TABLE OF CONTENTS

General

1.1 Introduction

1.2 Installation

2.2 Flowcharts

2.3 Attenuator (AOM)

Circuits

3.1 Block Diagram

3.2 Test Points

3.3 Connector Description

Software

4.1 Service GUI

4.2 Command Set

4.3 Revisions & Upgrade Procedure

Maint. & Calibration

5.1 Cover Removal

5.2 Wavelength Calibration

5.3 Photodiode Calibration and Replacement

5.4 PCBA Board Replacement

Universal Procedures

6.1 Tera Term Set-up

FRU Part List

Manual Rev History

LIST OF FIGURES

List of Tables

This Page Intentionally Left Blank

Laser Safety

This user information is in compliance with the following standards for Light-Emitting Products IEC 60825-1:2014/EN 60825-1:2014 *"Safety of laser products - Part 1: Equipment classification and requirements"* 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 *"Performance standards for light-emitting products"* except for conformance with IEC 60825-1 Ed. 3 and IEC 60601-2-22 Ed. 3.1, as described in Laser Notice No. 56, dated May 8, 2019.

WARNING!
VISIBLE AND INVISIBLE LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT!

WARNING!
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The laser safety section for the relevant laser must be reviewed thoroughly prior to operating any Chameleon Discovery systems.

Refer to the applicable operator's manual for the most up-to-date safety information.

Table 1.1-1. Safety Reference

LASER	OPERATOR'S MANUAL PART #
Classic and NG	1313627
NX	1412963

Signals and Symbols Used in the Manual

Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and ***NOTICE***.

The signal words **DANGER**, **WARNING** and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!

Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word "***NOTICE***" is used when there is the risk of property damage:

NOTICE

Indicates information considered important, but not hazard-related.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:

This symbol is intended to alert the operator to the presence of additional information.

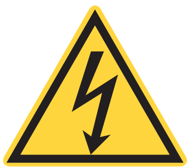
This symbol is intended to alert service personnel of information relevant to the Classic Discovery.

This symbol is intended to alert service personnel of information relevant to the NG Discovery.

This symbol is intended to alert service personnel of information relevant to the NX Discovery.

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.



This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

This symbol is intended to alert the operator to the danger of a lifting hazard.

Chameleon Discovery Introduction

The purpose of this document gives details about installation requirements and procedures on the Chameleon Discovery laser system. The document reflects current procedures for the Chameleon Discovery. This document does not replace the Discovery Operator's manual. Users must refer to the Operator's manual before turning ON the laser system. The document is intended for Coherent Field Service.

NOTICE

This document must be used with the operator’s manual. Refer to the Chameleon Discovery Operator’s manual before turning ON the laser.

Figure 1.2-1. Discovery Laser Head

Installation Checklist

[ ] Inspect and unpack the laser system

[ ] Move system to installation location

[ ] Verify PSU fuses

[ ] Connect the two umbilicals to the PSU and laser head

[ ] Connect the MRU interlock to the PSU and MRU

[ ] Connect the MRU hoses to the MRU and laser head

[ ] Install the door override connector to the MRU

[ ] Connect the chiller hoses to the chiller and laser head

[ ] Fill chiller with CoolFlow

[ ] Verify chiller setpoint

[ ] Verify the correct service and customer software is installed

[ ] Start the MRU, chiller and PSU

[ ] Start service GUI

[ ] Take EEPROM data

[ ] Connect the Beam Profiler, WaveScan and PowerMaxUSB tools to service GUI

[ ] Run pump map routine
(Optional if the specified power and stability is reached but return the values to original data. Keep the image and text files in records.)

[ ] Perform data run and verify specifications

[ ] Run AOM calibrations (for systems with a TPC). See “AOM Calibration Introduction” on page 5.9-1 for the AOM calibrations procedure.

[ ] Complete installation

[ ] Perform customer demo and training

[ ] Hand over the AOM calibration file. Ensure the customer knows the location, purpose and significance of the file.

System Configuration

The power supply contains all of electrical controls and DC supplies to the head. The connections for the classic are military style electrical cables that are 3 m in length, with the NX comprising of one D-connector and one military style connector. There are no optical connections from the PSU to the head.

Maximum electrical consumption of the system is in the range of 2300 W with a typical output draw of 1000 W.

Table 1.2-1. System Dimensions and Weight

	LENGTH	WIDTH	HEIGHT	WEIGHT
STANDARD HEAD[a]	820.8 mm (32.31 in.)	445.2 mm (17.53 in.)	286.7 mm (11.29 in.)	90 kg (198.42 lb.)
TPC HEAD[a]	1010.8 mm (39.80 in)	445.2 mm (17.53 in)	286.7 mm (11.29 in)	98 kg (216.05 lb.)
POWER SUPPLY	417.7 mm (16.45 in.)	483.0 mm (19.02 in)	132.3 mm (5.21 in.)	11 kg (24.25 lb.)
MRU X1	450.09 mm (17.75 in.)	431.8 mm (17.00 in.)	95.4 mm (3.76 in.)	12 kg (26.5 lb.)
CHILLER[b]	400 mm (15.75 in.)	484 mm (19.06 in.)	267 mm (10.51 in.)	21 kg (46.30 lb.)

a. The Chameleon Discovery is available in two versions, Standard or TPC. Verify the version for the correct head dimensions.
b. Dimension values are of the recommended chiller SMC HECR Series.

System Utility and Environmental Requirements

Refer to the datasheet and user manual for specifications.

The system requires 3 single-phase power outlets:

90-250 Vac auto-ranging, 50-60 Hz.

Shipping Containers

The laser system shipment is sent with five pieces. The information below gives the details of the shipping containers

Table 1.2-2. Container Type, Dimension and Weight

SHIPPING CONTAINER INFORMATION			
ITEM	CONTAINER TYPE	WEIGHT, KG	DIMENSIONS (LxWxH), MM
Laser Head[a]	Wooden Crate (See Figure 1.2-2)	173	1230 x 840 x 730
Power Supply	Cardboard Box	12	580 x 550 x 210
MRU	Cardboard Box	12	580 x 550 x 210
Chiller	Cardboard Box	24	650 x 600 x 300
CoolFlow	Small Cardboard Box	6	200 x 200 x 300
Total Weight		227	

a. The laser head weight listed is for the Discovery TPC. If the laser does not include the TPC option, the head weight is 165 kg.

