VFL Firmware and Serial Interface

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1 Purpose

The MPBC VFL laser includes a controller module that consists in an electronic assembly including a micro-controller. Its main objective is to control and monitor the laser. It can also communicate with a computer either using its RS-232 or USB ports. This document provides information how to establish the communication and how to exchange information with the laser module.

The MPBC VFL laser includes a Second-Harmonic Generator (SHG) located in the laser head. The SHG includes a Thermal-Electric Cooler (TEC) to maintain the temperature of the SHG crystal at a given temperature to provide optimal performance of the laser output power while minimizing laser pump diode current. Over the VFL laser lifetime, the SHG TEC temperature should be retuned to a slightly different temperature set point in order to ensure the laser continues to operate at its optimum point.

2 Scope

This document provides a short description of the functionalities of the firmware running on the micro-controller to control and monitor the laser.

Then, it describes how to configure the Serial COM port or the USB port of a personal computer (PC) running the Microsoft Windows operating system to establish communication with the laser module.

The command format used to communicate with the laser module is provided. Examples of essential commands sent using the hyperteminal application are showed.

The MPBC VFL controller firmware provides functionality to retune the SHG TEC temperature to the optimal point. The SHG tuning can be performed in automatic current control (ACC) at a given current. It can also be performed while operating the laser at a user-defined output power set point, in automatic power control (APC) mode. The firmware can also indicate to the user when the next SHG retuning should be performed.

This document provides information about how to use the SHG Tuning functionality included in the MPBC VFL laser firmware.

Finally, a detailed list of the user command set is provided.

3 List of Acronyms

ACC	Automatic Current Control
ALS	Automatic Laser Shutdown
APC	Automatic Power Control
DSP	Digital Signal Processor
GUI	Graphical User Interface
LOO	Loss Of Output
LD	Laser Diode
LDD	Laser Diode Driver board assembly to drive one Laser Diode set. It also includes one TEC driver.
MCU	Micro-Controller Unit
RS-232	Standard of voltage levels, timing and connector pins assignments for serial data transmission
SHG	Second-Harmonic Generator
TEC	Thermal-Electric Cooler
USB	Universal Serial Bus.

VFL	Visible Fiber Laser

4 Product Firmware

4.1 Firmware Objectives

The objective of the firmware is to provide essential functions to control and monitor the laser. Such functions include:

- Control of the laser pump current
- Monitoring of currents and temperatures
- Reporting of alarms and faults

4.2 MCU States

The VFL controller firmware runs on a micro-controller unit (MCU). Essential functions provided by the MCU make it possible to control and monitor the laser operational parameters, as well as trigger alarms or faults when problems are detected.
MCU functions are called from a sequential finite-state automaton described in Figure 1. States used are as follows:

State	Description
INIT_STATE	Initialization state. The first state when the laser is switched on or reset.
NORMAL_STATE	Operational state. Once the initialization has been completed and the laser operates under normal conditions.
ALS_STATE	Automatic laser shutdown. When the amplifier detects a fault, which prevents the laser from operating normally.

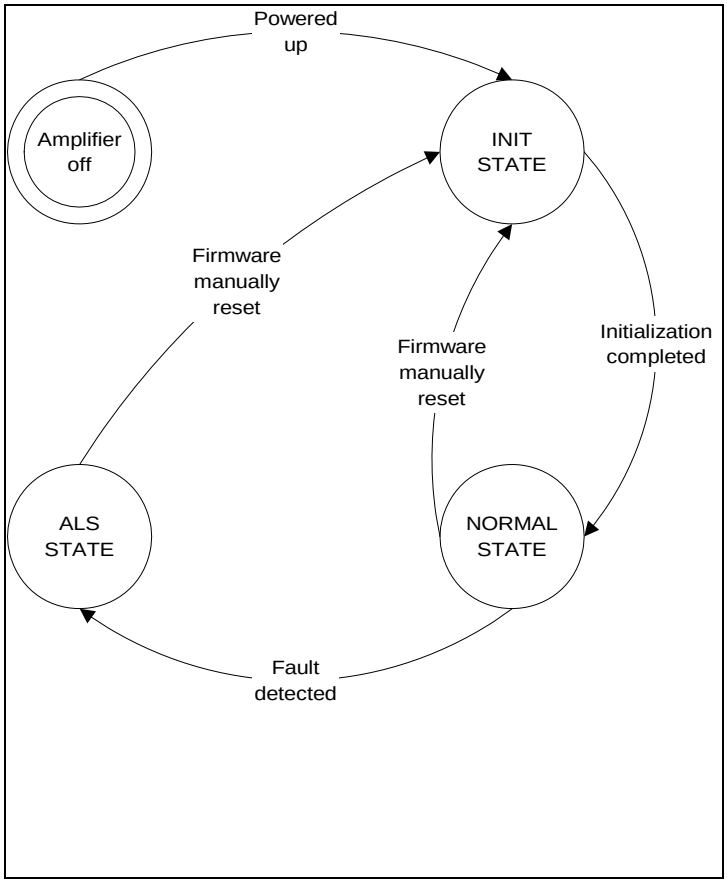

Figure 1: MCU State-machine

4.3 Laser States

The laser is initially in the OFF state. If a fault is detected, it automatically goes in Fault state and the unit must be reset to get out of this state. If the laser is not in the two previous states and the INTERLOCK input is opened, the laser goes in INTERLOCK state.

ONLY FOR KEY SAFE VERSION
For the Key Safe version, the key must first be in the ON position before the laser can be software enabled. Then a start-up delay (3 seconds) will be initiated. During this delay, the Laser Emission LED will be flashing. At the end of this period, if the laser is still enabled, the laser driver will be turned on. Turning the Key in the OFF position immediately shut down the laser if enabled, and it prevents to enable it. Upon power-up or after interlock is closed, if the Key is ON position, it must be first reset in OFF position then set in ON position before the laser can be software enabled.

The user can operate the laser in two modes.
If the user operates the laser in Manual mode, the laser driver is driven to maintain a constant current (ACC) using a current set point. During the transient state where the laser current is changing, the laser is the Manual Turning On state. Once the steady current is reached, the laser stays in Manual On state.

If the user operates the laser in Auto mode, the laser driver is driven to maintain a constant laser output power (APC) using a power set point. The different laser states are the following:

State	Description
OFF	Laser driver disabled by user. TEC drivers are enabled.
KEYLOCK	Laser driver disabled. Key must be switched OFF then ON. (Only for KEY SAFE version)
INTERLOCK	Laser driver disabled by interlock input signal
FAULT	Laser in fault conditions
START-UP	Laser driver ready to start up as soon as start-up delay is expired
MANUAL_TURNING_ON	Laser driver turning on in manual mode.
MANUAL_ON	Laser driver running in manual mode.
AUTO_ON	Laser driver running in automatic mode

4.4 Controlled Parameters

Controlled parameters can be checked and changed by the user.

Data	Comment	Unit
Laser mode	To select the laser mode of operation; 0=Manual(ACC or Current Control); 1= Auto(APC or Power Control).	-
LD current	Laser diode current set point in ACC mode.	mA
LD enable / disable	To switch laser on and off. User-driven control that has the same effect as the Interlock input	-
Output power	Output-power set point in APC.	mW
SHG Temperature	Second-Harmonic Generator TEC Temperature	°C

4.5 Monitored Parameters

Data	Comment	Unit
TEC temperature	TEC temperature	º C
TEC current	TEC current	mA
LD Case temperature	Measured laser diode case temperature	º C
LD current	Laser diode current	mA
Optical output power	Optical power at the output of the laser	mW
SHG TEC temperature	SHG TEC temperature	º C
SHG TEC current	SHG TEC current	mA

4.6 Alarms

The alarms are used to signal abnormal conditions to the user. If any of those alarms is declared when the laser is already operating, the operation will be maintained.

However, if the laser is turned off, the SHG Temperature and the TEC temperature Alarms will prevent the laser to be turned ON.

SHG Temperature: The alarm is activated if the monitored SHG temperature gets lower or higher than its set point by more than 2 °C.

TEC Temperature: The alarm is activated if any TEC Temperature exceeds its factory pre-defined limits.

Pump Bias: The alarm is activated if the Laser diode pump is driven below its minimum current limit or at current greater than 96% of its maximum current limit.

Loss Of Output: In Auto (APC) mode, the alarm is activated if the measured output power cannot be maintained within the LOS Output range relative to the output power setpoint.

For example, in the case of a output power setpoint of 17dBm, with a LOS Output range of -3 dB and +2 dB, the alarm is set if the output power is below 14 dBm (17 dBm – 3 dB) or if the output power is higher than 19 dBm (17 dBm + 2 dB).

Case Temperature: The alarm is activated if the measured Laser diode pump Case temperature gets lower than the Case Temperature Low Threshold or gets higher than the Case Temperature High Threshold.

4.7 Faults

The faults are different conditions that prevent the laser to operate safely. When such a condition is detected, the laser is immediately put in Automatic Laser Shutdown (ALS). The laser current is automatically turned off.
To restart the laser stuck in ALS mode, the user must use the Firmware Reset serial interface command or power down/power-up the laser.

SHG Temperature: The fault is activated if the monitored SHG temperature gets lower or higher than its set point by more than 5 °C.

TEC Temperature: The fault is activated if any TEC Temperature exceeds its factory safety limits or TEC current or TEC driver Fault bits are set on the Laser Driver board.

LD Current: The fault is activated if the LD Current or LD Driver Fault bits are set on the Laser Driver board.

Case Temperature: The fault is activated if the measured Laser pump Case temperature gets lower than the Case Temperature Low Limit or gets higher than the Case Temperature High Limit.

Other Faults: The fault is activated if the communication is interrupted between laser controller and the Laser Driver boards. It is also activated if +5V or +12V Monitor Fault bits are set on the Laser Driver board.

4.8 Tuning Procedure Control and Monitoring

The SHG tuning process is initiated or aborted by the user using the SETSHGCMD command. The GETSHGCMD command is used to read back the actual SHG command executing.

SETSHGCMD arg1

Where **arg1**:

1: to initiate SHG tuning according to schedule and warm-up conditions.
2: to abort SHG tuning presently in progress.
99: to initiate SHG tuning ignoring schedule and warm-up conditions.

GETSHGCMD
arg1

Where **arg1**:

0: No SHG tuning command executing.
1: SHG tuning initiated according to schedule and warm-up conditions.
2: SHG tuning aborting.
99: SHG tuning initiated ignoring schedule and warm-up conditions.

The tuning process can also be aborted by the procedure itself if an internal error is detected. When the procedure is aborted by the user or internally, the SHG temperature set point is always set back to its Starting point value before the tuning process is initiated.

Before initiating the tuning process, the laser must be enabled in Automatic Current Control (ACC) or in Automatic Power Control (APC) mode.

If the SHG tuning is initiated in ACC mode, the user current will be compared with a pre-defined current threshold (typ: 50% of Max Current). If the user current is above the threshold, the user current will be used during the SHG tuning. Otherwise the threshold current will be used. After the SHG tuning is completed or aborted, the laser will always be set back to the initial user current.

If the SHG is initiated in APC mode, the laser tries to maintain the user selected power level. The SHG must also be adjusted at a temperature set point where the laser output power level can be reached otherwise the tuning process will abort after the Start Step.

While tuning is in progress, the laser does not accept a modification of the output power, LD current or SHG temperature set point to avoid disturbing the tuning process. However, it is always possible to disable the laser driver using the SETLDENABLE command or the INTERLOCK input. In this case, the tuning process will be aborted and an error #1 will be reported. As stated previously, the SHG temperature will be set back to its Starting point value.

Depending how far the initial SHG temperature set point is far from its optimum point, the SHG tuning procedure can take from 5 to 20 minutes to complete

The SHG tuning process is monitored using the GETSHGTUNESTATE command. It returns the recent state of the SHG tuning process and a possible error status if the process is aborted by the procedure itself.

