LDC-3722
LASER DIODE CONTROLLER

INSTRUCTION MANUAL

May 25, 1990

ILX Lightwave Corporation
920 Technology Boulevard West
P. O. Box 6310
Bozeman, Montana, U.S.A 59771

(406) 586-1244
Telex: 4931552
Fax: (406) 586-9405

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period we will repair or replace the unit, at our option, without charge.

Limitation

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to use of the product for which it was not intended.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages.

If a problem occurs, please notify ILX Lightwave Corporation and thoroughly describe the nature of the problem and give the serial number.

Returning an Instrument

Before returning an instrument, obtain a return authorization number from the factory. The instrument should be shipped in the original packing carton or one that will provide equal protection. Shipping damage is not covered by this warranty. Send the instrument, transportation pre-paid to the factory, referencing the return authorization number. Repairs will be made and the instrument returned, transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Chapter 1

GENERAL INFORMATION

1.1 Introduction

This manual contains operation and maintenance information for the 3722 Low Power Laser Diode Controller and optional Model 1231 GPIB/IEEE-488.2 Interface. If you want to get started right away, read Chapter 2, which covers Operation, first.

In the following chapters there are three areas of discussion, one for functions which are common to both the TEC and the LASER controller, one for the functions which pertain to the TEC controller only, and one for functions which pertain to the LASER current source only.

1.2 Product Overview

The 3722 Low Power Laser Diode Controller is a combination current source/temperature controller. The current source provides a high stability output with a fully redundant current limit and multiple laser protection features. The built-in temperature controller can work with most thermistors and TE modules to deliver precision laser temperature control over a wide range of temperatures. And, the 3722's fast, sophisticated GPIB option lets you automate your experiment.

1.3 Available Options and Accessories

Options and accessories available for the 3722 include the following:

DESCRIPTION	MODEL NUMBER
GPIB/IEEE-488.2 Interface	1231
Rack mount flange kit (enables installation into a standard 19 inch wide rack)	132
Temperature Controlled Laser Diode Mount	4412
Current Source/Laser Diode Mount Interconnect Cable	303
Temperature Controller/Laser Diode Mount Interconnect Cable	505
Calibrated 10 Kohm Thermistor	510
Uncalibrated 10 Kohm Thermistor	520
Uncalibrated AD590LH IC Temperature Sensor	530
Uncalibrated LM335AH IC Temperature Sensor	540

Other Laser Diode Mounts and Thermistor models are available. Please contact ILX Lightwave for information on additional options for your applications.

1.4 Specifications

The specifications for the LDC-3722's laser diode current are found in Section 1.4.1, the specifications for the LDC-3722's temperature controller are found in Section 1.4.2, and the general specifications are found in Section 1.4.3.

1.4.1 Laser Current Source Specifications

Current Source	200 mA Range	500 mA Range
Set Point Resolution:	14 bit	14 bit
Set Point Accuracy:	±4 mA	±10 mA
Compliance Voltage (user-adjustable):	1 to 5 V	1 to 5 V
Temperature Coefficient:	<100 ppm/°C	<100 ppm/°C
Stability[1], for 10 min.:	<10 ppm,	<10 ppm
Stability[1], for 24 hours:	<50 ppm	<50 ppm
Noise and Ripple[2]		
High Bandwidth Mode:	<5 uA	<10 uA
Low Bandwidth Mode:	<1 uA	<2 uA
Noise Density, @ 50/60 Hz:	<20 nA/rt Hz	<50 nA/rt Hz
Worst Case Transients:	<5 mA	<5 mA
Photodiode Feedback		
Range:	1 to 5000 uA	1 to 5000 uA
Output Stability[3]:	±0.1%	±0.1%
Accuracy:	±2 uA	±2 uA
Bias Voltage:	5 V reverse bias	5 V reverse bias
Laser Drive Current Display		
Output Current Resolution:	0.01 mA	0.01 mA
Output Current Accuracy @ 25°C:	±2% of full scale	±2% of full scale
Photodiode Current Range:	0 - 5000 uA	0 - 5000 uA
Photodiode Current Resolution:	1 uA	1 uA
Photodiode Current Accuracy:	±2 uA	±2 uA
Responsivity Range:	0 - 600.00 uA/mW	0 - 600.00 uA/mW
Responsivity Resolution:	0.01 uA /mW	0.01 uA/mW

1 Stability specifications are measured at half-scale output, after a one hour warm-up period.

2 Noise and ripple are measured across 50 ohm load, at 100 mA output, with a high input impedance rms millivoltmeter which has a 10 Hz to 10 MHz bandwidth.

3 Specified values are a percent of nominal. Constant power mode stability specification assumes zero drift in detector responsivity.

Laser Drive Current Display (Cont.)

Optical Power Range:	0 - 200.00 mW	0 - 200.00 mW
Output Power Resolution:	10 uW	10 uW
Temperature Coefficient:	<100 ppm/°C	<100 ppm/°C
Type:	5-digit green LED	5-digit green LED

Current Limit Setting

Range:	0 - 200 mA	0 - 500 mA
Resolution:	1 mA	2.5 mA
Accuracy:	±2 mA	±5 mA

Analog Mod./Voltage Control

Input:	Differential	Differential
Transfer Function:	20 mA/V	50 mA/V
Transfer Function Accuracy:	±5% of full scale	±5% of full scale
Bandwidth[1] (3 db):	DC to 100 KHz	DC to 100 KHz

1.4.2 Temperature Controller Specifications

TEC Output[2]

Output Type:	Bipolar constant current source
Compliance Voltage:	4 Volts at 4 Amps
Maximum Current Output:	4 Amps
Maximum Output Power[3]:	16 Watts typical
Current Limit Control Range:	0 to 9999 mA, ±20 mA
Current Limit Accuracy:	±50 mA
Ripple/Noise[4]:	<1 mA

Temperature Control

Temperature Range[5]:	-99°C to +150°C -20°C to +70°C with typical 10 K thermistor.

1 Bandwidth is specified for 50% modulation.

2 Output current and power are rated into a 1 ohm load.

3 Higher output powers can be accomodated by using an external booster. Contact ILX Lightwave for further information.

4 Broadband noise (10 Hz to 10 MHz) is measured at 1 Amp output current.

5 Temperature control range depends primarily on the type of thermistor and TE module used. The range can be extended higher and lower by selecting appropriate components. See Appendix B for more details.

Resolution and Accuracy[1]:	Temperature	Resolution	Accuracy
	-20°C	±0.1°C	±0.2°C
	0°C	±0.1°C	±0.2°C
	20°C	±0.1°C	±0.2°C
	50°C	±0.2°C	±0.2°C

LM335 Setting Accuracy:	±0.2°C
AD590 Setting Accuracy:	±0.2°C
Short Term Stability[2]:	±0.005°C or better, over 10 minutes
Long Term Stability:	±0.01°C or better, over 24 hours
Sensor Type:	2-wire thermistor, AD590 current type, or LM335 voltage type
Usable Thermistor Range:	25 ohms to 450 Kohms, typical
LM335 Voltage:	V(25°C) = 2980 mV, V_T = 10 mV/K over rated sensor range
LM335 Bias:	1 mA
AD590 Current:	I(25°C) = 298.2 uA, I_T = 1 uA/K over rated sensor range
AD590 Bias:	+8 VDC
Thermistor Sensing Current:	10 uA or 100 uA (user selectable)
Temperature Calculation Methods:	AD590 or LM335 calibrated with two-point method. Thermistors are calibrated by storing three constants of the Steinhart-Hart equation, listed below, in internal non-volatile memory.
Thermistor:	$1/T = (C1 * 10^{-3}) + (C2 * 10^{-4})(\ln R) + (C3 * 10^{-7})(\ln R)^3$.
LM335:	T = C1 + C2 * (V / (10 mV/K) - 273.15)
AD590:	T = C1 + C2 * (I / (1 uA/K) - 273.15)

TEC Display

Display Type:	5-digit green LED display
Maximum Current Reading:	1.0 Amps, 10.0 Amps with a current booster
Maximum Temp. Reading:	199.9°C
Current Resolution:	0.001 Amps
Current Display Accuracy	±0.01 Amps
Temperature Resolution:	0.1°C
Temperature Display Accuracy:	±0.5°C
Thermistor Resistance Resolution:	0.01 Kohms, at 10 uA setting 0.001 Kohms, at 100 uA setting
Thermistor Resistance Display Accuracy:	±0.05 Kohms, at 10 uA setting ±0.005 Kohms, at 100 uA setting

1 Accuracy figures quoted are typical for a 10 K ohm thermistor and 100 uA source current setting. Accuracy figures are relative to calibration standard. Both resolution and accuracy are dependent on the user defined configuration of the instrument.

2 Short term temperature stability is a strong function of the thermal environment of the thermistor and TE module. Room air currents in particular can easily cause fluctuations of 0.1°C in an exposed mounting configuration.

1.4.3 General LDC-3722 Specifications

Connectors

Photodiode Monitor and Current Source Connectors:	9-pin D-connector, banana jacks for LASER output, BNC for photodiode input
External Modulation Input:	BNC connector, instrumentation amplifier input
Temperature Controller:	15-pin D-connector, banana jacks for TEC output and thermistor input

Optional GPIB

Meets ANSI/IEEE Std 488.1-1987
Meets ANSI/IEEE Std 488.2-1987

General

Size:	5.7" x 12.6" x 17.0" 145 x 320 x 432 mm
Weight:	<18 lbs (8.2 kg)
Power Requirements:	90 - 110 VAC, 110 - 130 VAC, 210 - 230 VAC, or 230 - 250 VAC, 50 - 60 Hz
Temperature:	0 to +50°C operating -40 to +70°C storage
Humidity:	<95% relative humidity, non-condensing

1.5 Your Comments

Our goal is to make the best laser diode instrumentation available anywhere. To achieve this, we need your ideas and comments on ways we can improve our products. We invite you to contact us at any time with your suggestions. (See the third cover page.)

Chapter 2

OPERATION

2.1 Introduction

This chapter describes how to install, adjust, and operate the LDC-3722. It is divided into four sections covering installation, familiarization and adjustment of the 3722, warm-up and environmental considerations, and normal operating procedures.

Section 2.4.1 gives an overview of the 3722's front panel features, and it presents a guide to quickly familiarize the user with the front panel operations.

2.2 Installation

Installation procedures and considerations are covered in Sections 2.2.1 - 2.2.3.

2.2.1 AC Power Considerations

The 3722 can be configured to operate at nominal line voltages of 100, 120, 220, or 240 VAC. Normally, this is done at the factory and need not be changed before operating the instrument. However, check to be sure that the voltage printed on the back panel of the instrument matches the power-line voltage in your area. Refer to Chapter 6 Maintenance if it is necessary to reconfigure the input voltage range.

WARNING

To avoid electrical shock hazard, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury or death.

2.2.2 Tilt-Foot Adjustment

The LDC-3722 has front legs that extend to make it easier to view the LED displays. To use them, place the 3722 on a stable base and rotate the legs downward until they lock into position.

2.2.3 Rack Mounting

The LDC-3722 may be rack mounted by installing a rack mount flange on either side of the enclosure. All rack mount accessory kits contain detailed mounting instructions. Refer to Section 1.4 for applicable rack mount accessory part numbers.

2.3 Power-Up Sequence

With the LDC-3722 connected to an AC power source, turning the Power key switch clockwise (CW) will supply power to the instrument and start the power-up sequence.

During the power-up sequence, the following takes place. For about 3 seconds a lamp test is conducted. During the lamp test all indicators light up for about 3 seconds, and all of the 7-segment displays indicate "8".

Then, a self-test is performed to ensure that the 3722's hardware and software are communicating. If the 3722 cannot successfully complete this test, an error message of E-512 or E-513 will be displayed.

After this test, the 3722 is configured to the state it was in when the power was last shut off. The TEC and LASER switches in the ADJUST section are not engaged (illuminated) after power up. The user must push either switch to select the desired operating mode.

The user may choose to "clear" the parameters that appear by recalling "BIN 0" either manually or through the GPIB. When "BIN 0" is called, the front panel will be in the following state:

3722 DEFAULT CONFIGURATION

GPIB mode in LOCAL via front panel, or in REMOTE via GPIB
Bar graph unlit
PARAMETERS not selected
TEC and LASER adjust not selected
TEC output off
TEC DISPLAY enabled, in T mode
Constant T mode selected
TEC Display showing actual temperature
Temperature Set Point = 0°C
Resistance/Reference Set Point = 1 ohm or uA or mV
(depending on the setting of the SENSOR SELECT switch)
I_{TE} Set Point = 0
LIM I_{TE} set to 4.0 Amps
LIM THI set to 99.9°C
TEC STEP value = 1
TEC Tolerance values = 0.2°C, 5 seconds
GAIN = 30
C1 = 1.125 (x 10^{-3})
C2 = 2.347 (x 10^{-4})
C3 = 0.855 (x 10^{-7})

Table 2.1 3722 Default Settings

3722 DEFAULT CONFIGURATION

CAL PD = 0 uA/mW
LIM I2 (200 mA range) = 200 mA
LIM I5 (500 mA range) = 500 mA
LIM P = 200 mW
LASER output off
LASER DISPLAY enabled, in I mode
Constant I, low bandwidth, mode selected
LASER display showing actual current
RANGE in 200 mA setting
LASER STEP value = 1
LASER Tolerance values = 10.0 mA, 1.0 seconds
LASER I Set Point = 0
LASER IPD Set Point = 0
LASER PPD Set Point = 0
RECALL BIN number = 0

Table 2.1 3722 Default Settings (Cont.)

2.4 Introduction to the LDC-3722 Front Panel

The LDC-3722 front panel contains displays and controls for both the TEC and LASER controller hardware. Each of the labeled areas on the front panel (i.e. TEC DISPLAY or GPIB) is described in a separate section later in this chapter.

Generally, the controls are simple to operate. The setup parameters, however, are intentionally awkward to use so that their values are not inadvertently changed.

> **Note: Section 2.4.1 gives a quick introduction to the front panel functions by briefly describing the switches and indicators.**

Sections 2.5 and 2.6 describe the GPIB and ADJUST areas, respectively. The functions in these areas are common to both TEC and LASER operation. Sections 2.7 - 2.10 cover the TEC functional areas of the front panel, including TEC error indicators.

Sections 2.11 - 2.17 describe the LASER functional areas of the front panel, including LASER controller error indicators.

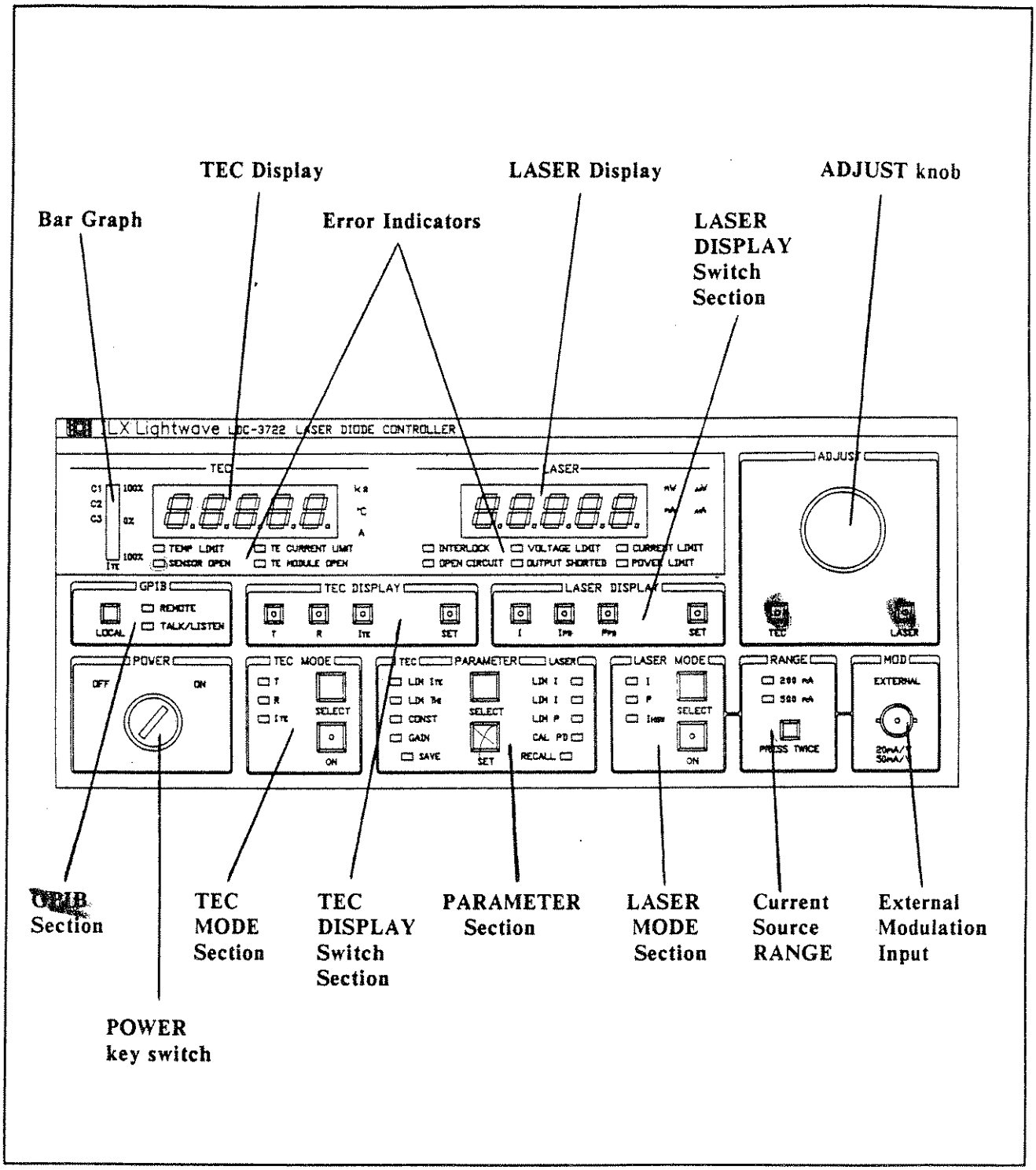


Figure 2.1 3722 Front Panel

2.4.1 Front Panel Familiarization

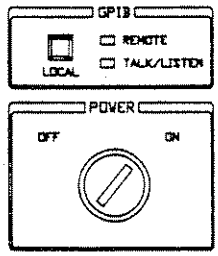
Notice in Figure 2.1 that the TEC functions are near center on the left side, and the LASER functions are near the center on the right side of the front panel.

Functions which are common to both TEC and LASER, such as GPIB or ADJUST, are on the outer sides of the front panel. Note also that the PARAMETER area is divided into TEC and LASER components. The TEC parameters are on the left, and the LASER parameters are on the right, while the common SAVE and RECALL parameters are at the bottom.

Refer to Figure 2.1 for the following discussions of the 3722 front panel sections. The key words are in bold type for quick identification.

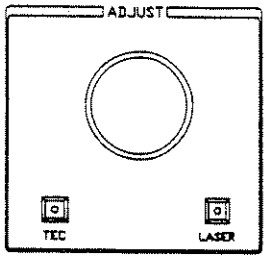
2.4.1.1 General Functions

This section gives a brief synopsis of functions which effect both TEC and LASER controller operation.

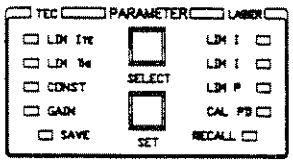


The **GPIB section** is used when the optional remote GPIB operations are implemented. (For more information, see Section 2.5).

The **POWER key switch** is used to power-up and power-down the 3722.



The ADJUST section contains the **ADJUST knob** for entering values, and it contains the (ADJUST) TEC and LASER switches for selecting the adjustment mode. (For more information, see Section 2.6).



The **PARAMETER section** is divided into TEC and LASER components. When the (ADJUST) TEC mode is selected, repeatedly pressing the (PARAMETER) SELECT switch will cycle through the TEC parameters. Likewise, when the (ADJUST) LASER mode is selected, repeatedly pressing the (PARAMETER) SELECT switch will cycle through the LASER parameters. The (PARAMETER) SET switch is used to enter the SET mode for changing parameter values. (For more information, see Sections 2.9 and 2.13).

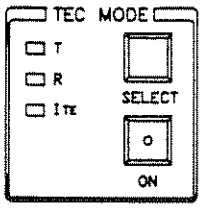
The **SAVE** and **RECALL** parameter functions are used to quickly configure the 3722 parameters to user-determined preset values. In order to use these functions, both of the ADJUST modes (TEC and LASER) must be off, (ADJUST) TEC and (ADJUST) LASER indicators unlit.

With neither ADJUST mode selected, pressing the (PARAMETER) SELECT switch will cycle between the SAVE and RECALL parameter functions. The (PARAMETER) SET switch is used to enter SAVE and RECALL values in a similar manner as with the other parameters. (For more information, see Section 2.17).

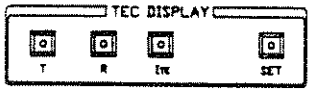
When the 3722 is powered-up, the parameters will automatically be restored to the same values that were present at the last power-down. Furthermore, all of the saved setups will be "remembered", and easily recalled.

2.4.1.2 TEC Functions

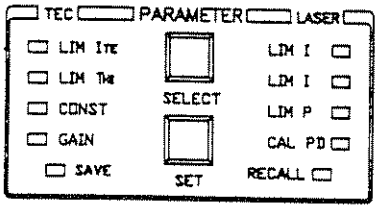
This section gives a brief synopsis of the TEC controller sections on the 3722 front panel.



The **TEC MODE section** is used to turn the TEC output on/off and select the output control mode. Repeatedly pressing the (TEC MODE) SELECT switch cycles through the constant temperature (T), resistance/linear sensor reference (R), or TE current (I_{TE}) control modes. The LED indicators show the selected mode. (For more information, see Section 2.7).



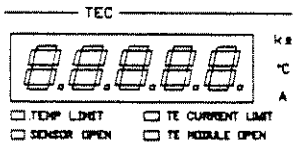
The **TEC DISPLAY switch section** is used to select the measured T, R, or I_{TE} values or the set point value. The set point is determined by the TEC MODE selection. (For more information, see Section 2.8).



When the (ADJUST) TEC mode is selected, the TEC set point may be displayed and adjusted (automatically) by simply turning the ADJUST knob. (For more information, see Section 2.6.1).

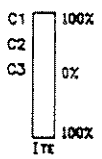
The TEC parameters are TE current limit (LIM I_{TE}), high temperature limit (LIM T_{HI}), constants (CONST) for converting from sensor measurements to temperature, and control loop gain (GAIN). (For more information, see Section 2.9).

When the CONST parameter is selected, the constants C1, C2, and C3 are sequenced by pressing the (PARAMETER) SELECT switch, and the corresponding indicator on the bar graph will become lit.



The **TEC display** is used to show TEC control (measured and set point) and parameter values. It may also display errors which relate to TEC operation.

The **TEC error indicators** become lit when the corresponding TEC conditions occur. (For more information, see Section 2.10).



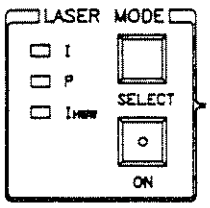
The **Bar graph** is used to display the TEC output as a percentage of TEC current limit (LIM I_{TE}) value. It is also used in conjunction with the (TEC) CONST parameter to indicate which constant is being displayed on the TEC display. (For more information, see Section 2.7).

Conditions Which Will Automatically Shut Off the TEC OUTPUT

1. High Temperature Limit
2. TEC Interlock Disabled (see Section 5.7.2)
3. Booster Changed (While Output On), (see Section 5.8)
4. Sensor Open (While Output On), (see Section
5. TEC Module Open (While Output On)
6. SENSOR SELECT Switch Moved (While Output On)
7. Sensor Shorted (While Output On)

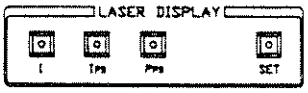
2.4.1.3 LASER Functions

This section gives a brief synopsis of the LASER controller sections on the 3722 front panel.

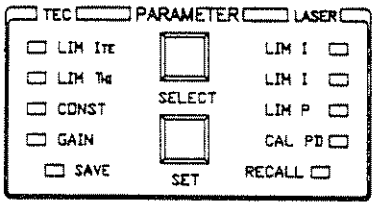


The **LASER MODE section** is used to turn the LASER output on/off and select the output control mode. Repeatedly pressing the (LASER MODE) SELECT switch cycles through the current (I), light power (P), or high bandwidth current (I_{HBW}) control modes. The LED indicators show the selected mode. (For more information, see Section 2.11).

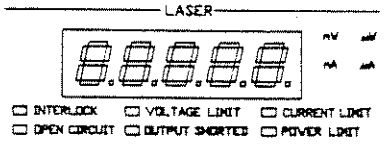
A constant I_{PD} mode may be used when P mode is selected, and the CAL PD parameter value is set to zero. (For more information on I_{PD} mode, see Section 2.11).



The **LASER DISPLAY switch section** is used to select the measured I, I_{PD}, or P_{PD} values or the set point value. The set point is determined by the LASER MODE selection. (For more information, see Section 2.12).

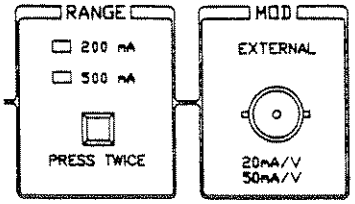


The LASER parameters are LASER current limits (LIM I) for both 200 mA (blue) and 500 mA (black) output ranges, laser light power limit (LIM P), and monitor photodiode responsivity (CAL PD) for converting from monitor current to light power. (For more information, see Section 2.13).



The **LASER display** is used to show LASER control (measured and set point) and parameter values. It may also display errors which relate to LASER operation.

The LASER error indicators become lit when the corresponding LASER conditions occur. (For more information, see Section 2.14). The OUTPUT SHORTED light comes on whenever the LASER output is off.



The **RANGE section** is used to select the LASER 200 or 500 mA output range. (For more inforamtion, see Section 2.15).

The **MOD section** is used to connect a DC to 100 kHz modulation signal which is applied to the laser. (For more information, see Section 2.16).

Conditions Which Will Automatically Shut Off the LASER OUTPUT

1. LASER High Power Limit
2. LASER Interlock State Changed (see Section 5.7.1)
3. LASER Open Circuit (While Output On)
4. TEC High Temperature Limit Condition

2.5 GPIB Section

The GPIB section is located just above the POWER section at the left side of the 3722 front panel (see Figure 2.1).

The GPIB section contains the LOCAL switch and the REMOTE and TALK/LISTEN indicators. The functions of the indicators and switch are related to GPIB operations, as described below.

The **LOCAL switch** is used for several functions. When the 3722 is in REMOTE mode, pressing the LOCAL switch returns the 3722 to LOCAL control mode unless the Local Lockout state has been activated by the host computer. (Local Lockout disables all 3722 front panel switches until this condition is changed by the host computer.) When the unit is in LOCAL mode, pressing the LOCAL switch causes the GPIB address to be displayed, e.g. "--01", and the GPIB address may be changed by turning the ADJUST knob while also pressing the (PARAMETER) SET switch. The usable GPIB address range is 0 - 30.

The **REMOTE indicator** is lit when the 3722 is in GPIB remote mode. When the 3722 is put in Local Lockout Mode by the host computer, the REMOTE indicator will flash at a 1 Hz rate to indicate that the front panel is completely disabled by Local Lockout.

The **TALK/LISTEN indicator** is illuminated when the 3722 is communicating over the GPIB bus. The indicator light is on for a minimum of 0.2 seconds.

2.6 ADJUST Section

The ADJUST section is located on the right side of the 3722 front panel. It consists of the ADJUST (main control) knob and the TEC and LASER mode enable switches.

The **ADJUST knob** is used to change the set points, enter parameter values, enter the GPIB address, or enter instrument calibration data.

The (ADJUST) TEC switch is used to enter or exit TEC mode. If the (ADJUST) TEC switch is pressed when the (ADJUST) TEC indicator LED is unlit, the 3722 enters TEC mode and the (ADJUST) TEC LED becomes lit.

The (ADJUST) LASER switch is used to enter or exit LASER mode. If the (ADJUST) LASER switch is pressed when the (ADJUST) LASER indicator LED is unlit, the 3722 enters LASER mode and the (ADJUST) LASER LED becomes lit.

Only one (or none) ADJUST mode, TEC or LASER, may be operating at any given time. In order to use the SAVE or RECALL functions, both the TEC and LASER ADJUST modes must be disengaged (both ADJUST indicators unlit).

2.6.1 Automatic Set Point Adjustment

If the ADJUST knob is turned during operation, while a measured TEC value is being displayed and the (ADJUST) TEC switch is selected, the TEC display will indicate the set point of the selected operating mode (T, R, or I_{TE}). This control mode set point display will continue for three seconds, and then the display will revert to its former state (a measured value).

For example, assume that (ADJUST) TEC mode is in effect and T is selected as the TEC MODE, but the (TEC DISPLAY) R switch is selected and the sensor (thermistor) resistance is displayed on the TEC display. If the ADJUST knob is turned, the TEC display will then show the temperature set point for 3 seconds. After 3 seconds the TEC display will revert to showing the measured R value.

Likewise, if the ADJUST knob is turned during operation, while a measured LASER value (I, I_{PD}, or P_{PD}) is being displayed and the (ADJUST) LASER switch is selected and the (LASER MODE) ON switch is off, the LASER display will indicate the set point of the selected operating mode (I/I_{HBW} or P). This control mode set point display will continue for 3 seconds, and then the display will revert to its former state (a measured value).

For example, assume that (ADJUST) LASER mode is in effect, the (LASER MODE) ON switch is off, and I is selected as the LASER MODE, but I_{PD} is selected in the LASER DISPLAY switch section and the photodiode current is displayed on the LASER display. If the ADJUST knob is turned, the LASER display will then show the LASER current set point for 3 seconds. After 3 seconds the LASER display will revert to showing the measured I_{PD} value.

Note, in the LASER DISPLAY switch section, the I_{PD} and P_{PD} display modes both correspond to the P control mode, while the I display mode corresponds to either I or I_{HBW} control modes of the LASER MODE section.

2.7 TEC MODE Section

The TEC MODE selection determines which parameter is used to control the output of the TEC controller. One of the following may be selected at one time: constant temperature (T), constant thermistor resistance/linear sensor reference (R), or constant TEC current (I_{TE}) mode.

The **(ADJUST) TEC indicator** must be lit before adjusting the parameters of the TEC MODE functions. Refer to Figure 2.2 for the discussion of the features in the TEC MODE section of the 3722 front panel.

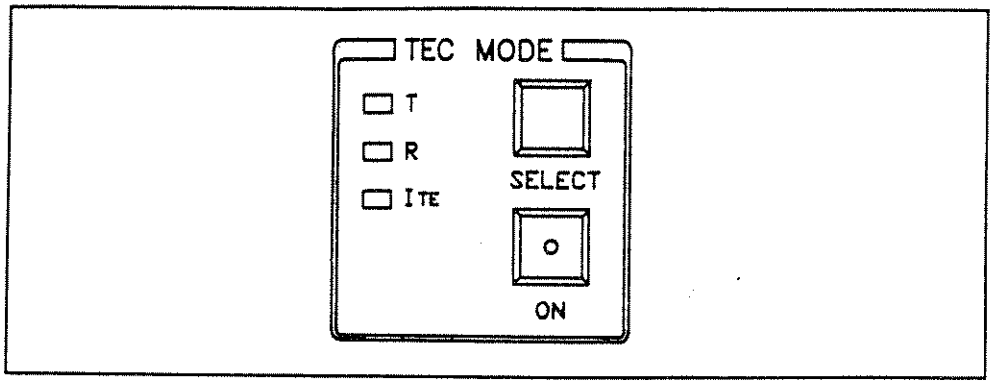


Figure 2.2 3722 TEC MODE Section

2.7.1 TEC MODE SELECT

The SELECT switch is used for selecting one of the three TEC modes available. The chosen mode will be indicated by the corresponding lit LED indicator.

If the SELECT switch is pressed repeatedly, the TEC modes are cycled through in the order T, R, I_{TE}, then back to T, and so on, with the appropriate TEC MODE indicator being lit.

2.7.2 TEC MODE Indicators

The **T indicator** becomes lit when the 3722 is in the temperature control mode. When the 3722 is in constant temperature mode, the TEC is controlled to the constant T set point value.

The **R indicator** becomes lit when the 3722 is in the sensor resistance/reference control mode. When the 3722 is in constant R mode, the TEC is controlled to the constant R set point value (in Kohms, for back panel SENSOR SELECT settings of 100 or 10 uA thermistor sensor currents; in mV, for the LM335; and in uA, for the AD590 setting).

The **I_{TE} indicator** becomes lit when the unit is in the TEC drive current control mode. When the 3722 is in constant TEC current mode, the TEC is controlled to the constant I_{TE} set point value.

2.7.3 TEC MODE ON

This ON switch is used for turning the TEC output on and off. The ON switch has a toggling action. Push it once to turn the TEC output on, and push it again to turn the TEC output off. The TEC output is off whenever the 3722 is first powered up, and the TEC output is toggled off whenever TEC control modes are switched.

The (TEC MODE) ON indicator becomes lit when the TEC output is on. The TEC output will drive to the set point value of the corresponding selected (indicator lit) TEC MODE, T, R, or I_{TE}.

When the TEC output is on, the bar graph display will indicate the level of I_{TE} current, as a percentage of the I_{TE} limit value. The TE CURRENT LIMIT indicator will become lit if the LIM I_{TE} current limit is reached.

2.8 TEC DISPLAY Switch Section

The TEC DISPLAY switch section is used to select the TEC set point or measured T, R, or I_{TE} values to appear on the TEC display.

Any of the TEC measured values may be selected by pressing the desired TEC DISPLAY section switch. When the selection is made to read a measured value by pressing its switch, the (TEC DISPLAY) SET indicator LED will go off (if previously on). In order to read the set point value on the TEC display again, the (TEC DISPLAY) SET switch must be pressed.

Refer to Figure 2.3 for the discussion of the TEC DISPLAY switch section features.

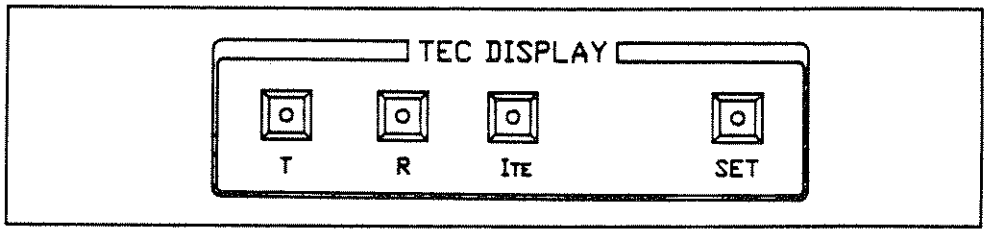


Figure 2.3 3722 TEC DISPLAY Switch Section

2.8.1 TEC DISPLAY SET

When the (TEC DISPLAY) SET switch is pressed, the SET switch indicator and the (TEC DISPLAY) indicator of the set point mode (T, R, or I_{TE}) will become lit, if they are not already lit. The set point may then be changed by turning the ADJUST knob (within 3 seconds of releasing the SET switch) until the desired value is on the TEC display. The SET switch may be held in while the ADJUST knob is being turned, but it is not necessary. Three seconds after releasing the ADJUST knob, or the (TEC DISPLAY) SET switch (whichever occurs later), the new value will be stored in non-volatile memory.

The (TEC DISPLAY) SET mode may also be activated automatically by just turning the ADJUST knob while a measured value (TEC DISPLAY parameter) is being displayed.

If the TEC DISPLAY is set to a mode that is different from the selected TEC MODE when the ADJUST knob is turned, the TEC DISPLAY will automatically switch to the same mode selected in the TEC MODE section.

If it is desired to change a set point for a mode other than the present TEC MODE selection, it is first necessary to select the desired TEC MODE (see Section 2.7.2).

After an adjustment has been made (and the SET switch and ADJUST knob are released), the SET mode will time out in three seconds, the new set point will be stored in non-volatile memory, and the TEC display will revert to the original display mode (T, R, or I_{TE}) which was being displayed before the adjustment was made.

2.8.2 TEC DISPLAY Indicators and Switches

The **T indicator** becomes lit when temperature is displayed. When the T switch is pressed, the display will show measured temperature in °C. If the SET switch is then pressed (and T mode is selected in the TEC MODE section), the display will show the temperature set point value in °C.

The **R indicator** becomes lit when the thermistor resistance or sensor reference is displayed. When the R switch is pressed, the display will show the measured thermistor resistance in Kohms, or the measured LM335 voltage in mV, or the measured AD590 current in uA, depending on the position of the back panel SENSOR SELECT switch. If the SET switch is then pressed (and R mode is selected in the TEC MODE section), the display will show the thermsitor resistance set point value in Kohms, or the LM335 set point voltage in mV, or the AD590 set point current in uA, depending on the position of the SENSOR SELECT switch.

The **I_{TE} indicator** becomes lit when the TEC drive current is displayed. When the I_{TE} switch is pressed, the display will show the measured TEC drive current in Amps. If the SET switch is then pressed (and I_{TE} mode is selected in the TEC MODE section), the TEC display will show the TEC drive current set point value, in Amps.

The (TEC DISPLAY) **SET indicator** becomes lit when the display is showing the set point for the selected (lit) TEC value. The SET indicator goes off when the display is showing a measured TEC value.

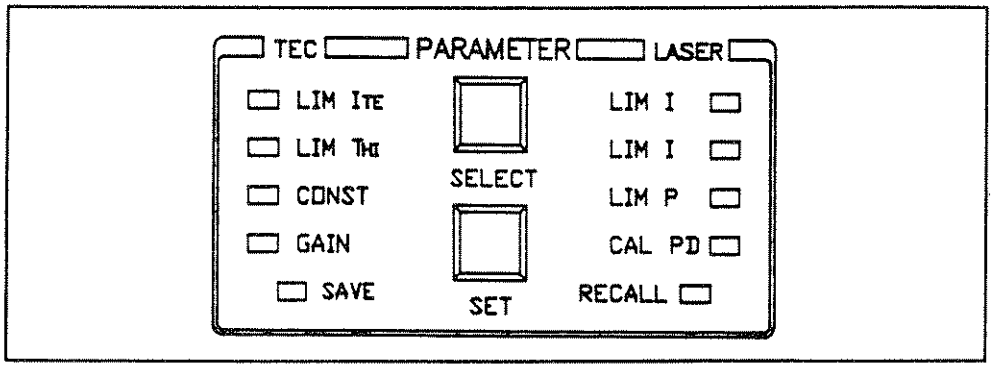


Figure 2.4 3722 PARAMETER Section

2.9 TEC PARAMETER Section

The (ADJUST) TEC mode indicator must be lit (TEC mode selected) before adjusting the TEC PARAMETER values.

The following sections describe the function and form of each of the parameters which may be adjusted from the 3722's front panel. Refer to Figure 2.4.

2.9.1 TEC PARAMETER SELECT

The (PARAMETER) SELECT switch is used to enter SELECT mode. While the ADJUST TEC mode is engaged (indicator lit), press the (PARAMETER) SELECT switch to enter this mode.

When the SELECT mode is first entered, the LIM I_{TE} indicator becomes lit, and the 3722 displays the current limit value, in Amps. All indicators in the TEC DISPLAY switch section are turned off. If the (PARAMETER) SELECT switch is released, this state continues for three seconds, after which the instrument reverts to its former state.

If the (PARAMETER) SELECT switch is pressed repeatedly, successive parameter values are displayed, with the appropriate parameter setup indicator LED being lit. The order of cycling through the parameter list is LIM I_{TE}, LIM T_{HI}, CONST, GAIN, then back to LIM I_{TE}, and so on.

2.9.2 TEC PARAMETER SET

The (PARAMETER) SET switch is used to enter SET mode, where parameter values are stored into non-volatile memory.

If the (PARAMETER) SET switch is pressed while the 3722 is in SELECT mode, the 3722 will enter SET mode. While the (PARAMETER) SET switch is held in, the selected parameter value can be change by rotating the ADJUST knob. The new value is stored in non-volatile memory when the (PARAMETER) SET switch is released.

2.9.3 LIM I_{TE}

The LIM I_{TE} function limits the TEC output current so that the LDC-3722 does not provide more current than your device can safely handle. During operation, when the TEC current limit is reached, the TE CURRENT LIMIT error indicator will flash.

If the GPIB option is installed, the TE current limit condition may be used to shut the TEC output off via the TEC:ENABle:OUTOFF command.

To read the current limit, press the (PARAMETER) SELECT switch until the LIM I_{TE} indicator is lit. If the LIM I_{TE} value is to be changed, press and hold in the (PARAMETER) SET switch, turn the ADJUST knob until the desired value is displayed, then release the SET switch. When the SET switch is released, the new value will be stored in non-volatile memory. The TEC current limit is displayed in Amps.

When the TEC output is on, the bar graph display will indicate the level of I_{TE} current, as a percentage of the LIM I_{TE} value.

2.9.4 LIM T_{HI}

The LIM T_{HI} function sets the maximum TEC output temperature, in °C. During operation, when this limit is reached, the TEMP LIMIT error indicator will flash. Normally, this limit will cause the TEC output to be shut off, unless this ability is disabled remotely via the TEC:ENABle:OUTOFF command.

To read the upper temperature limit, press the (PARAMETER) SELECT switch until the LED by LIM T_{HI} is lit. The TEC display will show the value of the LIM T_{HI} (in °C).

To change the upper temperature limit, sequence the parameters to the LIM T_{HI} value. Press and hold in the (PARAMETER) SET switch, turn the ADJUST knob until the desired new value is on the TEC display, then release the (PARAMETER) SET switch. When the (PARAMETER) SET switch is released, the new value will be stored in non-volatile memory.

2.9.5 CONST

These are the constants of the Steinhart-Hart equation that the user enters to calibrate the TEC for different thermistors. The Steinhart-Hart equation is used to derive temperature from the non-linear resistance of an NTC (Negative Temperature Coefficient) thermistor. When a linear sensor device (such as an AD590 or LM335) is used, only C1 and C2 need to be entered, and a linear equation is used.

The range of values for C1, C2, and C3 are -9.999 to +9.999.

To read a C1, C2, or C3 constant, press the (PARAMETER) SELECT button until it sequences to CONST. The CONST indicator will become lit, and the appropriate LED on the I_{TE} bar graph will be lit to indicate which constant is selected. To change the value, press and hold in the (PARAMETER) SET switch, and turn the ADJUST knob until the correct value is displayed. Release the (PARAMETER) SET switch to store the new value in non-volatile memory.

Appendix A contains an explanation of the Steinhart-Hart equation, the values of these constants for some common thermistors, and a computer program to determine these values for any thermistor.

Appendix C contains information on sensor calibration constants for AD590 and LM335 sensors. Since these devices are used over their linear range, the constants C1 and C2 are used in this case to determine a linear approximation of the temperature, rather than the Steinhart-Hart non-linear approximation which applies for thermistors. The appropriate algorithms are automatically implemented whenever the sensor type is selected via the back panel SENSOR SELECT switch. However, C1 and C2 must be changed by the user.

2.9.6 GAIN

The GAIN function sets the analog feedback gain which, in part, determines how fast the actual temperature reaches and settles to the set-point temperature. If the gain is set too low (1 is lowest), the TE cooler will take longer to reach the temperature set-point. If it is set too high (300 is highest), the actual temperature may overshoot and may cycle around the set temperature.

The GAIN indicator becomes lit when the control loop gain level is displayed. The allowed GAIN values are: 1, 3, 10, 30, 100 and 300. These values actually define the proportional loop gain.

The gain setting depends on the type of TE cooler that you are using, but we can suggest guidelines for selecting the proper gain. Set the gain to 1 and increase it until the actual temperature oscillates around the set temperature. Then reduce the gain to the next lower value.

To read the gain setting, press the (PARAMETER) SELECT switch until the GAIN indicator is lit. The TEC display will show the value of the GAIN setting. To change the GAIN, sequence the parameters to the GAIN value. Press and hold in the (PARAMETER) SET switch, turn the ADJUST knob until the desired new value is on the TEC display, then release the (PARAMETER) SET switch. When the (PARAMETER) SET switch is released, the new value will be stored in non-volatile memory.

2.9.7 Bar Graph

When the TEC output is on, the bar graph display will indicate the level of I_{TE} current, as a percentage of the LIM I_{TE} value, for both positive and negative polarities.

When the CONST parameter is selected, the bar across from C1 or C2 or C3 becomes lit, as they are selected by pressing the (PARAMETER) SELECT switch.

2.10 TEC Error Indicators

The functions of the 3722 TEC error indicators are shown in Table 2.2. Refer to Figure 2.5 during the discussion of the TEC error indicators.

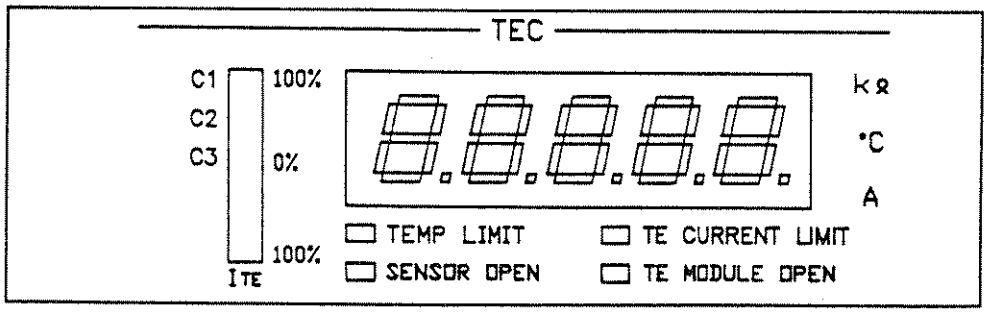


Figure 2.5 3722 TEC Error Section

3722 TEC ERROR INDICATORS

Error Condition	Action
Temperature limit	TEMP LIMIT light flashes at 1 Hz
Open sensor	Output off, SENSOR OPEN indicator LED flashes at 1 Hz
TE Current limit	TE CURRENT LIMIT light flashes at 1 Hz
TE Module Open	TE MODULE OPEN indicator LED flashes at 1 Hz (not in effect when booster source is used)
TE Compliance Voltage Limit	TE CURRENT LIMIT light flashes at 2 Hz

Table 2.2 TEC Error Indicators

2.11 LASER MODE Section

The (LASER MODE) SELECT switch determines which LASER mode is used to control the output of the LASER current source. One of the following may be selected at one time: constant current (I), constant optical (light) power (P), or constant current with a high bandwidth output (I_{HBW}) mode.

The (ADJUST) LASER indicator must be lit before changing the values of the LASER MODE functions. Refer to Figure 2.6 for the discussion of the LASER MODE section features.

Constant I mode is the normal mode for driving lasers. This mode uses a low-pass filter on the laser drive current output to significantly reduce noise.

Constant P mode is also a low bandwidth mode. It is used when it is desired to control the optical power of the laser via a monitor photodiode feedback arrangement.

When P mode is selected, the 3722 will be in either I_{PD} or P_{PD} modes, depending on the setting of the **CAL PD** (monitor photodiode responsivity) parameter. If the CAL PD value is non-zero, the 3722 will operate in constant P_{PD}, monitor photodiode power (light power) mode. (For more information on the CAL PD parameter, see Section 2.13.4).

However, the 3722 has a special mode for operating at a constant monitor photodiode current when the CAL PD parameter value is set to zero. This constant I_{PD} mode is useful for driving a laser when the monitor photodiode's responsivity is not known, but a desired constant light output can be determined to produce a constant monitor photodiode current. The constant I_{PD} mode is also used for monitor feedback calibration.

Constant I_{HBW} is a high bandwidth constant current mode. This mode allows the laser drive current output to be modulated up to 100 KHz via the front panel MOD EXTERNAL connector.

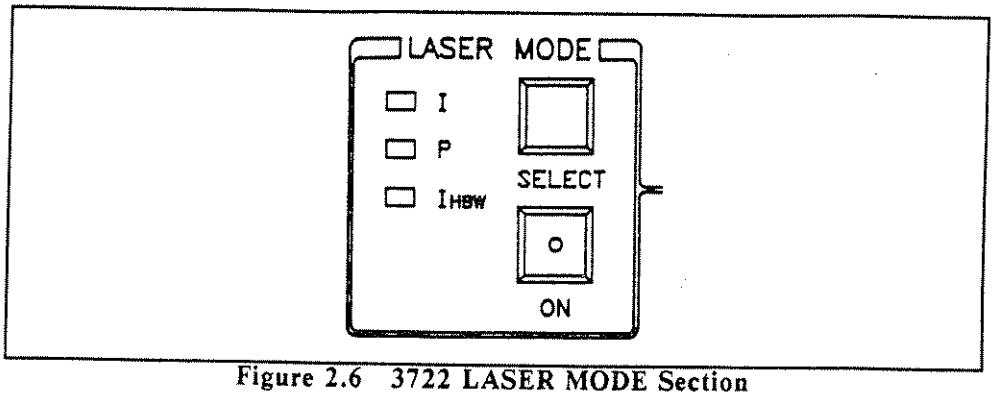


Figure 2.6 3722 LASER MODE Section

2.11.1 LASER MODE SELECT

The (LASER MODE) SELECT switch is used to select one of the three available LASER operating modes. When a mode is selected, the corresponding LED becomes lit.

