
`channel_nr` is the probe channel to be used. Default is 1.

`driver-base-delay`  
The returned values for this command are:

`error` an integer in the range 0 .. 99999 indicating a calibration error code. Value 0 indicates no error.

`channel` the channel being calibrated

`probe-channel- nr` the cal probe channel used for the calibration

`period` the period used in nanoseconds

`base-delay`

`le` Leading edge correction - master

`le-slave` Leading edge correction - slave

`te` Trailing edge correction - master

`te-slave` Trailing edge correction - slave

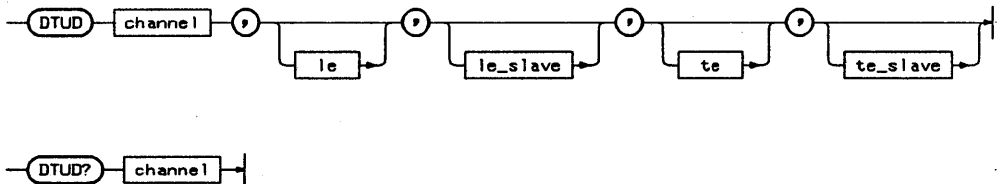
## Example

For more information on user calibration, refer to Chapter 10.

---

## DTUD, DTUD?

**Calibration** Transfer user calibration values for a driver



where

<b>channel</b>	channel whose user calibration data is to be downloaded
<b>le</b>	Leading edge correction in nanoseconds - master
<b>le-slave</b>	Leading edge correction in nanoseconds - slave
<b>te</b>	Trailing edge correction in nanoseconds - master
<b>te-slave</b>	Trailing edge correction in nanoseconds - slave

### Example

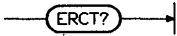
Refer to Chapter 10 and Servicing the HP 82000 for more information about user calibration.

---

## ERCT?

**Test Results** Read number of errors in Error Map

ERCT? returns the number of errors in the error map.



This command return the the number of errors detected in the last test. This number is an integer in the range 0 .. **size-of-error-map**

This command is only valid for compare mode.

## Errors

An error will be generated for the following reasons:

- Parameter range errors
- Command not allowed in acquisition mode
- No data available

## Example

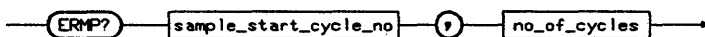
<code>ftst?</code>	<i>Performs a functional test and returns</i>
<code>FTST F</code>	<i>if the test fails</i>
<code>erct?</code>	<i>Returns the number of errors detected</i>
<code>ERCT xx</code>	<i>xx is base 10</i>

---

## ERMP?

### Test Results Upload Error Map

ERMP? returns the contents of the error map in a binary format.



This command returns

**sample\_start\_cycle\_#** is in the range 1 .. size-of-error-map -8.

**#\_of\_cycles** is in the range 1 .. size-of-error-map.

**spec** is in the range digit{ digit}

**#\_of\_cycles** is in the range 1 .. size-of-error-map.

The command is only valid for compare mode and only applicable to the master mainframe.

The transfer command ERMP sets up the mainframe to transfer a large amount of data via the HP-IB bus to be displayed in the Error Map results display. The data consists of full 8-bit bytes in an unreadable (non ASCII) format and will be transferred in one block for all the received data specified.

The '#' marks the start of the binary data.

**spec** defines the number of transferred bytes in the following manner: the first <digit> specifies the number of valid number digits, immediately followed by the digits defining the number of transferred bytes, followed by the binary data. No white space is allowed after the '#' sign!

The **sample\_start\_address** and the (**sample\_start\_address** + **#\_of\_cycles**) will be rounded to the next byte boundaries for binary transfers.

Note that the error map will report only one error per machine cycle. Due to this cycle oriented error map, two errors occurring in the same machine cycle (but in distinct user cycles) are sampled as a single error and the error count (accessible using the ERCT command) is incremented by one (instead of two).

This command works on byte boundaries

## **ERMP?**

### **Errors**

An error will be generated for the following reasons:

- Parameter range errors
- Command not allowed in acquisition mode
- No data available

---

## ERRS?

### Error Handling Interrogate hardware

This command is used to interrogate the hardware to see if an error has been detected.



Sending this command will result in the following message being output

```
ERRS error_code , command , pin_list
```

where

`error_code` is an integer value. Refer to Chapter 9 for more information.

`command` is the command that caused the error or 0 if no error has been detected.

`pin_list` will contain all 'bad pins', that is, the pins which caused an execution error, or those changed by an Autocorrection. If the error is not related to a `pin_list` the field will contain an empty `pin_list`.

The ERRS? query reads the contents of the Error Queue. The mainframe responds with all the errors queued so far and then clears the error queue.

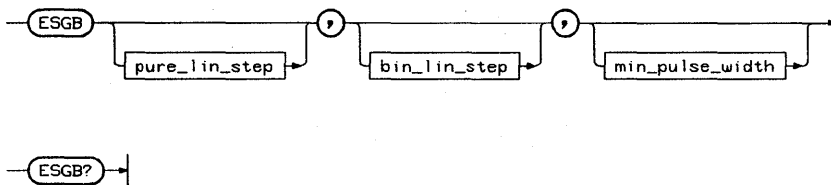
### Example

See Chapter 9 for more information on this command.

---

## ESGB, ESGB?

AC tests Define edge search parameters



where

- pure\_lin\_step** the step width to be used for a linear edge search in nanoseconds. See RCES?, TSUP?, and THLD? If this is negative, an infinite step width is used (see RCES?).
- bin\_lin\_step** the step width used for a linear/binary search in nanoseconds.
- min\_pulse\_width** the minimum pulse width to be used for an input pin timing measurement. (See TSUP? and THLD?)

The query ESGB? returns the current settings.

### Power On Defaults

At power-on, the current settings are:

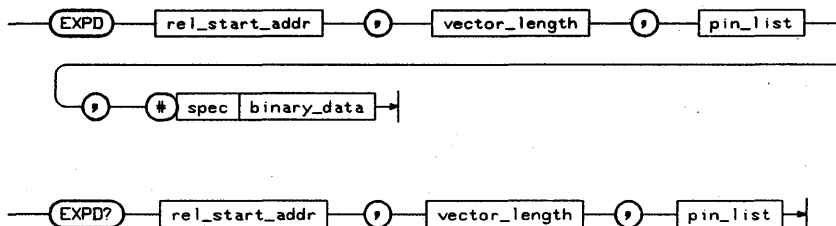
ESGB -1,2,2.5	<i>D100, D200 and D400</i>
ESGB -1,4,5	<i>D50</i>



## EXPD, EXPD?

### Vector Setup Transfer receiver data

These commands are used to transfer receiver vector data for one pin from or to the host using a packed binary data format.



The vector data transfer command EXPD and the corresponding query EXPD? are used to transfer large size vectors via the HP-IB. The data itself is transferred in an unreadable (non ASCII) format and will be transferred as an entire block for the specified pin.

The `pin_list` parameter must specify exactly one pin for the setup command EXPD while the `pin_list` for the query EXPD? may hold any number of pins.

The `#` marks the start of the binary data block to transfer. It will be immediately followed by the `spec` parameter, which defines the number of bytes to transfer. This parameter follows the following rules: The first digit specifies the number of digits the length specifier consists of. The specifier itself has to be transferred immediately after the first `spec` digit. The vector bytes are transferred immediately after the `spec` parameter.

Note that the number of bytes has to match the length specifier value. No white space is allowed between the elements of the length specifier.

The vector data block itself will be loaded to the vector ram unchanged. Therefore the contents of the data stream depends on the hardware vector ram organization. Refer to the Vector Data Format section at the beginning of this chapter for a detailed explanation of the data block format used for the various pin configurations.

## **EXPD, EXPD?**

If the number of vectors to be downloaded exceeds the vector memory size, the remaining bytes are ignored and a warning message will be issued.

The vector transfer starts at the byte location of the vector specified by the previously defined vector start address and the `rel_start_addr` parameter (which is regarded as an offset value, added to the vector start address).

The vector base address can be altered by the VESA command.

Note that all vectors affected by the bytes sent will be overwritten. To avoid erroneous vector ram contents, you should set both the vector start address and the `rel_start_addr` to multiples of 4 (because one byte specifies four vectors).

If the requested download operation was successful, the first free vector address will be updated to show the first unused vector ram location.

This address can also be altered by the VEFA command.

At power on the entire receiver vector memory contents will be initialized to X and the vector start address and the first free vector address are both set to 0.

## **Errors**

Errors will be generated if:

- A parameter is out of range
  - Vector length exceeds data block size (EXPD)
  - Invalid vector length (EXPD?)
  - Vector start address exceeds vector memory limits (EXPD)
- More than one pin in `pin_list` (EXPD)
- Tester is not in real-time compare mode (EXPD, EXPD?)
- Execution conflicts with current configuration for `pin_list` (EXPD)
- DMA transfer failed or aborted (EXPD, EXPD?). In this case the vector memory contents may be partially overwritten if this error occurs.

## Warnings

A warning will be generated if vector data has been truncated (EXPD)

## Example

In the following example, the vector ram of the 200 MHz (MUX) input pin A0 is loaded from vector address 0 through 15 with the first 4 bytes of each binary 1K data block. Bytes 1 through 4 are loaded to the master channel's vector ram, bytes 1025 through 1028 are loaded to the slave channel's vector ram. All other bytes are discarded and will have no effect. The vectors 0, 1, 14 and 15 will be overwritten. The first free vector address `ffvad` will be set to 14.

```
CONF I, MUX, P, (A0)
```

```
VESA 2
```

```
EXPD 0, 12, (A0), #420481 followed by 2 KByte of binary data
```

```
VEFA? now returns VEFA 14
```

<sup>1</sup> # specifies the start of a binary block, 4 specifies the number of digits for the length specifier, 2048 is the length of data in bytes.

---

### Note



Vector data cannot be edited or generated using a text editor. Use the EDA Interface or Vector Setup editor to generate this binary data.

---

---

## FTCK?

**AC Tests** Run a functional test and not stop clock



This command can be used when you have a vector pattern that exceeds the length of the pattern memory. Unlike the FTST? command, the FTCK? command does not stop the clock before starting the sequencer. In addition, the error flags (accessible with the CHER? command) do not get reset and will hold the total number of errors when the test finishes.

---

### Note



The FTCK? command is meant to be used in real-time compare mode. If it is used in data acquisition mode, the acquired data may be invalid.

---

### Example

The following example illustrates the use of the FTCK? command.

```
DRVD 0,65536,(Din),#516384....    load first part of vectors
EXPD 0,65536,(Dout),#516384....
SQL "DEFAULT"                    perform functional test

FTST?
ERCT?                             read error counter for first part of
test

DRVD 0,65536,(Din),#516384....    load second part of vectors
EXPD 0,65536,(Dout),#516384....    perform functional test without stop-
ping the clock

FTCK?
ERCT?                             read error counter for second part of
test

CHER?                             read channel error flags for complete
test
```

---

## FTST?

**AC tests** Perform functional test

**FTST? AC tests** Perform functional test



This command will perform a functional test with the current settings.

### Example

**ftst?**     *Performs a functional test and returns*  
**FTST F**   *if the test fails*

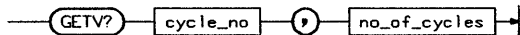
The number of errors can be read by using ERCT?

---

## GETV?

**Test Results** Vector and sequencer line number

GETV? returns the vector and sequencer instruction number for the given cycles. Although the number of cycles to the logical 0 address is reported.



This results in the following message being sent by the system.

GETV cycle\_#, vector\_#, instr\_#, instr\_type, rep\_factor where

#_of_cycles	is in the range 1 .. highest vector memory address
vector_#	is in the range 0 .. size of vector memory
instr_#	is in the range 0 .. 2 <sup>11</sup>
instr_type	is one of INC, HOLD, SCAN, or DEAD
repeat_factor	is in the range 1 .. last cycle number
cycle_#	is in the range 0 .. last cycle number
#_of_cycles	is in the range 1 .. highest vector memory address

The GETV? query returns the cycle - vector relationship in a compressed form. It reports the cycle number after the logical 0 address, the vector number, the sequencer instruction number and gives the information how the next cycles were generated by giving the mode how the next cycle was generated and how often (see examples).

