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***PTR20 through *PTR39;*DTA**

Description: Difference Equation Coefficients - Bank 2

GPIO Command Number: 120 (command), 121 to 139 (write)

Same as *PTR0 through *PTR19;*DTA for Coefficient Bank 2

***PTR40 through *PTR59;*DTA**

Description: Difference Equation Coefficients - Bank 3

GPIO Command Number: 140 (command), 141 to 159 (write)

Same as *PTR0 through *PTR19;*DTA for Coefficient Bank 3

***PTR60 through *PTR79;*DTA**

Description: Difference Equation Coefficients - Bank 4

GPIO Command Number: 160 (command), 161 to 179 (write)

Same as *PTR0 through *PTR19;*DTA for Coefficient Bank 4

***PTR80 through *PTR99;*DTA**

Description: Difference Equation Coefficients - Bank 5

GPIO Command Number: 180 (command), 181 to 199 (write)

Same as *PTR0 through *PTR19;*DTA for Coefficient Bank 5

***PTR100;*DTA**

Description: First Trace Data Item

Type: Read-Only Integer Data

Range: -32768 to +32767

GPIO Command Number: 1 (read)

GPIO Data Length: One or Two-Word Integer (See *TRC)

This mnemonic initializes the trace data pointer to the beginning of trace data, and loads the *DTA item with the first value in Trace Memory. How this value should be interpreted depends on which parameters have been traced (see *TRC). For additional information on reading trace data, see Buffer Utilization and Reading Trace Data on Page 4F-17.

For the binary interface, additional reads by the computer will retrieve successive values from trace memory. Zeroes will be returned when all of trace memory has been read.

NOTE

Initializing or loading data into the Reference Buffer (*PTR105) may move the Trace Memory area, causing invalid data to be read with this mnemonic.

***PTR101;*DTA**

Description: Next Trace Data Item

Type: Read-Only Integer Data

Range: -32768 to +32767 Power-up Default: 0

GPIO Command Number: none (see *PTR100;*DTA - GPIO command 1)

GPIO Data Length: One or Two-Word Integer (see *TRC)

The *PTR101 mnemonic increments the Trace Data pointer and loads *DTA with the next item in Trace Memory. How this value should be interpreted depends on which parameters were traced (*TRC) and how many trace data items have already been read. See Buffer Utilization and Reading Trace Data for additional details. Zeroes will be loaded into *DTA when the pointer passes the end of Trace Memory.

NOTE

Initializing or loading data into the Reference Buffer (*PTR105) may move the Trace Memory area, causing invalid data to be read with this mnemonic.

***PTR102;*DTA**

Description: Trip State

Type: Read-Only Integer Data

Range: 0 to 24

GPIO Command Number: 62 (read)

GPIO Data Length: One-Word Integer

The value of trip state indicates where in a position or velocity profile the Servo-Axis board is. Alternately, it indicates the type of buffered profiling currently being executed. *Figure 4F-7* illustrates the possible profiles and the corresponding values for the trip state.

***PTR103;*DTA**

Description: Motor Drive Value

Type: Read-Only Integer Data

Range: -32768 to +32767

GPIO Command Number: 63 (read)

GPIO Data Length: One-Word Integer

This is the current value of the motor drive signal. It is the value that would be on the 16-bit Motor Drive Output if that output were selected.

***PTR104;*DTA**

Description: Reference Position

Type: Read-Only Floating Point Data

GPIO Command Number: None†

† GPIO command 64 will return the reference position in RAW counts as a two-word integer regardless of the current I/O units.

The *PTR104 mnemonic loads *DTA with the current Reference Position. The value returned by *DTA? will be in the selected units (*ENG, *MET, *LAM or *RAW).

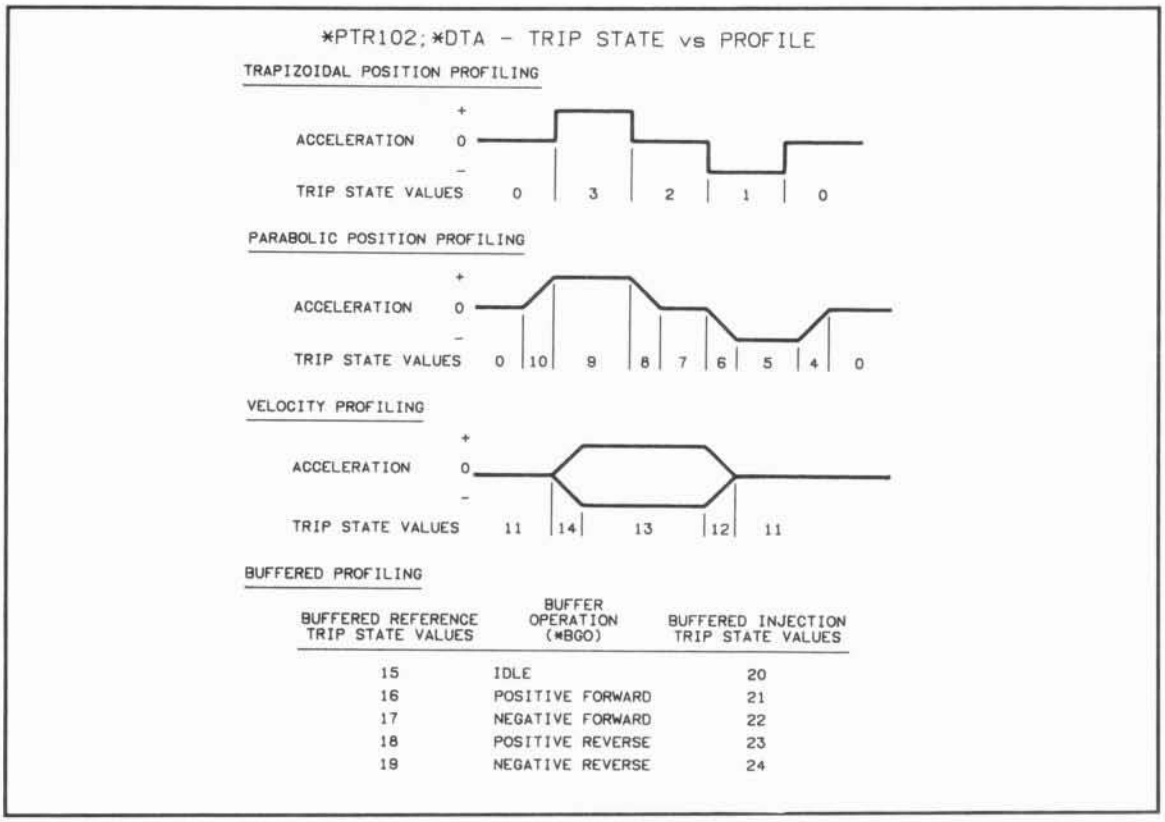


*Figure 4F-7. *PTR102;*DTA - Trip State vs Profile*

***PTR105;*DTA**

Description: Initialize Reference Buffer and Write

Type: Command/Write-Only Floating Point Data

Range:

English I/O units† : ±209 inches

Metric I/O units† : ±5310 millimeters

Raw or Lambda I/O : ±1,073,741,823 counts

† Values are for plane mirror interferometer. Range doubles if linear or single beam optics are used.

Power-up Default: 0

GPIO Command Number: 216 (command), 65 (write)

GPIO Data Length: Four-Word Floating Point Data

*PTR105 initializes (clears) the reference buffer (see Buffer Utilization). After sending this command, values sent to *DTA will be loaded into the reference buffer for buffered position profiling. The values are assumed to be in the current units (*RAW, *LAM, *MET, or *ENG).

NOTE

Initializing or loading data into the reference buffer may also move the start of Trace memory, causing invalid data to be read with the *PTR100 and *PTR101 mnemonics. If there is valid data in Trace Memory, read it before sending this command (see Buffer Utilization).

***PTR106;*DTA**

Description: Define Mnemonic for *UCN Command

Type: Write-Only Integer Data (Two Items)

Range: -32768 to +32767 Power-up Default: 0

GPIO Command Number: 66 (write)

GPIO Data Length: Two One-Word Integers

This mnemonic and two data values define the mnemonic to be executed when the *UCN command is sent. The value returned by the defined mnemonic must be a floating point value, or an error will be generated. *Figure 4F-8* illustrates how to determine the two values to send to *DTA to define a particular mnemonic.

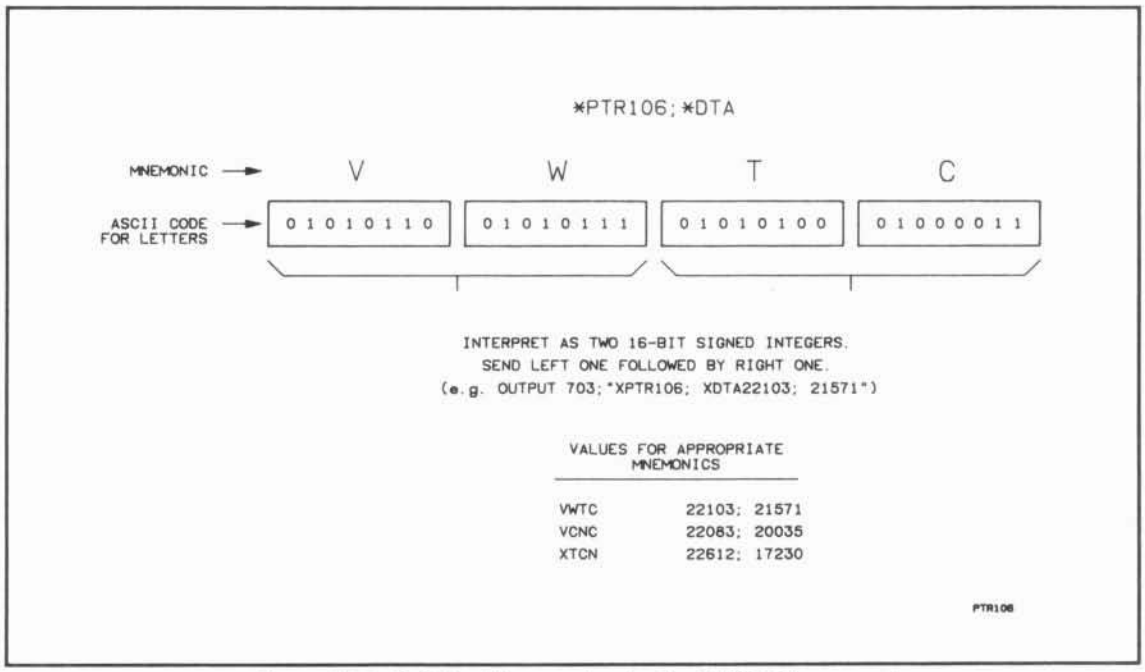


*Figure 4F-8. Defining Mnemonics for the *UCN Command*

***PTR107;*DTA**

Description: Last Bad Value

Type: Read-Only Floating Point Data

Range: ± 10 E 308

GPIO Command Number: 67 (read)

GPIO Data Length: Four-Word Floating Data

The *PTR107 mnemonic loads *DTA with the last value that generated an error on the Servo-Axis board.

***PTR108**

Description: Reserved

***PTR109**

Description: Update Position

Type: Command

GPIO Command Number: 218

This command is equivalent to a pulse on the external sample input. It causes the Servo-Axis board to update the *POS value when set to external sample mode (*EXT). The command will be ignored in internal sample mode.

***PTR110;*DTA**

Description: Drive Limit

Type: Read/Write Integer data

Range: 0 to +32767 Power-up Default: 0

GPIO Command Number: 68 (write) 69 (read)

GPIO Data Length: One-Word Integer

Sending a value to this mnemonic sets the maximum value for the motor drive signal. For example, sending XPTR110;XDTA16384 will limit the ±10V motor drive output to ± 5 volts.

***PTR 111;*DTA**

Description: Following Error Limit

Type: Floating Point data

Range: Power-up Default: −1count

English I/O units† : ±0 to 418 inches

Metric I/O units† : ±0 to 10620 millimeters

Raw or Lambda I/O : ±0 to 2,147,483,647 counts

† Values are for plane mirror interferometer. Range doubles if linear or single beam optics are used.

GPIO Command Number: 70 (write) 71 (read)

GPIO Data Length: Four-Word Floating Point

***PTR111;*DTA: Following Error Limit (Continued)**

Sending values to this mnemonic sets the maximum following error limits. Should the actual position differ from the reference position by more than the specified distance, an error will be generated and the servo turned off.

Sending values outside the specified range turns off the following error limit function by setting the limit to a value greater than the maximum position error (power-up default).

***PTR112;*DTA**

Description: Limit Switch Polarity

Type: Read/Write Integer data

Range: 0 to 7 Power-up Default: 0

GPIO Command Number: 72 (write) 73 (read)

GPIO Data Length: One-Word Integer

The *DTA value for *PTR112 specifies the polarity of the Hi Limit- and Low Limit- input lines as shown in *Figure 4F-9*. Bit 2 of this value may be set to disable the limit function and use these lines as general purpose input lines. Note that bits 0 and 1 do not affect the values returned in bits 0 and 1 of the Miscellaneous Status Word (*PTR113;*DTA).

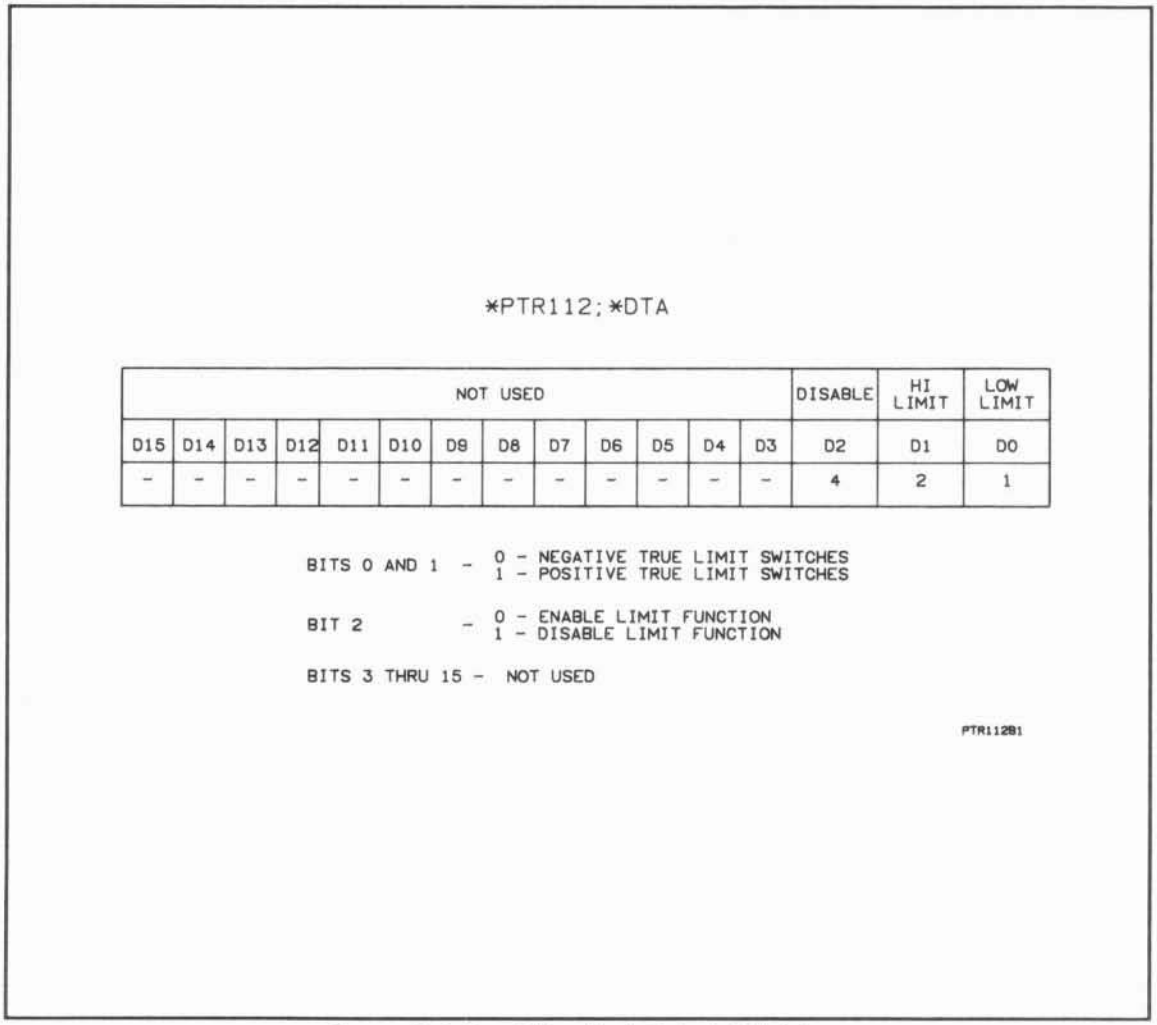


Figure 4F-9. Specifying Limit Switch Polarities

***PTR113;*DTA**

Description: Miscellaneous Status Word

Type: Read-Only Integer Data

Range: 0 to 16383 Power-up Default: 8716 to 8719

GPIO Command Number: 74

GPIO Data Length: One-Word Integer

Sending *PTR113 loads *DTA with the board/instrument status as indicated in *Figure 4F-10.*

*PTR113;*DTA

NOT USED	DELTA COMP	SYSTEM NULL	PATH ERROR	SYSTEM ERROR	RESERVED	AXIS NULL	COUNTER OVERFLOW	MEAS GLITCH	SLEW ERROR	RES. EXT. RESET	SAMPLE MODE	I/O UNITS		HI LIMIT	LOW LIMIT
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
-	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1

BITS 0,1 - LOGIC LEVEL OF REAR PANEL LIMIT SWITCH INPUTS

BITS 2,3 - PROGRAMED I/O UNITS
0 0 - RAW
0 1 - LAMBDA
1 0 - ENGLISH
1 1 - METRIC

BIT 4 - 0-INTERNAL *POS SAMPLE TRIGGERING
1-EXTERNAL *POS SAMPLE TRIGGERING

BITS 5 THRU 9 - POSITIVE TRUE STATUS OF THIS AXIS

BIT 10 - RESERVED

BITS 11 THRU 14 - POSITIVE TRUE STATUS OF HP5507A

BIT 15 - NOT USED

PTR113B1

Figure 4F-10. Instrument/Board Status Word

***PTR114;*DTA**

Description: Initialize User Difference Equation

Type: Command/Write-Only Integer Data

Range: -32768 to +32767 Power-up Default: 0

GPIO Command Number: 221 (command), 75 (write)

GPIO Data Length: One-Word Integer

*PTR114 initializes (clears) the memory area used for a downloaded difference equation. Values sent to *DTA after sending this command will be put in successive memory locations and executed by the 68020 each servo sample period when *DEQ is set to 2. See Custom Difference Equations on page 4F-24 for additional detail.