Unpacking the Laser Head

1. Remove the top cover of the wooden crate.
   - The top cover will be used to form a ramp.
2. Remove the short end (840 mm) of the crate labeled with “BRAKES THIS SIDE”, “FRONT THIS SIDE”.
3. Remove the top foam insert and accessories.
4. Turn the top cover over and fit into the crate form a ramp as shown in Figure 1.2-4. The two clips (shown with arrows in

Figure 1.2-2. Laser Head Crate and Label

Figure 1.2-4) on the side panels must be removed for the ramp to fit.

5. Remove any accessories located under the laser head cart.
6. Release the brakes on the wheeled cart and carefully roll the laser head down on to the floor.

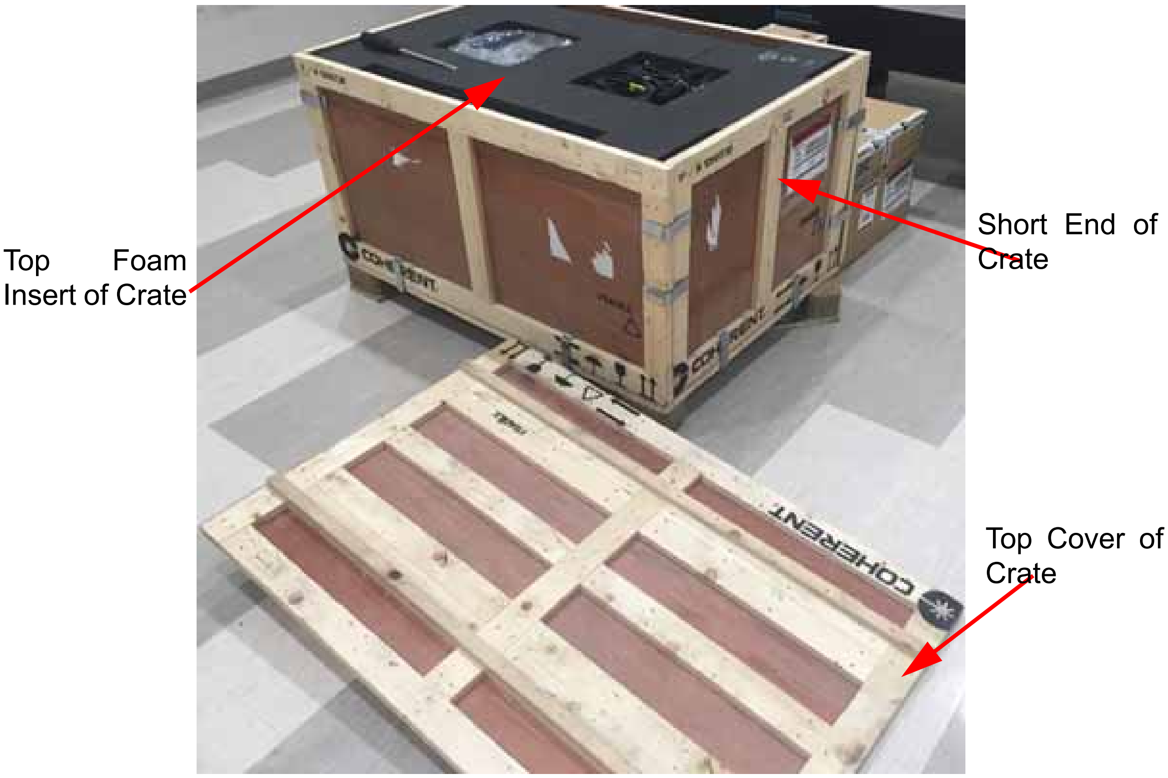


Figure 1.2-3. Laser Crate with Top Cover Removed

NOTICE
Do not bump the laser head while rolling down and off the ramp.

7. Roll the laser head on the wheeled cart to the install location.

CAUTION!
Coherent recommends that multiple personnel transport and lift the Chameleon Discovery Laser System.

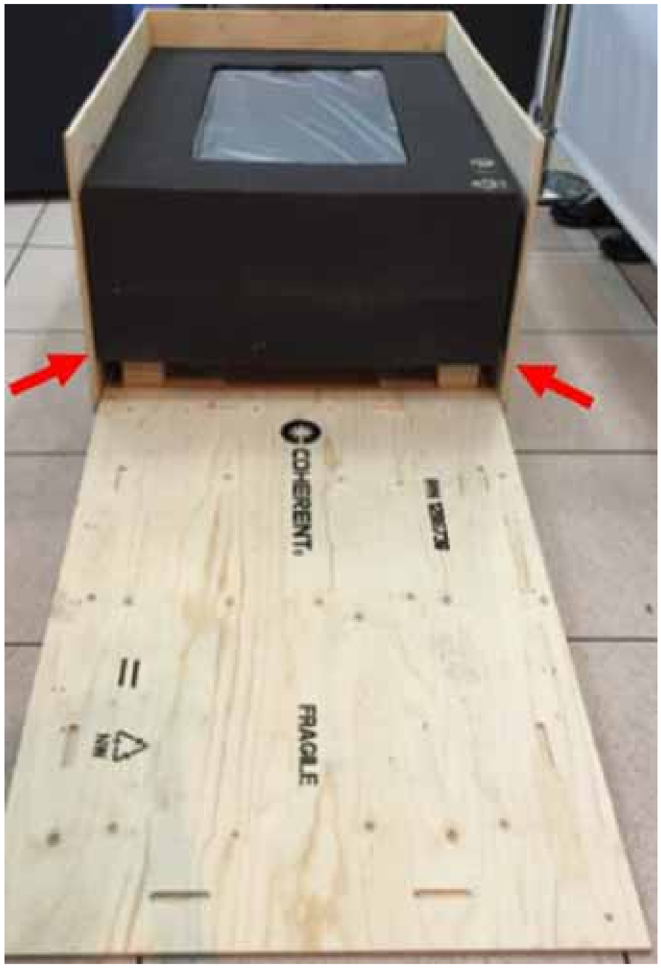


Figure 1.2-4. Crate Ramp

Removable Handles

Removable handles are provided to help the final lifting of the laser head on to the optical table. The handles are attached to the front and rear bulkheads using the M8 bolts supplied in the accessory kit.

Flash Drive

Locate the flash drive with the GUI, manuals and AOM calibration files.