If the (LASER MODE) SELECT switch is pressed repeatedly, the modes are cycled through in the order I, P, I_{HBW}, and back to I, and so on, with the appropriate mode indicator being lit.

2.11.2 LASER MODE Indicators

The I indicator becomes lit when the 3722 is in the constant current control mode. When constant I mode is selected, the LASER output is controlled to the constant I set point value.

The P indicator becomes lit when the 3722 is in constant optical power control mode. When constant P mode is selected, the LASER output is controlled to the constant I_{PD} (monitor PD current) or P_{PD} (monitor PD power, when the CAL PD value is non-zero) set point value.

The I_{HBW} indicator becomes lit when the 3722 is in high bandwidth constant current control mode. When constant IHBW mode is selected, the LASER output is controlled to the constant I set point value.

2.11.3 LASER MODE ON

The (LASER MODE) ON switch is used to turn the LASER output on and off. When the LASER output is off, an internal short is placed across the LASER output. This condition is indicated by the OUTPUT SHORTED indicator becoming lit.

The (LASER MODE) ON switch has a toggling action. Push it once to turn the LASER output on, and push it again to turn the LASER output off. The output is off when the 3722 is powered up. The (LASER MODE) ON indicator becomes lit when the LASER current output in on. The LASER output will drive to the value set by the corresponding LASER MODE.

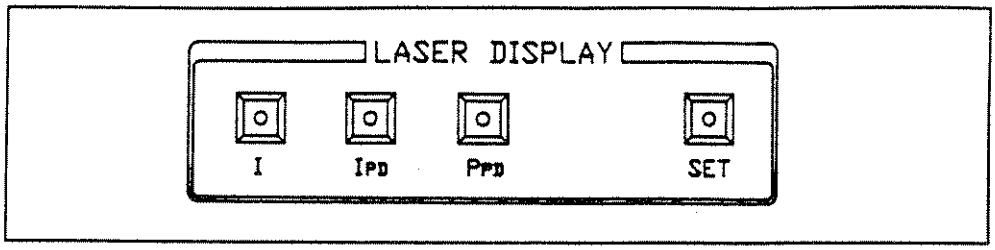


Figure 2.7 3722 LASER DISPLAY Switch Section

2.12 LASER DISPLAY Switch Section

The LASER DISPLAY switch section is used to select the LASER set point or measured I, I_{PD}, or P_{PD} values to appear on the LASER display.

The corresponding LASER MODE must first be selected in order to read and/or adjust the set point value. For example, I or I_{HBW} modes are first selected before reading the I set point display, and P mode must be selected before reading the I_{PD} or P_{PD} displays.

Any of the (LASER) measured values may be selected by pressing the desired LASER DISPLAY switch. When a measured value is selected by pressing the corresponding LASER DISPLAY switch, the (LASER DISPLAY) SET indicator LED will go off (if it was previously on). Refer to Figure 2.7 during the discussion of the LASER DISPLAY switch section features.

2.12.1 LASER DISPLAY SET

When the (LASER DISPLAY) SET switch is pressed, the (LASER DISPLAY) indicator for the corresponding mode will also become lit, if it is not already lit.

For example, if (LASER MODE) I_{HBW} is selected, and then the (LASER DISPLAY) SET switch is pressed, the (LASER DISPLAY) I indicator will also become lit to indicate that the I set point is being displayed.

The set point may then be changed by turning the ADJUST knob (within 3 seconds of releasing the LASER DISPLAY SET switch) until the desired set point value appears on the LASER display. The (LASER DISPLAY) SET switch may be held in while the ADJUST knob is turned, but it is not necessary.

After an adjustment has been made (and the LASER DISPLAY SET switch and ADJUST knob are released), the SET mode will time out in three seconds, the new set point will be stored in non-volatile memory, and the LASER display will revert to the original display mode (I, I_{PD}, or P_{PD}) which was displayed before the set point adjustment was made.

When (LASER MODE) P is selected, and the (LASER DISPLAY) SET switch is pressed, the (LASER DISPLAY) I_{PD} or P_{PD} indicator will become lit. If the CAL PD value is zero, the I_{PD} set point will be displayed, since the 3722 is in constant photodiode current mode. If the CAL PD value is non-zero, the P_{PD} set point will be displayed, since the 3722 is in constant photodiode power mode by virtue of CAL PD being non-zero.

2.12.2 LASER DISPLAY Indicators and Switches

The I indicator becomes lit when laser drive current is displayed. When the I switch is pressed, the display will show measured laser current in mA. If the (LASER DISPLAY) SET switch is then pressed (and I mode is selected in the LASER MODE section), the display will show the laser current set point value in mA.

The I_{PD} indicator becomes lit when monitor photodiode current is displayed. When the I_{PD} switch is pressed, the LASER display will show measured PD monitor current in uA. If the (LASER DISPLAY) SET switch is then pressed (and P mode is selected in the LASER MODE section, and the CAL PD value is zero), the display will show the monitor PD current set point value, in uA.

The P_{PD} indicator becomes lit when the user-programmed optical power is displayed. When the P_{PD} switch is pressed, the LASER display will show measured optical power in mW, as it relates to the monitor photodiode current (see Section 2.13.3). If the (LASER DISPLAY) SET switch is then pressed (and I or I_{HBW} mode is selected in the LASER MODE section and the CAL PD value is non-zero), the display will show the optical power set point value, in mW.

If the CAL PD parameter value is zero, and the P mode is selected in the LASER MODE section, the 3722 will operate in constant I_{PD} mode, and the P_{PD} display will indicate "-.-" when the P_{PD} display is selected.

The (LASER DISPLAY) **SET indicator** becomes lit when the display is showing the SET (set point) value. The (LASER DISPLAY) SET indicator goes off when the display is showing a measured value.

2.13 LASER PARAMETER Section

The LASER switch (in the ADJUST section) must be engaged (indicator lit) to adjust the LASER PARAMETER values.

The following sections describe the function and form of the LASER PARAMETER Selections. Refer to Figure 2.8 for the discussion of the LASER PARAMETER features.

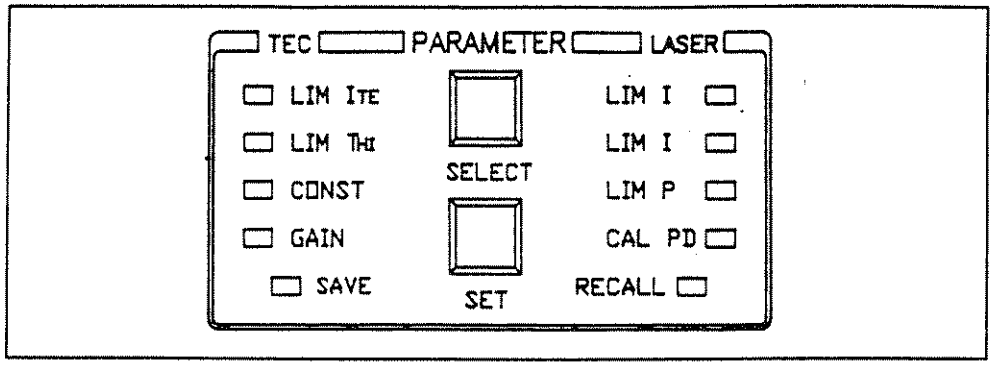


Figure 2.8 3722 PARAMETER Section

2.13.1 LASER PARAMETER SELECT

The (PARAMETER) SELECT switch is used to enter this SELECT mode. While the (ADJUST) LASER indicator is lit (LASER mode selected), press the (PARAMETER) SELECT switch to enter this mode.

When the (LASER PARAMETER) SELECT mode is first entered, the LIM I (blue) indicator becomes lit, and the 3722 displays the current limit value, in mA. All LED indicators in the LASER DISPLAY switch section are turned off. If the (PARAMETER) SELECT switch is released, this state continues for three seconds, after which the 3722 reverts to its former state.

If the (PARAMETER) SELECT switch is pressed repeatedly, successive (LASER) parameter values are displayed, and the appropriate (LASER) parameter indicator LED becomes lit. The order of cycling through the (LASER) parameter list is LIM I (blue), LIM I (black), LIM P, CAL PD, then back to LIM I (blue), and so on.

2.13.2 LASER PARAMETER SET

The (PARAMETER) SET switch is used to enter SET mode, where parameter values are stored into non-volatile memory.

If the (PARAMETER) SET switch is pressed while the 3722 is in SELECT mode, the 3722 will enter SET mode. While the (PARAMETER) SET switch is held in, the selected parameter value can be change by rotating the ADJUST knob. The new value is stored in non-volatile memory when the (PARAMETER) SET switch is released.

2.13.3 LIM I

The LIM I parameters are used to set the absolute upper limit for LASER output current. There are two limit settings, one for the 200 mA range (blue), and another for the 500 mA range (black). The LIM I value which is in use depends on the RANGE selection. Only one LIM I (and one RANGE) is in effect at any time.

During operation, when the LASER current limit is reached, the CURRENT LIMIT error indicator flashes.

If the optional GPIB is implemented, the LASER current limit condition may be used to turn the LASER output off via the LASer:ENABle:OUTOFF command.

The LIM I (blue) indicator becomes lit when the laser current limit for the 200 mA range is displayed.

The LIM I (black) indicator becomes lit when the laser current limit for the 500 mA range is displayed.

The current limit setting is independent of the voltage drop of the device connected to the LASER output, and therefore, no dummy load is required for precise adjustment of the current limit. Furthermore, since the current limit circuitry is fully independent of the main current control, the current limit can be adjusted safely, even while the LASER output is active.

2.13.4 LIM P

The LIM P is the absolute limit of optical power, as detected by the 3722 via the monitor PD feedback scheme. In order for this limit to be meaningful, the monitor photodiode responsivity (CAL PD) must be adjusted correctly. See Section 2.12.4.

This limit is a software limit only. The LASER output is normally turned off if this limit is reached (unless this condition to turn the LASER output off is disabled via the remote LASer:ENABle:OUTOFF command). The maximum LIM P value is 200.0 mW.

During operation, when the LASER power limit is reached, the POWER LIMIT error indicator flashes.

2.13.5 CAL PD

The CAL PD indicator becomes lit when the monitor photodiode responsivity parameter is displayed. The responsivity is displayed in uA/mW. The responsivity is entered by the user (in uA/mW) after performing the following measurements:

1. Measure (with a calibrated detector) the output power of the device.
2. Measure the corresponding photodiode current.
3. Calculate the responsivity by dividing the optical power into the corresponding photodiode current.

This value is normally used to convert between optical power and optical current of the monitor photodiode. This parameter is used to convert between I_{PD} and P_{PD} values. However, when the CAL PD value is set to zero, the 3722 may be operated in constant I_{PD} mode.

When the CAL PD value is zero, the LASER output will be controlled to the I_{PD} set point value, and the P_{PD} display will indicate "-.-" when it is selected.

2.14 LASER Error Indicators

The functions of the 3722 LASER error indicators are shown in Table 2.3. Refer to Figure 2.9 during the discussion of the LASER error indicators.

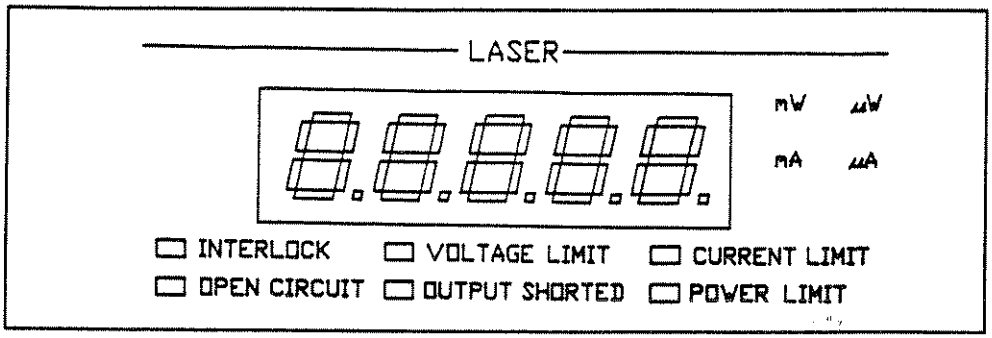


Figure 2.9 LASER Error Indicators

LASER ERROR INDICATORS

Error Condition	Action
Interlock	Output off, INTERLOCK light flashes at 1 Hz
Open circuit	Output off, OPEN CIRCUIT light flashes at 1 Hz
Compliance Voltage Limit	VOLTAGE LIMIT light flashes at 2 Hz
Output Shorted	OUTPUT SHORTED light comes on. This indicator becomes lit whenever the LASER output is off.
Current limit	CURRENT LIMIT light flashes at 1 Hz
Optical Output Power Limit	Output off, POWER LIMIT light flashes at 1 Hz

Table 2.3 LASER Error Indicators

2.15 RANGE Section

The RANGE switch (marked PRESS TWICE) is pressed twice to switch from the 200 mA laser drive current setting to the 500 mA setting, and vice versa. It must be pressed twice quickly (within less than 1 second) to switch between modes, and the LASER output must be off (LASER MODE ON indicator unlit) in order to change ranges. See Figure 2.10.

If the LASER output is on when the RANGE (PRESS TWICE) switch is pressed, the 3722 will beep to indicate that the range cannot be changed while the LASER output is on.

2.16 MOD Section

The EXTERNAL (BNC) connector allows a DC to 100 kHz modulation signal to be applied to the laser. The 20 mA/V scale applies to the 200 mA range (blue) and the 50 mA/V scale applies to the 500 mA range (black). See Figure 2.10.

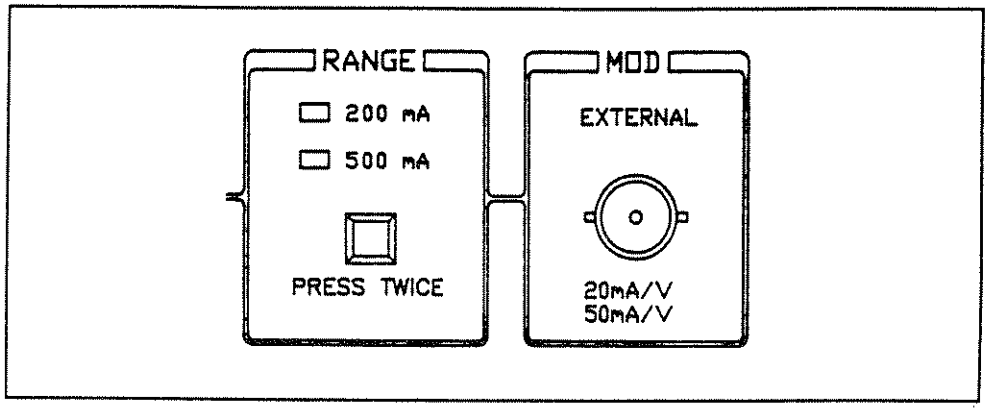


Figure 2.10 3722 RANGE and MOD Sections

2.17 SAVE and RECALL Parameter Functions

The SAVE and RECALL parameter functions are used to store and retrieve 3722 parameter configurations for future use. For example, a specific test setup may be saved for later use, and then another setup may be used presently. Then, when the user desires to perform the specific test, its setup is simply recalled. This saves setup time, and it reduces the chance of setup error for tests which are repeated periodically.

Refer to Figure 2.8 for the discussion of the SAVE and RECALL parameters.

Non-volatile memory is used for saving the instrument parameters. When a save operation is performed, all of the parameters which are currently in effect on the 3722 are stored. The user selects a "bin" number (1 - 10) for saving the parameters. Then, when that "bin" number is recalled, the 3722 is restarted and the parameters are reconfigured to the previously stored values.

To enter the SAVE/RECALL mode, first exit both TEC and LASER modes. If either TEC or LASER mode is engaged, the corresponding LED indicator will be lit in the ADJUST section of the front panel. To exit, press the switch of the indicated (lit) mode, so that both indicators are off. Then press the SELECT switch in the PARAMETERS section of the front panel.

When the **SELECT switch** is pressed in SAVE/RECALL mode, the 3722 enters the SELECT mode. Then, the SAVE indicator LED becomes lit and the 3722 displays the SAVE "bin" number. If the SELECT switch is pressed again, the RECALL indicator LED becomes lit, and the 3722 displays the RECALL "bin" number. If the SELECT switch is released, the SELECT mode state continues for three seconds, after which the instrument reverts to its former state.

The **SAVE indicator** becomes lit when the 3722 is displaying a save bin number. The "bin" number is displayed as a number in the range 1 - 10. "Bin" 0 holds the reset (default) parameters.

The **RECALL indicator** becomes lit when the 3722 is displaying a recall "bin" number. The "bin" number is displayed as a number in the range 0 - 10. "Bin" 0 is reserved for the reset (default) parameters.

If the (PARAMETER) SET switch is pressed while the 3722 is in this SELECT mode, then the 3722 will enter SET mode. While the (PARAMETER) SET switch is pressed, the selected "bin" number can be changed by rotating the ADJUST knob. The new value is accepted when (PARAMETER) SET switch is released.

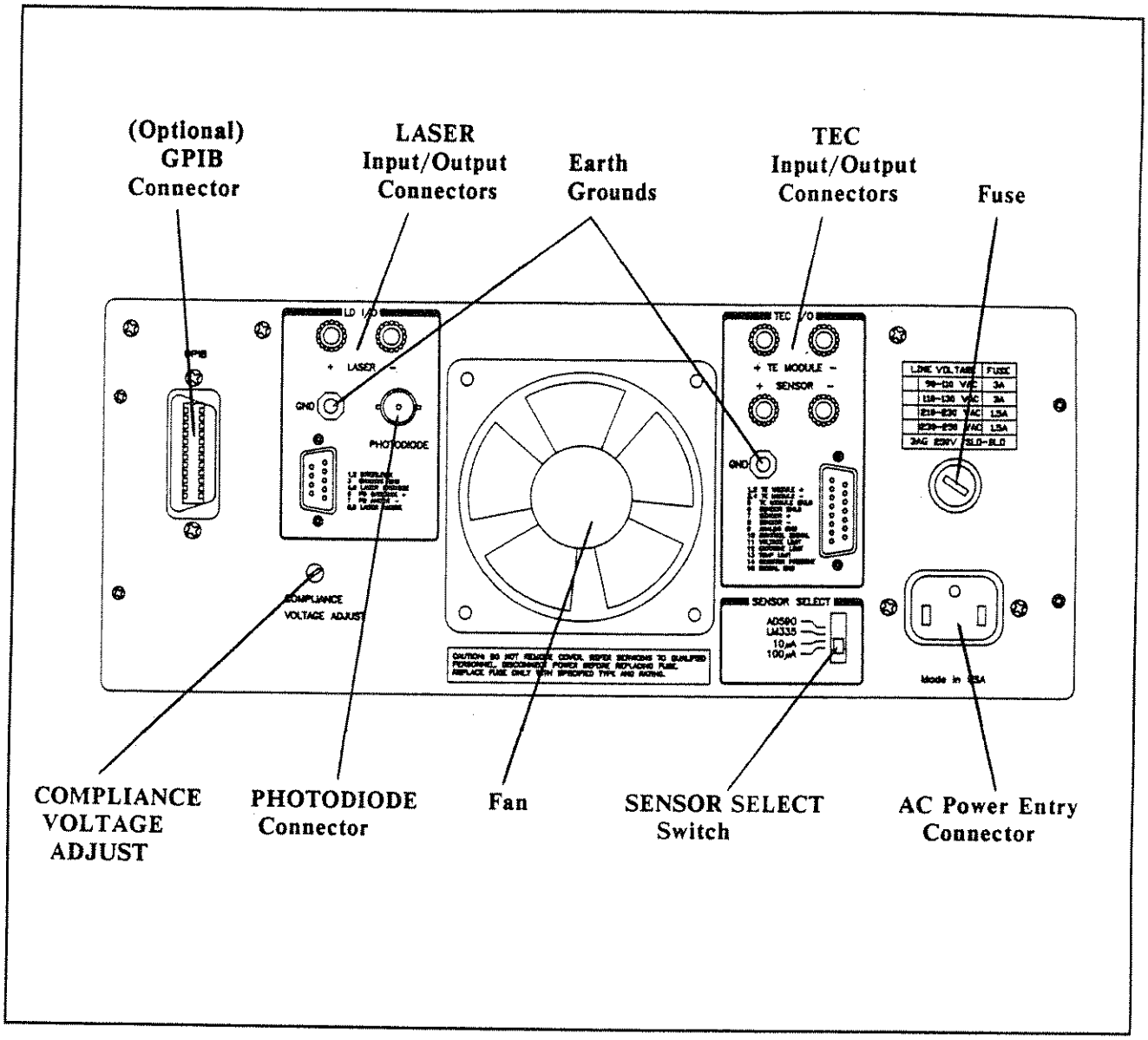


Figure 2.11 3722 Back Panel

2.18 Back Panel Controls and Connections

Refer to Figure 2.11 for the following discussions of back panel controls and connectors. Notice that on the back panel the TEC controls and connectors are directly behind the TEC display, and the LASER controls and connectors are behind the LAS display.

2.18.1 SENSOR SELECT Switch

The SENSOR SELECT switch is used to select sensor type and, in the case of thermistor sensor, the source current level. Table 2.4 shows the SENSOR SELECT positions and corresponding position code. When the sensor switch is changed during TEC mode operation, the new sensor position code will be indicated on the TEC display for three seconds.

SENSOR SELECT POSITION CODES

SWITCH POSITION	CODE
100 uA	--01
10 uA	--02
LM335	--03
AD590	--04

Table 2.4 SENSOR SELECT Switch Positions

The 10 uA and 100 uA designations are for the current source level; thermistor sensor type is implied. When using a thermistor, the supply current depends on the thermistor operating temperature range and the required temperature resolution. Guidelines for setting this switch are contained in Appendix B.

The AD590 sensor operates as a current source which is proportional to the sensed temperature. The LM335 sensor operates as a voltage source which is proportional to the sensed temperature. Both of these sensors are approximately linear over their operating ranges. When they are used, the constants C1 and C2 are used for a two-point conversion. For more information on setting the constants for use with these sensors, see Section 2.9.3 and Appendix C.

Note, on the back panel, the SENSOR SELECT switch positions are arranged from highest (top) to lowest (bottom). Therefore, the AD590 position is at the top, 100 uA at the bottom.

2.18.2 The TEC Connectors

On the TEC side of the back panel you will find the post connectors for the TEC MODULE, SENSOR, and ground (GND). An auxiliary 15-pin d-connector is used for input and output connections, as shown by the pin-out diagram of Figure 2.12.

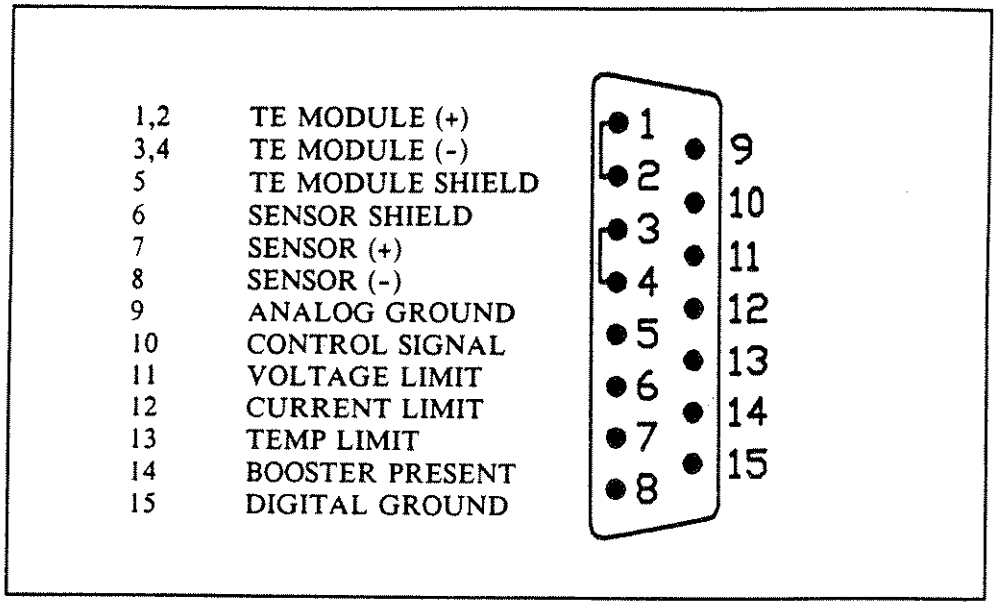


Figure 2.12 Back Panel TEC Input/Output Connector

2.18.3 TEC Grounding Considerations

The TEC outputs of the LDC-3722 are isolated from chassis ground, allowing either output terminal to be grounded at the user's option. The thermistor's (-) terminal and the TEC module's (-) terminals are internally connected.

2.18.4 COMPLIANCE VOLTAGE Control

The COMPLIANCE VOLTAGE for the LASER output may be adjusted by turning the slotted ADJUST screw on the back panel. The screw is recessed into the back panel so that it can't be accidentally reset. To adjust the compliance voltage, turn the ADJUST screw with a small blade screwdriver.

When the adjustment is made while facing the front of the 3722 and reaching behind to the back panel, turning the ADJUST screw counter-clockwise (CCW) will decrease the compliance voltage.

If the user faces the back panel of the 3722, turning the ADJUST screw clockwise (CW) will decrease the compliance voltage.

2.18.5 The LASER Connectors

On the LASER side of the back panel you will find the post connectors for the LASER, PHOTODIODE, and ground (GND). An auxiliary 9-pin d-connector is used for input and output connections, as shown by the pin-out diagram of Figure 2.13.

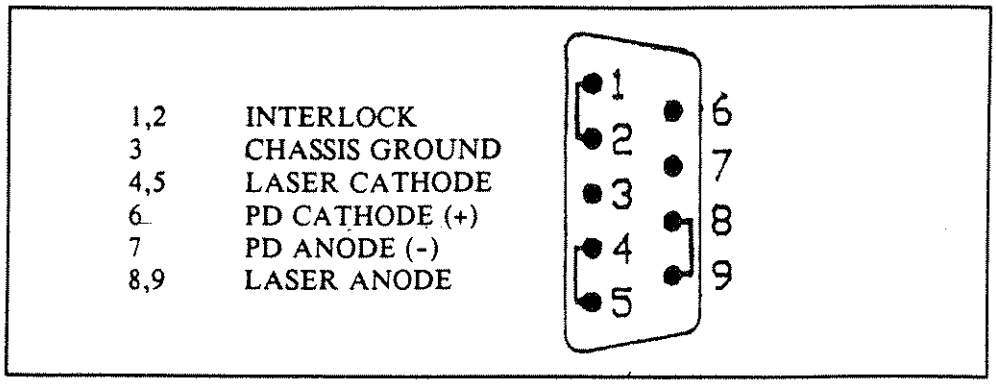


Figure 2.13 Back Panel LASER Input/Output Connector

2.18.6 Connecting to Your Laser

When connecting laser diodes and other sensitive devices to the 3722, we recommend that the 3722 be powered-up and the LASER output be off (LASER MODE ON LED unlit). In this condition, a low impedance shunt is active across the output terminals. When disconnecting devices, it is only necessary to turn the LASER Output off.

Pins 4 and 5 of J121 are the negative output, and pins 8 and 9 are the positive output current connections (see Figure 2.13). These pins are jumpered to provide greater contact area for the output connections. This is done to reduce the risk of an open output connection due to a loose connector. Thus, the output is made safer for laser diodes.

> **NOTE - Whenever external connections are made to the output at pins 4 and 5, and 8 and 9, these connector leads must be jumpered as shown in Figure 2.13 to ensure the greatest laser diode safety.**

We also recommend the use of the 9-pin D-connector (J121), rather than the binding posts, whenever possible. The 9-pin connector is safer to use.

2.18.7 Laser Diode Connections and Shielding

> **IMPORTANT**
>
> **Before connecting the laser diode to the LDC-3722, be sure that the front panel (LASER MODE) ON switch is in the OFF position (ON LED unlit). Before turning on the LASER output, be sure that the current limit has been correctly set.**

Figures 2.14 A - D show the possible configurations of connecting laser diodes and photodiodes with the 3722.

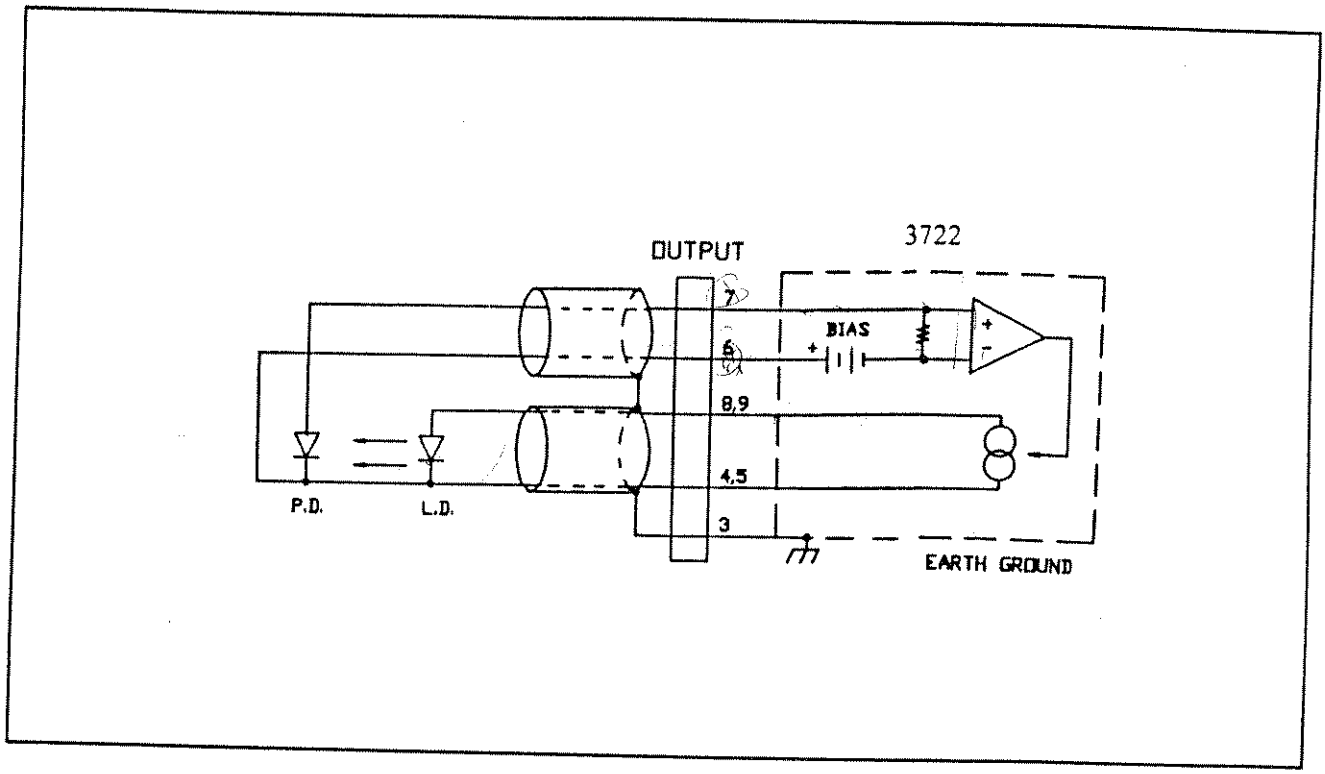


Figure 2.14A Common Laser Cathode - Photodiode Cathode

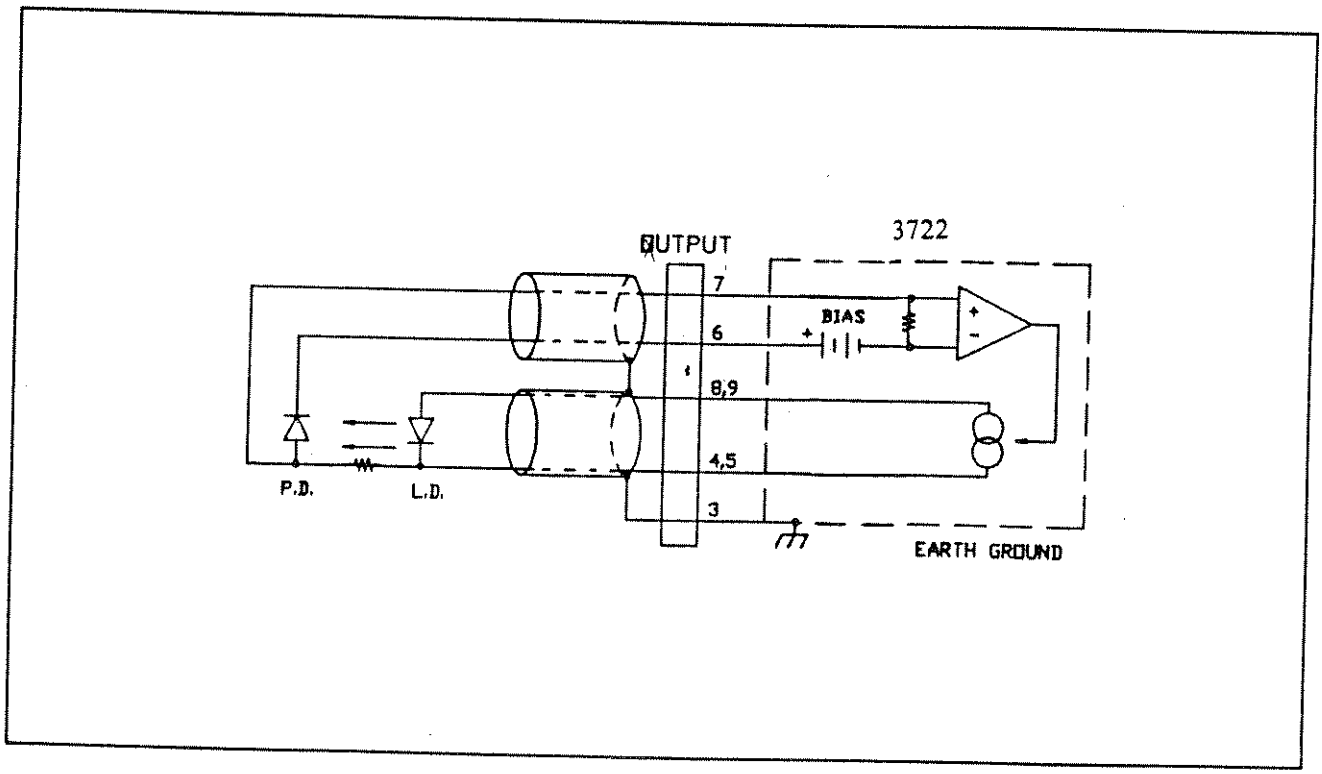


Figure 2.14B Common Laser Cathode - Photodiode Anode

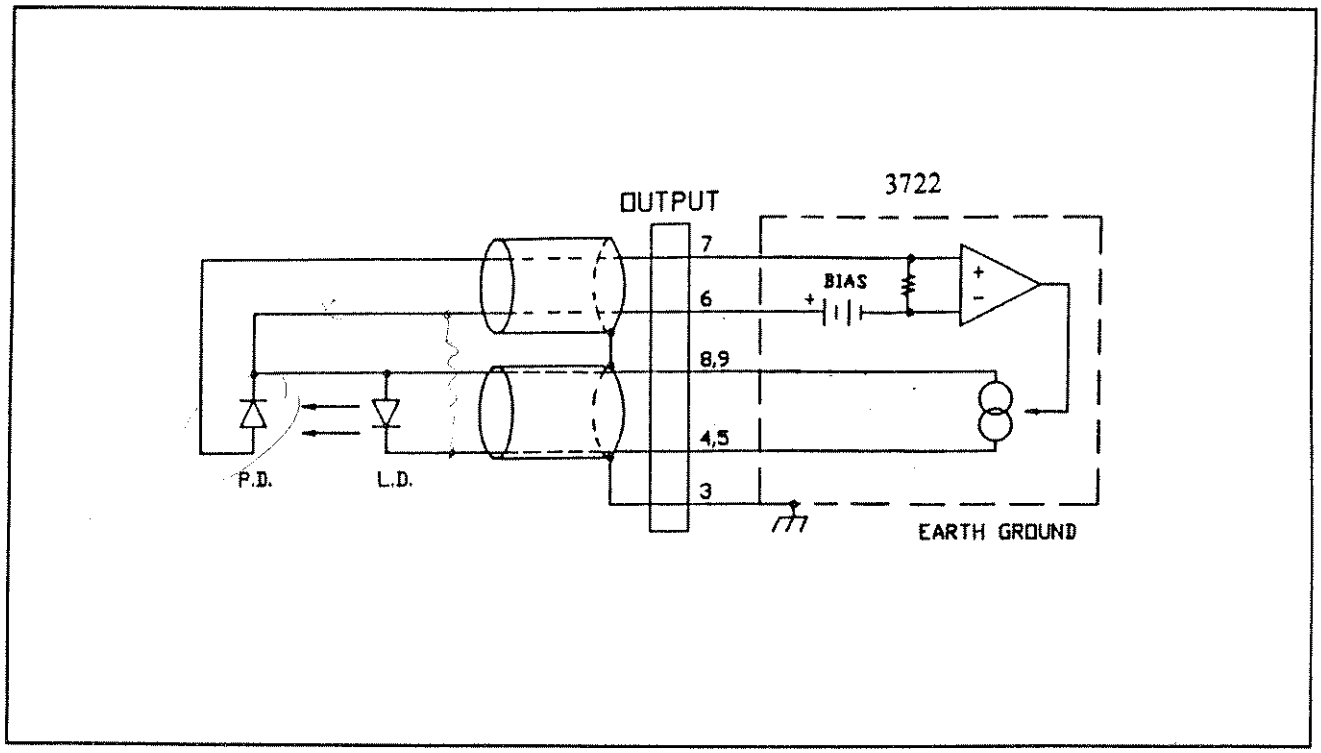


Figure 2.14C Common Laser Anode - Photodiode Cathode

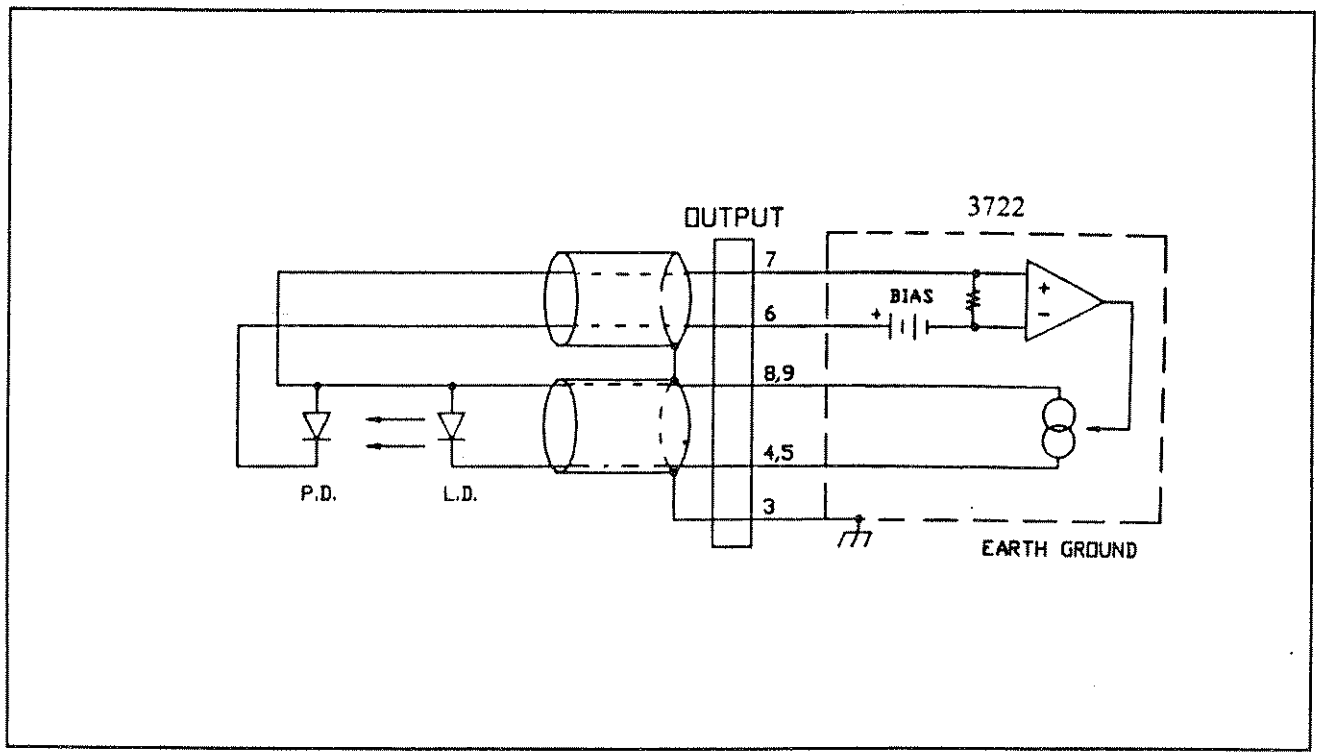


Figure 2.14D Common Laser Anode - Photodiode Anode

IMPORTANT

The cable connections to the laser must be secure enough that they won't open-circuit, should they be jostled or bumped. Should an open circuit occur during laser operation, the LASER output will normally be turned off (ON LED unlit) automatically[1].

Experience indicates that should an open circuit occur during laser operation (while the LASER is ON), the laser may be damaged by a momentary circuit break-and-remake before the final circuit break. Therefore, secure cabling is very important.

It is recommended that the connections to the LDC-3722 output be made using twisted wire pairs with an earth-grounded shield (see Figures 2.14 A - D). The output terminals of the 3722 are left floating relative to earth ground to suppress AC power-on/power-off transients that may occur through an earth-ground path. If the output circuit is earth-grounded at some point (such as through the laser package and mount), the user must be careful to avoid multiple earth grounds in the circuit. Multiple earth grounds may provide circuit paths that induce spurious currents in the photodiode feedback circuit and output leads.

2.18.8 Photodiode Feedback Connections

The 9-pin D-connector (J121, Figure 7.22) on the back panel contains the current supply output and earth ground. The photodiode signal is input at the connector at pins 6 and 7 (see Figure 2.13). The 3722 provides a reverse bias of 5 V for the photodiode.

Many laser diode modules contain an internal photodiode that monitors the back-facet emission of the laser. Usually, this photodiode is internally connected to either the laser anode or cathode. Figures 2.14A - 2.14D show the recommended connections and shielding for the various configurations of laser diode modules and photodiode feedback schemes.

If a feedback photodiode is used, which is electrically isolated from the laser, the feedback circuit must be resistively "tied" at some point to the output circuit. A large resistance of about 1 Mohm, connected from the laser cathode to the photodiode anode, may be used in place of the direct connection (see Figure 2.14B). This is done to keep the feedback inputs within the specified maximum $\pm$10 volt common mode voltage, relative to the "-" laser current output terminal. If possible, use the circuit of Figure 2.14B.

1 This is normally true, and is true in the default condition of the 3722. However, the conditions and events which turn the LASER OUTPUT off may be altered by using the LASer:ENABle:COND command over the GPIB, if desired.

2.18.9 Grounding Considerations

The LASER outputs of the 3722 are isolated from chassis ground allowing either output terminal to be grounded at the user's option. Figure 2.14 shows the proper earth-ground shielding for laser diode/photodiode connections.

2.18.10 GPIB Connector

When the optional Model 1231 GPIB is installed, its connector is located on the back panel, directly behind the ADJUST section of the front panel.

2.19 General Operating Procedures

The following sections present some guidelines for operation, as well as some common operating procedures. Remote operations are discussed in Chapter 4.

2.19.1 Warm-up and Environmental Considerations

Operate the LDC-3722 at an ambient temperature in the range of 0 to +50 °C. Storage temperatures should be in the range of -40 to +70 °C. To achieve rated accuracy, let the LDC-3722 warm up for about 1 hour before use.

2.19.2 TEC Mode Operation

You can operate the TEC controller portion of the LDC-3722 in several modes, constant T, constant R, or constant I_{TE}. This example is for constant T mode, the most commonly used mode. However, the other operating modes follow similar procedures.

a. Plug the LDC-3722 into an AC power source supplying the correct voltage and frequency for your unit (refer to the back panel for the correct ratings).

b. Turn on the 3722. The TEC OUTPUT stage will be off at power-up and the unit will automatically configure its parameters to the state which existed when the power was last shut off.

c. Check the setting of the SENSOR SELECT switch for the desired operation. The sensor code will be displayed for three seconds during the power-up sequence (see Section 2.3).

d. Press the TEC switch in the ADJUST section of the front panel to enter TEC mode. Press the SELECT switch in the TEC MODE section until the T mode is selected.

e. Press the SELECT switch (in the PARAMETER section) and check the setting of LIM I_{TE}, LIM T_{HI}, GAIN, and C1, C2, and C3 to insure that they are compatible with the equipment you are using. Refer to Section 2.9 if you need to change them.

If a pre-configured setup is to be recalled, use the RECALL feature (see Section 2.17) and then recheck the parameter settings for confirmation.

f. Press the T switch and SET switch (in the TEC DISPLAY switch section) and check the set point temperature. If it requires changing, turn the knob until the desired value is displayed.

g. Turn the TEC output on by pressing the ON switch (in the TEC MODE section).

   The 3722 will automatically control the temperature to the set point.

h. When the 3722 is powered off, the state of the unit at power-down is saved in non-volatile memory.

2.19.3 LASER Mode Operation

You can operate the LASER current source portion of the LDC-3722 in several modes, constant I, constant P, or constant I, high bandwidth. This example is for constant I mode, the most commonly used mode. However, the other operating modes follow similar procedures.

a. Plug the LDC-3722 into an AC power source supplying the correct voltage and frequency for your unit (refer to the back panel for the correct ratings).

b. Turn on the 3722. The LASER OUTPUT stage will be off at power-up and the unit will automatically configure its parameters to the state which existed when the power was last shut off.

c. Press the LASER switch in the ADJUST section of the front panel to enter LASER mode. Press the SELECT switch in the LASER MODE section until the I mode is selected.

e. Press the SELECT switch (in the PARAMETER section) and check the setting of LIM I to insure that it is compatible with the laser you are using. Refer to Section 2.13 if you need to change the current limit.
   If a pre-configured setup is to be recalled, use the RECALL feature (see Section 2.17) and then recheck the parameter settings for confirmation.

f. Press the I switch and SET switch (in the LASER DISPLAY switch section) and check the set point (operating) current. If it requires changing, turn the knob until the desired value is displayed.

g. Turn the LASER output on by pressing the ON switch (in the LASER MODE section).

   The 3722 will automatically drive the laser to the set point current.

h. When the 3722 is powered off, the state of the unit at power-down is saved in non-volatile memory.

2.19.3 Simultaneous TEC and LASER Mode Operation

Follow the steps outlined in Sections 2.19.1 and 2.19.2 for each of the operating modes. When both TEC and LASER modes are in operation, the following should also be considered.

a. When alternating adjustments of the LASER and TEC operations, the corresponding switch in the ADJUST section of the front panel must be pressed.

b. The SAVE and RECALL parameter functions save the LASER and TEC parameters simultaneously.

3.3 Common Commands

Another type of command is the "common command". These commands are common to instruments which support the ANSI-IEEE-488.2 standard and are not necessarily reflected by front panel operations. Some of the common commands are useful for advanced programming techniques, such as generating service requests. However, common commands are not necessary for remote operation, and the beginning programmer may chose to ignore them entirely. The common commands for the 3722 are documented in Chapter 4.

Two common commands which are reflected by front panel operations are *SAV and *RCL. These commands remotely perform the same operations as when the SAVE and RECALL parameters are changed during Local (front panel) operation.

3.4 3722 Device-Dependent Commands

This section contains all of the device-dependent commands for the 3722, listed in alphabetical order. Sub-sections for each path are presented, listing the commands which are legal for that path. See Figure 3.2 for command path tree structure. All of the 3722's common commands and queries are listed in Section 4.3. The lower level remote interface messages are also listed in Chapter 4.