GETSHGTUNESTATE
arg1 arg2

Where **arg1**:

0: indicates no SHG tuning operation initiated since last reset.
1: indicates SHG tuning has completed with success.
2: indicates SHG tuning has been initiated then aborted at user request or because of an error has been detected during SHG tuning.
3: indicates SHG tuning is actually in progress.

Where **arg2**:

0: indicates no error detected during last SHG tuning.
1: indicates Laser not running in expected mode.
2: indicates Error when setting SHG Temperature.
4: indicates Error monitoring SHG Temperature stabilization.
8: indicates Error monitoring Output Power stabilization in APC mode.
16: indicates SHG Temperature out of limits.
32: indicates Error monitoring LD Current stabilization in ACC mode.
64: indicates no Power Peak Detected in ACC mode.

If many errors are detected, the error status is the sum of all error counts.

Error # 1: "Laser not running in expected mode"

This error is returned if the laser driver is not running in ACC or APC mode. This error occurs if the laser is disabled for any reason (software command, Interlock input active, Fault detected). The user should verify these points and address them before initiating a new SHG tuning.

Error # 2: "Error when setting SHG Temperature"

This error is returned if the SHG procedure tries to set a new SHG Temperature set point but the command is not executed. This error occurs if a problem is detected with the SHG TEC. For example, disconnecting the SHG cable during the SHG tuning would generate this error and the error #1. The user should verify the SHG cable and SHG TEC control.

Error # 4: "Error monitoring SHG Temperature stabilization"

This error is returned after averaging the SHG temperature, if the difference between the SHG temperature set point and the monitored temperature is greater than a pre-defined threshold (typ. +/- 1 ºC). This indicates a problem in the SHG temperature control or a SHG outside of its operating range. The user should verify the SHG temperature (set point and monitored value), just before the error is signaled and report the problem to the manufacturer.

Error # 8: "Error monitoring Output Power stabilization in APC mode"

This error is returned after averaging the Output Power, if the difference between the Output Power set point and the monitored power is greater than a pre-defined threshold (typ. +/-1 %). This error may occur because the SHG Temperature starting set point is too far from its optimum value. As the SHG procedure is designed for fine-tuning, the user must adjust the initial SHG temperature close enough to its optimum point so the laser can reach its output power set point with the maximum pump diode laser current. Otherwise, the user should report the problem to the manufacturer.

Error # 16: "SHG Temperature out of limits"

This error is returned if the SHG procedure cannot find a SHG temperature that is within the accepted limits of the SHG temperature. This indicates a problem in the SHG temperature control or a SHG outside of its operating range. The user should report the problem to the manufacturer.

Error # 32: "Error monitoring LD Current stabilization in ACC mode"

This error is returned after averaging the LD Current, if the difference between the LD Current set point and the monitored current is greater than a pre-defined threshold (typ. +/-100 mA). This user should report the problem to the manufacturer.

Error # 64: "No Power Peak detected in ACC mode"

This error is returned if the SHG procedure cannot find a SHG Temperature where the Output Power is above a pre-defined threshold (typ. 10% of Max.Power Set point). The ACC current could be increased above its actual value to increase the possibility to detect some power peak. Otherwise, the user should report the problem to the manufacturer.

4.9 Tuning Procedure Prerequisites

From experience, it appears that the optimum temperature can vary slightly as the laser accumulates hours of operation especially during the first thousand hours of the laser. Presently, the laser manufacturer recommends SHG retuning after 0 hours, 200 hours, 500 hours, 1000 hours and every 1000 hours of laser operation thereafter.

In order to ease SHG tuning maintenance, the firmware includes functionalities to monitor the number of hours of the laser head operation. It also stores in its non-volatile memory the information about previous SHG tuning operations. With such information available, the firmware can inform the user when the next SHG tuning operation should be scheduled.

The quality of the SHG tuning is dependant upon the laser components reaching stable temperature conditions (30 minutes minimum), before SHG tuning is initiated. The firmware includes a "warm-up counter", that increments when the laser is operating in APC mode. This counter resets every time the laser is stopped or the output power set point is modified.

The SHG tuning procedure prerequisites are monitored using the GETSHGTUNERDY command. It returns a flag set if the laser meets all the pre-requisites for SHG tuning. It also returns the number of hours left before the next SHG tuning and the number of seconds left before the warm-up period is completed.

GETSHGTUNERDY
arg1 arg2 arg3

Where arg1:

0: indicates VFL has not met all the prerequisites to perform the SHG tuning.
1: indicates VFL has met all the prerequisites to perform the SHG tuning.

Where arg2:

0: indicates the next scheduled SHG tuning time has been reached.
1-1000: indicates the next scheduled SHG tuning is planned within the next 1-1000 hours of operation.

Where arg3:

0: indicates the warm-up period has been completed.
1-1800: indicates the warm-up period will not complete before 1-1800 seconds of operation.

Under normal conditions, the user should only perform SHG tuning when all prerequisites are met. In this case, the command SETSHGCMD 1 should be used.

However under some circumstances, the user may want to perform SHG tuning without waiting for the next schedule time. In this case, the command SETSHGCMD 99 could be used to initiate SHG tuning even if all the prerequisites are not met.

5 Communication with PC

5.1 RS-232 COM Port Settings

To communicate with the unit through RS-232 port, a standard serial extension cable should be used to connect the unit to a COM port of a computer. **For the RS-232 communication to be effective, the USB cable must be unplugged.**

Use the Windows Hyper Terminal program to establish a communication. Settings for COMx port are as follows:

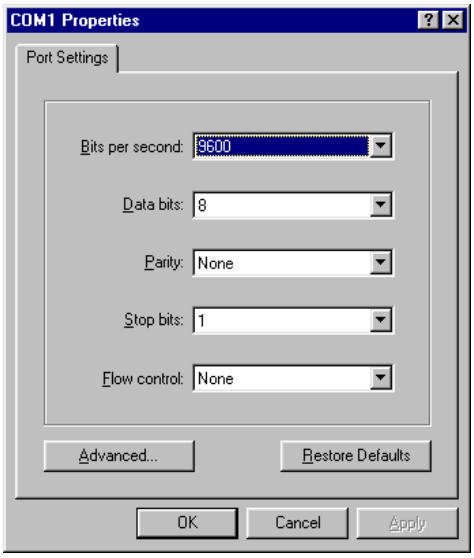

Figure 2: COM Port Basic Settings

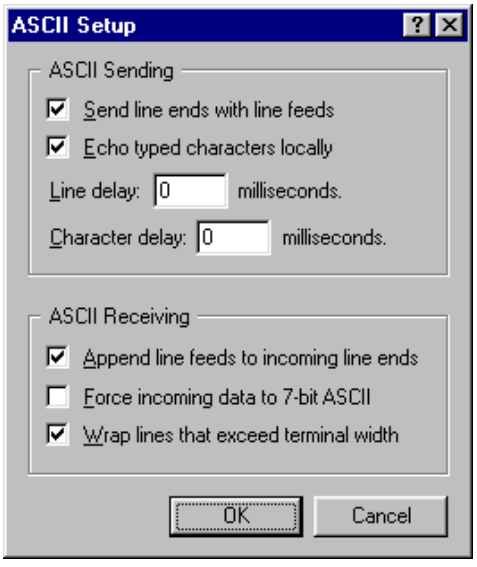

Figure 3: COM Port ASCII Setup

5.2 USB Port Settings

To communicate with the unit through USB port, a standard USB cable should be used to connect the computer USB port (USB Type A connector) to the unit (USB Type B connector) . If the USB cable is installed, the unit will communicate through the USB port and the RS-232 port will be automatically disabled.

The unit supports the standard USB Communication Device Class (CDC), used to simulate RS-232 port using the USB hardware. Once the USB device is properly configured, a virtual COM port will be available through the USB device. So the PC application will be the same one as for the RS-232 option. The USB CDC driver is included in Windows 2000, XP and Vista.

Once the unit is powered-on and the USB cable is connected properly, a new device detection wizard will appear in Windows, the first time the USB device is detected.

Figure 4: USB Install Hardware Device Drivers

Point the wizard to the folder where the info file ***mpbcusbcdc64bit.inf*** is located.

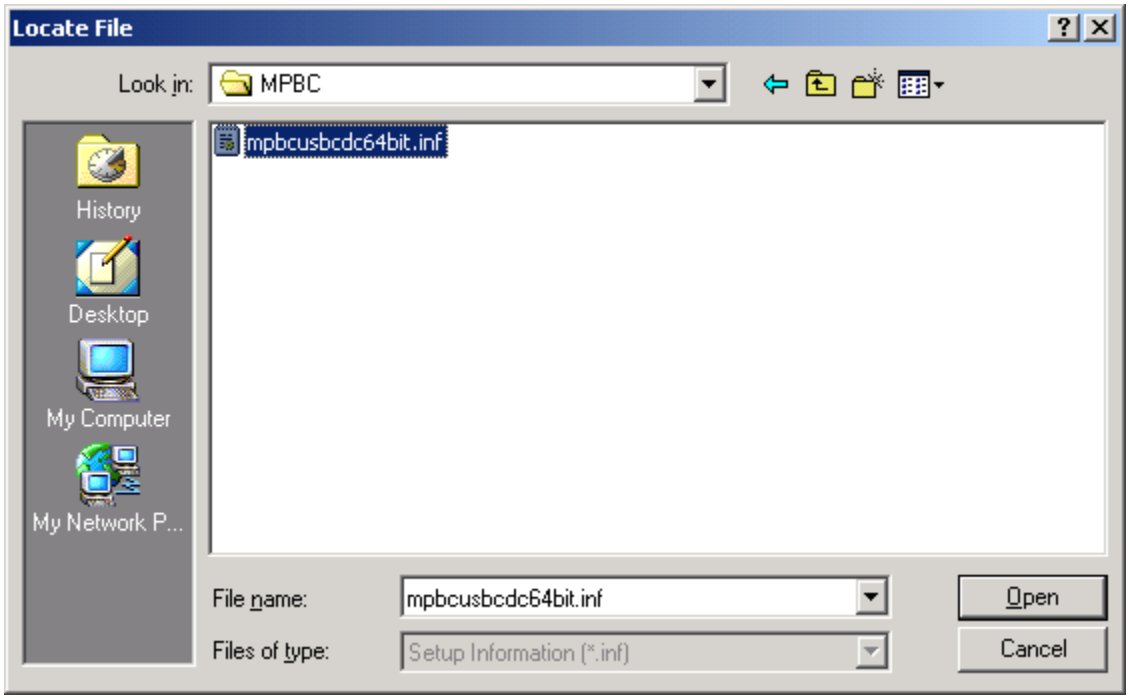

Figure 5: USB Locate File

For older Windows 32-bit systems, you may also use ***mpbcusbcdc.inf***.

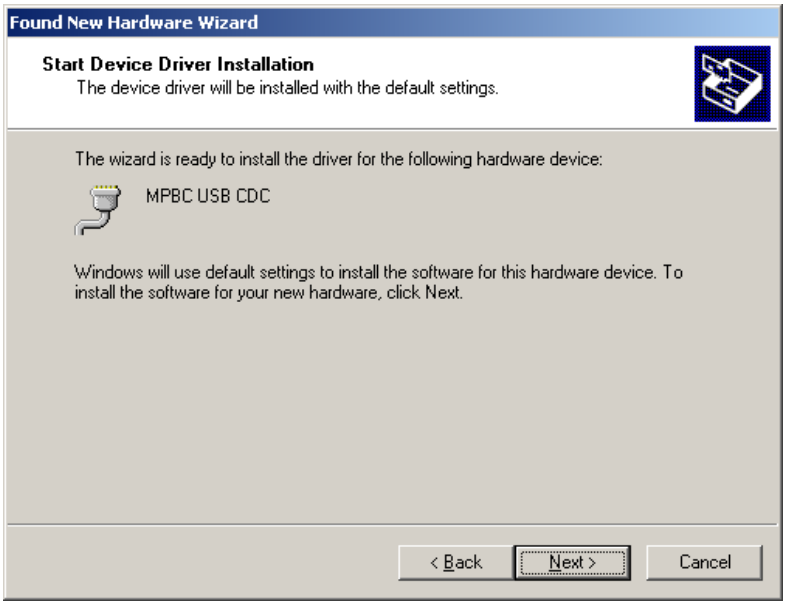

Figure 6: USB Start Device Driver Installation

Then check in the Device Manager utility, that the unit is enumerated as a **MPB USB CDC** COMn Port.