### Errors

An error will be generated for the following reasons:

- Parameter range errors
- No data available

**Example**

In this example of part of a vector sequence, the cycle-vector relationship will be reported as shown below.

cycle #	vector #	sequ	instr #	instr	type
800	??				??
more lines					
900	??		0		inc
more lines					
1000	2		1		hold
1001	2		1		hold
1002	2		1		hold
1003	2		1		hold
1004	BREAK		2		dead cycle
1005	4		2		inc
1006	5		2		inc
1007	6		2		inc
1008	7		2		inc
1009	8		2		inc
1010	9		2		inc
1011	10		2		inc

Sending GETV? 800, 210

will result in

GETV	800,,,100
GETV	900,,0,INC,100
GETV	1000,2,1,HOLD,4
GETV	1004,-1,2,DEAD,1
GETV	1005,4,2,INC,6

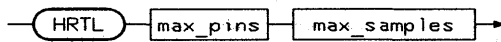
---

## HRTL?

**Test Functions** Read limitations imposed on the High Res. Timing Diagram by hardware.



Returns the string:



Where:

**max\_no\_pins** is the maximum number of pins which can be measured in parallel, by a single HRTM command.

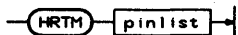
**max\_samples** is the maximum number of samples that can be measured in parallel, by a single HRTM command.



---

## HRTM

**Test Functions** Run high res timing diagram



### Errors

- Pin not applicable
- Measurement failed
- Too many pins
- Invalid tester mode

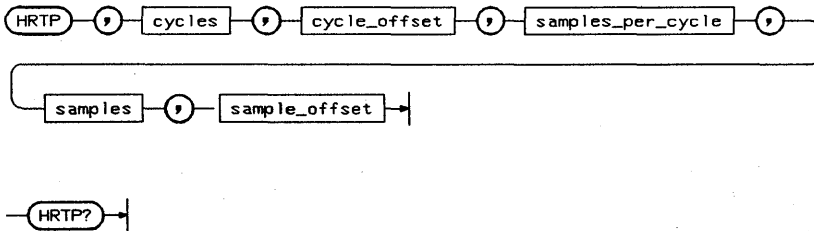
### Example

Refer to Chapter 7 for an example of the use of this command.

---

## H RTP, H RTP?

Test Functions Setup high res timing diagram



### Errors

Value range errors.

### Example

Refer to Chapter 7 for an example of the use of this command.

---

## HRTR?

**Test Functions** Read high res timing diagram



This command returns the data to be displayed in the Timing Diagram results display.

The data is in an unreadable format, similar to the vector transfer commands.

### Example

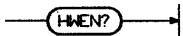
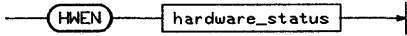
Refer to Chapter 7 for an example of the use of this command.

---

## HWEN, HWEN?

**Status** Hardware Status Enable Register

These two commands set and read the Status Enable Register of the Hardware Status.



### Example

Refer to Chapter 9 for more details.

---

## HWET?

**Status** Hardware Event Register

This command reads the Event Register of the Hardware Status Register.



### Example

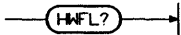
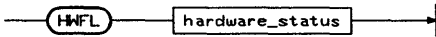
Refer to Chapter 9 for more details.

---

## HWFL, HWFL?

### Status Hardware Status Register

These commands set and define the falling transition event generation of Hardware Status Register.



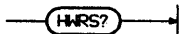
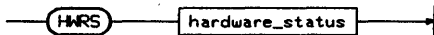
### Example

Refer to Chapter 9 for more details.

## HWRS, HWRS?

### Status Hardware Status Register

These commands define and read the rising transition event generation of Hardware Status Register.



### Example

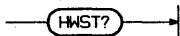
Refer to Chapter 9 for more details.

---

## HWST?

### Status Hardware Status

This command reads the Hardware Status of the Hardware Status Register.



The bits in the Hardware Status Register have the following meaning: (This is the meaning, when the bit is set; the meaning when the bit is cleared is the opposite)

- [1] Relays active, the relays of connected channels are closed.
- [2] Channel drivers active and driving programmed levels.
- [3] clock active (running)
- [4] Sequencer busy (not BREAK), armed or active, test has not finished
- [5] Sequencer active (not ARMED and not BREAK))

### Example

Sending HWST? while the sequencer is in BREAK will return 4 (bit3). After sending sqst off, HWST? will return 0.



---

**IFC**

**HP-IB Commands Interface Clear**



**IFC**

**Example**

Refer to the BASIC-UX Interfacing Techniques manual for more information on this command.

---

## ITMC?

**Calibration** Initialize calibration process

ITMC? cal\_period

This command performs timing calibration of the calibration probe and sets the system into calibration mode. The given calibration period is used for all subsequent calibration commands. If this command is sent with the `u` option, a user calibration will be started.

This command returns

- a calibration error number in the range 0 .. 999999, 0 indicates no error
- the number of usable calibration probe channels
- the period in use
- the round-trip delay measured
- leading and trailing edge basepoints

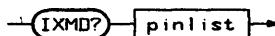
### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

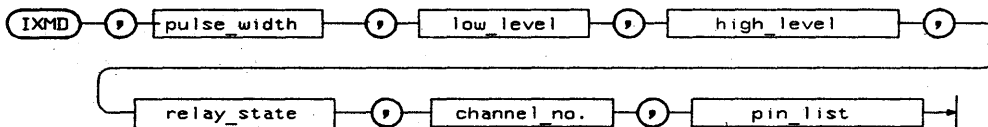
---

## IXMD?

**Configuration List** configuration of IX mode pins.



**Returns:**



**where:**

- pulse\_width** is the programmed pulse width of the 400 MHz RZ channel (in ns). A value of -1 shows that the channel is in AC feed-through mode.
- low\_level** is the programmed low level of the High Speed Width Generator, HSWG (in mV).
- high\_level** is the programmed high level of the High Speed Width Generator, HSWG (in mV).
- relay\_state** is the state of the HSWG relays:
- 0 = disconnected (pin is inactive)
  - 1 = connected (pin is active)
  - 2 = non-inverted output is connected to PMU
  - 3 = inverted output is connected to PMU
  - 6 = both HSWG outputs are connected to PMU
- channel\_no** is the tester channel to which the IX pin is connected.

---

## LDHW, LDHW?

**High Throughput Tests Load** the hardware with a parameter set which was previously saved with PSAV.

LDHW param\_set\_id

LDHW? param\_set\_id

where:

`param_set_id` is the id number (1 to 64) of the parameter set to be loaded.  
The id number "0" loads the hardware with the *foreground* settings.

The query LDHW? returns the id number of the parameter set which is presently loaded in the hardware.

### Example

To load the parameter set with the id number 24 into the hardware, you enter:

LDHW 24

To find out the id of the parameter set which is presently loaded in the hardware, you can enter the query:

LDHW?

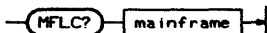
If parameter set 24 is still loaded, the returned string would be:

LDHW 24

---

## MFLC?

**Calibration** Perform mainframe level calibration



The mainframe level calibration command MFLC? returns the clock driver and cal-receiver calibration values. These values must be downloaded (see MLCD) prior to a subsequent timing calibration.

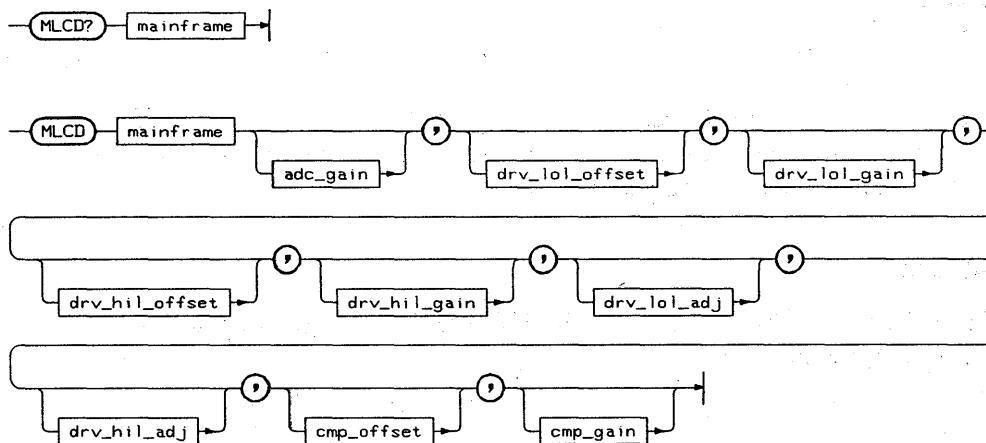
### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about the use of this command.

---

## MLCD, MLCD?

**Calibration** Read and modify mainframe level calibration



The mainframe level calibration values are accessible with the MLCD command. One set of calibration data is held for each mainframe. The calibration values include the clock driver data (drv-lol-offset, drv-lol-gain, drv-hil-offset, drv-hil-gain, drv-lol-adj, drv-hil-adj), the calibration comparator data (cmp-offset, cmp-gain), and the clock board ADC gain (adc-gain).

### Errors

An error will be generated for the following reasons:

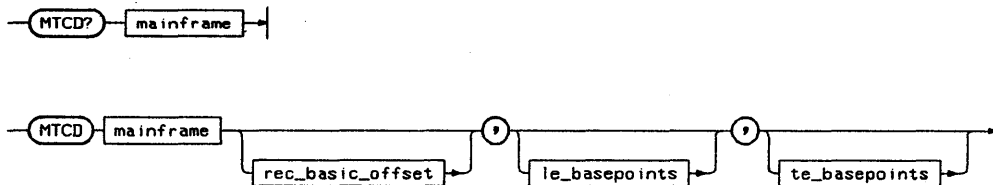
- error

### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## MTCD, MTCD?

**Calibration** Read or modify mainframe timing data



This command is used to read and modify timing calibration data for a mainframe.

### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

---

## PASS?

**Test Results** Last test result

PASS? returns passed / failed information for the last test.



returns either P or F depending on whether the last test passed or failed.

The command is only valid for compare mode.

## Errors

An error will be generated for the following reasons:

- Command not allowed in acquisition mode
- No data available

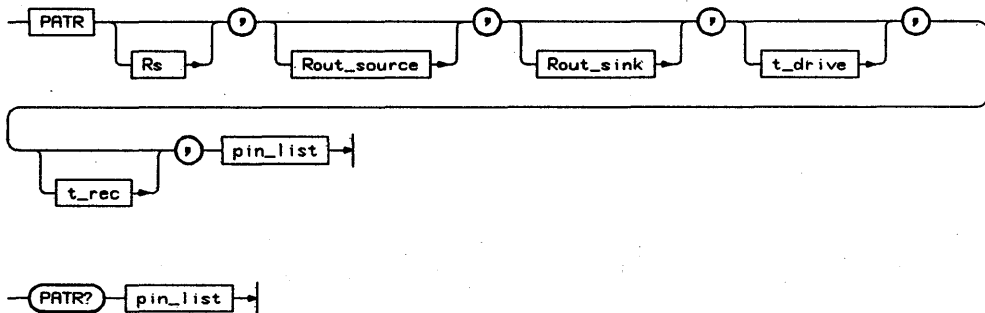
## Example

Sending PASS? after a test has been performed returns the string PASS F or PASS P depending on whether the test failed or passed.



## PATR, PATR?

**Attributes** Set or read pin attributes



<b>Rs</b>	is a real in the range 0 .. 6553.5 with the implied units Ohm
<b>Rout-source</b>	No longer used. Leave this parameter blank.
<b>Rout-sink</b>	No longer used. Leave this parameter blank.
<b>t-drive</b>	is a real in the range -32.767 .. +32.767 with the implied units nanoseconds
<b>t-rec</b>	is a real in the range -32.767 .. +32.767 with the implied units nanoseconds

### Errors

An error will be generated for the following reasons:

- Parameter out of range
- Attempting to program a non-applicable pin (DC or OFF)

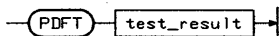
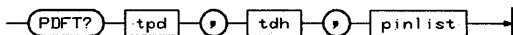
### Example

**PATR?** (⓪) returns the current settings of pin attributes for all configured pins. Files containing this data and system attribute data (see SATR) should be written using the Pin Attributes setup window, or using a text editor and stored in the `pin_attributes` directory for the DUT.

---

## PDFT?

**AC tests** Perform a propagation delay/hold time test



where

**tpd** propagation delay pass value in nanoseconds

**tdh** data hold time pass value in nanoseconds

**pin\_list** pins to be tested

**test\_result** P = passed; F = failed.

## Errors

An error will be generated for the following reasons:

- Non-applicable pins

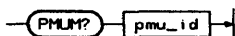
## Example

PDFT? 10,2,(Q0,Q1,Q2,Q3) will check that the propagation delay is less than 10 nanoseconds and the data hold time less than 2 nanoseconds for the pins Q0 to Q3.

---

## PMUM?

DC tests Read PMU state



where `pmu_id` has the form `Pmp` where `m` is the mainframe whose PMU is being read, and `p` is the PMU channel.

Sending this command results in the following string being sent by the hardware.