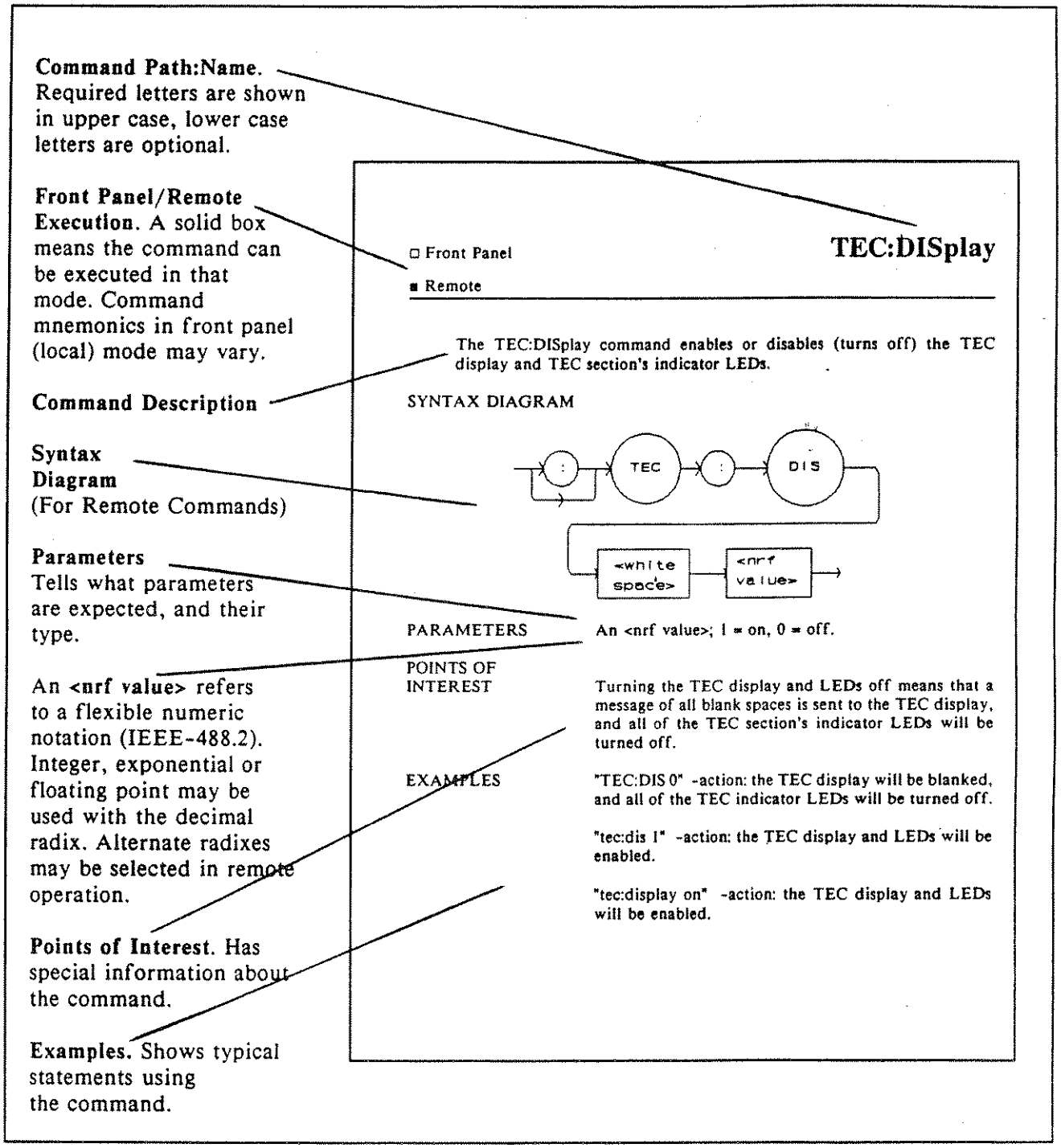


Figure 3.1 Command Description Format

□ Front Panel

■ Remote

BEEP

The BEEP command controls the 3722's beeper. The beeper can be used to signal error or warning conditions.

SYNTAX DIAGRAM

PARAMETERS

An <nrf value>, 0 = OFF (totally disabled); 1 = ON, enabled for normal operation; and 2 = beep once.

POINTS OF INTEREST

Disabling the BEEP will prevent the audible beeper signal from working during front panel operation, including the calibration signals.

The parameter must be a numeric value (0, 1, or 2), and not a character data substitute (such as ON or OFF).

EXAMPLES

"BEEP 0" -action: The beeper is disabled.

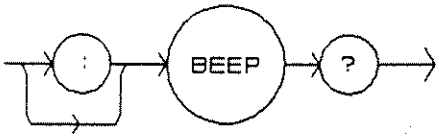
"BEEP 1" -action: The beeper is enabled for normal operation.

"BEEP 2" -action: The beeper is beeped once.

BEEP?

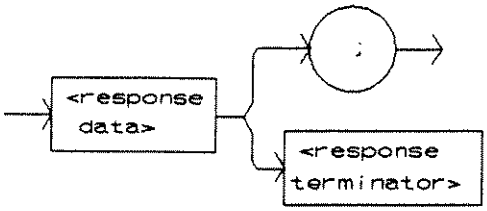
The BEEP? query returns the enable status of the 3722's beeper.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where a <response data> of 0 = OFF (totally disabled); 1 = ON, enabled for normal operation.

POINTS OF INTEREST

Disabling the BEEP will prevent the audible beeper signal from working during front panel operation, including the calibration signals.

The beeper is normally enabled, unless it is specifically disabled via the "BEEP 0" remote command.

EXAMPLES

"BEEP?" -response: 0, means the beeper is disabled.

"Beep?" -response: 1, means the beeper is enabled for normal operation.

□ Front Panel

■ Remote

DELAY

The DELAY command causes the execution of commands to be delayed by a user-defined time. This command is similar to the *WAI common command, except that execution resumes after the specified number of milliseconds, instead of waiting for the Operation-Complete flag to be set.

SYNTAX DIAGRAM

PARAMETERS

An <nrf value> which represents the delay time, in milliseconds.

POINTS OF INTEREST

The Operation-Complete flag is held false until the delay period elapses, but the *OPC? query will not execute until the delay period has elapsed.

This command is useful for creating delays which don't require a lot of program code and don't tie up the GPIB during execution.

EXAMPLES

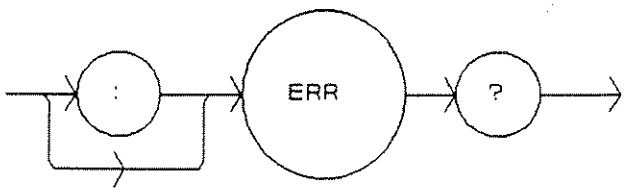
"DELAY 500" -action: Further commands and queries are not executed until 0.5 seconds have elapsed from the time this command is executed.

"Tec:T 22;Delay 2000;Tec:T?" -actions: The TEC is set to 22.0°C, then the 3722 waits for about 2.0 seconds before returning the measured temperature.

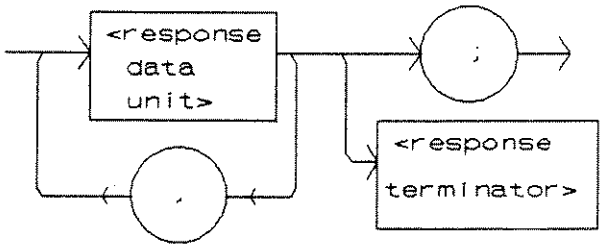
ERRors?

The ERRors? query returns a list of command and device errors which have occured since the last query. These errors are notated by a number which corresponds to the type of error which occured. See Appendix D for information regarding error handling.

SYNTAX DIAGRAM



PARAMETERS None. The response will be in the form:



-where each <response data unit> consists of an error code value.

POINTS OF INTEREST

The response data will be a list of the current errors. The errors are represented by numbers and are separated by commas. A response of 0 indicates that no errors were reported. The response data is sent as character data.

EXAMPLES

"ERR?" -response: 0, means no errors reported.

"Errors?" -response: 201,407, means that the <PROGRAM DATA> (parameter) value out of range error and the High Temperature Limit error were reported since the last query.

LASer:

The LASer: command path is used to get to the 3722's laser current source commands. The following command paths may be reached from the LASer: command path.

LASer:CAL:
LASer:DISplay:
LASer:ENABle:
LASer:LIMit:
LASer:MODE:
LASer:SET:

The following commands may be reached directly from the LASer: command path.

LASer:CALPD
LASer:CALPD?
LASer:COND?
LASer:DEC
LASer:EVEnt?
LASer:DISplay
LASer:DISplay?
LASer:I
LASer:I?
LASer:INC
LASer:IPD
LASer:IPD?
LASer:MODE?
LASer:OUTput
LASer:OUTput?
LASer:P
LASer:P?
LASer:RANge
LASer:RANge?
LASer:STEP
LASer:STEP?
LASer:TOLerance
LASer:TOLerance?

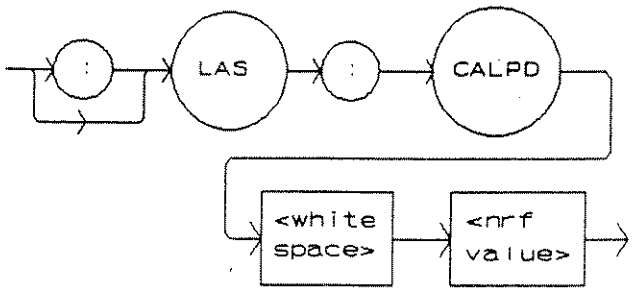
■ Front Panel

■ Remote

LASer:CALPD

The LASer:CALPD command sets the laser's photodiode feedback responsivity (the CAL PD parameter).

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>, in microamps/milliwatt.

POINTS OF INTEREST

If the parameter is set to 0, the 3722 will operate in a constant I_{PD} mode, when Constant P mode is selected.

The parameter should be set to 0 for I_{PD} calibration modes. Otherwise, the value of this parameter is used to convert between I_{PD} and P_{PD} values. The units of this parameter are microamps/milliwatt.

In local operation, the LASER:CALPD value is entered via the CAL PD parameter. When the CAL PD parameter is selected (LED lit), pressing and holding in the (PARAMETER) SET switch will allow the user to enter the parameter value by adjusting the ADJUST knob.

EXAMPLES

"LAS:CALPD 0" -action: sets the CAL PD parameter to 0. This enables the constant I_{PD} mode of operation.

"Laser:Calpd 1" -action: sets the CAL PD parameter to 1.00 microamp/milliwatt. Therefore, a photodiode feedback current of 1 microamp will cause the P_{PD} display to read 1 milliwatt.

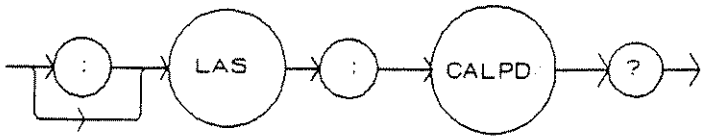
■ Front Panel

■ Remote

LASer:CALPD?

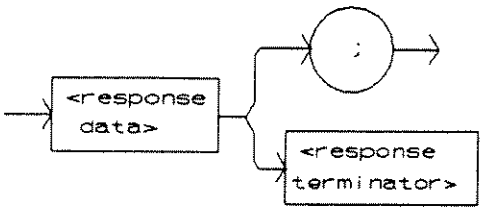
The LASer:CALPD? query returns the value of the laser's photodiode feedback reponsivity (CAL PD parameter) setting.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

If this value is 0, the 3722 will be set to operate in constant I_{PD} mode, and the IPD set point value will be in effect. If this value is non-zero, the 3722 will be set to operate in constant P_{PD} mode, and the P_{PD} set point value will be in effect.

If this value is 0, the front panel P_{PD} will display " -.-", and no P_{PD} value can be calculated.

In local operation, the CAL PD value can be read by selecting the CAL PD parameter and visually reading the LASER display.

EXAMPLES

"LASER:CALPD?" -response: 0, means the 3722 is set for operation in constant I_{PD} mode (if P mode is also selected).

"Las:Calpd?" -response: 1.1, means the 3722 is set for operation in constant P_{PD} mode (if P mode is also selected) and the responsivity is set to 1.1 uA/mW. 1.1 uA of photodiode feedback current represents 1 mW of optical power.

LASer:CAL:

The LASer:CAL: command path is used to get to the 3722's laser calibration commands.

In local operation, the LASER calibration mode is reached by pressing the (GPIB) LOCAL and (LASER DISPLAY) I or I_{PD} switches at the same time.

The following commands may be reached directly from the LASer:CAL: command path.

LASer:CAL:I
LASer:CAL:I?
LASer:CAL:IPD
LASer:CAL:IPD?

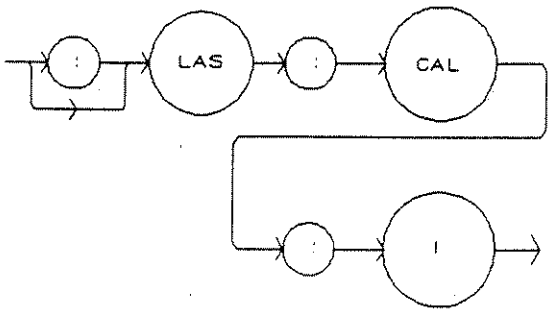
■ Front Panel

■ Remote

LASer:CAL:I

The LASer:CAL:I command is used to enter the LASER current set point, measurement, and limit (in low bandwidth mode) calibration mode.

SYNTAX DIAGRAM



PARAMETERS

None.

POINTS OF INTEREST

Since the limit circuit is the same for both high and low bandwidth modes, it is only calibrated when low bandwidth mode is selected.

After this command is issued, the 3722 will allow calibration of the current set point, measurement, and limit (if low bandwidth mode is seleted). This procedure is outlined in Section 6.4.2.

The calibration defaults to the selected current range and bandwidth settings. Therefore, it is necessary to select the desired output current range (200 or 500 mA) and bandwidth (I or I_{HBW}), and turn the LASER output on before performing the calibration for that range and bandwidth.

Calibration is performed at the current set point, wherever it is set. If the LASER output is not ON, the 3722 will beep each time you try to enter this mode, indicating a calibration procedural error.

In remote operation, the LASer:CAL:I? query may be used to determine if the 3722 is ready for the user to enter a value.

In local operation, the 3722 will beep once when it is ready for the user to enter a value.

EXAMPLES

"Las:CAL:I" -action: the 3722 enters calibration mode for LASER current.

"Las:Cal:I" -action: the 3722 enters calibration mode for LASER current.

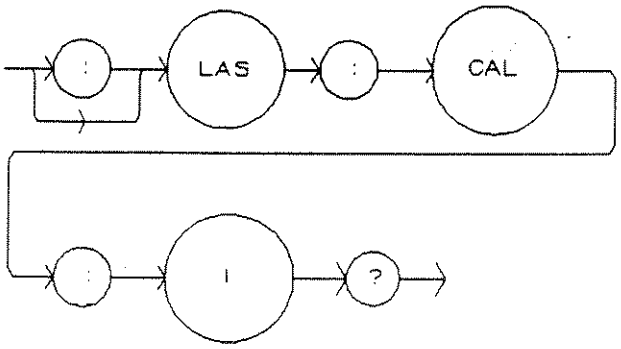
■ Front Panel

■ Remote

LASer:CAL:I?

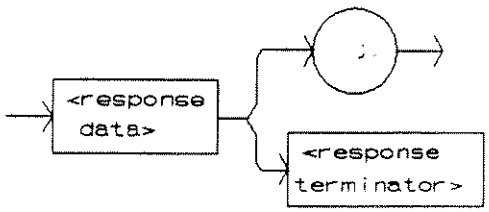
The LASer:CAL:I? query is used to determine that the 3722 is ready for a value to be entered during the calibration cycle of the LASer:CAL:I mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where 1 = ready, 0 = not ready.

POINTS OF INTEREST

After this query is issued and a response of 1 is received, the 3722 will be ready for the user to enter a current value via the LASer:I command (see Section 6.4.2).

In local operation, the ready state during the calibration cycle is indicated by a beep (if the beeper is enabled) which is issued by the 3722 when it is ready for a value to be entered.

EXAMPLES

"LASer:CAL:I?" -response: 1, means the 3722 is ready for the user to enter a current value via the LASer:I command.

"LASer:Cal:I?" -response: 0, means the 3722 is not yet ready for the user to enter a LASER current value.

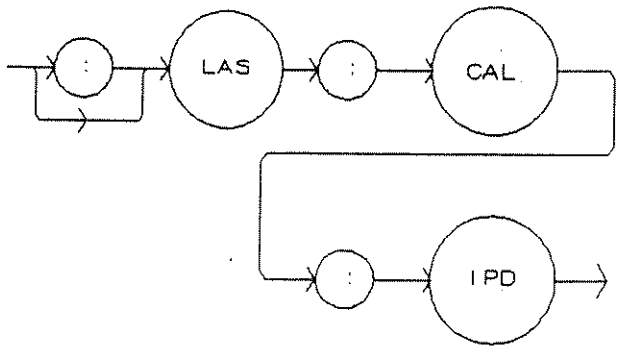
■ Front Panel

■ Remote

LASer:CAL:IPD

The LASer:CAL:IPD command is used to enter the LASER photodiode current calibration mode.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST

After this command is issued, the 3722 will automatically enter the LASER photodiode current calibration mode for the current LASER range. When the 3722 is ready, the user should enter the true measured value. This procedure is outlined in Section 6.4.4.

If the LASER output is not ON, or the CALPD parameter value is 0, or the P mode is not selected, the 3722 will beep each time you try to enter this mode, indicating a calibration procedural error.

In remote operation, the LASer:CAL:IPD? query may be used to determine if the 3722 is ready for the user to enter a value via the LASer:IPD command.

In local operation, the 3722 will BEEP when it is ready for the user to enter a value.

EXAMPLES

"Las:CAL:IPD" -action: the 3722 enters the LASER photodiode current calibration mode.

"LAS:Cal:IPD" -action: the 3722 enters the LASER photodiode current calibration mode.

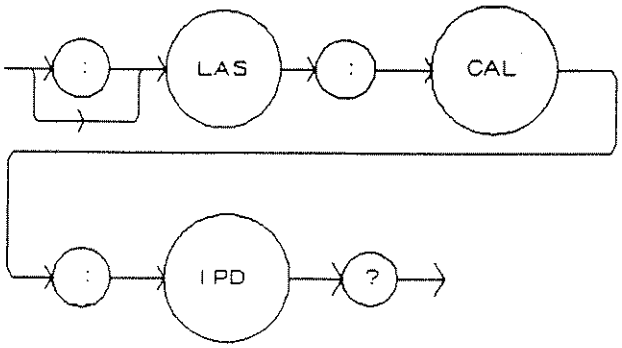
■ Front Panel

■ Remote

LASer:CAL:IPD?

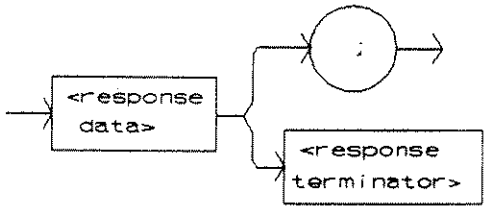
The LASer:CAL:IPD? query is used to determine that the 3722 is ready for a value to be entered during the calibration cycle of the LASer:CAL:IPD mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where 1 = ready, 0 = not ready.

POINTS OF INTEREST

After this query is issued and a response of 1 is received, the 3722 be ready for the user to enter a current value via the LASer:IPD command (see Section 6.4.4).

In local operation, the ready state during the calibration cycle is indicated by a beep which is issued by the 3722 when it is ready for a value to be entered.

EXAMPLES

"LAS:CAL:IPD?" -response: 1, means the 3722 is ready for the user to enter a photodiode current value via the LASer:IPD command.

"Laser:Cal:Ipd?" -response: 0, means the 3722 is not yet ready for the user to enter a photodiode current value.

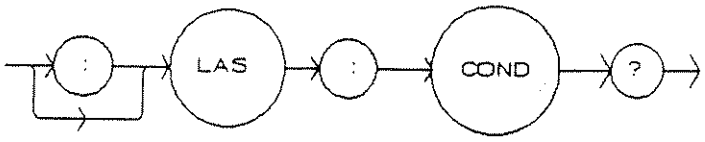
□ Front Panel

■ Remote

LASer:COND?

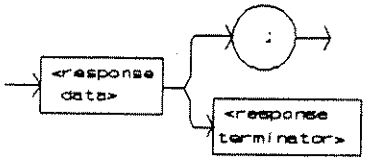
The LASer:COND? query returns the value of the status condition register of the LASER operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - Laser limit current
2 - Voltage limit error
4 - N/A
8 - Power limit
16 - Interlock disabled
32 - N/A
64 - N/A
128 - Open circuit
256 - Output is shorted
512 - Output is outside tolerance limit
1024 - Output on/off state
2048 - Ready for calibration data state
4096 - Calculation error
8192 - Error communicating with LASER board
16384 - Software error in LASER control
32768 - LASER eeprom checksum error

POINTS OF INTEREST

The LASER conditions which are reported to the status byte are set via the LASer:ENABle:COND command.

The LASER condition status is constantly changing, while the event status is only cleared when the event status is read or the *CLS command is issued.

EXAMPLES

"LAS:COND?" -response: 513, means that the LASER limit current and out of tolerance LASER conditions currently exist.

"Radix Hex; Laser:Cond?" -response: #H108, means that the LASER Output shorted and Power limit conditions currently exist.

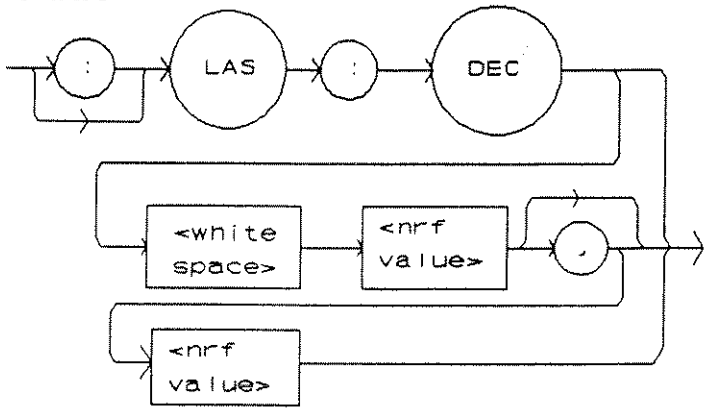
□ Front Panel

■ Remote

LASer:DEC

The LASer:DEC command decrements the selected laser control mode set point by one or more steps. Optional parameters allow multiple steps to be decremented and the time (in milliseconds) between decrements to be set, respectively.

SYNTAX DIAGRAM



PARAMETERS

None, 1, or 2. If no parameters are specified, the LASER set point value will be decremented by one step. The first optional parameter allows the user to set the number of steps for the LAS:DEC operation. The second optional parameter allows the user to set the time (in mSec) between each decremented step.

POINTS OF INTEREST

The decremental default amount is one step. The step size can be edited via the LAS:STEP command, its default value is 0.01 mA, 0.01 mW, or 1 uA (if CALPD = 0), depending on the mode of operation.

If the first optional parameter is used, but not the second, the user may decrement the LASER set point by a multiple of the LAS:STEP size, without changing the LAS:STEP size.

If the both optional parameters are used, the user may create an automated stepping ramp function for the LASER output.

If the first optional parameter is entered as zero, "LAS:DEC 0", the command will do nothing.

(Continued on next page.)

LASer:DEC

(Continued from previous page.)

POINTS OF INTEREST

The minimum time to complete one decrement is about 10 to 20 mSec. Therefore, values for the second optional parameter (time between decrements) have a practical minimum of 20.

EXAMPLES

"LAS:MODE:I; LAS:STEP 30; LAS:DEC" -action: The laser source current set point is decremented by 0.3 mA.

"LAS:MODE:I; LAS:STEP 30; LAS:DEC 3" -action: The laser source current set point is decremented by 0.9 mA (0.3 mA * 3).

"LAS:MODE:I; LAS:STEP 30; LAS:DEC 3,5000" -action: The laser source current set point is decremented by 0.3 mA, three times, with 5 seconds between decremental steps. So the LASER output is decremented a total of 0.9 mA after 10 seconds.

"LAS:STEP 10; LAS:Mode:P; Las:DEC" -action: The power set point is decremented by 0.1 mW.

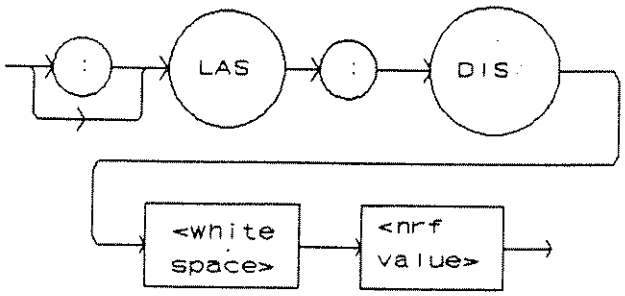
□ Front Panel

■ Remote

LASer:DISplay

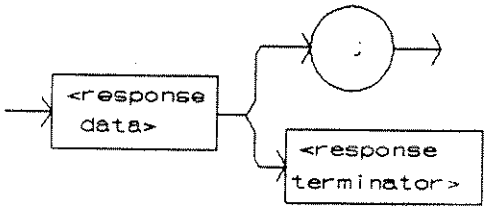
The LASer:DISplay command enables or disables (turns off) the LASER display and LASER section's indicator LEDs.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>



-where 1 = on, 0 = off.

POINTS OF INTEREST

Turning the LASER display and LEDs off means that a message of all blank spaces is sent to the LASER display, and all of the LASER section's indicator LEDs will be turned off.

EXAMPLES

"las:dis 1" -action: turns the LASER display on and enables the LASER indicator LEDs.

"Laser:dis Off" -action: turns the LASER display and disables the LASER indicator LEDs.

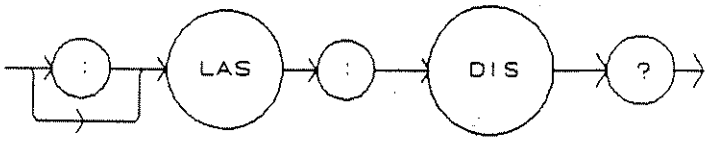
■ Front Panel

■ Remote

LAS:DISplay?

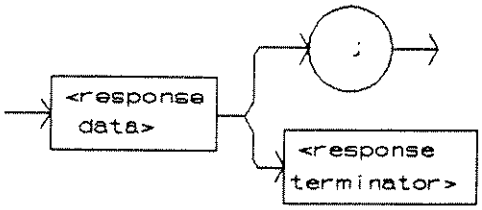
The LASer:DISplay? query returns the value shown on the LASER display.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



POINTS OF INTEREST

Returns the actual (6-character) string from the output buffer to the LASER display. If the display is disabled, it returns " .".

In local mode, the user would read the LASER display visually.

EXAMPLES

"LAS:DIS?" -response: "- 99.9", means the LASER display shows "- 99.9".

"Laser:DISp?" -response: " 0.6", means the LASER display shows " 0.6".

■ Front Panel

■ Remote

LASer:DISplay:

The LASer:DISplay: command path is used to get to the 3722's laser display commands.

The following commands may be reached directly from the LASer:DISplay: command path.

LASer:DISplay:I
LASer:DISplay:I?
LASer:DISplay:IPD
LASer:DISplay:IPD?
LASer:DISplay:PARAM
LASer:DISplay:PPD
LASer:DISplay:PPD?
LASer:DISplay:SET
LASer:DISplay:SET?

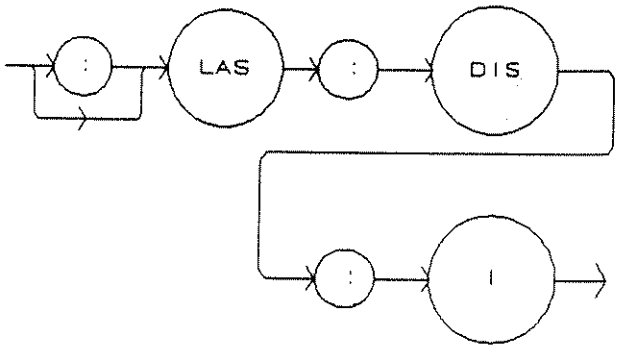
■ Front Panel

■ Remote

LASer:DISplay:I

The LASer:DISplay:I command sets the laser display to show the constant current measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The actual LASER I display is turned off automatically when another LASER DISPLAY selection is enabled.

In local operation, the LASER I value is displayed by pressing the I switch in the LASER DISPLAY area of the front panel.

EXAMPLES — "LAS:DIS:I" -action: enables the LASER display for current values.

"Laser:Display:I" -action: enables the LASER display for current values.

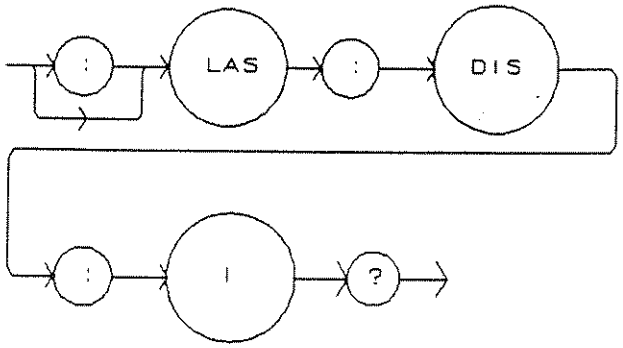
■ Front Panel

■ Remote

LASer:DISplay:I?

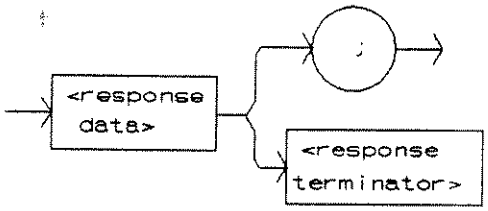
The LASer:DISplay:I? query returns the value of the displayed laser current measurement value.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response of 0 = off, 1 = on.

POINTS OF INTEREST

The response will be the status of the (LASER DISPLAY) I switch.

In local operation, the status of the I switch is determined by visually inspecting the I and SET indicators in the LASER DISPLAY area of the front panel. The status of the I switch is "on" if its indicator is lit and the SET indicator is not lit.

EXAMPLES

"LAS:DIS:I?" -response: 0, means that the (LASER DISPLAY) I switch is not currently active, laser current is not displayed.

"Las:dis:I?" -response: 1, means that the (LASER DISPLAY) I switch is currently active, laser current may be displayed.

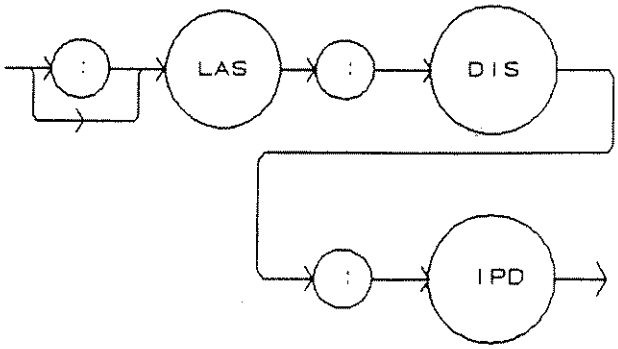
■ Front Panel

■ Remote

LASer:DISplay:IPD

The LASer:DISplay:IPD command sets the laser display to show the monitor photodiode current measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST

The actual (LASER DISPLAY) I_{PD} display is turned off automatically when another LASER DISPLAY selection is enabled.

In local operation, the (LASER DISPLAY) I_{PD} value is displayed by pressing the I_{PD} switch in the LASER DISPLAY area of the front panel.

EXAMPLES

"LAS:DIS:IPD" -action: enables the LASER display for photodiode current values.

"Laser:Disp:Ipd" -action: enables the LASER display for photodiode current values.

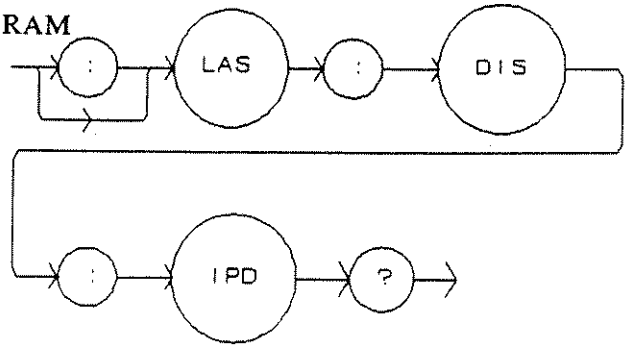
■ Front Panel

■ Remote

LASer:DISplay:IPD?

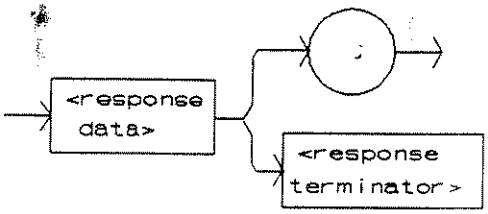
The LASer:DISplay:IPD? query returns the status of the (LASER DISPLAY) I_{PD} switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response of 0 = off, 1 = on.

POINTS OF INTEREST

The response will be the status of the (LASER DISPLAY) I_{PD} switch.

In local operation, the status of the I_{PD} switch is determined by visually inspecting the I_{PD} indicator in the LASER DISPLAY area of the front panel. The status of the I_{PD} switch is "on" if its indicator is lit and the SET indicator is not lit.

(lit = ON).

EXAMPLES

"LAS:DIS:IPD?" -response: 0, means that the (LASER DISPLAY) I_{PD} switch is not currently active, laser photodiode monitor current is not displayed.

"Las:dis:IPD?" -response: 1, means that the (LASER DISPLAY) I_{PD} switch is currently active, PD current may be displayed.

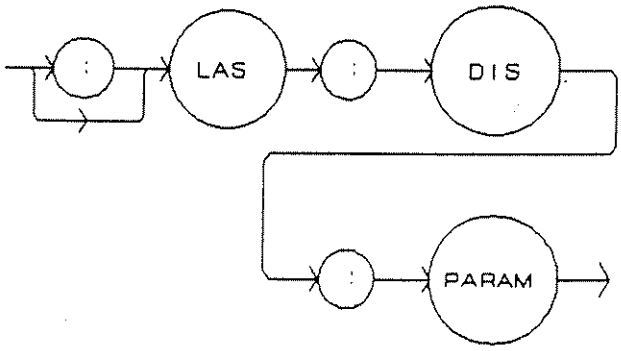
■ Front Panel

■ Remote

LASer:DISplay:PARAM

The LASer:DISplay:PARAM command enables the LASer display to show the LASER parameter values.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST

This command has the same effect as pressing the (PARAMETER) SELECT switch while in LASER mode. The selected parameter will be displayed for three seconds. The actual LASER PARAM display is turned off automatically when a LASER display selection is enabled.

Each time the command is issued, the next LASER parameter will be selected, see Section 2.13.

In local operation, the LASER PARAMETER is displayed by pressing the SELECT switch in the LASER PARAMETER area of the front panel, while in LASER mode.

EXAMPLES

"Laser:Display:Param" -action: selects a LASER parameter and displays its value.

"LAS:DIS:PARAM" -action: selects a LASER parameter and displays a its value.

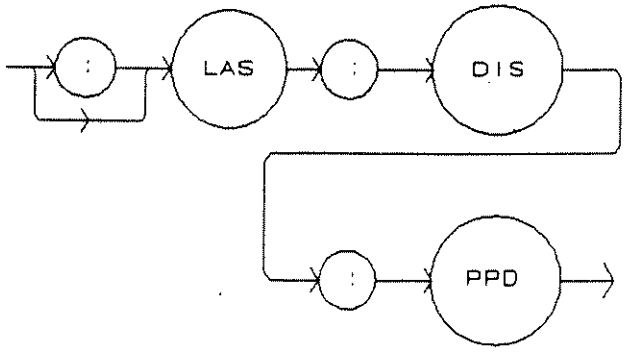
■ Front Panel

■ Remote

LASer:DISplay:PPD

The LASer:DISplay:PPD command sets the laser display to show the monitor photodiode power measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The actual (LASER) P_{PD} display is turned off automatically when another LASER DISPLAY selection is enabled.

In local operation, the (LASER) P_{PD} value is displayed by pressing the P_{PD} switch in the LASER DISPLAY area of the front panel.

EXAMPLES — "Las:Display:ppd" -action: enables the LASER display for photodiode power values.

"Laser:Disp:PPD" -action: enables the LASER display for photodiode power values.

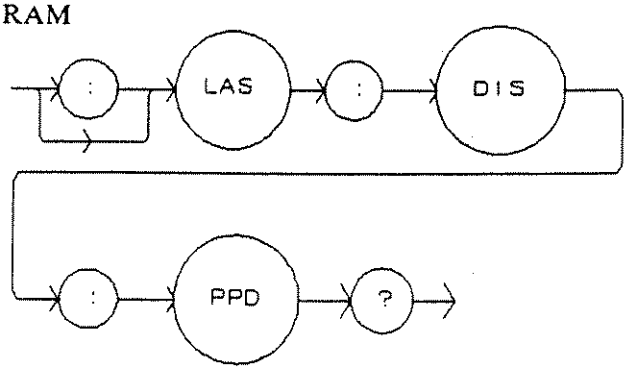
■ Front Panel

■ Remote

LASer:DISplay:PPD?

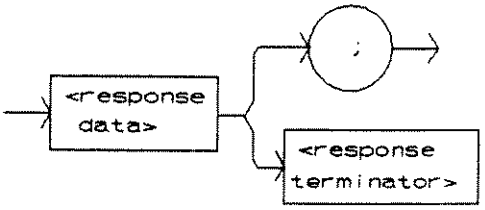
The LASer:DISplay:PPD? query returns the status of the (LASER DISPLAY) P_{PD} switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response of 0 = off, 1 = on.

POINTS OF INTEREST

The response will be the status of the (LASER DISPLAY) P_{PD} switch.

In local operation, the status of the P_{PD} switch is determined by visually inspecting the P_{PD} indicator in the LASER DISPLAY area of the front panel. The status of the P_{PD} switch is "on" if its indicator is lit and the SET indicator is not lit.

EXAMPLES

"LAS:DISp:Ppd?" -response: 0, means that the (LASER DISPLAY) PPD switch is not currently active, laser photodiode monitor power is not displayed.

"Las:dis:Ppd?" -response: 1, means that the (LASER DISPLAY) P_{PD} switch is currently active, PD power may be displayed.

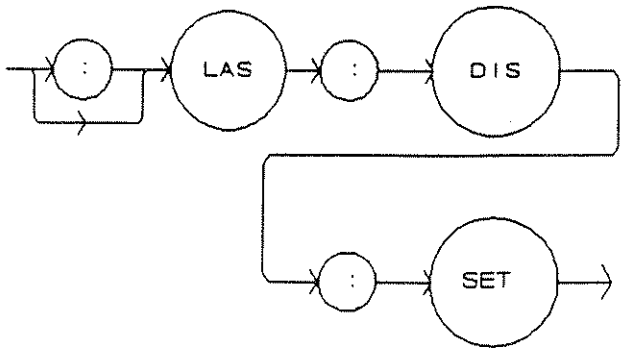
■ Front Panel

■ Remote

LASer:DISplay:SET

The LASer:DISplay:SET command sets the laser display to show the set point of the selected LASER DISPLAY mode.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — Using this command has the same effect as physically holding the DIS SET switch down (in).

EXAMPLES — "Las:Dis:Set" -action: enables the LASER display for the set point of the selected mode: I, I_{PD}, or P_{PD}.

"LAS:Dis:Set" -action: enables the LASER display for the set point of the selected display mode.

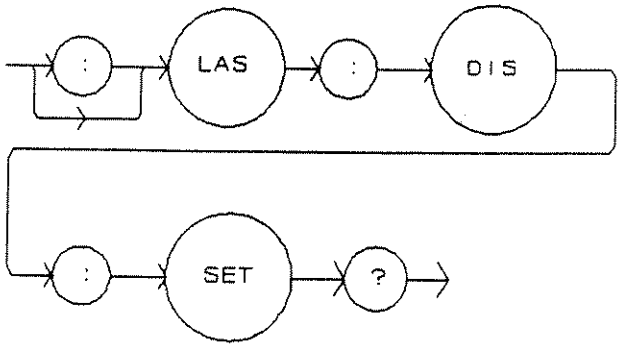
■ Front Panel

■ Remote

LASer:DISplay:SET?

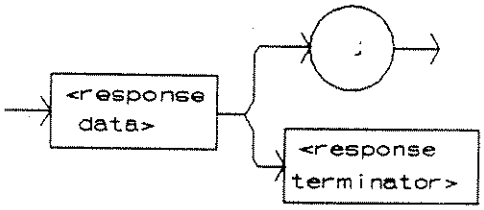
The LASer:DISplay:SET? query returns the status of the LASER display set point switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The set point display will not time out when REMOTE operation is used. (It will be continuously displayed.)

In local operation, the status of the SET switch is determined by visually inspecting the LED on the switch (lit = ON).

EXAMPLES

"LAS:DISPLAY:SET?" -response: 0, means the measured value is enabled for the LASER display.

"Las:Dis:Set?" -response: 1, means the set point value is enabled for the LASER display.

LASer:ENABle:

The LASer:ENABle: command path is used to get to the 3722's laser status enable commands and queries.

The following commands may be reached directly from the LASer:ENABle: command path.

LASer:ENABle:COND
LASer:ENABle:COND?
LASer:ENABle:EVEnt
LASer:ENABle:EVEnt?
LASer:ENABle:OUTOFF
LASer:ENABle:OUTOFF?

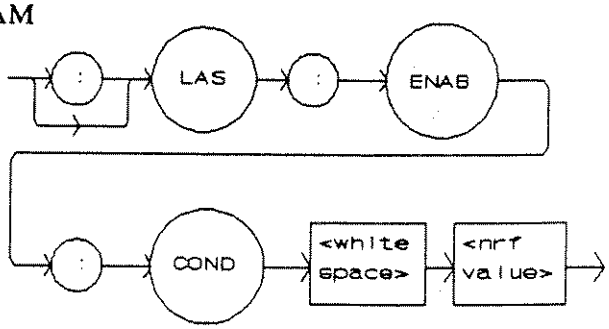
□ Front Panel

■ Remote

LASer:ENABle:COND

The LASer:ENABle:COND command sets the condition status enable register of the LASER operations for summary (in bit 3 of the status byte) and generation of service requests.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the enabled bits:

1 - Laser Limit Current
2 - Voltage Limit Error
4 - N/A
8 - Power Limit
16 - Interlock Disabled
32 - N/A
64 - N/A
128 - Open Circuit
256 - Output is Shorted
512 - Output is Outside Tolerance Limit
1024 - Output On/Off State
2048 - Ready for Calibration Data State
4096 - Calculation Error
8192 - Error Communicating with LASER Board
16384 - Software Error in LASER Control
32768 - LASER Eeprom Checksum Error

POINTS OF INTEREST

The enabled or disabled LASER conditions can be read by using the LASer:ENABle:COND? query.

The LASER condition status can be monitored by the LASer:COND? query. If any of the enabled LASER conditions are true, bit 3 of the status byte register will be set.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 4).

(Continued on next page.)

LASer:ENABle:COND

(Continued from the previous page.)

EXAMPLES

"LAS:ENAB:COND 129" -action: enables the LASER status condition register so that the Open circuit and LASER current limit conditions will be summarized in the status byte (bit 3).

"Laser:Enable:Cond #HFF97" -action: enables the LASER status condition register so that any and all of the above conditions will be reported in the status byte register (bit 3).

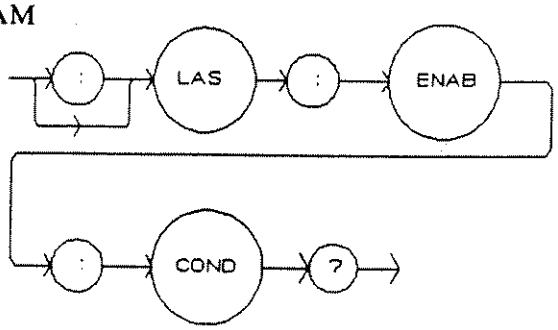
□ Front Panel

■ Remote

LASer:ENABle:COND?

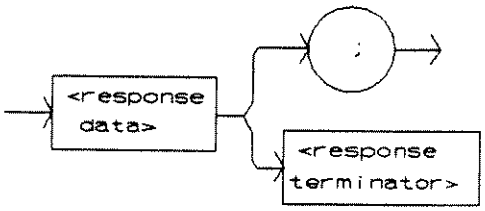
The LASer:ENABle:COND? query returns the value of the status condition enable register of the LASER operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - Laser Limit Current
2 - Voltage Limit Error
4 - N/A
8 - Power Limit
16 - Interlock Disabled
32 - N/A
64 - N/A
128 - Open Circuit
256 - Output is Shorted
512 - Output is Outside Tolerance Limit
1024 - Output On/Off State
2048 - Ready for Calibration Data State
4096 - Calculation Error
8192 - Error Communicating with LASER Board
16384 - Software Error in LASER Control
32768 - LASER Eeprom Checksum Error

POINTS OF INTEREST

The enabled LASER conditions can be set by using the LASer:ENABle:COND command.

The LASER condition status can be monitored by the LASer:COND? query.

(Continued on next page.)

LASer:ENABle:COND?

(Continued from previous page.)

EXAMPLES

"LAS:ENAB:COND?" -response: 18, means that the Voltage limit and Interlock disabled LASER conditions will be reported (in summarized form) to the status byte (bit 3).

"Radix Hex; Laser:Enable:Cond?" -response: #HFF97, means that all of the above conditions will be reported (in summarized form) to the status byte (bit 3).

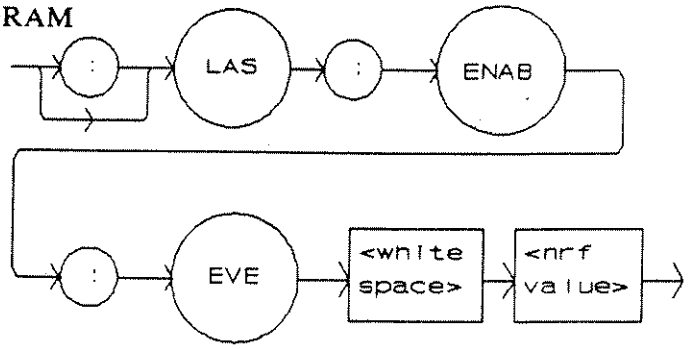
□ Front Panel

■ Remote

LASer:ENABle:EVEnt

The LASer:ENABle:EVEnt command sets the status event enable register of the LASER operations. These events are summarized in bit 2 of the status byte register.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the bits which are enabled:

1 - Laser Current Limit
2 - Voltage Limit
4 - N/A
8 - Power Limit
16 - Interlock State Changed
32 - N/A
64 - N/A
128 - Open Circuit
256 - Output is Shorted
512 - Output Changed to be In/Out of Tolerance
1024 - Output On/Off State Changed
2048 - New Measurements Taken
4096 - Calculation Error
8192 - Communication with LASER Board Error
16384 - Software Error in LASER Control
32768 - LASER Eeprom Checksum Error

POINTS OF INTEREST

The enabled LASER events can be read by using the LASer:ENABle:EVEnt? query. The LASER event status can be monitored by the LASer:EVEnt? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 4).

(Continued on next page.)

LASer:ENABle:EVEnt

(Continued from previous page.)

EXAMPLES

"LAS:ENAB:EVENT 136" -action: enables the LASER status event register so that the Open circuit and Power limit events will be reported (in summarized form) to the status byte (bit 2).

"Laser:Enable:Event #HFF9B" -action: enables the LASER status event register so all of the above events will be reported (in summarized form) to the status byte (bit 2).

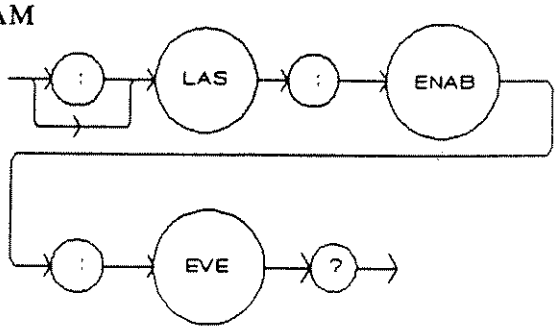
□ Front Panel

■ Remote

LASer:ENABle:EVEnt?

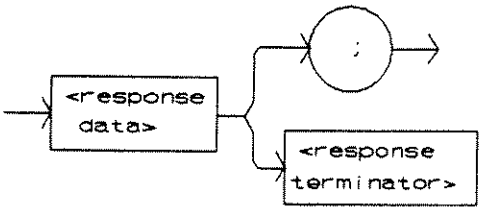
The LASer:ENABle:EVEnt? query returns the value of the status event enable register of the LASER operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - Laser Current Limit
2 - Voltage Limit
4 - N/A
8 - Power Limit
16 - Interlock State Changed
32 - N/A
64 - N/A
128 - Open Circuit
256 - Output is Shorted
512 - Output Changed to be In/Out of Tolerance
1024 - Output On/Off State Changed
2048 - New Measurements Taken
4096 - Calculation Error
8192 - Communication with LASER Board Error
16384 - Software Error in LASER Control
32768 - LASER Eeprom Checksum Error

POINTS OF INTEREST

The enabled LASER events can be set by using the LASer:ENABle:EVEnt command. The LASER event status can be monitored by the LASer:EVEnt? query.