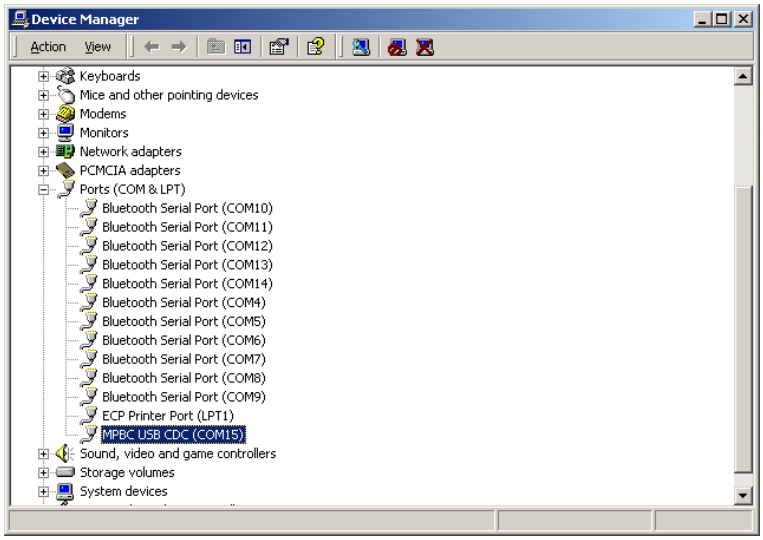

Figure 7: Device Manager Ports

Then you can select this COMn port in the GUI application to communicate with the unit.

6 Command Set

6.1 Command Format

All commands are to be typed on one line. There can be one or more spaces between the command and the first argument, and between arguments. A command ends with a carriage return.
When the User submits a command from the HyperTerminal to the laser, the command gets processed, and then the laser returns the related reply to the HyperTerminal.
If this reply happens to be positive, the expected arguments are returned. However, if the reply is negative, the only argument returned is a single string containing an error message.

Each command will have the format 'Cmnd(CR)' where:

Cmnd is the command string from the command set
(CR) is the Carriage Return(0xD) terminating character of the command string

An optional Line Feed (LF) character can be added after the Carriage Return (CR) character.
(LF) is the Line Feed (0xA) optional character

Each reply to a valid command will have the format 'Data(CR)D >' where:

Data is the Data string returned in response to the command string
(CR) is the Carriage Return (0xD) character
D > is the reply prompt for a valid command

Each reply to an invalid command will have the format 'Data(CR)F >' where:

Data is the Data string returned in response to the command string
(CR) is the Carriage Return (0xD) character
F > is the reply prompt for an invalid command

6.2 Essential Commands

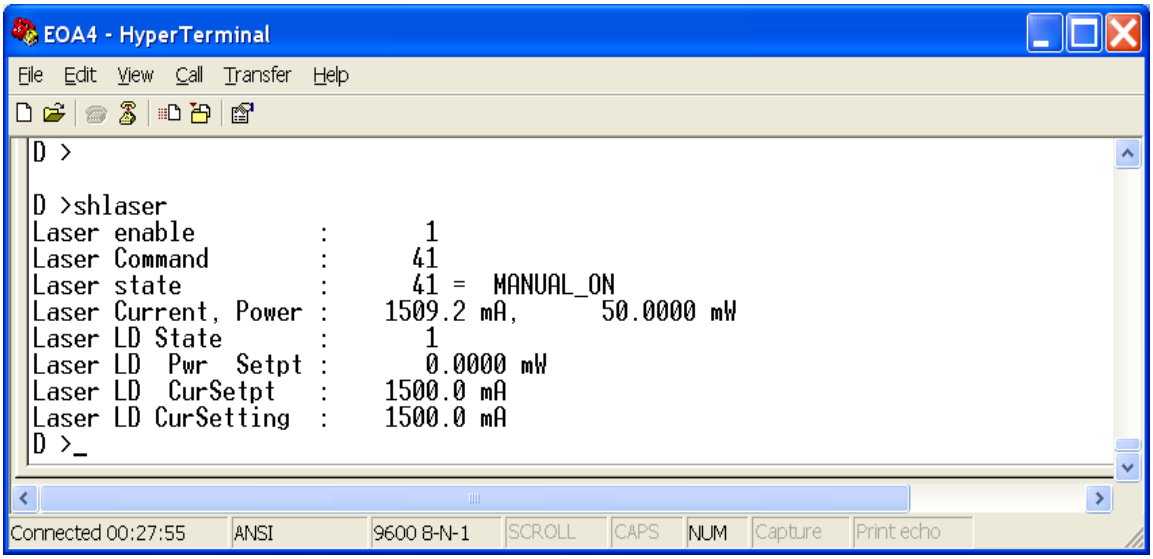

Figure 8: SHLASER - to show various laser parameters

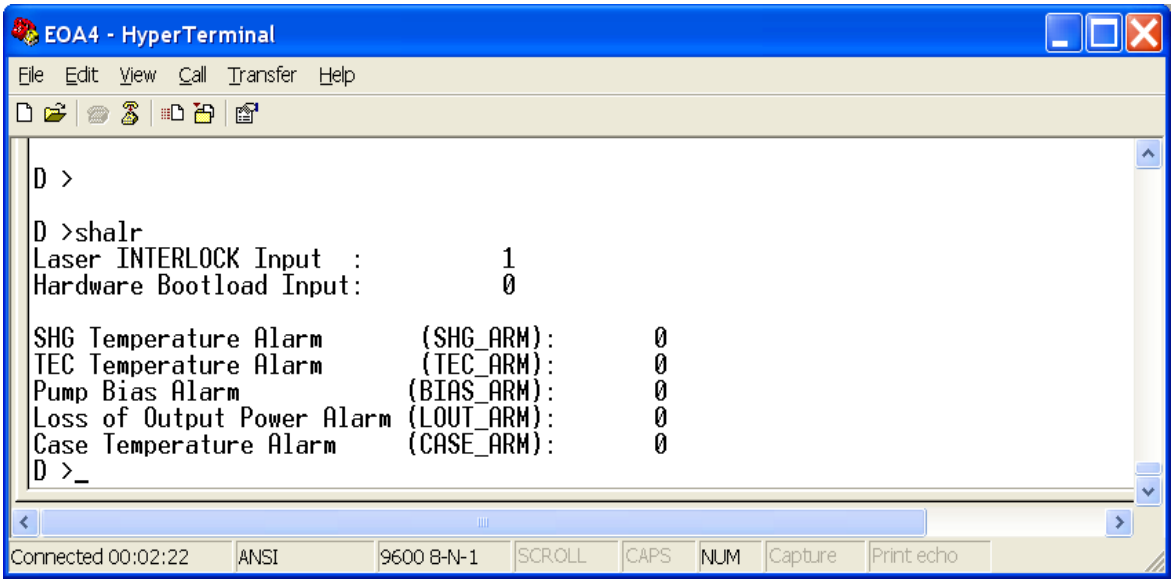

Figure 9: SHALR - to see input and alarm states

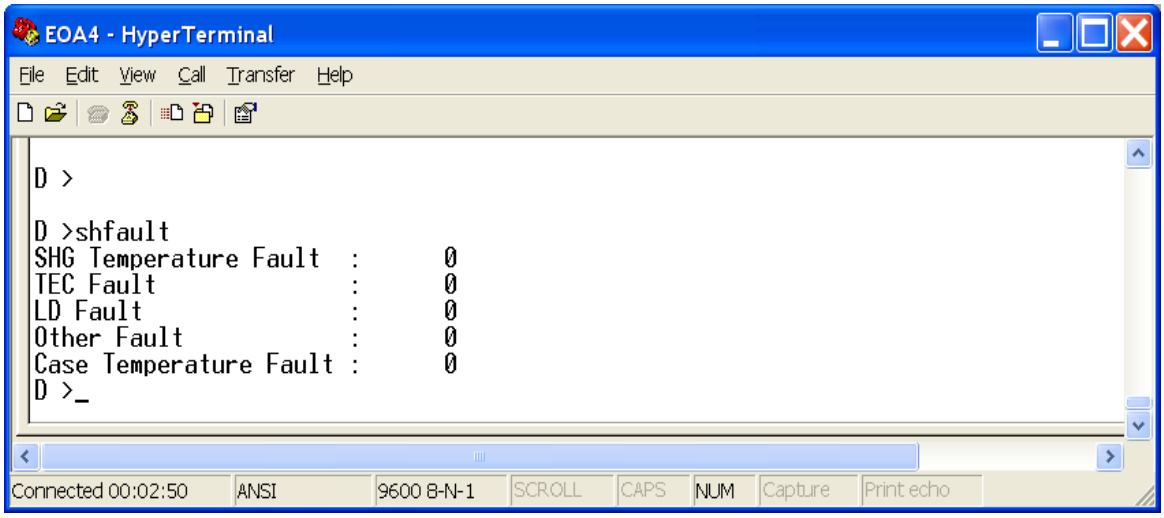

Figure 10: SHFAULT - to see fault states

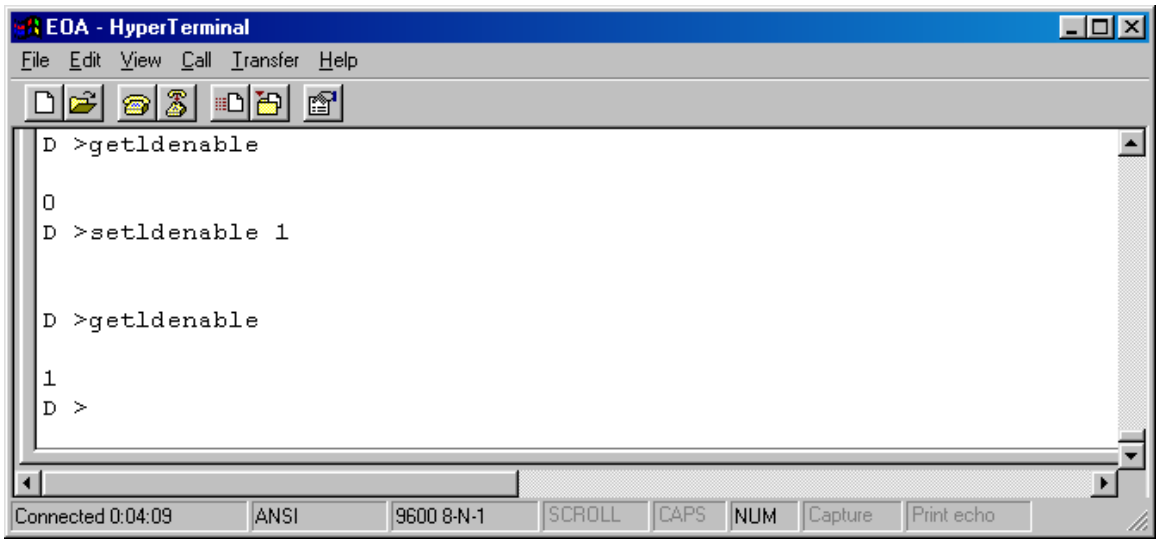

Figure 11: SETLDENABLE – to enable and disable Laser Driver

SETLDENABLE 1 :	To enable the Laser Driver
SETLDENABLE 0 :	To disable the Laser Driver
GETLDENABLE :	To get the Laser Driver Enable status