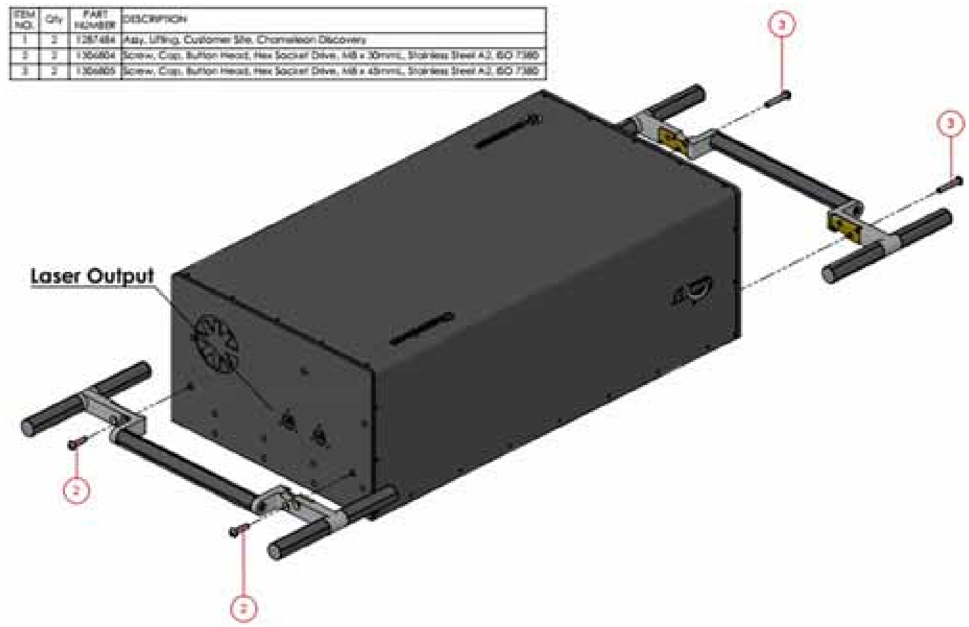


Figure 1.2-5. Laser Head with Handles

AOM Calibration Files

The AOM calibration file will need to be moved to the customer's local PC. AOM calibration file is by the TPC module and is feed to the laser by the customer GUI.

See "AOM Calibration Introduction" on page 5.9-1 for the AOM calibration procedure.

Installation Procedure

Tooling

- ThorLabs BP209 Beam Profiler
- APE WaveScan Spectrometer
- Coherent PowerMaxUSB power meter (min. 10W)
- 1 % pick-off beam sampler
  - Thorlabs PN BSF10-C

  - Thorlabs PN WW41050
- Measuring tape (for 1.2 m)
- Silver mirror
- Second pickoff
- Assorted standard laser installation hand-tools
- USB Hub
- All associated software
  Tera term (or terminal program)
  Team Viewer
- Discovery Service GUI
- Discovery Customer GUI
  Available at:

http://www.coherent.com/products/?2171/Chameleon-Discovery

System Connections

Fuses for PSU

Confirm the operating voltage and fuse type by checking that the white arrow is pointed toward the white mark for the needed voltage range. The arrow indicates the contact end for the fuses. The lasers are sent with both 4 A and 8 A fuses inserted into the holder or with the 8 A fuses enclosed in the PSU accessory kit. See Figure 1.2-6 for an operating voltage range of 220-240Vac (4 A fuses).

Figure 1.2-6. Fuse Verification

PSU Connections

The two electrical umbilicals have different pin-configurations that are directional and keyed to assist with connections. When the umbilical position is aligned to the PSU, turn the umbilical connection to hear an audible locking click noise.

Figure 1.2-7. PSU Connections - Rear View

The MRU interlock cable is supplied within the Discovery accessory kit. This cable must be fitted between the MRU and PSU to prevent the user from running the Discovery with the MRU turned off.

If the MRU has a power failure, the user interface will display an interlock error and the PSU fault LED will illuminate. Refer to “MRU Connections” below.

MRU Connections

1. Connect the MRU X1 hoses. (The Discovery MRU hoses are the same type used on the Chameleon Laser Systems.)
2. Install the supplied MRU interlock cable as shown in Figure 1.2-8. The interlock cable is found in the accessory kit.
3. Install the door contact override connector as shown in Figure 1.2-8. The connector is found in the MRU shipping box.

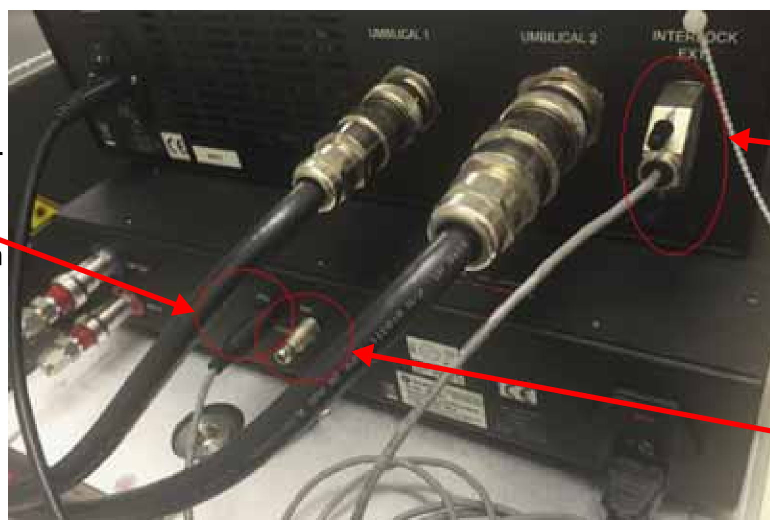


Figure 1.2-8. PSU to MRU Interlock Connection

Chiller Connections

1. Connect the chiller hoses. The Chiller label identifies the IN and OUT connectors as shown in Figure 1.2-9.(The Discovery chiller hoses are the same type used on a Chameleon System.)
2. Use the funnel and short red hose supplied with the Discovery accessory kit to fill the chiller with CoolFlow between the H (high) and L (low) indicators. See Figure 1.2-10.

Chiller Label

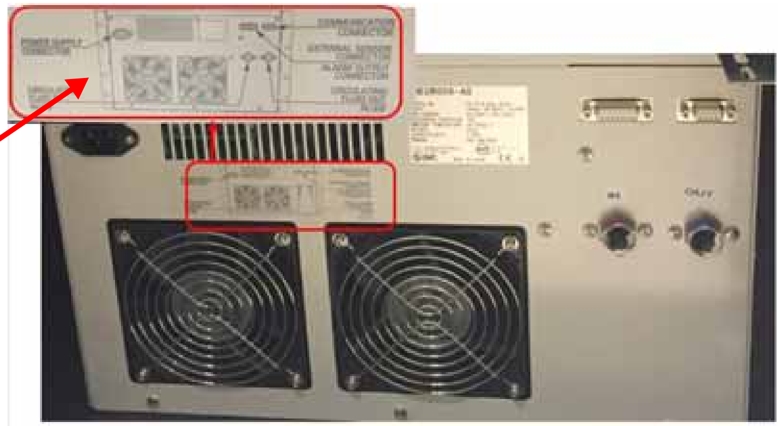


Figure 1.2-9. Chiller - Rear View

Funnel and Red Hose

H and L Water Level

Figure 1.2-10. Chiller - CoolFlow Filling

3. Connect the chiller hoses to the laser head.

NOTICE

Continue to "Laser Head Connections" for the orientation of the chiller hoses at the laser head.