(Continued on next page.)

□ Front Panel

■ Remote

LASer:ENABle:EVEnt?

(Continued from previous page.)

EXAMPLES

"LAS:ENAB:EVE?" -response: 1040, means that the Output on/off state change and Interlock changed LASER events will be reported (in summarized form) to the status byte register (bit 2).

"Radix Hex; Las:Enab:Eve?" -response: #HFF9B, means that all of the above events will be reported (in summarized form) to the status byte register (bit 2).

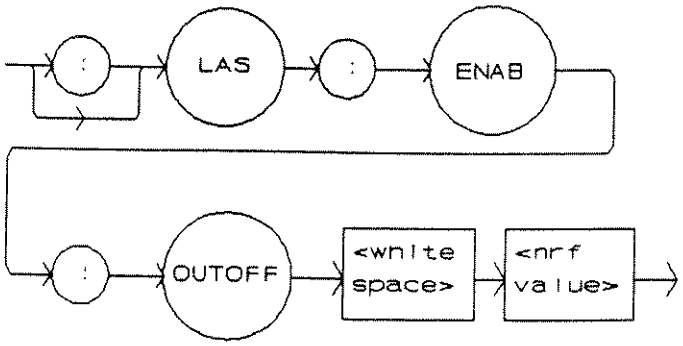
□ Front Panel

■ Remote

LASer:ENABle:OUTOFF

The LASer:ENABle:OUTOFF command sets the status outoff enable register of the LASER operations (things which will turn the LASER output off).

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the enabled bits:

1 - Laser Current Limit
2 - Voltage Limit
4 - N/A
8 - Power Limit (While Output On)
16 - Interlock State Changed
32 - N/A
64 - N/A
128 - Open Circuit (While Output is On)
256 - N/A
512 - Output is Out of Tolerance
1024 - TEC Output Off
2048 - TEC High Temperature Limit Condition
4096 - Hardware Error
8192 - N/A
16384 - N/A
32768 - N/A

POINTS OF INTEREST

The enabled LASER outoff bits can be read by using the LASer:ENABle:OUTOFF? query.

WARNING: If the Output is Outside of Tolerance Limit condition is set in this register when the LASER output is off, you will not be able to turn the LASER output on until this bit is reset.

(Continued on next page.)

LASer:ENABle:OUTOFF

(Continued from previous page.)

POINTS OF INTEREST

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 4).

The factory default value for this register is #H898, or 2200 decimal.

EXAMPLES

"LAS:ENAB:OUTOFF 9" -action: enables the LASER status outoff register so that Power limit and LASER current limit conditions will cause the LASER output to be turned off.

"Las:Enab:Outoff #H1E9B" -action: enables the LASER status outoff register so that any or all of the above conditions will cause the LASER output to be turned off.

"Las:Enable:Outoff #B10000000" -action: enables the LASER status outoff register so that an Open Circuit (While the Output is On) will cause the LASER output to be turned off.

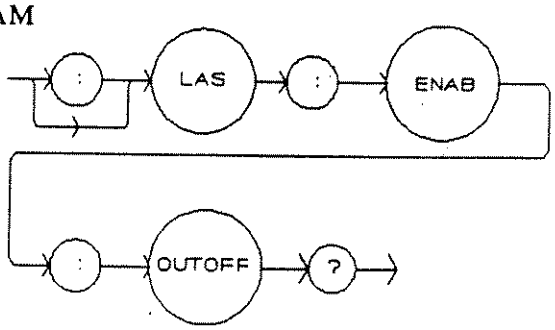
□ Front Panel

■ Remote

LASer:ENABle:OUTOFF?

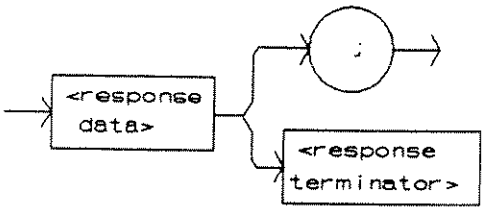
The LASer:ENABle:OUTOFF? query returns the value of the status outoff enable register of the LASER operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - LASER Current Limit
2 - Voltage Limit Error
4 - N/A
8 - Power Limit (While Output On)
16 - Interlock Disabled
32 - N/A
64 - N/A
128 - Open Circuit (While Output On)
256 - N/A
512 - Output is Outside of Tolerance Limit
1024 - TEC Output is Off
2048 - TEC High Temperature Limit
4096 - Hardware Error
8192 - N/A
16384 - N/A
32768 - N/A

POINTS OF INTEREST

The enabled LASER events can be set by using the LASer:ENABle:OUTOFF command. The LASER output status can be monitored by the LASer:EVEnt? query.

(Continued on next page.)

LASer:ENABle:OUTOFF?

(Continued from previous page.)

EXAMPLES

"LAS:ENAB:OUTOFF?" -response: 4097, means that LASER Hardware error and Current limit conditions will cause the LASER output to be turned off.

"Radix Hex; Las:Enab:Eve?" -response: #H1E9B, means that all of the above conditions will cause the LASER output to be turned off.

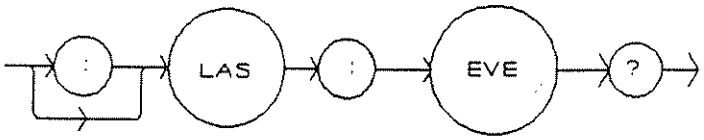
□ Front Panel

■ Remote

LASer:EVEnt?

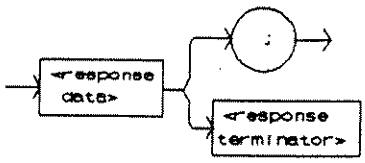
The LASer:EVEnt? query returns the value of the status event register of the LASER operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - Laser current limit
2 - Voltage limit
4 - N/A
8 - Power Limit
16 - Interlock state changed
32 - N/A
64 - N/A
128 - Open Circuit
256 - Output is shorted
512 - Output changed to be in/out of tolerance
1024 - Output on/off state changed
2048 - New measurements taken
4096 - Calculation error
8192 - Communication with LASER board error
16384 - Software error in LASER control
32768 - LASER eeprom checksum error

POINTS OF INTEREST

The LASER conditions which are reported in the status byte can be set by using the LASer:ENABle:EVEnt command.

The LASER event status is only cleared when the event status is read or by the *CLS command, while the condition status is constantly changing.

EXAMPLES

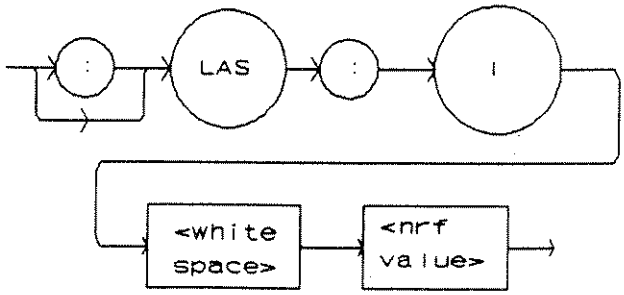
"LAS:EVE?" -response: 513, means that the LASER output tolerance changed and current limit events have occured since the last LASer:EVEnt? query.

"Radix Hex; Laser:Event?" -response: #H88, means that the LASER Power limit and Open circuit events have occured since the last LASer:EVEnt? query.

LASer:I

The LASer:I command sets the laser control current.

SYNTAX DIAGRAM



PARAMETERS — An <nrf value> which represents the (laser) output current, in mA.

POINTS OF INTEREST — Set point is the same for both low and high bandwidth output modes.

In local mode, the LASER I switch in the LASER DISPLAY area of the front panel would be pressed. Then, the desired value would be entered via the ADJUST knob, and the (LASER DISPLAY) SET switch pressed.

EXAMPLES — "Las:I 40" -action: sets the laser output current to 40.00 mA.

"LAS:i 100" -action: sets the laser output current to 100.00 mA.

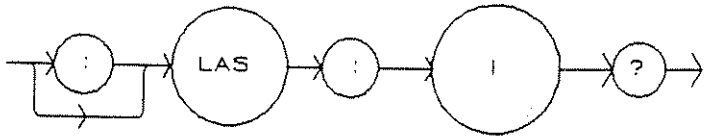
■ Front Panel

■ Remote

LASer:I?

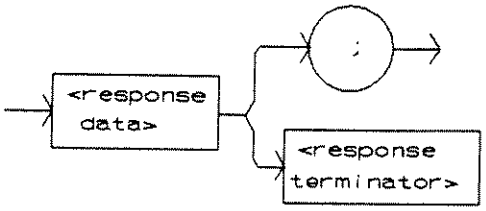
The LASer:I? query returns the value of the measured laser current.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

Response is the measured laser output current, for either low or high bandwidth modes.

This measurement is updated approximately once every 400 mSec.

In local mode, the measured laser output current would be read by pressing the I switch and visually reading the LASER display.

EXAMPLES

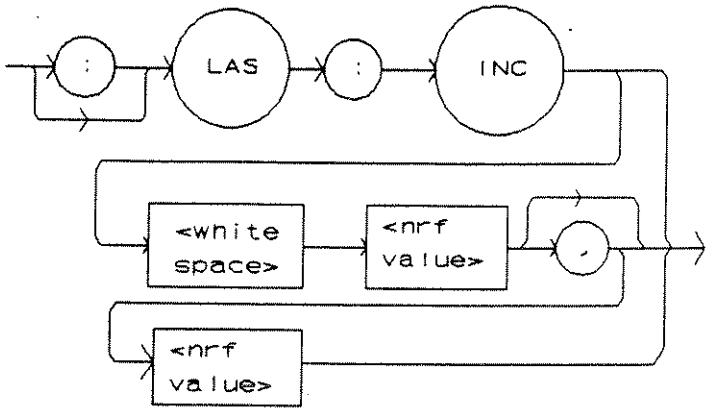
"LAS:i?" -response: 30.0, means the measured laser output current is 30.00 mA.

"Laser:I?" -response: 100.0, means the measured laser output current is 100.00 mA.

LASer:INC

The LASer:INC command increments the selected laser control mode set point by one or more steps. Optional parameters allow multiple steps to be incremented and the time (in milliseconds) between increments to be set, respectively.

SYNTAX DIAGRAM



PARAMETERS

None, 1, or 2. If no parameters are specified, the LASER set point value will be incremented by one step. The first optional parameter allows the user to set the number of steps for the LAS:INC operation. The second optional parameter allows the user to set the time (in mSec) between each incremented step.

POINTS OF INTEREST

The incremental default amount is one step. The step size can be edited via the LAS:STEP command, its default value is 0.01 mA, 0.01 mW, or 1 uA (if CALPD = 0), depending on the mode of operation.

If the first optional parameter is used, but not the second, the user may increment the LASER set point by a multiple of the LAS:STEP size, without changing the LAS:STEP size.

If the both optional parameters are used, the user may create an automated stepping ramp function for the LASER output.

If the first optional parameter is entered as zero, "LAS:INC 0", the command will do nothing.

(Continued on next page.)

LASer:INC

(Continued from previous page.)

POINTS OF INTEREST

The minimum time to complete one increment is about 10 to 20 mSec. Therefore, values for the second optional parameter (time between increments) have a practical minimum of 20.

EXAMPLES

"LAS:MODE:I; LAS:STEP 30; LAS:INC" -action: The laser source current set point is incremented by 0.3 mA.

"LAS:MODE:I; LAS:STEP 30; LAS:INC 3" -action: The laser source current set point is incremented by 0.9 mA (0.3 mA * 3).

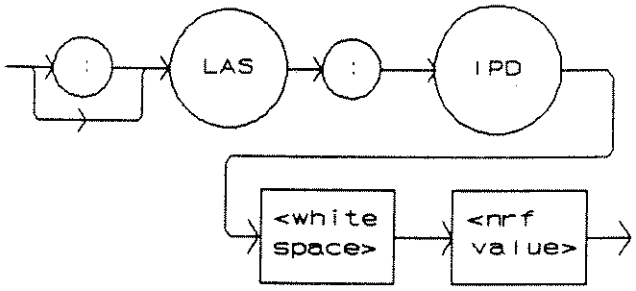
"LAS:MODE:I; LAS:STEP 30; LAS:INC 3,5000" -action: The laser source current set point is incremented by 0.3 mA, three times, with 5 seconds between incremental steps. So the LASER output is incremented a total of 0.9 mA after 10 seconds.

"LAS:STEP 10; LAS:Mode:P; Las:INC" -action: The power set point is incremented by 0.1 mW.

LASer:IPD

The LASer:IPD command sets the value of the optical power set point, in uA, if the (CAL PD) responsivity is 0.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the photodiode feedback current, in uA.

POINTS OF INTEREST

If the CAL PD parameter is not set to 0, the LAS:IPD value will not be used. In this case, the measured IPD would be converted to P_{PD} (by the CAL PD factor), and the P_{PD} set point would be used.

In local mode, the photodetector current set point would be set by first pressing the I_{PD} switch, and then pressing the SET switch, and then turning the ADJUST knob until the desired value appeared on the LASER display.

EXAMPLES

"Las:Ipd 40" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 40 uA.

"Laser:IPD 200" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 200 uA.

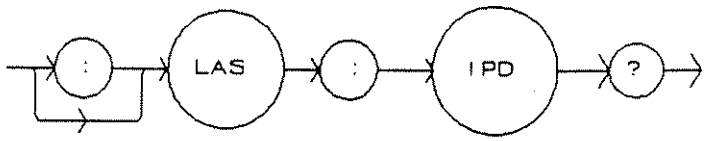
■ Front Panel

■ Remote

LASer:IPD?

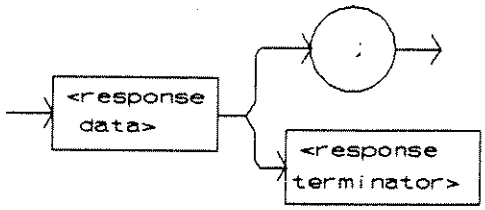
The LASer:IPD? query returns the value of the laser photodetector current measurement, in uA.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The response is in uA. The response is valid, even when the unit is not in constant P mode.

This measurement is updated approximately once every 400 mSec.

In local mode, the measured photodetector current would be read by pressing the (LASER DISPLAY) I_{PD} switch and visually reading the LASER display, assuming P mode is selected and CALPD is zero.

EXAMPLES

"Las:Mode:P; Las:Calpd 0; Las:Ipd?" -response: 100.0, means 100 uA of photodetector current. This feedback is controlling the laser current output.

"LAS:MODE:I; LAS:IPD?" -response: 20.0, means 20 uA of photodetector current, but photodiode monitor current is not controlling the laser output current.

LASer:LIMit:

The LASer:LIMit: command path is used to get to the 3722's laser limit commands.

The following commands may be reached directly from the LASer:LIMit: command path.

LASer:LIMit:I2
LASer:LIMit:I2?
LASer:LIMit:I5
LASer:LIMit:I5?
LASer:LIMit:P
LASer:LIMit:P?

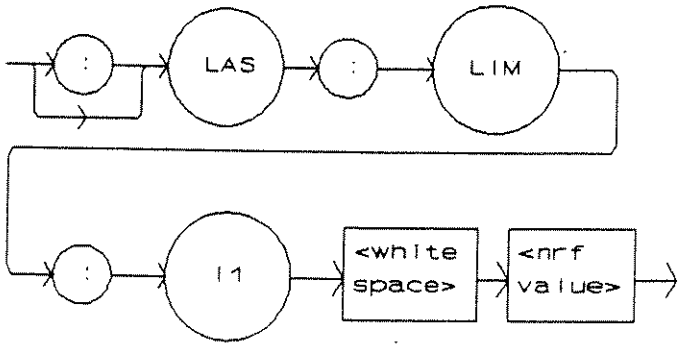
■ Front Panel

■ Remote

LASer:LIMit:I2

The LASer:LIMit:I2 command sets the LASER current limit value for the 200 mA range.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the LASER 200 mA range limit current, in mA.

POINTS OF INTEREST

The current limit is in effect in all modes of operation of the laser output, while in the 200 mA range.

In local operation, the limit current is entered by selecting the 200 mA range, selecting the LIM I parameter, pressing and holding in the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value is displayed, and then releasing the SET switch.

EXAMPLES

"LAS:LIM:I2 50" -action: the LASER current limit, for the 200 mA output range, is set to 50.00 mA.

":Laser:Limit:I2 60" -action: the LASER current limit, for the 200 mA range, is set to 60.00 mA.

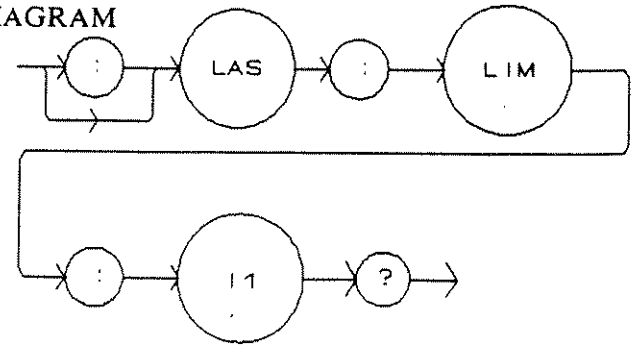
■ Front Panel

■ Remote

LASer:LIMit:I2?

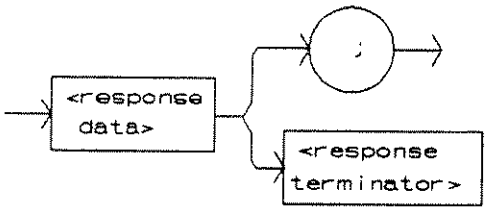
The LASer:LIMit:I2? query returns the value of the LASER current limit for the 200 mA range.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The current limit is valid for all modes of Laser operation, while in the 200 mA range.

In local operation, the limit current value is read by selecting the 200 mA output range, selecting the LIM I parameter, and visually reading the LASER display.

EXAMPLES

"LAS:LIM:I2?" -response: 40.0, means the laser current limit is 40.00 mA.

"Laser:LIM:I2?" -response: 50.0, means the laser current limit is 50.00 mA.

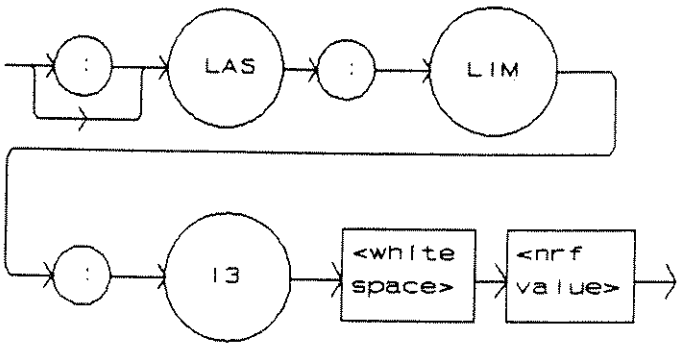
■ Front Panel

■ Remote

LASer:LIMit:I5

The LASer:LIMit:I5 command sets the LASER current limit value for the 500 mA range.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the LASER 500 mA range limit current, in mA.

POINTS OF INTEREST

The current limit is in effect in all modes of operation of the laser output, while in the LASER 500 mA range.

In local operation, the limit current is entered by selecting the 500 mA range, selecting the LIM I parameter, pressing and holding in the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value is displayed, and then releasing the SET switch.

EXAMPLES

"LAS:LIM:I5 50" -action: the LASER current limit, for the 500 mA output range, is set to 50.00 mA.

"Laser:Limit:I5 60" -action: the LASER current limit, for the 500 mA range, is set to 60.00 mA.

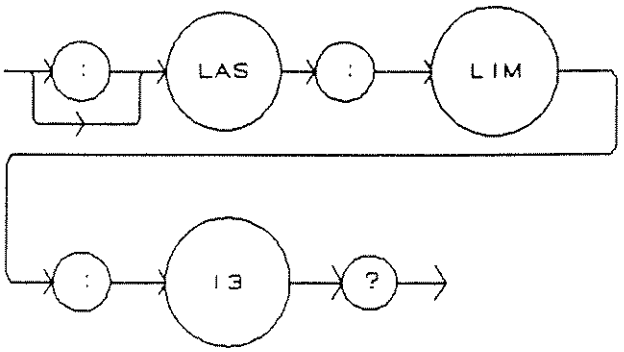
■ Front Panel

■ Remote

LASer:LIMit:I5?

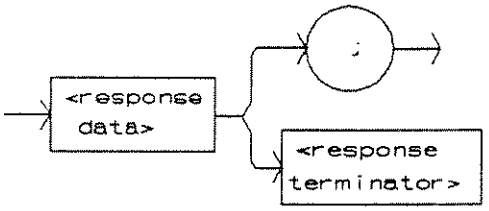
The LASer:LIMit:I5? query returns the value of the LASER current limit for the 500 mA range.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The current limit is valid for all modes of Laser operation, while in the LASER 500 mA range.

In local operation, the limit current value is read by selecting the 500 mA output range, selecting the LIM I parameter, and visually reading the LASER display.

EXAMPLES

"LAS:LIM:I5?" -response: 40.0, means the laser current limit is 40.00 mA.

"Laser:LIM:I5?" -response: 500.0, means the laser current limit is 500.00 mA.

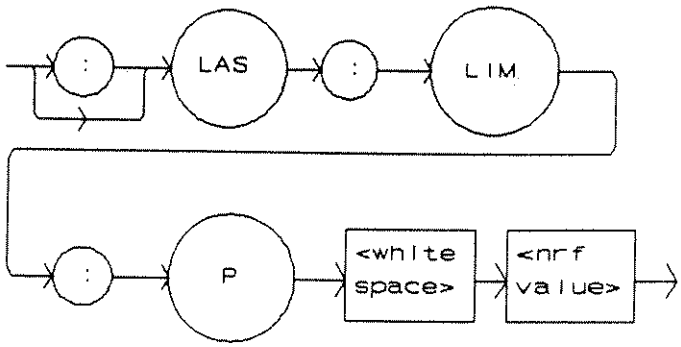
■ Front Panel

■ Remote

LASer:LIMit:Ppd

The LASer:LIMit:Ppd command sets the laser monitor photodiode power limit value.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the laser monitor photodiode power limit, in mW.

POINTS OF INTEREST

When constant P mode is used, the output is limited only by the LIM I value.

The LIM P condition may be used to shut the LASER output off, but this must requires the use of the LASer:ENABle:OUTOFF command to set bit 3 of the LASER OUTOFF ENABLE register.

In local operation, the limit power is entered by selecting the LIM P parameter, adjusting the ADJUST knob until the desired value is displayed, and then pressing the SET switch in the PARAMETER area of the front panel.

EXAMPLES

"LAS:LIM:P 10" -action: sets the laser output power limit to a value which corresponds to producing 10.00 mW of PD feedback (optical) power.

"Las:Limit:Ppd 5" -action: sets the laser output power limit to a value which corresponds to producing 5.00 mW of PD feedback (optical) power.

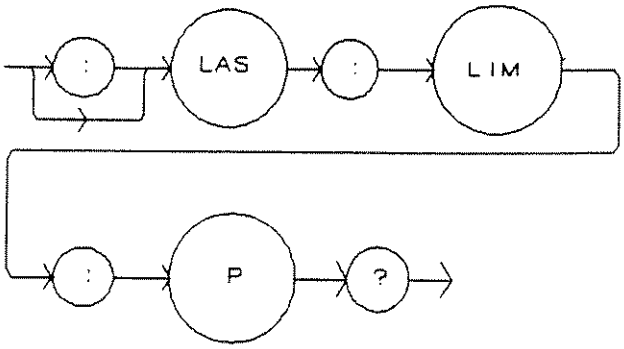
■ Front Panel

■ Remote

LASer:LIMit:Ppd?

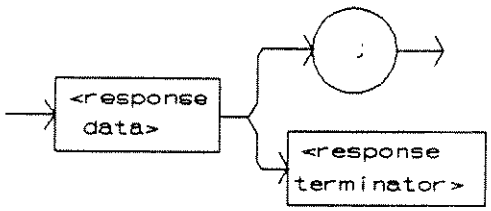
The LASer:LIMit:P? query returns the value of the laser monitor PD power limit.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The (LASER) P limit is in effect for both laser output current ranges.

In local operation, the limit power value is read by selecting the LIM P parameter, in the PARAMETER area of the front panel, and visually reading the LASER display.

EXAMPLES

"LAS:LIM:P?" -response: 3.0, means the monitor PD power limit is set to 3.00 mW.

":LAS:Limit:P?" -response: 10.0, means the monitor PD power limit is set to 10.00 mW.

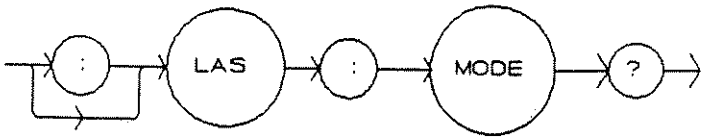
■ Front Panel

■ Remote

LASer:MODE?

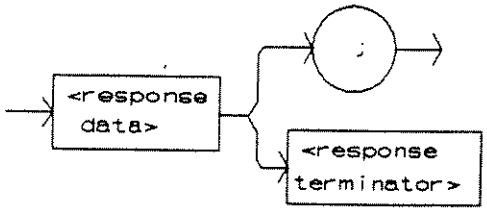
The LASer:MODE? query returns the selected laser control mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is character data.

POINTS OF INTEREST

I_{HBW} mode is the same as I mode, except that the output low bandpass filter is disabled in I_{HBW} mode.

In local mode, the LASER control mode is indicated by the LED in the LASER MODE area of the front panel. If the P mode LED is lit, the mode is I_{PD} if the CALPD value is zero, and the mode is P_{PD} if the CALPD value is non-zero.

EXAMPLES

"LAS:MODE?" -response: I, means that constant I (current) mode is in effect for the laser output.

":Las:Mode?" -response: Ppd, means that constant P (power) mode is in effect for the laser output, and CALPD > 0.

"Las:Mode?" -response: Ipd, means that constant P (power) mode is in effect for the laser output, and CALPD = 0.

"Laser:MODE?" -response: Ihbw, means that constant I_{HBW} (current, high bandwidth) mode is in effect for the laser output.

■ Front Panel

■ Remote

LASer:MODE:

The LASer:MODE: command path is used to get to the 3722's laser mode selection commands.

The following commands may be reached directly from the LASer:MODE: command path.

LASer:MODE:I
LASer:MODE:IHBW
LASer:MODE:P

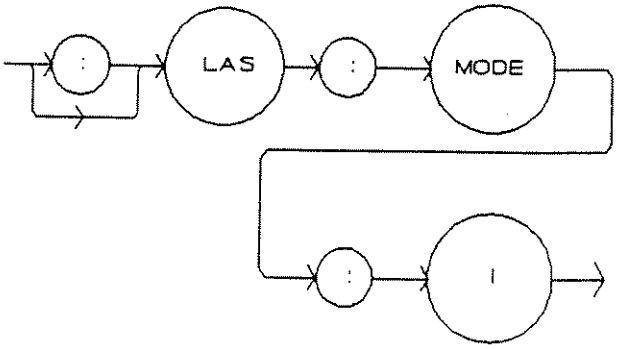
■ Front Panel

■ Remote

LASer:MODE:I

The LASer:MODE:I command selects laser constant current mode.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — Constant I mode (low bandwidth) enables the output low bandpass filter.

In local operation, the constant I mode is selected by pressing the SELECT switch in the LASER MODE area of the front panel until the I indicator is lit.

EXAMPLES — "LAS:MODE:I" -action: sets the laser output for constant I mode.

"Laser:Mode:i" -action: sets the laser output for constant I mode.

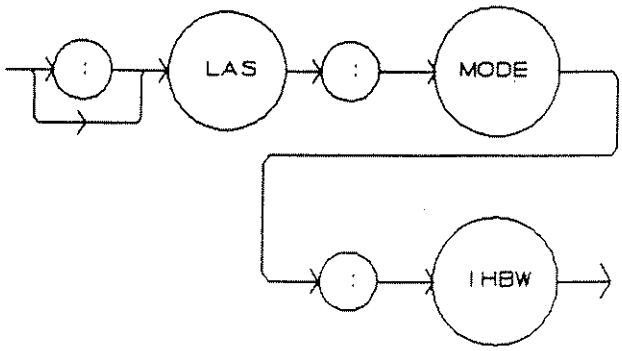
■ Front Panel

■ Remote

LASer:MODE:IHBW

The LASer:MODE:IHBW command selects laser high bandwidth constant current mode.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST

This mode of operation is constant I mode with the output lowpass filter disabled.

In local operation, the constant I mode is selected by pressing the (LASER MODE) SELECT switch until the I_{HBW} indicator is lit.

EXAMPLES

":las:mode:ihbw" -action: enables the laser high bandwidth constant current mode.

"LAS:Mode:Ihbw" -action: enables the laser high bandwidth constant current mode.

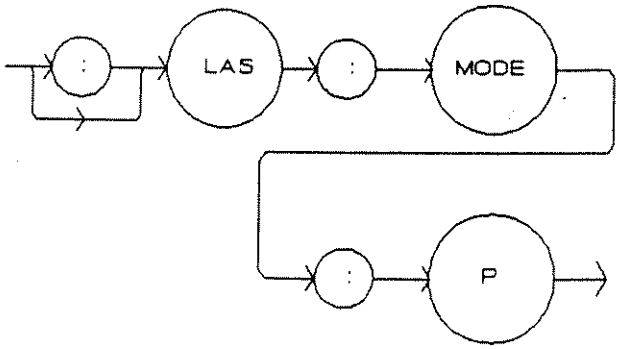
■ Front Panel

■ Remote

LASer:MODE:Ppd

The LASer:MODE:Ppd command selects laser constant power mode.

SYNTAX DIAGRAM



PARAMETERS

None.

POINTS OF INTEREST

This mode of laser operation requires the laser's monitor PD feedback to maintain constant optical power or constant monitor current.

In this mode, the displayed parameter will be either I_{PD} (if CALPD = 0) in uA, or P_{PD} (if CALPD > 0) in mW.

In local operation, the constant P mode is selected by pressing the (LASER MODE) SELECT switch until the P indicator is lit.

EXAMPLES

"LAS:MODE:P" -action: sets the laser output mode of operation to constant optical power mode.

"Laser:Mode:Ppd" -action: sets the laser output mode of operation to constant optical power mode.

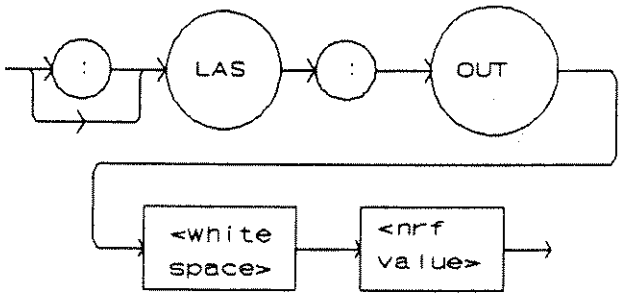
■ Front Panel

■ Remote

LASer:OUTput

The LASer:OUTput command turns the laser output on or off.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>; 1 = on, 0 = off.

POINTS OF INTEREST

After the output is turned on, it may be useful to wait until the output is stable (within tolerance) before performing further operations, but it is not necessary. When the LASER output is off, it is safe to connect or disconnect devices to the LASER output terminals.

When the LASER output is off, an internal short is placed across the output terminals. This condition causes the OUTPUT SHORTED light to come on.

In local mode, the LASER output is turned on or off by pressing the ON switch in the LASER MODE area of the front panel.

EXAMPLES

"LAS:I 20; LAS:OUT ON" -action: sets the laser output current to 20 mA and then turns the output on.

"Las:Out 0" -action: turns the laser output off.

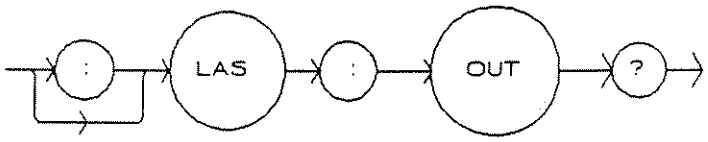
■ Front Panel

■ Remote

LASer:OUTput?

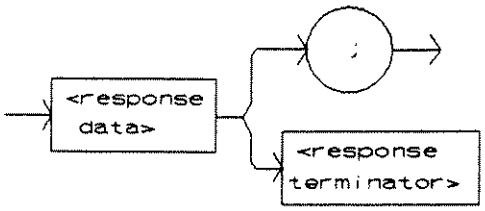
The LASer:OUTput? query returns the status of the laser output switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

Although the status of the switch is on, the output may not have reached the set point value.

In local mode, the LASER output status is read by visually reading the ON indicator LED in the LASER MODE area of the front panel (lit = on).

EXAMPLES

"Las:OUT?" -response: 0, means that the output switch is disabled, devices may be safely disconnected or connected at the LASER output terminals.

"LAS:OUT?" -response: 1, means that the LASER output switch is enabled, LASER output is present.

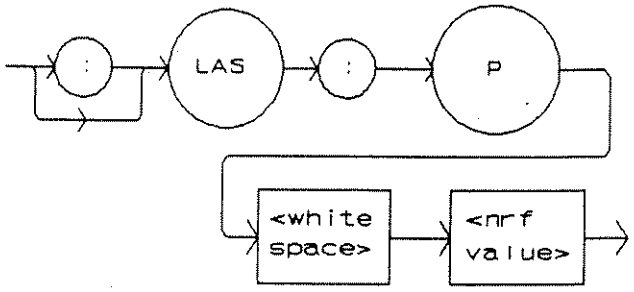
■ Front Panel

■ Remote

LASer:Ppd

The LASer:Ppd command sets the laser's photodetector power setpoint, in mW.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the monitor photodiode power in mW.

POINTS OF INTEREST

This set point is used with operation in constant P (power) mode only.

In local mode, the (LASER DISPLAY) P_{PD} switch would be pressed. Then, the desired value would be entered via the ADJUST knob, and then the (LASER DISPLAY) SET switch would be pressed.

EXAMPLES

"LAS:PPD 200" -action: sets the photodiode monitor set point for operation with 200.0 mW of photodiode monitor power.

"laser:mode p; laser:calpd 1; laser:P 100" -actions: sets the control mode to constant P, with 1 uA/mW responsivity factor, and 100.0 mW of photodiode monitor power as the set point.

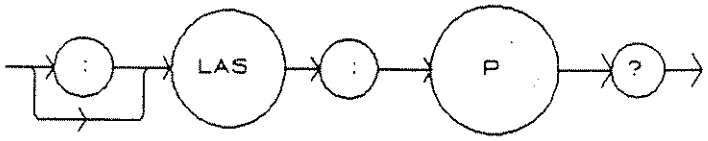
■ Front Panel

■ Remote

LASer:Ppd?

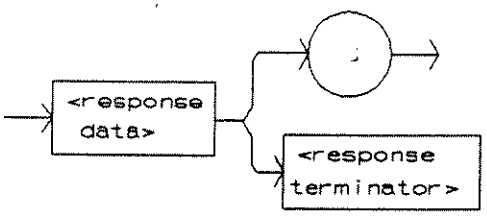
The LASer:Ppd? query returns the value of the laser photodiode monitor power measurement.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The P_{PD} measurement is valid, even when the unit is not in constant P mode.

This measurement is updated approximately once every 400 mSec.

In local mode, the measured photodetector power would be read by pressing the (LASER DISPLAY) P_{PD} switch and visually reading the LASER display, assuming the P mode is selected and CALPD is non-zero.

EXAMPLES

"LAS:P?" -response: 160.0, means that the photodiode monitor power is 160.0 mW.

"Las:MODE:p; Las:Calpd 1; Las:Ppd?" -response: 300.0, means that the photodiode monitor power is 300.0 mW (the unit is in constant power mode).

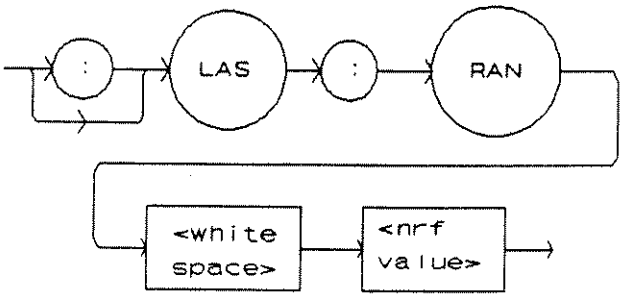
■ Front Panel

■ Remote

LASer:RANge

The LASer:RANge command selects the laser's current output range.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>; 2 = 200 mA, 5 = 500 mA range.

POINTS OF INTEREST

This range setting effects the LASER output current range only, the same effect as local (front panel) operation.

The LASER output should be off when this command is issued. If the LASER output is on when this command is parsed, the 3722 will generate error E-515, and the range will not be changed.

In local mode, the RANGE switch would be pressed twice (within 1 second) to toggle between the two ranges.

EXAMPLES

"LAS:RAN 2" -action: sets the laser output current range to 200 mA.

"Laser:Range 5" -action: sets the laser output current range to 500 mA.

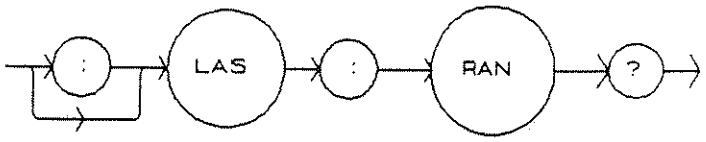
■ Front Panel

■ Remote

LASer:RANge?

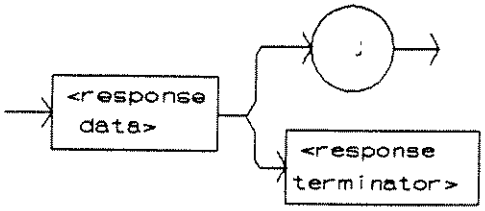
The LASer:RANge? query returns the value of the laser current range.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>; 2 means 200 mA, and 5 means 500 mA range.

POINTS OF INTEREST

The resolution and accuracy of the laser limit current are dependent on the laser output current range.

In local mode, the RANGE is determined by visually reading the LED indicator in the RANGE area of the front panel.

EXAMPLES

"LAS:RAN?" -response: 2, means the laser output current range is 200 mA.

":Las:Range?" -response: 5, means the laser output current range is 500 mA.

LASer:SET:

The LASer:SET: command path is used to get to the 3722's laser set point queries.

The following commands may be reached directly from the LASer:SET: command path.

LASer:SET:I?
LASer:SET:IPD?
LASer:SET:P?

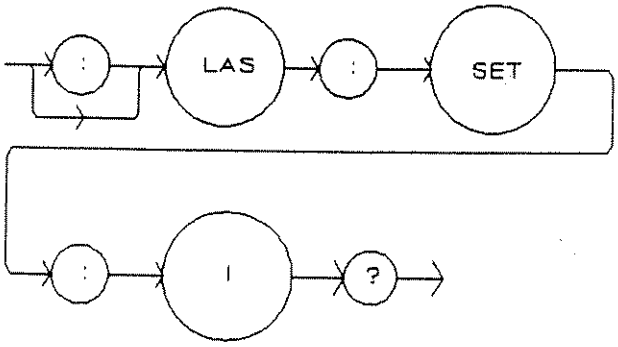
■ Front Panel

■ Remote

LASer:SET:I?

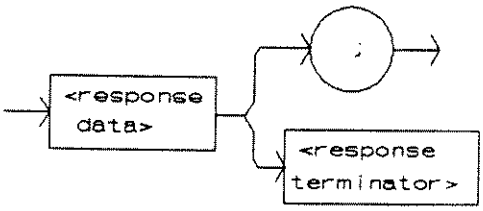
The LASer:SET:I? query returns the constant I value which is used for both output ranges and both bandwidths.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value> which represents the constant I set point value, in mA.

POINTS OF INTEREST

The set point value does not change when the laser output current range is changed.

In local operation, the constant I set point is read by selecting I or IHBW mode, pressing the SET switch in the LASER DISPLAY area of the front panel, and then visually reading the LASER display.

EXAMPLES

"LAS:SET:I?" -response: 50.0, means the laser output current set point value is 50.00 mA.

"Laser:set:i" -response: 120.0 means the laser output current set point value is 120.00 mA.

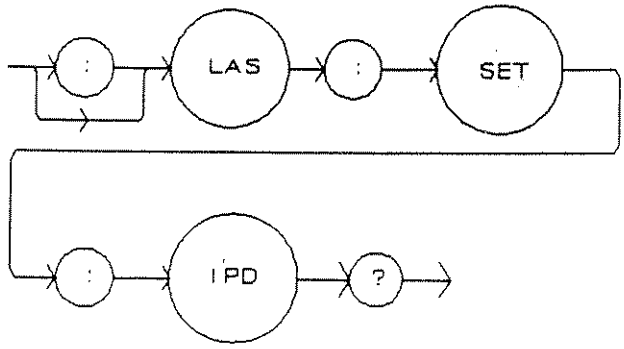
■ Front Panel

■ Remote

LASer:SET:IPD?

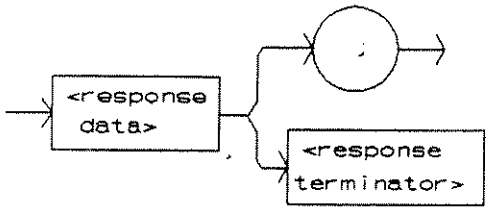
The LASer:SET:IPD? query returns the laser monitor PD current set point value (when CALPD = 0), in uA.

SYNTAX DIAGRAM



PARAMETERS

None. The resposnse will be in the form:



-where the response is an <nrf value> which represents the constant I_{PD} set point value, in uA.

POINTS OF INTEREST

The monitor photodiode current is directly proportional to the laser optical output power. Therefore, the I_{PD} set point may be used to control optical output of the laser.

In local operation, the constant I_{PD} set point is read by selecting P mode (when CALPD =0), then pressing the SET switch in the LASER DISPLAY area of the front panel, and then visually reading the LASER display.

EXAMPLES

"las:set:ipd?" -response: 30.0, means the laser monitor PD current is set point is 30 uA, for use in constant P mode with CALPD = 0.

"LAS:Set:IPD?" -response: 100.0 means the laser monitor PD current is set point is 100 uA, for use in constant P mode with CALPD = 0.

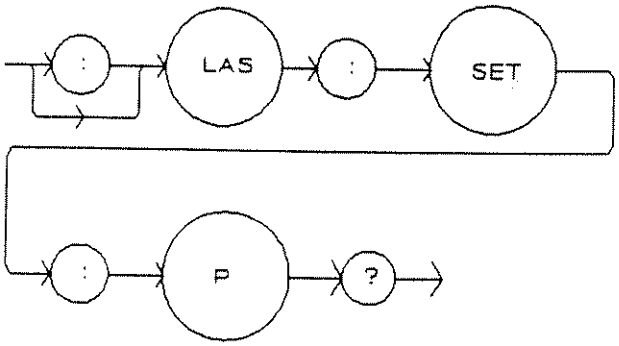
■ Front Panel

■ Remote

LASer:SET:Ppd?

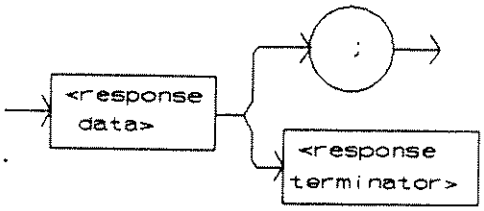
The LASer:SET:Ppd? query returns the laser monitor PD power set point value (when CALPD is not zero), in mW.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value> which represents the constant P_{PD} set point, in mW.

POINTS OF INTEREST

This set point is used in constant P mode only.

In local operation, the constant P_{PD} set point is read by selecting P mode (when CALPD > 0), then pressing the (LASER DISPLAY) SET switch, and then visually reading the LASER display.

EXAMPLES

"LAS:Set:Ppd?" -response: 10.0, means the laser monitor PD feedback set point is 10.0 mW (CALPD > 0).

"Laser:Set:P?" -response: 25.0, means the laser monitor PD feedback set point is 25.0 mW (CALPD > 0).

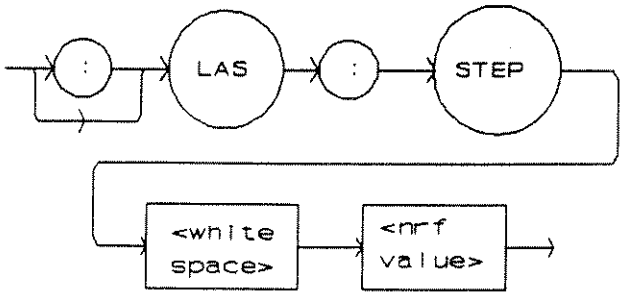
□ Front Panel

■ Remote

LASer:STEP

The LASer:STEP command is used to increment or decrement the selected laser control mode set point by the given amount, when used with the LASer:INC or LASer:DEC command.

SYNTAX DIAGRAM



PARAMETERS

An integer value of the step amount, in the range 1 to 9999.

POINTS OF INTEREST

The step of 1 corresponds to the smallest incremental change of the mode. For example, a step of 1 means 0.01 mA, 0.01 mW, or 1 uA (if CALPD = 0).

EXAMPLES

"Las:Mode:i; Las:i 20; Las:Step 100; Las:Inc; Las:set:i?" -action: sets the step to 1.0 mA, so the Las:set:i? query will return a value of 21.0 mA.

"LAS:STEP 1000" -action: sets the step size to 1000; could mean 10.0 mA, 10.0 mW, or 100 uA.

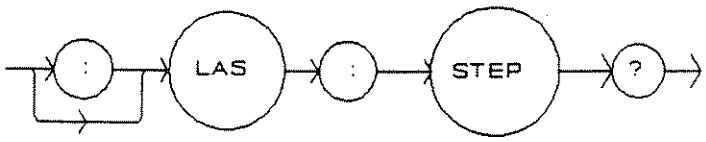
□ Front Panel

■ Remote

LASer:STEP?

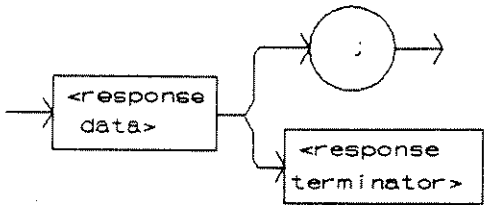
The LASer:STEP? query is used to read back the LASer STEP value. This value is used to increment or decrement the selected laser control mode set point by the given amount, when used with the LASer:INC or LASer:DEC command.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value> of the step amount.

POINTS OF INTEREST

The step of 1 corresponds to the smallest incremental change of the mode. For example, a step of 1 means 0.01 mA, 0.01 mW, or 1 uA (if CALPD = 0). A step of 9999 means 99.99 mA, 99.99 mW, or 9999 uA.

EXAMPLES

"Las:Mode:I; Las:Step?" -response: 1 means the step size is 0.01 mA, since Const I mode is in effect.

"LAS:MODE:P; LAS:CALPD 1; LAS:STEP?" -response: 10 means the step size is 0.1 mW, since Const P mode is in effect.

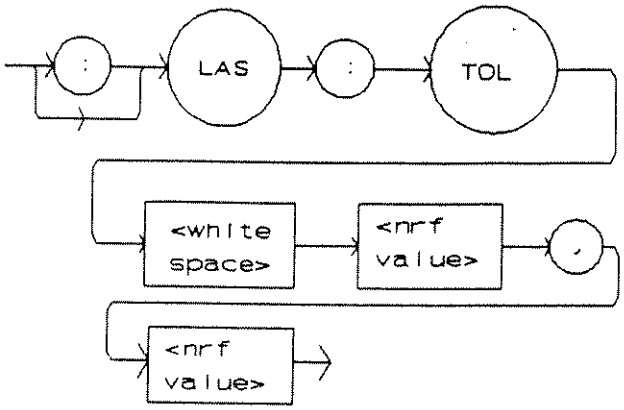
□ Front Panel

■ Remote

LASer:TOLerance

The LASer:TOLerance command allows the programmer to determine the LASER current tolerance, and time window for it to occur, in order that the operation complete flag be set after a "LASer:OUTput 1" command is issued, or the LASER set point is changed.

SYNTAX DIAGRAM



PARAMETERS

Two <nrf values>; the first represents the LASER current tolerance, in mA, with a range of 0.1 to 100.0 mA; and the second represents the time window, in seconds, with a range of 0.001 to 50.000 seconds.

This command may be used in conjunction with the common query *OPC? and common command *WAI to delay further program activities until the LASER current reaches its set point to the specifications of the LASer:TOLerance command.