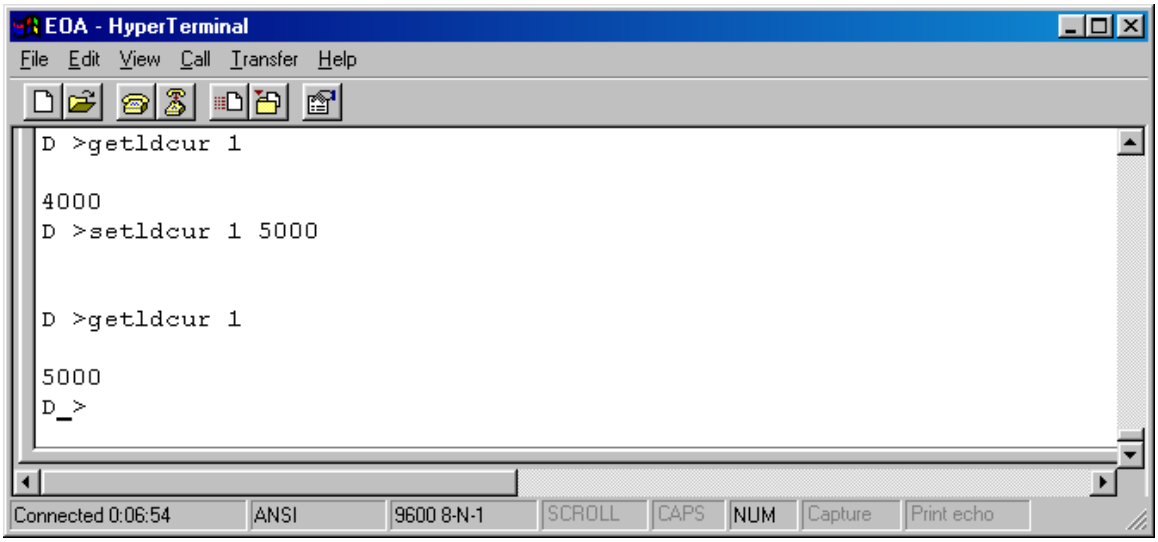

Figure 12: SETLDCUR – to set the Laser Current

SETLDCUR : To set laser diode current (mA) in ACC Mode
GETLDCUR : To get laser diode current set point (mA) in ACC Mode

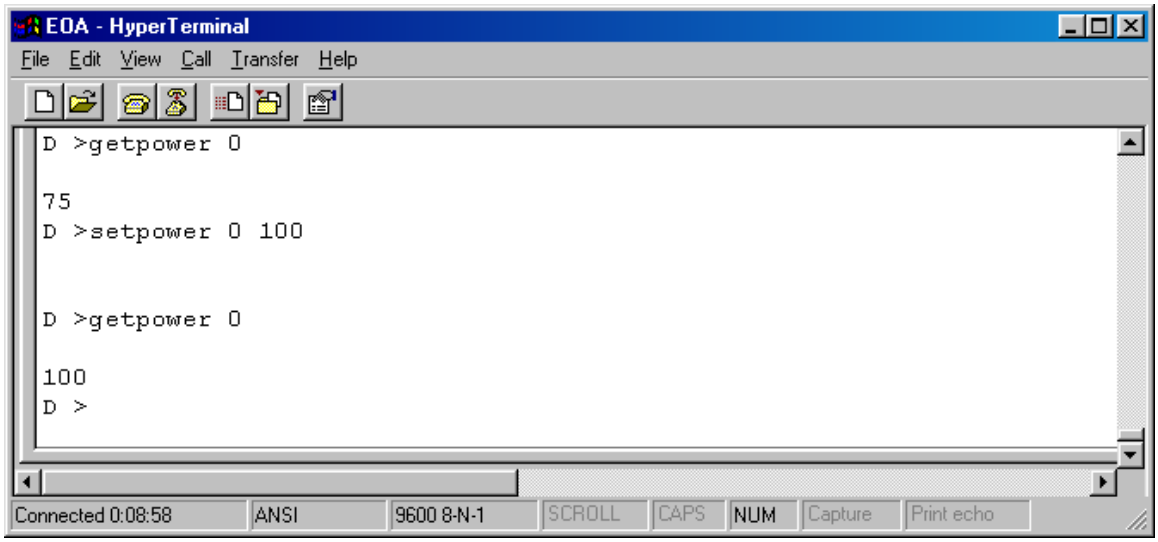

Figure 13: SETPOWER – to set the Laser Power

SETPOWER 0: To set output power set point (mW) in APC Mode
GETPOWER 0: To see output power set point (mW) in APC Mode

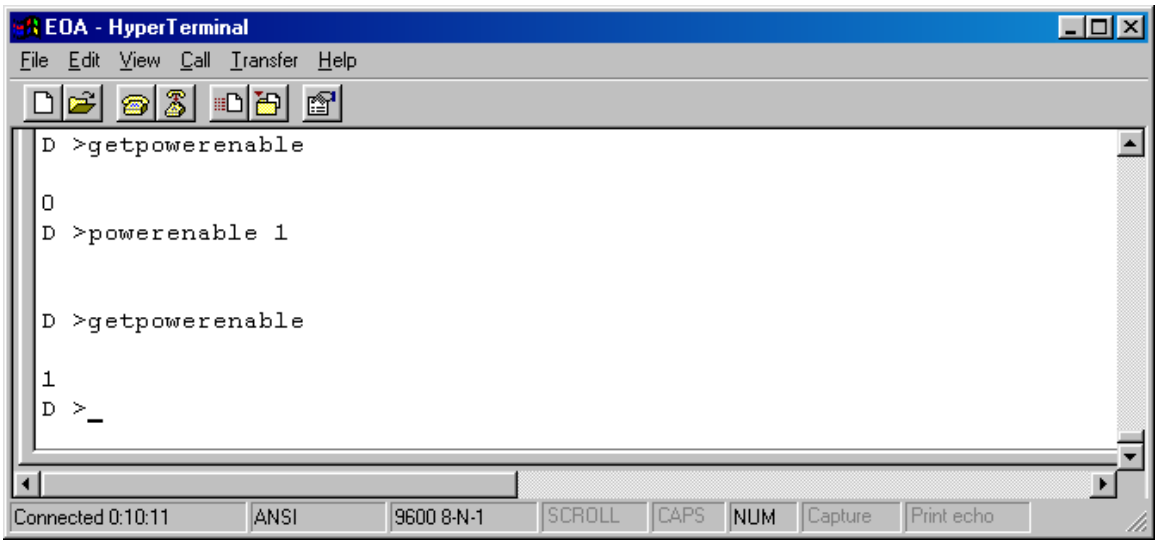

Figure 14: POWERENABLE – to set the Laser mode of Operation

POWERENABLE 1 :	To set the Laser in Automatic Power Control (APC)
POWERENABLE 0 :	To set the Laser in Automatic Current Control (ACC)
GETPOWERENABLE :	To get the Laser Mode of Operation

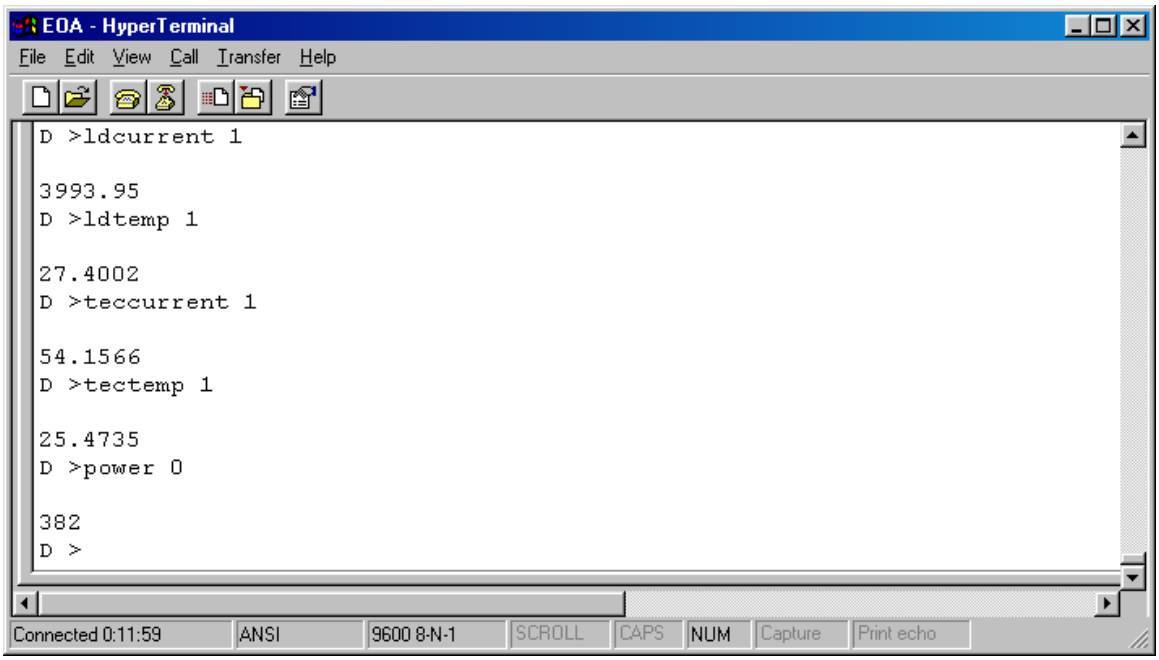

Figure 15: Various Commands – to monitor the Laser

LDCURRENT : To get the Laser Diode current (mA)
LDTEMP : To get the Laser Diode temperature (ºC)
TECCURRENT : To get the TEC Driver current (mA)
TECTEMP : To get the TEC temperature (ºC)
POWER 0 : To get the laser output power (mW)

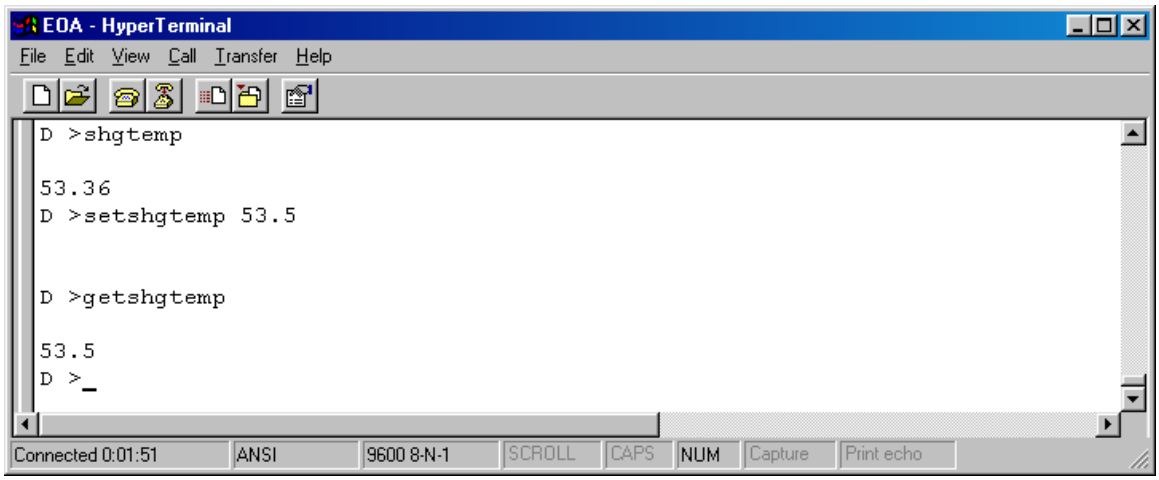

Figure 16: Various Commands – to control the SHG

SETSHGTEMP : To set the SHG temperature set point(ºC)
GETSHGTEMP : To get the SHG temperature set point (ºC)
SHGTEMP : To get the SHG temperature (ºC)