4. After connecting the chiller hoses to the head, turn ON the chiller. CoolFlow is pumped through the hoses to the head and will require refilling at least one more time.
   - Turn the chiller OFF.
   - Refill to above the L indicator.
   - Turn ON the chiller again to restart the pump. The CoolFlow must not go above the H line.

Chiller Setpoint Temperature

- Press **SEL** to move the **<** down to **SV**.
- Use the up and down arrow buttons to adjust the chiller setpoint temperature for 20 °C.

NOTICE

The chiller could be delivered with a setpoint temperature of 25 °C. Verify the setpoint temperature is set to 20 °C.

- Press **RET** to finish.

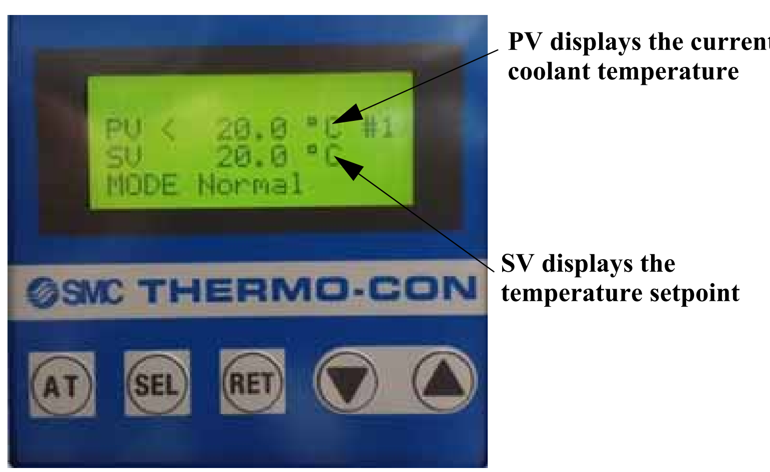


Figure 1.2-11. Chiller Display

Laser Head Connections

1. Position the Umbilical 1 and Umbilical 2 into their locating sockets and turn to hear the contact click-lock.

Figure 1.2-12. Laser Head Connections - Rear View

2. Connect the MRU hoses. (The connections are the same type used on a Chameleon System).

3. Connect the chiller hoses:
   - **COOLING IN** (head) to **OUT** (chiller),
   - **COOLING OUT** (head) to **IN** (chiller).

NOTICE
Confirm the chiller hose connections for the correct orientation! Incorrect orientation of the chiller hoses can damage the laser.

4. Make the laser (and if needed, attenuator) USB connections.

Power ON

Make sure that the correct Service and Customer software is installed **BEFORE** connecting the laser USB communication cable to a suitable PC.

Initialize

1. Make sure that all connections are securely made. Start the MRU, chiller, and PSU.
2. When the mains are switched ON, the fault LED on the PSU will flash as the laser modules initialize. This continues for approximately 10 minutes until the laser is ready for the key ON position.

Service GUI

The Service GUI is required to perform the installation, take data and calibrate the laser. More detail on the Service GUI is located in "Service GUI" on page 4.1-1.

1. Open the Service GUI and establish communications through the Connection Menu.See Figure 1.2-13.

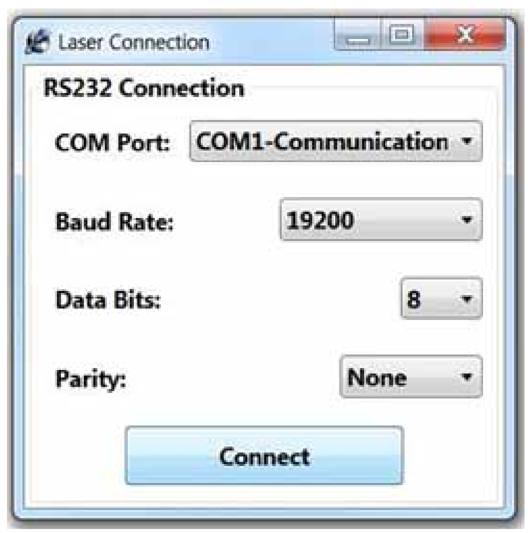


Figure 1.2-13. Connections Menu

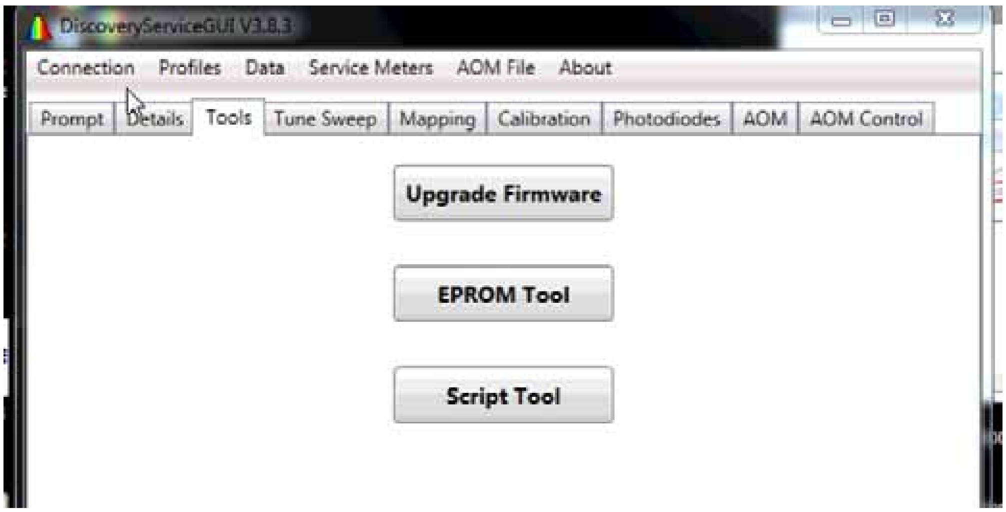
2. From the Prompt tab send the commands:
   - `?ST` and `?F`

The commands will confirm that there are no faults and the laser is in Standby mode.