***PTR115;*DTA**

Description: Buffered Reference Interpolation Count/Loop Count

Type: Read/Write Floating Point Data

Range: 0 to 65535 (Integers only) Power-up Default: 0

GPIO Command Number: 76 (write) 77 (read)

GPIO Data Length: One-Word Integer (unsigned)

For *SVC 8 to 10, the *PTR115;*DTA value specifies how many servo sample periods will take place between each buffered reference value. For example, if a value of 4 was sent, then the reference position will be updated in the following manner.

Servo Sample Period	Reference Position Equals
X	Buffer Value (N)
X + 1	Buffer Value (N) + 1/5 D
X + 2	Buffer Value (N) + 2/5 D
X + 3	Buffer Value (N) + 3/5 D
X + 4	Buffer Value (N) + 4/5 D
X + 5	Buffer Value (N + 1)

where D = Buffer Value (N + 1) minus Buffer Value (N)

For *SVC 11 and 12‡, this value specifies how many times to repeat a *BGOn command. A value of 4 means the buffer will be looped through 5 times.

***PTR116;*DTA**

Description: Next Buffered Reference Index

Type: Read-Only Integer data

Range: 0 to 23999 Power-up Default: 0

GPIO Command Number: 78 (read)

GPIO Data Length: One-Word Integer

*PTR116 loads *DTA with a number indicating which value in the buffer is next. Referring to the example above, if the Servo-Axis board is in sample period X + 2, then *PTR116;*DTA? will return the value N + 1. If the board is in sample period X + 5, then N + 2 will be returned.

---

‡ Revisions after 2820 only; earlier revisions ignore this value in these modes.

***PTR117;*DTA**

Description: Current Buffered Reference Interpolation Count/Loop Count

Type: Read-Only Floating Point Data

Range: 0 to 65535 (integers only) Power-up Default: 0

GPIO Command Number: 79 (read)

GPIO Data Length: One-Word Integer (unsigned)

*PTR117 loads *DTA with the number of servo sample periods left before the next buffered reference value is used (*SVC 8-10) or the number of repetitions left (*SVC 11 and 12). Referring to the *PTR115 example, a value of 3 will be returned if the Servo-Axis board is in sample period X + 1, and a value of 0 will be returned when it is in period X + 4.

***PTR118 - *PTR199 (Reserved)**

***PTR200;*DTA through *PTR215;*DTA**

Description: Miscellaneous 16-Bit Variables

Type: Read/Write Integer data

Range: -32768 to 32767 Power-up Default: 0

GPIO Command Number: 300 to 315 (write) 316 to 331 (read)

GPIO Data Length: One-Word Integer

These variables are available for reading or writing parameters (other than the coefficient values) required by a downloaded difference equation.

***PTR216;*DTA through *PTR231;*DTA**

Description: Miscellaneous 32-Bit Variables

Type: Read/Write Floating Point

Range: -2,147,483,648 to 2,147,483,647 Power-up Default: 0

GPIO Command Number: 332 to 347 (write) 348 to 363 (read)

GPIO Data Length: Two-Word Integer

These variables are available for reading or writing parameters (other than the coefficient values) required by a downloaded difference equation.

***RAW**

Description: Select Raw-Count I/O Units

Type: Command

GPIO Command Number: 204

This command sets the I/O units to uncompensated lambda units (lambda/64, lambda/128, or lambda/256 depending on optics used -see *OPT). Bits 2 and 3 of *PTR113;*DTA indicate which units have been selected. The mnemonics affected are *DES, *DPD, *MKR, *NUL, *POS, *VEL, and *PTR 104, 105, and 111. Also see *ENG, *LAM, and *MET.

Note that *RAW also turns off deadpath correction (see *DPD).

The Servo-Axis board powers up in Metric units.

***REV**

Description: Servo-Axis Board's Software Revision Date

Type: Read-only Integer Data

GPIO Command Number: 3

GPIO Data Length: One-Word Integer

The *REV mnemonic returns the Servo-Axis board's software revision date in the following format:

<space>DDDD

where DDDD is the HP standard four-digit date code (e.g., 2732 represents the 32nd week of 1987).

***SPD**

Description: Servo Sample Period (in units of 125 ns)

Type: Read/Write Integer Data

Range: 1000 to 32000 Power-up Default: 8000

GPIO Command Number: 52 (write) 53 (read)

GPIO Data Length: One-Word Integer

*SPD sets the Servo Sample period, controlling how often the selected difference equation is run. This frequency can be calculated from the following equation:

Frequency = 8E+6 / *SPD value

NOTE - Setting a sample period shorter than the difference equation execution time causes the servo-axis board to lock-up. This is only a concern when using the IIR or downloaded difference equations. (See Custom Difference Equations.)

***STA**

Description: Servo-Axis Board's Status Byte

Type: Read-only Integer Data

GPIO Command Number: 61

GPIO Data Length: One-Word Integer

The value returned from *STA is normally zero. Non-zero values indicate various error conditions (see table). The status byte is reset with the 5507A front panel (soft) reset button, or with the equivalent ERST command. (GPIO command 219)

*STA Value	Condition
0	No errors; normal
40	Measurement Loss of Lock
41	Measurement Signal Absent
42	Position Counter Overflow
50	DEQ Entry with Drive On
51	DEQ Entry Out of Range
52	SVC Entry Out of Range
53	Profile Parameter error
54	PTR Entry Out of Range
55	DRE Entry Out of Range
56	Negative Feedfwd Entry
57	TST Entry Out of Range
58	Slaved Board is Not Servo
59	NUL Entry Out of Range
60	MKR Entry Out of Range
61	MKW Entry Out of Range
62	Data Sent to Non-Data PTR
63	CLK Entry Out of Range
64	Bad CLK for Multi-Axis Move
65	BGO Entry Out of Range
66	Bad SVC for Buffered Move
67	OPT Entry Out of Range
68	SPD Entry Out of Range
69	DIR Entry Out of Range
70	EMD Entry Out of Range
71	TCN Entry Out of Range
72	DES Entry Out of Range
73	GPIO Command to Non Servo Board
74	Unable to Locate UCN Mnemonic
75	UCN Mnemonic Not Initialized
76	Excessive Following Error
77	Limit Sense Entry Out of Range
78	Unable to Compile Mnemonic
79	Compiled Mnemonic non-existant
80	Attempted Read from Compiled Command
81	Write to non-writable Mnemonic
82	Too Many Compiled Mnemonics
83	Data Mnemonic Used as Command
84	User Equation Space Overflow
99	Fatal Exception: SSSS PPPPPPPP FVVV

***SVC**

Description: Servo Service Mode

Type: Read/Write Integer Data

Range: 0 to 12 Power-up Default: 0

GPIO Command Number: 54 (write), 55 (read)

GPIO Data Length: One-Word Integer

*SVC sets the servo-axis board's service mode (profiling method) as follows:

0 - Internal position profile ..... stand alone
1 - Internal position profile ..... master
2 - Internal position profile ..... slave
3 - External position profile
4 - Internal velocity profile..... stand alone
5 - Internal velocity profile..... master
6 - Internal velocity profile..... slave
7 - External velocity profile
8 - Buffered position profile..... stand alone
9 - Buffered position profile..... master
10 - Buffered position profile..... slave
11 - Buffered post filter injection..... stand alone
12 - Buffered filter stimulus ..... stand alone

Internal position/velocity profiling indicates that the reference positions are calculated from the programmed destination, velocity, acceleration and delta-acceleration values.

External position/velocity profiling indicates that the reference positions are calculated directly from the destination or velocity value.

Buffered profiling indicates the reference positions will be downloaded to the board prior to a *BGO command.

The Servo Clock source (*CLK) and Master Control Mask (*MCM) must correspond to the Master/Slave service mode set with this mnemonic.

***TCN**

Description: Total Compensation Number

Type: Read/Write Floating Point Data

Range: 0.99 to 1.01 Power-up Default: 0.999728766 (20 deg C, 760 mm Hg, 50% RH)

GPIO Command Number: 22 (write), 23 (read)

GPIO Data Length: Four-Word Floating Point

*TCN is the wavelength-of-light and material temperature compensation number used internally to multiply raw counts to obtain compensated position information for *POS. It is also used to compensate values for *DES, *MKR, *NUL, *DPD, and *PTR 104. Its value may be changed by the *UCN mnemonic.

In master-slave systems, the master's *TCN value is used by all of its slave boards.

***TRC**

Description: Trace Control Byte

Type: Read/Write Integer Data

Range: 0 to 255 Power-up Default: 0

GPIO Command Number: 56 (write), 57 (read)

GPIO Data Length: One-Word Integer

Selects which parameters are traced (value saved in internal memory once per Servo Sample period) and when trace is started. Each bit enables a trace as follows:

Bit	Value	Purpose
0	1	Reference data (Two-Word Integer)
1	2	Actual Position Data (Two-Word Integer)
2	4	Difference Equation Output (One-Word Integer)
3	8	Motor Drive (One-Word Integer)
4	16	Not currently used
5	32	Not currently used
6	64	Start trace on *DES/*VEL/*BGO Command (depends on *SVC value)
7	128	Start trace on this *TRC command

The order of the data in the buffer is Reference Position, Actual Position, Difference Equation, Motor Drive, Reference Position, Actual Position, etc. For example, *SVC0;*TRC67 causes the Servo-Axis board to store reference psoition and actual position data starting after the next *DES command. See Reading Trace Data for additional detail.

***TST**

Description: Special Test Mnemonic

Type: Read/Write Integer Data

Range: 0 to 7 Power-up Default: 0

GPIO Command Number: 58 (write), 59 (read)

GPIO Data Length: One-Word Integer

*TST is a special test mnemonic which switches the measurement input between the normal measurement inputs (selected by *MIN and *MEX) and seven fixed test frequency values equal to 6/(N+1) MHz where N is the value sent to *TST. Sending a *TST value of zero switches the measurement back to the last input selected by a *MIN or *MEX command (the position counter may lose lock).

***UCN**

Description: Update Compensation Number

Type: Command

GPIO Command Number: 217

*UCN causes the servo-axis board to read the value of the mnemonic sent to *PTR 106 and update the *TCN value.

***VEL**

Description: Profiling Velocity Limit (current units per second)

Type: Read/Write Floating Point Data

Range:

Plane Mirror or Differential Optics: ±25.4 cm/sec

Linear or Single Beam Interferometers: ±50.8 cm/sec

Power-up Default: 50 mm/sec

GPIO Command Number: 4 (write), 5 (read)

GPIO Data Length: Four-Word Floating Point

*VEL sets the maximum velocity for an internal position profile move, or actual velocity for an internal or external velocity profile move (see Reference Source and *SVC).

***ZRO**

Description: Position Counter Reset

Type: Command

GPIO Command Number: 210

*ZRO resets the position counter and destination to zero, defines TCN_0 for deadpath equations and stops position profile moves.

Servo-Axis Board Reset Response

Hard Reset

The variables and mode conditions listed in *Table 4F-3* are set when the system is forced into the "hard reset" cycle. The user may initialize hard reset by either:

- Power-cycling the HP 5507A Laser Transducer (i.e., cycling the ac power switch from on-to-off-to-on), or
- Sending the BOOT command to the HP-IB board
- Sending 220 to the Binary Interface
- Toggling the Internal Master Reset Switch located on the HP-IB board

Table 4F-3. Servo-Axis Board Hard Reset Defaults

Variable or Mode	Mnemonic	Reset Variable or Mode to
Optics Type	*OPT0, *OPT1, *OPT2	*OPT1 (Plane Mirror)
Direction Sense	*DIR0, *DIR1	*DIR0
Limit Switch Polarity	PTR112;*DTA0 ... *PTR112;*DTA7	*PTR112;*DTA0 (Negative true Limit Switch)
Measurement Input	*MEX, *MIN	*MEX (HP 10780A)
I/O Units	*MET, *ENG, *LAM, *RAW	*MET
Deadpath Distance	*DPD distance	*DPD0
Maximum Following Error	*PTR111;*DTA distance	Turned off
Sample Trigger Mode	*INT, *EXT	*INT (Internal Clock)
Error Mode	*EMD0, *EMD1, *EMD2, *EMD3	*EMD0 (This axis measurement errors)
Mnemonic for *UCN Command	*PTR106;*DTA Value, Value	Undefined
Master/Slave Relationship	*MCM0, ... *MCM255	*MCM0
Position Profiling Method	*SVC0 ... *SVC12	*SVC0 (Internal -Stand Alone)
Servo Clock Source	*CLK0 ... *CLK4	*CLK0 (Internal -Stand Alone)
Servo Sample Period	*SPD1000 ... *SPD32000	*SPD8000 (1 kHz)
Difference Equation	*DEQ0, *DEQ1, *DEQ2	*DEQ0 (PID)
Motor Drive Outputs	*OUT0 ... *OUT7	*OUT1 (±10V Analog)
Difference Equation Coefficients	*PTR0 thru *PTR99	Zero
Profile Parameter	*VEL, *ACC, *DAC	50 mm/sec, 0.1g, 1g/sec
Feed Forward Terms	*FFV, *FFA, *FFD	Zero
Drive Enable	*DRE0, *DRE1, *ACQ	*DRE0 (OFF)
Compensation	*TCN	0.999728766
Position	*POS	Zero
Destination	*DES	Zero
Status	*STA	Zero
Miscellaneous Status Word	*PTR113;*DTA	8716 to 8719
Hardware Outputs	*NUL,*MKR,*MKW	Zero
Reference Buffer	*PTR105	Cleared
Interpolation Count	*PTR115	Zero
Trace Buffer	*PTR100,*PTR101	Cleared
Downloaded Difference Equation	*PTR114	Cleared
Miscellaneous Variables	*PTR200 to *PTR231	Zero

Soft Reset

The "soft reset" cycle may be initialized by performing one of the following:

- Depressing the front panel RESET key
- Sending the ERST command to the HP-IB board
- Sending 219 to the Binary Interface
- Sending the HP-IB device independent commands Device Clear (DCL) or Selected Device Clear (SDC)

The "soft reset" performs the following on any axis with an error:

- Status byte (*STA) reset to zero
- Position counter reset to zero (only if measurement error)
- Measurement error reset
- Programming error reset

Only axes with an error will be reset. All other axes remain the same.

ERROR MESSAGES

The error messages, combined with the front panel annunciators (LEDs), provide assistance with both system programming and hardware problems. LED indications and sequences are covered briefly on page 4B-25 of the HP 5527A Designer's Guide.

Error Indications

The SYSTEM ERROR LED remains off if the system operates properly. If an error is detected in the system - be it a hardware, programming, or data entry error - the HP 5507A's operation is not suspended. Internal software enables the user to interrogate the system via the controller as to the source of the error. The ERRM? data request and binary interface commands 4810 through 4826 return an ASCII data item that contains the following information:

- Error source information
- Error number
- Short description of the error

After eliminating the cause of the error, the error message can be cleared by initiating a system "soft reset". Out of range values can be read back through the last bad value mnemonic (*PTR107;*DTA).

Servo-Axis Board Error Messages

–102 Card Self-test Failure

Servo-Axis board hardware errors found during the power-up self tests produce this error.

740 Measurement Loss of Lock

This error is sourced when a glitch or dropout affects the axis measurement input. The measurement data will be invalid when this occurs.

741 Measurement Signal Absent

This error indicates that there was no measurement signal present when the last "soft reset" was received.

742 Position Counter Overflow

The optics have traveled beyond the range of the electronics.

750 DEQ Entry with Drive On

The difference equation type cannot be changed while the servo is turned on.

751 DEQ Entry Out of Range

An attempt was made to load a difference equation number outside the permissible range (0, 1, 2).

752 SVC Entry Out of Range

An attempt was made to load a profiling method number outside the permissible range (0 to 12).

753 Profile Parameter error

This error is generated when a profiled move segment will take longer than (4.15) × (*SPD) minutes for the specified *DES, *VEL, *ACC, *DAC values.

754 PTR Entry Out of Range

An attempt was made to load a data pointer number outside the permissible range (0 to 231).

755 DRE Entry Out of Range

An attempt was made to load a servo enable/disable number outside the permissible range (0 or 1).

756 Negative Feed fwd Entry

An attempt was made to load a negative number for a feedforward term. The number must be positive (0 to 32767).

757 TST Entry Out of Range

An attempt was made to load a test number outside the permissible range (0 to 7).

758 Slaved board is Not Servo

There is no Servo-Axis board set to the backplane address that is specified by the value sent to the *MCM mnemonic.

759 NUL Entry Out of Range

An attempt was made to set the null window larger than the permissible range (0 to 10620 mm-plane mirror optics).

760 MKR Entry Out of Range

An attempt was made to set the marker position number beyond the permissible range (±5310 mm-plane mirror optics).

761 MKW Entry Out of Range

An attempt was made to load a marker width number outside the permissible range (0 to 12).

762 Data Sent to Non-Data PTR

A value was sent to the *DTA mnemonic when *PTR's value corresponds to a command or read-only operation.

763 CLK Entry Out of Range

An attempt was made to load a number for the servo sample clock source that is outside the permissible range (0 to 4).

764 Bad CLK for Multi Axis Move

*CLK must be set to 1 or 4 on a master Servo-Axis board for multiaxis moves.

765 BGO Entry Out of Range

An attempt was made to load a start sequence number outside the permissible range (0 to 4).

766 Bad SVC for Buffered Move

*SVC must be 8, 9 or 10 for *BGO entries of 1 to 4.

767 OPT Entry Out of Range

An attempt was made to load an optics type number outside the permissible range (0, 1, 2).

768 SPD Entry Out of Range

An attempt was made to load a number for the servo sample period that is outside the permissible range (1000 to 32000).

769 DIR Entry Out of Range

An attempt was made to load a direction sense number outside the permissible range (0 or 1).

770 EMD Entry Out of Range

An attempt was made to load an error mode number outside the permissible range (0 to 3).

771 TCN Entry Out of Range

An attempt was made to load a compensation number outside the permissible range (0.99 - 1.01).

772 DES Entry Out of Range

The destination data sent to the Servo-Axis board is outside the permissible range for the programmed combination of optics type and readout units.

773 GPIO Command to Non-Servo-Axis Board

No Servo-Axis board is set to the address specified by a binary interface command in the 512 to 4607 range.

774 Unable to Locate UCN Mnemonic

The mnemonic specified by the *PTR106;*DTA values does not exist in this HP 5507A configuration.

775 UCN Mnemonic Not Initialized

The *UCN command was sent before the update mnemonic has been defined with the *PTR106;*DTA values.

776 Excessive Following Error

The distance between the reference position and actual position has exceeded the Following Error Limit specified with the *PTR111;*DTA mnemonic.