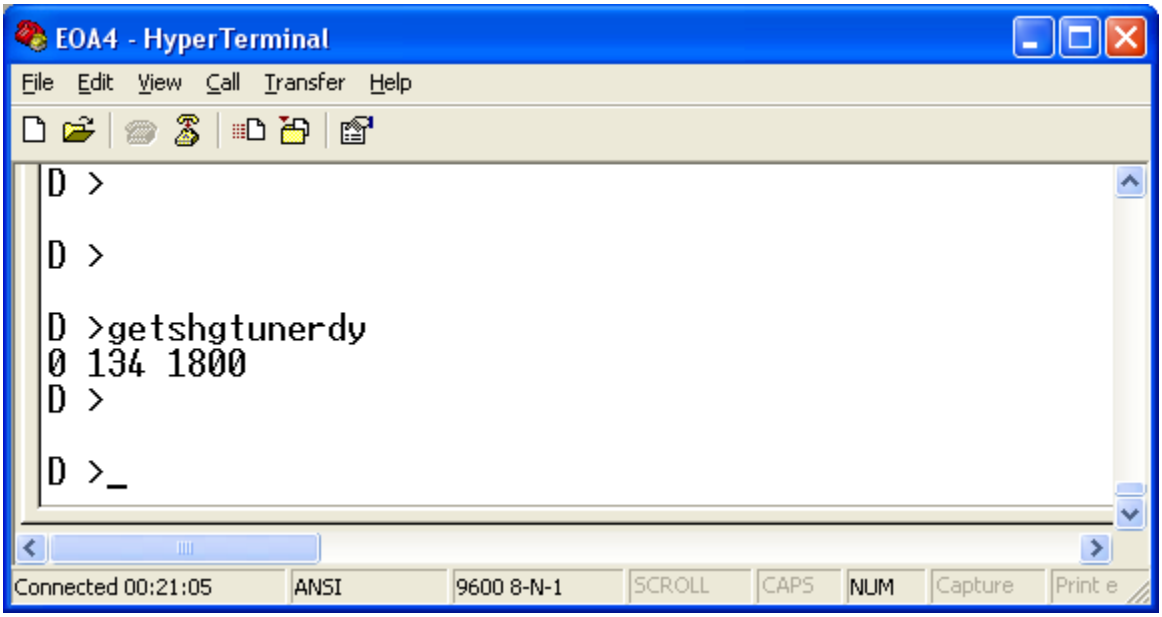

Figure 17: Getting information about laser ready for SHG tuning

GETSHGTUNERDY returns 0 134 1800
Arg1 = 0: indicates Laser not ready
Arg1 = 134: indicates Next SHG tuning scheduled in 134 hours of operation
Arg2 = 1800: indicates Warm-up period expired in 1800 seconds

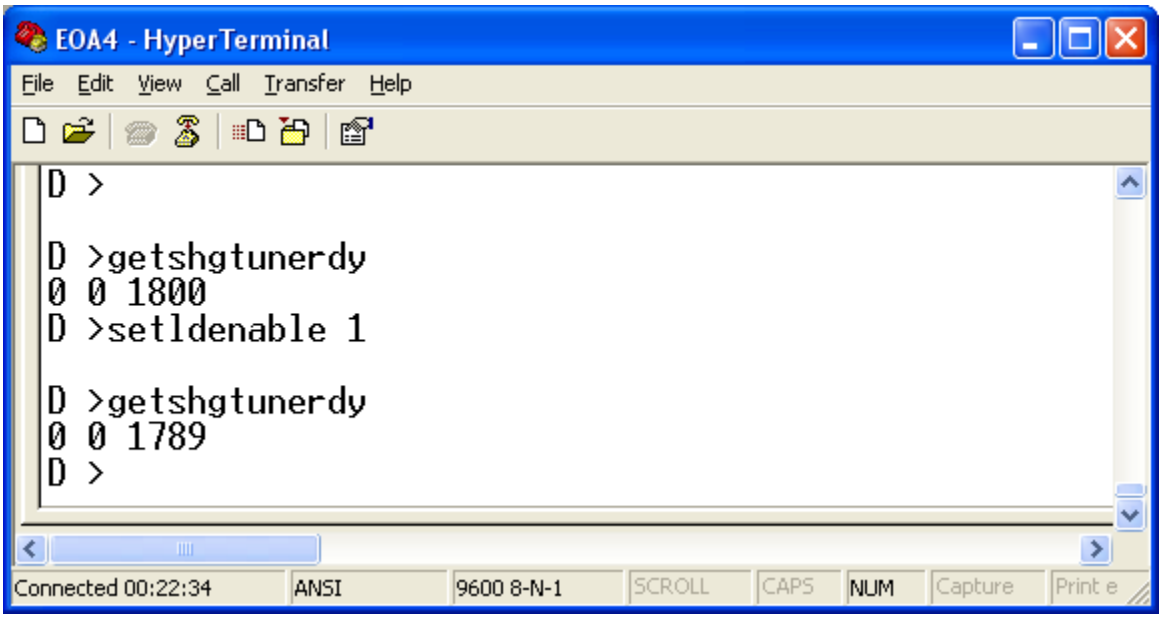

Figure 18: Enabling Laser driver

GETSHGTUNERDY returns 0 0 1800
Arg1 = 0: indicates Laser not ready
Arg2 = 0: indicates Next SHG tuning is scheduled for now
Arg3 = 1800: indicates Warm-up period expires in 1800 seconds

SETLDENABLE 1
Arg1 = 1: to enable Laser driver

GETSHGTUNERDY returns 0 0 1789
Arg1 = 0: indicates Laser not ready
Arg2 = 0: indicates Next SHG tuning is scheduled for now
Arg3 = 1789: indicates Warm-up period expires in 1789 seconds

Once laser driver is enabled, Warm-up period is decrementing

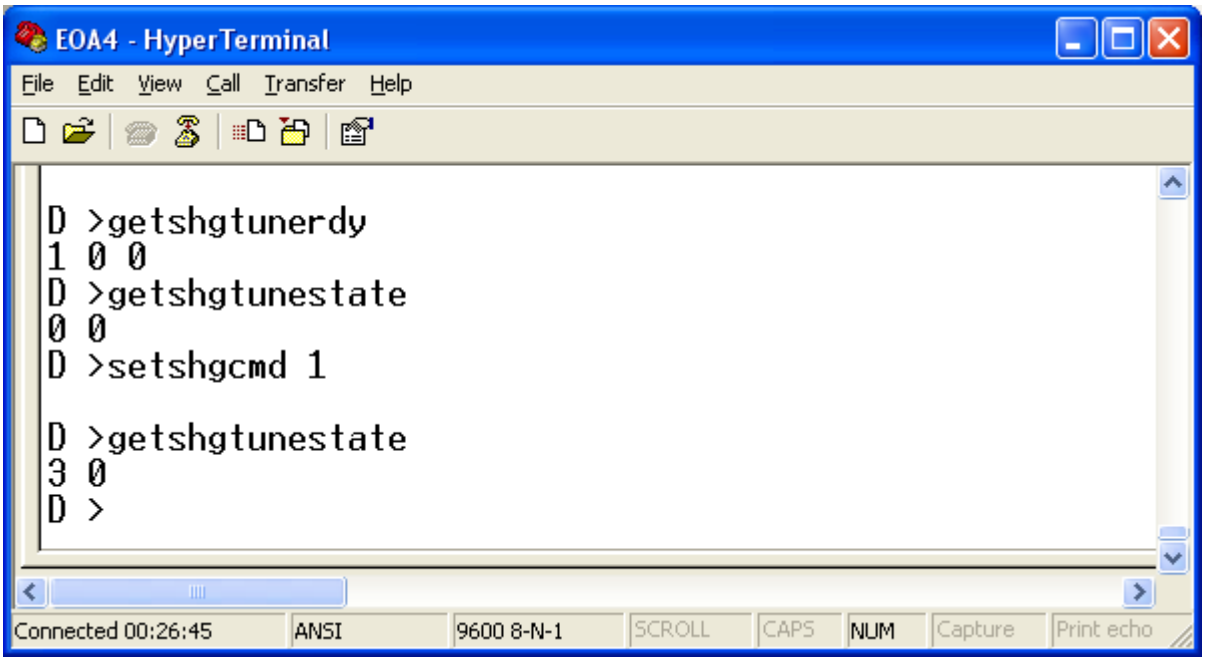

Figure 19: Initiating SHG tuning

GETSHGTUNERDY returns 1 0 0
Arg1 = 1: indicates Laser is ready for SHG tuning
Arg2 = 0: indicates Next SHG tuning is scheduled for now
Arg3 = 0: indicates Warm-up period has expired

GETSHGTUNESTATE returns 0 0
Arg1 = 0: indicates no SHG tuning performed since last reset
Arg2 = 0: indicates no error detected

SETSHGCMD 1
Arg1 = 1: to initiate SHG tuning

GETSHGTUNESTATE returns 3 0

Arg1 = 3: indicates SHG tuning in progress
Arg2 = 0: indicates no error detected

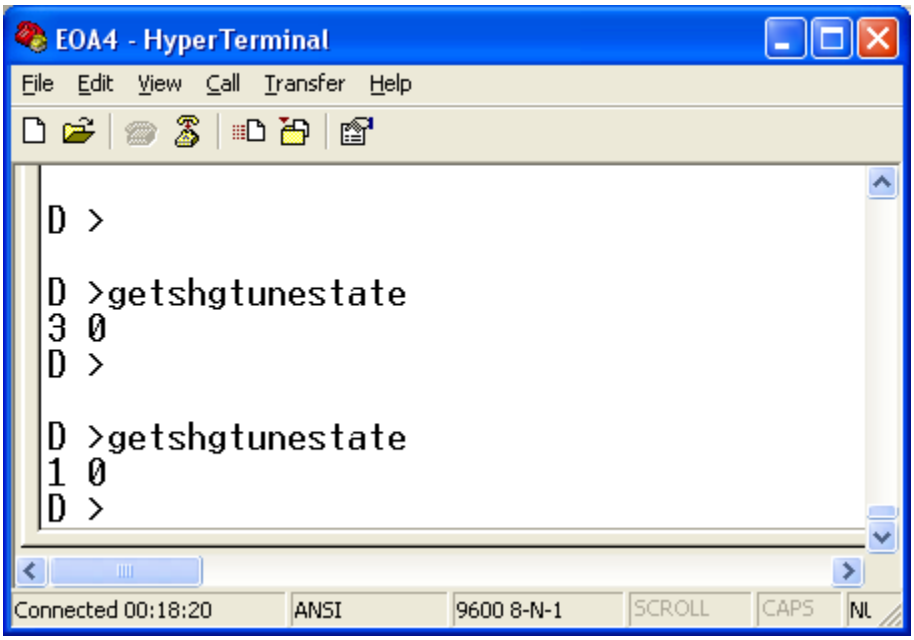

Figure 20: Checking SHG tuning state

GETSHGTUNESTATE returns 3 0
Arg1 = 3: indicates SHG tuning in progress
Arg2 = 0: indicates no error detected

GETSHGTUNESTATE returns 1 0
Arg1 = 1: indicates SHG tuning completed successfully
Arg2 = 0: indicates no error detected