For example, if the set point is 40.5 mA, tolerance is 1.0 mA for 5 seconds, and the LASER output is turned on, the user may issue the *WAI command to ensure this set point is reached before continuing. In this case, the 3722 will wait until its LASER current is within 1.0 mA of 40.5 mA for a period of 5 seconds before the next command is executed.

POINTS OF INTEREST

The 3722 defaults to a tolerance of 10.0 mA for 5 seconds, unless changed by the LASer:TOLerance command.

If the 3722 is operated in P mode, the current tolerance parameter is not used. Instead a fixed value of 50 uA is used for the I_{PD} current, and only the time window parameter may be adjusted.

(Continued on next page.)

LASer:TOLerance

(Continued from previous page.)

POINTS OF INTEREST

WARNING: If the tolerance is set too tight it may never be achieved. This is due to the calibration of the set point and measurement values.

EXAMPLES

"Las:Tol 0.5,10" -action: the 3722's LASER current source will be in tolerance when the LASER current is within 0.5 mA for 10.000 seconds.

"LAS:TOL 1,1.5" -action: the 3722's LASER current source will be in tolerance when the LASER current is within 1.0 mA for 1.500 seconds.

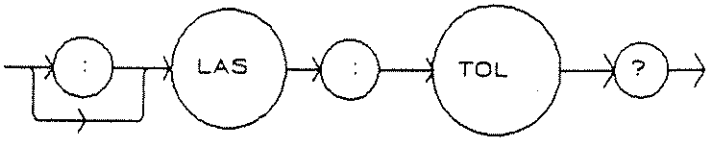
□ Front Panel

■ Remote

LASer:TOLerance?

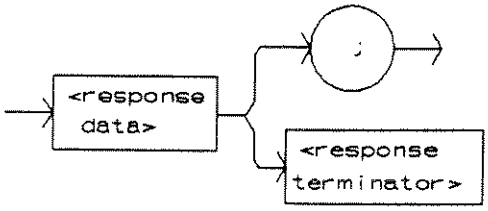
The LASer:TOLerance? query allows the programmer to determine how the LASER current tolerance is set.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response consists of two data units, the first for the current tolerance, in mA; and the second for the time window, in seconds.

POINTS OF INTEREST

The tolerance of the 3722 LASER current may be used to delay programming after an "LASer:OUTput 1" command is issued or the set point is changed.

A change of the output into or out of tolerance flag sets a flag in the LASER status event register, and so entering or exiting LASER current tolerance may be used to generate service requests.

EXAMPLES

"Las:Tol?" -response: "0.2,5.0", means the 3722 has a LASER current tolerance setting of 0.2 mA with a time window of 5.000 seconds.

"LASER:TOL?" -response: "1.0,20.0", means the 3722 has a LASER current tolerance setting of 1.0 mA with a time window of 20.000 seconds.

□ Front Panel

■ Remote

MESsage

The MESsage command allows the user to enter an ASCII string of up to 16 non-zero characters. This command may be useful for storing messages which relate to a test or configuration.

SYNTAX DIAGRAM

PARAMETERS

An ASCII string which is 1 - 16 bytes in length.

POINTS OF INTEREST

The message may contain any ASCII character, but will be terminated when a NULL terminator character is received. If the message has less than 16 bytes, the software will fill the remaining message space with the space character. After 16 bytes have been entered, the software will null-terminate the string.

EXAMPLES

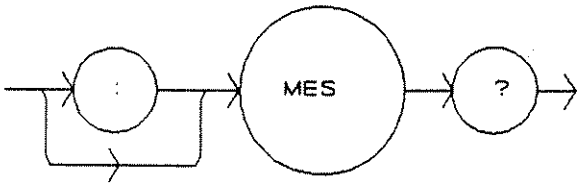
MESSAGE "This is a test." -action: The string, "This is a test. " will be stored in non-volatile memory.

Mes "Test 3" -action: The string, "Test 3 " will be stored in non-volatile memory.

MESsage?

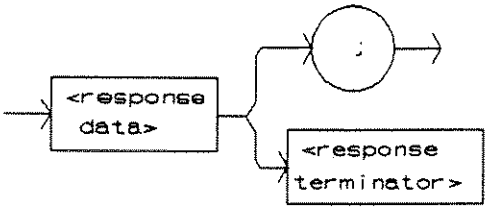
The MESsage? query returns the previously stored message. This message will always be 16 bytes long and enclosed in quotes. The message is entered via the MESsage command.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the <response data> is a 16-byte long string.

POINTS OF INTEREST

The response data will be a 16-byte long string. If there is no previously stored message, the response will be " ", all spaces.

EXAMPLES

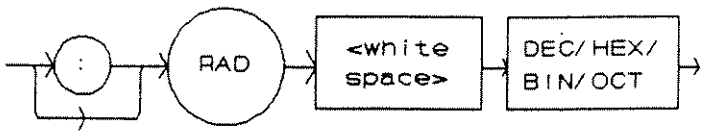
"MES?" -response: "Test 3 ", means the previously stored message was "Test 3".

"Message?" -response: "This is a test. ", means the previously stored message was "This is a test."

RADix

The RADix command allows the programmer to select the radix type for status, condition, and event query response data. Decimal, binary, hexadecimal, and octal are allowed.

SYNTAX DIAGRAM



PARAMETERS

Character program data is expected, as shown above.

POINTS OF INTEREST

DECimal is the default type. Only the first three letters of the words decimal, hexadecimal, binary, or octal are required.

When the RADIX is selected, all status, condition, and event queries will return values in the new radix.

In the cases where the radix is not DECimal, the flexible numeric type <nrf value> (as shown in the Command Reference diagrams) will be replaced by HEX, BIN, or OCT representation.

All of the above radixes may be used to enter program data at any time, without the need for issuing the RADix command. The proper prefix must also be used with Hex (#H), binary (#B), or octal (#O).

This command may be useful for setting up status reporting blocks. The bit-wise status representation may be more easily read in BIN, HEX, or OCT.

EXAMPLES

"RAD dec" -action: the decimal radix is selected.

"rad hex; *ESR?" -action: the hexadecimal radix is selected; -response: #H80, means power-on was detected.

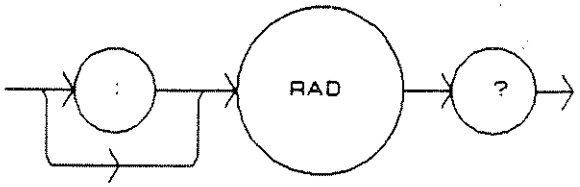
"RADIX BIN" -action: the binary radix is selected.

"rad octal" -action: the octal radix is selected.

RADix?

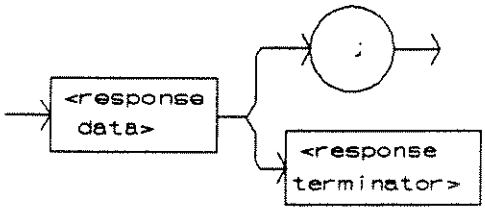
The RADix? query allows the programmer to determine which radix type for status, condition, and event query response data is currently selected. Decimal, binary, octal, and hexadecimal are allowed.

SYNTAX DIAGRAM



PARAMETERS

None.. The response will be in the form:



-where the character response data of DEC means decimal, BIN means binary, HEX means hexadecimal, and OCT means octal.

POINTS OF INTEREST

DEC is the default type. The 3722 defaults to this radix at power-up.

The RADix command is used to select the desired radix. Once it is changed, the new radix will remain in effect until the power is shut off or a new RADix command is issued.

EXAMPLES

"RAD?" -response: Dec, means the selected radix is decimal.

"rad?" -response: Hex, means the selected radix is hexadecimal.

"RADIX?" -response: Oct, means the selected radix is octal.

"rad?" -response: Bin, means the selected radix is binary.

TEC:CAL:

The TEC:CAL: command path is used to get to the 3722's TEC calibration commands.

In local operation, the TEC calibration mode is reached by pressing the (GPIB) LOCAL and (TEC DISPLAY) R or ITE switches at the same time. When sensor calibration mode is selected (with the R switch), the position of the SENSOR SELECT switch will be displayed on the TEC display for two seconds.

The following commands may be reached directly from the TEC:CAL: command path.

TEC:CAL:ITE
TEC:CAL:ITE?
TEC:CAL:SENsor
TEC:CAL:SENsor?

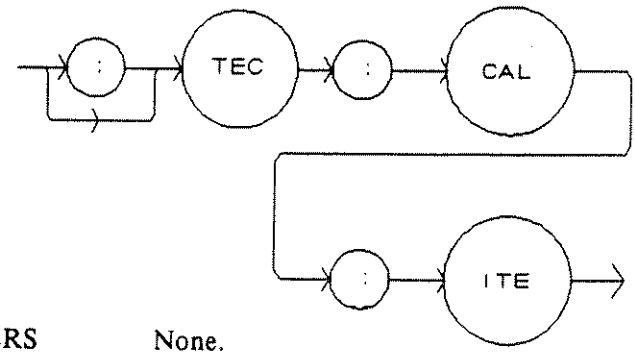
■ Front Panel

■ Remote

TEC:CAL:ITE

The TEC:CAL:ITE command is used to enter the TEC's current set point, measurement, and limit calibration mode.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST

This is a service related command. When this command is issued, the front panel becomes disabled, and the appropriate adjustments are made to the operating modes. This mode should not be entered unless the user has the proper measurement equipment in place. See Section 6.3.

After this command is issued, the 3722 will automatically change to ITE mode, turn the TEC output on, determine its zero current offset, set the ITE limit to 4.0 amps, and drive the output to 1.0 amps. This procedure is outlined in Section 6.3.8.

In remote operation, the TEC:CAL:ITE? query (or bit 11 of the TEC status condition register) may be used to determine if the 3722 is ready for the user to enter a value.

In local operation, the TEC ITE calibration mode is entered by pressing the (LOCAL) GPIB and (TEC DISPLAY) ITE swutches at the same time. The 3722 will BEEP when it is ready for the user to enter a value (the SET switch is enabled).

EXAMPLES

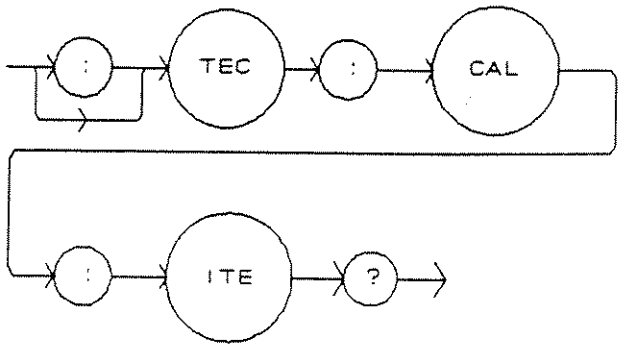
"Tec:CAL:ITE" -action: the 3722 enters calibration mode for current.

"Tec:Cal:Ite" -action: the 3722 enters calibration mode for current.

TEC:CAL:ITE?

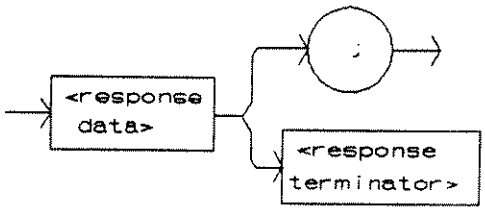
The TEC:CAL:ITE? query is used to determine that the 3722 is ready for a value to be entered during the calibration cycle of the TEC:CAL:ITE mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>; 1 = ready, 0 = not ready.

POINTS OF INTEREST

This query can be used to poll the 3722 after the TEC:CAL:ITE command to determine if its waiting for a value. If the response is 1, the 3722 is ready to receive a calibration value via the TEC:ITE command (see Section 6.3.8). This query may then be repeated for the second half of the calibration cycle. (A query of the TEC condition status register, bit 11, has the same results.)

In local operation, the ready state during the calibration cycle is indicated by a beep which is issued by the 3722 when it is ready for a value to be entered (if the beeper is enabled).

EXAMPLES

"Tec:CAL:ITE?" -response: 1, means the 3722 is ready for the user to enter a current value via the TEC:ITE command.

"Tec:Cal:Ite?" -response: 0, means the 3722 is not yet ready for the user to enter a current value, or it is not in the TEC current calibration cycle.

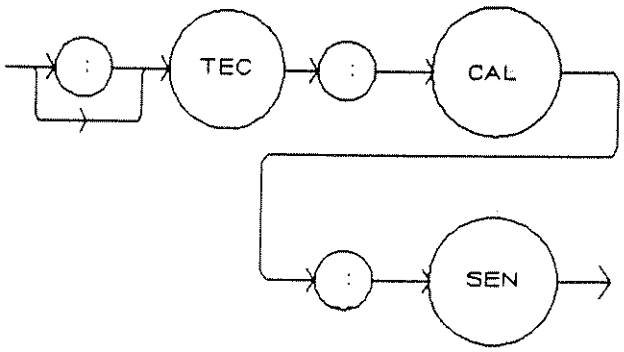
■ Front Panel

■ Remote

TEC:CAL:SENsor

The TEC:CAL:SENsor command sets the TEC's sensor calibration mode for the activated (via the rear panel switch) sensor, and it enters that mode.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST

After this command is issued, the front panel is disabled, and the 3722 will automatically enter the sensor calibration mode. When the 3722 is ready, the SET switch will become enabled, and the user should enter the true measured value. This procedure is outlined in Section 6.3.

In remote operation, the TEC:CAL:SENsor? query may be used to determine if the 3722 is ready for the user to enter a value.

In local operation, the 3722 will display " --0x", where x is a digit from 1 - 4, to indicate the calibration mode. (This number corresponds to the sensor switch display number). Then it will enable the SET switch and BEEP when it is ready for the user to enter a value.

EXAMPLES

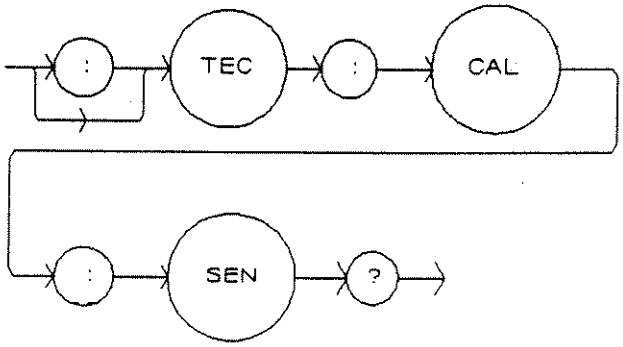
"Tec:CAL:Sen" -action: the 3722 enters calibration mode for the sensor which is selected by the back panel switch.

"Tec:Cal:Sensor" -action: the 3722 enters calibration mode for the sensor which is selected by the back panel switch.

TEC:CAL:SENsor?

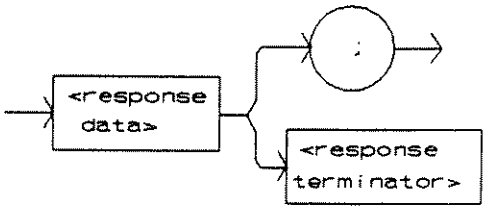
The TEC:CAL:SENsor? query is used to determine that the 3722 is ready for a value to be entered during the calibration cycle of the TEC:CAL:SENsor mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>; 1 = ready, 0 = not ready.

POINTS OF INTEREST

This query can be used to poll the 3722 after the TEC:CAL:SEN command to determine if its waiting for a value. If the response is 1, the 3722 is ready to receive a calibration value via the TEC:R command (see Section 6.3). (A query of the TEC condition status register, bit 11, has the same results.)

In local operation, the ready state during the calibration cycle is indicated by a beep which is issued by the 3722 when it is ready for a value to be entered (if the beeper is enabled).

EXAMPLES

"Tec:CAL:SEN?" -response: 1, means the 3722 is ready for the user to enter a resistance value via the TEC:R command.

"Tec:Cal:Sensor?" -response: 0, means the 3722 is not yet ready for the user to enter a resistance value.

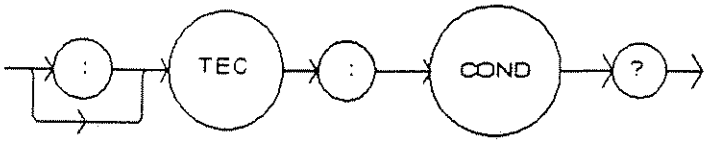
□ Front Panel

■ Remote

TEC:COND?

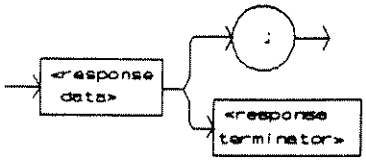
The TEC:COND? query returns the value of the status condition register of the TEC operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - TE Current Limit
2 - Voltage Limit Error
4 - N/A
8 - High Temperature Limit
16 - Interlock Enable
32 - Booster Enable
64 - Sensor Open
128 - TE Module Open
256 - N/A
512 - Output Out of Tolerance
1024 - Output On
2048 - Ready for Calibration Data
4096 - Calculation Error
8192 - Internal Communication Error with TEC Board
16384 - Software Error
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The enabled TEC conditions can be set by using the TEC:ENABle:COND command.

The TEC condition status is constantly changing, while the event status is only cleared when the event status is read or the *CLS command is issued.

EXAMPLES

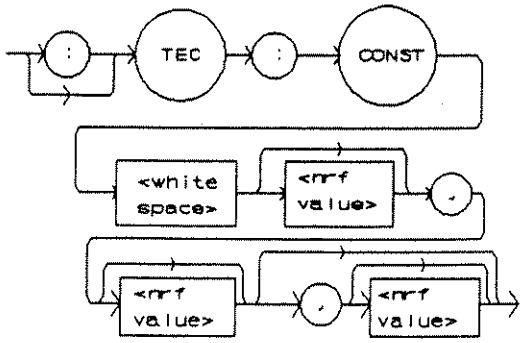
"TEC:COND?" -response: 513, means that the Output Out of Tolerance and TE Current Limit TEC conditions currently exist.

"Radix Hex; TEC:Cond?" -response: #H82, means that the TE Module Open and Voltage Limit TEC conditions currently exist.

TEC:CONST

The TEC:CONST command sets the TEC's Steinhart-Hart equation constants.

SYNTAX DIAGRAM



PARAMETERS

One, two, or three <nrf values>, for the three Steinhart-Hart equation constants or the two linear calibration constants for linear IC sensors. The range of values is -9.999 to +9.999 for all three constants.

POINTS OF INTEREST

If less than three parameters need to be changed, only the desired change needs to be specified, along with the separating commas (see examples).

When the LM335 or AD590 sensors are selected via the SENSOR SELECT switch, only C1 and C2 are used. Therefore, only two parameters are required in those cases.

In local operation, the constants are entered individually by selecting CONST (C1, C2 or C3 are lit successively by the BAR GRAPH) in the PARAMETER section of the front panel. Then, with the SET switch pressed and held in, the parameter value may be adjusted by turning the ADJUST knob. When the SET switch is released, the value is stored in non-volatile memory.

EXAMPLES

"Tec:CONST 1, 2.33, 0.5 " -action: sets C1 to 1.000, C2 to 2.330, and C3 to 0.500.

"TEC:const 1.4, ," -action: sets C1 to 1.400, C2 and C3 unchanged.

"TEC:Const ,4.5,0.3" -action: sets C2 to 4.500, C3 to 0.300, and C1 is unchanged.

"Tec:CONST 1.4,2.015" -action: sets C1 to 1.400, C2 to 2.015 for two-point calibration of AD590 or LM335 sensors (C3 is unchanged, but not used).

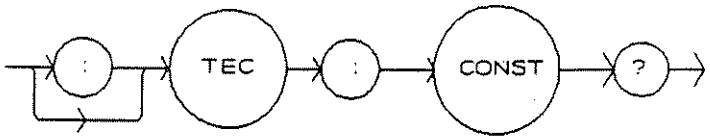
■ Front Panel

■ Remote

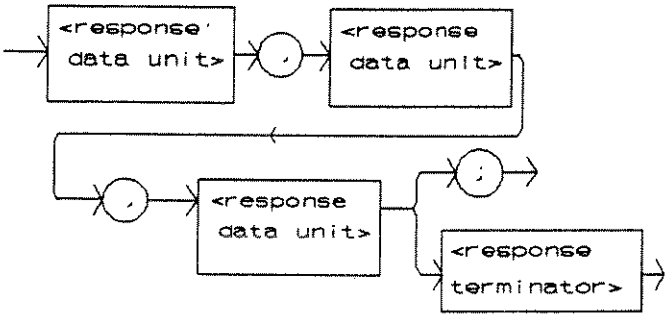
TEC:CONST?

The TEC:CONST? query returns the value of the TEC's Steinhart-Hart constants or the linear sensor conversion constants.

SYNTAX DIAGRAM



PARAMETERS None. The response will be in the form:



-where the response data represent C1, C2, and C3, respectively.

POINTS OF INTEREST

The response is always in the form: C1,C2,C3.

When the LM335 or AD590 sensors are selected via the SENSOR SELECT switch, only C1 and C2 are used. Therefore, C3 values may be ignored for these cases.

In local operation, the constants may be read by selecting (LED lit) the desired parameter in the PARAMETER section of the front panel and visually reading the value on the TEC display.

Appendices A, B and C contain information on the use of these constants with the various sensor types.

EXAMPLES

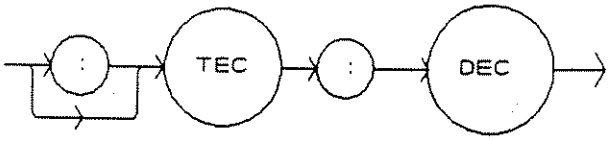
"TEC:CONST?" -response: 1.111,2.03,0.85 means C1 = 1.111, C2 = 2.030, and C3 = 0.850.

"TEC:Const?" -response: 1.00,2.222,0.07 means C1 = 1.000, C2 = 2.222, and C3 = 0.070.

TEC:DEC

The TEC:DEC command decrements the selected control mode setpoint by one step.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The decremental amount is one step. The step size can be edited via the STEP command, its default value is 0.1°C, 1 mA (ITE), 1 ohm, 0.01 uA (AD590), or 0.1 mV (LM335), depending on the mode of operation.

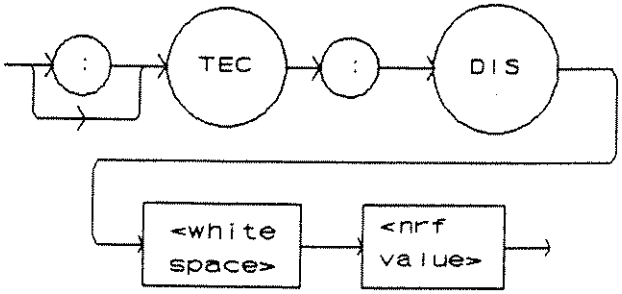
EXAMPLES — "TEC:MODE:T; TEC:STEP 2; TEC:DEC" -action: The mode is set for constant temperature and the set point is decremented by 0.2°C.

"TEC:Mode:r; Tec:STEP 20; Tec:Dec" -action: The mode is set for constant resistance and the set point is decremented by 20 (0.02 K) ohms, assuming that the SENSOR SELECT switch is in the 100 uA or 10 uA (thermistor current) position.

TEC:DISplay

The TEC:DISplay command enables or disables (turns off) the TEC display and TEC section's indicator LEDs.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>; 1 = on, 0 = off.

POINTS OF INTEREST

Turning the TEC display and LEDs off means that a message of all blank spaces is sent to the TEC display, and all of the TEC section's indicator LEDs will be turned off.

EXAMPLES

"TEC:DIS 0" -action: the TEC display will be blanked, and all of the TEC indicator LEDs will be turned off.

"tec:dis 1" -action: the TEC display and LEDs will be enabled.

"tec:display on" -action: the TEC display and LEDs will be enabled.

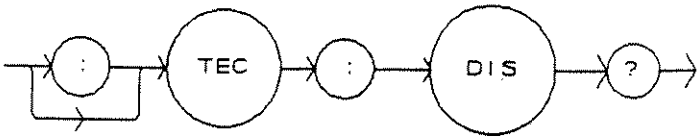
■ Front Panel

■ Remote

TEC:DISplay?

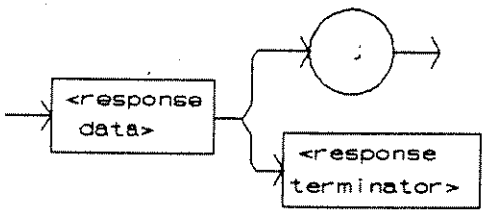
The TEC:DISplay? query returns the status of the TEC display.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is a string.

POINTS OF INTEREST

Returns the actual (6-character) string from the output buffer to the TEC display. If the display is disabled, it returns " .".

In local operation, the TEC display value is read by visually inspecting the TEC display.

EXAMPLES

"TEC:DIS?" -response: "- 99.9", means "- 99.9" is on the TEC display.

"Tec:DISp?" -response: " 0.6", means " 0.6" is on the TEC display.

TEC:DISplay:

The TEC:DISplay: command path is used to get to the 3722's TEC display commands.

The following commands may be reached directly from the TEC:DISplay: command path.

TEC:DISplay:ITE
TEC:DISplay:ITE?
TEC:DISplay:PARAM
TEC:DISplay:R
TEC:DISplay:R?
TEC:DISplay:SET
TEC:DISplay:SET?
TEC:DISplay:T
TEC:DISplay:T?

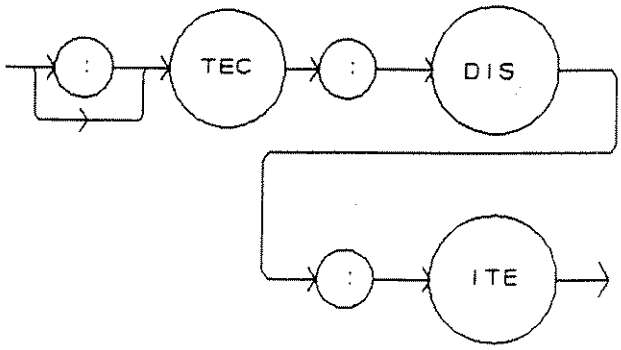
■ Front Panel

■ Remote

TEC:DISplay:ITE

The TEC:DISplay:ITE command enables the TEC display to show the TE current measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The actual TEC ITE display is turned off automatically when another TEC display selection is enabled.

In local operation, the TEC ITE display is enabled by pressing the ITE switch in the TEC DISPLAY area of the front panel.

EXAMPLES — ":Tec:Display:Ite" -action: enables the TEC display for measured current values.

"TEC:DIS:ITE" -action: enables the TEC display for measured current values.

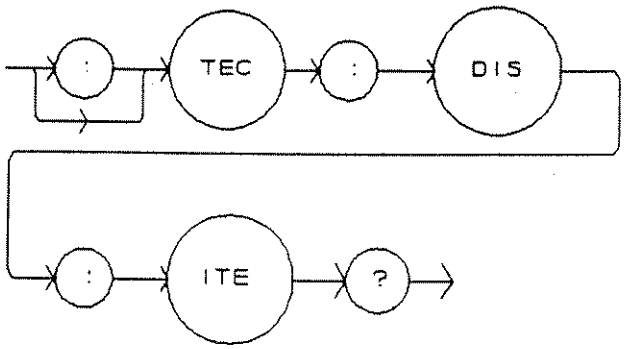
■ Front Panel

■ Remote

TEC:DISplay:ITE?

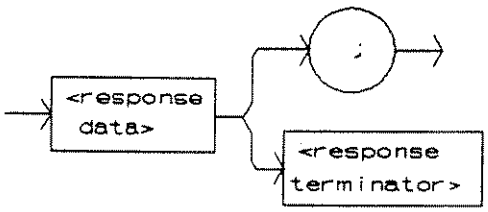
The TEC:DISplay:ITE? query returns the status of the (TEC DISPLAY) ITE switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The response will be the status of the TEC DIS ITE switch, 1 = on, 0 = off.

In local operation, the status of the TEC ITE display switch is determined by visually inspecting the LED indicator on the (TEC DISPLAY) ITE and SET switches. The ITE measurement will be displayed if the SET indicator is off and the R indicator is on (lit = ON).

EXAMPLES

"TEC:DIS:ITE?" -response: 0, means that the TEC DIS ITE switch is not enabled, TEC output current is not displayed.

"Tec:dis:Ite?" -response: 1, means that the TEC DIS ITE switch is enabled, TEC current may be displayed.

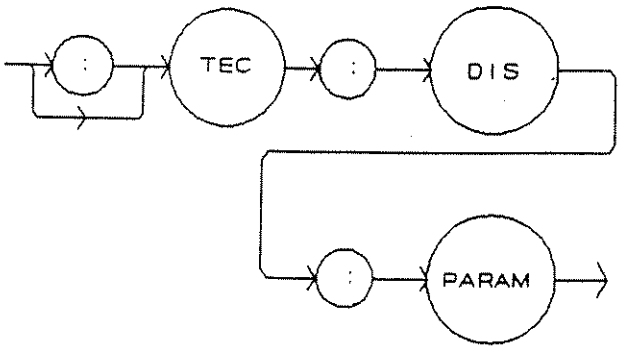
■ Front Panel

■ Remote

TEC:DISplay:PARAM

The TEC:DISplay:PARAM command enables the TEC display to show the parameter values.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST

This command has the same effect as pressing the (PARAMETER) SELECT switch while in TEC mode. The selected parameter will be displayed for three seconds. The actual TEC PARAM display is turned off automatically when a TEC display selection is enabled.

Each time the command is issued, the TEC next parameter will be selected, see Section 2.9.

In local operation, the TEC PARAMETER is displayed by pressing the SELECT switch in the TEC PARAMETER area of the front panel, while in TEC mode.

EXAMPLES

":Tec:Display:Param" -action: selects a TEC parameter and displays its value.

"TEC:DIS:PARAM" -action: selects a TEC parameter and displays its value.

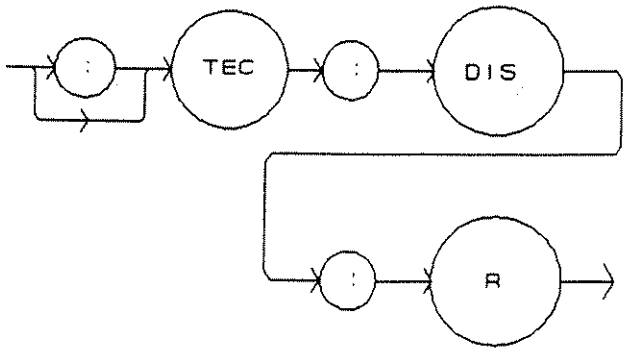
■ Front Panel

■ Remote

TEC:DISplay:R

The TEC:DISplay:R command sets the TEC display to show the thermistor resistance, AD590 current, or LM335 voltage measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The actual TEC R display is turned off automatically when another TEC display selection is enabled.

In local operation, the TEC R display is enabled by pressing the R switch in the TEC DISPLAY area of the front panel.

EXAMPLES — "TEC:DIS:R" -action: enables the TEC display for measured resistance or linear sensor reference values.

"TEC:Display:R" -action: enables the TEC display for measured resistance or linear sensor reference values.

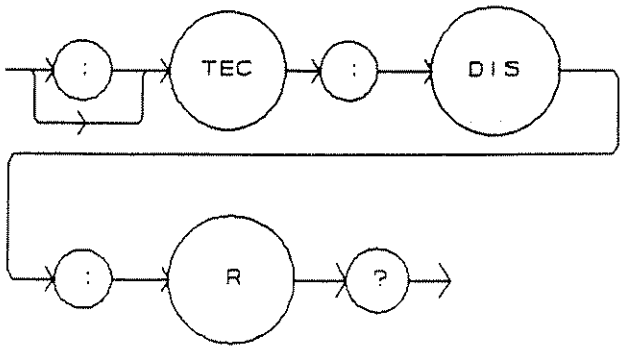
■ Front Panel

■ Remote

TEC:DISplay:R?

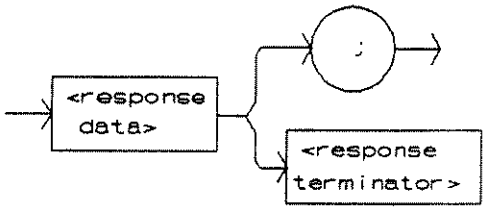
The TEC:DISplay:R? query returns the status of the (TEC DISPLAY) R switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The response will be the status of the TEC DIS R switch, 1 = on, 0 = off.

In local operation, the status of the TEC R display switch is determined by visually inspecting the LED indicator on the (TEC DISPLAY) R and SET switches. The R measurement will be displayed if the SET indicator is off and the R indicator is on (lit = ON).

EXAMPLES

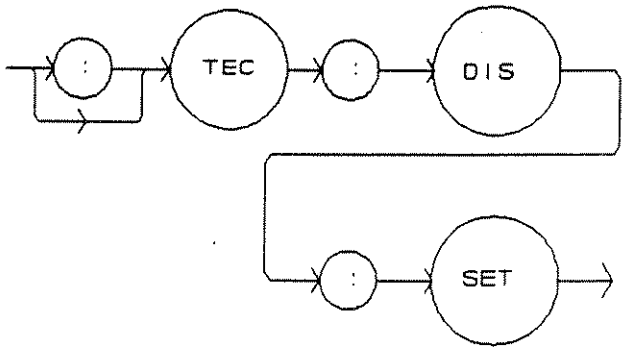
"TEC:Dis:R?" -response: 0, means that the TEC DIS R switch is not active. Therefore, TEC thermistor resistance, or AD590 current, or LM335 voltage is not displayed.

"Tec:dis:R?" -response: 1, means that the TEC DIS R switch is active. Therefore, TEC thermistor resistance, or AD590 current, or LM335 voltage may be displayed.

TEC:DISplay:SET

The TEC:DISplay:SET command sets the TEC display to show the currently selected mode's set point value.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — Using this command has the same effect as physically holding the (TEC DISPLAY) SET switch down (in).

EXAMPLES — "Tec:Dis:Set" -action: enables the TEC display for the set point of the selected mode: ITE, R or T.

"TEC:Dis:Set" -action: enables the TEC display for the set point of the selected mode: ITE, R or T.

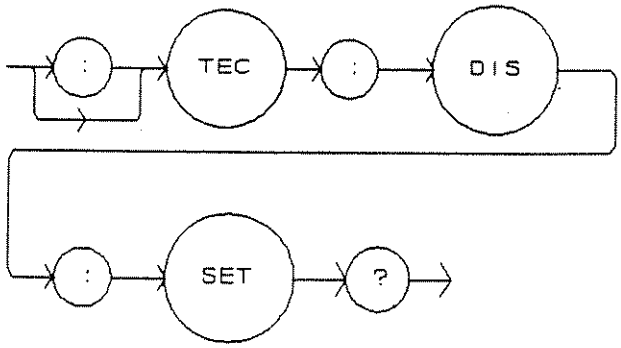
■ Front Panel

■ Remote

TEC:DISplay:SET?

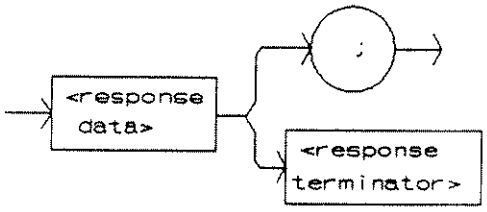
The TEC:DISplay:SET? query returns the status of the TEC display set point switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where an <nrf> response value of 0 = set point disabled (measured value may be displayed), 1 = set point enabled.

POINTS OF INTEREST

The set point display will not time out when remote operation is used. (It will be continuously displayed.)

In local operation, the status of the (TEC DISPLAY) SET switch is determined by visually inspecting the LED indicator on the switch (lit = ON).

EXAMPLES

"TEC:DISPL:SET?" -response: 0, means the set point value is disabled for the TEC display.

"Tec:Dis:Set?" -response: 1, means the set point value is enabled for the TEC display.

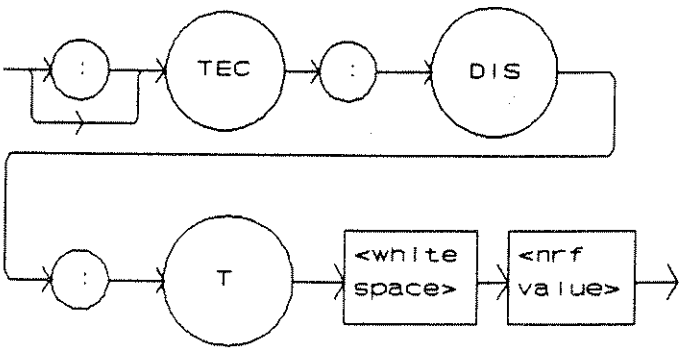
■ Front Panel

■ Remote

TEC:DISplay:T

The TEC:DISplay:T command enables the TEC display to show the TEC load temperature measurement.

SYNTAX DIAGRAM



PARAMETERS — None.

POINTS OF INTEREST — The actual TEC T display is turned off automatically when another TEC display selection is enabled.

In local operation, the TEC T display is enabled by pressing the T switch in the TEC DISPLAY area of the front panel.

EXAMPLES — "Tec:Dis:T" -action: enables the TEC display for the TEC load's measured temperature.

"TEC:DIS:T" -action: enables the TEC display for the TEC load's measured temperature.

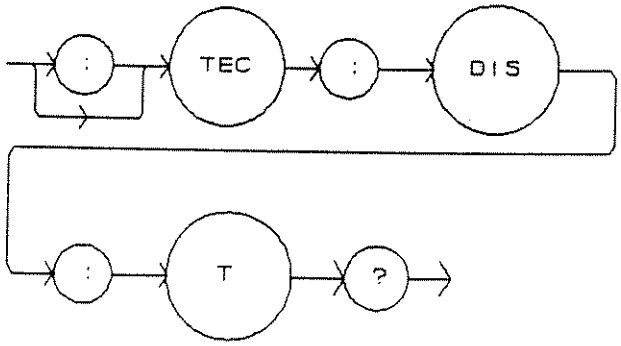
■ Front Panel

■ Remote

TEC:DISplay:T?

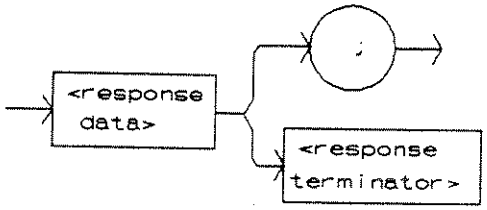
The TEC:DISplay:T? query returns the status of the (TEC DISPLAY) T switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The response will be the status of the TEC DIS T switch, 1 = on, 0 = off.

In local operation, the status of the TEC T display switch is determined by visually inspecting the LED indicator on the (TEC DISPLAY) T and SET switches. The T measurement will be displayed if the SET indicator is off and the T indicator is on (lit = ON).

EXAMPLES

"TEC:Dis:T?" -response: 0, means that the TEC DIS T switch is not enabled, TEC load temperature is not displayed.

"Tec:dis:T?" -response: 1, means that the TEC DIS T switch is enabled, temperature may be displayed.

TEC:ENABle:

The TEC:ENABle: command path is used to get to the 3722's TEC status enable commands and queries.

The following commands may be reached directly from the TEC:ENABle: command path.

TEC:ENABle:COND
TEC:ENABle:COND?
TEC:ENABle:EVEnt
TEC:ENABle:EVEnt?
TEC:ENABle:OUTOFF
TEC:ENABle:OUTOFF?

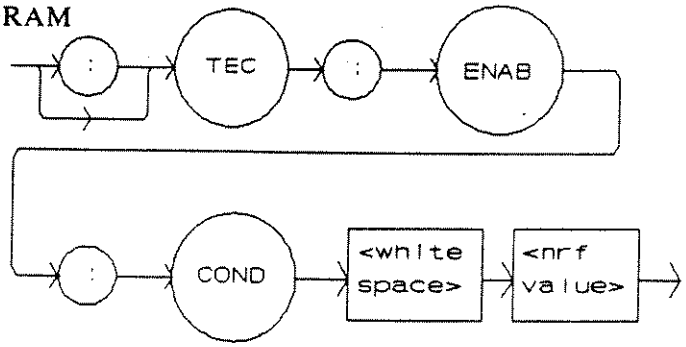
□ Front Panel

■ Remote

TEC:ENABle:COND

The TEC:ENABle:COND command sets the status condition enable register of the TEC operations. These conditions are summarized in bit 1 of the status byte.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit
2 - Voltage Limit Error
4 - N/A
8 - High Temperature Limit
16 - Interlock Enable
32 - Booster Enable
64 - Sensor Open
128 - TE Module Open
256 - N/A
512 - Output Out of Tolerance
1024 - Output On
2048 - Ready for Calibration Data
4096 - Calculation Error
8192 - Internal Communication Error with TEC Board
16384 - Software Error
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The enabled TEC conditions can be read by using the TEC:ENABle:COND? query.

The TEC condition status can be monitored by the TEC:COND? query. If any of the enabled TEC conditions are true, bit 1 of the status byte rregister will be set.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 4).

(Continued on next page.)

TEC:ENABle:COND

(Continued from previous page.)

EXAMPLES

"TEC:ENAB:COND 513" -action: enables the TEC status condition register so that the Output Out of Tolerance and TE Current Limit conditions will be reported in the status byte register.

"Tec:Enable:Cond #HFDFB" -action: enables the TEC status condition register so that any and all of the above conditions will be reported in the status byte register.

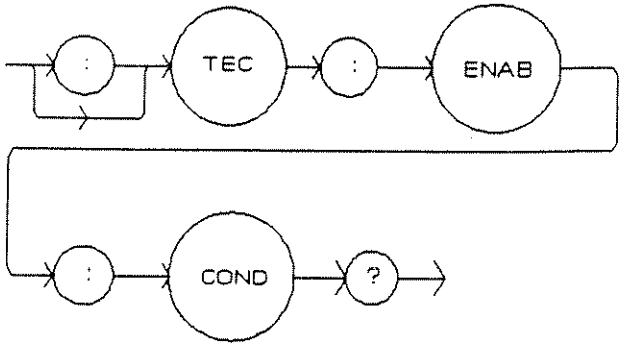
□ Front Panel

■ Remote

TEC:ENABle:COND?

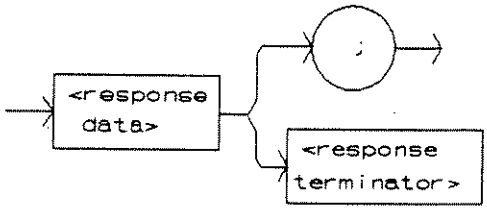
The TEC:ENABle:COND? query returns the value of the status condition enable register of the TEC operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - TE Current Limit
2 - Voltage Limit Error
4 - N/A
8 - High Temperature Limit
16 - Interlock Enable
32 - Booster Enable
64 - Sensor Open
128 - TE Module Open
256 - N/A
512 - Output Out of Tolerance
1024 - Output On
2048 - Ready for Calibration Data
4096 - Calculation Error
8192 - Internal Communication Error with TEC Board
16384 - Software Error
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The enabled TEC conditions can be set by using the TEC:ENABle:COND command.

(Continued on next page.)

TEC:ENABle:COND

(Continued from previous page.)

POINTS OF INTEREST

The enabled TEC condition status can be monitored by the TEC:COND? query.

EXAMPLES

"TEC:ENAB:COND?" -response: 129, means that the TE Module Open and TE Current Limit conditions may be reported in the status byte register.

"Radix Hex; TEC:Enable:Cond?" -response: #HFDFB, means that any and all of the above conditions will be reported in the status byte register.

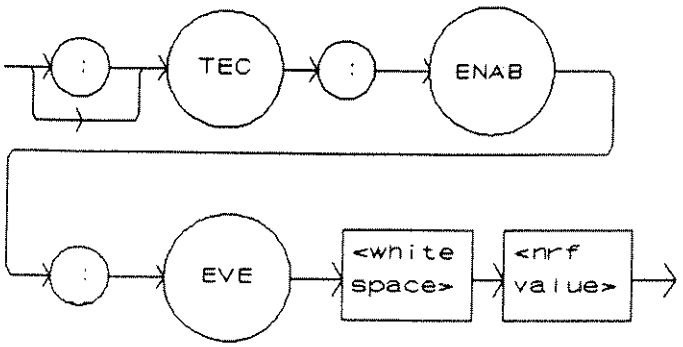
□ Front Panel

■ Remote

TEC:ENABle:EVEnt

The TEC:ENABle:EVEnt command sets the status event enable register of the TEC operations. These events are summarized in bit 0 of the status byte register.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit
2 - Voltage Limit
4 - N/A
8 - High Temperature Limit
16 - Interlock Disabled
32 - Booster Changed
64 - Sensor Open
128 - TE Module Open
256 - Sensor Type Changed
512 - Output Changed to be In or Out of Tolerance
1024 - Output On/Off Changed
2048 - New Measurements Taken
4096 - Calculation Error
8192 - Internal TEC Control Communication Error
16384 - Software Error in TEC Control
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The enabled TEC events can be read by using the TEC:ENABle:EVEnt? query.

The enabled TEC event status can be monitored by the TEC:EVEnt? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 4).

(Continued on next page.)

TEC:ENABle:EVEnt

(Continued from previous page.)

EXAMPLES

"Tec:Enab:EVENT 160" -action: enables the TEC status event register so that the TE Module Open and Booster Changed conditions will be reported (in summarized form) to the status byte register (bit 1).

"Tec:Enable:EVEnt #HFFFB" -action: enables the TEC status event register so that any and all of the above events will be reported (in summarized form) to the status byte register (bit 1).

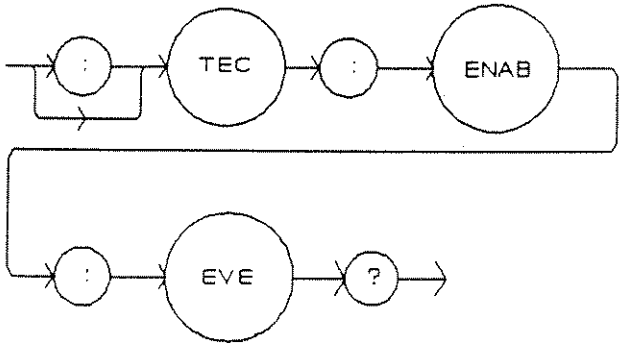
□ Front Panel

■ Remote

TEC:ENABle:EVEnt?

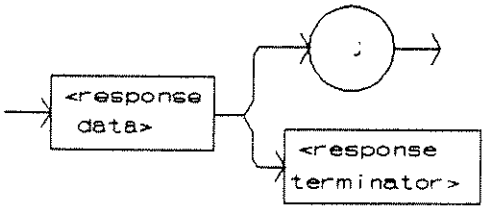
The TEC:ENABle:EVEnt? query returns the value of the status event enable register of the TEC operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - TE Current Limit
2 - Voltage Limit
4 - N/A
8 - High Temperature Limit
16 - Interlock Disabled
32 - Booster Changed
64 - Sensor Open
128 - TE Module Open
256 - Sensor Type Changed
512 - Output Changed to be In or Out of Tolerance
1024 - Output On/Off Changed
2048 - New Measurements Taken
4096 - Calculation Error
8192 - Internal TEC Control Communication Error
16384 - Software Error in TEC Control
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The enabled TEC events can be set by using the TEC:ENABle:EVEnt command.

(Continued on next page.)

TEC:ENABle:EVEnt?

(Continued from previous page.)

POINTS OF INTEREST

The TEC event status can be read and reset by issuing the TEC:EVEnt? query.

EXAMPLES

"TEC:ENAB:EVE?" -response: 520, means that the High Temperature Limit and Output Out of Tolerance TEC events will be reported (in summarized form) to the status byte register (bit 0).

"Radix Hex; TEC:Enab:Eve?" -response: #HFFFB, means that all of the above events will be reported (in summarized form) to the status byte register (bit 0).

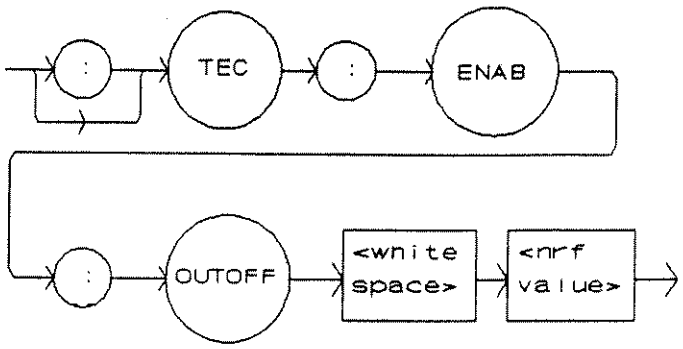
□ Front Panel

■ Remote

TEC:ENABle:OUTOFF

The TEC:ENABle:OUTOFF command sets the status outoff enable register of the TEC operations (things which will turn the TEC output off).