777 Limit Sense Entry Out of Range

An attempt was made to load a number for the limit sense that is outside the permissible range (0 to 7).

778 Unable to Compile Mnemonic

The mnemonic specified in the 4800 binary interface command does not exist in this HP 5507A configuration.

779 Compiled Mnemonic non-existent

The compiled mnemonic specified in the 4801, 4802, 4803, or 4804 binary interface command has not been compiled yet.

780 Attempted Read from Compiled Command

The compiled mnemonic specified in the 4801 binary interface command is a command mnemonic and does not have readable data.

781 Write to non-writable Mnemonic

The compiled mnemonic specified in the 4802 binary interface command is a command or read-only type and cannot have data sent to it.

782 Too Many Compiled Mnemonics

An attempt was made to compile too many mnemonics . Maximum is 300.

783 Data Mnemonic Used as Command

The compiled mnemonic specified in the 4803 binary interface command is not a command mnemonic and must have data associated with it.

784 User Equation Space Overflow

The maximum space for a downloaded difference equation, 4096 bytes or 2048 words, has been exceeded.

799 Fatal Exception: SSSS PPPPPPPP FVVV

This error indicates a firmware execution error indicating a hardware failure or an incorrect instruction sequence in a downloaded difference equation.

S's = Status Register, P's = Prgm Counter, F = Format, V's = Exception Vector Offset.

Record the numbers (S, P, F and V) and contact HP for assistance.

SUMMARY LIST OF SERVO-AXIS BOARD MNEMONICS

Table 4F-4. Summary of Servo-Axis Board Mnemonics

HP-IB Mnemonic	Binary Interface #			Type	Response
	Write	Command	Read		
*ACC	6		7	Read/Write Floating Point	Read or writes the acceleration value used to calculate profiles. Range: greater than 0, Default: 0.1 g
*ACQ		200		Command	Causes the Servo-Axis board to turn on the servo with the destination set equal to the current position.
*BGO			60	Read/Write Integer	Start sequence in buffer. Range: 0 to 4
		211 thru 215		Command	Start sequence in Buffer
*CLK	36		37	Read/Write Integer	Selects the servo sample clock source. Range: 0 to 4, Default: 0
*DAC	8		9	Read/Write Floating Point	Reads or writes the delta acceleration value used to compute a profile. Power up Default: 1g/sec Range: Greater than 0
*DEQ	38		39	Read/Write Integer	Selects the difference equation (PID, IIR, downloaded). Range: 0,1,2 Power-up Default: 0

Table 4F-4. Summary of Servo-Axis Board Mnemonics (Continued)

HP-IB Mnemonic	Binary Interface #			Type	Response
	Write	Command	Read		
*DES	10		11	Read/Write Floating Point	Writes the servo-axis board's destination register in selected units (*ENG, *MET, *LAM, or *RAW). Range: ±5310 mm (plane mirror optics). Power-up Default: 0
	12		13	Read/Write 2-Word Integer	Destination in Raw Counts (binary interface only) Range: ±1,073,741,823
*DIR	40		41	Read/Write Integer	Sets the Direction sense Range: 0 or 1
*DPD	24		25	Read/Write Floating Point	Reads or writes the deadpath distance. Range: ±5310 mm (plane mirror optics). Power-up Default: 0
*DRE	42		43	Read/Write Integer	Turns the servo on or off. Range: 0 or 1
*DTA		See *Table 4F-5.*		Read/Write Floating Point	Used with *PTR for data entry. Range: Varies with *PTR value.
*EMD	44		45	Read/Write Integer	Reads or writes the Servo-Axis board's error mode. Range: 0 to 3, Default: 0
*ENG		201		Command	Sets the Position and Destination I/O units to compensated inches.
*EXT		205		Command	Selects the external (hardware) sample triggering source for the position data (*POS).
*FFA	18		19	Read/Write Integer	Reads or writes the acceleration feedforward term. Range: 0 to 32767, Default: 0
*FFD	20		21	Read/Write Integer	Reads or writes the delta acceleration feedforward term. Range: 0 to 32767, Default: 0
*FFV	16		17	Read/Write Integer	Reads or writes the velocity feedforward term. Range: 0 to 32767, Default: 0
*INT		206		Command	Selects the internal (software) sample triggering source for the position data (*POS).
*LAM		203		Command	Sets the Position and Destination I/O units to compensated raw counts (λ/64 or λ/128 depending on the optics used).
*MCM	46		47	Read/Write Integer	Reads or writes the master control mask used for coordinated multiaxis moves. Range: 0 to 255

Table 4F-4. Summary of Servo-Axis Board Mnemonics (Continued)

HP-IB Mnemonic	Binary Interface #			Type	Response
	Write	Command	Read		
*MET		202		Command	Sets the Position and Destination I/O units to compensated millimetres (power-up default).
*MEX		207		Command	Selects the external measurement input channel (HP 10780B Receiver). Power-up Default.
*MIN		208		Command	Selects the internal measurement input channel (HP 5518's internal Receiver).
*MKR	26		27	Read/Write Floating Point	Reads or writes the marker position used for Threshold and Window Outputs. Range: (plane mirror optics) ±5310 mm
	28		29	Read/Write 2-Word Integer	Marker position in Raw Counts (binary interface only) Range: ±1,073,741,823
*MKW	30		31	Read/Write Integer	Reads or writes the width specifier for the Window Output. Range: 0 to 12
*NAM			--	Read-only ASCII	Returns the string "SRVO <CR> <LF> and EOI"
*NUL	32		33	Read/Write Floating Point	Defines the Position Error Null range in current units. Range: 0 to 10620 mm (plane mirror optics). Power up Default: 0
	34		35	Read/Write 2-Word Integer	Nul range in Raw Counts (binary interface only) Range: 0 to 2,147,483,647
*OPT	48		49	Read/Write Integer	Specifies the Optics type. Range: 0,1,2; Default: 1
*OUT	50		51	Read/Write Integer	Selects which motor drive outputs will be active. Range: 0 to 7, Default: 1
*POS			14	Read-only Floating Point	Returns the Position counter's value in the selected I/O units (*RAW, *LAM, *ENG, *MET).
			15	Read-only 2-Word Integer	Position in Raw Counts (binary interface only)
*PRE		209		Command	Presets the position counter to the value currently in the Servo-Axis board's Marker register. (The five least significant bits are zeroed).
*PTR		See *Table 4F- 5.*		Read/Write Integer	Data pointer used with *DTA for data entry. Range: 0 to 231

Table 4F-4. Summary of Servo-Axis Board Mnemonics (Continued)

HP-IB Mnemonic	Binary Interface #			Type	Response
	Write	Command	Read		
*RAW		204		Command	Sets the Position and Destination I/O units to uncompensated raw counts.
*REV			3	Read-only Integer	Returns the Servo-Axis board's software revision date.
*SPD	52		53	Read/Write Integer	Specifies the servo sample period in increments of 125 ns. Range: 1000 to 32000. Default: 8000
*STA			61	Read-only Integer	Reads the status byte of the Servo-Axis board. See page 4F-51 for status byte values.
*SVC	54		55	Read/Write Integer	Selects the Servo-Axis board's profiling method. Range: 0 to 12, Default: 0
*TCN	22		23	Read/write Floating Point	*TCN is the wavelength-of-light and material temperature compensation number. Range: 0.00 to 1.01 Power-up Default: 0.999728766
*TRC	56		57	Read/Write Integer	Specifies which parameters will be traced. Range: 0 to 255
*TST	58		59	Read/Write Integer	A special test mnemonic that switches the axis measurement input between the normal measurement inputs (as selected by *MIN and *MEX) and seven test frequencies (6/(Value+1) MHz). Range: 0 to 7 Power-up Default: 0
*UCN		217		Command	Updates the compensation number (*TCN) using a previously defined mnemonic (see *PTR106)
*VEL	4		5	Read/Write Floating Point	Reads or writes the maximum velocity for profiled moves. Range: (Plane Mirror Optics) ±25.4 cm/sec Default: 50 mm/sec
*ZRO		210		Command	Resets the position counter and destination to zero and defines TCN_0 for deadpath correction.

*Table 4F-5. Binary Interface Command Numbers for Various *PTR Values*

*PTR Value	Binary Interface #			HP-IB Type	Function	*DTA	
	Write	Command	Read			Range	Default
0		100		Com	Start using Coefficient Bank 1 (*PTR1 to *PTR19)		
1-19	101 thru 119			R/W	Coefficients for bank 1 (PTR auto-increments after *DTA is sent)	−524,28 to 524,287 Resolution is 1/4096	
1	101			R/W	Kp for PID, Kx0 for IIR		0
2	102			R/W	Ki for PID, Ky1 for IIR		0
3	103			R/W	Kd for PID, Kx1 for IIR		0
4	104			R/W	Not Used-PID, Ky2 for IIR		0
5	105			R/W	Not Used-PID, Kx2 for IIR		0
6	106			R/W	Not Used-PID, Ky3 for IIR		0
7	107			R/W	Not Used-PID, Kx3 for IIR		0
8	108			R/W	Not Used-PID, Ky4 for IIR		0
9	109			R/W	Not Used-PID, Kx4 for IIR		0
10	110			R/W	Not Used-PID, Ky5 for IIR		0
11	111			R/W	Not Used-PID, Kx5 for IIR		0
12	112			R/W	Not Used-PID, Ky6 for IIR		0
13	113			R/W	Not Used-PID, Kx6 for IIR		0
14	114			R/W	Not Used-PID, Ky7 for IIR		0
15	115			R/W	Not Used-PID, Kx7 for IIR		0
16	116			R/W	Not Used-PID, Ky8 for IIR		0
17	117			R/W	Not Used-PID, Kx8 for IIR		0
18	118			R/W	Not Used-PID, Ky9 for IIR		0
19	119			R/W	Not Used-PID, Kx9 for IIR]		0
20		120		Com	Same as 0 for Bank 2		
21-39	121-139			R/W	Same as 1-19 for bank 2		
40		140		Com	Same as 0 for Bank 3		
41-59	141-159			R/W	Same as 1-19 for Bank 3		
60		160		Com	Same as 0 for Bank 4		
61-79	161-179			R/W	Same as 1-19 for Bank 4		
80		180		Com	Same as 0 for bank 5		
81-99	181-199			R/W	Same as 1-19 for bank 5		
100			1	RO	Set trace buffer to start, and read first item	−32768 to +32767	0
101			--	RO	Read next trace buffer location (see GPIO command 1)	−32768 to +32767	0
102			62	RO	Read current trip state See *Figure 4F-7* for *DTA meaning	0 to 24	0
103			63	RO	Read current Motor Drive value	−32768 to +32767	0
104			--	RO	Read current reference position in selected units (see GPIO command 64)	±5310 mm (plane mirror optics)	

*Table 4F-5. Binary Interface Command Numbers for Various *PTR Values (Continued)*

*PTR Value	Binary Interface #			HP-IB Type	Function	*DTA	
	Write	Command	Read			Range	Default
105	65	216		WO	Write buffer reference	±5310 mm (plane mirror optics)	0
106	66			WO	Define mnemonic for *UCN command. See *Figure 4F-8.*	−32768 to +32767	undefined
107			67	RO	Read last bad value	± 10E308	0
108					Reserved		
109		218		Com	Update position		
110	68		69	R/W	Read/write Motor Drive Limit	0 to +32767	0
111	70		71	R/W	Read/Write Following error limit (current units)	0 to 10620 mm (plane mirror optics)	−4.94nm
112	72		73	R/W	Read/Write Limit Switch polarity. See *Figure 4F-9* for *DTA meaning	0 to 7	0
113			74	RO	Read Miscellaneous Status Word (See *Figure 4F-10* for *DTA meanings)	0 to 16383	8716 to 8719
114	75	221		WO	Initialize User Difference Equation and Write Code to it.	−32768 to +32767	0
115	76		77	R/W	Read/Write Buffered Reference Interpolation/Loop Count	0 to 65535 (integers only)	0
116			78	RO	Read next Buffered Reference Index	0 to 23999	0
117			79	RO	Read current Buffered Reference Interpolation/Loop Count	0 to 65535 (integers only)	0
118-199					Reserved		
200-215	300-315		316-331	R/W	Read/Write miscellaneous 16-bit variables	−32768 to 32767	0
216-231	332-347		348-363	R/W	Read/Write miscellaneous 32-bit variables	−2,147,483,648 to	

Table 4F-6. HP-IB Board Equivalences

HP-IB Mnemonic	Equivalent Binary Interface Command Number
BOOT	220
ERST	219
ERRM	4810 thru 4826

Table 4F-7. Summary of Binary Interface Command Numbers

Command		Operation	Data Type
Binary Interface Number	**HP-IB Mnemonic**		
0		No operation	None - Command
1	PTR	Read trace buffer	One/two word integer
2		Read board address	One-word integer
3	REV	Read revision number	One-word integer
4	VEL	Set velocity	Four-word floating point
5	VEL	Read velocity	Four-word floating point
6	ACC	Set acceleration	Four-word floating point
7	ACC	Read acceleration	Four-word floating point
8	DAC	Set delta-acceleration	Four-word floating point
9	DAC	Read delta-acceleration	Four-word floating point
10	DES	Set destination in current units	Four-word floating point
11	DES	Read destination in current units	Four-word floating point
12		Set destination in raw units	Two-word integer
13		Read destination in raw units	Two-word integer
14	POS	Read position in current units	Four-word floating point
15		Read position in raw counts	Two-word integer
16	FFV	Set velocity feed forward	One-word integer
17	FFV	Read velocity feed forward	One-word integer
18	FFA	Set acceleration feed forward	One-word integer
19	FFA	Read acceleration feed forward	One-word integer
20	FFD	Set delta-acceleration feed forward	One-word integer
21	FFD	Read delta-acceleration feed forward	One-word integer
22	TCN	Set TCN value	Four-word floating point
23	TCN	Read TCN value	Four-word floating point
24	DPD	Set dead path distance	Four-word floating point
25	DPD	Read dead path distance	Four-word floating point
26	MKR	Set marker position-current units	Four-word floating point
27	MKR	Read marker position-current units	Four-word floating point
28		Set marker position in raw counts	Two-word integer
29		Read marker position in raw counts	Two-word integer
30	MKW	Set marker width	One-word integer
31	MKW	Read marker width	One-word integer
32	NUL	Set null in current units	Four-word floating point
33	NUL	Read null in current units	Four-word floating point
34		Set null in raw counts	Two-word integer
35		Read null in raw counts	Two-word integer
36	CLK	Set clock mode	One-word integer
37	CLK	Read clock mode	One-word integer
38	DEQ	Set difference equation type	One-word integer
39	DEQ	Read difference equation type	One-word integer
40	DIR	Set direction sense	One-word integer
41	DIR	Read direction sense	One-word integer
42	DRE	Set drive enable	One-word integer
43	DRE	Read drive enable	One-word integer
44	EMD	Set error mode	One-word integer
45	EMD	Read error mode	One-word integer
46	MCM	Set master control mask	One-word integer
47	MCM	Read master control mask	One-word integer
48	OPT	Set optics type	One-word integer
49	OPT	Read optics type	One-word integer
50	OUT	Set output mode	One-word integer
51	OUT	Read output mode	One-word integer
52	SPD	Set sample period	One-word integer
53	SPD	Read sample period	One-word integer
54	SVC	Set service mode	One-word integer
55	SVC	Read service mode	One-word integer
56	TRC	Set trace mode	One-word integer

Table 4F-7. Summary of Binary Interface Command Numbers (Continued)

Command		Operation	Data Type
Binary Interface Number	**HP-IB Mnemonic**		
57	TRC	Read trace mode	One-word integer
58	TST	Set test mode	One-word integer
59	TST	Read test mode	One-word integer
60	BGO	Read buffered go value	One-word integer
61	STA	Read board status byte	One-word integer
62	PTR	Read trip state	One-word integer
63	PTR	Read motor drive	One-word integer
64		Read reference position in Raw Counts	Two-word integer
65	PTR	Write next buffer location	Four-word floating point
66	PTR	Set TCN update mnemonic	Two One-word integers
67	PTR	Read last bad value	Four-word floating point
68	PTR	Set motor drive limit	One-word integer
69	PTR	Read motor drive limit	One-word integer
70	PTR	Set following error limit	Four-word floating point
71	PTR	Read following error limit	Four-word floating point
72	PTR	Set limit sense	One-word integer
73	PTR	Read limit sense	One-word integer
74	PTR	Read miscellaneous status word	One-word integer
75	PTR	Load user equation	One-word integer
76	PTR	Set buffered reference interpolation count	One-word integer
77	PTR	Read buffered reference interpolation count	One-word integer
78	PTR	Read current buffer index	One-word integer
79	PTR	Read current interpolation index	One-word integer
80 to 99		No operation	None - Command
100	PTR	Activate bank 1 coefficients	None - Command
101-119	PTR	Set Bank 1 coefficients	Four-word floating point
120	PTR	Activate bank 2 coefficients	None - Command
121-139	PTR	Set Bank 2 coefficients	Four-word floating point
140	PTR	Activate bank 3 coefficients	None - Command
141-159	PTR	Set Bank 3 coefficients	Four-word floating point
160	PTR	Activate bank 4 coefficients	None - Command
161-179	PTR	Set Bank 4 coefficients	Four-word floating point
180	PTR	Activate bank 5 coefficients	None - Command
181-199	PTR	Set Bank 5 coefficients	Four-word floating point
200	ACQ	Acquire lock	None - Command
201	ENG	Set english units	None - Command
202	MET	Set metric units	None - Command
203	LAM	Set lambda units	None - Command
204	RAW	Set raw units	None - Command
205	EXT	Set external sample mode	None - Command
206	INT	Set internal sample mode	None - Command
207	MEX	Set external measurement source	None - Command
208	MIN	Set internal measurement source	None - Command
209	PRE	Preset position counter	None - Command
210	ZRO	Zero destination and position counter	None - Command
211	BGO	Buffered go - follow master	None - Command
212	BGO	Buffered go - positive forward	None - Command
213	BGO	Buffered go - negative forward	None - Command
214	BGO	Buffered go - positive reverse	None - Command
215	BGO	Buffered go - negative reverse	None - Command
216	PTR	Clear and initialize buffer	None - Command
217	UCN	Update compensation number	None - Command
218	PTR	Update position	None - Command
219	ERST	Soft reset	None - Command
220	BOOT	Hard reset	None - Command

Table 4F-7. Summary of Binary Interface Command Numbers (Continued)

Command		Operation	Data Type
Binary Interface Number	**HP-IB Mnemonic**		
221	PTR	Clear and initialize user equation space	None - Command
222-299		No operation	None - Command
300-315		Set 16-bit miscellaneous variables 0-15	One-word integer
316-331		Read 16-bit miscellaneous variables 0-15	One-word integer
332-347		Set 32-bit miscellaneous variables 0-15	Two-word integer
348-363		Read 32-bit miscellaneous variables 0-15	Two-word integer
364-511		No operation	None - Command
512-1023		Same as 0-511† for servo at S address	Varies
1024-1535		Same as 0-511† for servo at T address	Varies
1536-2047		Same as 0-511† for servo at U address	Varies
2048-2559		Same as 0-511† for servo at V address	Varies
2560-3071		Same as 0-511† for servo at W address	Varies
3072-3583		Same as 0-511† for servo at X address	Varies
3584-4095		Same as 0-511† for servo at Y address	Varies
4096-4607		Same as 0-511† for servo at Z address	Varies
4608-4799		No operation	
4800		Compile new mnemonic	Write: Two One-word integers, Read: Two One-word integers
4801		Read from compiled mnemonic	Write: One-word integer, Read: compiled mnemonic data type
4802		Write to compiled mnemonic	Write: One-word integer, and compiled mnemonic data type
4803		Execute compiled mnemonic	Write: One-word integer,
4804		Read compiled mnemonic type	Write: One-word integer, Read: One-word integer and ASCII
4805-4809		No operation	None - Command
4810		Read error message this card	ASCII
4811		Read error message from card at address K	ASCII
4812		Read error message from card at address L	ASCII
4813		Read error message from card at address M	ASCII
4814		Read error message from card at address N	ASCII
4815		Read error message from card at address O	ASCII
4816		Read error message from card at address P	ASCII
4817		Read error message from card at address Q	ASCII
4818		Read error message from card at address R	ASCII
4819		Read error message from card at address S	ASCII
4820		Read error message from card at address T	ASCII
4821		Read error message from card at address U	ASCII
4822		Read error message from card at address V	ASCII
4823		Read error message from card at address W	ASCII
4824		Read error message from card at address X	ASCII
4825		Read error message from card at address Y	ASCII
4826		Read error message from card at address Z	ASCII

† To execute a function at a specific backplane address, add the command number for that function (0 through 511) to the base number for the desired address. For example, to set the servo-axis board at address Z to RAW units, 204 is added to 4096 yielding 4300 for the command number.