3. Upload calibration file if installing a TPC. See Figure 1.2-14, EPPROM System values for the AOM file.

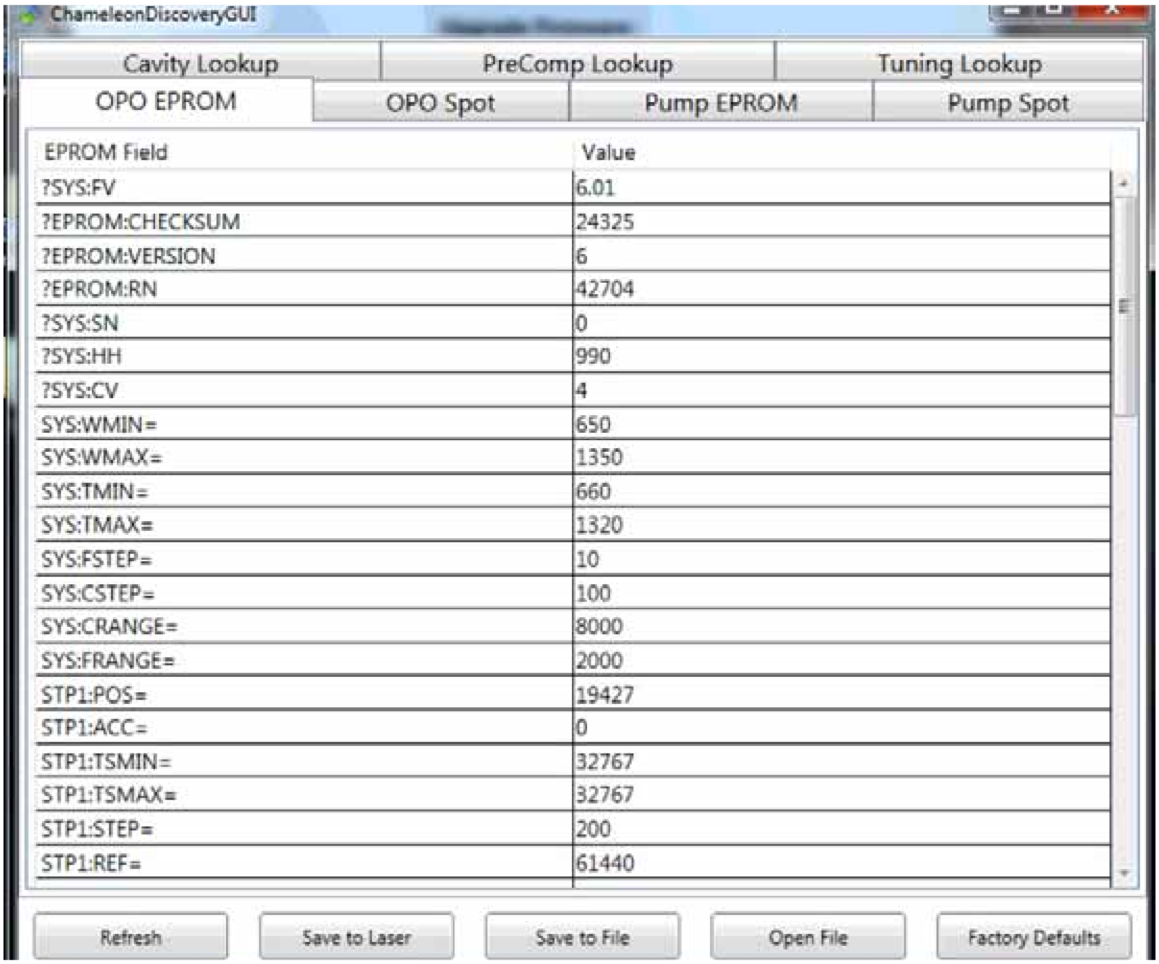
EEPROM Tool

1. Open the Tools Tab to select the EEPROM tool.



TOOLS

Figure 1.2-14. EEPROM Menu



EPROM Field	Value
?SYS:FV	6.01
?EPROM:CHECKSUM	24325
?EPROM:VERSION	6
?EPROM:RN	42704
?SYS:SN	0
?SYS:HH	990
?SYS:CV	4
SYS:WMIN=	650
SYS:WMAX=	1350
SYS:TMIN=	660
SYS:TMAX=	1320
SYS:FSTEP=	10
SYS:CSTEP=	100
SYS:CRANGE=	8000
SYS:FRANGE=	2000
STP1:POS=	19427
STP1:ACC=	0
STP1:TSMIN=	32767
STP1:TSMAX=	32767
STP1:STEP=	200
STP1:REF=	61440

EPPROM SYSTEM VALUES

Figure 1.2-14. EEPROM Menu (Continued)

2. Wait for the system values to load.
3. Save the initial EEPROM to a suitable file location. The EEPROM data fields will automatically save to the header tab when the initial save is performed.

NOTICE

Any system calibration changes will require a new EEPROM save.

4. Key ON the laser. The laser will take approximately 2 minutes to fully turn on.
5. Tune the laser to:
   - 680 nm for TPC and Classic
   - 660 nm for NX
6. Assemble metrology set-up as shown in

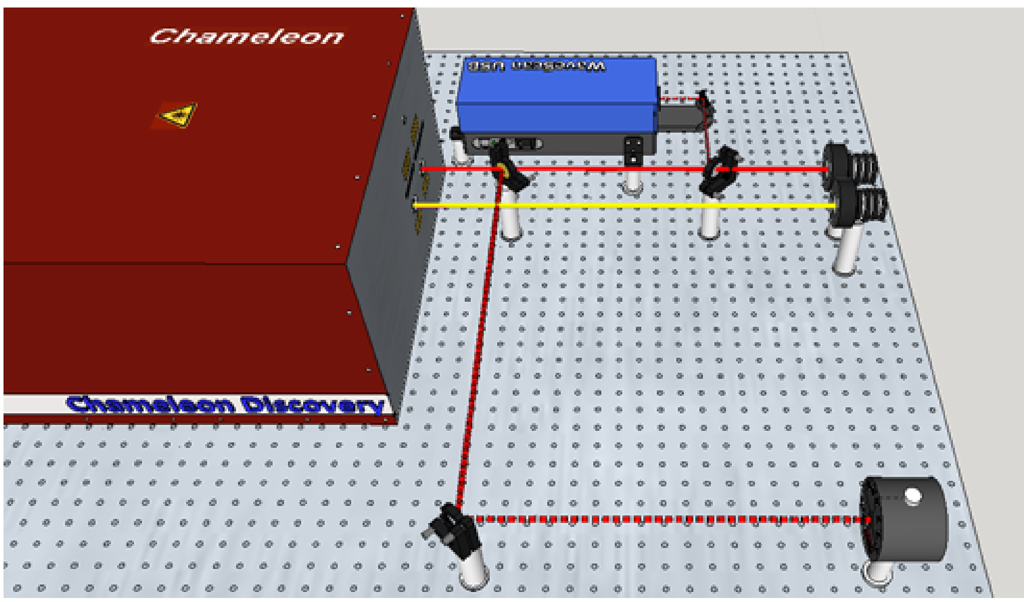


Figure 1.2-15. Metrology Set-up

DANGER!
All personnel in the area of the laser system must wear the appropriate laser safety glasses to prevent injury. Refer to “Laser Safety” on page 1.1-1 to learn the correct laser safety practices.