`PMUM pmu_id, pmu_state, u_read, i_read`

where

<code>pmu_id</code>	is the PMU being read as described above
<code>pmu_state</code>	is the current PMU state in an integer in the range 0 .. 31 that must be read in binary format: <ul style="list-style-type: none"> <li>Bit 5 - Voltage overflow if set</li> <li>Bit 4 - Current overflow if set</li> <li>Bit 3 - Measurement unstable if set</li> <li>Bits 2 and 1 - limit detection               <ul style="list-style-type: none"> <li>00 - not used</li> <li>01 - Negative current limit</li> <li>10 - Positive current limit</li> <li>11 - Voltage limit</li> </ul> </li> </ul>
<code>u_read</code>	measured voltage in millivolts
<code>i_read</code>	measured current in microamperes

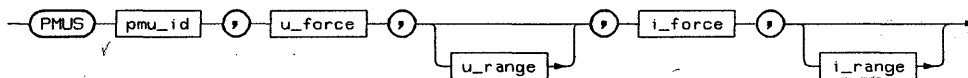
### Example

Sending `PMUM? P12` results in the output string `PMUM P12,1,-5.012,0` which indicates the state of the second PMU in mainframe 1.

---

# PMUS

## DC tests Set up PMU



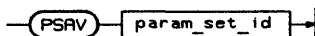
where

- pmu\_id** is the PMU being read. It has the form Pmp where m is the mainframe whose PMU is being read, and m is the PMU channel.
- u\_force** the force voltage in millivolts. Must be in the range -20000 to +20000.
- u\_range** the voltage range to be used. This has an effect on the rounding that will occur to the force value being programmed.
- U2E3  $\pm 2000$  mV
  - U1E4  $\pm 10000$  mV
  - U2E4  $\pm 20000$  mV
- AUTO autoranging - will use the smallest range possible to force u\_force.
- i\_force** the force current in microamperes. Must be in the range 0 to 200000.
- i\_range** the current range to be used. The resolution of a measurement is fixed at 1/4000 of the specified range.
- I2E0 0.001  $\mu$ A .. 2  $\mu$  A
  - I2E1 0.01  $\mu$ A .. 20  $\mu$  A
  - I2E2 0.1  $\mu$ A .. 200  $\mu$  A
  - I2E3 1  $\mu$ A .. 2000  $\mu$  A
  - I2E4 10  $\mu$ A .. 20000  $\mu$  A
  - I2E5 100  $\mu$ A .. 200000  $\mu$  A
  - I5E5 200  $\mu$ A .. 500000  $\mu$  A
- AUTO autoranging - uses the lowest range possible for the required current

---

## PSAV

**High Throughput** Save the hardware state as a set of ac test parameters (a *parameter set*) in RAM;



The PSAV command saves the *foreground* settings of the tester hardware, into RAM, and assigns an id number (between 1 and 64) to enable these settings to be quickly reloaded during a test.

The foreground settings are the values that you enter using the interactive windows, or via the other HP-IB commands.

---

### Note

After a system reset, all 64 parameter sets are loaded with the foreground values.



---

### Example

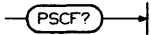
To save the present foreground settings as a parameter set with the id number 24, you can enter the instruction:

**PSAV 24**

---

## PSCF?

**Pin Configuration Read DPS channels**



This command reads the number of channels available in the DPS. For each DPS unit fitted to the system, this query returns the string:

**PSCF dps\_name, nr\_of\_channels**

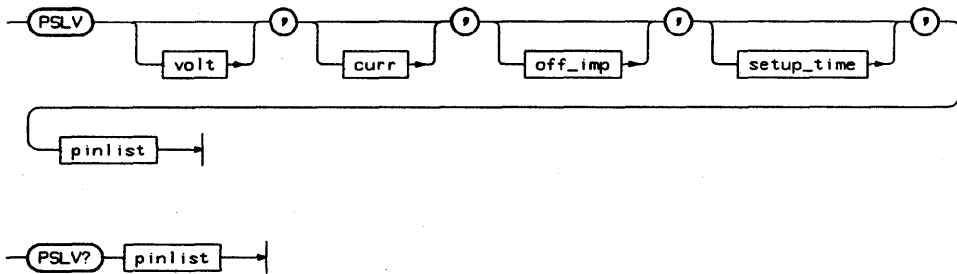
where

**dps\_name** is the model number of the installed DPS  
**nr\_of\_channels** is the number of outputs available

---

## PSLV, PSLV?

### Level Setup Read and modify DPS settings



These commands are used to read and modify DPS channels that have previously been defined with a DFPS command.

**volt**                    real number in the range 0 to 40000 to specify the output voltage in millivolts.

---

#### Note



Maximum voltage output is limited to 40 Volt for power supplies with higher levels available.

**curr**                    current limit in Amperes - maximum depends on power supply in use.

**off\_imp**                either HIZ or LOZ to specify high or low impedance in off state.

**setup\_time**           specifies an additional setup time between applying power and starting a test. Implied units are milliseconds.

#### Example

Entering

PSLV -5.200,0.500,hiz,15,(Vee)

## **PSLV, PSLV?**

sets the previously defined power supply pin **Vee** to a level of -5.2 Volt and a current limit of 0.5 A. When the test system is in the disconnected state, the power supply will be set to its minimum output current. When the power supply is connected or disconnected, there will be an additional delay of 15 milliseconds before the next command is executed.



---

## PSME?

**DC measurements** Perform measurement with DPS

`PSME? pin_list`

Sending this command will result in the following string being output for each pin in `pin_list`.

**PSME status, voltage, current, pin**

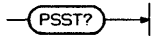
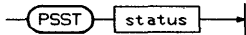
where

<b>status</b>	is either CV for constant voltage or CC for constant current.
<b>voltage</b>	real number indicating DPS output voltage with polarity as given in DFPS command.
<b>current</b>	real number indicating current flow at DPS output.
<b>pin</b>	DPS pin being read

---

## PSST, PSST?

**Utility** Set and read state of DPS relays



The PSST command switches the DPS relays to connect the DPS (state=ON) or disconnect the DPS (state=OFF). The DPS settings will be as set up with the relevant PSLV commands.

PSST returns the current state of the DPS relays.

### Errors

Parameter error

No power supplies defined

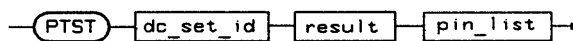
### Warnings

PSST OFF and a DPS output is in CC mode.

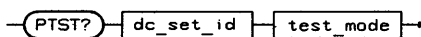
PSST OFF and the power supply is in the power on state.

## PTST?

High Throughput Tests Execute a PMU test from pre-saved dc parameters that you have previously entered with the DFVM and DFCM commands.



Returns the parameters:



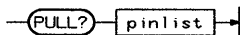
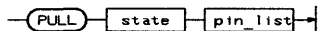
where:

- **dc\_test\_set** is the id number of the dc parameter set that has been used in the test;
- **mode** is either:
  - **gpf** (global pass/fail)—for a single pass/fail result;
  - **ppf** (per pin pass/fail)—for a pass/fail result per pin;
  - **pval** (per pin value)—for a value result per pin.
- **result** is either P for a passed test, F for a failed test, or the measured value;
- **pin list** is a list of the pins to which *result* applies. If the test mode **gpf** was chosen for the test, then *result* applies to all the pins, and *pin list* is returned empty.

---

## PULL, PULL?

Level Setup Set/read driver pull-up or pull-down resistor (D50 only).



where:

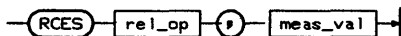
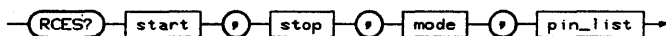
state can be :

- UP - to connect a 1 K $\Omega$  pull-up resistor (from the driver output to +5V.)
- DOWN - to connect a 1 K $\Omega$  pull-down resistor (from the driver output to 0V.)
- INT - to connect 1 K $\Omega$  resistors from the driver output to +5V and 0V.
- OFF - no pull-up or pull-down resistors connected.

---

## RCES?

**AC tests** Perform linear search



This command performs a propagation time/data hold time measurement using a linear search pattern.

**start** is a real number with implied units nanoseconds used to define the start of a window

**stop** is a real number with implied units nanoseconds used to define the end of a window

**mode** either L or LB to specify a linear or linear/binary search sequence

**pin\_list** the pins on which the measurement is to take place

### Errors

An error will be generated for the following reasons:

- Non-applicable pin

---

## RCLC?

**Calibration** Perform receiver level calibration

— RCLC? — query\_channel —

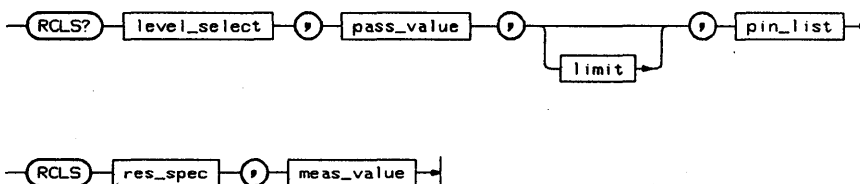
### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

---

## RCLS?

**AC tests** Perform an output voltage test



where

**level-select** is either H or L to specify the level to be measured  
**pass-value** is the pass limit, specified in millivolts  
**limit** either H or L to specify the limit to be used for a binary search.

The return value consists of **rel-spec** which can be one of:

<b>EQ</b>	The value could be measured
<b>GT</b>	if all tests failed, level select = H
<b>GE</b>	if all tests passed, level select = L
<b>LE</b>	if all tests passed, level select = H
<b>LT</b>	if all tests failed, level select = L

The **meas-value** parameter returns the actual measured value in millivolts.

### Errors

In a multi-mainframe system, only the master mainframe responds to this command.

**Pin-list** must contain pins with o, io, iol, ioh, or nc mode only.

If the value ranges are exceeded for **pass-value** or **limit**, no test will be run.

### Example

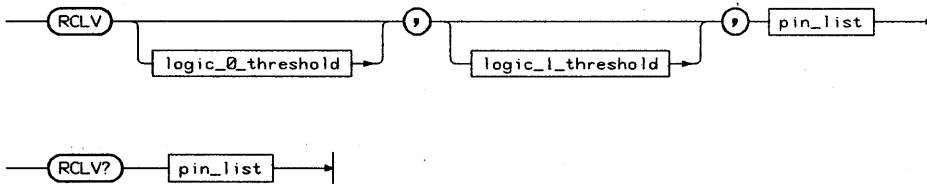
See Chapter 9 for an example of command usage.

---

## RCLV, RCLV?

### Level Setup Receiver Levels

These commands are used to set up and query the threshold settings of the system receiver channels (DUT outputs). The default values and setting ranges are shown below.



**Table 12-3. Receiver Threshold Settings**

Parameter	Implicit Unit	Range (D100,D200,D400)	Range (D50)	Default Value
logic-0-threshold	mV	-4000..7994	-2000..6950	-1.470
logic-1-threshold	mV	-3994..8000	-2010..7000	-1110

As in the driver level commands, there is a swing limitation such that there must be a minimum swing between `logic-0-threshold` and `logic-1-threshold`. The minimum swing limitation depends on the defined pin's attributes. The minimum threshold swing is 6 mV (10 mV for 50 MHz boards). See the pin attribute chapter for the relationship between the pin and comparator threshold values.

In the case of 200 MHz operation\_mode the necessary single threshold is set by the `logic_1_threshold` parameter. The first parameter `logic_0_threshold` is ignored and silently autocorrected to the necessary value depending on the given single threshold. Querying such a configured pin returns the single threshold with the `logic_1_threshold` parameter and the first parameter `logic_0_threshold` will be omitted.



## **Errors**

Errors will be generated for:

- low level out of range
- high level out of range
- swing violations
- attempting to program non-applicable pins (configured as I, DC, OFF)

## **Warnings**

A warning will be generated if:

- auto-correction has occurred
- level programming exceeds the hardware specifications

## **Example**

**RCLV 400, 4800, (D0, D1)**

All levels received at D0 and D1 (O pins) lower than 0.4 Volt will be recognized as a digital 0 (low) and greater than 4.8 Volt as a logical 1 (high). A stable level in between these two levels will be interpreted as intermediate.

---

## RCMD, RCMD?

**Test results** Set receive mode

RCMD receive\_mode

RCMD?

`receive_mode` either **RTC** to set real time compare mode, or **DA** for data acquisition mode.

In **RTC** mode, the DUT response will be compared against the expected data downloaded previously using the **EXPD** command.

In data acquisition mode (**DA**), the DUT response will be stored in the received data memory. The **RECD?** query may be used to examine the sampled data.