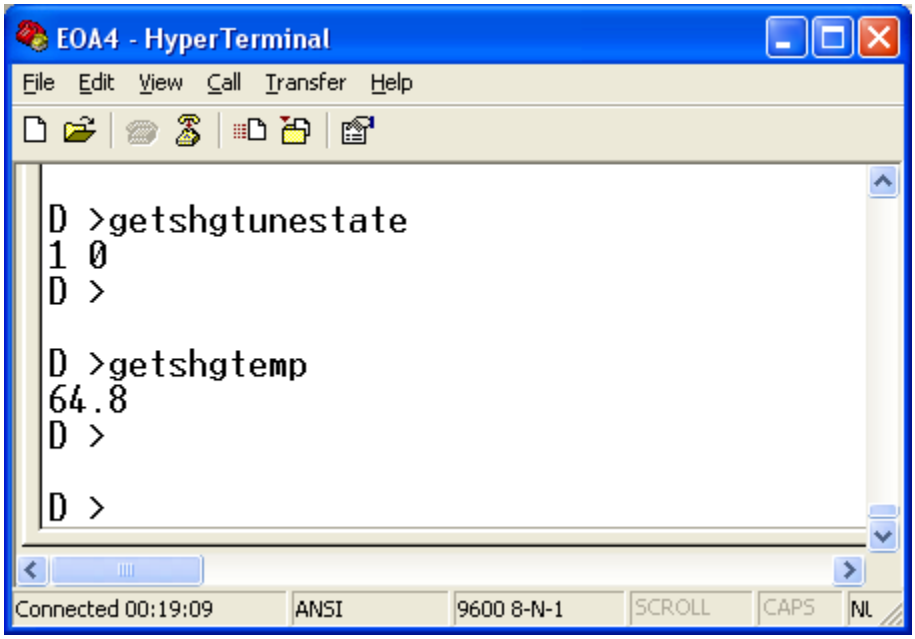

Figure 21: Checking SHG temperature after SHG Tuning

GETSHGTUNESTATE returns 1 0
Arg1 = 1: indicates SHG tuning - completed successfully
Arg2 = 0: indicates no error detected

GETSHGTEMP returns 64.8
Arg1 = 64.8: indicates 64.8 ºC is the new SHG Temperature set point after SHG tuning has completed

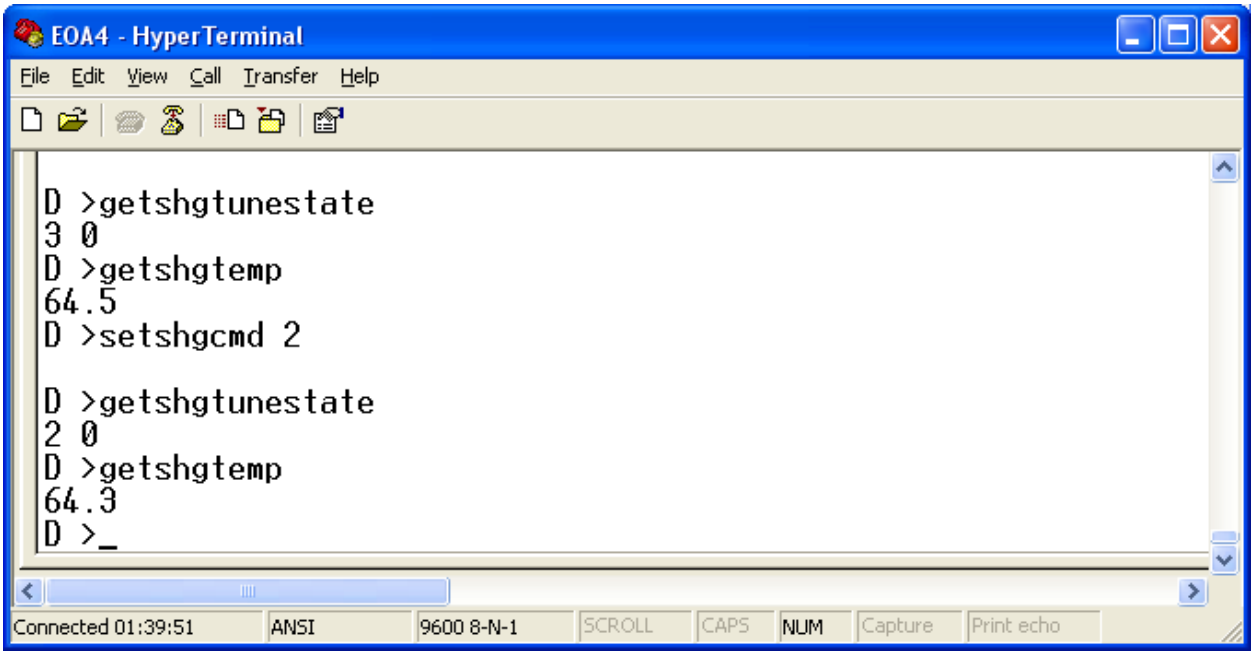

Figure 22: Aborting SHG Tuning

GETSHGTUNESTATE returns 3 0
Arg1 = 3: indicates SHG tuning in progress
Arg2 = 0: indicates no error detected

GETSHGTEMP returns 64.5
Arg1 = 64.5: indicates 64.5 ºC is the actual SHG Temperature set point averaged during the SHG tuning in progress

SETSHGCMD 2
Arg1 = 2: to abort SHG tuning

GETSHGTUNESTATE returns 2 0
Arg1 = 2: indicates SHG tuning aborted
Arg2 = 0: indicates no error detected because it is aborted by the user

GETSHGTEMP returns 64.3
Arg1 = 64.3: indicates 64.3 ºC was the SHG Temperature set point before SHG tuning was started. Because the SHG tuning was aborted, the initial SHG Temperature set point is restored.

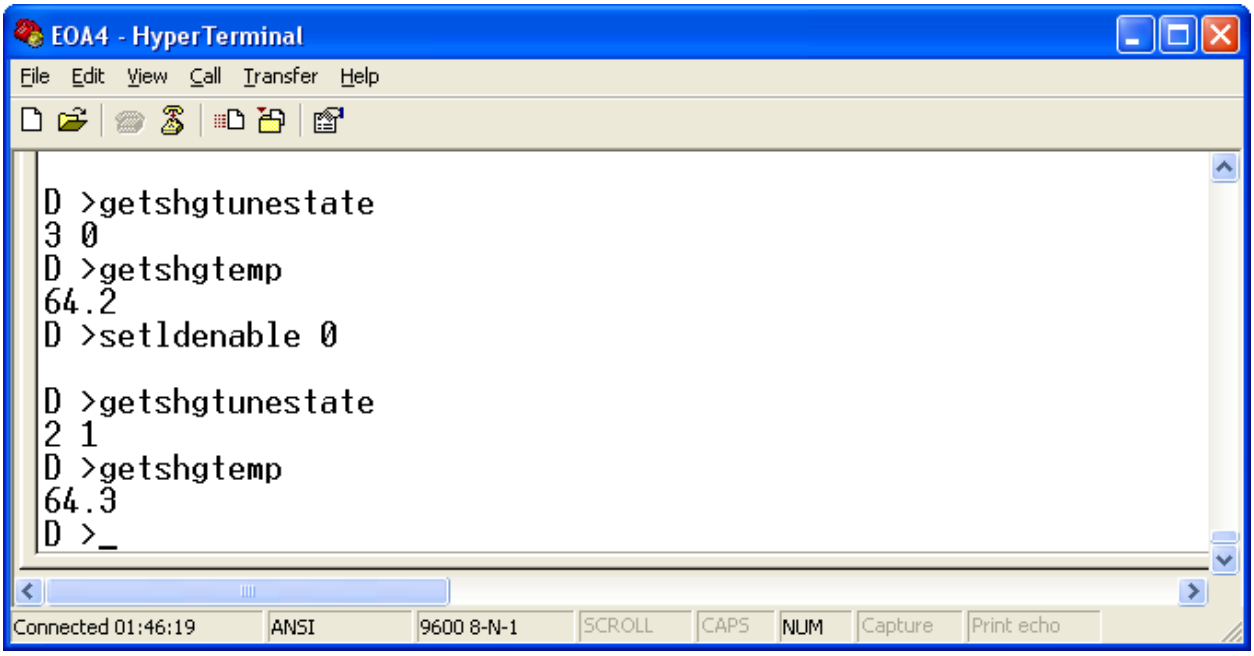

Figure 23: Disabling Laser during SHG Tuning

GETSHGTUNESTATE returns 3 0
Arg1 = 3: indicates SHG tuning in progress
Arg2 = 0: indicates no error detected

GETSHGTEMP returns 64.2
Arg1 = 64.2: indicates 64.2 ºC is the actual SHG Temperature set point averaged during the SHG tuning in progress

SETLDENABLE 0
Arg1 = 0: to disable Laser driver

GETSHGTUNESTATE returns 2 1
Arg1 = 2: indicates SHG tuning aborted
Arg2 = 1: indicates error “Laser not running in expected state”

GETSHGTEMP returns 64.3
Arg1 = 64.3: indicates 64.3 ºC was the SHG Temperature set point before SHG tuning was started. Because the SHG tuning was aborted, the initial SHG Temperature set point is restored.

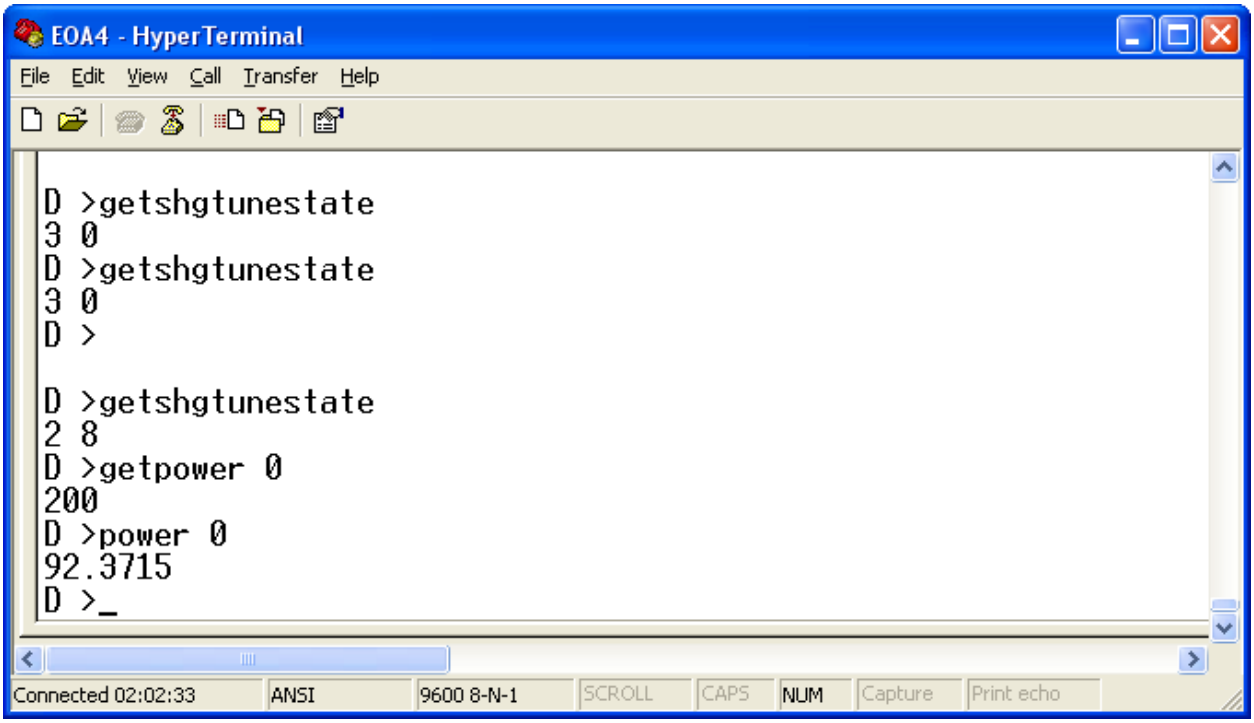

Figure 24: Output Power not Stabilized during SHG Tuning

GETSHGTUNESTATE returns 3 0
Arg1 = 3: indicates SHG tuning in progress
Arg2 = 0: indicates no error detected

GETSHGTUNESTATE returns 2 8
Arg1 = 2: indicates SHG tuning aborted
Arg2 = 0: indicates error “Output Power not stabilized”

GETPOWER 0 returns 200
Arg1 = 200: indicates 200 mW is the laser Output Power setpoint

POWER 0 returns 92.3712
Arg1 = 92.3712: indicates 92.3712 mW is the monitored Output power of the laser system

The SHG Tuning algorithm expects the average monitored output power to be within +/- 1% of the output power set point. Because the monitored value is out of this range, an error is returned and the SHG tuning is aborted. Because the SHG tuning is aborted, the initial SHG Temperature set point is restored.