Note that commands 12, 13, 15, 28, 29, 34, and 35 (DES, POS, MKR, and NUL) read/write values in RAW counts only for the axis that receives the instruction. For example, sending 15 reads the position on this axis board in RAW counts, sending 3599 (3584 + 15) reads the position on the Y Servo-Axis board in its current units (unless this is the Y board, in which case RAW units would be used).

SECTION IV

SUBSECTION G
RESERVED FOR FUTURE USE

SECTION IV

SUBSECTION H
RESERVED FOR FUTURE USE

SECTION IV

SUBSECTION I
HP 10941A PROTOTYPING KIT

CONTENTS

SECTION IV

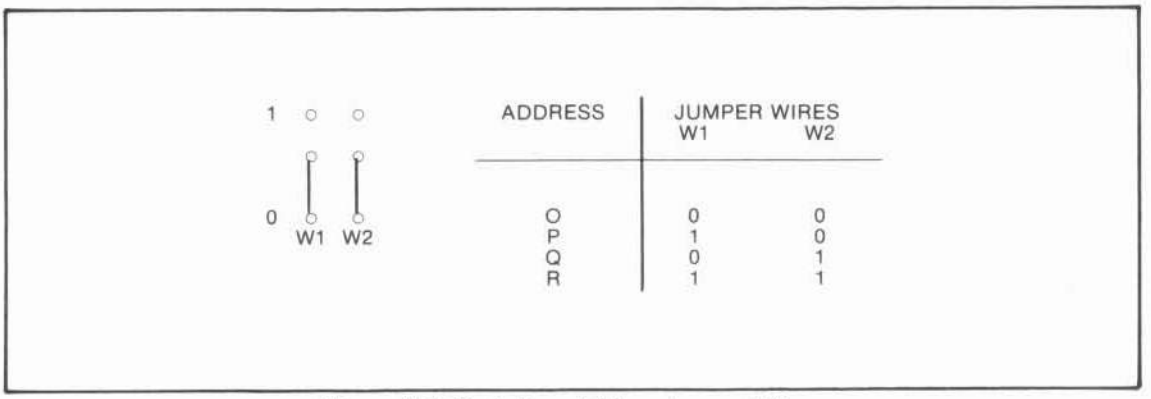
SUBSECTION I
HP 10941A PROTOTYPING KIT

HP 10941A PROTOTYPING BOARD

The prototyping board provides OEMs and other end users with an electrically and mechanically compatible foundation for adding custom circuitry to the HP 5507A. The board's bus interface allows the eight input strobes (INA- through INH-) and eight output strobes (OUTA- through OUTH-) to be accessed as eight unsigned byte type data items (range 0-255), four two's complement 16-bit data items (range -32768 to +32767), or any combination of the two.

Addresses

The prototyping board may be configured to backplane address O, P, Q, or R by adjusting the position of two jumper blocks as shown in *Figure 4I-1* below. Each prototyping board installed MUST be set to a unique address. All are preset to 0 at the factory.



ADDRESS	JUMPER WIRES W1	W2
O	0	0
P	1	0
Q	0	1
R	1	1

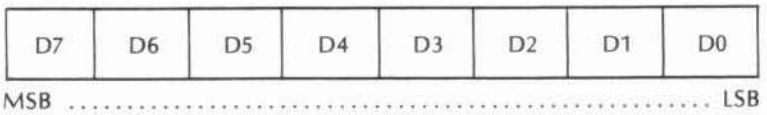
Figure 4I-1. Backplane Address Jumper Wires

Data Transfer

Unsigned 8-bit data items are accessed using byte mnemonics *BYA through *BYH to activate the strobe lines. The 16-bit two's complement word mnemonics (*WDA, *WDC, *WDE, and *WDG), sequentially activate pairs of the same strobes activated individually by the byte mnemonics. *Table 4I-1* includes a summary of data mnemonics and their corresponding I/O strobe lines.

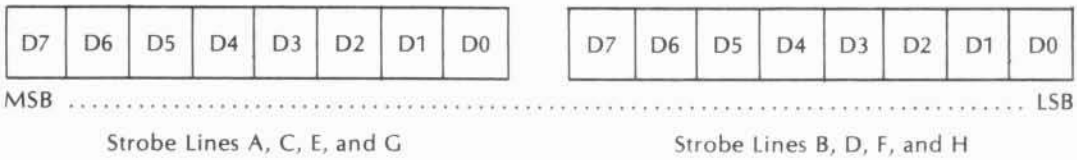
DATA FORMAT

8-Bit Data Format



Range: 0-255
Type: Unsigned Binary (Positive Logic)

16-Bit Data Format



Range: -32768 to +32767
Type: Two's complement (Positive Logic)

READING DATA FROM THE PROTOTYPING BOARD

Reading data from a mnemonic causes the associated data strobe line(s) to momentarily pulse low. For example, sending the byte mnemonic "PBYH?" momentarily pulses the INH- input strobe on a prototyping board set to address P. On the trailing edge of the strobe line, the HP-IB board reads the prototyping board's data bus and loads the ASCII equivalent into its output buffer. This data will then be output over the HP-IB bus when the HP 5507A is addressed to talk.

Word mnemonics *WDA, *WDC, *WDE, and *WDG, are used to transfer 16-bit two's complement integers, high byte first. For example, sending "PWDC?" momentarily pulses the INC- input line low first, followed by the IND- strobe line. Together, these lines may be used to gate both bytes of a 16-bit two's complement integer.

WRITING DATA TO THE PROTOTYPING BOARD

Sending data to a prototyping board byte mnemonic causes that data to appear on the prototyping board bus in unsigned 8-bit form and simultaneously pulses low a corresponding output strobe line. For example, sending "PBYC 147" causes the prototyping board's OUTC- line to pulse low and the binary equivalent of 147 to appear on the data bus.

Sixteen-bit two's complement integers may be sent using a word mnemonic (*WDA, *WDC, *WDE, or *WDG), and the corresponding pair of data strobes. The most significant byte is written first using strobe lines A, C, E, or G.

Software Mnemonics Recognized by the Prototyping Board

NOTE

In all programming instructions, 0 is zero and O is the letter O.

The following mnemonics are recognized by the prototyping board. The "*" preceding them denotes the current address of the board, which can be "O", "P", "Q", or "R". The address is selected by the system designer.

Mnemonics noted as "Read-only" or "Read/Write", are read over HP-IB by issuing the mnemonic, followed by a "?" (e.g., QNAM?).

Mnemonics noted as "Read/Write" are written to via the HP-IB Bus by issuing the appropriate mnemonic followed by data (numeric argument). (e.g., QBYB 127.)

Table 4I-1. Prototyping Board Mnemonics

Mnemonic *=Board Address	Type	Response All strobe lines are negative true logic	Page
*BYA	Read/Write Integer Data	INA- or OUTA- data strobe lines activated. Range: 0-255	4I-1
*BYB	Read/Write Integer Data	INB- or OUTB- data strobe lines activated. Range: 0-255	4I-1
*BYC	Read/Write Integer Data	INC- or OUTC- data strobe lines activated. Range: 0-255	4I-1
*BYD	Read/Write Integer Data	IND- or OUTD- data strobe lines activated. Range: 0-255	4I-1
*BYE	Read/Write Integer Data	INE- or OUTE- data strobe lines activated. Range: 0-255	4I-1
*BYF	Read/Write Integer Data	INF- or OUTF- data strobe lines activated. Range: 0-255	4I-1
*BYG	Read/Write Integer Data	ING- or OUTG- data strobe lines activated. Range: 0-255	4I-1
*BYH	Read/Write Integer Data	INH- or OUTH- data strobe lines activated. Range: 0-255	4I-1
*NAM	Read-only ASCII Data	Reading *NAM returns the string "PROT<CR><LF> and EOI"	—
*STA	Read-only Integer Data	Prototyping board's status byte. A status byte value of zero indicates that the Prototyping board is operational.	—
*WDA	Read/Write Integer Data	INA- then INB- or OUTA- then OUTB- data strobe lines activated. Range: -32768 to +32767	4I-1
*WDC	Read/Write Integer Data	INC- then IND- or OUTC- then OUTD- data strobe lines activated. Range: -32768 to +32767	4I-1
*WDE	Read/Write Integer Data	INE- then INF- or OUTE- then OUTF- data strobe lines activated. Range: -32768 to +32767	4I-1
*WDG	Read/Write Integer Data	ING- then INH- or OUTG- then OUTH- data strobe lines activated. Range: -32768 to +32767	4I-1

The asterisk (*) preceding the mnemonic denotes the selected address of the prototyping board (O, P, Q, or R).

"IN-"strobes are activated when the "?" is sent.

"OUT-" strobes are activated when a numeric argument is sent.

Table 4I-2. HP-IB Board Mnemonics Affecting the Prototyping Board

BOOT	Command	Causes the Hard Reset line to pulse low (see HP-IB Board mnemonics for more information).
ERST	Command	Causes Soft Reset line to pulse low (see HP-IB Board mnemonics for more information).

Prototyping Board Error Messages

The prototyping board will not source any error messages. If a designer-added gate is used to pull the backplane Error– line low, the HP-IB board responds with an "Error –500: Unidentified system error" indication when polled with the "ERRM?" data request.

PROTOTYPING BOARD CONFIGURATION SHEET

Address (O, P, Q, or R) Set at _____

MNEMONIC	INPUT MEANING (Mnemonic followed by "?")	OUTPUT MEANING (Mnemonic followed by Data)
*BYA (High Byte of *WDA)		
*BYB (Low Byte of *WDA)		
*BYC (High Byte of *WDC)		
*BYD (Low Byte of *WDC)		
*BYE (High Byte of *WDE)		
*BYF (Low Byte of *WDE)		
*BYG (High Byte of *WDG)		
*BYH (Low Byte Of *WDG)		
*WDA		
*WDC		
*WDE		
*WDG		

The asterisk (*) preceding the mnemonic denotes the selected address of the prototyping board (O, P, Q, or R).

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PROTOTYPING BOARD CONFIGURATION SHEET

Address (O, P, Q, or R) Set at _____

MNEMONIC	INPUT MEANING (Mnemonic followed by "?")	OUTPUT MEANING (Mnemonic followed by Data)
*BYA (High Byte of *WDA)		
*BYB (Low Byte of *WDA)		
*BYC (High Byte of *WDC)		
*BYD (Low Byte of *WDC)		
*BYE (High Byte of *WDE)		
*BYF (Low Byte of *WDE)		
*BYG (High Byte of *WDG)		
*BYH (Low Byte Of *WDG)		
*WDA		
*WDC		
*WDE		
*WDG		

The asterisk (*) preceding the mnemonic denotes the selected address of the prototyping board (O, P, Q, or R).

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PROTOTYPING BOARD CONFIGURATION SHEET

Address (O, P, Q, or R) Set at _____

MNEMONIC	INPUT MEANING (Mnemonic followed by "?")	OUTPUT MEANING (Mnemonic followed by Data)
*BYA (High Byte of *WDA)		
*BYB (Low Byte of *WDA)		
*BYC (High Byte of *WDC)		
*BYD (Low Byte of *WDC)		
*BYE (High Byte of *WDE)		
*BYF (Low Byte of *WDE)		
*BYG (High Byte of *WDG)		
*BYH (Low Byte Of *WDG)		
*WDA		
*WDC		
*WDE		
*WDG		

The asterisk (*) preceding the mnemonic denotes the selected address of the prototyping board (O, P, Q, or R).

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SECTION IV

SUBSECTION J
RESERVED FOR FUTURE USE

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SECTION IV

SUBSECTION K
HP 10946B AUTOMATIC COMPENSATION BOARD

CONTENTS

SECTION IV

SUBSECTION K
HP 10946B AUTOMATIC COMPENSATION BOARD

HP 10946B AUTOMATIC COMPENSATION BOARD

The HP 10946B Automatic Compensation board converts analog temperature, pressure, and humidity information from the HP 10751A/B Air Sensor and the HP 10757A/B/C Material Temperature Sensor into wavelength-of-light or total compensation number data. It also monitors an HP 10717A Wavelength Tracker to produce an extremely accurate wavelength-of-light compensation number.

Addresses

The automatic compensation board may be set to backplane address S, T, U, or V (see *Figure 4K-1*). Logical "ones" are indicated when the individual switch levers point away from the printed circuit board.

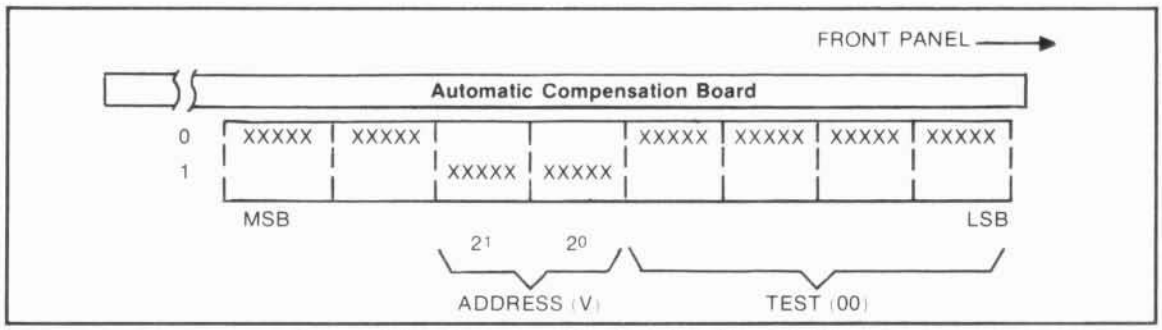

Figure 4K-1. Compensation Board, Address Setting

Programming Summary for the Automatic Compensation board

The compensation board can be used in four basic ways for wavelength-of-light compensation:

1. Manual Compensation,
2. Air Sensor Input,
3. Wavelength Tracker Input, and
4. Both Air Sensor and Wavelength Tracker Inputs.

Each method is covered in detail by subsequent paragraphs. In all cases, HP 10757A/B/C Material Temperature Sensors may be connected. The measurement units are selected [*ENG or *MET (default)] and then the sensor values can be read with the *MT1?, *MT2? and *MTA? queries. To include material expansion/contraction effects in the compensation numbers, the coefficient of thermal expansion (n) must be set with the *ECVn mnemonic. Using n = 0 removes material temperature correction from the compensation numbers.

An auxiliary channel is also available to read voltages between +1 and −1 Volts. It is accessed through the *VAC? query (*CEB bit 5 must be set).

Troubleshooting and calibration mnemonics are listed in *Tables 4K-1* and *4K-2* respectively.

Table 4K-1. Troubleshooting Mnemonics

*RST	Resets the Compensation board
*STA	Reads the Status Byte
*TST	Selects Output Units — sensor values (Pressure and Temperature) or actual sensor voltages
*VGC	Reads the Ground Channel Voltage
*VRC	Reads the Reference Channel Voltage

Table 4K-2. Calibration Mnemonics

*CRC	Stores the Calibration Numbers
*CRE	Enables the *CRC Command
*RVA	Reads/Writes +10 V Calibration Value
*RVB	Reads/Writes +0.5 V Calibration Value
*WRL	Reads/Writes Wavelength Tracker Reference Length (Length stamped on etalon)

MANUAL COMPENSATION

For manual compensation, the units are selected with *ENG or *MET (default) and then the environmental parameters are sent to the compensation board with the following mnemonics:

*AHV — Air Humidity Value
*APV — Air Pressure Value
*ATV — Air Temperature value
*MTA — Material Temperature Average
*ECV — Expansion Coefficient Value

The compensation number is calculated and available through the *CNV? query. The number read (n) can then be sent to any axis board (*TCN n). This method of generating a compensation number is always available regardless of what sensors are connected.

AIR SENSOR INPUTS

When an HP 10751A/B Air Sensor is connected, the compensation board uses the sensor's values for calculating the compensation number *CNV. These values (air pressure, temperature and humidity) may be read or written using the above mnemonics. If a value is written, then the board disables (stops updating the value from the sensor) the associated sensor channel. To re-enable a channel (or selectively enable/disable one), the Channel Enable Byte (*CEB) may be sent a new value. Reading the current value (*CEB?) reveals which channels are enabled. This is useful when some sensors do not apply to the compensation number, but need to be monitored.

WAVELENGTH TRACKER INPUTS

In order to use the HP 10717A Wavelength Tracker, the compensation board's Wavelength Tracking function must be enabled by setting *WTE to 1 with either of the following two mnemonics:

*CMC1 — Configures the compensation board so it will power-up with *WTE = 1 (should be sent only once).