If using a non-TPC system, alignment mode (align=1, alignfixed=1) can be used to roughly align the optical elements and instruments before releasing the full power beam. On TPC models, turn modulators to 1% to release a suitable beam.

NOTE - Do not use alignment mode on a TPC system!

APE WaveScan

1. When the laser is ready, open the tunable shutter by sending commands `s=1`, or `svar=1`.

NOTICE
Closing and re-opening the GUI will turn the AOM transmission to 0 as well as closing the shutter.

CAUTION!
Make sure the beam path is safe before opening the shutter.

2. Open the APE WaveScan software and confirm or change to the following settings:
   - TCP Autostart box checked
   - TCP/IP port set to 51123
3. Press the **Start** button. It can take some minutes for the display to register a signal.
4. Check/uncheck the Autoscale Y. Make sure the Autoscale is checked when aligning.
5. Pick off a small portion of the tunable beam and align into the WaveScan head, using the pinhole guides for initial alignment.

   Once the pickoff has been aligned, the power can be increased so that the beam is visible at the WaveScan.

Once a peak can be seen amidst the noise, fine-tune alignment for strongest signal (> 40000 at 680 nm).

For TPC models, the attenuation function must be used instead of alignment mode.

- Verify the signal is not saturated or the peak detection may be difficult to determine. The WaveScan signal saturates at approximately 60,000.

Figure 1.2-16. Tuning with APE WaveScan GUI

6. Tune to 1300 nm. Confirm the WaveScan can register and measure the wavelength and bandwidth at the longest wavelength.

PowerMaxUSB

1. Connect the USB power meter through the PowerMax software. Confirm that the PC recognizes the PowerMaxUSB.
2. Close the power meter software.

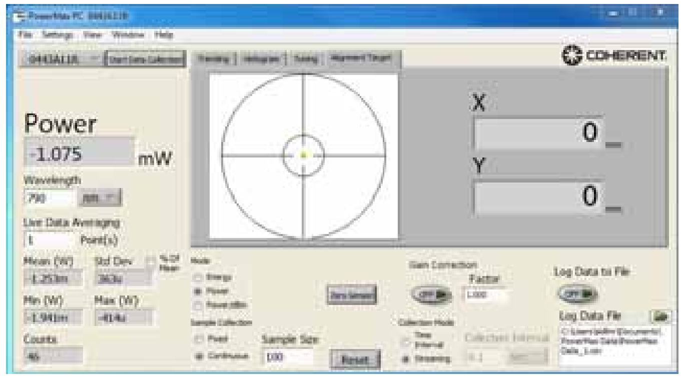


Figure 1.2-17. PowerMax GUI

BP209 Beam Profiler

1. Start the BP209 beam profiler using the Thorlabs GUI for alignment.
2. When the beam is aligned with the center of the profiler, ensure the it is striking normally to the face of the profiler.

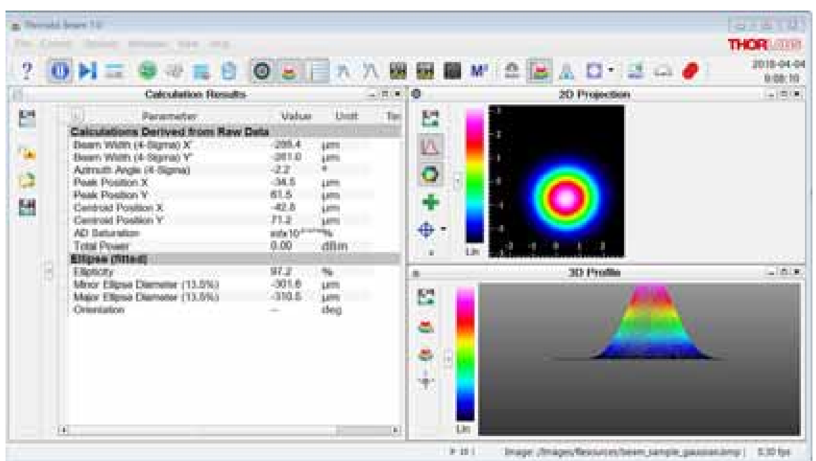


Figure 1.2-18. Thorlabs Beam 7.0 GUI

Connect Measurement Devices within Service GUI

The external meters will need to be connected to the Service GUI for the automated routines to operate. See "Service Meters Menu" on page 4.1-6 if additional details are needed for connecting the meters.

NOTICE
It is important to start the software in the correct order in for the Service GUI to communicate with the external meters/WaveScan and to operate with the automated routines.

1. External software and Service GUI:
   a. Step 1:
      - APE WaveScan software Open, with TCP/IP checked and port set to 51123
      - PowerMax Stopped and PowerMax software Closed
      - Discovery Service GUI Closed
      - Beam profiler software Closed
   b. Step 2:
      - APE WaveScan software Open, with TCP/IP checked and port set to 51123
      - PowerMax software Closed
      - Discovery Service GUI Open
2. Connect the PowerMax power meter, BP209 beam profiler and WaveScan through the Service Meters menu. See Figure 1.2-19.

NOTICE
The Service GUI closes the shutter when reconnected. Reopen the shutter before starting any optimization procedures.

3. If the meters are not recognized, it can be necessary to close and reopen the GUI again. Check that the separate instrument software is closed down.
   - Confirm the APE software is connected and running.
   - Confirm the PowerMax software is closed before reopening the Service GUI.