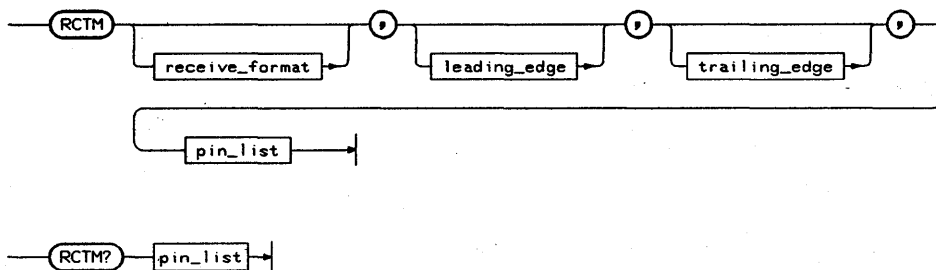
### Example

Sending the command **RCMD?** responds with either **RCMD RTC** for real time compare mode, or **RCMD DA** for data acquisition mode.

## RCTM, RCTM?

### Timing Setup Receiver timing

These commands are used to set and query receiver timing and compare mode settings.



`receive_format` can be either `WIDW` for window compare mode or `EDGE` for edge compare mode.

Programmed edges that do not have the necessary HW resources are ignored and no warning message is generated.

The default receiver timing is `EDGE` format with `LE= 0`.

### Errors

An error will be generated if:

- there are any value range errors
- attempting to program non-applicable pins (configured as I, DC, or OFF)

### Warnings and Autocorrections

Contextual edge mismatching generated by using optional edge parameters is autocorrected in the following manner:

If the value of a programmed edge exceeds the allowed range, the optional parameter is set to the maximum possible value. On the other hand, if

## **RCTM, RCTM?**

a programmed value goes below the minimum, the optional parameter is autocorrected to the minimum possible value.

### **Examples**

```
DFPN 1,,(TC)
CONF 0,STD,,(TC)
SCLK INT,10,
RCTM EDGE,5,,(TC)
RCTM WIDW,,6,(TC)
```

This would result in  $TE - LE < 2ns$ . So autocorrection sets  $LE = TE - 2ns$ .

```
RCTM? (TC)
```

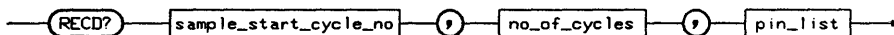
would return RCTM WIDW,4,6,(TC) at this point.

---

## RECD?

### Test Results Read received data

RECD? returns the contents of the data acquisition memory in a binary format.



`sample_start_cycle_#` is in the range 0 .. highest vector memory address `V_LAST`

`no_of_cycles` is in the range 1 .. size of vector memory `V_MEM`

The transfer commands RECD sets up the system to transfer a large amount of data via the HP-IB bus for the state list or timing diagram results displays. The data consists of full 8-bit bytes in an unreadable (non ASCII) format and will be transferred in one block for all the specified pins (received\_data).

The '#' marks the start of the binary data.

`spec` defines the number of transferred bytes in the following manner: the first <digit> specifies the number of valid number digits, immediate followed by the digits defining the number of transferred bytes, followed by the binary data. No white space is allowed after the '#' sign!

Up-loading will be performed in a by pin oriented manner (RECD), each byte containing information of 4 cycles for one pin. The contents of the data stream reflects the HW RAM organization and will not be altered by the transfer commands.

The `sample_start_address` and the (`sample_start_address + #_of_cycles`) will be rounded to the next byte boundaries for binary transfers.

This command works on byte boundaries

## **RECD?**

### **Errors**

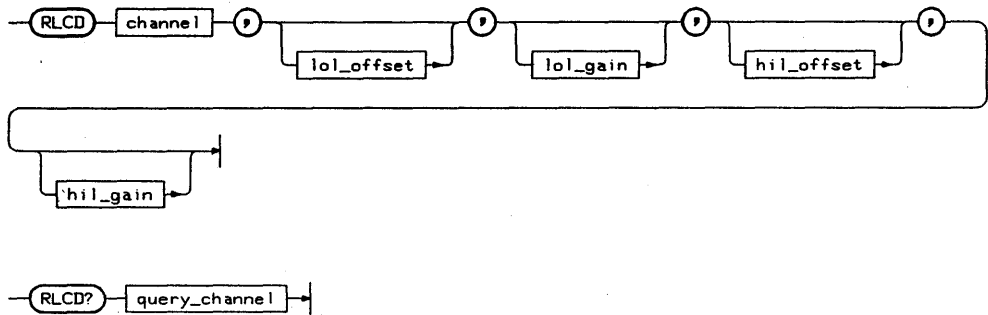
An error will be generated for the following reasons:

- Parameter range errors
- Command not allowed in real-time compare mode
- No data available

## RLCD, RLCD?

### Calibration Receiver Levels

These commands are used to modify and read receiver level calibration values.



where `channel` is the sequential channel number defined with the DFPN command.

The values and implied units for the offsets and gains are shown below.

**Level Parameter Value Ranges**

		min	max	unit
Receiver	Offset	-500	+500	mV
	Gain	3440.40	3879.60	$\mu\text{V}/\text{LSB}$

### Errors

An error will be generated for the following reasons:

- Sequencer not idle
- Gain value out of range
- Trying to set or read receiver calibration data for an I channel

**RLCD, RLCD?**

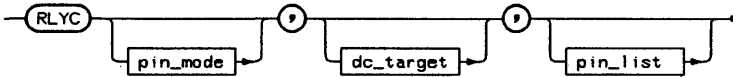
**Example**

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.



# RLYC

## Test Functions Relay Control



RLYC is a low level command used to connect DUT pins to tester resources.

- pin\_mode** sets up how a pin is connected to the tester. Can be:
- IDLE - pin is disconnected
  - AC - pin is connected only to pin electronics
  - DC - pin is connected to `dc_target` only
  - BOTH - pin is connected to pin electronics and `dc_target`
  - DCC - complementary output of HSWG is connected to `dc_target`
  - DCB - both outputs of HSWG are connected to `dc_target`
- dc\_target** defines where a pin is connected for dc measurements. Can be:
- PMU1 connected to PMU1
  - PMU2 connected to PMU2
  - EXT connected to external input
  - OFF disconnected from `dc_target`
  - X change relay states except those for `dc_target`
- pin\_list** list of pins to be connected to tester resources.

### Example

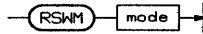
See Chapter 7 for an example of the use of this command.

---

## RSWM

**High Throughput Tests Set the relay switching method**

RSWM allows you to specify the order in which the AC and DC relays are switched, when you perform a measurement using PTST? or DTST?.



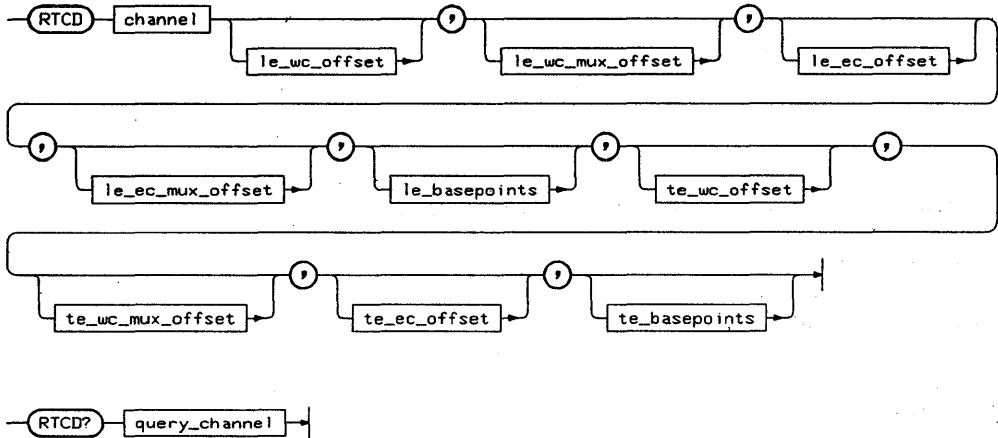
The **method** parameter can be either

- **bbm** - Break Before Make, i.e.
  1. all relays are opened,
  2. the relays needed for the measurement are closed.
- **mbb** - Make Before Break, i.e.
  1. the relays needed for the measurement are closed.
  2. the relays not needed for the measurement are opened.

## RTCD, RTCD?

### Calibration Receiver timing

These commands are used to modify and read receiver timing calibration values.



**Note** le- and te-basepoints may contain up to ten values.



where `channel` is the sequential channel number defined with the DFPN command.

The values for the offsets and gains are shown below.

## RTCD, RTCD?

### Timing Parameter Value Ranges

			min	max	unit
Gain	Channel		29.41	39.22	ps/LSB
Offset	Leading Edge	Standard	0.0	+16.0	ns
		MUX Mode	-5.0	+16.0	ns
	Trailing Edge	Standard	-1.0	+16.0	ns
		MUX Mode	-6.0	+16.0	ns
	Tristate Edge		0.0	+16.0	ns

## Errors

An error will be generated for the following reasons:

- Sequencer not idle
- Gain value out of range
- Trying to set or read receiver calibration data for an I channel

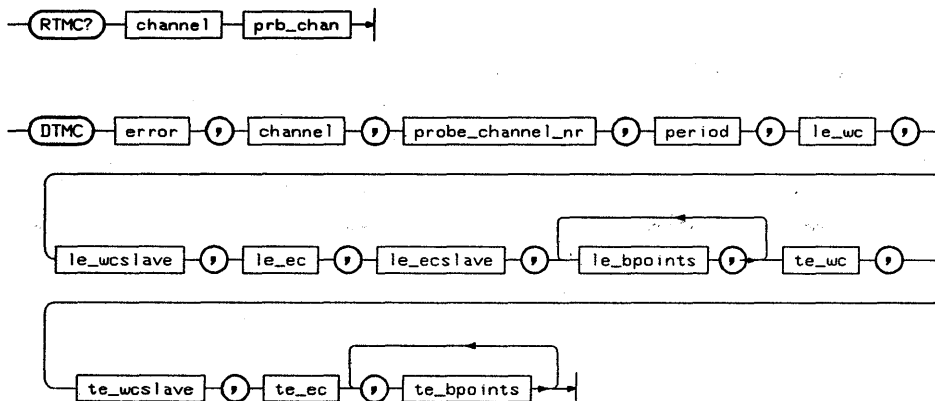
## Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## RTMC?

### Calibration Receiver timing calibration

Performs receiver timing calibration of the specified pin using the given calibration probe channel (default is channel 1).



where

**channel** is the channel number to be calibrated

**prb\_chan** is the probe channel to be used. Default is 1.

The returned values for this command are:

<b>error</b>	an integer in the range 0 .. 99999 indicating a calibration error code. Value 0 indicates no error.
<b>channel</b>	the channel being calibrated
<b>probe-channel- nr</b>	the cal probe channel used for the calibration
<b>period</b>	the period used in nanoseconds
<b>le-wc</b>	Leading edge to window compare - master channel
<b>le-wcslave</b>	Leading edge to window - slave channel
<b>le-ec</b>	Leading edge return to edge compare - master channel
<b>le-ecslave</b>	Leading edge return to edge compare - slave channel
<b>le-bpoints</b>	Leading edge fine delay basepoints (10 values)

## **RTMC?**

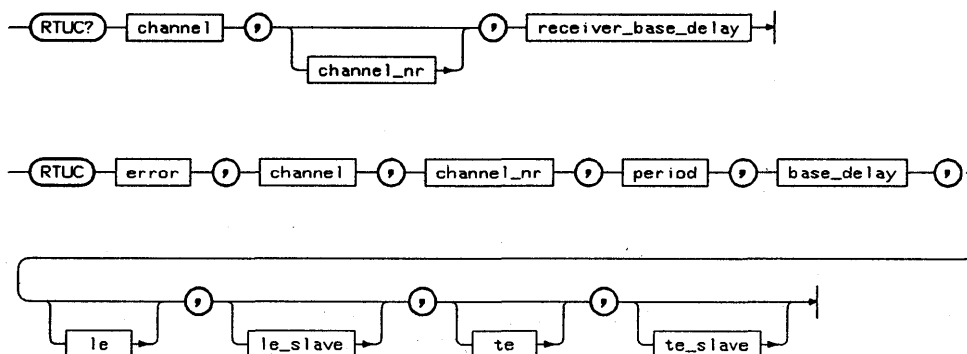
<b>te-wc</b>	Trailing edge return to window compare - master channel
<b>te-wcslave</b>	Trailing edge return to window compare - slave channel
<b>te-ec</b>	Trailing edge return to edge compare - master channel
<b>te-bpoints</b>	Trailing edge fine delay basepoints (10 values)

## **Example**

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## RTUC?