*WTE1 — Immediately enables Wavelength Tracking Compensation (doesn't need to be sent if *CMC has been set to 1 and the system has been reset).

Once Wavelength Tracking has been enabled, the compensation board uses phase information to update the Wavelength Tracker Compensation number (*WTC). This number is initially set to

0.999728766 (20°C, 760 mm Hg, and 50% Relative Humidity), but can be preset to another value (n) by sending *WTCn.

Wavelength Tracking Compensation numbers may optionally be filtered by the compensation board. A simple digital filter simulates an analog filter with a time constant equal to the *FTC value. HP recommends setting *FTC to at least the time between *WTC? queries if possible.

The compensation board can also recover from measurement signal interruptions. The beginning of an interruption starts a timer which can be read with the *DDV? query. When the measurement signal returns, the board stops the timer, assumes the wavelength changed less than ±0.62 ppm (signal changed less than ±180° of phase) and recovers the measurement. If this assumption is false, then the *WTC value will be off by at least 1.25 ppm (board locks onto the signal a multiple of 360° out of phase). The *DDV time gives an indication of the assumption's validity for the current environment.

After a hard reset, any signal interruption will generate COMP ERROR 903: MEASUREMENT signal error. This immediate error reporting can be changed by using the Downtime Timeout Value mnemonic *DTV. Setting *DTV to a nonzero value prevents error generation for signal interruptions shorter than the specified timeout value. Doing this does not affect the operation of the *DDV? query, which returns the duration of any signal interruption.

BOTH AIR SENSOR AND WAVELENGTH TRACKER INPUTS

Using both of these inputs may be useful in some applications. For instance, the *CNV value could be used to initialize the *WTC value to get good absolute accuracy, and then the *WTC value used for actual compensation to get great repeatability.

Operationally, the board multiplexes the above calculations. Most of the mnemonics work the same. The difference is in the alert function (discussed in the next paragraph). Only one of the two compensation numbers (*CNV or *WTC) is permitted to generate an alert. The *CNV mnemonic will be used unless Wavelength Tracking is enabled (*WTE = 1), in which case *WTC will be used.

Programming the Compensation Alert Function

Some applications may choose to read the compensation number and update an axis board's *TCN value before every measurement read or destination write. However, doing this could take valuable time. An alternative solution is to only update the *TCN value when the compensation number changes by an amount great enough to affect system accuracy. The compensation alert function does this task.

The following steps are required to set-up and enable the alert:

1. Select which compensation number will be used to generate the alert, *CNV or *WTC. If Wavelength Tracking is enabled (*WTE = 1) then *WTC is chosen, otherwise *CNV is used.
2. Determine the minimum compensation number change that degrades system accuracy (e.g. ± 0.4 ppm).
3. Send this value to the compensation board with the *CNL (used if *CNV was selected) or the *WTL (used if *WTC was selected) mnemonic. For example, sending *WTL4E-7 sets the limit to ±0.4 ppm.

4. Set the system controller so it will recognize, and respond to, an HP-IB SRQ interrupt (see programming manuals for system controller). Usually this will involve labeling a program segment as the interrupt handling routine and then enabling the specific interrupt.
5. Enable the HP 5507A to issue SRQ interrupts over HP-IB by setting IMSK to a value ≤128 (see Section IV-B).

Now, when the selected compensation number changes by an amount greater than the *CNL/*WTL value, the new number is latched in a register and an SRQ interrupt generated. The interrupt handling routine can read the latched value with either the *CNR? (used if *CNV was selected) or the *WTR? (used if *WTC was selected) query. The value returned, or the *CNV/*WTC value, can then be sent to the axis board (*TCN). The interrupt routine must also clear the SRQ request (see Section IV-B) and repeat step 3 above to re-enable the alert.

Sending a value of 0 to *CNL/*WTL disables the alert function.

Software Mnemonics Recognized by the Automatic Compensation Board

The following mnemonics are recognized by the compensation board. The '*' preceding them denotes the current address of the board, which can be "S", "T", "U", or "V". It will be shipped as "V".

Mnemonics noted as "read only" or "read/write" can by read over HP-IB by issuing the mnemonic, followed by a "?" (e.g., VCNV?).

Values can be written to "read/write" mnemonics by adding a numerical suffix (argument) to the mnemonic (e.g., VAHV 75.0).

Mnemonics noted as "commands" are not associated with a value that can be read or written. Issuing the command causes some action to be taken, or causes the compensation board to change states.

***AHV**

Description: Air Humidity Value

Type: Read/Write Floating Point Data
Range: 0 to 95% No Sensor Default: 50%

*AHV sets or reads air humidity. Writing data to *AHV also disables the channel (see *CEB).

When *TST is set to 1, *AHV reads the actual voltage on the appropriate A/D channel.

***APV**

Description: Air Pressure Value

Type: Read/Write Floating Point Data
Range: 500 to 800 mm Hg (19.69 to 31.5 inches Hg) No Sensor Default: 760 mm Hg

*APV sets or reads air pressure. Writing data to *APV also disables the channel (see *CEB). The mnemonics *MET and *ENG program the units used (mm Hg or in Hg respectively).

When *TST is set to 1, *APV reads the actual voltage on the appropriate A/D channel.

***ATV**

Description: Air Temperature Value

Type: Read/Write Floating Point Data
Range: 0 to 40°C (32 to 104°F) No Sensor Default: 20°C

*ATV sets or reads air temperature. Writing data to *ATV also disables the channel (see *CEB). The mnemonics *MET and *ENG program the units used (°C or °F).

When *TST is set to 1, *ATV reads the actual voltage on the appropriate A/D channel.

***CEB**

Description: Channel Enable Byte

Type: Read/Write Integer Data
Range: 0-255 Power-up Default: ≤128 (depends on sensors connected)

This mnemonic reads or writes a byte corresponding to the sensor channels enabled. Enabled channels have a 1 in their associated bit and will be read for A/D conversion. Disabled channels have a zero and will be ignored.

Use of this feature allows direct enabling or disabling of sensors. The fewer enabled channels, the faster the enabled channels are updated. For example, enabling only the air pressure channel (*CEB 1) results in the fastest possible update rate of 2.5 times per second. When a channel is disabled, the last update value or the latest programmed value is used for that variable in calculations.

Channels are also disabled indirectly whenever the associated variable value is programmed. Attempting to enable a channel without a sensor connected will neither generate an error, nor enable the channel.

Neither the Analog Ground Channel nor the +0.5 Volt Reference Channel are enabled unless a fault occurs or the *TST mnemonic is set to 1.

Bits in the Channel Enable Byte have the following significance (Bit set to 1 = channel enabled):

Analog Ground Channel	+0.5 Volt Reference Channel	Aux Channel	Air Humidity	Material Temper-ature 2	Material Temper-ature 1	Air Temper-ature	Air Pressure
D7	D6	D5	D4	D3	D2	D1	D0
128	64	32	16	8	4	2	1
MSB							LSB

***CMC**

Description: Compensator Mode Control

Type: Read/Write Integer Data
Range: 0 or 1 Factory Setting: 0

*CMC is stored in non-volatile memory and its value instructs the the HP 10946B to ignore (*CMC = 0) or implement (*CMC = 1) the Wavelength Tracking function automatically following a system power-up or reset (see *WTE).

***CNL**

Description: Compensation Number Limit ("Alert Range")

Type: Read/Write Floating Point Data
Range: -0.0000100 to +0.0000100 (±10.0 ppm)
Power-up Default: 0.0000000

Although compensation is generally required, the compensation value only needs updating when it changes. This mnemonic instructs the automatic compensation board to generate an alert through the HP-IB SRQ interrupt (must be enabled by IMSK ≥128) if the total compensation number (*CNV) changes by an amount exceeding the *CNL value. (If Wavelength Tracking is being used, then the alert function is controlled by *WTL and *WTR, not *CNL and *CNR.)

To enable the alert (or re-enable it after one has occurred), *CNL must be set to a nonzero number. This clears any previous alerts and sets the *CNR value = *CNV. The alert is generated when |*CNV - *CNR| ≥ |*CNL|.

Note that writing either 0 or 1 to *WTE sets *CNL to 0.

***CNR**

Description: Compensation Number Change Register

Type: Read-only Floating Point Data

This register is both the base line and the latch for the compensation number change limit feature. It tracks the value of *CNV (compensation number value) but is frozen when *CNL is set to a nonzero number. Then when *CNV deviates from this base line by more than the programmed limit, the register latches the new value and SRQ will be asserted (if enabled by IMSK). *CNR will retain this new value until *CNL is set again.

If Wavelength Tracking is in use, then *WTR should be used instead of *CNR.

***CNV**

Description: Compensation Number Value

Type: Read-only Floating Point Data
No Sensor Default: 0.999728766 (20°C, 760 mm Hg, 50% Relative Humidity)

Reads the current total compensation number calculated from air pressure (*APV), air temperature (*ATV), air humidity (*AHV), material temperature (*MTA) and the expansion coefficient (*ECV) values.

***CRC**

Description: Calibrate References Command

Type: Command

This command instructs the compensation board to store the +10V REF (*RVA), +0.5V REF (*RVB), and Wavelength Reference Length (*WRL) data currently stored in the mailbox. The error message "Error 890 - CRE command must precede CRC" will be generated if the *CRE command has not been received prior to this one. Receipt of the *CRC command also disables calibration until another *CRE is received.

***CRE**

Description: Calibrate References Enable

Type: Command

This command enables the automatic compensator for the calibration command. At least one *CRE command must be sent prior to each calibration command. However, once this command is sent, only BOOT *RST, *TST, or *CRC will disable calibration.

***DDV**

Description: Downtime Duration Value

Type: Read-only Floating Point Data
Resolution: 0.001 seconds

This mnemonic reads the duration (in seconds) of the most recent (or current) Wavelength Tracker measurement interruption that has generated an error. Measurement interruptions that do not exceed the *DTV value won't generate an error or affect the Downtime Duration Value. Interruptions that exceed 65 seconds are reported as 65 seconds.

***DTV**

Description: Downtime Timeout Value

Type: Read/Write Floating Point Data
Range: 0 to 65 seconds Power-up Default: 0 seconds
Resolution: 0.001 seconds

*DTV reads or writes the amount of time that a Wavelength Tracker measurement signal interruption exists before the error is indicated by the HP 10946B. See "Wavelength Tracker Inputs" paragraphs found in this section for more information.

***ECV**

Description: Expansion Coefficient Value

Type: Read/Write Floating Point Data
Range: ±0.000180/°C (±180 ppm/°C)
±0.000100/°F (±100 ppm/°F)
Power-up Default: 0.000000

Sets or reads the material thermal expansion coefficient value. When *ECV is set to a nonzero value, material expansion compensation is enabled and both compensation numbers (*CNV and *WTC) includes its effects. The mnemonics *MET and *ENG program the units in parts/°C and parts/°F respectively.

***ENG**

Description: Set English Units
Type: Command

Sets the measurement units of the inputs and outputs of the automatic compensator to English (°F, inches Hg, and parts/°F). The following mnemonics are affected: *APV, *ATV, *ECV, *MTA, *MT1, and *MT2.

***FTC**

Description: Filter Time Constant

Type: Read/Write Floating Point Data
Range: 0, 0.050 to 5 seconds Power-up Default: 0 seconds (disabled)

The compensation board can be programmed to filter the Wavelength Tracker Compensation number data (*WTC). When *FTC is a non zero value, *WTC data is filtered by a digital filter that simulates a single pole analog filter with a time constant equal to *FTC. Setting *FTC to zero disables the filter. See "Wavelength Tracker Inputs" paragraphs found in this section for more information.

***MET**

Description: Set Metric Units

Type: Command

Sets the measurement units of the inputs and outputs of the automatic compensator to Metric (power-up default) (°C, mm Hg, and parts/°C). The following mnemonics are affected: *APV, *ATV, *ECV, *MTA, *MT1, and *MT2.

***MTA**

Description: Material Temperature Average

Type: Read/Write Floating Point Data
Range: 0 to 40°C (32 to 104°F) No Sensor Default: 20°C

*MTA reads or writes the temperature value (*MET and *ENG select units) used to calculate the magnitude of material expansion effects. When HP 10757A/B/C Material Temperature Sensors are connected and their respective A/D channels enabled, this value is the average of the two sensors (or the sensor value if only one is used). When *MTA is written to, the MT1 and MT2 A/D channels are automatically disabled and the new value is used in calculations. These A/D channels can be re-enabled by using the *CEB mnemonic. Re-enabling them would overwrite the programmed temperature average with the actual measured value.

It is not possible to enter particular values for Material Temperature 1 or 2, only the average.

***MT1**

Description: Material Temperature 1

Type: Read-only Floating Point Data No Sensor Default: 0°C

Reads the Material Temperature 1 transducer channel. The mnemonics *MET and *ENG program the units.

When *TST is set to 1, *MT1 reads the actual voltage level on this particular channel.

***MT2**

Description: Material Temperature 2

Type : Read-only Floating Point Data No Sensor Default: 0°C

Reads the Material Temperature 2 transducer channel. The mnemonics *MET and *ENG program the units.

When *TST is set to one, *MT2 reads the actual voltage level on this particular channel.

***NAM**

Description: Board Name

Type: Read-only ASCII Data

Requesting *NAM from the compensation board returns the string "COMP<CR><LF> and EOI".

***REV**

Description: Automatic Compensation Board's Software Revision Date

Type: Read-only Integer Data

The *REV data mnemonic returns the Automatic Compensation board's software revision date in the following format:

<space>DDDD

where DDDD is the HP standard four-digit date code (e.g., 2432 represents week 32 of 1984).

***RST**

Description: Reset

Type: Command

This command resets the HP 10946B to its initial power-up condition without booting the system.

Note: *TST0 = *RST

***RVA**

Description: +10 Volt Reference Value

Type: Read/Write Floating Point Data
Range: +9.99 to +10.01 Volts

This mnemonic is only used during HP 10946B calibration (see Section VII). *RVA programs the actual reference value measured at the rear panel +10 VOLT REFERENCE BNC connector. Both the *CRE and the *CRC commands must be sent after *RVA for the compensator to use this new value.

***RVB**

Description: +0.5 Volt Reference Value

Type: Read/Write Floating Point Data
Range: +0.49875 to +0.50125 Volts

This mnemonic is only used during HP 10946B calibration (see Section VII). *RVB programs the actual reference value measured at the rear panel +0.5 VOLT REFERENCE BNC connector. Both the *CRE and the *CRC commands must be sent after *RVB for the compensator to use this new value.

***STA**

Description: Compensation Board Status Byte

Type: Read-only Integer Data

This mnemonic allows the user to read the status of the compensation board. See *Table 4K-5*, Page 4-22 for summary of status byte values and meaning (0 = OK).

***TST**

Description: Test

Type: Read/Write Integer Data Range: 0 or 1 Power-up Default: 0

*TST reads or writes the operating mode. Mode 0 is for normal operation (power-up default). Mode 1 is for testing. In the latter mode, the values returned from all sensor channels are actual sensor voltages (±1V) and the *WTC value is the accumulated phase count in λ/32 units. Self-test error messages 895 through 902 are also enabled in *TST1. Writing either 0 or 1 to this mnemonic causes the board to:

a. Test the calibration memory
b. Test the A/D converter
c. Test the Wavelength Tracking counter
d. Set the channel enable byte for any connected sensors.

Note that for *TST0, the *CEB value is always set ≤128. For *TST1, *CEB is set ≥192. Also, *RST performs the same operation as *TST0. The following mnemonic's units are changed to Volts by *TST = 1: *AHV, *APV, *ATV, *MT1, and *MT2. *WTC is changed to λ/32 units.

***VAC**

Description: Voltage – Auxiliary Channel

Type: Read-only Floating Point Data

With this mnemonic, the voltage on the auxiliary channel can be read. *CEB bit 5 must be set for this data to be continually updated.

***VGC**

Description: Voltage – Ground Channel

Type: Read-only Floating Point Data

This mnemonic reads the voltage on the ground channel. The value is updated once following a hard reset, *RST, *TST0, or *CEBn command (n ≠ 128). Repetitive updates are enabled after a *TST1 command, or a fault is detected on this channel during one of the above updates.

***VRC**

Description: Voltage – Reference Channel

Type: Read-only Floating Point Data

This mnemonic reads the voltage on the reference channel. The value is updated once following a hard reset, *RST, *TST0, or *CEBn command (n ≠ 128). Repetitive updates are enabled after a *TST1 command, or a fault is detected on this channel during one of the above updates.

***WRL**

Description: Wavelength Tracker Reference Length

Type: Read/Write Floating Point Data

Range: ±1.00 metre, ≠ 0 Default Setting: 0.127 m

This mnemonic reads and writes the Wavelength Tracker Reference Length. The Factory default setting of 0.127 meters is an approximate value and should be changed to the actual etalon length stamped on the end of each etalon. Failing to do this reduces the accuracy of the wavelength tracker compensation number. The proper sequence of mnemonics is *WRL n; *CRE; *CRC. The *CRE and *CRC mnemonics transfer the new *WRL value to non-volatile memory (see page 4K-7). Using a negative value for *WRL changes the direction sense. See Section V to determine the proper sign.

***WTC**

Description: Wavelength Tracker Compensation

Type: Read/Write Floating Point Data

Input Range: 0 to 1 Power-up Default: 0.999728766
(20°C, 760 mm Hg, 50% Relative Humidity)
(68°C, 29.92 inches Hg)

This mnemonic reads or writes the compensation number derived from the Wavelength Tracker measurement. *WTC includes Material Expansion Compensation if *ECV<>0.

When *TST is set to 1, *WTC reads the accumulated phase in units of λ/32.

***WTE**

Description: Wavelength Tracker Enable

Type: Read/Write Integer Data

Range: 0 or 1 Power-up Default: 0 when *CMC = 0, and 1 when *CMC = 1

When *WTE = 1, the Compensation board will track any change in phase between the REF signal (generated by the system laser head) and the MEAS signal (generated by the Wavelength Tracking system) and update the Wavelength Tracker Compensation number. When *WTE = 0, the Compensation board ignores phase measurement, leaving *WTC unchanged.

The value of *WTE also selects which compensation number is used to generate a compensation alert. 0 selects *CNV, and 1 selects *WTC. Writing either value to *WTE will also set both *CNL and *WTL to 0.

***WTL**

Description: Wavelength Tracker Limit ("Alert Range")

Type: Read/Write Floating Point Data

Range: -0.0000100 to +0.0000100 (±10 ppm) Power-up Default: 0.0000000

This mnemonic instructs the automatic compensation board to generate an alert through the HP-IB SRQ interrupt (must be enabled by IMSK ≥128) if the Wavelength Tracking Compensation number (*WTC) changes by an amount exceeding the *WTL value. (If Wavelength Tracking is not being used, then the alert function is controlled by *CNL and *CNR, not *WTL and *WTR.)