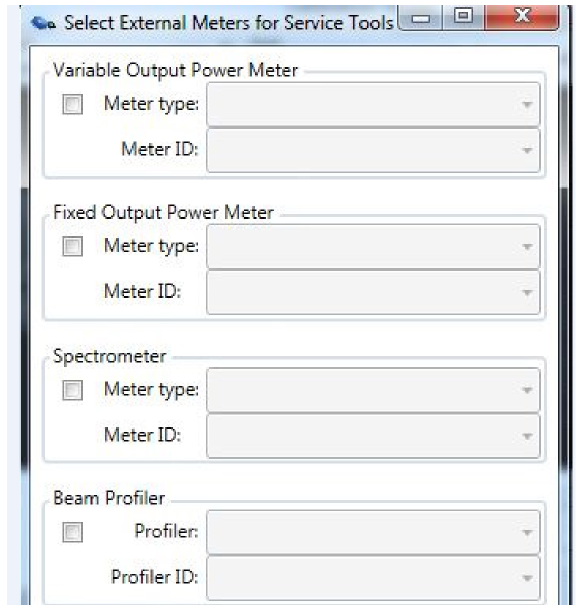


Figure 1.2-19. External Meters Menu

Pump Map Routine

This procedure should only be performed if the pump power is good but the OPO power is below specification or there are confirmed beam profile anomalies. A data run should be performed before the pump map routine is run to establish this. It can be useful to save the pump map image as a visual representation of the pump map. This can help to manually tweak the value to a suitable point. If a pump map has been required, a new data run should be made directly afterwards and compared with the old one. If the tunable power has increased to above the specified power, the new pump map position can remain. If no significant improvement is seen, move the pump mirrors back to the factory set positions and continue with troubleshooting.

1. Record pump mirror starting positions for Px & Py.

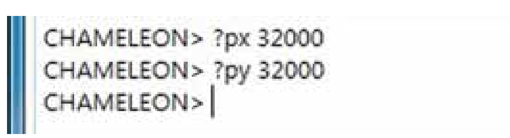


Figure 1.2-20. Pump Mirror Commands

2. In the AOM tab, change the transmission value to 100 %.
3. In the Mapping Tab:
    a. Set the wavelength to 1000 nm.
    b. Browse to a desktop location to save the map.
    c. Confirm the power meter is connected to the Service GUI before starting the procedure.
    d. Begin the procedure by clicking the Start button. See Figure 1.2-21.

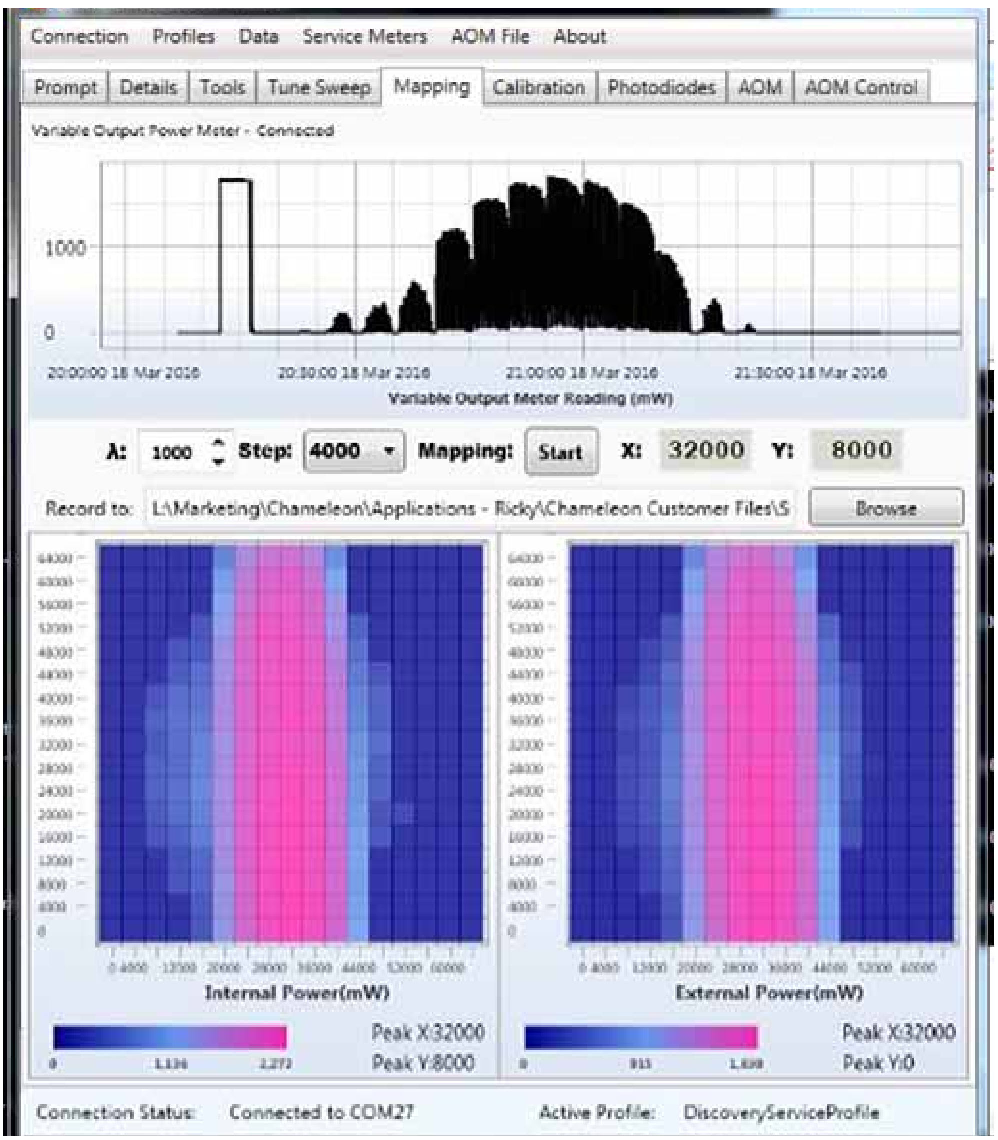


Figure 1.2-21. Mapping Menu

4. The pump map will complete and move Px & Py to their current optimal positions at the end of the procedure.
5. When complete save a screenshot of the pictorial representation of the pump 'heat' map for future reference.

AOM Calibration File

See “AOM Calibration” on page 5.9-1

Data Run

1. Make sure the power meter and WaveScan are connected in Service Meters menu.
2. Tune the laser to 660 nm and open the tuneable shutter.
3. Go to the Tune Sweep tab and select a desktop location to save the file. See Figure 1.2-22.