**Calibration** Generate receiver timing user calibration



where

**channel** is the channel number to be calibrated  
**channel-nr** is the probe channel to be used. Default is 1.  
**receiver-base-delay**

The returned values for this command are:

**error** an integer in the range 0 .. 99999 indicating a calibration error code. Value 0 indicates no error.  
**channel** the channel being calibrated  
**probe-channel- nr** the cal probe channel used for the calibration  
**period** the period used in nanoseconds  
**base-delay**  
**le** Leading edge - master channel  
**le-slave** Leading edge - slave channel  
**te** Trailing edge - master channel  
**te-slave** Trailing edge - slave channel

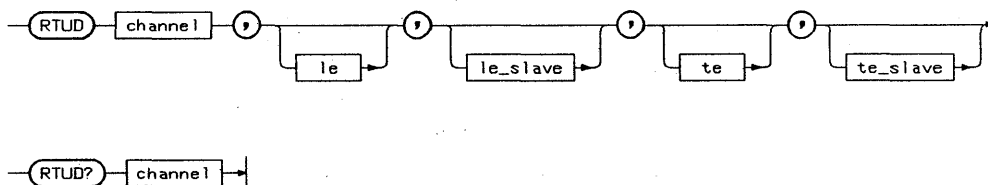
### Example

Refer to Chapter 10 and Servicing the HP 82000 for more information about user calibration.

---

## RTUD, RTUD?

**Calibration** Transfer receiver timing user calibration data



The parameters are:

<b>channel</b>	The name of the channel to be calibrated
<b>le</b>	The leading edge correction for the master channel
<b>le_slave</b>	The leading edge correction for the slave channel
<b>te</b>	The trailing edge correction for the master channel
<b>te_slave</b>	The trailing edge correction for the slave channel

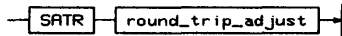
Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.



---

## SATR, SATR?

**Attributes** Set system attributes



`round-trip-adjust` is a fixed point value with the implied units nanoseconds.

See Chapter 11 for more details of this command.

### Errors

An error will be generated if the parameter is out of range.

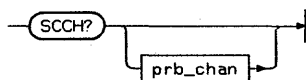
### Example

`SATR?` returns the current settings of the system round-trip adjust. Files containing this data and pin attribute data (see `PATR`) should be written using a text editor and stored in the `pin_attributes` directory for the DUT, or entered in the Pin Attributed setup window.

---

## SCCH?

**Calibration** Set calibration probe channel



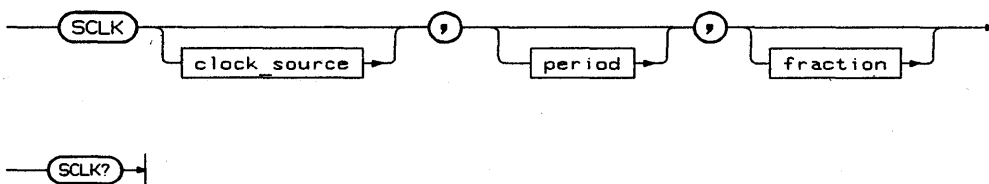
The command returns the pin name of the channel where the selected probe channel is connected.

Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

## SCLK, SCLK?

### Timing Setup System Clock

This command sets the source, period and fraction (for external clock source only) of the system clock.



`clock_source` is either INT - for the internal clock, or EXT - for a signal connected to the external clock input.

`period` has the implicit unit ns and can be programmed as shown in the following table.

**Table 12-4. System Clock Ranges and Resolutions**

Range	Parameter	Resolution
10 $\mu$ s .. 99.9ns	10 .. 99.9	100ps
100 $\mu$ s .. 999ns	100 .. 999	1ns
1 $\mu$ s .. 9.99 $\mu$ s	1000 .. 9990	10ns
10 $\mu$ s .. 99.9 $\mu$ s	10000 .. 99900	100ns

## SCLK, SCLK?

**Table 12-5. System Clock Period Settings for External Source**

Fraction	Range
F1T8	10ns .. 720ns
F1T4	10ns .. 1.44 $\mu$ s
F1T2	10ns .. 2.88 $\mu$ s
F1T1	10ns .. 5.76 $\mu$ s
F2T1	10ns .. 11.5 $\mu$ s
F4T1	10ns .. 23 $\mu$ s
F8T1	13.3ns .. 46 $\mu$ s

**fraction** - needs to be programmed when the external clock is used. It comes out of the formula:

$$\text{fraction} = \frac{f(\text{ext.clock})}{f(\text{int.clock})}$$

and only the quotients F1t8, F1t4, F1t2, F1t1, F2t1, F4t1 and F8t1 are allowed. These quotients correspond to ratios of 1:8, 1:4, 1:2, 1:1, 2:1, 4:1 and 8:1 respectively. This parameter is ignored if **clock\_source** is internal.

The default (power on) settings for the system clock are INT, 10,.

## Errors

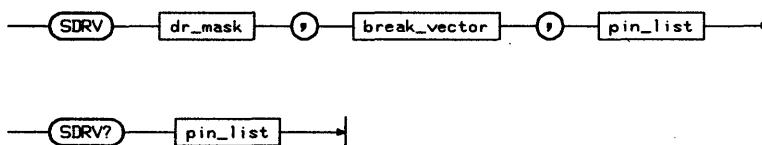
Errors are generated if:

- Period is out of range

## SDRV, SDRV?

### Vector Setup Mask and break vectors

Set and read driver channel pin mask and break vectors.



**dr\_mask** is either ACT for active or TT for tristate mode.

**break\_vec** modifies the pin's behavior during break cycles. and can be one of:

LO	channel goes to low
HI	channel goes to high
LZ	low combined with tri-state <sup>1</sup>
HZ	high combined with tri-state <sup>1</sup>
HOLD	channel repeats last vector

<sup>1</sup> The driver signal will be forced to tristate at the first trailing edge (for 100 mode pins with DNRZ format only).

This command affects the channel's behavior without modifying the contents of the vector memory.

Masking a driver pin forces the output driver to tristate mode ( **dr\_mask** = TT).

At power on, all driver channels are set to tristate, the break vector is set to LOW.

### Autocorrection

If the configuration of an already defined pin is changed, the following autocorrection rules apply. Note that no warnings will be generated for the corrections noted below.

## SDRV, SDRV?

100 MHz to 200 MHz modes Invalid break vector and expected data setups are changed from:

- LZ to LO, HZ to HI
- IM to LO, X to HI

## Errors

Errors will be generated for:

- Bad positioned mnemonic
- Execution conflicts with current configuration
- LZ | HZ for 200 MHz pins
- IM | X for 200 MHz double frequency pins

## Warnings

A warning will be generated by attempting to unmask a word mask pin.

## Example

```
CONF I, STD, P, (A0)
CONF I, FD, P, (A1)
CONF 0, STD, P, (D0)
CONF 0, MUX, P, (D1)
SDRV ACT, HOLD, (A0, A1)
SREC ACT, LOW, (D0, D1)
```

In this example, the DUT input pins A0 and A1 are active. Both pins will repeat the last machine cycle vector in break mode. The DUT output pins D0 and D1 will be monitored. In data acquisition mode, the failure condition becomes false, if the output signal of both pins is LOW for an entire machine cycle.

## **SELF?**

### **Diagnostics Self test**

The firmware performs checks at power-on and during download and command execution. The SELF? query is used to read self test reports.

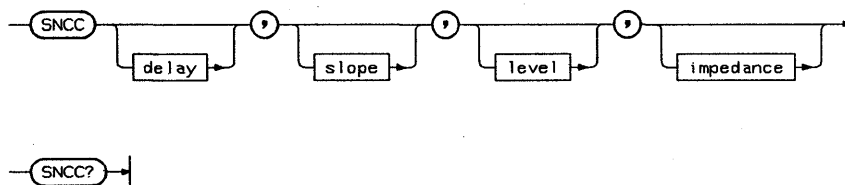


This command is for HP service personnel.

---

## SNCC, SNCC?

### Timing Setup External clock synchronization



This command is used to setup external clock synchronization. The parameters are:

- delay**            The delay between the external clock and the internal clock. It is a positive real number in the range 0 to  $10^6$  (0 ns to 1 ms) with the implied unit nanoseconds.
- slope**            Sets the active edge to be used for synchronization. Can be either POS or NEG.
- level**            Sets the threshold level for the external clock signal. This must be in the range  $\pm 10000$  millivolt.
- impedance**        Input impedance to be used for external clock input. Can be either R10K for 10 k $\Omega$  or R50 for 50  $\Omega$ . Note that if 50  $\Omega$  is selected, the threshold levels are limited to  $\pm 5000$  mV.

### Errors

An error will be generated for the following reasons:

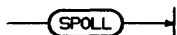
- Parameter out of range



---

## **SPOLL**

**HP-IB Serial Poll**



Refer to the **BASIC-UX Interfacing Techniques** manual for more information on this command.

---

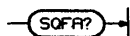
## **SQCL**

**Sequencer Control Clear label**



This command clears all the label definitions of previous SQSL command.

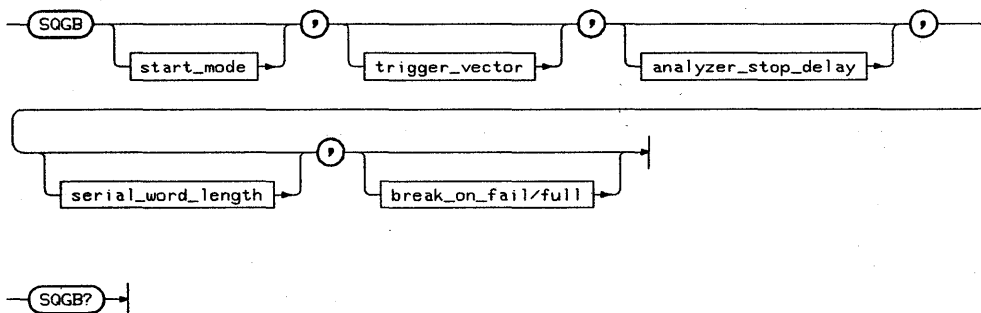
---

**SQFA?****Sequencer Control First free address**

This command returns the first free vector address (ffvad).

## SQGB, SQGB?

### Sequencer Control Global setup



This command defines and reads sequencer global parameters. These parameters are:

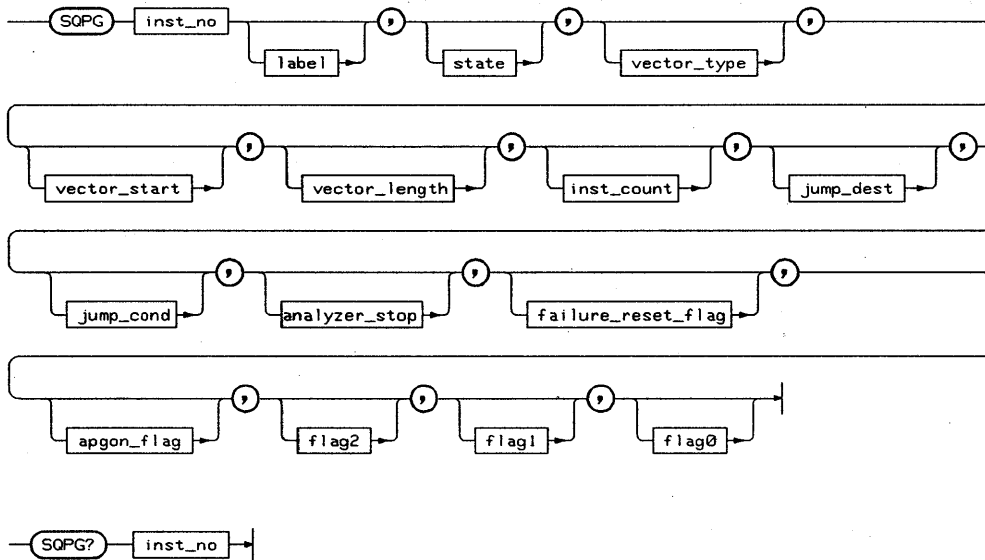
<code>start-mode</code>	How the sequencer reacts to a sequencer start command SQST. Can be either: <ul style="list-style-type: none"><li>■ ARM - the sequencer goes into the armed state</li><li>■ RUN - the sequencer starts immediately</li></ul>
<code>trigger- vector</code>	specifies the address of the vector that activates the trigger output. Must be a valid vector address.
<code>analyzer-stop- delay</code>	specifies the number of cycles that will be output and analyzed after the analyze-stop flag was set in an SQPG command. This can be in the range 1 to 16777000.
<code>serial-word- length</code>	The number of channels that are to be serialized for serial vectors. Must be in the range 4 to total installed channels.
<code>break-on- fail/error</code>	If set, the tester goes into break if a compare error occurs or the analyze memory is full. If it is not set, no break occurs.

**Example**

Look at the sample vectors sequence files supplied with the system for examples of the use of this command. Refer to the Advanced Testing manual for more information about sequencer programming.