6.3 List of Commands

Command Outgoing request submitted from HyperTerminal				**Reply** Incoming positive response returned by the amplifier
P/T	**Name**	**Arguments**	**Description**	**Arguments**
P	CLREE	None or 1:[0]	Restore Default Settings in non-volatile memory	None
P	FWRESET	None	Firmware reset	None
P	GETACCCURMAX	None	Get the maximum current setpoint in ACC mode. A zero value indicates no special limit in ACC mode than the one returned by GETLDLIM	1: : Maximum Current in ACC mode, integer, mA
P	GETAINUM	None	Get the number of analog input signals	1: Number, integer
P	GETAISYM	1: Index, integer	Get the analog input symbol name that has the given index	1: Symbol, string
P	GETAIVAL	1: Analog input signal [0..6]	Get specified analog input value	1: Value, float
P	GETALARM	1: Alarm case [0..4]	Get specified alarm state	1: Flag [0, 1]
P	GETALR	None	Get alarms	1: SHG Temperature, flag [0, 1] 2: TEC Temperature, flag [0, 1] 3: Pump Bias, flag[0,1] 4: Loss Of Output, flag [0, 1] 5:Case Temperature, flag[0,1]
P	GETALRLOG Version 2.3.0.0 or later	1: Alarm case [0..4]	Get specified alarm accumulated elapsed time	1: # of Hours, integer [0..11930046] 2: # of seconds, integer [0..3599]
P	GETCASELIM	1: LDD Board [1-3]	Get laser diode Case Temperature limit parameters for the specified pump	1: Minimum Temperature, float °Celsius 2: Maximum Temperature, float °Celsius
P	GETCASETHR	None	Get laser diode Case Index and Case Temperature thresholds to generate alarm	1: LDD Board [1-3] 2: Low Temperature, float °Celsius 3: High Temperature, float °Celsius
P	GETFAULT	1: Fault case [0..4]	Get specified fault	1: Flag [0, 1]
P	GETFLT	None	Get faults	1: SHG temperature, flag [0, 1] 2: Tec temperature, flag [0, 1] 3: Laser diode current, flag [0, 1] 4: Watchdog timeout, flag [0, 1] 5: Case temperature, flag [0, 1]

Command Outgoing request submitted from HyperTerminal				**Reply** Incoming positive response returned by the amplifier
P/T	**Name**	**Arguments**	**Description**	**Arguments**
P	GETFLTLOG Version 2.3.0.0 or later	1: Fault case [0..4]	Get specified fault accumulated latched counts	1: Fault Count, integer [0..65535]
P	GETFWREV	None	Get laser controller firmware revision	1: Version, string
P	GETINPUT	11: Input index: [0: Interlock input, 1: Hardware Bootload input, Only for Key version : 2: Key OFF input	Get specified physical input actual state	1: Flag [0:Off, 1: On]
P	GETLASERSTATE	None	Get laser actual state	1: Laser State Code, integer
P	GETLASERSTATENUM	None	Get the number of laser different states	1: Number, integer
P	GETLASERSTATESYM	1:Index, integer	Get the laser state code and symbol name for the specified index	1; Laser State Code, integer 2: Laser State Symbol, string
P	GETLDCUR	1: LD pump [1-3]	Get specified laser diode current set point when laser in manual mode	1: Current, integer, mA
P	GETLDENABLE	None	Get laser software enable flag value	1: Flag [0: Disable, 1: Enable]
P	GETLDLIM	1: LD pump [1-3]	Get laser diode limit parameters for the specified pump	1: Minimum Current, integer, mA 2: Maximum Current, integer, mA 3: Current Protection Threshold, integer, [0…255]
P	GETLDMODE Only for VFL MOPA	1: LD pump [1: Seed, 2:PreAmp, 3:Booster]	Get laser diode control mode when laser in automatic mode	1:Mode, integer,[0: ACC, 1: APC]
P	GETLDSTATE	1: LD pump [1-3]	Get the State for the specified laser diode driver	1: State [0: Off, 1:On, 2: Turning Off, 3:Turning On, 4: Fault]
P	GETLOOLIM	None	Get the Low and High power difference relative to the output power set point (In APC mode to declare the LOS output Alarm	1: Low power, Float, dB 2: High Power Float, dB
P	GETLOOLIMPC	None	Get the Low and High power difference relative to the output power set point (In APC mode to declare the LOS output Alarm	1: Low power, Float, % 2: High Power Float, %
P	GETMODEL	None	Get laser model number	1: Model, string

Command Outgoing request submitted from HyperTerminal				**Reply** Incoming positive response returned by the amplifier
P/T	**Name**	**Arguments**	**Description**	**Arguments**
P	GETOUT	None	Get outputs	1: Fault flag [0, 1] 2: Laser ON, flag [0, 1] 3: Laser Warming up and not ready to operate. flag [0, 1] 4: Service Affected, flag [0, 1]
P	GETPOWER	1: 0	Get laser output power set point in APC mode	1: Power, float, mW
P	GETPOWERENABLE	None	Get laser mode	1:Mode, integer,[0: ACC, 1: APC]
P	GETPOWERSETPTLIM	1: 0	Get limit parameters for the laser output power set point	1: Minimum Power, float, mW 2: Maximum Power, float, mW
P	GETSHGCMD Only for SHG Temp Tuning version	None	Get SHG actual command	1: SHG Command [0: No command executing, 1:SHG Tuning w/prerequisites initiated, 2: SHG Tuning aborting, 99: SHG Tuning w/out prerequisites initiated]
P	GETSHGTEMP	None	Get SHG sensor temperature set point	1: Float, °Celsius
P	GETSHGTUNERDY	None	Get SHG Ready for Tuning state and left time	1: State [0: SHG Tuning w/prerequisites Not Ready, 1:SHG Tuning w/prerequisites Ready] 2: # of Hours of laser operation left before next scheduled SHG Tuning, integer [0…65535] 3: # of Seconds of laser operation left before end of warm-up at actual output power, integer, [0..65535]

Command Outgoing request submitted from HyperTerminal				**Reply** Incoming positive response returned by the amplifier
P/T	**Name**	**Arguments**	**Description**	**Arguments**
P	GETSHGTUNESTATE	None	Get SHG Tuning state and error status	1: State [0: Tuning OFF, 1:Tuning Completed, 2:Tuning Aborted, 3: Tuning In Progress] 2:Error Status Bitmap [0..31] where: 0: No Error, 1: Laser not running in espected state, 2: SHG Temp not set, 4: SHG Temp not stabilized, 8: Output Power not stabilized in APC mode 16: SHG Temp out of limits] 32: LD Current not stabilized in ACC mode, 64: No Power Peak detected in ACC mode
P	GETSN	None	Get laser serial number	1: Serial #, string
P	GETSTATE	None	Get laser controller state	1: State, integer [0:Init, 1: Normal, 2: ALS]
P	GETSTATUS	1: LDD Board [1-3]	Get the State for the specified laser diode driver board	1: LDD Alarms [0..511] 2: LDD Faults [0..1023] 3: LDD state [0:Init, 1:Normal, 2:ALS]
P	GETTECSETPT	1: TEC driver [1-3: TEC1-3, 4:SHG, 5:TEC5]	Get specified TEC driver temperature set point	1: Temperature, Float, °Celsius
P	GETTECSTATE	1: TEC driver [1-3: TEC1-3, 4:SHG, 5:TEC5]	Get the State for the specified TEC driver	1: State [0: Off, 1:On, 2: Turning Off, 3:Turning On, 4: Fault]
P	GETTIMEOP	None	Get Time of Operation of laser head	1: # of Hours, integer [0..11930046] 2: # of seconds, integer [0..3599] 3: # of msec, integer [0.999]
P	GETTIMEOPCTRL	None	Get Time of Operation of laser controller	1: # of Hours, integer [0..11930046] 2: # of seconds, integer [0..3599] 3: # of msec, integer [0.999]
P	LASERSTATE Only for VFL MOPA	1: Laser Stage [1: Seed, 2:PreAmp, 3:Booster]	Get specified laser stage actual state flag	1: Flag [0 : Output not OK , 1 : Output OK]
P	LDCURRENT	1: LD pump [1-3]	Get specified laser diode actual current	1: Current, integer, mA
P	LDTEMP	1: LD pump [1: LD1]	Get specified laser diode actual case temperature	1: Temperature, Float, °Celsius
P	NOOPERATION	None	Do nothing .	None
P	POWER	1: Power INDEX [0:Output, 1-3: LD1-3]	Get laser monitored powers	1: Power, float, mW

Command Outgoing request submitted from HyperTerminal				**Reply** Incoming positive response returned by the amplifier
P/T	**Name**	**Arguments**	**Description**	**Arguments**
P	POWERENABLE	1:Mode, integer,[0: ACC, 1: APC]	Set laser mode	None
P	SAVEALL	None or 1:[0]	Save actual settings in non-volatile memory	None
P	SETCASETHR	1: LDD Board [1-3] 2: Low Temperature, float °Celsius 3: High Temperature, float °Celsius	Set laser diode Case Index and Case Temperature thresholds to generate alarm	None
P	SETLDCUR	1: LD pump [1-3] 2: Current, integer, mA	Set specified laser diode current set point when laser in manual mode	None
P	SETLDENABLE	1: Flag [0: Disable, 1: Enable]	Set laser software enable flag value	None
P	SETLOOLIM	1: Low power, Float, dB 2: High Power Float, dB	Set the Low and High power difference relative to the output power set point (In APC mode to declare the LOS output Alarm	None
P	SETLOOLIMPC	1: Low power, Float, % 2: High Power Float, %	Set the Low and High power difference relative to the output power set point (In APC mode to declare the LOS output Alarm	None
P	SETPOWER	1: 0 2: Power, float, mW	Set laser output power set point in APC mode	None
P	SETSHGCMD	1: SHG Command [1:Initiate SHG Tuning w/prerequisites, 2: Abort SHG Tuning, 99: Initiate SHG Tuning w/out prerequisites]	Set SHG command	None
P	SETSHGTEMP	1: Float, °Celsius	Set SHG sensor temperature set point	None
P	SHAI	None	Show analog input signals	
P	SHALR	None	Show alarms	
P	SHFAULT	None	Show faults	
P	SHGTEMP	None	Get SHG sensor actual temperature	1: Float, °Celsius
P	SHLASER	None	Show Laser settings and measurements	
P	TECCURRENT	1: TEC driver [1-3: TEC1-3, 4:SHG, 5:TEC5]	Get specified TEC driver actual current	1: Current, integer, mA
P	TECTEMP	1: TEC driver [1-3: TEC1-3, 4:SHG, 5:TEC5]	Get specified TEC sensor actual temperature	1: Float, °Celsius
P	VCCMON	1: LD pump [1] 2:VCC index[1:12Volt VCC, 2:5Volt VCC]	Get the specified VCC voltage	1: Voltage, float, Volt

6.3.1 MCU and LDD States

Code	Symbol	Meaning
0	ST_INIT	Initialization state
1	ST_NORMAL	Operational state
2	ST_ALS	Fault state