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit Condition
2 - Voltage Limit Condition
4 - N/A
8 - High Temperature Limit Condition
16 - Interlock Disabled Condition
32 - Booster Changed (While Output On) Event
64 - Sensor Open (While Output On) Condition
128 - Module Open (While Output On) Condition
256 - Sensor Type Change (While Output On) Event
512 - Output Out of Tolerance Condition
1024 - Sensor Shorted (While Output On) Condition
2048 - N/A
4096 - Software Error Condition
8192 - N/A
16384 - N/A
32768 - N/A

POINTS OF INTEREST

The enabled TEC outoff bits can be read by using the TEC:ENABle:OUTOFF? query.

The value of the TEC outoff enable register is stored in non-volatile memory and is retained at power-up.

The factory default setting for this register is #H5F8, or 1528 decimal.

(Continued on next page.)

TEC:ENABle:OUTOFF

(Continued from previous page.)

POINTS OF INTEREST

The High Temperature Limit Condition, Sensor Open (While Output On) Condition, and Sensor Type Change (While Output On) Event bits will not be in effect and will not cause the TEC output to be shut off, if the 3722 is in ITE mode.

WARNING: If the Outout Out of Tolerance Change Event bit is set when the power is off, the TEC output will not be able to be turned on until this bit is reset.

EXAMPLES

"TEC:ENAB:OUTOFF 9" -action: enables the TEC status outoff register so that a High Temperature Limit Condition or a TE Current Limit Condition will cause the TEC output to be turned off.

"Tec:Enab:Outoff #H17FB" -action: enables the TEC status outoff register so that any and all of the above conditions will cause the TEC output to be turned off.

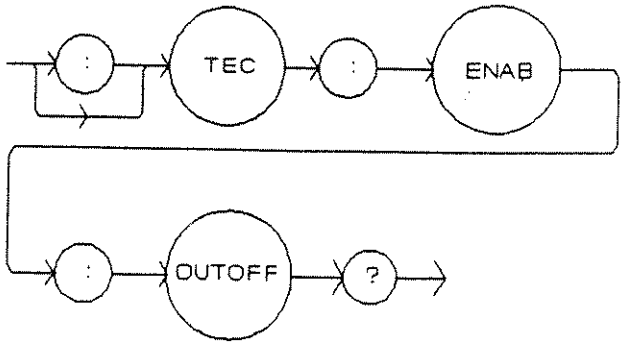
□ Front Panel

■ Remote

TEC:ENABle:OUTOFF?

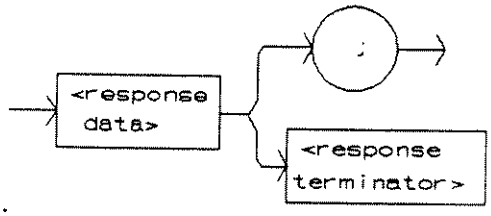
The TEC:ENABle:OUTOFF? query returns the value of the status outoff enable register of the TEC operations (things which will turn the TEC output off).

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - TE Current Limit Condition
2 - Voltage Limit Condition
4 - N/A
8 - High Temperature Limit Condition
16 - Interlock Disabled Condition
32 - Booster Changed (While Output On) Event
64 - Sensor Open (While Output On) Condition
128 - Module Open (While Output On) Condition
256 - Sensor Type Change (While Output On) Event
512 - Output Out of Tolerance Condition
1024 - Sensor Shorted (While Output On) Condition
2048 - N/A
4096 - Software Error Condition
8192 - N/A
16384 - N/A
32768 - N/A

POINTS OF INTEREST

The enabled TEC outoff events and conditions (which can turn the TEC output off) can be set by using the TEC:ENABle:OUTOFF command.

(Continued on next page.)

TEC:ENABle:OUTOFF?

(Continued from previous page.)

EXAMPLES

"TEC:ENAB:OUTOFF?" -response: 258, means that a Sensor Type Change Condition or a Voltage Limit Condition will cause the TEC output to be turned off.

"Radix Hex; TEC:Enab:Outoff?" -response: #H17FB, means that all of the above conditions will cause the TEC output to be turned off.

"Radix Bin; TEC:Enab:Outoff?" -response: #B1001, means that the High Temperature Limit and TE Current Limit conditions will cause the TEC output to be turned off.

"Radix Oct; TEC:Enab:Outoff?" -response: #Q101, means that the Sensor Open (While Output On) and TE Current Limit conditions will cause the TEC output to be turned off.

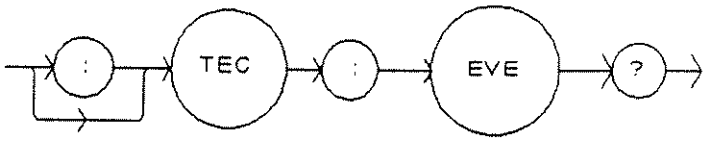
□ Front Panel

■ Remote

TEC:EVEnt?

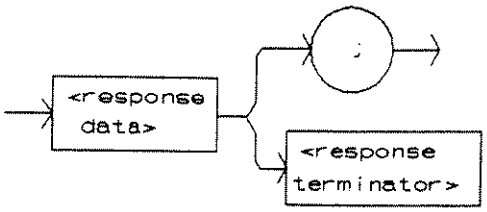
The TEC:EVEnt? query returns the value of the status event register of the TEC operations.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is the sum of the following:

1 - TE Current Limit
2 - Voltage Limit
4 - N/A
8 - High Temperature Limit
16 - Interlock Disabled
32 - Booster Changed
64 - Sensor Open
128 - TE Module Open
256 - Sensor Type Changed
512 - Output Changed to be In or Out of Tolerance
1024 - Output On/Off Changed
2048 - New Measurements Taken
4096 - Calculation Error
8192 - Internal TEC Control Communication Error
16384 - Software Error in TEC Control
32768 - TEC EEPROM Checksum Error

POINTS OF INTEREST

The TEC conditions which are reported to the status byte are set via the TEC:ENABle:EVEnt command.

The TEC event status is only cleared when the event status is read or a *CLS command is issued, while the condition status is constantly changing.

EXAMPLES

"TEC:EVE?" -response: 513, means that the Output went In or Out of Tolerance and the TE Current Limit events have occured since the last TEC:EVEnt? query.

"Radix Hex; TEC:Event?" -response: #H82, means that the Voltage Limit and TE Module Open events have occured since the last TEC:EVEnt? query.

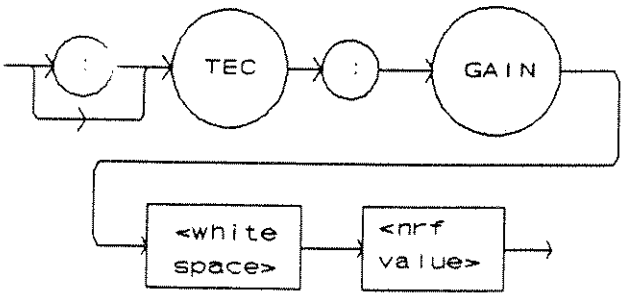
■ Front Panel

■ Remote

TEC:GAIN

The TEC:GAIN command sets the TEC control loop gain.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> between 1 - 300, the value will be stored to the nearest of: 1, 3, 10, 30, 100, or 300.

POINTS OF INTEREST

If the user enters a gain value which is greater than 300, a value of 300 will be stored. If the user enters a gain value which is less than 1, a value of 1 will be stored.

If the user enters a value which is not legal, the 5910B will round that value to the nearest legal value, if possible.

In local operation, the gain is entered by selecting the GAIN parameter, pressing and holding in the SET switch, and entering the desired value by adjusting the front panel knob. When the SET switch is released, the gain value is stored in non-volatile memory.

EXAMPLES

"TEC:GAIN 100" -action: the TEC control loop gain is set to 100.

"Tec:gain 3" -action: the TEC control loop gain is set to 3.

"TEC:Gain 200" -action: the TEC control loop gain is set to 100 (the 3722 rounds 200 to the nearest valid number).

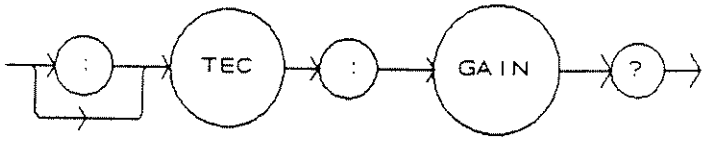
■ Front Panel

■ Remote

TEC:GAIN?

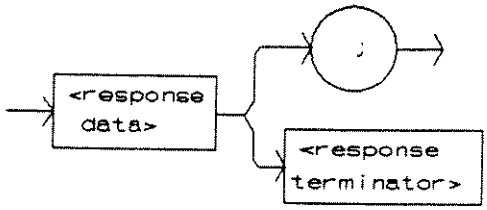
The TEC:GAIN? query returns the value of the control loop gain.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response value is one of the following integers: 1, 3, 10, 30, 100, or 300.

POINTS OF INTEREST

If a value other than 1, 3, 10, 30, 100, or 300 is entered via the GAIN command, the nearest valid value will be stored.

In local operation, the gain value is queried by selecting the GAIN parameter and visually reading the display.

EXAMPLES

"TEC:Gain?" -response: 30.0, means the control loop gain is set to 30.

"Tec:GAIN?" -response: 100.0, means the control loop gain is set to 100.

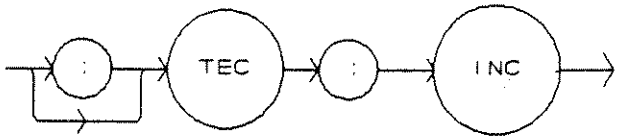
□ Front Panel

■ Remote

TEC:INC

The TEC:INC command increments the selected control mode set point by one step.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST The incremental amount is one step. The step size can be edited via the STEP command, its default value is 0.1°C, 1 mA (ITE), 1 ohm, 0.01 uA (AD590), or 0.1 mV (LM335), depending on the mode of operation.

EXAMPLES "TEC:MODE:T; TEC:STEP 2; TEC:INC" -action: The mode is set for constant temperature and the set temperature is incremented by 0.2°C.

"TEC:Mode:r; Tec:STEP 20; Tec:inc" -action: The mode is set for constant resistance and the set point is incremented by 20 (0.02 K) ohms, assuming that the SENSOR SELECT switch is in the 100 uA or 10 uA (thermistor current) position.

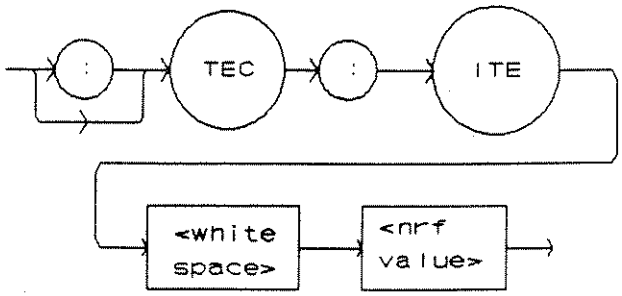
■ Front Panel

■ Remote

TEC:ITE

The TEC:ITE command sets the TEC control current set point. It is also used to enter the TEC current calibration value.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the ITE set point current, in Amps. In ITE current calibration mode, the <nrf value> represents the measured current value in Amps.

POINTS OF INTEREST

This set point is used by the TEC's constant ITE mode only.

In local operation, the ITE set point is entered by selecting (ADJUST) TEC and ITE modes, pressing the (TEC DISPLAY) SET switch, adjusting the ADJUST knob (within 3 seconds), and then releasing the SET switch when the desired value is shown on the TEC display.

EXAMPLES

"TEC:ITE 1" -action: sets the TEC output current set point to 1.000 Amps.

"TEC:MODE:ITE; Tec:Ite 3.5" -action: sets the TEC output current set point to 3.500 Amps and the output is controlled to that value.

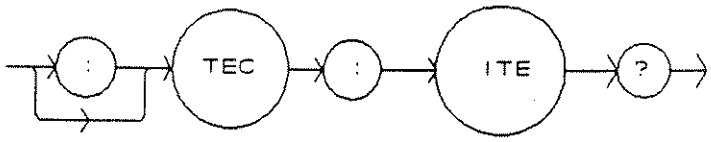
■ Front Panel

■ Remote

TEC:ITE?

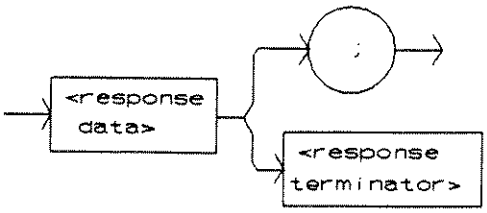
The TEC:ITE? query returns the value of the measured TEC output current.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response value represents the measured ITE current, in Amps.

POINTS OF INTEREST

The TEC load current is constantly measured and updated, regardless of the TEC mode of operation.

This measurement is updated approximately once every 400 mSec.

If an external booster is used, the ITE measurement will remain zero, as the internal output section is disabled in that case.

In local operation, the ITE measured value is determined by pressing the ITE switch in the TEC DISPLAY area of the front panel, and visually reading the value on the TEC display.

EXAMPLES

"TEC:ITE?" -response: 2.43, means the measured TEC output current is 2.430 Amps.

"Tec:Ite?" -response: -3.27, means the measured TEC output current is -3.270 Amps.

TEC:LIMit:

The TEC:LIMit: command path is used to get to the 3722's TEC limit commands.

The following commands may be reached directly from the TEC:LIMit: command path.

TEC:LIMit:ITE
TEC:LIMit:ITE?
TEC:LIMit:THI
TEC:LIMit:THI?

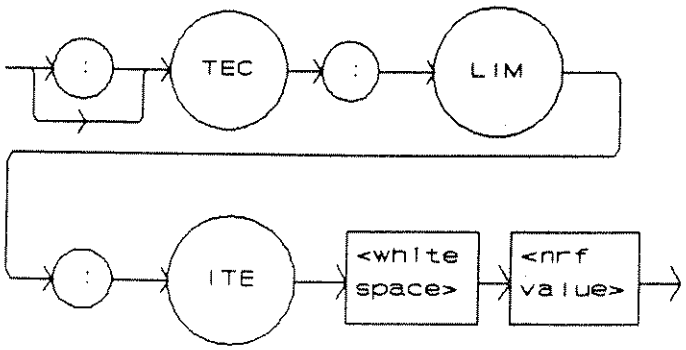
■ Front Panel

■ Remote

TEC:LIMit:ITE

The TEC:LIMit:ITE command sets the TEC TE current limit value.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> representing the limit value of the TE current, in Amps.

POINTS OF INTEREST

This value also limits the TEC booster output signal voltage to a value which is proportional to the TEC limit current (approximately 1 V/A).

In local operation, the ITE limit is set by selecting the LIM I_{TE} parameter, pressing the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value appears on the TEC display, and then releasing the SET switch.

EXAMPLES

"TEC:LIM:ITE 3.5" -action: the TEC current limit is set to 3.500 amps.

"Tec:Limit:Ite 4.0" -action: the TEC current limit is set to 4.000 amps.

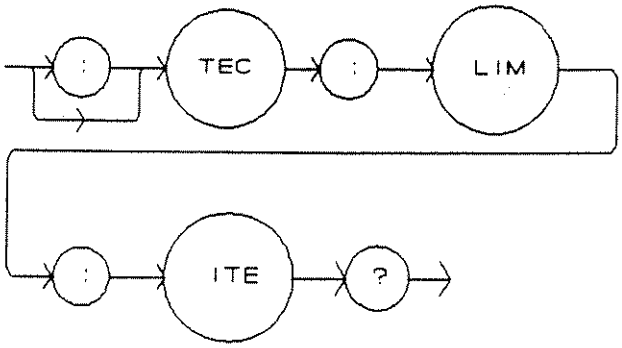
■ Front Panel

■ Remote

TEC:LIMit:ITE?

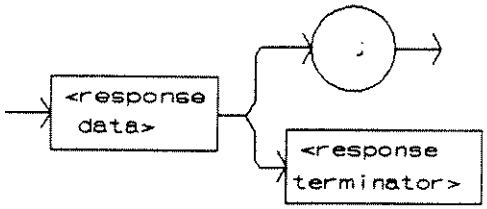
The TEC:LIMit:ITE? query returns the value of the TEC's TE current limit.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The response value is in amps.

In local operation, the ITE limit value is read by pressing the (TEC PARAMETER) SELECT switch until the LIM I_{TE} indicator is lit, and reading the value on the TEC display.

EXAMPLES

"TEC:LIM:ITE?" -response: 3.5, means the TEC output current limit is 3.500 amps.

"Tec:Limit:Ite? -response: 4.0, means the TEC output current limit is 4.000 amps.

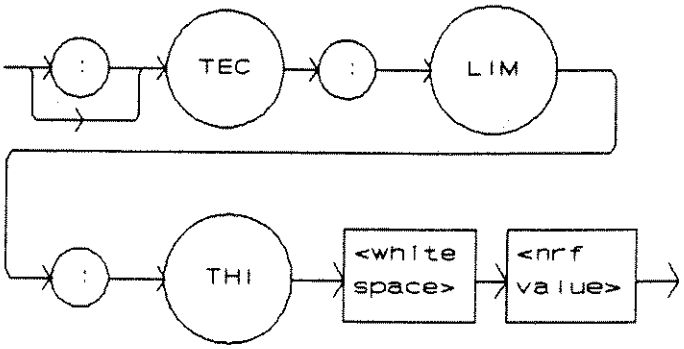
■ Front Panel

■ Remote

TEC:LIMit:THI

The TEC:LIMit:THI command sets the TEC high temperature limit value.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the upper bound of the TEC load temperature, in °C.

POINTS OF INTEREST

The THI limit value must be in the range 0 - 199.9 °C.

In local operation, the THI limit is set by selecting the LIM T_{HI} parameter, pressing the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value appears on the TEC display, and then releasing the SET switch.

The default setting of the TEC outoff enable register forces the TEC output to be shut off if the high temperature limit is reached. (See the TEC:ENABle:OUTOFF command.)

EXAMPLES

"TEC:LIM:THI 100" -action: sets the TEC load temperature limit to 100.0°C.

"Tec:Lim:thi 30.3" -action: sets the TEC load temperature limit to 30.3°C.

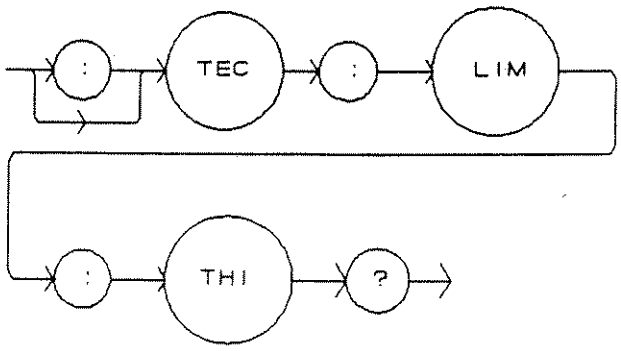
■ Front Panel

■ Remote

TEC:LIMit:THI?

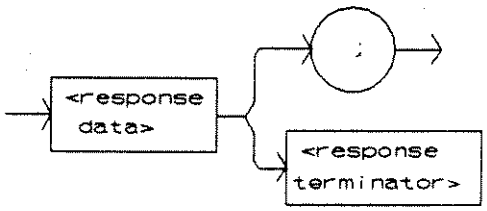
The TEC:LIMit:THI? query returns the value of the TEC load's high temperature limit.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The temperature limit is valid for R and T modes of TEC output operation.

In local operation, the THI limit value is read by pressing the (TEC PARAMETER) SELECT switch until the LIM T_{HI} indicator is lit, and reading the value on the TEC display.

If the high temperature limit is set too low, the TEC output may not be able to be turned on, if the high temperature condition is also used to turn the TEC output off (see TEC:ENABle:OUTOFF).

EXAMPLES

"TEC:LIM:Thi?" -response: 30.5, means the TEC load's high temperature limit is 30.5°C.

"Tec:Limit:THI? -response: 184.7, means the TEC load's high temperature limit is 184.7°C.

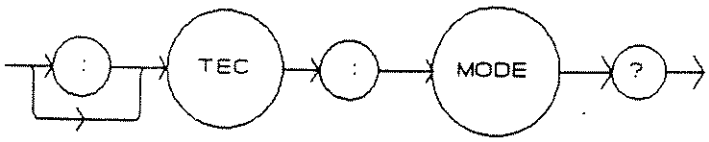
■ Front Panel

■ Remote

TEC:MODE?

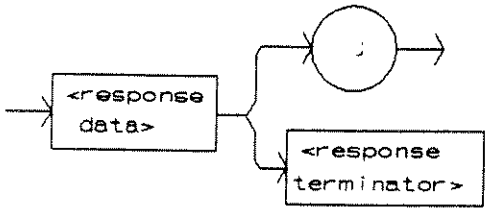
The TEC:MODE? query returns the selected TEC control mode.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is a character response.

POINTS OF INTEREST

The TEC mode is also the parameter which is controlled. The TEC output is kept at the set point.

In local operation, the mode is of operation is determined by visually inspecting the LED indicators in the TEC MODE area of the front panel (lit = ON).

EXAMPLES

"Tec:MODE?" -response: ITE, means that constant ITE (current) mode is in effect for the TEC output.

":TEC:Mode?" -response: R, means that constant R (resistance) mode is in effect for the TEC output.

"Tec:Mode?" -response: T, means that constant T (temperature) mode is in effect for the TEC output.

TEC:MODE:

The TEC:MODE: command path is used to get to the 3722's TEC mode selection commands.

The following commands may be reached directly from the TEC:MODE: command path.

TEC:MODE:ITE
TEC:MODE:R
TEC:MODE:T

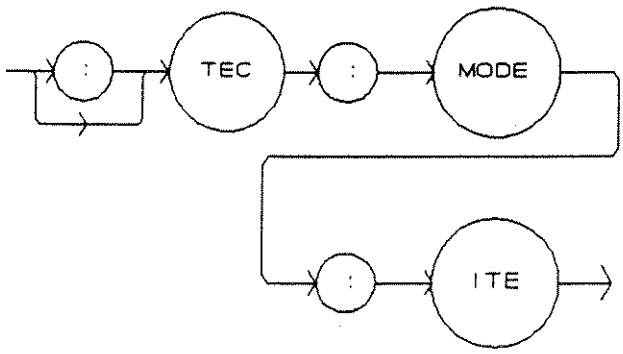
■ Front Panel

■ Remote

TEC:MODE:ITE

The TEC:MODE:ITE command selects TEC constant TE current mode.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST

This mode keeps the TEC current constant, regardless of load temperature variations.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

In local operation, the TEC control mode is set by pressing the (TEC MODE) SELECT switch until the desired mode is indicated by corresponding LED (lit = ON).

EXAMPLES

"TEC:MODE:ITE" -action: sets the TEC controller for constant TEC current operation.

"Tec:Mode:Ite" -action: sets the TEC controller for constant TEC current operation.

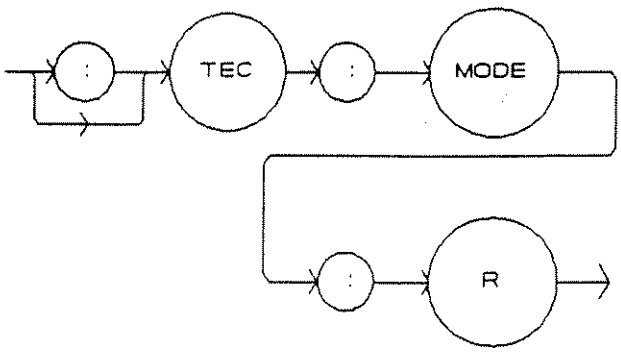
■ Front Panel

■ Remote

TEC:MODE:R

The TEC:MODE:R command selects TEC constant thermistor resistance/linear sensor reference mode.

SYNTAX DIAGRAM



PARAMETERS None.

POINTS OF INTEREST

Since sensor resistance (or linear sensor reference) is a function of temperature, this mode also controls the TEC output load temperature, but it bypasses the use of the conversion constants for set point calculation. This allows finer control of temperature in cases where the sensor's temperature model (and therefore the constants) is not known.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

In local operation, the TEC control mode is set by pressing the (TEC MODE) SELECT switch until the desired mode is indicated by corresponding LED (lit = ON).

EXAMPLES

"TEC:MODE:R" -action: sets the TEC controller for constant thermistor resistance/linear sensor reference operating mode.

"Tec:Mode:R" -action: sets the TEC controller for constant thermistor resistance/linear sensor reference operating mode.

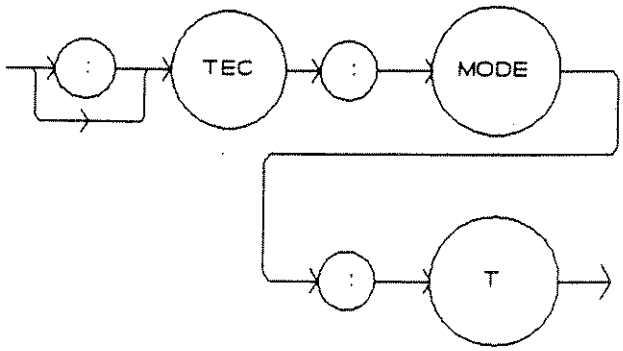
■ Front Panel

■ Remote

TEC:MODE:T

The TEC:MODE:T command selects TEC constant temperature mode.

SYNTAX DIAGRAM



PARAMETERS

None.

POINTS OF INTEREST

Since TEC load temperature is derived from sensor resistance/reference, constant R and T modes are related. In T mode the set point is converted to resistance or reference using the appropriate constants and conversion model.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

In local operation, the TEC control mode is set by pressing the (TEC MODE) SELECT switch until the desired mode is indicated by corresponding LED (lit = ON).

EXAMPLES

"TEC:MODE:T" -action: sets the TEC controller for constant load temperature operating mode.

":tec:mode:T" -action: sets the TEC controller for constant load temperature operating mode.

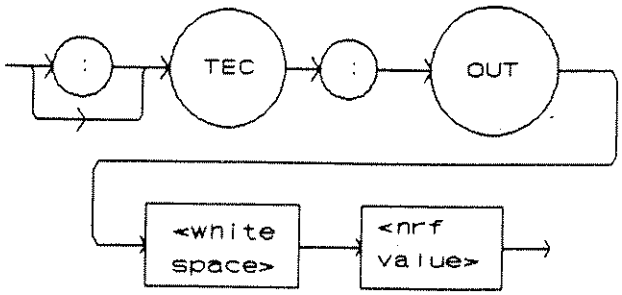
■ Front Panel

■ Remote

TEC:OUTput

The TEC:OUTput command turns the TEC output on or off.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value>; 1 = on, 0 = off.

POINTS OF INTEREST

After the output is turned on, it may be useful to wait until the output is stable (within tolerance) before performing further operations, but it is not necessary.

In local operation, the TEC output is toggled off and on by pressing the ON switch in the TEC MODE area of the front panel.

EXAMPLES

"TEC:OUTPUT 1" -action: turns the TEC output on.

"Tec:Out 0" -action: turns the TEC output off.

"Tec:Out OFF" -action: turns the TEC output off.

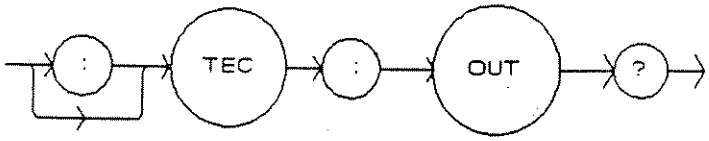
■ Front Panel

■ Remote

TEC:OUTput?

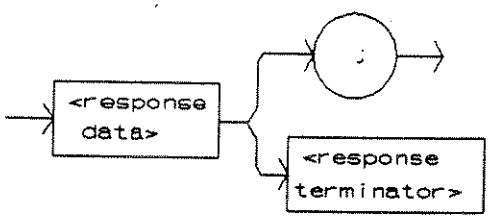
The TEC:OUTput? query returns the status of the TEC output switch.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

Although the status of the switch is on, the output may not have reached the set point value.

In local operation, the status of the TEC output is determined by visually inspecting the indicator LED of the ON switch in the TEC MODE area of the front panel (lit = ON).

EXAMPLES

"Tec:Out?" -response: 0, means the TEC output switch is off, TEC output is off.

"TEC:OUT?" -response: 1, means the TEC output switch is on, TEC output is on.

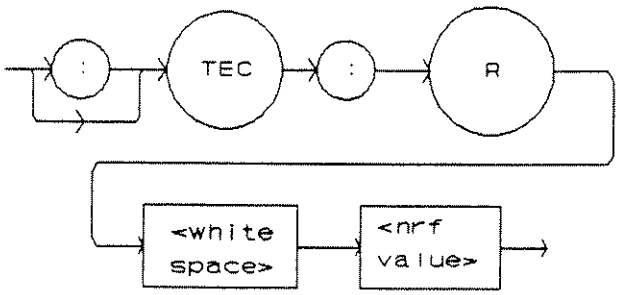
■ Front Panel

■ Remote

TEC:R

The TEC:R command sets the TEC's constant thermistor resistance or linear sensor reference set point.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the thermistor resistance set point value, in Kohms; the AD590 current set point, in uA; or the LM335 voltage set point, in mV, depending on the selected sensor type.

POINTS OF INTEREST

The R set point is used to control the TEC output in R mode only. Using the R mode, the user may also monitor the temperature of the TEC load via a remote algorithm of his/her own design.

In local operation, the R set point is entered by selecting (ADJUST) TEC and R modes, pressing the (TEC DISPLAY) SET switch, adjusting the ADJUST knob (within 3 seconds), and then releasing the SET switch when the desired value is shown on the TEC display.

EXAMPLES

"TEC:R 20.5" -action: sets the set point thermistor resistance to 20.5 Kohms, or sets the AD590 current to 20.5 uA, or sets the LM335 voltage to 20.5 mV.

"TEC:Mode:R; TEC:R 10" -action: sets the set point thermistor resistance to 10.0 Kohms, or the AD590 current to 10.0 uA, or the LM335 voltage to 10.0 mV. The TEC output sensor is controlled to that value, if the output is on.

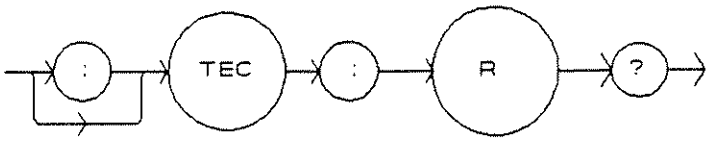
■ Front Panel

■ Remote

TEC:R?

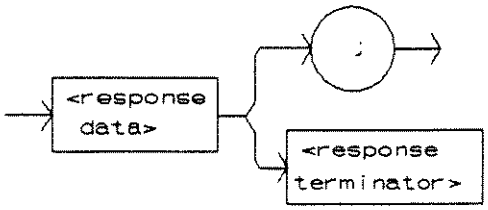
The TEC:R? query returns the value of the TEC thermistor resistance, or AD590 current, or LM335 voltage measurement.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the <nrf> response value is the measured TEC thermistor resistance, in Kohms, or AD590 current in uA, or the measured LM335 voltage in mV.

POINTS OF INTEREST

TEC load temperature is derived from the thermistor resistance or linear sensor reference measurement.

This measurement is updated approximately once every 400 mSec.

In local operation, the R measured value is determined by pressing the R switch in the TEC DISPLAY area of the front panel, and visually reading the value on the TEC display.

EXAMPLES

"TEC:R?" -response: 10.543, means the measured TEC thermistor resistance is 10.543 Kohms, or the measured AD590 current is 10.543 uA, or the measured LM335 voltage is 10.543 mV, depending on the SENSOR SELECT switch position.

"Tec:R?" -response: 0.728, means the measured TEC thermistor resistance is 728 ohms, or the measured AD590 current is 0.728 uA, or the measured LM335 voltage is 0.728 mV, depending on the SENSOR SELECT switch position.

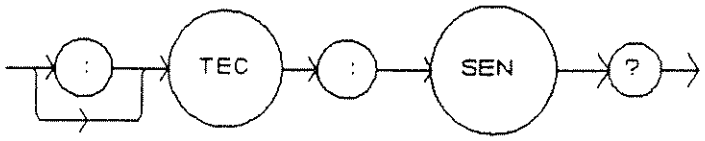
□ Front Panel

■ Remote

TEC:SENsor?

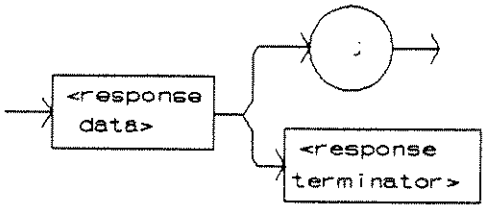
The TEC:SENsor? query is used to read back the SENSOR SELECT switch position value. This value is a coded representation of the sensor type/thermistor sensor current.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response of 1 = thermistor, at 100 uA; 2 = thermistor, at 10 uA; 3 = LM335 sensor; 4 = AD590 sensor.

POINTS OF INTEREST

The sensor code is displayed on the TEC display, and bit 8 of the TEC event register is set, whenever the back panel SENSOR SELECT switch position is changed.

The sensor selection must be made locally at the back panel SENSOR SELECT switch.

In local operation, the setting of the SENSOR SELECT switch may be read by visually inspecting the back panel SENSOR SELECT switch.

If the response is 0, the sensor type is undetermined and a hardware error must exist.

EXAMPLES

"TEC:Sensor?" -response: 1, means the SENSOR SELECT switch is in the 100 uA thermistor position.

"Tec:SEN?" -response: 3, means the LM335 sensor is selected by the back panel SENSOR SELECT switch.

■ Front Panel

■ Remote

TEC:SET:

The TEC:SET: command path is used to get to the 3722's TEC set point queries.

The following commands may be reached directly from the TEC:SET: command path.

TEC:SET:ITE?
TEC:SET:R?
TEC:SET:T?

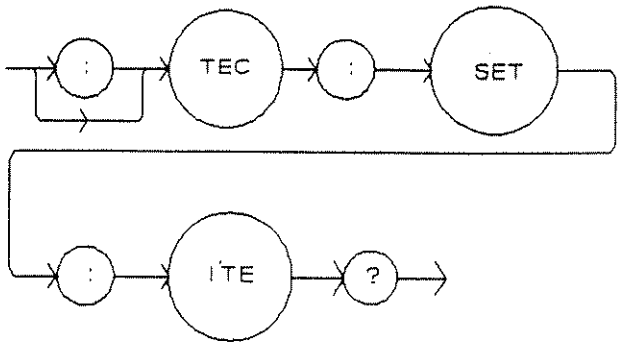
■ Front Panel

■ Remote

TEC:SET:ITE?

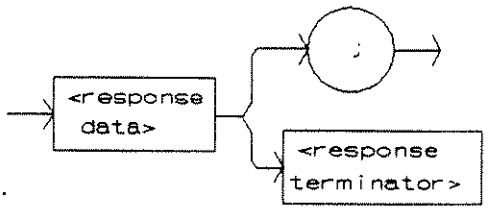
The TEC:SET:ITE? query returns the TEC constant TE current set point value.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response <nrf value> represents the ITE set point, in amps.

POINTS OF INTEREST

The TEC output is controlled to this set point value only when constant ITE mode is in effect.

In local operation, the ITE set point value is read by pressing the (TEC DISPLAY) SET switch while in ITE mode, and visually reading the TEC display.

EXAMPLES

"TEC:SET:ITE?" -response: 3.0, means the ITE set point is 3.000 amps.

"Tec:Set:Ite?" -response: 4.0, means the ITE set point is 4.000 amps.

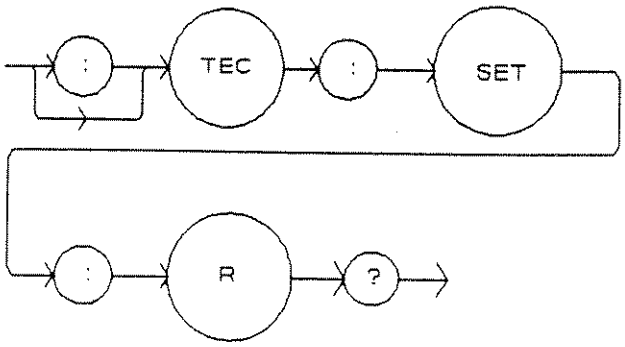
■ Front Panel

■ Remote

TEC:SET:R?

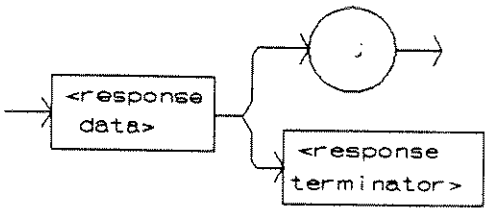
The TEC:SET:R? query returns the TEC load's constant thermistor resistance or linear sensor reference set point value.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response <nrf value> represents the set point thermistor resistance value, in Kohms; or the AD590 set point current, in uA; or the LM335 set point voltage, in mV.

POINTS OF INTEREST

The TEC output is controlled to this set point value only when constant R mode is in effect.

In local operation, the R set point value is read by pressing the (TEC DISPLAY) SET switch while in R mode, and visually reading the TEC display.

EXAMPLES

"TEC:SET:R?" -response: 3.4, means the R set point is 3.400 Kohms, or 3.40 uA, or 3.4 mV, depending on the SENSOR SELECT switch position.

"Tec:Set:R?" -response: 4.0, means the R set point is 4.000 Kohms, or 4.00 uA, or 4.0 mV, depending on the SENSOR SELECT switch position.

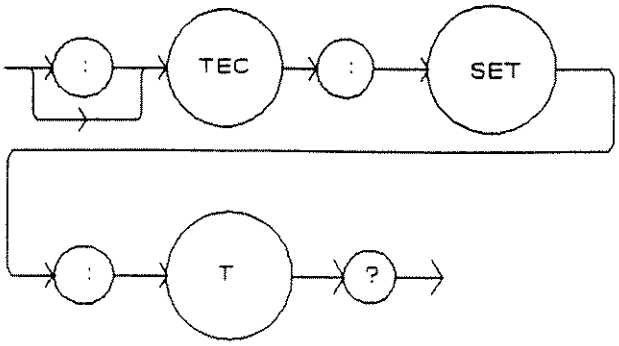
■ Front Panel

■ Remote

TEC:SET:T?

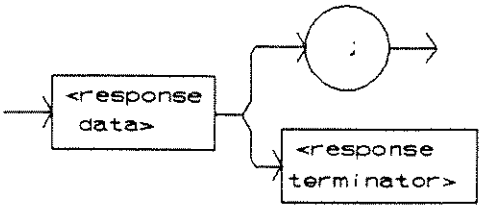
The TEC:SET:T? query returns the TEC constant temperature set point value, in °C.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response <nrf value> represents the set point temperature, in °C.

POINTS OF INTEREST

The TEC output is controlled to this set point value only when constant T mode is in effect.

In local operation, the T set point value is read by pressing the (TEC DISPLAY) SET switch while in T mode, and visually reading the TEC display.

EXAMPLES

"TEC:SET:T?" -response: 33.4, means the constant T set point is 33.4°C.

"Tec:Set:t?" -response: -4.0, means the constant T set point is -4.0°C.

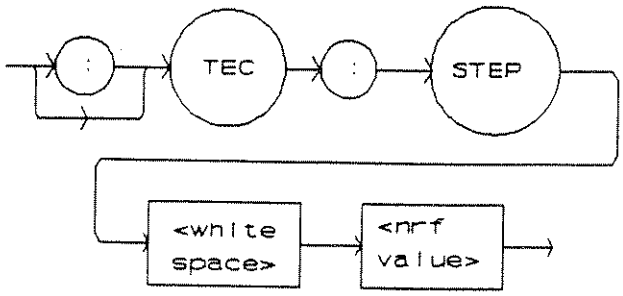
□ Front Panel

■ Remote

TEC:STEP

The TEC:STEP command is used to increment or decrement the selected TEC control mode set point by the given amount, when used with the TEC:INC or TEC:DEC command.

SYNTAX DIAGRAM



PARAMETERS

An integer value of the step amount, in the range 1 - 9999.

POINTS OF INTEREST

The step of 1 corresponds to the smallest incremental change of the mode. For example, a step of 1 means 0.1°C, 1 ohm, 0.01 uA (AD590), 0.1 mV (LM335), or 1 mA (ITE mode).

EXAMPLES

"TEC:Mode:t; TEC:t 20; TEC:Step 10; TEC:Inc; TEC:Set:t?" -sets the step to 1°C, so the TEC:Set:t? query will return a value of 21 mA.

"Tec:Step 100" -sets the step size to 100; could mean 10.0°C, 100 ohms, 1 uA (AD590), 10 mV (LM335), or 100 mA (ITE mode).

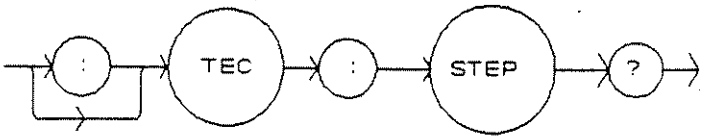
□ Front Panel

■ Remote

TEC:STEP?

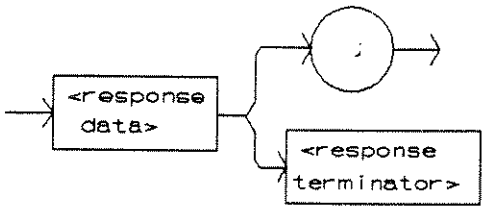
The TEC:STEP? query is used to read back the TEC STEP value. This value is used to increment or decrement the selected TEC control mode set point by the given amount, when used with the TEC:INC or TEC:DEC command.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The step of 1 corresponds to the smallest incremental change of the mode. For example, a step of 1 means 0.1 °C, 0.001 Kohm, 0.01 uA (AD590), 0.1 mV (LM335), or 1 mA.

EXAMPLES

"TEC:Mode:T; TEC:Step?" -response: 2, means the step size is 0.2°C. This value is in tenths of a degree C, since Const T mode is in effect.

"Tec:MODE:R; TEC:STEP?" -response: 40, means the step size is 40 ohms, assuming the SENSOR SELECT switch is in the 100 or 10 uA position. This value is in ohms, since Const R mode is in effect and a thermistor sensor is selected.

"Tec:MODE:ITE; Tec:STEP?" -response: 20, means the step size is 20 mA. This value is in mA, since Const ITE mode is in effect.

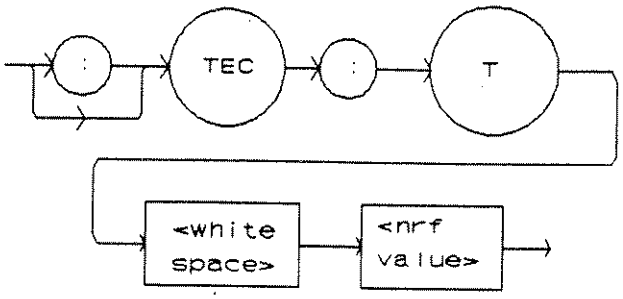
■ Front Panel

■ Remote

TEC:T

The TEC:T command sets the TEC's constant temperature setpoint.

SYNTAX DIAGRAM



PARAMETERS

An <nrf value> which represents the TEC temperature, in °C.

POINTS OF INTEREST

The TEC temperature will be controlled to this set point only when the TEC is operated in T mode.

In local operation, the R set point is entered by selecting (ADJUST) TEC and R modes, pressing the (TEC DISPLAY) SET switch, adjusting the ADJUST knob (within 3 seconds), and then releasing the SET switch when the desired value is shown on the TEC display.

EXAMPLES

"Tec:T 20" -action: sets the TEC temperature set point to 20.0°C.

"TEC:MODE:T; TEC:T 25.3" -action: sets the TEC temperature set point to 25.3°C. The output is controlled to this value, if the output is on.

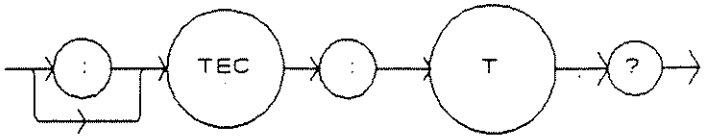
■ Front Panel

■ Remote

TEC:T?

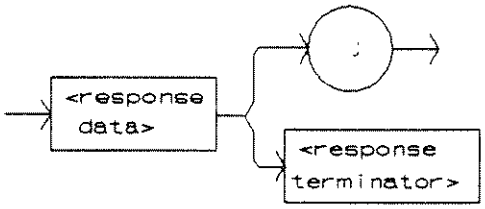
The TEC:T? query returns the value of the TEC temperature measurement.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is an <nrf value>.

POINTS OF INTEREST

The measured TEC temperature is valid for all modes of TEC operation. Temperature is continually updated.

This measurement is updated approximately once every 400 mSec.

In remote operation, the response value has 6 digits of precision.

In local operation, the T measured value is determined by pressing the T switch in the TEC DISPLAY area of the front panel, and visually reading the value on the TEC display.

EXAMPLES

"TEC:T?" -response: 10.4231, means the measured TEC load temperature is 10.4231°C.

"Tec:Mode:R; Tec:T?" -response: -3.0778, means the measured TEC load temperature is -3.07780°C.

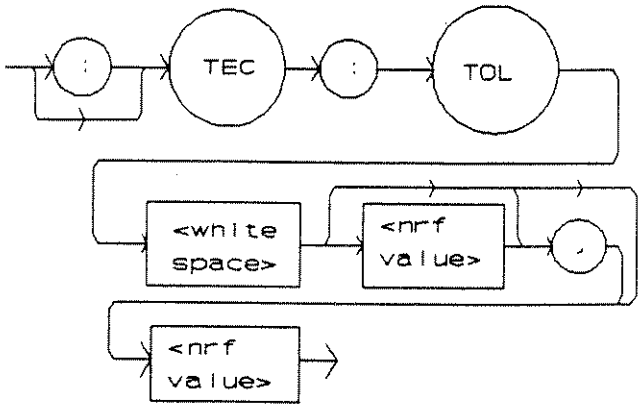
□ Front Panel

■ Remote

TEC:TOLerance

The TEC:TOLerance command allows the programmer to determine the TEC temperature tolerance, and time window for it to occur, in order that the operation complete flag be set after a "TEC:OUTput 1" command is issued or the set point is changed.

SYNTAX DIAGRAM



PARAMETERS

Two <nrf values>; the first represents the temperature tolerance, in °C, with a range of 0.1°C to 10.0°C; and the second represents the time window, in seconds, with a range of 0.001 to 50.0 seconds.

This command may be used in conjunction with the common query *OPC? and common command *WAI to delay further program activities until the TEC temperature reaches its set point to the specifications of the TEC:TOLerance command.

For example, if the set point is 10°C, tolerance is 0.2°C for 5 seconds, and the TEC output is turned on, the user may issue the *WAI command to ensure this set point is reached before continuing. In this case, the 3722 will wait until its TEC load temperature is within 0.2°C of 10°C for a period of 5 seconds before the next command is executed.

POINTS OF INTEREST

The 3722 defaults to a tolerance of 0.2°C for 5 seconds, unless changed by the TEC:TOLerance command.

WARNING: If the tolerance is set too tight, the output may never reach tolerance, and the Operation-Complete flag (see *OPC, Chapter 4) may never be set.

Continued on next page.

TEC:TOLerance

Continued from previous page.

POINTS OF INTEREST

In R mode the temperature and time parameters are both in effect, as in T mode.

In ITE mode, the temperature parameter is not used. A fixed value of 10 mA is used instead of the temperature parameter, and only the time window may be adjusted.

EXAMPLES

"Tol 0.5,10" -action: the 3722's TEC controller will be in tolerance when the temperature is within 0.5°C for a period of 10.000 seconds.

"TOLer 0.1,1.05" -action: the 3722's TEC controller will be in tolerance when the temperature is within 0.1°C for a period of 1.050 seconds.

"TEC:MODE:ITE; TOLer ,10" -action: the 3722's TEC controller is set for ITE mode, and will be in tolerance when the ITE current is within 10 mA for a period of 10.000 seconds.

"Tec:Mode:R; TOLer 0.1,2.5" -action: the 3722's TEC controller will be in tolerance when the temperature is within 0.1°C for a period of 2.500 seconds.

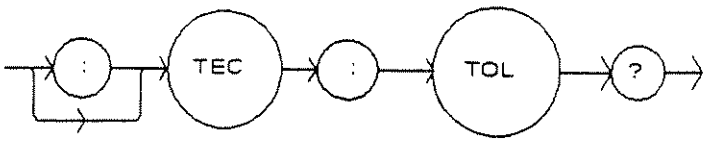
□ Front Panel

■ Remote

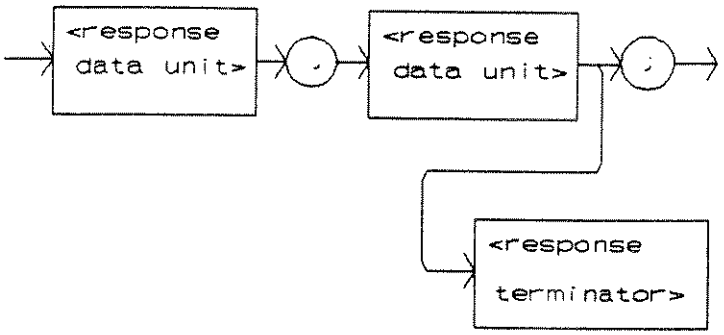
TEC:TOLerance?