## SQPG, SQPG?

### Sequencer Control Program line



This command is used to set up sequences of vectors. The parameters are:

- |                    |   |
|--------------------|---|
| <b>inst-no</b>     | Instruction number, this must be an integer in the range 0 .. 999.  |
| <b>label</b>       | The label assigned to the program line.   |
| <b>state</b>       | Sequencer state. Can be either: <ul style="list-style-type: none"><li>■ CONT - to continue</li><li>■ BRK - go to break state</li><li>■ ARM - got to arm state</li></ul>   |
| <b>vector-type</b> | Specifies how vectors are output. Can be either: <ul style="list-style-type: none"><li>■ LIN - outputs vectors set by vector-start and vector-length.</li><li>■ REP - outputs vector at vector-start number of times set by vector-length.</li><li>■ SCAN - outputs vector-length vectors starting at vector-start in serial mode using number of</li></ul> |

## SQPG, SQPG?

	channels set in <b>serial-word-length</b> of SQGB command.
<b>vector-start</b>	Start address for vectors. Entered relative to VESA.
<b>vector-length</b>	Number of vectors to be output. Minimum is 32 (except for jump source EVER or NEV then 8), maximum 1048575 ( $2^{20} - 1$ ).
<b>instruction-count</b>	Repetition factor for this instruction in range 1 .. 2048. Value -1 indicates infinite repetition or until jump condition occurs.
<b>jump-destination</b>	Specifies the instruction to process after the jump condition has occurred.
<b>jump-condition</b>	Specifies the jump condition. Can be either: <ul style="list-style-type: none"><li>■ SS - software signal. This is set by the SQSS command.</li><li>■ APG - not used</li><li>■ FAIL - Compare failed</li><li>■ XA - External Input A active. This condition is set with SQXI.</li><li>■ XB - External Input B active. This condition is set with SQXI.</li><li>■ EVER - Used as a constant for unconditional jumps. If positive, jumps to value of <b>jump-destination</b>, if negative, to the next instruction.</li></ul>
	Additionally, all of these conditions can be negated by preceding them with N, for example, NSS, NXA and so on.
<b>analyzer- stop</b>	The first occurrence of this flag triggers the end of data analysis after <b>analyzer-stop</b> vectors.
<b>failure- reset-flag</b>	Resets the test failed condition before the instruction is executed. Prevents a jump on fail coming from a previous instruction affecting this line.
<b>apg-on-flag</b>	Not used
<b>flag-2</b>	Not used
<b>flag-1</b>	Not used
<b>flag-0</b>	Not used

## **SQPG, SQPG?**

SQPG? returns the program line for the given `inst_no`. The special value `-1` lists all the instructions from `sequencer-start` to `first-free-sequencer-instruction - 1`.

## **Errors**

An error will be generated for the following reasons:

- Range errors
- Instruction number `-1` and `vector-start` or `'sequencer-start'` not set to zero.

## **Example**

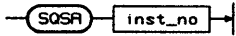
See vector files supplied with system software and Advanced Testing manual.



---

## SQSA, SQSA?

Sequencer Control Start address

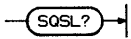
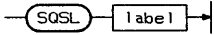


This command sets and reads the absolute sequencer start instruction number. **inst\_no** must be in the range 0 .. 999.

---

## SQSL, SQSL?

**AC tests** Set/read sequencer start label



This command sets and reads the current sequencer start label.

### Errors

An error will be generated for the following reasons:

- Label not defined by a previous SQPG command.

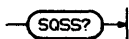
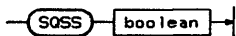
### Example

See vector files supplied with system software and Advanced Testing manual.

---

## SQSS, SQSS?

**Test Functions** Sequencer software signal



This command is used to set the sequencer software signal to allow conditional jumps in a vector sequence.

### Errors

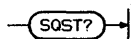
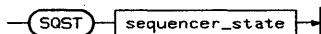
An error will be generated for the following reasons:

- Value error

---

## SQST, SQST?

**AC tests** Set/read current sequencer state



This command sets and reads the current state of the sequencer. Allowed sequencer states are:

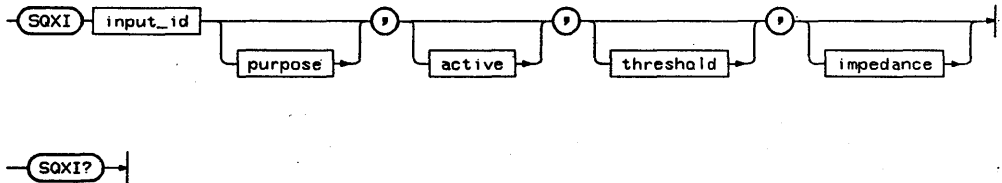
- **OFF** - sequencer and system clock are stopped. Only static signals are at the DUT pins.
- **BRK** - sequencer in break state. Output vectors are break vectors.
- **RUN** - sequencer is set to running. Whether it starts or goes into the armed state is determined by the SQGB command. If it starts, it starts at the defined start label.

### Example

See Advanced Testing and Test Function manuals.

## SQXI, SQXI?

### Sequencer Control External Inputs



Sets and reads operating conditions for sequencer external inputs. The parameters are:

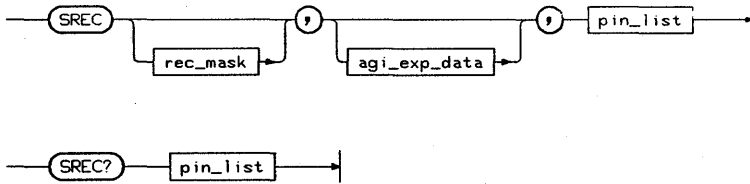
<b>input-id</b>	Can be XA or XB to set up A or B input respectively.
<b>purpose</b>	Sets purpose of input. Can be either: <ul style="list-style-type: none"> <li>■ BRK - input is used to switch sequencer to break state. Cannot be used for conditional jumps.</li> <li>■ CONT - Changes sequencer from arm state to active (RUN) state.</li> <li>■ JUMP - input is used for jump instructions</li> </ul>
<b>active</b>	Defines the active edge or level for the input. Can be either H or L for high or low levels, or R or F for rising and falling edges.
<b>threshold</b>	Threshold level in millivolts in range -10000 to 10000. If the value is greater than $\pm 5000$ , a warning will be generated if impedance is set to L as higher voltages could result in damage to the tester. They will however be programmed.
<b>impedance</b>	Specifies the input impedance of the external input. Can be either L for 50 $\Omega$ or H for 10 k $\Omega$ .

---

## SREC, SREC?

### Vector Setup Read mask and expected data

These commands set and read the state of the mask and expected data vector in data acquisition mode.



`rec_mask` can be ACT or X for active or masked respectively.

`aqi_exp_data` can be:

IM	for an expected intermediate level (tristate)
LO	for an expected low level
HI	for for an expected high level
X	for the don't care (masked) condition

This command affects the channel's behavior without modifying the contents of the vector memory.

Masking a receiver pin (`rec_mask = X`) changes the pin to a "Don't Care" pin in real time compare mode. The receiver pin mask has no effect in data acquisition mode.

The `aqi_exp_data` parameter of the SREC command is valid for data acquisition mode only. This parameter allows you to define a vector which will be compared against the incoming data in acquisition mode. Similar to the break vector, this vector will be valid for an entire machine cycle. For 200 MHz pins an error will be generated if the test fails in either of the user cycles.

At power on, all receiver channels are masked (set to Don't Care mode), the expected data vector (valid in AQI mode only) is set to Don't Care.

## **Autocorrection**

If the configuration of a previously defined pin is changed, the following autocorrection rules apply. Note, that no warnings will be generated for the corrections noted below.

- Any mode to 200 MHz frequency doubling mode
  - Invalid expected data vector setups are changed from IM to LO and X to HI

## **Errors**

Errors will be generated for:

- Badly positioned mnemonic
- Execution that conflicts with current configuration, for example, IM or X for 200 MHz pins.

## **Example**

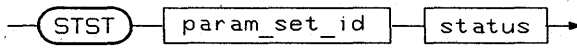
```
CONF I, STD, P, (A0)
CONF I, FD, P, (A1)
CONF O, STD, P, (D0)
CONF O, MUX, P, (D1)
SDRV ACT, HOLD, (A0, A1)
SREC ACT, LOW, (D0, D1)
```

In this example, the DUT input pins A0 and A1 are active. Both pins will repeat the last machine cycle vector in break mode. The DUT output pins D0 and D1 will be monitored. In data acquisition mode, the failure condition becomes false, if the output signal of both pins is LOW for an entire machine cycle.

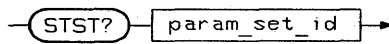
---

## STST?

**High Throughput Tests** Perform a functional test using a presaved parameter set (saved with PSAV).



Returns the parameters:



where:

- **param\_set\_id** is the id number of the parameter set that has been used in the test;
- **status** is either **P** for a passed test, **F** for a failed test, or the measured value;

The STST? command is functionally the same as:

LDHW *id*

FTST?

### Example

To perform a functional test with the parameter set id 24, you can enter the command string:

```
STST? 24
```

If the test result is a pass, the returned string is:

```
STST 24,P
```

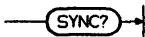
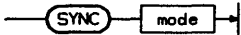


---

## **SYNC, SYNC?**

### **Timing Setup** Clock synchronization

When selected, the internal clock will be synchronized to the external clock input defined by a previous SNCC command.



**mode** can be ON or OFF depending on whether the internal clock should be synchronized.

The SYNC? query returns the current state of mode.

### **Example**

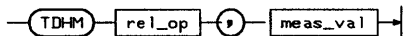
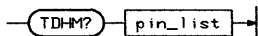
**SYNC ON**

This synchronizes the system clock with an external synchronizing signal.

---

## TDHM?

**AC tests** Perform data hold time test



This command performs a data hold time test on the pins listed in `pin_list`.  
The parameters are:

`rel-op`            Relational operator to describe the test result. Can be one of  
                    LT, LE, EQ, GE, or GT.  
`meas-val`         Returns the measured data hold time

Refer to Chapter 7 for more information on this command.

### Errors

An error will be generated for the following reasons:

- Pin not applicable

---

## TEMP?

**Calibration** Read mainframe temperature



This command returns the current temperature for each mainframe in Kelvin units. (Centigrade = Kelvin - 273) (Fahrenheit =  $1.8 \times (\text{Kelvin} - 273) + 32$ )

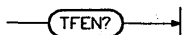
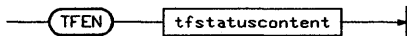
Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

---

## TFEN, TFEN?

**Status** Test function enable register

These commands define and read the Status Enable Register of the Hardware Status Register.



The response to the query commands is an integer value.

Refer to Chapter 9 for more details.

---

## TFET?

**Status** Test function event register

This command reads the Event Register of the Test Function Status.



The response to the query commands is an integer value.

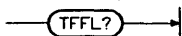
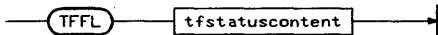
Refer to Chapter 9 for more details.

---

## TFFL, TFFL?

**Status** Test function transition event

These commands set and read the falling transitions event for Test Function status.



The response to the query commands is an integer value.

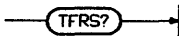
Refer to Chapter 9 for more details.

---

## TFRS, TFRS?

**Status** Test function transition event

These commands set and read the rising transition for test function status.



The response to the query commands is an integer value.

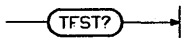
Refer to Chapter 9 for more details.

---

## TFST?

**Status** Test function status register

This command reads the Status Register of the Test Function Status.



The response to the query commands is an integer value in the range 0 .. -1000.

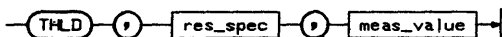
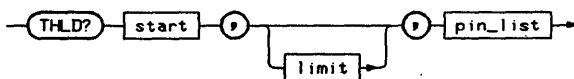
Refer to the Test Function Programming Manual for full details.



---

## THLD?

**AC tests** Perform a hold time test



This command performs a hold time measurement and returns a pass/fail indication. The parameters have the following meanings:

- |              |   |
|--------------|---|
| <b>start</b> | Defines the start of a measurement window. The value has the implied units nanoseconds.                   |
| <b>limit</b> | Sets the pass limit for the measurement. If this is omitted, the test returns only pass/fail information. |

### Errors

An error will be generated for the following reasons:

- Non applicable pins

### Example

Refer to Chapter 7 for examples of this command.

---

## TPDM?

**AC tests** Perform a propagation delay measurement

— TPDM? pin\_list →

— TPDM rel\_op \* meas\_val →

This command performs a propagation delay measurement and returns a pass/fail indication.

### Errors

An error will be generated for the following reasons:

- Non applicable pins

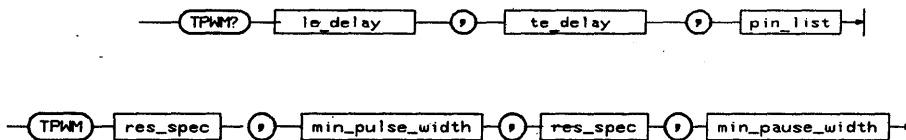
### Example

See Chapter 7 for examples of this command.