6.3.2 Laser States

Code	Symbol	Meaning
0	OFF	Laser driver disabled by user. TEC drivers are enabled.
6	KEYLOCK	Laser driver disabled. Key must be switched OFF then ON. (Only for KEY version)
7	INTERLOCK	Laser driver disabled by interlock input signal
8	FAULT	Laser in fault conditions
20	STARTUP	Laser driver ready to start up.
31	MANUAL_TURNING_ON	Laser driver turning on in manual mode.
41	MANUAL_ON	Laser driver running in manual mode.
42	AUTO_ON	Laser driver running in automatic mode Only for not VFL MOPA
43	SEED_ON	Laser driver SEED stage is running. Only for VFL MOPA
44	SEED_OK	Laser driver SEED stage state power is OK. Only for VFL MOPA
45	PREAMP_ON	Laser driver PREAMP stage is running. Only for VFL MOPA
46	PREAMP_OK	Laser driver PREAMP stage state power is OK. Only for VFL MOPA
47	BOOSTER_TURN_ON	Laser driver BOOSTER stage is turning on. Only for VFL MOPA
49	BOOSTER_ON	Laser driver BOOSTER stage is running. Only for VFL MOPA
50	BOOSTER_OK	Laser driver BOOSTER stage state power is OK. Only for VFL MOPA

6.3.3 Analog Input Signals

Code	Symbol	Meaning
0	TEC_TH4_CH	TEC4 (SHG) temperature
1	TEC_TH5_CH	TEC5 temperature
2	TEC_C4_CH	TEC4 (SHG) current
3	TEC_C5_CH	TEC5 current
4	PW_OUT_CH	Optical output power
5	VCC_5V_CH	5 Volt Power Supply
6	VCC_12V_CH	12 Volt Power Supply

6.3.4 Alarm Cases

Code	Symbol	Meaning
0	AC_SHG	SHG temperature alarm
1	AC_TEC	TEC temperature alarm
2	AC_BIAS	Pump Bias alarm
3	AC_LOUT	Loss of Output Power alarm
4	AC_CASE	Case temperature alarm

6.3.5 Fault Cases

Code	Symbol	Meaning
1	FC_SHG	SHG temperature fault
2	FC_TECTEMP	TEC temperature fault
3	FC_LDCURRENT	Laser diode current fault
4	FC_OTHER	Other Faults
5	FC_CTEMP	Case temperature fault

6.3.6 LDD Alarms

Bit Value	Symbol	Meaning
1	TEC_TH	TEC Temperature
2	LD_CASE_TH	LD Case Temperature
4	PW_MON0	Power Monitor #1
8	PW_MON1	Power Monitor #2
16	TEC_C	TEC Current
32	LD_C	LD Current
64	VCC_MON	+5V Monitor
128	VIN_MON	+12V Monitor
256	INTL_LOW	Interlock active-low

6.3.7 LDD Faults

Bit Value	Symbol	Meaning
1	TEC_TH	TEC Temperature
2	LD_CASE_TH	LD Case Temperature
4	PW_MON0	Power Monitor #1
8	PW_MON1	Power Monitor #2
16	TEC_C	TEC Current
32	LD_C	LD Current
64	TEC_DRV	TEC Driver
128	LD_DRV	LD Driver
256	VCC_MON	+5V Monitor
512	VIN_MON	+12V Monitor

6.4 Error Messages

6.4.1 General Serial Errors (RS232 Module)

Error number	Error Message
0	Unidentified message number
1	Unknown command
2	Incorrect number of arguments
3	Casting buffer overflow
4	Unable to cast an argument
5	Undefined serial state
6	Command execution failed
7	Can only be used for tests

6.4.2 Specific Errors (CMD Module)

Where (A.n) refers to: request argument number “n”.

Error number	Error Message
0	Unidentified message number
1	Cannot retrieve request arguments
2	Command not implemented
3	Missing argument(s)
4	Not a Boolean (A.1)
5	Inactive ADC channel # (A.2)
6	Inactive AIN channel # (A.1)
7	Not an alarm case # (A.1)
8	Address out of range (A.1)
9	Cannot read from EEPROM
10	Not a fault case # (A.1)
11	Inactive LD # (A.1)
12	Buffer full
14	Cannot write to EEPROM
15	Not a Boolean (A.2)
16	Minimum should be lower than maximum
17	Current out of range (A.2)
18	Period out of range (A.1)
20	Temperature out of range (A.2)
21	Cannot apply new temperature
22	Out of range (A.3)
24	Not smaller or equal than high limit (A.3)
25	Not a Laser Mode (A.1))
26	Cannot update EEPROM checksum
27	Missing pointer
31	Not greater or equal than low limit (A.2)
33	Unable to access EEPROM
35	Power out of range
36	Cannot be applied when LD in APC mode
39	Number out of range (A.1)
40	Incorrect date (A.1)
42	Single letter or digit required (A.1)
43	Revision number required [0..99]
46	Data cannot be set
51	Not an analog input index (A.1)
53	Not a positive integer number (A.1)
57	Can only be done in test environment
58	Number out of range (A.2)
59	Warning, Voltage points must be INCREASING (A.2)
60	Warning, Attenuation points must be DECREASING (A.3)
63	Number out of range (A.3)
67	Non-initialized LDD module (A.1)
71	Number out of range (A.2)
72	Number out of range (A.4)
73	Number out of range (A.5)
74	Inactive TEC# (A.1)
75	Slope too small (A.3)
76	Not a positive integer number (A.2)
77	Not a positive integer number (A.3)
78	Inactive LDD # (A.1)
79	Password Requested (A.2)
80	Incorrect Password (A.2)
81	Cannot be applied when tuning SHG temperature
82	Cannot be applied when SHG not ready for tuning
83	Cannot be applied when SHG tuning not in progress

Error number	Error Message
84	Cannot be accepted, actual Setpoint out of range",

6.4.3 Error Message Examples

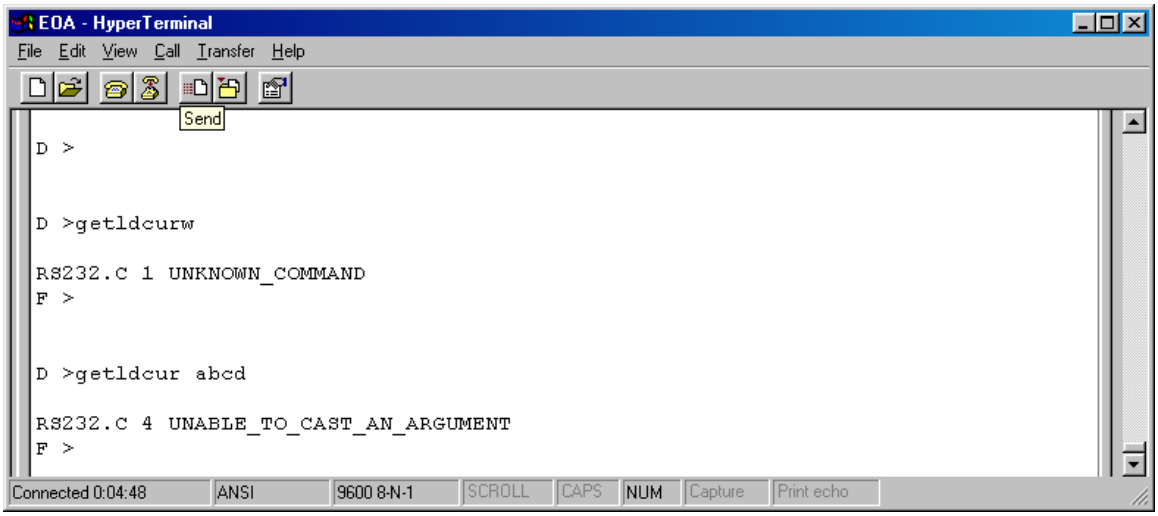

Figure 25: Various RS232 module Error messages

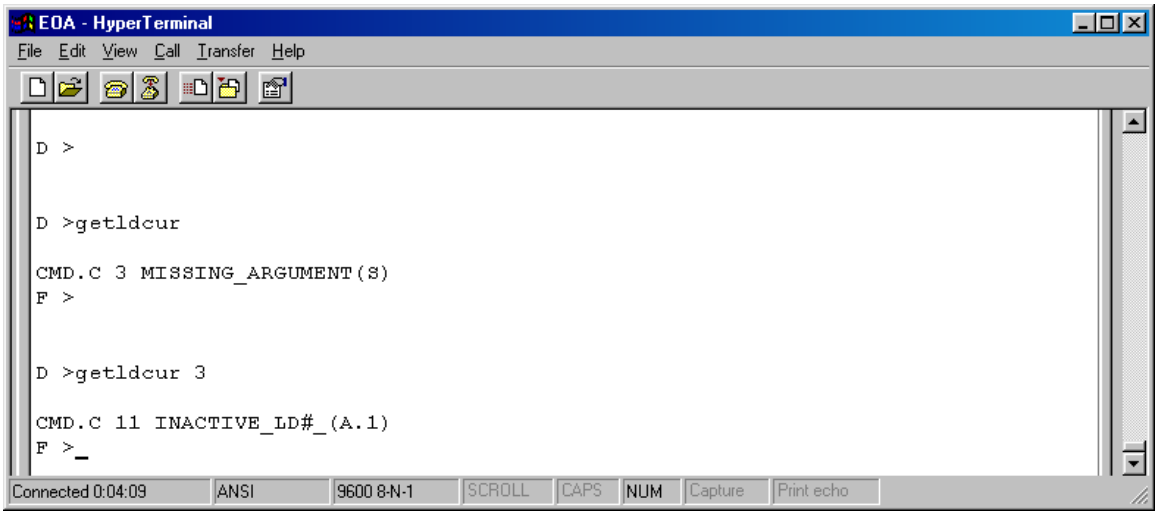

Figure 26: Various CMD module Error messages

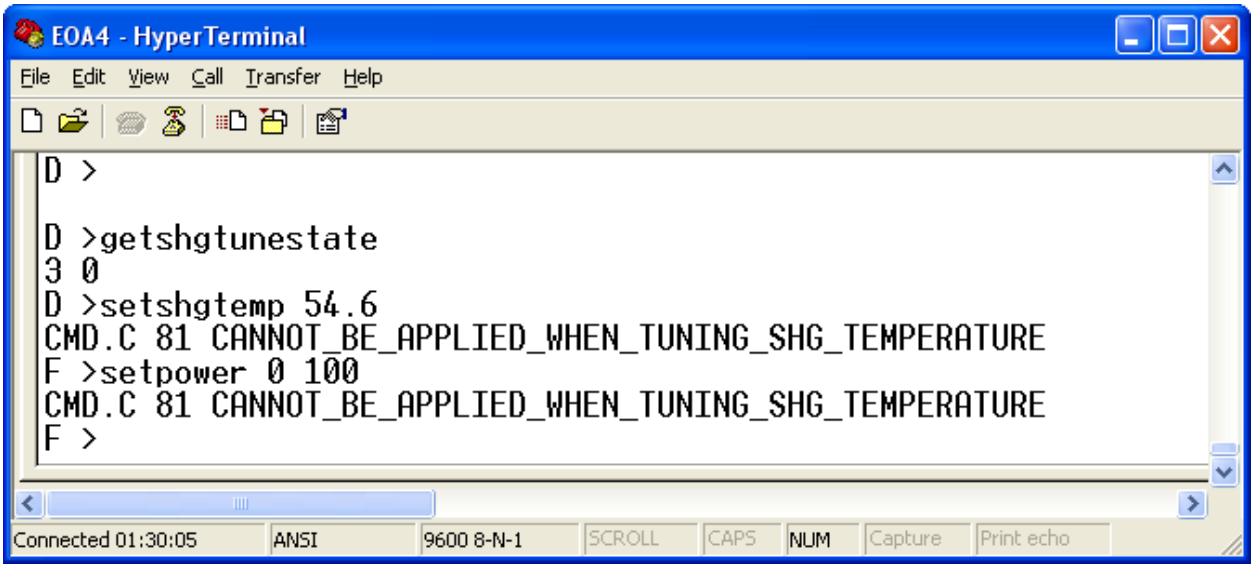

Figure 27: SHG Temperature and Output Power cannot be modified during SHG Tuning