The TEC:TOLerance? query allows the programmer to determine how the TEC temperature tolerance is set.

SYNTAX DIAGRAM



PARAMETERS None. The response will be in the form:



-where the response consists of two data units, the first represents the temperature tolerance, in °C, and the second represents the time window, in seconds.

POINTS OF INTEREST

The tolerance of the 3722 temperature controller may be used to delay programming after an "TEC:OUTput 1" command is issued or the set point is changed.

The TEC tolerance specification is also used in the TEC status event and condition registers, and so entering or exiting TEC temperature tolerance may be used to generate service requests.

EXAMPLES

"Tec:Tol?" -response: "0.2,5", means the 3722 has a TEC tolerance setting of 0.2°C with a time window of 5.000 seconds.

"TEC:TOL?" -response: "1.0,20", means the 3722 has a TEC tolerance setting of 1.0°C with a time window of 20.000 seconds.

□ Front Panel

■ Remote

TERM

The TERM command allows the programmer to select the message terminator type for GPIB messages. <CR> (carriage return), <CR><NL> (new line), <CR><^END> (EOI), <CR><NL><^END>, <NL><^END>, <NL>, and <^END> are allowed.

SYNTAX DIAGRAM

PARAMETERS

An <nrf value>, where 0 = <CR><NL><^END>, 1 = <CR><NL>, 2 = <CR><^END>, 3 = <CR>, 4 = <NL><^END>, 5 = <NL>, 6 = <^END>, and 7 = No terminators are appended.

POINTS OF INTEREST

<CR><NL><^END> (0) is the default type.

EXAMPLES

"TERM 5" -action: the <NL> (new line) terminator is selected. The 3722 will terminate a message with the <NL> character.

"Term 4" -action: the <NL> (new line) <^END> (EOI) terminator is selected. The 3722 will terminate a message with the <NL><^END> characters, in succession, and in that order.

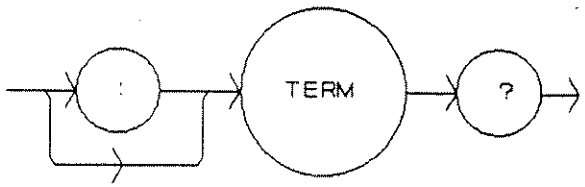
□ Front Panel

■ Remote

TERM?

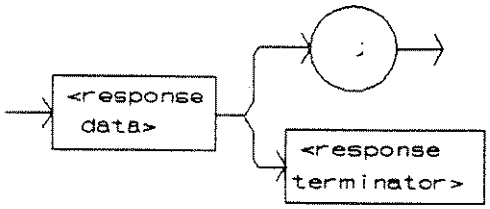
The TERM? query allows the programmer to determine which program message terminator is currently selected. <CR> (carriage return), <CR><NL> (new line), <CR><^END> (EOI), <CR><NL><^END>, <NL><^END>, <NL>, and <^END> are allowed.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



where 0 = <CR><NL><^END>, 1 = <CR><NL>, 2 = <CR><^END>, 3 = <CR>, 4 = <NL><^END>, 5 = <NL>, 6 = <^END>, and 7 = No terminators are appended.

POINTS OF INTEREST

<CR><NL><^END> (0) is the default type.

Although the <CR> is recognized as <white space> by the IEEE-488.2 standard, it is used as a possible terminator in order to be compatible with our old products' command syntax.

EXAMPLES

"Term?" -response: 0, means the selected program message terminator is the <CR><NL><^END> characters, in succession, in that order.

"TERM?" -response: 2, means the selected program message terminator is the <CR><^END> characters, in succession, and in that order.

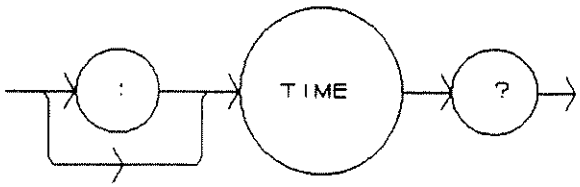
□ Front Panel

■ Remote

TIME?

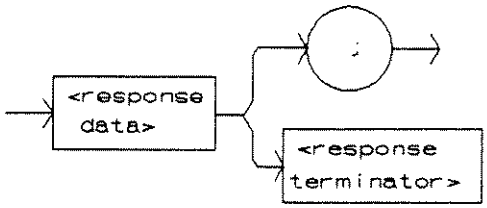
The TIME? query allows the programmer to determine how much time has passed since the 3722 was last powered up.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is character data in the form: hours:minutes:seconds.

POINTS OF INTEREST

The TIME clock is independent of the TIMER clock.

EXAMPLES

"Time?" -response: 1:02.36, means that 1 minute and 2.36 seconds have passed since the 3722 was powered up.

"TIME?" -response: 32:00:76, means that 32 minutes and 0.76 seconds have passed since the 3722 was powered up.

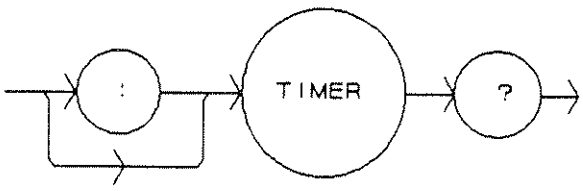
□ Front Panel

■ Remote

TIMER?

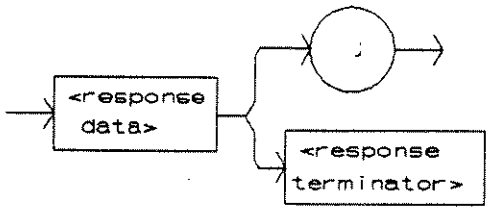
The TIMER? query allows the programmer to determine how much time has passed since the last TIMER? query was issued.

SYNTAX DIAGRAM



PARAMETERS

None. The response will be in the form:



-where the response is character data which represents hours:minutes:seconds.

POINTS OF INTEREST

Each time the TIMER? query is issued, the timer is reset to 0 and the elapsed time since the last TIMER? query is returned.

The timer counter is initially set at power-up, the same as the TIME? counter. So the first time the TIMER? is issued its response will be the same as if a TIME? query's response.

EXAMPLES

"Timer?" -response: 00:02:00.31, means the 3722 has been on for 2 minutes and 0.31 seconds since the last TIMER? query was issued.

"TIMER?" -response: 00:00:12.03, means the 3722 has been on for 12.03 seconds since the last TIMER? query was issued.

3.5 Error Messages

Error messages may appear on the TEC or LASER displays when error conditions occur in the respective functions of the 3722. For example, a current limit error in the TEC side of the 3722 will be displayed on the TEC display.

In most cases, the error message will appear for three seconds and then the display will revert to its former state. In the case of multiple error messages, the 3722 will show each message for three seconds in succession.

In remote operation, the current error list can be read by issuing the "ERR?" query. When this is done, a string will be returned containing the previously unread error messages (up to 10) which are currently in the error message queue.

Appendix D contains an explanation of the error messages which may be reported by the 3722 on the displays or via remote operation.

3.6 3722 Programming Examples

This section is intended as a simple example of programming the 3722 over the GPIB. The first short examples contain sections of a BASIC program. These examples are not complete programs, and therefore cannot be used by themselves. However, they illustrate the simplicity of programming the 3722, and show some possible uses of its features, but the initialization of variable and files has been omitted for simplicity. The last example contains a complete BASIC program which uses both the TEC and LASER controller of the 3722 to gather L/I data at varying temperatures.

The following BASIC programming example, Example Program 3.1, exercises the TEC controller of the 3722, and it demonstrates the DELAY, and TEC:STEP commands.

This example assumes that the 3722's LASER controller is set up for measuring laser light power. It also assumes the use of a subroutine for talking to the 3722 over the GPIB. This subroutine is shown in Example Program 3.3.

```
200  CMD$ = "Tec:Const 1.125,2.347,0.855" : GOSUB 1000     'Set constants for typical 10K thermistor
210  CMD$ = "Tec:Gain 10" : GOSUB 1000                     'Set control loop gain
220  CMD$ = "Tec:Step 100; Tec:Mode:T" : GOSUB 1000        'Temperature mode, with 10°C  step
230  CMD$ = "Tec:T 0; Output ON" : GOSUB 1000              'Start laser temperature at 0°C
240  FOR X=1 TO 10                                         'Step temperature from 0 to 100 °C
250    CMD$ = "Delay 20000; Las:P?; Tec:Inc" : GOSUB 1000  'Wait 20 seconds for temperature to
260    INPUT#2,P$                                          'stabilize, measure laser light power,
270                                                        'and increment laser temp. by 10°C
280  NEXT X                                                '
```

Example Program 3.1 TEC Step and Delay

The following BASIC programming example, Example Program 3.2, exercises the LASER controller of the 3722, and it demonstrates the use of the LAS:CALPD, LAS:MODE:P, and LAS:P? commands for working in constant optical power mode.

This program example assumes that a laser and a monitor photodiode detector are properly installed, and the detector responsivity is known to be 1.2 uA/mW. It also assumes the use of a subroutine for talking to the 3722 over the GPIB. This subroutine is shown in Example Program 3.3.

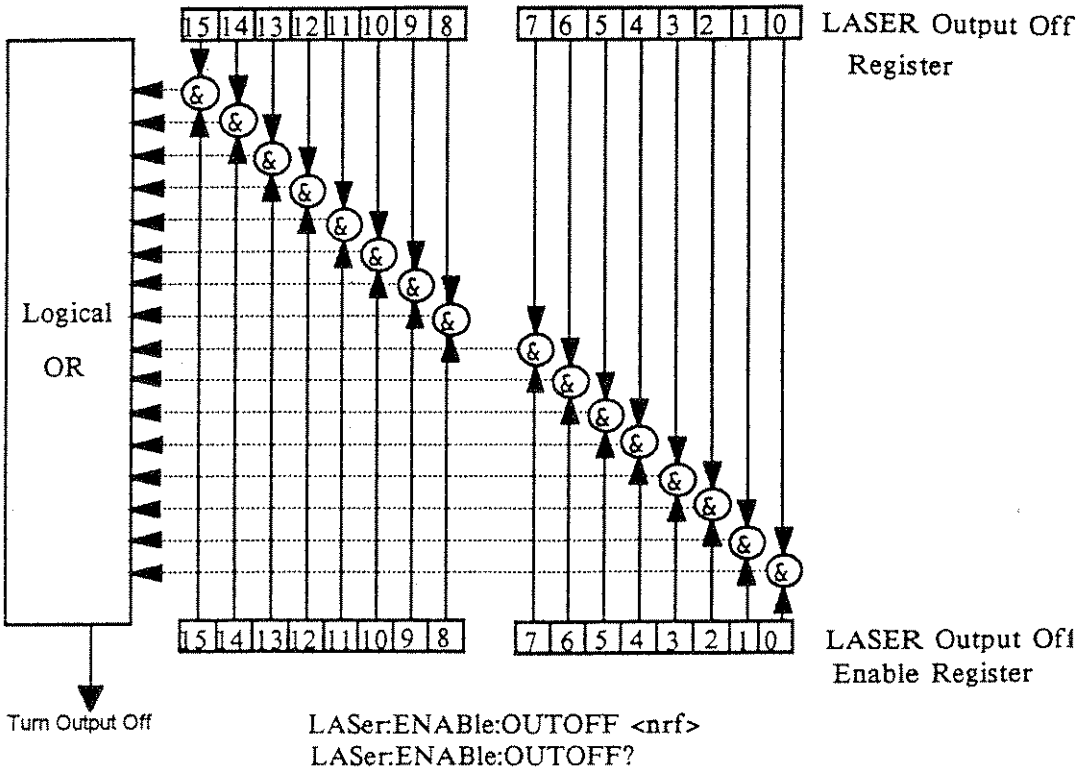
```
300 CMD$ = "Las:Calpd 1.2" : GOSUB 1000                    'Set the detector responsivity to 1.2 uA/mW
310 CMD$ = "Las:Output OFF; Las:Mode:P" : GOSUB 1000       'Output off; set to constant power mode
320 CMD$ = "Las:Ran 1; Las:Lim:I1 100" : GOSUB 1000        'Set output range to 1 A, limit to 100 mA
330 CMD$ = "Las:Output ON" : GOSUB 1000                    'Turn LASER output on
340 FOR X=1 TO 50                                          'Take 50 measurements
350   CMD$ = "Delay 1000; Las:P?" : GOSUB 1000             'Wait 1 second between readings
360   INPUT#2,P$                                           'Input is monitor photodiode power, in mW
370 NEXT X                                                 '
```

Example Program 3.2 LASER Constant Optical Power Measurement

The following example program, Example Program 3.3, is a BASIC program for use with the LDC-3722. It may be used to gather L/I data (laser output vs. drive current) at several different stabilized temperatures.

```
10  '                    * * *  L/I vs TEMP  * * *
20  '
30  'This program measures laser light output vs. drive current over several temperatures.
40  'It is intended for use with an LDC-3722, an IBM PC/XT or compatible using an IOTech
50  'GP488 controller cand and PERSONAL488 software (IOTech, P.O.Box 21204, Cleveland,
60  'OH 44121). This program assumes that the GPIB address of the 3722 is "01".
70  '
80  'This program was written in GWBASIC (Microsoft Corp.)
90  '
100 '---------- INITIALIZE PROGRAM PARAMETERS ----------
110 '
120 'AD$ = "01"                                            'Set GPIB address for 3722
130 'OUT$ = "OUTPUT"                                       'Used in output subroutine
140 '
200 '---------- INITIALIZE THE GPIB DEVICE DRIVERS ----------
210 '
220 OPEN "\DEV\IEEEOUT" FOR OUTPUT AS #1
230 OPEN "\DEV\IEEEIN" FOR INPUT AS #2
240 IOCTL#1,"BREAK"                                        'Clear driver
250 PRINT#1,"RESET"
260 CMD$ = "*RST" : GOSUB 1000                             'Reset the 3722 to default values
270 '
300 '---------- INITIALIZE THE OUTPUT/PRINT HEADER ----------
310 '
320 CLS                                                    'Clear the screen
330 '
```

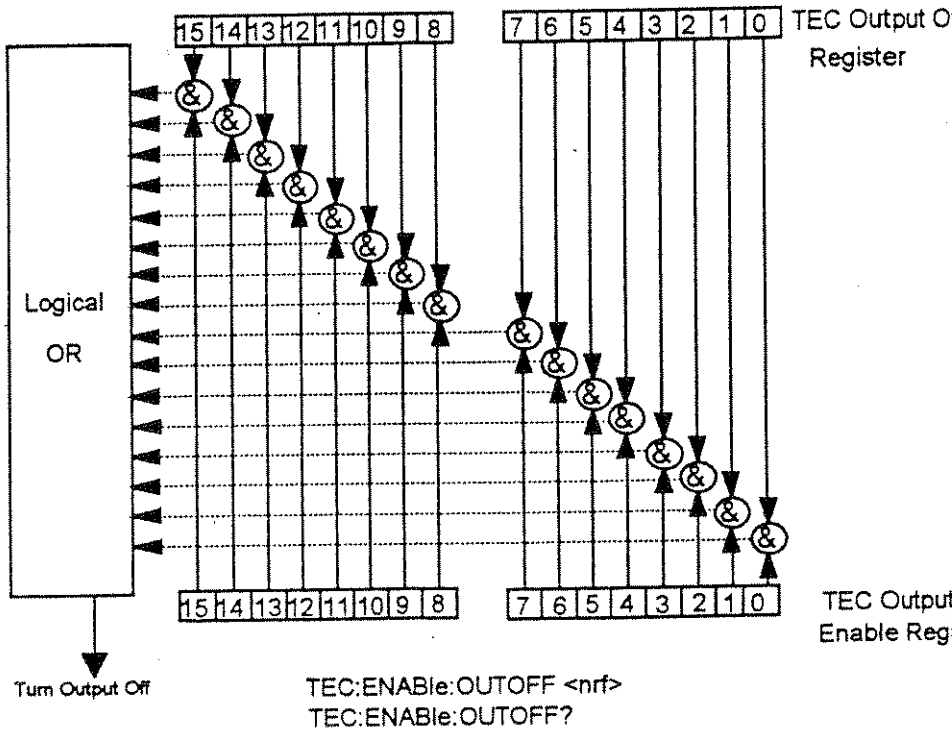
Example Program 3.3 L/I vs Temperature



Bit Reference

0- LASER Current Limit	8- N/A
1- LASER Voltage Limit	9- LASER Output Changed to be out of Tolerance
2- N/A	10- TEC Output is Off Event
3- LASER Power Limit (output on)	11- TEC High Temperature Limit Condition
4- N/A	12- Hardware Error
5- N/A	13- N/A
6- N/A	14- N/A
7- LASER Open Circuit (output on)	15- N/A

Figure 3.12 LDC-3700 Series Laser Diode Controller LASER Output Off Register



Bit Reference

0- TEC Current Limit
1- TEC Voltage Limit
2- N/A
3- High Temperature Limit
4- N/A
5- Booster Changed (while output on) Eve.
6- Sensor Open (while output on) Cond.
7- TEC Module Open (output on) Cond.
8- Sensor Type Change (while output on) E
9- Outside of TEC Tolerance Cond.
10- Sensor Shorted (while output on) Cond
11- N/A
12- Software Error Cond.
13- N/A
14- N/A
15- N/A

Figure 3.13 LDC-3700 Series Laser Diode Controller TEC Output Off Register

LDC-3700 OUTPUT OFF REGISTERS' DEFAULT SETTINGS

LASER Output Off Register		TEC Output Off Register	
0- disabled	8- N/A	0- disabled	8- enabled
1- disabled	9- disabled	1- disabled	9- disabled
2- N/A	10- disabled	2- N/A	10- enabled
3- enabled	11- enabled	3- enabled	11- N/A
4- N/A	12- disabled	4- N/A	12- disabled
5- N/A	13- N/A	5- enabled	13- N/A
6- N/A	14- N/A	6- enabled	14- N/A
7- enabled	15- N/A	7- enabled	15- N/A

Table 3.2 LDC-3700 Series Default Settings for Output Off Registers

```
340 PRINT " * * * *  LASER OUTPUT vs. DRIVE CURRENT at 10 DEGREE C STEPS  * * *"
350 PRINT
360 PRINT " Temperature     Drive Current     Output"
370 PRINT "      (C)              (mA)          (mW)"
380 PRINT " ========  ========  ======"
390 '
400 '-------------------- INITIALIZE LDC-3722 ----------------------------------------------------
410 '
420 CMD$ = "Tec:Tol 0.5,0.5" : GOSUB 1000                    'Set the tolerance to 0.5°C  for 0.5 seconds
430 CMD$ = "Tec:Gain 100" : GOSUB 1000                       'Set control loop gain
440 CMD$ = "Tec:Step 100; Tec:Mode:T" : GOSUB 1000           'Temperature mode, with 10°C  step
450 CMD$ = "Tec:T 30; Output ON" : GOSUB 1000                'Start laser temperature at 30°C
460 CMD$ = "Las:Tol 1,0.4" : GOSUB 1000                      'Set the tolerance to 1 mA for 0.4 seconds
470 CMD$ = "Las:Ran 1; Las:Lim:I1 520" : GOSUB 1000          'Set output range to 1 A, limit to 520 mA
480 CMD$ = "Las:Step 500; Las:Output ON" : GOSUB 1000        'Turn LASER output on, and set 5 mA step
490 '
500 '----------------------- TAKE DATA ----------------------------------------------------------
510 '
520 FOR X=1 TO 3                                            'Gather data over 3 temperatures
530   '
540   CMD$ = "Las:I 0; *WAI" : GOSUB 1000                   'Reset output to 0 mA; wait for temperature
550                                                          'and current to reach tolerance levels
560   FOR Y=1 TO 100                                         'Step drive current from 0 to 500 mA
570     '
580     CMD$ = "Las:Inc; *WAI" : GOSUB 1000                  'Wait until drive current is within tolerance
590     CMD$ = "Las:Ipd?" : GOSUB 1000                       'Take the monitor photodiode current measurement
600     INPUT#2,L$                                           'Input the value
610     CMD$ = "Las:I?" : GOSUB 1000                         'Take the drive current measurement
620     INPUT#2,I$                                           'Input the value
630     CMD$ = "Tec:T?" : GOSUB 1000                         'Take the temperature measurement
640     INPUT#2,T$                                           'Input the value
650     '
700     '------------------------ PRINT OUT RESULTS ---------------------------------
710     '
720     T = VAL(T$) : I = VAL(I$) : L = VAL(L$)              'Convert data types
720     IMAGE$ = "   ###.#     ###.##          ###.##"
730     PRINT USING IMAGE$;T,I,L
740     '
750   NEXT Y
760   '
770   CMD$ = "Tec:Inc" : GOSUB 1000                          'Increment the temperature
780   '
790 NEXT X
800 '              '
810 '------------------------------------ DONE ------------------------------
820 '
830 CMD$ = "Las:Output OFF; Tec:Output OFF"                  'Turn off outputs
840 END
850 '
1000 '------------------------------- OUTPUT SUBROUTINE ----------------------------
1010 '
1020 PRINT#1,OUT$;AD$;CMD$ : RETURN                          'Output the command; and return
```

Example Program 3.3 L/I vs Temperature (Cont.)

Chapter 4

GPIB/IEEE-488.2 REMOTE OPERATION

4.1 Introduction

When the model 1231 GPIB/IEEE-488.2 interface is installed and the instrument is connected to a host computer, the LDC-3722 can be used as a remotely controlled laser diode testing instrument. Possible applications include automatic L/I curve data gathering over a range of controlled temperatures.

In remote operating mode, the 3722 offers all of the features accessible from the front panel and some advanced features which can only be accessed via the interface bus. In remote mode you have access to commands for functions not found on the front panel, such as the STEP command which automatically increments or decrements the set point by a user-defined step value, calculation of measured temperature to 6-digit resolution, and control of the conditions which cause the TEC and LASER controller outputs to be shut off.

The model 1231 GPIB/IEEE-488.2 interface allows GPIB/IEEE-488.2 bus control of the LDC-3722. Information can also be read by the host computer and printed or stored. Other features include:

* A concise and straight-forward command set
* Full talk/listen capability
* Full serial poll capability, with SRQ
* Full local/remote capability including LOCAL LOCKOUT
* Meets ANSI/IEEE-488.2-1987 standards

This chapter is a guide to the syntax and usage of the various IEEE/488.2 common commands available for the 3722. It also includes advanced programming tips for remote use with the device-dependent commands, hardware diagrams, and other information relating to remote operation.

This chapter is divided into three parts. The first part has the information for using the GPIB with the 3722. It also has sections for each common GPIB (ANSI/IEEE-488.2) command which is supported by the 3722. The second part contains information on advanced programming techniques, and status reporting. The third part contains information on remote interface messages; these low-level messages are generally transparent to the user.

4.1.1 Preparation for Bus Control

To use the LDC-3722 remotely, you will need to install an IEEE-488 interface adapter in your host computer. These adapters and support software are available from several manufacturers and can be installed in most computers. This manual assumes that you have a basic knowledge of the GPIB/IEEE-488 interface bus and how to use it for instrument control. This chapter also assumes that you are familiar with the controls on the LDC-3722. Review Chapter 2 if you need more details on how to operate the LDC-3722.

The talk and listen addresses on the 3722 are identical. This GPIB address is read locally by pressing the GPIB LOCAL switch and reading the display. To set the GPIB address, press and hold in the (PARAMETER) SET switch while displaying the GPIB address. Turn the ADJUST knob until the desired address value is displayed, then release the SET switch. The new GPIB address will then be stored in non-volatile memory, independent of the SAVE and RECALL "bin" number. The allowable address range is 0 - 30 for primary GPIB addressing. It is not normally possible to exceed this range. However, if the GPIB address were to exceed 30, it will not hang up the bus. If the GPIB address is ever displayed as a value greater than 30, service of the 3722 would be required, since this value is normally limited by the 3722's firmware. Extended GPIB addressing is not implemented on the 3722 at this time.

4.2 Getting Started with GPIB

This section is intended as a quick guide to the GPIB syntax and commands used by the 3722. The 3722's unique (device-dependent) commands are described in Chapter 3.

4.2.1 Overview of the 3722 Syntax

Generally, a command or query is entered (spelled) as shown in Table 3.1. Upper or lower case may be used in any combination, but the command/query MUST contain all of the letters which are shown in upper case in Figure 3.2 and Table 3.1. The lower case letters shown with the commands in Section 3.4 are optional, and may be used for clarity. For example, the following commands are equal,

"TEC:DIS 1", "tec:DISPLAY 1", and "Tec:Disp 1".

The syntax of the 3722 commands follows the rules laid out in the IEEE-488.2 standard. Semicolons (:) indicate the start of a new command path, while semicolons (;) indicate a separation of commands within a command string. A leading semicolon on a command may be used to return the 3722 command parser to the command path root (see Figure 3.2).

Spaces or white space (see Section 4.6.2 for a definition of white space) may be placed anywhere in a command string (after the command header or query question mark), and must be used to separate the command (header) from the first parameter (or program data). The following examples show valid syntax for commands with the 3722:

```
"TEC:MODE:t; TEC:T 25; TEC:Const 1, 2, 3.5; TEC:OUT 1"
":TEC:DIS 1; tec:set:t?;
"Laser:limit:i1 40"
"LAS:display:i"
```

The following are examples of invalid syntax for the 3722. These command strings would produce an erroneous result, as explained:

"TEC:MODE T"	-Missing colon, MODE? expected
"TEC:MODE:R DEC"	-Missing semicolon, DEC command generates an error
"LAS:DIS ?"	-Space not allowed before question mark, DIS command expected.
"Las:I33;dis?"	-Space missing between I command and the parameter value, 33.

4.2.2 Using Commands with Parameters

Some commands expect a parameter. For example, if the temperature set point is to be entered, the command could be "TEC:T 30". This would set the 3722's set point temperature to 30°C. If a single parameter is expected, it should follow the command with at least one space between the command and the parameter.

The nominal value for on/off parameters is 1 = on, 0 = off. For example, the command:

"TEC:Display:Set 1" -turns the set point display on, and

"TEC:Display:Set 0" -turns the set point display off.

The words "on" and "off" may be substituted in the above example:

"TEC:Display:Set On" -turns the set point display on, and

"TEC:Display:Set OFF" -turns the set point display off.

For more information on parameter name substitutions, see Section 3.2.1.

If multiple parameters are expected, they should be separated with commas. For example, to set the Steinhart-Hart constants on the 3722 (C1, C2, and C3) the following command could be sent:

"TEC:CONST 1.111, 2.004, 0.456".

If not all of the parameters need to be changed, i.e. C2 only, the other parameters may be omitted as in:

"CONST ,2.004, "

A query has no space between the mnemonic and the question mark, as in:

"LAS:I?"

The 3722 uses a default terminator of carriage return (CR) - new line (line feed) - end of input (EOI). In almost all cases, these terminators are automatically inserted by the host (user's) computer or GPIB driver. The terminator can be user-selected by issuing the "TERM" command. For more information, see Section 4.6.5 or the IEEE-488.2 standard definition.

4.3 Common Commands and Queries

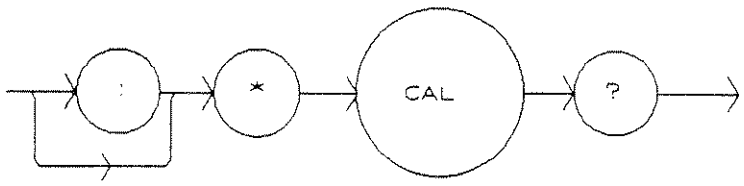
This section contains a list of the common commands and queries which are supported by the 3722. The common commands and queries are distinguished by the * which begins each mnemonic. The common commands and queries are listed in alphabetical order, and a brief description of their functions is given. For more information on these commands, refer to an ANSI/IEEE 488.2-1987 standards reference.

4.3.1 *CAL?

This is the calibration query. When it is sent, the 3722 performs the TEC and LASER controllers' A to D calibration procedure. After this query is sent, the 3722 responds with a message indicating that calibration has been completed successfully or unsuccessfully. A response of 0 means no errors, any other number means an error in calibration was detected.

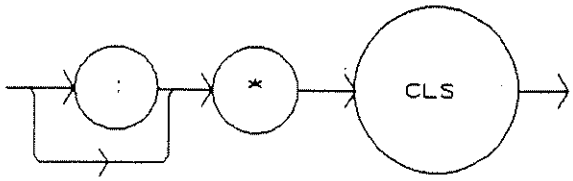
An auto-calibration is performed each time the 3722 accumulates 1 minute of inactive time since the last auto-calibration.

The syntax for the *CAL? query is:



4.3.2 *CLS

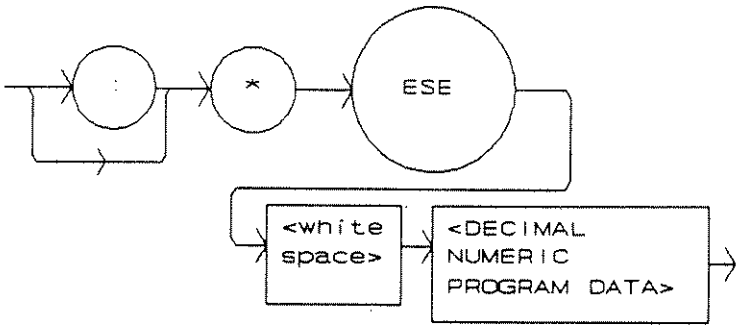
This is the Clear Status command. It is used to clear the status event registers. It may be used, for example, to clear the TEC Event Status Register, the LASER Event Status Register, the Standard Event Status Register, and the Error Queue before enabling SRQ generation from instrument events. The syntax for the *CLS command is:



4.3.3 *ESE

This is the Standard Event Status Enable command. This command enables the Standard Event Status Register to update bit 5 of the status byte. The Structure of the Standard Event Status Enable Register and Standard Event Status Register are shown in Figure 4.1. The contents of these two registers is logically ANDed then the bits are ORed to get the Event Summary Bit message.

The syntax for the *ESE command is:



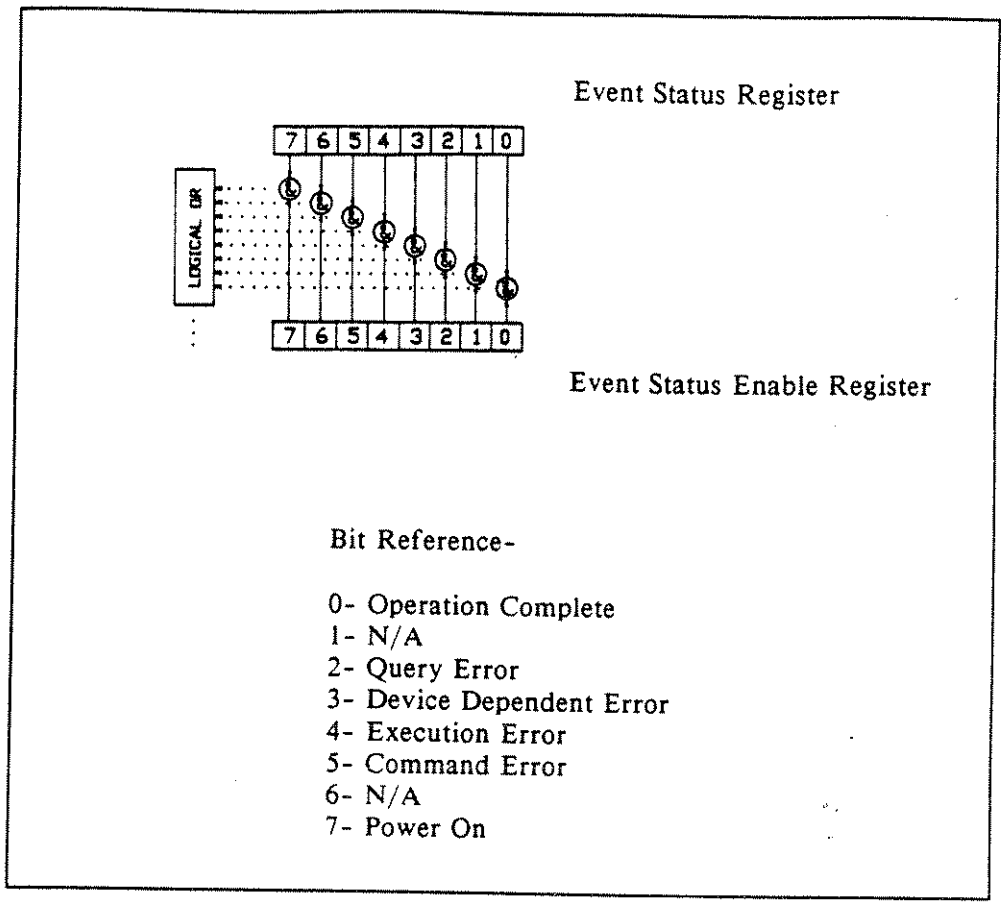


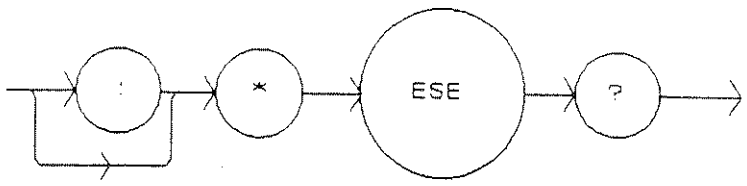
Figure 4.1 Standard Event Status Register/Standard Event Status Enable Register

Setting bit 0 allows the user to poll or generate SRQ from any overlapped commands after any previous operations are completed. This may be useful for ensuring that an operation, such as TEC output on and within tolerance, is complete before a measurement is made. Although this could be performed without using service requests, an interrupt-driven program makes more efficient use of the GPIB than polling or waiting (*WAI) routines. (See also Section 4.7.2).

4.3.4 *ESE?

This query will cause the 3722 to return the value of the Standard Event Enable Register. This allows the user to determine which status bits can set the summary bit (bit 5) in the status byte register. The response will be the sum of all of the enabled bits, as represented in Figure 4.1.

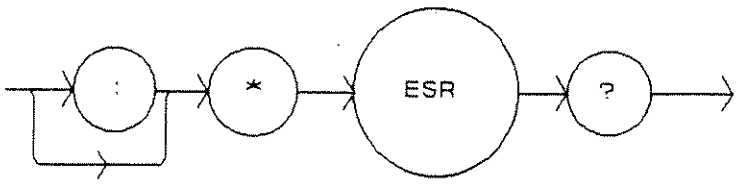
The syntax for the *ESE? query is:



4.3.5 *ESR?

This query will cause the 3722 to return the value of the Standard Event register. This allows the user to determine which type of error has occured, for example. The value of the response will be the sum of the bits as represented in Figure 4.1.

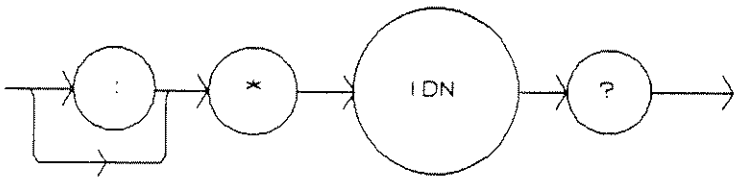
The syntax for the *ESR? query is:



4.3.6 *IDN?

This query will cause the 3722 to return the following identification string: ILX,LDC-3722,(7-digit serial number),(2-digit software version number). This identifies the specific device for the user. The manufacturer, model, serial number, and version number are listed in order.

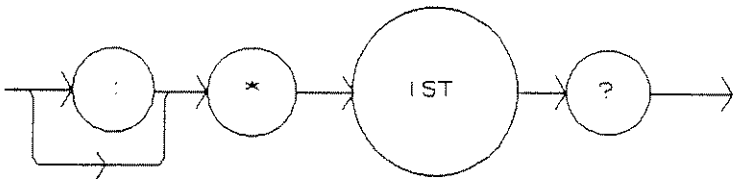
The syntax for the *IDN? query is:



4.3.7 *IST?

The Individual Status query allows the user to read the current state of the IEEE-488.1 'ist' local message in the 3722. The response is a 1 or 0. A '1' indicates that the message is true, and a '0' indicates that the message is false.

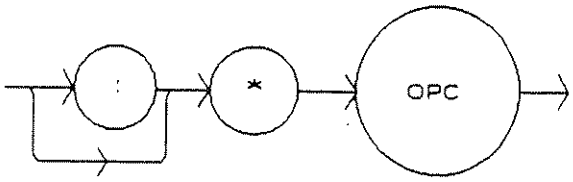
The syntax for the *IST? query is:



4.3.8 *OPC

The *OPC command causes the 3722 to generate the operation complete message in the Standard Event Status Register when all pending overlapped commands have been completed.

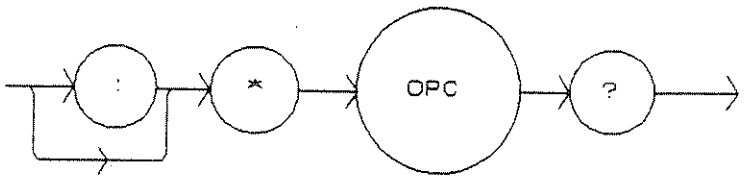
The syntax for the *OPC command is:



4.3.9 *OPC?

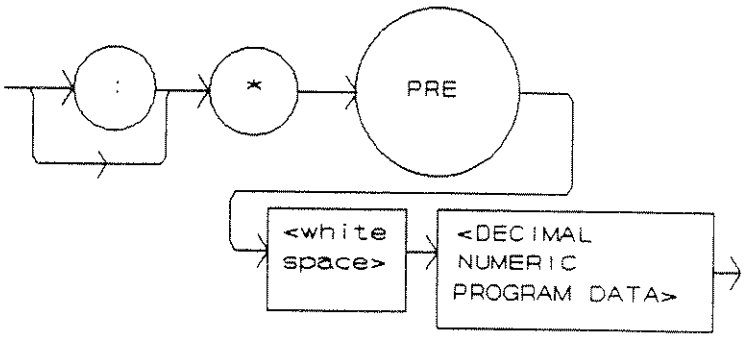
This query places an ASCII character 1 into the 3722's Output Queue when all pending operations have been finished. (See also Section 4.7.2)

The syntax for the *OPC? query is:



4.3.10 *PRE

This is the Parallel Poll Register Enable command. It sets the parallel poll register enable bits for the format required by the 3722 in order that it may participate in parallel polling from the controller. The syntax of this command is:



where- the value of the data must round off to an integer value between 0 and 65535

the value of the data corresponds to the sum of all of the enabled bits desired for parallel polling (see Figure 4.2).

The Parallel Poll Enable Register is ANDed with the Status Byte Register. This result is ORed to form the ist (individual status) local message, as seen in Figure 4.2.

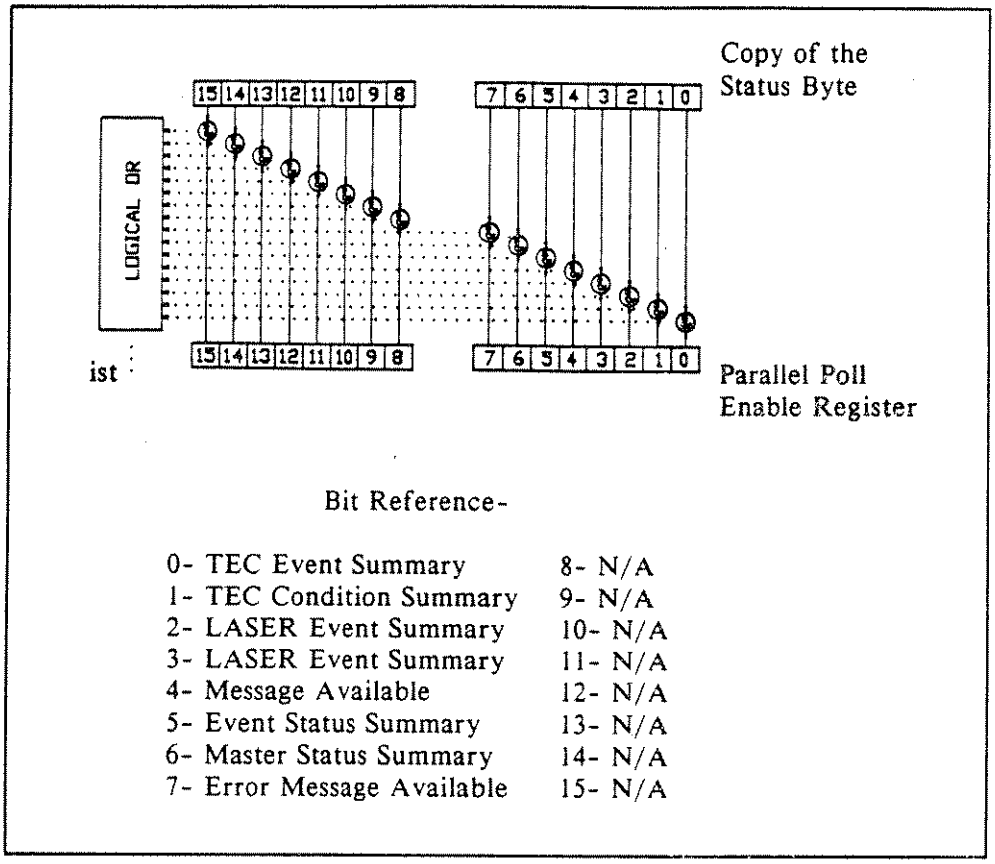
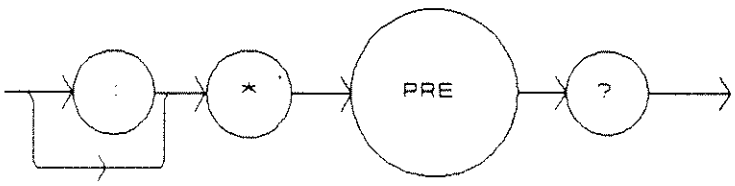


Figure 4.2 Parallel Poll Response Handling Data Structure

4.3.11 *PRE?

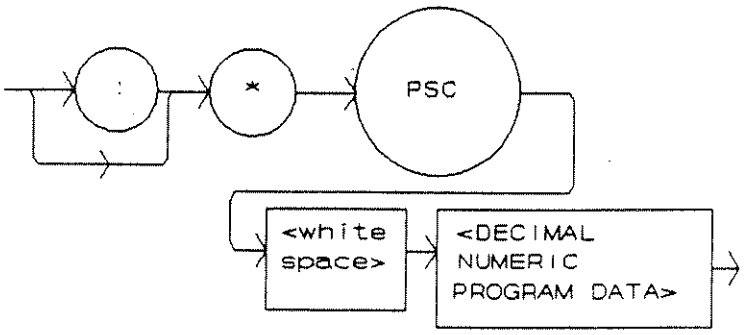
This query allows the programmer to determine the contents of the Parallel Poll Enable Register. The response will be the sum of the register bits, as represented in Figure 4.2.

The syntax for the *PRE? query is:



4.3.12 *PSC

The Power-on Status Clear command controls the automatic power-on clearing of the Service Request Enable Register, the Standard Event Status Enable Register, the TEC Event Status Enable Register, the LASER Event Status Enable Register, the TEC Condition Status Enable Register, the LASER Condition Status Enable Register, and the Parallel Poll Enable Register. The syntax for this command is:



where- a value which rounds to an integer value of 0 means the power-on-status-clear flag of the 3722 is set FALSE, therefore disallowing SRQ (interrupts) to be asserted after power-on.

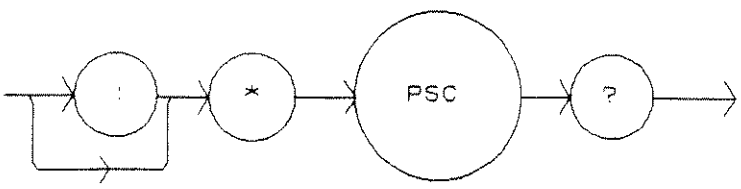
a value which rounds to any non-zero integer value between -32767 and +32767 means the power-on-status-clear flag of the 3722 is set TRUE, therefore allowing SRQ (interrupts) to be asserted after power-on.

When the "*PSC 1" command is sent, the 3722 will clear the above mentioned enable registers (set them all to 0) at power-up. This may be done to avoid any undesirable service requests after a power on/off cycle of the 3722.

The factory default value for this bit is 0, Power-on Status Clear is disabled. Therefore, the values of the enable registers are restored from their condition at the last power-down when a power-up occurs.

4.3.13 *PSC?

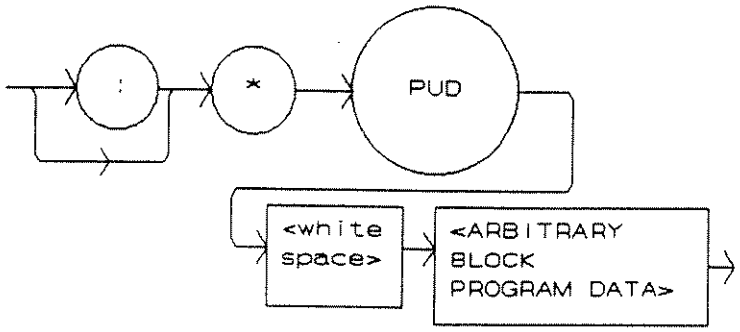
The Power-on Status Clear Query allows the programmer to query the 3722's power-on-status-clear flag. A response of 0 means that the Standard Event Status Enable Register, Service Request Enable Register, the TEC Event Status Enable Register, the LASER Event Status Enable Register, the TEC Condition Status Enable Register, the LASER Condition Status Enable Register, and the Parallel Poll Enable Register will retain their values when power is restored to the 3722. A returned value of 1 indicates that the registers listed above will be cleared when power is restored to the 3722. The syntax for this query is:



4.3.14 *PUD

The Protected User Data command stores data unique to the 3722, such as calibration date, serial numbers, etc. This data is protected by restricted entry ("SECURE <nrf>" command) and is usually only entered at the time of service or calibration.

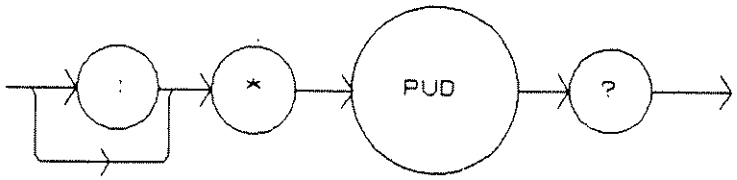
This data is a fixed size of 18 bytes. The syntax of the *PUD command is:



where- the user's input (unique data) is exactly 18 bytes.

4.3.15 *PUD?

The Protected User Device query allows the user to retrieve the contents of the *PUD storage area. The response is the contents of the unique data which was last entered. The syntax of the *PUD? query is:



The initial (factory set) response value of the *PUD? query is:

#218nnnnnnnvvMMDDYYABC

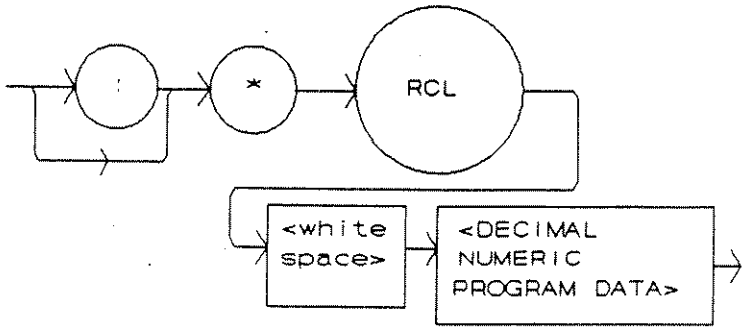
-where the response is <ARBITRARY BLOCK RESPONSE DATA>: nnhnnnn represents the 7-digit serial number, vv represents the software version number, MMDDYY represents the date of calibration (month, day, year), and ABC represents the initials of the calibrating technician.

4.3.16 *RCL

The *RCL (Recall) command restores the 3722 to the setup state which is in its local memory (Bin 0 - 10). The following criteria are restored when the *RCL command is given:

1. The 3722 is in the parameter state which was last stored in that bin.
2. The outputs (LASER and TEC) are both off.

The syntax for the *RCL command is:



where- the value must round-off to an integer between 0 and 10.

a value of 0 means the recalled state shall be the same as that of a *RST command (see Table 4.1).

Up to 11 different stored recall states can be used. Ten of these recall states (1 - 10) are saved by using the *SAV command.