---

## TPWM?

**AC tests** Perform a pulse width/pause measurement.



This command performs a minimum pulse width and maximum pause width measurement and returns a pass/fail indication.

The query parameters are:

<b>le-delay</b>	Real number with implied units nanoseconds to specify leading edge delay
<b>te-delay</b>	Real number with implied units nanoseconds to specify trailing edge delay
<b>pinlist</b>	Input pins to be tested

The command returns the following parameters:

<b>res-spec</b>	can be a relational operator of type <b>rel-op</b> (see DRLS) or <b>P</b> or <b>F</b> to indicate whether the test test or failed.
<b>min_width</b>	Minimum measured pulse width
<b>min_pause</b>	Maximum measured pause width

### Errors

An error will be generated for the following reasons:

- Non applicable pins
- Exceeding **le\_delay** or **te\_delay**

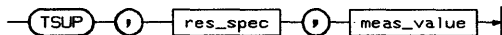
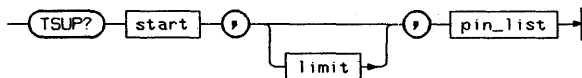
### Example

See Chapter 7 for examples of this command.

---

## TSUP?

**AC tests** Perform a setup time test



The query command measures the setup time for the pins in `pin-list`. The parameters are:

- start**            A real number with implied units nanoseconds to define the start of the measurement window.
- limit**            A real number with implied units nanoseconds to define the limit for the measurement. If this parameter is omitted, the test is made in pass/fail mode only.

The returned values are:

- res-spec**        A relational operator to show the test results. Can be of type `rel-op` (see DRLS) or `P` or `F` to indicate the test result.
- meas-val**        The measured value of setup time.

## Errors

An error will be generated for the following reasons:

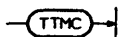
- Non-applicable pins

## Example

---

## TTMC

**Calibration** Terminate calibration process



Refer to Chapter 10 and Servicing the HP 82000 for more information about system calibration.

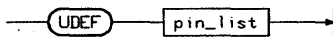
---

## UDEF

### Configuration Setup Undefine pins

This command undefines a pin that has been set up using the DFPN command.

All setups for the pin remain in memory and will come into effect again if the channel is defined by a subsequent DFPN command.



`pin_list` can consist of single pin names or the at symbol '@' which can be used to undefine all pins.

### Example

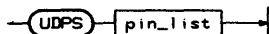
```
UDEF pin1
```

This command undefines the machine channel whose pin name was `pin1`.

---

## UDPS

### Configuration Setup Undefine DPS pins



```
UDPS pin_list
```

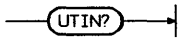
This command undefines a power supply pin previously defined by a DFPS command. **pin-list** can consist of a single pin name or the at symbol "@" which can be used to undefine all DPS pins.

---

## UTIN?

Utility Lines Read inputs

The UTIN? query reads the current state of the utility input port.



results in the string `UTIN? data_in` being output where `data_in` is a binary coded integer in the range 0000 to 1111.

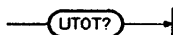
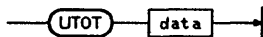


---

## UTOT, UTOT?

### Utility Lines Read and set outputs

These commands set and read the state of the system utility output lines.



The **UTOT** command sets the utility output to the value specified by **utility\_data**. This must be an integer in the range 0..127. The utility outputs will be set to a state equivalent to the binary equivalent of **utility\_data**.

The **UTOT?** query retrieves the current state of the utility output port and respond with the message **UTLI utility\_data** where **utility\_data** is the decimal representation of the current setting of the utility output lines.

### Example

```
UTOT 127
```

sets all seven utility lines to high

### Errors

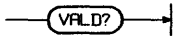
An error will be generated if the value is not in the range 0 to 255.

---

## VALD?

**Test Results** Valid data in received data

VALD? returns the number of valid data in the error map / received data ram.



returns where `#_of_valid_data` is in the range 0 .. `V_MEM`.

This command is only applicable for the master mainframe.

## Errors

An error will be generated for the following reasons:

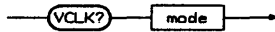
- Parameter range errors
- No data available

---

## VCLK?

**Timing Setup** Verify system clock

This command returns a flag to indicate whether auto-correction will take place at the current system clock setting.



**mode** returns 0 or 1 to indicate whether autocorrection will occur

### Errors

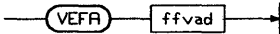
None

---

## VEFA, VEFA?

**Vector Setup** First free vector address

VEFA reads or modifies the first free vector address. This address is updated after each vector data transfer to show the first unused location in the vector data memory.



ffvad must be in the range 0 .. the size of the vector memory V\_MEM.

At power on the first free vector address is set to 0.

### Errors

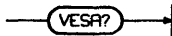
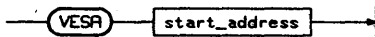
An error is generated if the specified address exceeds vector memory limits.

---

## VESA, VESA?

### Vector Setup Vector Start address

These commands are used to set and query the current setting of the Vector Start Address. This address is used as the base address for all subsequent vector data transfers.



`start_addr` must be in the range 0 .. highest vector memory address `V_LAST`.

A vector transfer starts at the byte location of the vector specified by the previously defined vector start address and the `rel_start_addr` parameter (which is regarded as an offset value, added to the vector start address).

The vector base address can be altered by the VESA command. It is recommended that you set the start address to a multiple of 4.

At power on the vector start address is set to 0.

### Errors

Errors will be generated if the address specified exceeds vector memory limits.

---

## **\*ESE, \*ESE?**

### **Error Handling Standard Event Enable Register**

These commands set and read the Standard Event Enable Register.

— **\*ESE** —|

— **\*ESE?** —|

The Standard Event Enable Register can be written with the **\*ESE** command and can be read with the **\*ESE?** query.

### **Example**

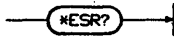
See Chapter 9 for more information on this command.

---

## \*ESR?

### Error Handling Event Status Register

The \*ESR? query command reads the state of the Event Status Register.



Using this command causes the system to respond with an integer value which the current value of the Event Status Register.

The Standard Event Register can only be read with the \*ESR? query. It can not be explicitly set. It will be cleared by the \*ESR? query, the DCL HP-IB message, the \*CLS command and at power on.

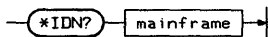
Refer to Table 9-2 for more information on this register.

---

## **\*IDN?**

### **Configuration Setup Identify firmware**

The query **\*IDN?** returns a firmware identification string.



This command returns the identification string for the hardware which includes the system type, and firmware type and revision.

### **Errors**

There are no errors associated with this command.

### **Example**

Sending **\*IDN?** will return a string similar to:

**HEWLETT PACKARD,82000 D200,0,REV 1.0**

indicating a 200 MHz system with revision 1.0 firmware.

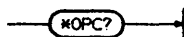


---

## **\*OPC, \*OPC?**

**Status** Operation Complete message

**\*OPC** generates an OPC message in the Standard Event register. **\*OPC?** responds with "1" when a command has been processed.



These commands provide a synchronization method without HP-IB holdoff. The **\*OPC**-command will generate an OPC event in the Standard Event Register. The OPC-event is generated after the processing of all previous commands is complete. By configuring status reporting appropriately, this can generate a SRQ and can be detected by a serial poll (SPOLL).

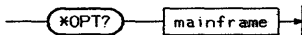
The **\*OPC?**-query will respond with a "1" after it and all previously sent commands have been processed.

---

## \*OPT?

### Configuration Setup Installed hardware

The \*OPT? query reports the type of hardware installed in each slot of a mainframe. The query response is a list of 18 fields separated by commas. Each field contains an identification of the board installed in the corresponding slot or a zero "0" if no board is installed.



For each mainframe, the response to this command consists of 18 fields containing either a zero (for an empty slot) or a `board_id` which consists of an integer. Refer to Chapter 3 for more information on these codes.

### Example

The command

\*OPT? results in the following response being issued.

4,17,52,52,52,80,0,0,0,0,0,0,0,0,0,0,0

In this particular system, there is one mainframe, with three 200 MHz IO Boards, 1 PMU Board and twelve unused slots.

### HP-IB Reset



\*RST

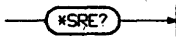
Performs complete system reset, and loads all registers with default values.

---

## \*SRE, \*SRE?

**Status** Service request enable register

These commands set and read the Service Request Enable Register. This allows you to make the system produce Service Requests only for specific error or status conditions.



`std_register` is an integer value between 0 and 256.

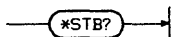
Refer to Chapter 9 for details of the SRE register.

---

## \*STB?

### HP-IB Read Status Byte

This command reads the Status Byte with MSS-bit via an ordinary query.



There are two ways to read the Status Byte. They differ in the format of the response and some side effects.

1. The controller can perform a SPOLL. This is usually done when it reacts to a Service Request. The firmware will send the status byte (without any coding). The SPOLL will also cause the Service Request to go to false for a subsequent SPOLL. This ensures that the RQS/MSS bit in the Status is only true for the first SPOLL after the Service Request. This enables the controller to decide whether this mainframe has generated the current Service Request. While a SPOLL clears the RQS/MSS bit, it does not change any other bits. The RQS/MSS will go to true again if a new reason for a Service Request is encountered.
2. The controller can send the \*STB? query. The firmware will respond with the decimal coded value of the Status Byte. However, in contrast to SPOLL, MSS is always returned, as it is not affected by resetting RQS.

**\*WAI**

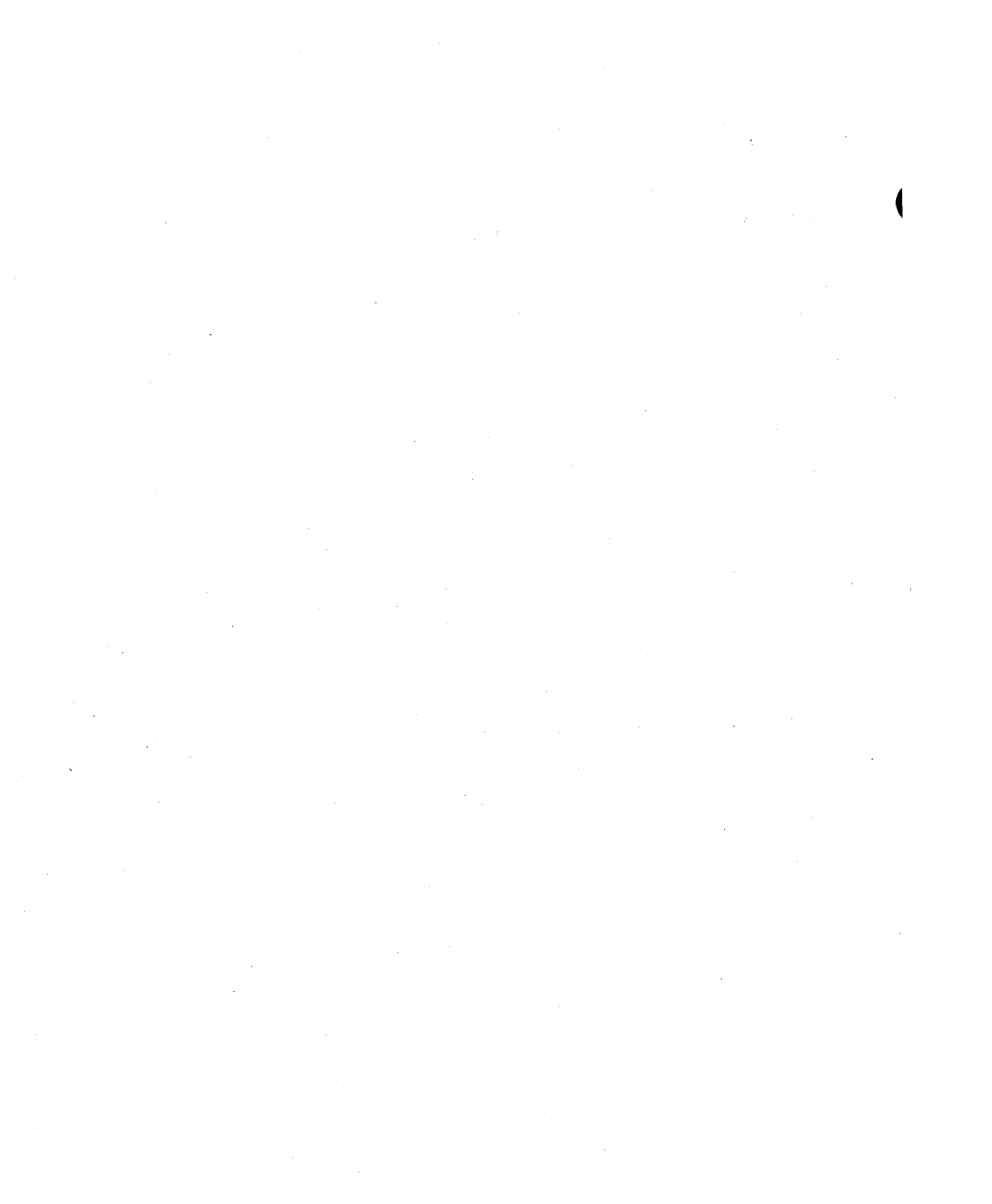
**Status** Perform wait

The **\*WAI** command is used to make the system wait for the completion of overlapping operations.