To enable the alert (or re-enable it after an alert has occurred), *WTL must be set to a nonzero value. This clears any previous alerts and sets the *WTR value equal to *WTC. The alert is generated when |*WTC - *WTR| ≥ |*WTL|.

Note that writing 0 or 1 to *WTE sets *WTL to zero.

***WTR**

Description: Wavelength Tracker Change Register

Type: Read-only Floating Point Data

This register is both the base line and the latch for the compensation alert feature. It tracks the value of *WTC (Wavelength Tracking Compensation) but is frozen when *WTL is set to a nonzero value. Then, when *WTC deviates from this base line by more than the programmed limit (*WTL value), the register latches the new number and SRQ is asserted (must be enabled by IMSK ≥128). *WTR will retain this new number until another value is written to *WTL.

If Wavelength Tracking is not in use, then *CNR should be used instead of *WTR.

Table 4K-3. Automatic Compensation Board Mnemonic Summary

Mnemonic	Type	Response	Reference
*AHV	Read/Write Floating Point Data	Normal Operation: Air humidity value Range: 0 to 95% No Sensor Default: 50% Service Mode (*TST=1): Reads the actual voltage on this A/D channel	4K-4
*APV	Read/Write Floating Point Data	Normal Operation: Air pressure value Range: 500 to 800 mm Hg No Sensor Default: 760 mm Hg Service Mode (*TST=1): Reads the actual voltage on this A/D channel	4K-5
*ATV	Read/Write Floating Point Data	Normal Operation: Air temperature value Range: 0 to 40°C No Sensor Default: 20°C Service Mode (*TST=1): Reads the actual voltage on this A/D channel	4K-5
*CEB	Read/Write Integer Data	Used to selectively enable and disable the 8 A/D channels Range: 0 to 255 Power-up Default: ≥128 (depends on sensors connected).	4K-5
*CMC	Read/Write Integer	Instructs the Compensation board to automatically ignore (*CMC=0) or implement (*CMC=1) the Wavelength Tracking function at power-up or system reset. Range: 0 or 1 Factory Seeting: 0	4K-6
*CNL	Read/Write Floating Point Data	Instructs the automatic compensation board to generate an alert (assert SRQ bit) if the total compensation number changes by an amount exceeding the *CNL value. (see also IMSK, *WTL, and *WTE). Range: ±0.0000100 (±10 ppm) Power-Up Default: 0.0000000	4K-6
*CNR	Read-only Floating Point Data	If the total compensation number (*CNV) deviates from this base line value by more than *CNL, the SRQ bit is asserted (see also IMSK, *WTR, and *WTE).	4K-6
*CNV	Read-only Floating Point Data	Used to read the current total compensation number (composed of air and material temperature and air pressure and humidity). No Sensor Default: 0.999728766 (20°C, 760 mm Hg, 50% Relative Humidity)	4K-7
*CRC	Command	Instructs the compensation board to store the +10V REF (*RVA), 0.5V REF (*RVB), and Wavelength Reference Length (*WRL) data currently stored in the board's mailbox (must be preceded by a *CRE command).	4K-7
*CRE	Command	Enables the automatic compensator to accept and execute a *CRC command.	4K-7
*DDV	Read-only Floating Point Data	Reads the time duration (in seconds) of the most recent or current measurement interruption that exceeds the *DTV time. Resolution: 0.001 seconds	4K-7

(Continued on next page)

Table 4K-3. Automatic Compensation Board Mnemonic Summary (Continued)

Mnemonic	Type	Response	Reference
*DTV	Read/Write Floating Point Data	Sets or reads the amount of time that a measurement problem exists before the error is indicated by the compensation board. Range: 0 to 64 seconds Resolution: 0.001 seconds Power-up Default: 0 seconds	4K-8
*ECV	Read/Write Floating Point Data	Sets or reads the material expansion coefficient value. Range: ±0.000180/°C Power-Up Default: 0.000000	4K-8
*ENG	Command	Sets the automatic compensator's input and output units to English. *ENG affects *APV, *ATV, *ECV, *MTA, *MT1, and *MT2 mnemonics.	4K-8
*FTC	Read/Write Floating Point Data	Sets and reads the Wavelength Tracker compensation number filter time constant. Range: 0, 0.050 to 5 seconds Power-up Default: 0 seconds (disabled)	4K-8
*MET	Command	Sets the automatic compensator's input and output units to metric (power-up default). *MET affects *APV, *ATV, *ECV, *MTA, *MT1, and *MT2 mnemonics.	4K-8
*MTA	Read/Write Floating Point Data	Sets or reads the material temperature average used in calculations. Range: 0 to 40°C No Sensor Default: 0°C	4K-9
*MT1	Read-only Floating Point Data	Normal Operation: Reads Material Temperature 1 channel. No Sensor Default: 0°C Service Mode (*TST=1): Reads the actual voltage on this channel.	4K-9
*MT2	Read-only Floating Point Data	Normal Operation: Reads Material Temperature 2 channel. No Sensor Default: 0°C Service mode (*TST=1): Reads the actual voltage on this channel.	4K-9
*NAM	Read-only ASCII Data	Returns the string "COMP<CR><LF> and EOI".	4K-9
*REV	Read-only ASCII Data	Returns the Automatic Compensation Board Software revision date.	4K-9
*RST	Command	Resets the board to its power-up condition.	4K-10
*RVA	Read/Write Floating Point Data	+10V Reference Value: used during calibration. Range: +9.99 to +10.01 Volts	4K-10
*RVB	Read/Write Floating Point Data	+0.5 Volt Reference Value: used during calibration. Range: +0.49875 to +0.50125	4K-10
*STA	Read-only Integer Data	Reads the status byte of the Automatic Compensation board. (See *Table 4K-5* for values.)	4K-10

(Continued on next page)

Table 4K-3. Automatic Compensation Board Mnemonic Summary (Continued)

Mnemonic	Type	Response	Reference
*TST	Read/Write Integer Data	Allows the reading of measured channel data(*TST0) or actual channel voltages (*TST1). (*TST0 also resets board to power-up state.) Range: 0 or 1 Power-up Default: 0	4K-10
*VAC	Read-only Floating Point Data	Reads the actual voltage on the auxiliary channel.	4K-11
*VGC	Read-only Floating Point Data	Reads the actual voltage on the ground channel.	4K-11
*VRC	Read-only Floating Point Data	Reads the actual voltage on the reference channel.	4K-11
*WRL	Read/Write Floating Point Data	Reads and writes the Wavelength Reference Length (etalon's length). Sign determines direction sense Actual length stamped on etalon Range: ±1.00 metre, ≠ 0 Factory Setting: 0.127 metre	4K-11
*WTC	Read/Write Floating Point Data	Reads or writes the compensation number derived from the Wavelength Tracker measurement and material expansion/contraction effects. Input Range: 0 to 1 Power-up Default:0.999728766 (20°C, 760 mm Hg, 50% Relative Humidity) Service Mode (with *TST set to 1: Reads the actual phase measurement in λ/32 units.	4K-11
*WTE	Read/Write Integer Data	Enables or disables Wavelength Tracking function and selects which compensation number, *WTC or *CNV, is used to generate an alert. Range: 0 or 1 Power-up Default: 0 when *CMC=0 and 1 when *CMC=1	4K-12
*WTL	Read/Write Floating Point Data	Instructs the Compensation board to generate an alert through the HP-IB SRQ interrupt if IMSK≥128, *WTL>0, and Wavelength Tracker Compensation number changes by an amount greater than or equal to the *WTL value (see also IMSK, *CNL, and *WTE). Range: –0.0000100 to +0.0000100 Power-up Default: 0.0000000	4K-12
*WTR	Read-only Floating	The SRQ bit is asserted if the total compensation number (*WTC) deviates from *WTR by more than *WTL (see also IMSK, *CNR, and *WTE).	4K-12

Reset Response

HARD RESET

The variables and mode conditions listed in *Table 4K-4* are set when the system is forced into the "hard reset" cycle. The user may initialize hard reset by either:

- Power-cycling the HP 5507A Laser Transducer (i.e., cycling the AC power from on-to-off-to-on), or
- Sending the BOOT command to the HP-IB board
- Toggling the Internal Master Reset Switch located on the HP-IB board
- Sending the *RST or *TST0 commands to the compensation board.
- Sending a hard reset command to an HP 10936A Servo-Axis Board through its binary interface.

Table 4K-4. Automatic Compensation Board Hard Reset Response

Variable or Mode	Mnemonic	Reset Variable or Mode to
Status Byte	*STA	Zero
I/O Units	*ENG/*MET	*MET
Expansion Coefficient	*ECV	Zero
Compensation Number Change Limit	*CNL *WTL	Zero Zero
Compensation Number	*CNV	Value calculated from air pressure, temperature and humidity (0.999728766 if no sensors connected).
Wavelength Tracking Compensation Number	*WTC	0.999728766 (20°C, 760 mm Hg, 50% Relative Humidity)
Wavelength Tracking Enable	*WTE	1 if *CMC=1, and 0 if *CMC=0
Air Pressure	*APV	760 mm Hg if HP 10751A/B Air Sensor is not connected to the HP 5507A. Actual pressure sensor reading if HP 10751A/B Air Sensor is connected to the HP 5507A.
Air Temperature	*ATV	20°C if HP 10751A/B Air Sensor is not connected to the HP 5507A. Actual temperature sensor reading if the HP 10751A/B is connected to HP 5507A.
Air Humidity	*AHV	50% if HP 10751A/B Air Sensor is not connected to the HP 5507A. Actual humidity switch setting if air sensor connected to the HP 5507A.
Material Temperature #1	*MT1	0°C if HP 10757A/B/C Material Temperature Sensor is not connected to the HP 5507A. Actual material sensor reading if the HP 10757A/B/C Material Temperature Sensor is connected to the HP 5507A.
Material Temperature #2	*MT2	0°C if HP 10757A/B/C Material Sensor is not connected to the HP 5507A. Actual material sensor reading if the HP 10757A/B/C Material Temperature Sensor is connected to the HP 5507A.
Material Temperature Average	*MTA	20°C if no HP 10757A/B/C Material Temperature Sensors are connected to the HP 5507A. MT1 or MT2 if only one HP 10757A/B/C Material Temperature Sensor is connected to the HP 5507A. Average of MT1 and MT2 if two HP 10757A/B/C Material Temperature Sensors are connected to the HP 5507A.
Channel Enable Byte	*CEB	Set to indicate all sensors connected to the HP 5507A.

SOFT RESET

The "soft reset" cycle may be initialized by performing one of the following:

- Depressing the HP 5507A front panel RESET key
- Sending the ERST command to the HP-IB board
- Sending the HP-IB device independent commands Device Clear (DCL) or Selected Device Clear (SDC)

The "soft reset" performs the following:

- Sets Status byte (*STA) to zero
- Clears error messages
- Clears programming errors

The "soft reset" clears error messages and the status byte when the errors are caused by programming mistakes, sensor errors, or Wavelength Tracker errors (i.e., status byte values 80 through 90 and 103 through 111).

Error Messages

The error messages, combined with the HP 5507A front panel annunciators (LEDs), provide assistance with both system programming and hardware problems. LED indications and sequences are covered briefly on page 4B-25.

ERROR INDICATION

The SYSTEM ERROR LED remains off if the system operates properly. If an error is detected in the system — be it a hardware, programming, or data entry error — the HP 5507A's operation is not suspended. Internal software enables the user to interrogate the system via the controller as to the source of the error. The ERRM? data request returns an ASCII data item that contains the following information:

- Error source information
- Error number
- Short description of the error

After correcting the cause of the error, the error can be cleared by initiating a system "soft reset".

AUTOMATIC COMPENSATION BOARD ERROR MESSAGES

-102 Card Self-test Error

Compensation board hardware errors found during the power-up self tests produce this error.

880 Sensor Channel Out of Range

This error occurs if an enabled sensor indicates a measurement value outside of its operating range and the board is not in *TST1 mode. This error should be cleared by writing to the *CEB byte and sending the ERST mnemonic.

881 AHV Entry Out of Range

The *AHV variable has been loaded with a value outside of the 0 to 95% range. The compensator will ignore this erroneous value and continue to use the previous value.

882 APV Entry Out of Range

The *APV variable has been loaded with a value outside the range of 500 to 800 millimeters of mercury (mm Hg). The compensator will ignore this erroneous value and continue to use the previous value.

883 ATV Entry Out of Range

The *ATV variable has been loaded with a value outside of the 0 to 40°C range. The compensator will ignore this erroneous value and continue to use the previous value.

884 CNL Entry Out of Range

The *CNL variable is loaded with a value outside of the -10 to +10 parts per million (ppm) range. The compensator will ignore this erroneous value and continue to use the previous value.

885 ECV Entry Out of Range

The *ECV variable is loaded with a value outside of the -180 to +180 parts per million/°C (ppm/°C) range. The compensator will ignore this erroneous value and continue to use the previous value.

886 MTA Entry Out of Range

The *MTA variable is loaded with a value outside of the 0 to 40°C range. The compensator will ignore this erroneous value and continue to use the previous value.

887 RVA Entry Out of Range

The *RVA variable is loaded with a value outside of the +9.99 to +10.01 Volt range. The compensator will ignore this erroneous value.

888 RVB Entry Out of Range

The *RVB variable is loaded with a value outside of the +0.49875 to +0.50125 Volt range. The compensator will ignore this erroneous value.

889 TST Entry Out of Range

The *TST variable is loaded with a value other than 0 or 1. The compensator will ignore this erroneous value.

890 CRE Command must Precede CRC

This error is generated if the compensation board receives a *CRC command without having received a *CRE.

891 Firmware Execution Error

Incorrect ROM code execution - contact HP Service Center.

892 Firmware Execution Error

Incorrect ROM code execution — contact HP Service Center.

893 Variable Address Byte Error

This error indicates a hardware failure or an HP 5507A backplane communication problem.

894 Command Byte Error

The compensation board produces this error when an undefined command from the HP-IB board is received. Undefined commands signify an internal system fault and should not occur during normal operation. If the BOOT command does not clear up the error, there is a backplane communication hardware problem on either the HP-IB or compensation board.

895 Ground Channel Tolerance

This error occurs when the A/D converter output for the analog ground channel exceeds the self-test tolerance. The *TST variable must be set to 1 for this error message to occur.

896 Reference Channel Tolerance Error

This error occurs when the A/D converter output for the reference channel exceeds the self-test tolerance. The *TST variable must be set to 1 for this error message to occur.

897 A/D Status Signal Not Working

This error occurs when the status signal output of the A/D converter is faulty. The *TST variable must be set to 1 for this error message to occur.

898 A/D Digital Output Read Error

This error occurs when the digital outputs of the A/D converter or its associated data bus buffer are faulty. The *TST variable must be set to 1 for this error message to occur.

899 Calibration Memory Checksum Error

Failure of the ROM checksum or the calibration number memory tests can cause this error. The *TST variable must be set to 1 for this error message to occur.

900 Counter Control Signal Error

This error occurs when faulty counter control signals are detected during board self-testing. The *TST variable must be set to 1 for this error message to occur.

901 Counter Preset Error

This error occurs when an incorrect counter preset value is detected during board self-testing. The *TST variable must be set to 1 for this error message to occur.

902 Counter Output Error

This error occurs an incorrect the counter output value occurs during board self-testing. The *TST variable must be set to 1 for this error message to occur.

903 Measurement Signal Error

This error occurs when a MEAS signal glitch or dropout from the HP 10780B is detected by the measurement signal phase-locked loop electronics located on the compensation board.

904 Reference Signal Error

This error occurs when a glitch or dropout of the system laser head's reference signal is detected by the reference signal phase-locked loop electronics located on the compensation board.

905 WTE Entry Out of Range

The *WTE variable was loaded with a value other than 0 or 1. The compensator will ignore this erroneous value.

906 FTC Entry Out of Range

The *FTC variable was loaded with a value other than 0 or outside the 0.050 to 5 second range. The compensator will ignore this erroneous value.

907 DTV Entry Out of Range

The *DTV variable was loaded with a value outside the 0 to 65 second range. The compensator will ignore this erroneous value.

908 WTL Entry Out of Range

The *WTL variable was loaded with a value outside the –10 to +10 parts per million (ppm) range. The compensator will ignore this erroneous value.

909 CMC Entry Out of Range

The *CMC variable was loaded with a value other than 0 or 1. The compensator will ignore this erroneous value.

910 WRL Entry Out of Range

The *WRL variable was loaded with a variable outside the ±1 meter range or with a zero. The compensator will ignore this this erroneous value.

911 WTC Entry Out of Range

The *WTC variable was loaded with a value outside the 0.000 to 1.000 range. The compensator will ignore this erroneous value.

Table 4K-5. Automatic Compensation Board Error Message Summary

System Error Number	Description	HP 10946B Status Byte Value
-102	Board Self-test Error	254
880	Sensor Channel Out of Range	80
881	AHV Entry Out of Range	81
882	APV Entry Out of Range	82
883	ATV Entry Out of Range	83
884	CNL Entry Out of Range	84
885	ECV Entry Out of Range	85
886	MTA Entry Out of Range	86
887	RVA Entry Out of Range	87
888	RVB Entry Out of Range	88
889	TST Entry Out of Range	89
890	CRE Command Must Precede CRC	90
891	Firmware Execution Error	91
892	Firmware Execution Error	92
893	Variable Address Byte Error	93
894	Command Byte Error	94
895†	Ground Channel Tolerance Error	95
896†	Reference Channel Tolerance Error	96
897†	A/D Status Signal Not Working	97
898†	A/D Digital Output Read Error	98
899†	Calibration Memory Checksum Error	99
900†	Counter Control Signal Error	100
901†	Counter Preset Error	101
902†	Counter Output Error	102
903	Measurement Signal Error	103
904	Reference Signal Error	104
905	WTE Entry Out of Range	105
906	FTC Entry Out of Range	106
907	DTV Entry Out of Range	107
908	WTL Entry Out of Range	108
909	CMC Entry Out of Range	109
910	WRL Entry Out of Range	110
911	WTC Entry Out of Range	111

*†These messages are enabled only if *TST is set to 1.*

SECTION IV

SUBSECTION L
RESERVED FOR FUTURE USE

SECTION IV

SUBSECTION M
HP-IB OPERATION WITH THE HP 9000 SERIES 200 COMPUTERS RUNNING BASIC 3.0

CONTENTS

SECTION IV

SUBSECTION M
HP-IB OPERATION WITH THE HP 9000 SERIES 200 COMPUTERS RUNNING BASIC 3.0

HP-IB OPERATION WITH THE HP 9000 SERIES 200 COMPUTERS RUNNING BASIC 3.0

Basic Programming Structure

Figure 4M-1 illustrates the basic program statement structure used for most communication with the HP 5507A. Additional BASIC 3.0 statements helpful for I/O with the HP 5507A are listed in *Table 4M-1*.