4.3.17 *RST

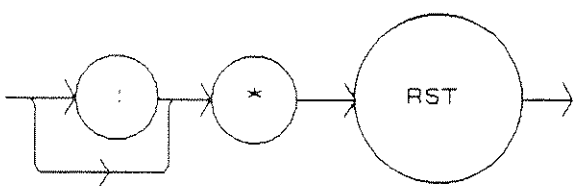
The *RST (Reset) command performs a device reset. This has the same effect as *RCL 0 (see Table 4.1), but with the 3722's OCIS and OQIS idle states set.

The Operation Complete Command Idle State (OCIS) is the state which the 3722 is in when it is no longer waiting for any operation to complete, after an *OPC command has been executed.

The Operation Complete Query Idle State (OQIS) is the state which the 3722 is in when it is no longer waiting for any operation to complete, after an *OPC? query has been executed.

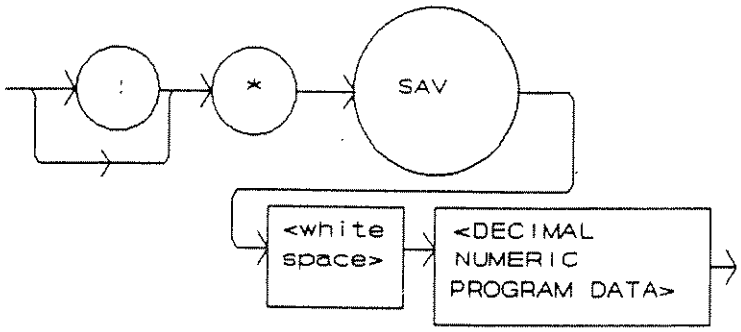
These idle states allow the 3722 to complete its reset process (and have no operations pending) before continuing with any other commands after the *RST is executed.

The syntax for the *RST command is:



4.3.18 *SAV

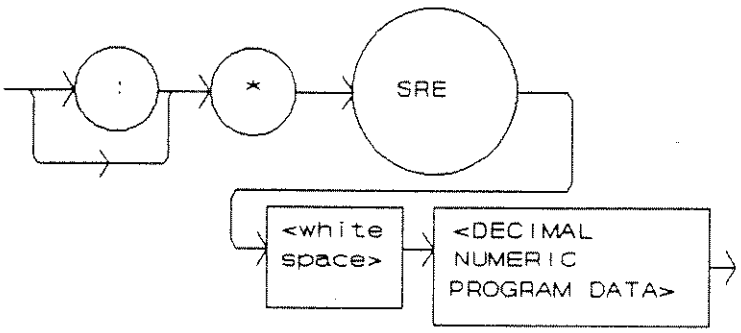
The Save command stores the current state of the 3722 in non-volatile local memory. A particular state is then recalled by using the *RCL recall command (see Section 4.3.16). There are 10 unique states which can be stored. The syntax of the *SAV command is:



where- the value must round off to an integer between 1 and 10
the rounded integer value corresponds to a unique saved state which can be recalled by using the same value with the *RCL command

4.3.19 *SRE

The Service Request Enable command sets the Service Request Enable Register bits to allow the 3722 to generate the user-selectable service requests. The syntax of the *SRE command is:



where- the value of the numeric data rounds off to an integer between 0 and 255.

the value of the numeric data corresponds to the bits enabled (see Figure 4.3)

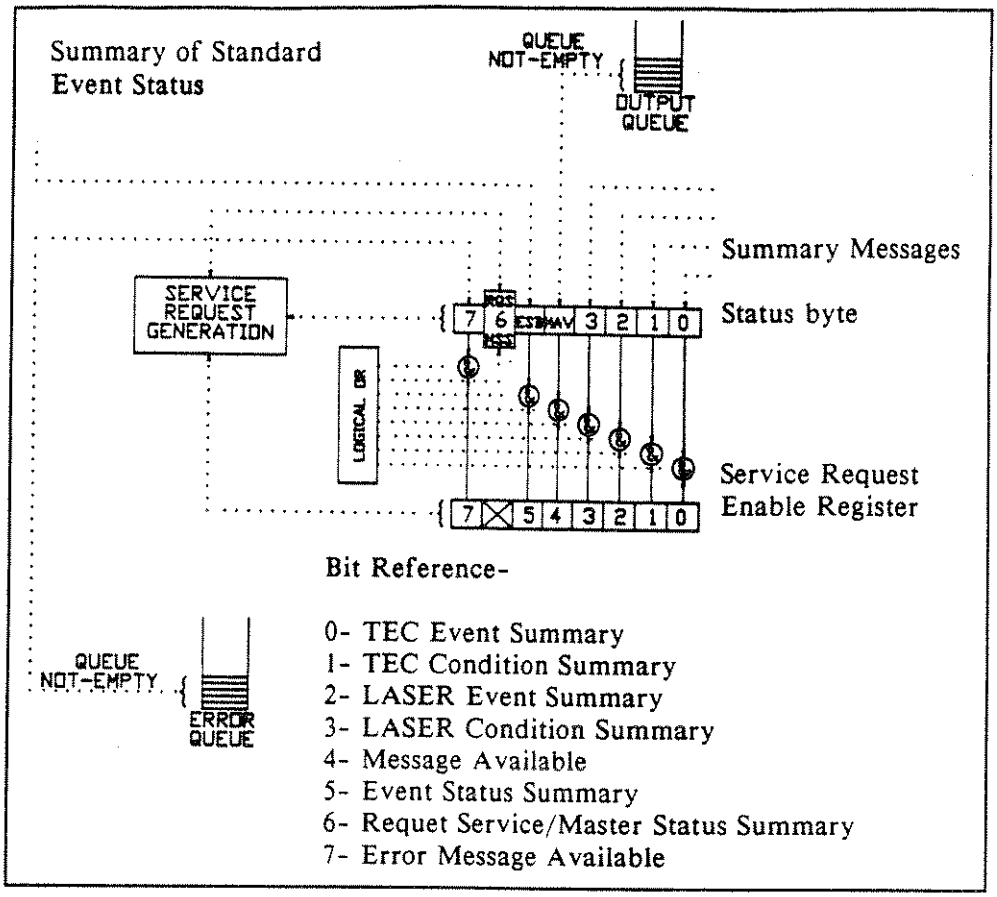
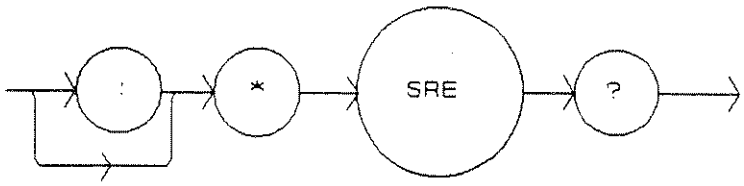


Figure 4.3 Service Request Enable Register

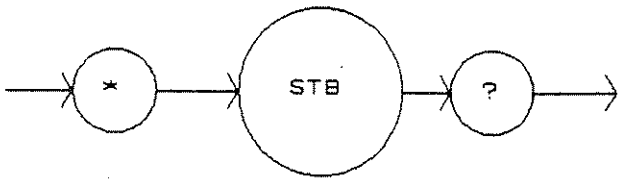
4.3.20 *SRE?

The Service Request Enable query allows the user to determine the current contents of the Service Request Enable Register. When this query is made, the response is the binary integer value of the contents of the register (see Figure 4.3). The syntax of the *SRE? query is:



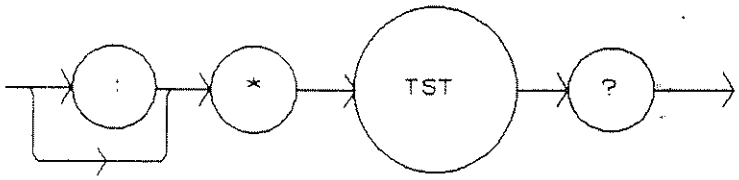
4.3.21 *STB?

The Read Status Back query allows the programmer to read the status byte and Master Summary Status bit. The response to this query is an integer value of the contents of the Status Byte Register, where bit 6 represents the MSS (Master Summary Status) bit and not the RQS message (see Figure 4.3). The syntax of the *STB? query is:



4.3.22 *TST?

The Self-Test query causes an internal self-test and returns a response when the self-test is complete. The syntax of the TST? query is:

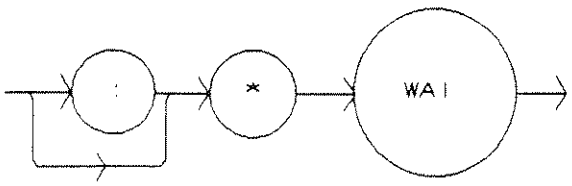


The response is <DECIMAL NUMERIC RESPONSE DATA>, where the value of the response is 0 if the self-test completes with no errors. If the response is a value other than 0, the self-test was not completed or it was completed with errors detected.

4.3.23 *WAI

The Wait-to-Continue command prevents the 3722 from executing any further commands until the No-Operation-Pending flag is true. This allows the programmer to make the 3722 wait for the completion of an operation before continuing. For example, after a change in temperature is made the *WAI command may be used before a measurement is taken. This would ensure that the correct temperature had been reached.

The syntax for the *WAI command is:



4.4 Advanced Programming

Once you have become familiar with the command syntax and structure, you may take advantage of some programming shortcuts which are available. Due to the "tree-walking" capabilities of the 3722 software, the user may elect to write command strings without constantly repeating the entire command path for each command.

4.4.1 Path Specification

The first command in the string must have its entire path entered. But once a path level is reached, other commands which are at the same level (or higher level) may then be entered without repeating the path. To accomplish this, the semicolon (;) must be used to separate the commands in the string, as usual. However, the command following the semicolon need not specify its full path, if the same path which was previously written out could be used for the new command.

For example, the following legal command string could be used to (1) set the 3722 TEC display to the measured temperature and (2) set the TEC display for the (temperature) set point value:

"TEC:DIS:T; SET"

The path "TEC:DIS:" is "remembered" by the 3722 software in this case. If the "SET" command were not found at this level, the software would walk back to the "TEC:" level and search for a "TEC:SET" command. If it is not found there, it will search at the next higher level, and so on until it finds the command or not. If the command is not found, an error message will be generated.

The following is an example of command "tree-walking", where (1) the LASER display is set for the current set point, and (2) the LASER output is turned on:

"Laser:display:set; out on"

The command "out" is first searched at the "LAS:DIS:" level. Since the command "LAS:DIS:OUT" does not exist, the next higher level "LAS:" is searched. There the command "LAS:OUT" is found, and the parameter "on" is legal, so there is no error.

Care must be taken to avoid errors which are caused by trying to implement commands from the wrong path or level. For example, the following command string was intended to (1) read back the set point resistance and (2) read back the measured resistance:

"TEC:SET:R?; R?"

Instead, the output would return the set point resistance twice. When the second "R?" is found, the software will first search for that command at its current level. Since it finds it there it will be executed. If this command did not exist at this level, the software would search down to the "TEC:" level and find and execute the intended command, "TEC:R?".

In order to ensure the proper command is executed for the example above, the following command string should have been issued:

"TEC:SET:R?; TEC:R?"

If you are not sure of the path level of a command, refer to the 3722 Command Path Structure diagram, Figure 3.2. For this discussion, the root level is the highest level, and moving down the diagram (Figure 3.2) decreases the level. Once the software has "walked" to a lower path level, it remains at that level when it receives the next command. For example, to (1) set the LASER display to show the set point, (2) decrement the set point, and (3) set the TEC display to show the measured temperature, the following command string could be used:

"LAS:DIS:SET; DEC; TEC:DIS:T"

When the "DEC" command is reached, the software is at the "LAS:DIS:" level. Since there is no "DEC" command there, it walks back up to the "LAS" level, and there it finds the "LAS:DEC" command.

The reason that the full path (including "TEC:") must be specified for the last part (TEC:DIS:T) is that otherwise it would look for the DIS:T command in the LAS:DIS: path, not find it, and generate error E-123.

After the second semicolon is reached (DEC;) the software will first look for the next word (TEC) at the current path. Since it is not found it will walk back up the tree until it finds it at the root level. Once the search walks up to the root level, it will not walk down any other paths, unless the path is specified.

The only exception to the rule described above is when common commands are used. In that case, the software remembers which level the user was at before the common command was found, and it returns to that same level after finding and executing the common command. Therefore the following command string is legal:

"TEC:DIS:T; *WAI; DEC"

Here, (1) the display is set to show the measured temperature (2) the software waits for the previous command to be executed, and (3) the set point is decremented one step.

4.4.2 Timing Considerations

Although the shortcuts mentioned in Section 4.4.1 reduce the command length, they may not necessarily optimize the speed of program execution. The following tip may be useful if speed of execution of a command is critical. If a command follows a semicolon (;) in a command string, and it is not at the root level, using the colon (:) will aid the software in locating the command, and time will be saved.

For example, the following command string will execute slightly faster (as shown) than it would if the first colon (:) after the second semicolon (;) was not included. This would save the time of two binary searches, one at the LAS:DEC level and one at the LAS: level.

"LAS:DIS:SET; DEC; :TEC:DIS:T"

In other cases, the hardware may not be able to react as quickly as the commands are executed. For example, if the set point is greatly incremented (i.e. by 10 °C) and a measurement is taken before that new set-point temperature has been reached, a decision based on the accuracy of the measured value may not produce the desired reaction. In other words, the test could be invalid due to a premature measurement. For cases like this, the *WAI command is useful. The *WAI command will suspend the execution of the next command until the previous command has been completed.

4.5 Error Messages

Error messages may appear on the TEC or LASER displays when error conditions occur which force the output off or reflect hardware errors in the respective functions of the 3722. For example, a module open error in the TEC side of the 3722 will be displayed on the TEC display.

In most cases, the error message will appear for three seconds and then the display will revert to its former state. In the case of multiple error messages, the 3722 will show each message for three seconds in succession.

In remote operation, the current error list can be read by issuing the "ERR?" query. When this is done, a string will be returned containing (up to 10 of) the error messages which are currently in the error message queue.

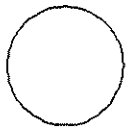
Appendix D contains an explanation of the error messages which may be reported remotely by the 3722.

4.6 ANSI/IEEE-488.2 Definitions

The following sections contain the relevent definitions for syntax diagrams and syntax elements for the 3722 commands, as defined by the IEEE-488.2 standard. A complete listing of that standard is not practical here, but these definitions are applicable to the remote operation of the 3722.

4.6.1 Syntax Diagrams

The syntax diagrams in Section 3.4 show the most complete form of command construction, but they don't show every possible construction. Some of the other possibilities which are not shown in the syntax diagrams of Section 3.4 are discussed in Section 4.4, Advanced Programming. These syntax diagrams conform to the ANSI/IEEE-488.2-1987 standard, and the terminology presented here reflects that standard.



The oval (or round) shape contains a terminal syntactic element. These represent a basic function, such as a single ASCII character, which cannot be divided.

Rectangles contain non-terminal syntactic elements. These represent elements which are expandable to a diagram of terminal syntactic elements. However, they are presented as a unit for clarity or emphasis.

Lines and arrows indicate correct paths through the syntax diagram. A reverse line around an element indicates that the element may be repeated indefinitely. A forward arrow around an element indicates that the element may be omitted.

4.6.2 White Space

White space is defined by the syntactic diagram shown in Figure 4.4, where <white space character> is defined as a single ASCII-encoded byte in the range 00-09, 0B-20 (0-9, 11-32 decimal). This range includes the ASCII control characters and the space, but excludes the newline character.

In most practical programming situations, the space character would be used, as white space is generally used in separating syntactic elements. White space is processed by the 3722 without interpretation.

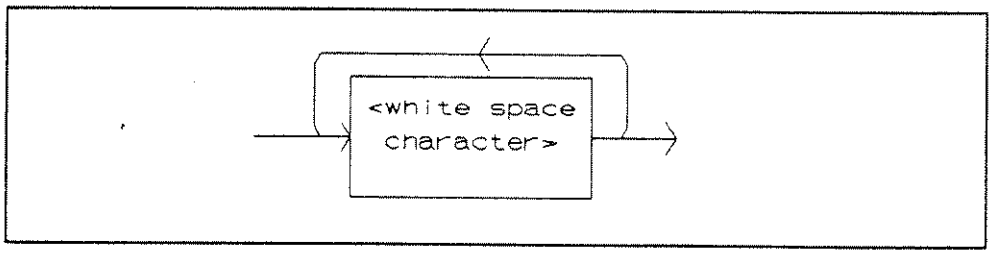


Figure 4.4 White Space Syntactic Diagram

4.6.3 Power-on Conditions

At power-on, the 3722 complies with the ANSI/IEEE Std 488.2-1987 requirements. It will initialize the setup parameters to be the same as when the power was last shut down. However, both LASER and TEC OUTPUTs will be off at power-up. The default conditions may be recalled by using the *RST command. The default conditions are outlined in Section 4.6.12.

4.6.4 <nrf value>

The symbol, <nrf value>, refers to the flexible numeric representation, as defined by the IEEE-488.2 standard. All this means is that numbers may be represented in one of three forms, integer, floating point, or engineering/scientific notation. For example the number "twenty" can be represented by an ASCII string of:

20 or +20,
20.0 or +20.0,
2.0E+1 or +2.0E+1 or 2.0e+1 or +2.0e+1

These three forms are denoted, NR1, NR2, and NR3, respectively, by the IEEE-488.2 standard. For more information on the precise syntax of these definitions, refer to the IEEE-488.2 standard.

4.6.5 <PROGRAM MESSAGE TERMINATOR>

When you send a command using the standard format, the host computer (or or GPIB driver) usually puts a <CR><LF><EOI> on the data bus following the command string. In this manner, a <PROGRAM MESSAGE TERMINATOR> is automatically sent. Some GPIB drivers allow the user to select the <PROGRAM MESSAGE TERMINATOR>.

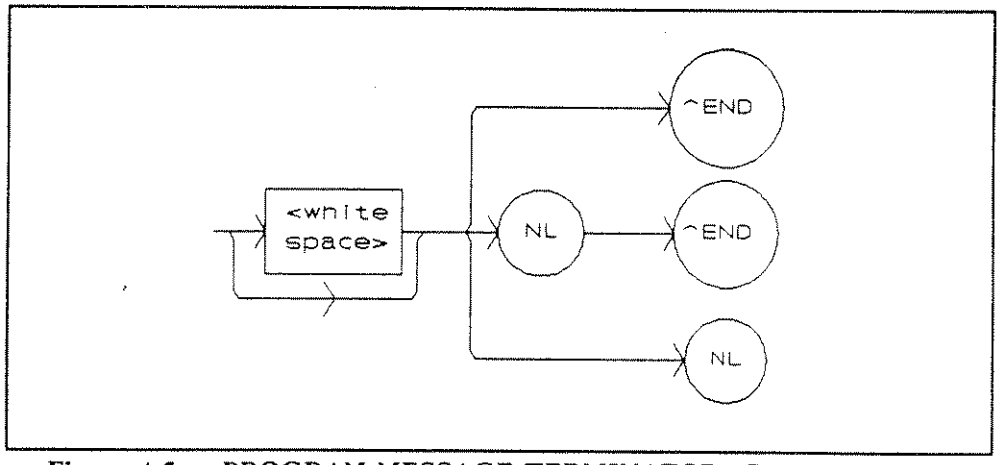


Figure 4.5 <PROGRAM MESSAGE TERMINATOR> Syntax Diagram

The 3722 uses the definition shown in Figure 4.5 for a <PROGRAM MESSAGE TERMINATOR>, where a <CR> is defined as white space. Note, LF (line feed) is equivalent to NL (newline), and ^END is equivalent to the EOI (end or identify) message.

The 3722's default value for a response terminator is: <CR><NL><^END>. This terminator may not be compatible with all host computers. Therefore, the TERM command (see Chapter 3) is available to set the 3722's response terminator, if needed.

If you encounter problems with GPIB communications with the 3722, refer to your GPIB driver manual for the exact syntax of the output terminator.

4.6.6 <PROGRAM MESSAGE UNIT SEPARATOR>

A <PROGRAM MESSAGE UNIT SEPARATOR> is used to separate sequential <PROGRAM MESSAGE UNIT> elements (commands) from one another within a <PROGRAM MESSAGE>. The syntax for a <PROGRAM MESSAGE UNIT SEPARATOR> is shown in Figure 4.6.

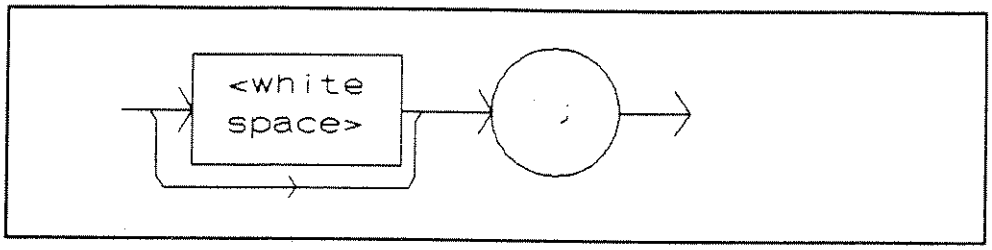


Figure 4.6 <PROGRAM MESSAGE UNIT SEPARATOR> Syntax Diagram

4.6.7 <PROGRAM HEADER SEPARATOR>

The <PROGRAM HEADER SEPARATOR> separates the <COMMAND PROGRAM HEADER> (3722 command) from the <PROGRAM DATA> (first parameter after the command). In the case of the 3722, a single white space must be used to separate the command from the first parameter. Note however, commands may be compounded, see Section 4.6.8.

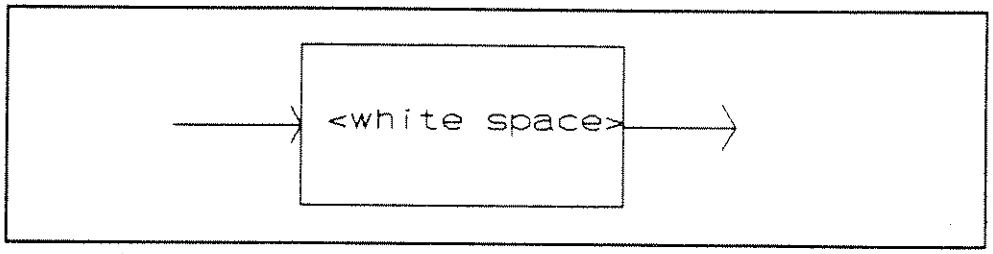


Figure 4.7 <PROGRAM HEADER SEPARATOR> Syntax Diagram

4.6.8 <compound command program header>

A <compound command program header> is a compound command heading which may be followed by <program data> (parameters). The 3722 command structure is a tree, as shown in Figure 3.2. A compound command or <compound command program header> determines the proper command by following a path from the root node. This is similar to determining a path for a file by starting with the root directory and listing the intermediate sub-directories. The syntax for a <compound command program header> is shown in Figure 4.8. The syntax diagram for a <compound query program header> is shown in Figure 4.9.

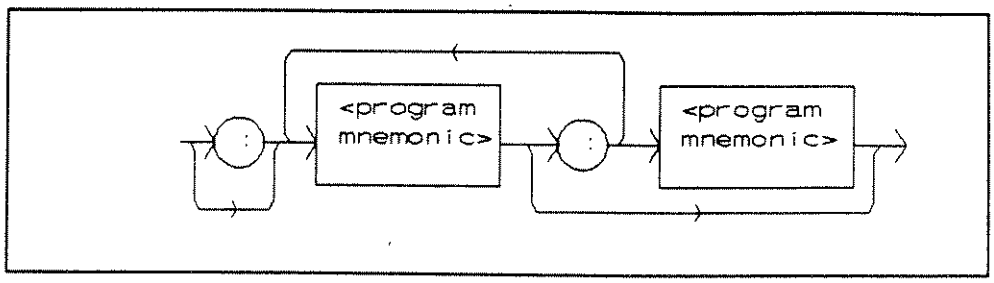


Figure 4.8 <compound command program header> Syntax Diagram

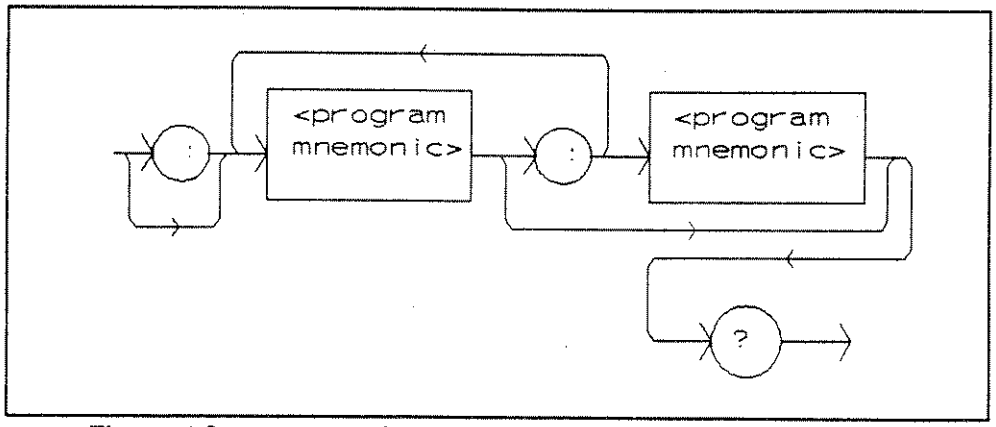


Figure 4.9 <compound query program header> Syntax Diagram

A <program mnemonic> is a command or command path identifier. For example, the <PROGRAM MESSAGE> "DISplay:T" consists of the command "T" and the path identifier "DISplay." All of the legal <compound command program headers>, may be traced by starting from the root node of the command structure and moving down by levels to paths, and finally to the command (see Figure 3.2).

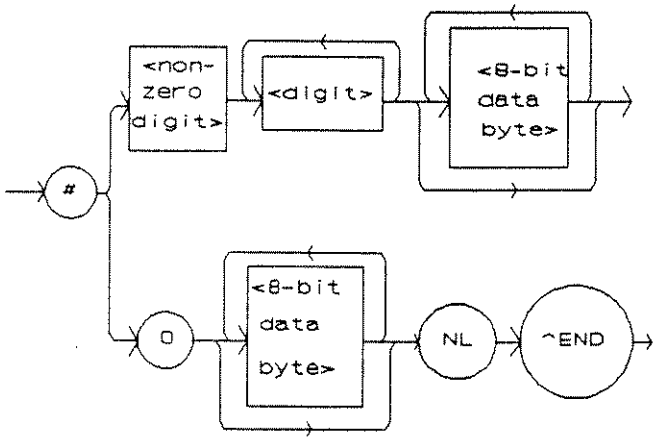
A <PROGRAM MESSAGE TERMINATOR> causes the next command search to begin at the root node. A leading colon (:) on a <PROGRAM MESSAGE UNIT> will cause the 3722 to begin searching for the command at the root node. Otherwise (after a semicolon), the 3722 will first search the most recently used node for the command. It will continue to search the command tree until it finds a legal command path, by searching each previously used node up to the root. If no legal path is found, the 3722 will generate an error message. For more information on creating and using 3722 commands, see Section 4.4, Advanced Programming.

4.6.9 <PROGRAM DATA> (Parameters)

Parameters (and other <PROGRAM DATA>) may be entered after a command in a <PROGRAM MESSAGE UNIT>. The <COMMAND PROGRAM HEADER> (command) and first <PROGRAM DATA UNIT> (parameter) must be separated by a <PROGRAM HEADER SEPARATOR> (white space), see Section 4.6.6.

4.6.10 <ARBITRARY BLOCK PROGRAM DATA>

This element allows any 8-bit bytes (including extended ASCII) to be transmited in a message. The syntax for an <ARBITRARY BLOCK PROGRAM DATA> element is:



where- a non-zero digit is defined as a single ASCII encoded byte in the range 31 - 39 (49 - 57 decimal).

8-bit data byte is defined as an 8-bit byte in the range 00 - FF (0 -255 decimal).

NL is a new line (LF) and ^END is an end or identify (EOI).

Figure 4.10 <ARBITRARY BLOCK PROGRAM DATA> Syntax Diagram

This element is used only with a *PUD command to the 3722.

4.6.11 <PROGRAM DATA SEPARATORS>

When there is a list of <PROGRAM DATA UNITS> (parameters) following a <PROGRAM HEADER SEPARATOR> (white space), the <PROGRAM DATA UNITS> must be separated with a <PROGRAM UNIT SEPARATOR>. The syntax diagram for a <PROGRAM UNIT SEPARATOR> is shown in Figure 4.11.

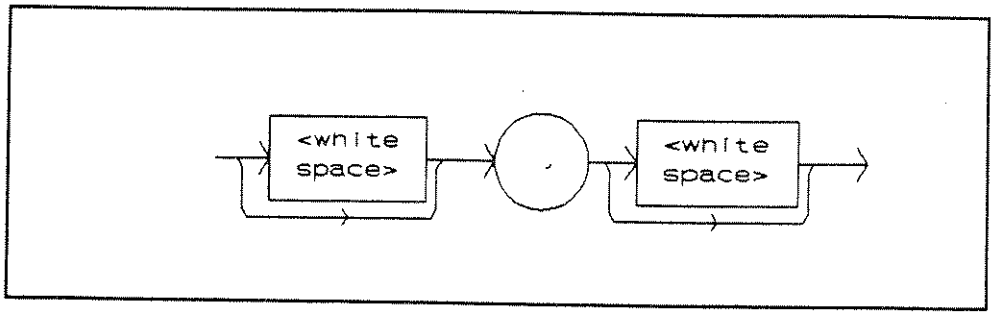


Figure 4.11 <PROGRAM DATA SEPARATOR> Syntax Diagram

4.6.12 Default Parameters

There are no default values for omitted parameters. If a command is expecting a parameter and none is entered, an error will be generated.

However, if a reset is performed via a *RST command (or a RCL 0 command), the following parameters will be set to the default state shown in Table 4.1.

3722 CONFIGURATION AFTER *RST

GPIB in local via front panel; in remote via GPIB
Bar graph off
PARAMETERS not selected
TEC and LASER adjust not selected
TEC output off
TEC DISPLAY enabled, in T mode
Constant T mode selected
TEC Display showing actual temperature
Temperature Set Point = 0°C
Resistance/Reference Set Point = 1 ohm or uA or mV
(depending on the setting of the SENSOR SELECT switch)
ITE Set Point = 0
LIM ITE set to 4.0 Amps
LIM THI set to 99.9°C
TEC STEP value = 1
TEC Tolerance values = 0.2°C, 5 seconds
GAIN = 30
C1 = 1.125 (x 10^{-3})
C2 = 2.347 (x 10^{-4})
C3 = 0.855 (x 10^{-7})
CAL PD = 10.0
LIM I2 (200 mA range) = 200 mA
LIM I5 (500 mA range) = 500 mA
LIM P = 200 mW
LASER output off
LASER DISPLAY enabled, in I mode
Constant I, low bandwidth, mode selected
LASER display showing actual current
RANGE in 200 mA setting
LASER STEP value = 1
LASER Tolerance values = 10.0 mA, 1.0 seconds
LASER I Set Point = 0
LASER IPD Set Point = 0
LASER PPD Set Point = 0
RECALL BIN number = 0

Table 4.1 State of the 3722 After *RST

4.7 Status Reporting

Figure 4.12 shows the status reporting scheme of the 3722. Each of the registers which may be accessed by a command or query has the appropriate command or query written above or below the register representation. For example, the LASER Condition Register may be queried via the "LASer:COND?" query, as shown by its register heading in Figure 4.12.

The condition or event registers are logically ANDed with their respective enable registers. These bits are then logically ORed to form a summary message in the status byte for that particular register.

4.7.1 Event and Condition Registers

The Event Registers are used to report events which occur during the operation of the 3722. Events differ from conditions in that events signal an occurance once, and are not reset until the Event Register is queried or the 3722 is powered off. Conditions reflect the current state of the device, and therefore may change many times during operation. Querying a Condition Register does not change its contents.

The 3722 contains Event and Condition Registers for TEC and LASER controller operations. It also contains the Standard Event Status Register which reports events for general operation of the 3722. The Standard Event Status Register conforms to the IEEE-488.2 standard.

4.7.2 Operation Complete Definition

Note that bit 0 of the Standard Event Status Register contains the status of the Operation Complete flag (see *OPC, Section 4.3.8). Enabling this bit via the *ESE command allows the user to update bits of the status byte. Then, if the SRE mask has bit 5 set, and the user issues an *OPC commaand, an SRQ will be issued upon completion of the currently processed commands. This may be used to initiate service request routines which depend on the completion of all previous commands.

For example, the user may set the TEC output to 30°C, enable the SRQ on Operation Complete, and have an SRQ handling routine in the user's software which begins a new measurement after the 30°C value has been reached.

This allows the use of the operation complete features of the 3722, such as the "TOLerance" commands, without the need for program looping or polling which can tie up the GPIB.

Operation Complete on the 3722 is defined as:

1) The LASER controller, which is updating the current source hardware, is idle.

2) The TEC controller, which is updating the temperature controller hardware, is idle.

3) No EEPROM (non-volatile) memory write cycles are in progress.

4) New LASER current and photodiode measurements are available, updated approximately every 400 mSec.

5) New TEC sensor and ITE measurements are available, updated approximately every 400 mSec.

6) No Display timeout clocks are running.

7) No calibration routines are running.

8) LASER output is off, or it is on and within tolerance.

9) TEC output is off, or it is on and within tolerance.

4.7.3 Command Timing and Completion

This section describes, for each device-dependent command, whether that command is performed in an overlapped or sequential manner. In other words, it states whether the next command may begin while this command is being executed, or if the next command must wait until this command is completed before its execution begins. The conditions for setting the operation complete flag are given in Section 4.7.2.

All 3722 device-dependent commands are executed in an overlapped manner, and the operation complete flag is set after the conditions outlined in Section 4.7.2 have been satisfied.

The *WAI (common command) is example of a sequential command which forces the next command to wait until the no-operation-pending flag is true. This is essentially the same as waiting for the OPC flag to become true, because the no-operations-pending flag is used to set the OPC flag (bit 0 of the Standard Event Status Register).

In normal operation, the overlapped commands execute faster than would appear by querying the OPC flag. This is due to the nature of the non-volatile memory storage process. Commands which change the status of the instrument limits, CAL PD, GAIN, C1, C2, C3, or change its mode or current range, tolerance or step values, or status enable registers will not have their OPC flag set until all current writing to non-volatile memory has been completed. This is done to ensure that the OPC flag is never set prematurely. However, in most cases, the individual operation will be completed immediately.

The speed of writing to non-volatile memory (EEPROM) is slow compared to processor speed, and the new information (to be written) is placed on a queue to reduce the processor overhead for non-volatile storage operations. However, the new information (i.e. new parameter value) is buffered and is essentially stored as soon as the command which created it is parsed. Therefore, even though the OPC flag may not be set immediately after a new parameter value is created, the new value is stored for all intents and purposes, and command throughput is not directly related to the OPC rate.

Whenever there is any output (response) data in the Output Queue, bit 4 is set in the Status Byte Register. Whenever there is any error message in the Error Queue, bit 7 is set in the Status Byte Register.

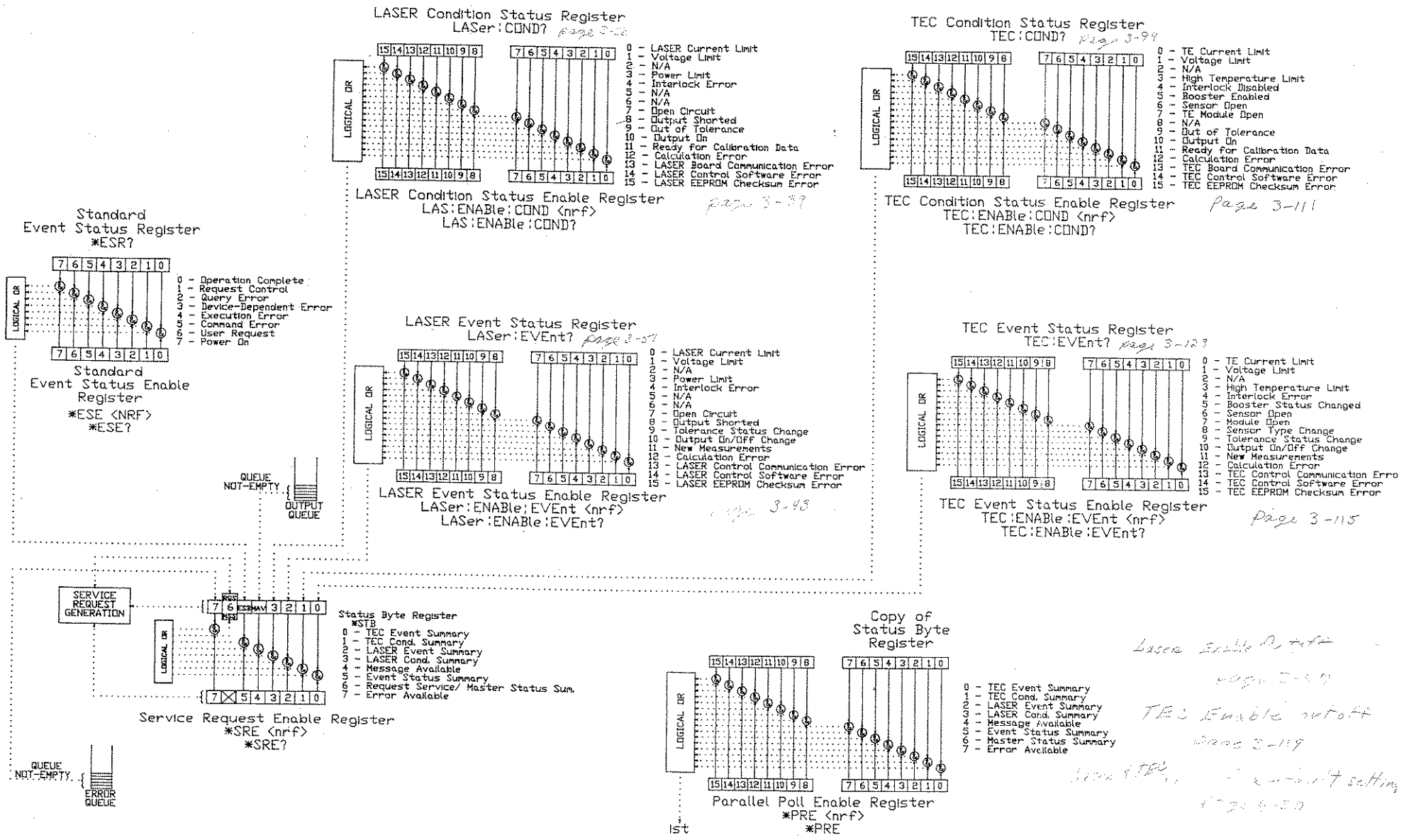


Figure 4.12 LDC-3722 Status Reporting Schematic Diagram

4.8 Output Off Registers

The Output Off Enable Registers allow the user to determine which conditions and events in the TEC and LASER controllers will cause their outputs to be turned off. These registers are configured in a manner which is similar to the status reporting registers. However, their outputs are not reported in the Status Byte Register. Rather, they go to the hardware which controls the output switching. The events and conditions which may be set to cause the TEC and LASER outputs to be turned off are shown in Figures 4.13 and 4.14.

The default (factory) settings for these registers are shown in Table 4.2. These settings are not effected by the *PSC (Power-On Status Clear) command.

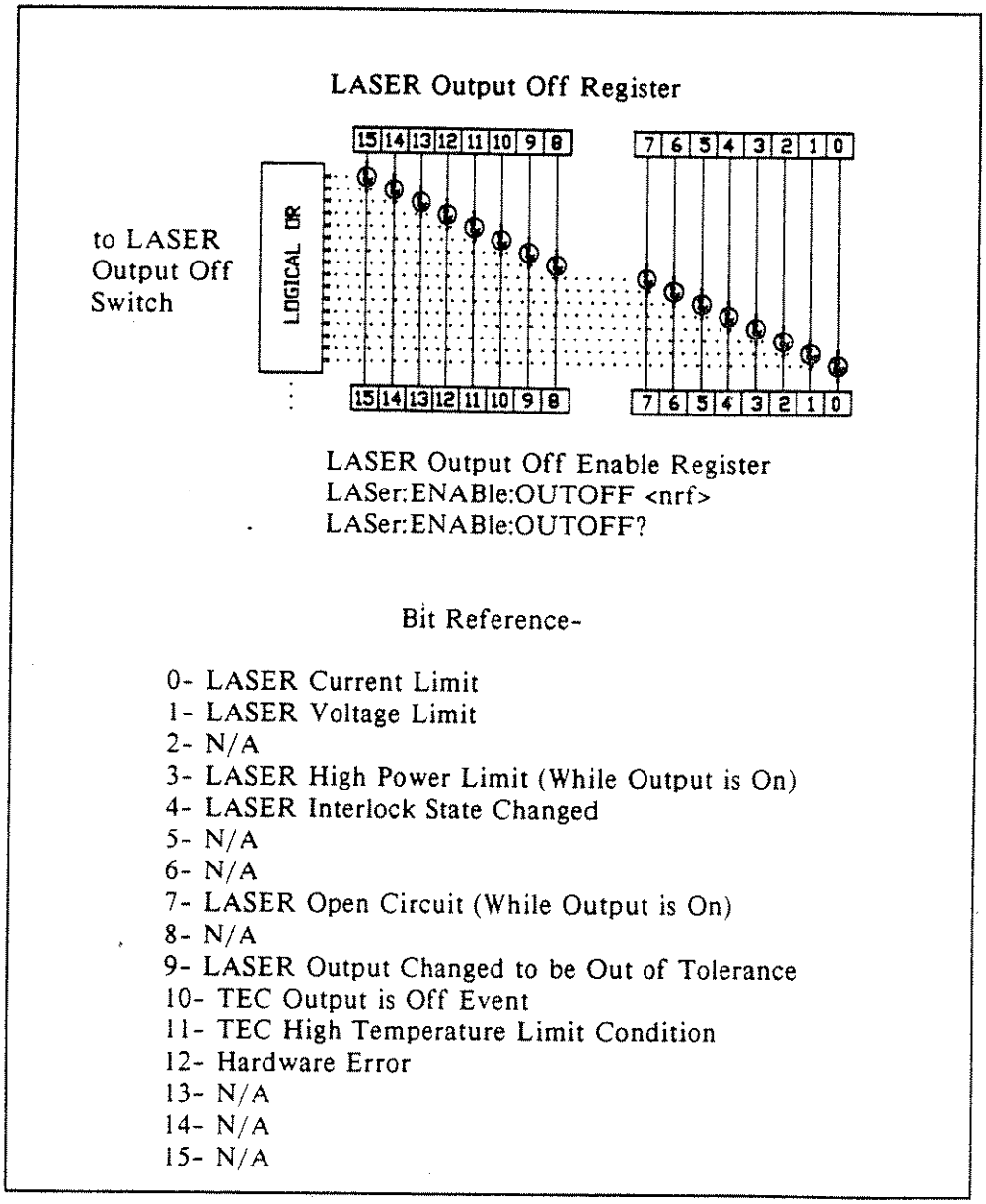
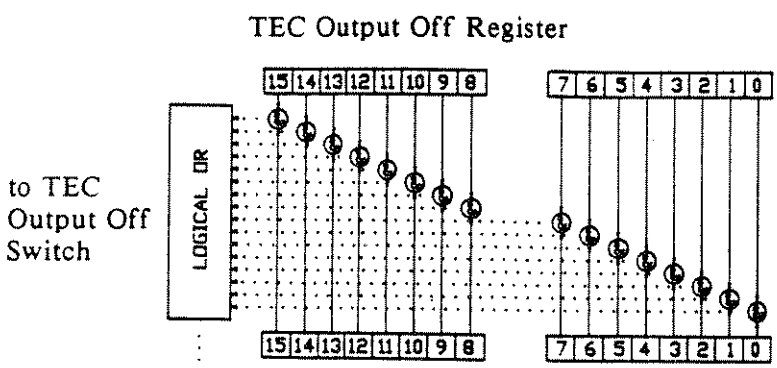


Figure 4.13 3722 LASER Output Off Register



TEC Output Off Enable Register
TEC:ENABle:OUTOFF <nrf>
TEC:ENABle:OUTOFF?

Bit Reference-

0- TEC Current Limit
1- TEC Voltage Limit
2- N/A
3- High Temperature Limit
4- TEC Interlock Disabled Condition
5- Booster Changed (While Output On) Event
6- Sensor Open (While Output On) Condition
7- TEC Module Open (While Output On) Condition
8- Sensor Type Change (While Output On) Event
9- Outside of TEC Tolerance Condition
10- Sensor Shorted (While Output On) Condition
11- N/A
12- Software Error Condition
13- N/A
14- N/A
15- N/A

Figure 4.14 3722 TEC Output Off Register

3722 OUTPUT OFF REGISTERS' DEFAULT SETTINGS

LASER Output Off Register		TEC Output Off Register	
0- disabled	8- disabled	0- disabled	8- enabled
1- disabled	9- disabled	1- disabled	9- disabled
2- N/A	10- disabled	2- N/A	10- enabled
3- enabled	11- enabled	3- enabled	11- N/A
4- enabled	12- disabled	4- enabled	12- disabled
5- disabled	13- N/A	5- enabled	13- N/A
6- disabled	14- N/A	6- enabled	14- N/A
7- enabled	15- N/A	7- enabled	15- N/A

Table 4.2 3722 Default Settings for Output Off Registers

4.9 Input Buffer and Output Data

The Input buffer of the 3722 is 80 bytes. However, the user's <PROGRAM MESSAGE> may be longer.

The output (response) data of the 3722 is sent in blocks of up to 80 bytes in length. It is sent using high speed DMA within the 3722, but may be of indefinite length. Although some commands have a definite length response, such as the MESsage? query, the response length is indefinite because the 3722 will respond to multiple queries in a single response output. The user may enter as many queries as desired in a single input message, and the 3722 will respond to all of them in the same output message, if possible. For example, the user may enter the following command:

"Mes?; Rad?; TEC:T?; Err?"

The response may appear in this manner:

"TEST1 ,DEC,25.0,0"

All query responses are evaluated at the time the query is parsed, and not at the time the response message is sent. In most cases this does not create a problem since the time between parsing a query and sending its response is small, unless the GPIB controller takes a long time to request the response.

4.10 Remote Interface Messages

The following sections are intended as a reference for using the 3722 with the GPIB option when an understanding of the lower level interface messages is required. These sections deal with the remote interface messages which are available with the 3722, and they contain a list of the Interface Function subsets. This information is generally not required by the user unless there is a question of compatibility of the 3722 with a specific controller. A list of interface messages which are not supported by the 3722 is shown in Section 4.10.3. These messages will be ignored by the 3722.

The interface messages listed in this chapter are handled by the 9914 GPIB interface IC and the 80C188 processor in the 3722, and are transparent to the higher level commands. However, they may be explicitly used in some GPIB programs. A list of the 3722's allowable interface messages is shown in Section 4.10.2.

4.10.1 Interface Function Subsets

Table 4.3 contains the remote Interface Function Subsets which are supported by the 3722. For more information, see the ANSI/IEEE-488.1-1987 standard.

3722 INTERFACE FUNCTION SUBSETS

SH1	Source Handshake - complete compatibility
AH1	Acceptor Handshake - complete capability
T6	Talker Functions
L4	Listener Functions
SR1	Service Request - complete capability
RL1	Remote Local Function - complete capability
PP0	Remote Configuration Parallel Poll - no capability
DC1	Device Clear - complete capability
DT0	Device Trigger - no capability
C0	Controller Function - no capability
E1, E2	Three-state bus drivers with automatic switch to open collector during Parallel Poll

Table 4.3 3722 Interface Function Subsets

4.10.2 3722 Remote Messages

The following list contains GPIB remote messages which are compatible with the 3722 GPIB driver.

3722 ALLOWED GPIB INTERFACE MESSAGES

ACG	LAG	PPR2	RQS
ATN	LLO	PPR3	SCG
DAB	MLA	PPR4	SDC
DAC	MTA	PPR5	SPD
DAV	OTA	PPR6	SPE
DCL	PCG	PPR7	SRQ
END	PPC	PPR8	STB
GTL	PPE	PPU	TAG
IDY	PPD	REN	UCG
IFC	PPR1	RFD	UNL
			UNT

Table 4.4 3722 Allowable GPIB Interface Messages

4.10.3 Non-Supported Remote Interface Messages

Table 4.5 contains GPIB interface messages which are known to be incompatible with the 3722. Other interface messages which do not appear in Section 4.4.2 may also be incompatible with the 3722.

NON-SUPPORTED INTERFACE MESSAGES FOR 3722

EOS	MSA	NUL
GET	OSA	TCT

Table 4.5 Non-Supported Interface Messages for the 3722