The **\*WAI** command will wait until all pending overlapping commands are complete.

Because the firmware has no overlapping commands, **\*WAI** degenerates to a NOP.



## ERRS? Error Codes

---

This appendix contains a list of the error codes associated with the ERRS? command. These codes are taken from the file /hp82000/pws/data/mc\_fw\_err.

Note that the variables @4 and @3 will be substituted by ERROR and WARNING respectively.

000	\$0
001	@4 HPIB interrupted state
002	@4 HPIB unterminated state
003	@4 HPIB deadlock state
004	@4 FW programming bug
005	@4 nothing to say
009	reserved
010	@4 decimal number too big
020	@4 invalid mnemonic received
021	@4 undefined data type
022	@4 invalid field separator
023	@4 empty data field with a multielement message unit
024	@4 character data not allowed
025	@4 character data overflow
026	@4 invalid character data character
027	@4 invalid character data token
028	@4 improper string data type termination
029	@4 string data is not allowed for entered mnemonic
030	@4 block data is not allowed for entered mnemonic
031	@4 invalid block type
032	@4 improper block data type termination
033	@4 non-decimal data type not allowed for entered mnemonic
034	@4 invalid non-decimal data type character
035	@4 non-decimal data type data overflow

036 @4 improper non-decimal data type termination  
 037 @4 decimal data not allowed for entered mnemonic  
 038 @4 improper decimal data type format  
 039 @4 improper character within decimal data type field  
 040 @4 data type exponent overflow  
 041 @4 data type suffix is not allowed for entered mnemonic  
 042 @4 data type received a invalid suffix  
 043 reserved  
 044 reserved  
 045 @4 query is not allowed for current mnemonic  
 046 @4 group execute trigger received in the middle of a message record  
 047 @4 improper non-decimal data type format  
 048 @4 improper expression data type termination  
 049 @4 expression data type is not allowed for entered mnemonic  
 050 @4 reserved  
 051 @4 invalid character received in the defined block length field  
 052 reserved  
 053 reserved  
 054 @4 invalid format  
 055 @4 invalid parameter  
 070 @4 bad positioned parameter in \$0  
 071 @4 bad pinlist in \$0  
 072 @4 can not apply \$0 to \$1  
 099 @4 bad syntax in message  
 100 @4 bad syntax in \$0  
 101 @4 bad positioned mnemonic in \$0  
 200 @4 parameter out of range in \$0  
 210 @4 low level out of range in \$0  
 211 @4 high level out of range in \$0  
 212 @4 level swing out of range in \$0  
 213 @4 level swing out of range for \$1 in \$0  
 220 @4 invalid format for \$1 in \$0  
 221 @4 leading edge out of range for \$1 in \$0  
 222 @4 trailing edge out of range for \$1 in \$0  
 223 @4 invalid combination of fraction and period in \$0  
 224 @4 \$0 can not be executed for internal clock source  
 225 @4 clock synchronization failed  
 230 @4 insufficient result data for \$0



300	@4 \$0 can not be executed in current tester state
310	@4 tester must be in idle-state for \$0
320	@4 execution of \$0 conflicts with current analyzer mode
400	@4 execution of \$0 conflicts with current configuration
401	@4 execution of \$0 conflicts with current configuration for \$1
410	@4 channel to be defined in \$0 is currently in use by \$1
411	@4 resource requested in \$0 for \$1 is already in use
412	@4 resource requested in \$0 for \$1 is not installed
413	@4 \$0 can not be executed while \$1 is in use
500	@4 invalid SW loaded into instrument
501	@4 SW blocksize greater 64 Kbyte
502	@4 to much SW loaded into instrument
599	@4 fatal error ocured in SW
600	@4 driver/receiver calibration aborted
601	@4 calibration allready in process
602	@4 calibration not in process
603	@4 ground connected to probe
604	@4 no ground connected to probe
605	@4 calibration probe not found
606	@4 calibration probe channel not found
607	@4 specified pin not found in mainframe
608	@4 user calibration not in process
609	@4 specified pin has no AC user setting
801	@4 bad instruction number in \$0
802	@4 bad label in \$0
803	@4 \$0 ignored; too many labels defined
804	@4 insufficient hardware installed for \$0
805	@4 channel error flags invalid
806	@4 address not readable / writeable
807	@4 no calibration probe connected
808	@4 execution of \$0 conflicts with pin setup
900	@3 missing calibration data for \$1
901	@3 \$1 may exist in multiple mainframes
902	@3 stoped logging errors
903	@3 vector data truncated
904	@3 re-definition of label in \$0
905	@3 threshold exceeds specifications in \$0
910	@3 propably wrong levels for \$1 in \$0

912 @3 propably wrong delays for \$1 in \$0  
913 @3 missing link to master mainframe  
914 @3 can't unmask \$1  
950 @3 execution of \$0 caused autocorrection  
951 @3 execution of \$0 caused autocorrection of \$1

## **Test Function Error Codes**

---

### **Status Messages**

The following test function status will be generated at the end of test function execution.

- 1                    Test function result is failed
- 0                    Test Function result is passed
- 1                   Warning were generated during test function execution.

If errors were generated, the following codes will be generated:

---

### **MCD Errors**

- 2                    Cannot execute firmware task successfully
- 3                    Internal answer buffer too small
- 4                    Internal task buffer too long
- 5                    Cannot open file
- 6                    Cannot read file
- 7                    No data in file
- 8                    Test file empty
- 9                    File is not an hp82000 file
- 10                   Wrong file type
- 11                   Wrong file revision
- 12                   File revision is newer
- 13                   file revision is older
- 14                   Invalid data in file
- 15                   Cannot write to file
- 16                   Cannot overwrite file

-17 File does not exist

---

## BASIC Errors

-50 Filename in Exec\_tf\_file too long  
-51 Parameter string in Exec\_tf\_param too long  
-52 Badly dimensioned result array  
-53 Buffer problem

---

## Test Function Process Errors

-100 TF environment failure  
-101 Bad tf keyword  
-102 TF parameter check failure  
-103 TF execution error  
-104 Configuration change during tf execution  
-105 Fatal error during tf execution

---

## Break Key

-1000 The test function was terminated with the Break key.

# Index

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## A

- ac calibration commands, 10-4
- acquisition stop, 8-4
- adjusting the PMU, 10-23
- adjusting timing settings, 11-3
- autocorrection
  - driver timing, 4-12
  - receiver timing, 4-14

## B

- boards
  - listing id codes, 2-2
- break vector, 5-2

## C

- calibrating driver outputs and receiver thresholds, 10-3
- calibrating the ADC, 10-2
- calibrating the cal probe, 10-6
- calibration, 10-1-25
  - pmu, 10-21
- calibration channel, 10-6
- calibration data
  - timing offsets, 11-3
- calibration data transfer, 10-8
- calibration period, 10-6
- cal probe
  - calibrating, 10-6
- channel being calibrated, 10-6
- clock output, 4-3
- command synchronization, 9-12
- comparator thresholds

corrections, 11-1

configuration setup commands, 2-1-12

## D

- data acquisition memory
  - reading, 8-4
- data formats
  - bit alignment, 5-12
- data transfer
  - calibration data, 10-8
- dc measurements
  - DPS, 7-35
  - PMU, 7-29
- defining pin names, 2-4
- defining power supply pins, 2-9
- defining the system clock, 4-2
- device power supply
  - defining, 2-9
- diagnostics
  - commands, 10-25
- diagnostics commands, 10-25
- DPS
  - maximum voltage, 3-8
  - supported models, 2-10
- driver
  - setting format and timing, 4-6
  - setting levels, 3-2, 3-4
  - timing reference, 3-2
- DUT
  - output resistor, 11-1
- DUT Board
  - series resistor, 11-1, 11-2

## **E**

- error commands, 9-1
- error handling, 9-1, 9-10
- error map
  - data, 8-4
- error map, reading the, 8-3
- error queue, 9-11
- event address, 8-4
- event enable register, 9-7
- event register, 9-7
- event status register, 9-4
- event summary register, 9-5
- expected data, 5-2
- external clock, 4-3

## **F**

- format and timing setup commands,  
4-1-15
- functional test
  - performing, 7-5
  - stopping, 7-6
- functional test commands, 7-2

## **H**

- handshake holdoff, 9-13
- hardware status, 9-9
- HP-IB
  - general, 12-1
  - global definitions, 12-2

## **I**

- implicit units, 12-3
- installed boards
  - listing, 2-2
- interrupts, 9-3

## **L**

- labels, clearing sequencer, 6-6
- last test result, 8-3
- leading edge
  - timing, 4-7

- level calibration, 10-1
- level settings
  - driver, 3-2, 3-4
  - power supply, 3-7
  - receiver, 3-6
- level setup commands, 3-1-9
- listing installed boards, 2-2

## **M**

- machine cycles, 8-5
- master status summary bit, 9-3
- match condition, 5-3
- maximum DPS voltage, 3-8
- measurement mode
  - commands, 8-1

## **O**

- operation complete message, 9-14
- order of setups, 12-2

## **P**

- pass/fail information for a pin, 8-3
- pass/fail information for a test, 8-3
- PATR, 11-1
- PATR?, 11-1
- performing system diagnostics, 10-25
- period
  - calibration, 10-6
- pin attributes, 11-1-4
- pin capabilities
  - setting, 2-6
- pin mask, 5-2
- pin names
  - defining, 2-4
  - removing, 2-5
- PMU adjustments, 10-23
- pmu calibration, 10-21
- PMU measurement, 7-43
- power supply
  - defining pins, 2-9
  - setting levels, 3-7

- power supply relay commands, 7-39
- programming
  - dependency, 12-2
- protocol re-synchronization, 9-14

## R

- reading the data acquisition memory, 8-4
- reading the error map, 8-3
- received data RAM, 8-4
- receive mode, 7-4
- receiver
  - setting format and timing, 4-12
  - setting levels, 3-6
- receiver delay, 11-4
- register
  - event, 9-7
  - event enable, 9-7
  - event status, 9-4
  - event summary, 9-5
  - service request enable, 9-3
  - tester status, 9-6
- registers
  - hardware status, 9-1
  - standard event status, 9-1
  - test function status, 9-1
- relay commands, 7-37
- removing pin name definitions, 2-5
- result command modes, 8-1
- result data storage, 8-7
- re-synchronization, protocol, 9-14
- round trip adjust, 11-1

## S

- SATR, 11-1
- SATR?, 11-1
- sequencer
  - DEFAULT program, 6-6
  - external input, 6-7
  - first free address, 6-6
  - global conditions, 6-6

- labels, 6-6
  - start address, 6-6
- sequencer commands, 7-41
- sequencer instructions
  - mapping to cycles, 8-5
- sequencer start label, 7-4
- sequencer states, 6-2, 7-5
- series resistor, 11-2
- service request, 9-3
- service request enable register, 9-3
- setting driver format and timing, 4-6
- setting pin capabilities, 2-6
- setting receiver format and timing, 4-12
- setting the system clock period, 4-2
- setting up power supply pins, 2-9
- setting up the system clock, 4-2
- setups
  - format, 4-1
  - timing, 4-1
- specifying the timing reference, 3-2
- SPOLL, 9-3
- standard event summary bit, 9-5
- states
  - setting tester, 7-1
- static vectors, 5-2
- status byte, 9-1, 9-2
- status commands, 9-1-16
- status register, 9-6
- status reports, 9-1
- stopping a functional test, 7-6
- supported power supplies, 2-10
- synchronization
  - command, 9-12
  - system clock, 4-2
- system attributes, 11-4-5
- system clock
  - setting, 4-2
  - source, 4-2
  - synchronization, 4-2
- system clock period
  - setting, 4-2

## **T**

- tester states
  - setting, 7-1
- tester status registers, 9-6
- test function
  - status, 9-9
- test result per pin, 8-3
- threshold correction, 11-2
- timing offset, 11-1
- timing offsets, 11-3
- timing setup
  - corrections, 11-1
- Timing Setup
  - leading edge, 4-7
  - trailing edge, 4-10
- trailing edge

- timing, 4-10

- transition filter, 9-7

## **U**

- utility lines, 7-45

## **V**

- vector data size, 5-9

- vector sequencer commands, 6-1-9

- vector setup commands, 5-1-8

- vector transfer

- format, 5-6

- vector transfer commands, 5-1, 5-5

## **W**

- wildcard, 12-3







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