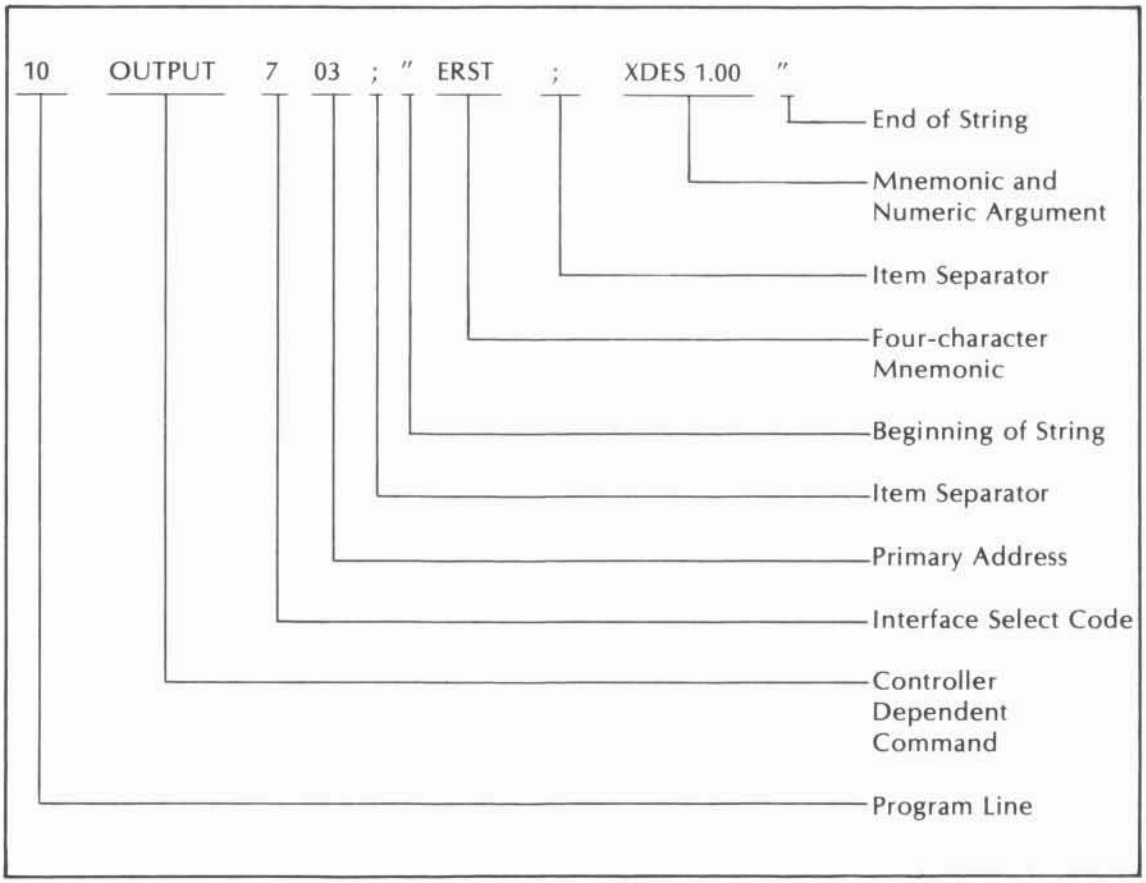

Figure 4M-1. Basic Program Statement Structure

NOTE

In all programming instructions, 0 is zero and O is the letter O.

Table 4M-1. HP 5507A HP-IB Messages and Controller Commands

Message	BASIC 3.0 Command	Description
Data Transfer	OUTPUT 703; Output List ENTER 703; Variable TRANSFER @Laser TO @Buffer	Data enters and exits the HP 5507A through the HP-IB Bus using the ENTER, OUTPUT and TRANSFER keywords.
TRIGGER	TRIGGER 7	Triggering the HP 5507A initiates another measurement.
CLEAR	CLEAR 7	Executes the HP-IB Device Clear command. This command causes all listening devices on the bus to perform a "soft reset."
	CLEAR 703	Executes the HP-IB Selected Device Clear command. This command causes the listening device (HP 5507A) to perform a "soft reset."
STATUS BYTE	OUTPUT 703;"ISTA?" ENTER 703; Status	Returns the value of the system status byte when queried. The value of the status byte always reflects the current operating status of the HP 5507A.
	Status=SPOLL(703)	Returns the value of the serial poll status byte. Once the HP 5507A has issued a SRQ, the serial poll status byte value freezes until the controller performs a serial poll of the bus.
INTERRUPTS	ON INTR 7 GOSUB Hpib_intrpt ENABLE INTR 7;2	Causes program to jump to a service routine in response to an [HP 5507A generated] SRQ message on the HP-IB bus.

Note: The HP 5507A HP-IB board address switch is factory set at 03.

Basic Operation Programming Examples

The following program segments demonstrate how some of the HP 5507A's capabilities are used with an HP computer. It is left to the programmer to write a complete program tailored to the specific needs of the overall system.

Reading Both Status Bytes

```
10 Status=SPOLL(703)
```

The HP 5507A has two status bytes: one that is read when the controller performs a serial poll of the devices on the HP-IB Bus, and the second read by performing a status query (ISTA?). The two status bytes are identical unless the SRQ bit has been asserted. The query status byte is updated on a continual basis reflecting the system's changing status. The serial poll status byte will freeze after SRQ-bit assertion and wait until the controller is free to read the status byte. After the controller reads the serial poll status byte, the byte is reset to reflect the system's current operating status and the SRQ bit is set false.

20 PRINT "Serial Poll Status=";Status	Controller instructs the printer to output the following: "Serial Poll Status=<numeric value>" where the numeric value is a decimal number ranging in value between 0-255.
30 !	Remark statement
40 OUTPUT 703;"ISTA?"	Places the query status byte in the HP 5507A HP-IB board's output buffer. This byte will reflect the current status of the HP 5507A.
50 ENTER 703;Status	The controller reads the query status byte over the HP-IB Bus.
60 Print "Status Query Byte=";Status	Controller instructs the printer to output the following: "Status Query Byte=<numeric value>" where the numeric value is a decimal number ranging in value between 0-255.

READING AN ERROR MESSAGE

10 DIM Error_message$[80]	This statement dimensions and reserves memory for a string. The name of the string is "Error_message$" and has a length of 80.
20 OUTPUT 703;"ERRM?"	Places the results of the error message query (ERRM?) in the HP-IB board's output buffer.
30 ENTER 703;Error_message$	The controller reads the contents of the output buffer into the "Error_message$" string.
40 DISP Error_message$	The controller sends the contents of the "Error_message$" string to the display line of the CRT.

READING COMPENSATION NUMBERS

10 OUTPUT 703;"VCNV?"	Places the compensation number value (calculated by the HP 10946A Automatic Compensation Board) in the HP-IB board's output buffer.
20 ENTER 703;Comp_num	The controller reads the contents of the output buffer into the variable "Comp_num".

SETTING AN AXIS BOARD'S COMPENSATION VALUE

10 OUTPUT 703;"VCNV?"	Places the compensation number value (calculated by the HP 10946A Automatic Compensation Board) in the HP-IB board's output buffer.
20 ENTER 703;Comp_num	The controller reads the contents of the output buffer into the variable "Comp_num".
30 OUTPUT 703;"XTCN"; Comp_num	Sends the value of "Comp_num" to the X-axis board for use as a total compensation number.

READING SENSOR VALUES

10 OUTPUT 703;"VMET"	Tells the compensation board to use Metric units for I/O.
20 OUTPUT 703;"VATV?"	Places the results of the air temperature value query (VATV?) in the HP-IB board's output buffer.
30 ENTER 703;Air_temp	The controller reads the contents of the output buffer into the variable "Air_temp".
40 PRINT "Air Temperature = "; Air_temp; Deg. C"	Controller instructs the printer to output the following: "Air Temperature = <numeric value>" where the numeric value is a decimal number ranging in value between 0-40.
50 OUTPUT 703;"VAPV?"	Places the results of the air pressure value query (VAPV?) in the HP-IB board's output buffer.
60 ENTER 703;Air_pres	The controller reads the contents of the output buffer into the variable "Air_pres".
70 PRINT "Air Pressure = "; Air_pres; mm Hg."	Controller instructs the printer to output the following: "Air Pressure = <numeric value>" where the numeric value is a decimal number ranging in value between 517-776.
80 OUTPUT 703;"VMT1?"	Places the results of the material temperature query (VMT1?) in the HP-IB board's output buffer.
90 ENTER 703;Mat_temp_1	The controller reads the contents of the output buffer into the variable "Mat_temp_1".

100 PRINT "Material Temperature = "; Mat_temp_1;"Deg. C"	Controller instructs the printer to output the following: "Material Temperature = <numeric value>" where the numeric value is a decimal number ranging in value between 0-40.

OVERWRITING SENSOR VALUES

10 OUTPUT 703;"VMET"	Tells the compensation board to use Metric units for I/O.
20 OUTPUT 703;"VATV 22.48"	Disables the Air Temperature Sensor and instructs the compensation board to use this value when calculating the compensation number
30 OUTPUT 703;"VAPV 700.4"	Disables the Air Pressure Sensor and instructs the compensation board to use this value when calculating the compensation number
40 OUTPUT 703;"VMTA 22.48"	Disables the Material Temperature Sensors and instructs the compensation board to use this value when calculating the compensation number

READING A SINGLE POSITION POINT MEASUREMENT

10 OUTPUT 703;"XPOS?"	Places the current X-axis position measurement in the HP-IB board's output buffer.
20 ENTER 703;Position	Controller reads the contents of the HP-IB board's output buffer over the HP-IB Bus. The controller stores the value in a newly created variable in memory called "Position".
30 !	
40 DISP Position	The controller sends the contents of the "Position" variable to the display line on the CRT.

READING MULTIPLE POSITION POINT MEASUREMENTS

Method 1 — Approximate Data Rate 100 Readings/Second

10 REAL Position(99)	Reserves memory space within the controller for floating point variables. "Position" is the name of the variable and has enough memory space to store 100 floating point variables. (Position(0) through Position(99)).
20 OUTPUT 703;"XPOS?"	Places the current X-axis position measurement in the HP-IB board's output buffer.

```
30 !
```

```
40 FOR I=0 TO 99
```

Defines a loop which is repeated until the loop counter passes 99. The loop counter initializes with a value of zero and increments in steps of one (default).

```
50 TRIGGER 703
```

This message sends a trigger message to the HP 5507A. It causes the HP-IB board to fill its output buffer with the current value of the last mnemonic sent (XPOS).

```
60 ENTER 703;Position(I)
```

Controller reads measurement data over the HP-IB Bus and stores it in the "I" th memory location of the "Position" array.

```
70 Next I
```

Loop counter (within the controller) is incremented by by 1. If I≤99, the loop is executed again beginning with line 40. If I>99 then the program continues at the line following the NEXT statement.

```
80 !
```

Method 2 — Approximate Data Rate 110 Readings/Second

```
10 REAL Position(99)
```

Reserves memory space within controller for floating point variables and arrays. "Position" is the name of the array and has memory space to accommodate 100 floating point variables.

```
20 !
```

```
30 FOR I=0 TO 99
```

Defines a loop that is repeated until the loop counter passes 99. The loop counter initializes with a value of zero and increments in steps of one (default).

```
40 OUTPUT 703;"XPOS?"
```

Places current X-axis position reading in the HP-IB board's output buffer.

```
50 ENTER 703;Position(I)
```

Controller reads the contents of the output buffer over the HP-IB Bus and stores it in the "I" th memory location of the "Position" array.

```
60 NEXT I
```

The loop counter is incremented by 1. If I≤99, the loop is executed again beginning with line 30. If I>99, then the program execution continues at the line following the NEXT statement.

```
70 !
```

Method 3 — Approximate Data Rate 1500 Readings/Second

10 REAL Position(2000) BUFFER	Reserves 2000 memory locations within the controller for floating point variables. "Position" is the name given the numeric variable by the Basic 3.0 program. The "Position" variable is declared a buffer — a section of controller memory reserved to hold data for later transfer. Defining a buffer is some what analogous to creating a high-speed device inside the computer. This gives two advantages: (1) a buffer is fast enough to accept incoming data from almost any device, and (2) the actual transfer operation can be handled concurrently with continued program execution.
20 ASSIGN @Buffer TO BUFFER Position(*)	Assigns an I/O path name to the "Position" buffer. The I/O path name, "@Buffer", can now be used to access the "Position" buffer.
30 ASSIGN @Transducer to 703	Assigns the I/O path name "@Transducer" to the HP 5507A.
40 OUTPUT @Transducer; "XRAW;FMT3;XPOS?"	Sets the X-axis I/O units to uncompensated wavelength counts, selects block data format 3 for floating point outputs and puts the current X-axis position reading in the HP-IB board's output buffer.
50 TRANSFER @Transducer TO @Buffer;WAIT	The TRANSFER statement permits the exchange of data between I/O paths "@Transducer" (HP 5507A) and "@Buffer" (controller). The transfer will continue until the buffer is full. The advantage of the TRANSFER statement over the INPUT and OUTPUT statements is that transfer can take place concurrently with continued program execution. The WAIT parameter specifies that the program execution will not leave the TRANSFER statement until the data transfer is complete.
60 ! Real array Position(*) now contains 2000 position readings.	
70 FOR I = 0 to 2000 STEP 200	Sets up loop to print 11 of the 2000 position readings.
80 PRINT Position (I)	Controller prints value of the "I" th element of the array "Position (*)".
90 NEXT I	

WRITING DESTINATIONS

10 OUTPUT 703;"XDES 1.00"	Loads the X-axis destination register with the numeric value 1.00.
20 OUTPUT 703;"XENG; XDES -1.00"	Sets the X-axis I/O units to compensated inches and the X-axis destination register is loaded with the numeric value -1.00.

WRITING MULTIPLE DESTINATIONS

10 OUTPUT 703;"XENG;XDR1; XDES?"	Sets the X-Axis board to English units (inches), turns on the Drive Enable signal, and loads the current X-Axis destination into the HP-IB output buffer. However, this buffer will not be read by the controller this time. The purpose of using XDES? here is to tell the HP-IB board that the data items that follow should all be sent to the X-Axis destination register.
20 FOR Destination = 0.5 to 3.0 STEP .01	Sets up loop to increment "Destination" from 0.5 to 3.00 in .01 increments.
30 OUTPUT 7; Destination	Causes the value of "Destination" to be sent to the current listener(s) on the HP-IB bus. In this case the HP 5507A, which sends the information to the X-Axis destination register.
40 WAIT 1	Delay 1 second before writing next destination
50 NEXT Destination	Increments loop counter (Destination) and repeats loop if less than or equal to 3.00.
60 OUTPUT 7;"0"	Causes the value of "Zero" to be sent to the current listener(s) on the HP-IB bus. In this case the HP 5507A, which sends the information to the X-Axis destination register.

EXTERNAL SAMPLING

```
10 OUTPUT 703;"VCNV?"
20 ENTER 703;Comp_num
30 OUTPUT 703;"XTCN";Comp_num
```

Sends the current compensation number to the X-Axis Board.

```
40 OUTPUT 703;"XEXT;HSON;
   XPOS?"
```

Sets X-axis board for external sampling mode, turns handshaking on, and requests X-axis position data.

```
50 LOOP
60 ENTER 703;Position
70 DISP Position
80 END LOOP
```

Endless loop which displays the X-Axis position value which is updated only by a pulse on the External Sample line.

Prototyping Board Programming Examples

The following program segments demonstrate the reading and writing of prototyping board ports using HP Series 200 Basic. The program segments assume that the prototyping board is set to address "P" and that octal buffers have been properly connected to strobe lines OUTA-, OUTB-, OUTC-, OUTD-, and IND- (see Section III).

READING FROM A PORT

```
10 OUTPUT 703;"PBYC?"
```

Places the data present at input port C in the HP-IB board's output buffer.

```
20 ENTER 703;Port_c_data
```

The controller reads the contents of the output buffer into the variable "Port_c_data"

WRITING TO A PORT

```
10 Port_c_data=206
```

Assigns the variable "Port_c_data" a value of 206

```
20 OUTPUT 703;"PBYC";
   Port_c_data
```

Causes the 8 bit binary equivalent of the value of "Port_c_data" to be latched in output port C.

WRITING TO MULTIPLE PORTS

10 Port_c_data=137	Assigns the variable "Port_c_data" a value of 137
20 Port_ab_data=-2400	Assigns the variable "Port_ab_data" a value of -2400.
30 OUTPUT 703;"PBYC"; Port_c_data;";PBYD 42; PWDA";Port_ab_data	Causes: 1. The 8 bit binary equivalent of the value of "Port_c_data" to be latched in output port C. 2. The 8 bit binary equivalent of 42 to be latched in output port D 3. The 16 bit 2's complement equivalent of "Port_ab_data" to be latched in output ports A and B.

WRITING MULTIPLE VALUES TO ONE PORT

10 DIM Data_list(10)	Reserves memory space within the controller for floating point variables. "Data_list" is the name of the variable and has enough memory space to store 11 floating point variables. Data_list(0) through Data_list(10).
20 READ Data_list(*)	Reads enough numbers (11) from the DATA statement to fill the array "Data_list(*)"
30 DATA 5, 127, 38, 49, 85, 192, 240, 85, 37, 78, 49	
40 OUTPUT 703;"PBYC'; Data_list(0)	Causes the 8 bit binary equivalent of the value of Data_list(0) to be latched in output port c.
50 FOR I=1 to 10	Sets up loop to write 10 data items.
60 OUTPUT 703;Data_list(I)	Causes 8 bit binary value of Ith element of array Data_list(*) to be latched in output port C.
70 Next I	Increments Loop Counter and repeats if less than or equal to 10.

EXAMPLE PROGRAM AND SUBROUTINE TO COMPILE MNEMONICS ON THE HP 10936A SERVO-AXIS BOARD

```
10    REM   Example program and subroutine to compile mnemonics
20    REM     on the HP 10936A Servo-Axis Board
30    REM
40    REM   15 MAY 1988                    BASIC 3.01
50    REM
100   !
110   COM @Bin_lsr
120   ASSIGN @Bin_lsr TO 12;FORMAT OFF,EOL OFF,WORD
130   DIM Mnemonic$[255],Type$[40]
140   INTEGER Command_number,Command_type
150   !
160   LOOP
170     REPEAT
180       INPUT "Type in four-character mnemonic to be compiled by the Servo-Axis board?",Mnemonic$
190       IF LEN(Mnemonic$)<>4 THEN
200         BEEP
210         DISP "String must be Four Characters Long!"
220         WAIT .5
230         BEEP
240       END IF
250     UNTIL LEN(Mnemonic$)=4
260   EXIT IF Mnemonic$="----"
270     Compile(Mnemonic$,Command_number,Command_type)
280     Decode_type(Command_type,Type$)
290     PRINT USING "4A,3X,3D,3X,3D,3X,40A";Mnemonic$,Command_number,Command_type,Type$
300   END LOOP
310   END
320   !*************************************************************************
330   SUB Compile(Cmd$,INTEGER Cmd_num,INTEGER Cmd_typ)
340     COM @Bin_lsr
350     INTEGER Wd1,Wd2
360     Wd1=256*NUM(Cmd$[1;1])+NUM(Cmd$[2;1])
370     Wd2=256*NUM(Cmd$[3;1])+NUM(Cmd$[4;1])
380     OUTPUT @Bin_lsr;4800,Wd1,Wd2
390     ENTER @Bin_lsr;Cmd_num,Cmd_typ
400     IF Cmd_num=0 THEN
410       BEEP
420       PRINT "Unable to Compile mnemonic ";Cmd$
430     END IF
440   SUBEND
450   !*************************************************************************
460   SUB Decode_type(INTEGER Typ,Typ$)
470     SELECT Typ
480     CASE 1
490       Typ$="Command"
500     CASE 2
510       Typ$="Read/Write One-Word Integer"
520     CASE 4
530       Typ$="Read/Write Floating Point"
540     CASE 8,72
550       Typ$="Read-Only ASCII"
560     CASE 66
570       Typ$="Read-Only One-Word Integer"
580     CASE 68
590       Typ$="Read Only Floating Point"
600     CASE ELSE
610       Typ$="Undefined"
620     END SELECT
630   SUBEND
640   !*************************************************************************
```

SECTION V
IMPORTANT NOTES ON INSTALLATION AND ACCURACY

CONTENTS

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SECTION V
IMPORTANT NOTES ON INSTALLATION AND ACCURACY

INTRODUCTION

This section provides the information necessary to help design the Laser Position Transducer into an application. The section has the following organization:

- Installation considerations — Discussion on proper installation of the laser heads, optics and receiver.
- Accuracy considerations — A complete discussion on what determines and affects the system accuracy. Details on effects internal and external to the system are discussed.

This section should be thoroughly understood before designing the Laser Position Transducer into any application.

GENERAL

Adjustment Considerations

When aligning the HP 5527A optics, it will be necessary to adjust most or all of the optical components. The optics are not referenced to their housings, and so it usually is not possible to "design in" good alignment. The HP 10710A and HP 10711A Adjustable Mounts should be used to provide the adjustment capability for the optical components. (The HP 10717A Wavelength Tracker has a built-in adjustable mount.)

In general, the alignment procedures are performed with all optical components in place. Provisions must be made to allow for adjustment of the laser head, optics, and receivers during alignment.

Laser Beam and Optics Protection

In some applications, such as machine tools, protection should be provided to prevent metal chips or cutting fluid from interfering with the measurements. The Laser Position Transducer requires protection against unintentional laser beam blockage and air turbulence problems. Also, the optical components usually require protection to prevent contamination of the optical surfaces by oil or cutting fluid. In applications which are considered "clean", protection may not be needed.

If protection of the laser beam and optical components is required, there are two general types; moving component protection and non-moving component protection.

In many applications, the only moving components are the interferometer or the reflector. Many of the beam benders are stationary and only direct the laser beam to the measurement axes. In these cases, it is only necessary to provide fixed tubing for the laser beam and some type of sealed enclosure for the optics. Since only one laser beam of approximately 6 mm (0.24 inch) in diameter is involved, relatively small diameter tubing can be used. Since either the interferometer or the reflector is moved during the measurement, protecting the laser beam and the moving components requires a telescoping cover or a cover that is self-sealing. There is a wide variety of commercially available protective covers which are suitable for this purpose.

Figure 5-1 illustrates techniques for protecting the laser beam and optical components with different types of protective covering. Note that the cover for the retroreflector allows the retroreflector to be moved very close to the interferometer. This helps minimize the deadpath errors.

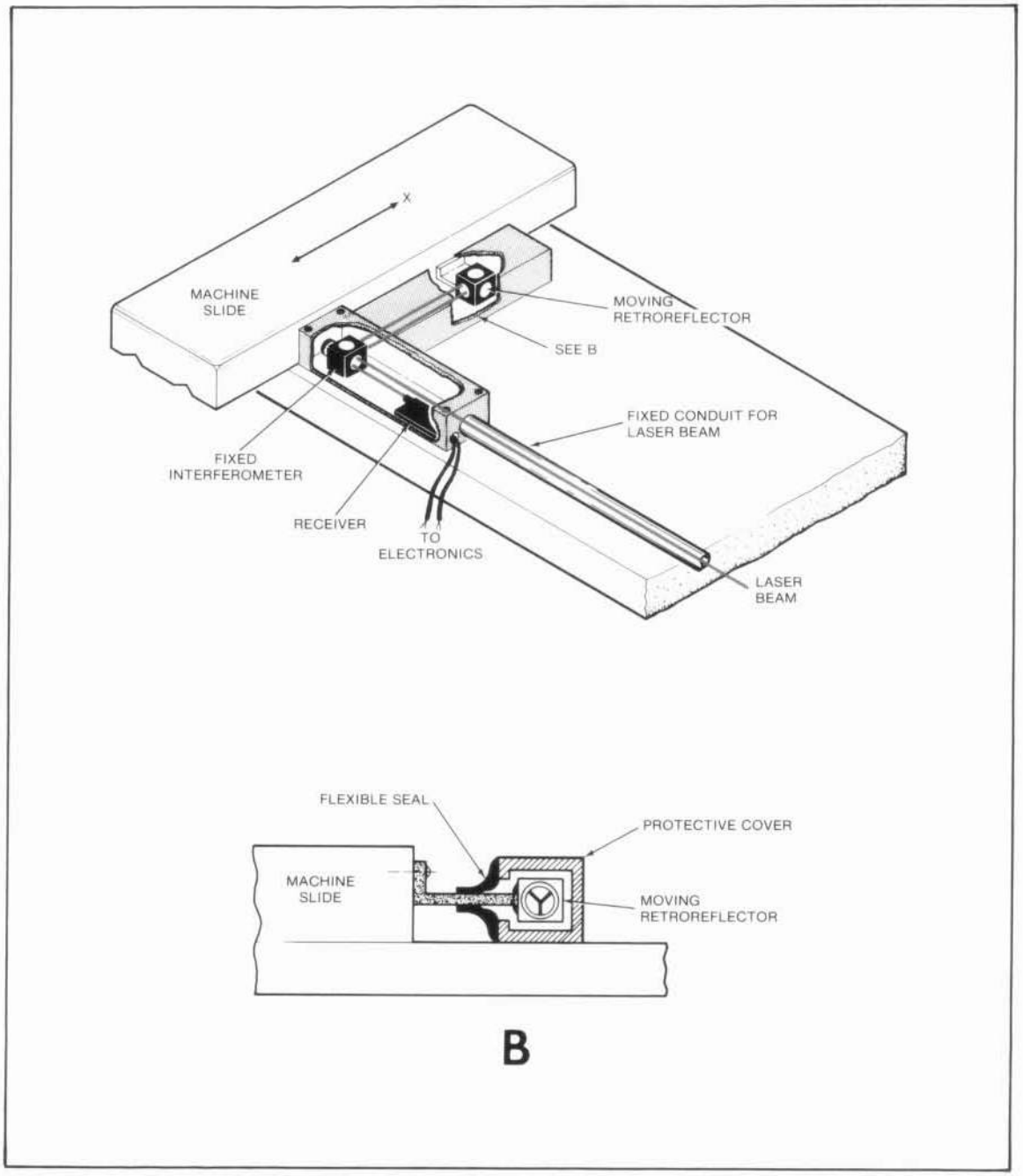

Figure 5-1. Protective Covers for Optics and Laser Beam

Figure 5-2 shows a different type of protective cover. Again, the mechanical arrangement allows the retroreflector to be in close proximity to the interferometer at the closest point of travel even though the telescoping cover is not entirely collapsible. Another type of protective cover is the flexible bellows. This is generally used for short travel distances.

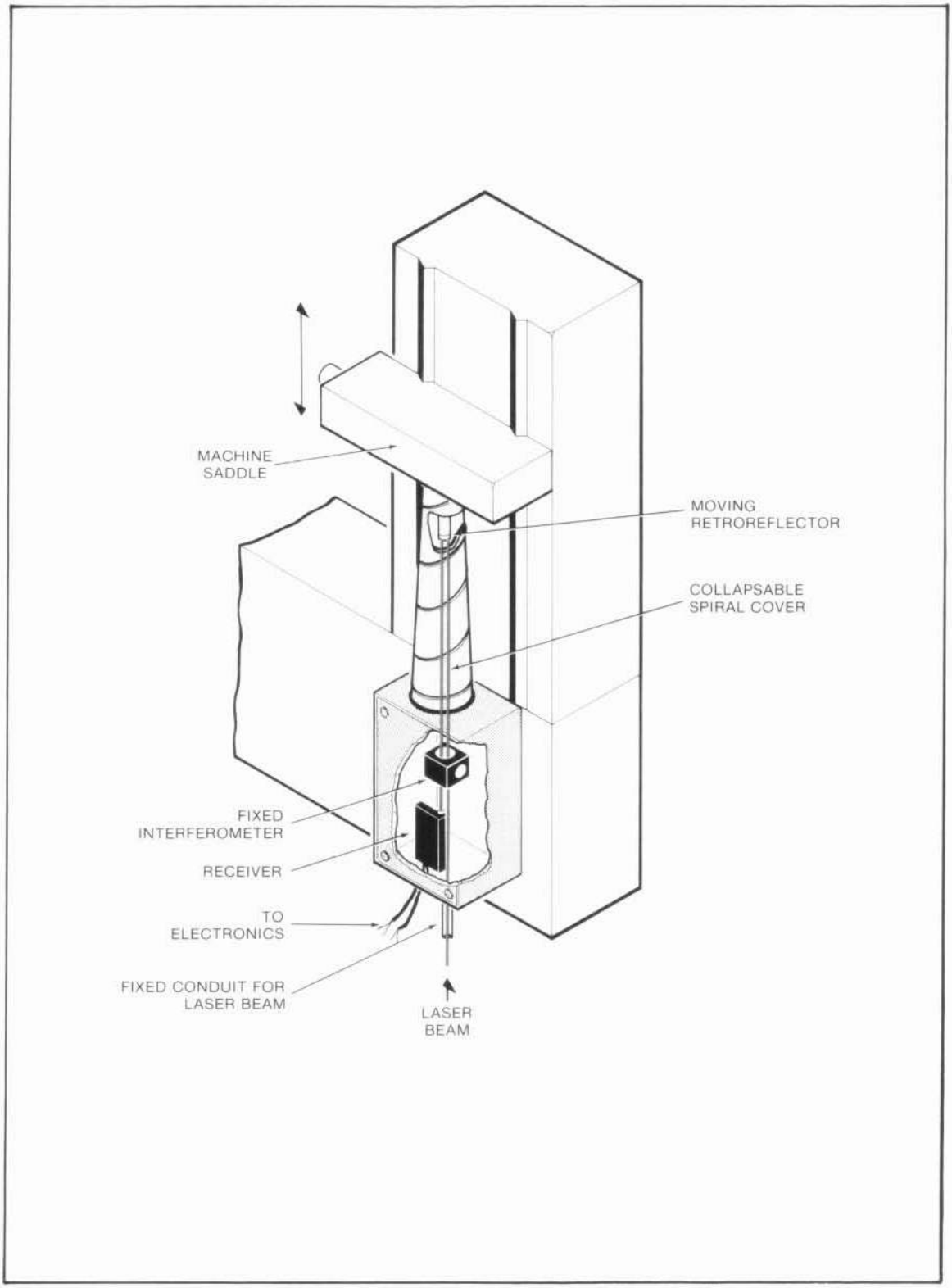

Figure 5-2. Collapsible Spiral Cover for Movable Retroreflector

System Grounding

The HP 5527A system has the potential to be grounded at a number of points, with the resulting ground loop areas measuring in the tens of square feet. Since the system can be operated in an electrically noisy environment, these ground loops could introduce an unacceptable level of noise into the electronics.

Signal grounds on the laser heads, HP 10780B Receiver and HP 5507A Laser Position Transducer Electronics are all connected to their chassis. To prevent ground loops they all should be grounded through one common point. The HP 10780B Receiver mounting is isolated from ground by using the supplied nylon screws. The HP 5507A Laser Position Transducer Electronics is referenced to earth ground through its power line and, therefore would be the most difficult to isolate. The recommended grounding for the system is through the HP 5507A and its power line, resulting in floating the laser head and receivers.

LASER HEADS (HP 5517A/5517B and HP 5518A)

Orientation

The HP 5517A/5517B and 5518A Laser Heads may be mounted in any orientation as long as they are positioned to direct the beam into the optical system parallel or orthogonal with the machine axes. When mounting the laser head vertically with the beam directed upwards, be careful not to mount an interferometer directly above because of heat dissipation from the laser head.

Mounting Plane Tolerance

The plane defined by the three mounting feet on either laser head must be roughly parallel to either the bottom or sides of the beam-splitters and bender housings to within ±3°, and to the bottom or sides of the interferometers to within ±1°.

This ensures that the polarizing axes of the interferometers are oriented properly relative to the polarization vectors of the laser beam (*Figure 5-3*). The laser head can be rotated in 90° increments about the beam axis (roll) without affecting the system performance, but the measurement direction sense will change with each 90° rotation.

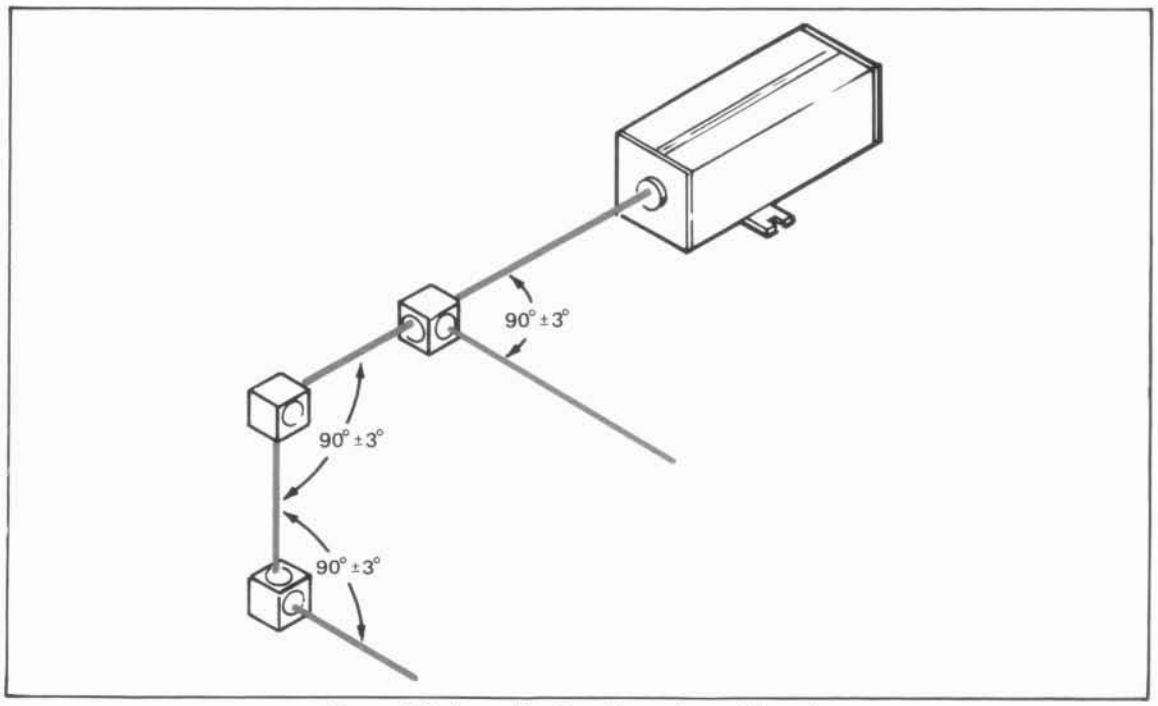

Figure 5-3. Laser Position Transducer Mounting

F1 and F2 Orientation of Laser Heads

HP laser heads produce a coherent collimated two-frequency laser beam consisting of two orthogonally polarized frequency components. To differentiate between the frequencies, the LOWER frequency is identified as F1 and the HIGHER F2. Frequencies F1 and F2 are always orthogonally polarized with respect to one another, however, either may be vertically (or horizontally) polarized. The HP 5517A/B and HP 5518A Laser Heads produce F1 with horizontal polarization and F2 with vertical polarization.

NOTE

The HP 5501A/B Laser Head produces F1 with vertical polarization and F2 with horizontal polarization.

Fastening

The HP 5517B Laser Head can be fastened down using the three mounting feet or six tapped holes on the base of the head. The mounting feet have clearance slots for 1/4 - 20 or M6 screws. Alternatively, the mounting feet can be removed and the head fastened using the 8-32 UNC tapped holes under the base.

The HP 5517A/5518A Laser Head has three mounting feet with tapped holes (M8 × 1.25) that go completely through the feet and allow mounting the laser on a mounting plate or bulkhead provided by the user. For measurement axis alignment purposes it is recommended that slotted holes be provided in the mounting plate. If temperature changes can occur which may introduce stress due to different coefficients of expansion of the cast aluminum laser base and the mounting plate, kinematic fixturing of the rear mounting foot is recommended. For both laser heads the following should be remembered.

a. Allow 50 mm (2 inches) clearance around the laser head for easy service.

b. To maintain good pointing stability it is good practice to use kinematic mounting principles.

Thermal Isolation

There is some heat dissipation from the laser heads. On small or very accurate machines, care must be taken in choosing a mounting method and location. Where possible the laser head should be mounted away from the measuring area, to avoid any thermal effects.

Vibration Isolation

Since the system only measures relative motion between the interferometer and reflector, measurements are not affected by vibration parallel to the beam axis of the laser source or the receiver.

When vibration of the laser head occurs that causes displacement of the beam (perpendicular to beam axis) at the interferometers and receivers, the beam signal power can fluctuate. If this fluctuation is too great, insufficient beam signal will arrive at the receiver, causing a "measurement signal error".

Magnetic Shielding

The laser heads used in the HP 5527A system contain a permanent magnet. When installing the Laser Position Transducer in an application sensitive to magnetic fields, shielding around the laser head may be required.