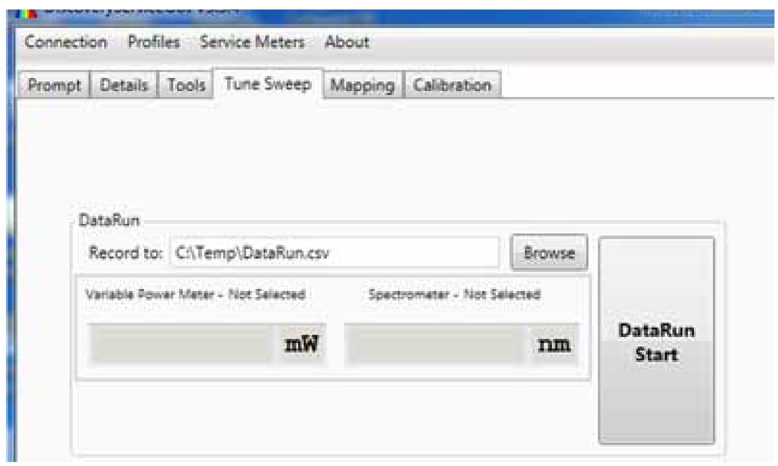


Figure 1.2-22. Tune Sweep Menu

4. Before starting the data run program, have all required information available. When the data run is started, a prompt will appear requesting the serial number for the MRU, PSU, chiller and requesting the measured fixed IR output power.
5. Start the data run. The procedure will take approximately 30 minutes to complete.
   - The program runs from the shortest to longest wavelength in 10 nm steps. It records measured power from the external power meter and wavelength accuracy on the WaveScan spectrometer.

- When complete review the data by checking power and wavelength accuracy against the datasheet specifications. Wavelength accuracy must be within ± 5 nm. See “Wavelength Calibration” on page 5.2-1 and “Photodiode Calibration” on page 5.3-1 if calibration is required.

6. If specifications are achieved and confirmed see “Complete Installation” to train the customer and complete the installation.

Complete Installation

1. If a pump map, wavelength, or PD calibration was required, the EPPROM data will need to be saved and sent to factory. Reference “Wavelength Calibration” on page 5.2-1 and “Photodiode Calibration” on page 5.3-1 for additional information on calibration procedures.
2. Return laser to customer mode with the `access=0` command.
3. Transfer the ‘final’ AOM calibration final to the customer PC. See “AOM Calibration” on page 5.9-1.
4. Before the customer training, refer to the GUI Operator's manual to become familiar with the user controls.
5. Start Customer GUI and regular maintenance training:
   - Place the key switch into STANDBY when the system is not in use (i.e. overnight)
   - CoolFlow 6 month replacement cycle
   - MRU cartridge inspection & replacement
   - Open the customer GUI and demonstrate the connection and control options, see Figure 1.2-23.
   - Explain the modulator usage (include external modulation) and present Laser control of modulator as default on NX TPC.
   - If customer requires legacy control mode, explain:
     - how to set this up
     - how to change between laser mode and USB legacy mode
     - Explain the significance of the calibration file. (See “TPC Commands” on page 4.2-21).

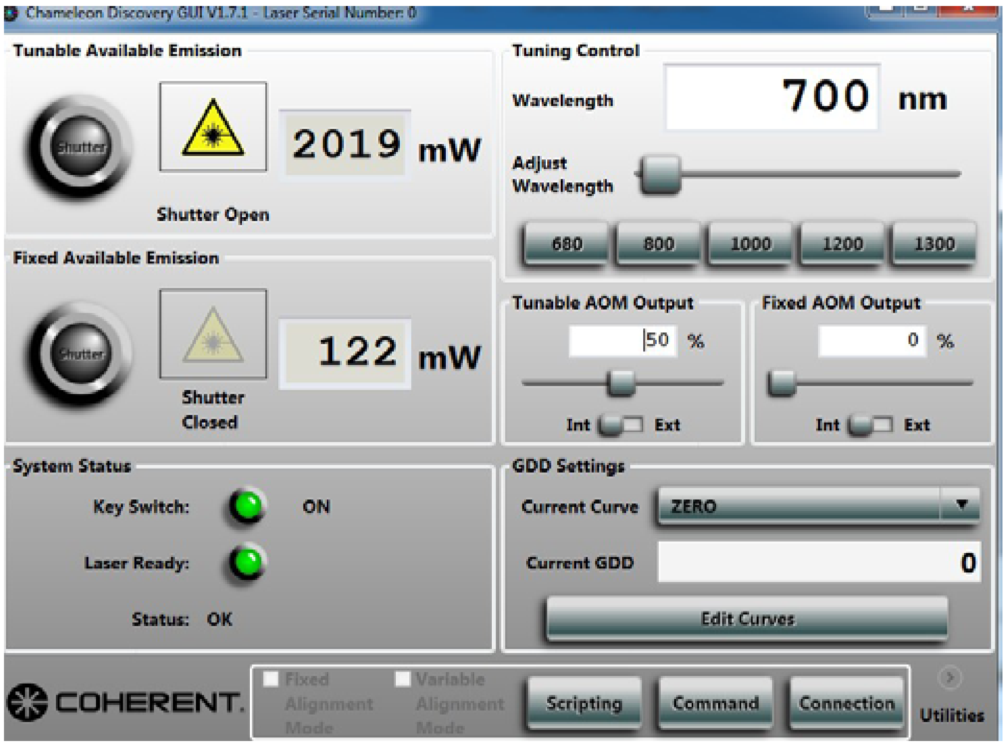


Figure 1.2-23. Customer GUI

This Page Intentionally Left Blank

CPC 1040 Introduction

The CPC 1040 module is an accessory for the Chameleon Discovery laser system. If the customer received the CPC 1040, continue with the installation on page 1.3-3.

This procedure will assist with the alignment of the CPC 1040 module and reflects the current information available for the module. This document does not replace the CPC 1040 Operator’s Manual. Users must refer to the operator's manual before operation of the module. This document is intended for Coherent Field Service.

NOTICE
The CPC 1040 installation must be performed by Coherent Field Service.

Figure 1.3-1. CPC 1040

The CPC 1040 is a passive device designed for use with Class 4 laser beams, specifically the fixed 1040 nm output of the Chameleon Discovery. In normal operation, the housing prevents access to radiation in excess of Class 1, except for the input/output beams. However, during initial alignment the housing must be removed.

Inside the tilting mirror assembly, laser beams are reflected at angles that are not parallel to the table top. If adjusted incorrectly, there is the potential for these beams to exit the CPC above table height. The following precautions are recommended to maintain a safe environment.

DANGER!
All personnel in the area of the laser system must wear the appropriate laser safety glasses to prevent injury. Refer to "Laser Safety" on page 1.1-1 to learn the correct laser safety practices.

- Use appropriate laser safety eyewear.
- Use suitable IR viewers/IR viewing cards during alignment.
- If possible, install beam blocks at either end and at the beam output as shown.
- Avoid standing at either end of the CPC. Adjustment should be done from either side as shown below.

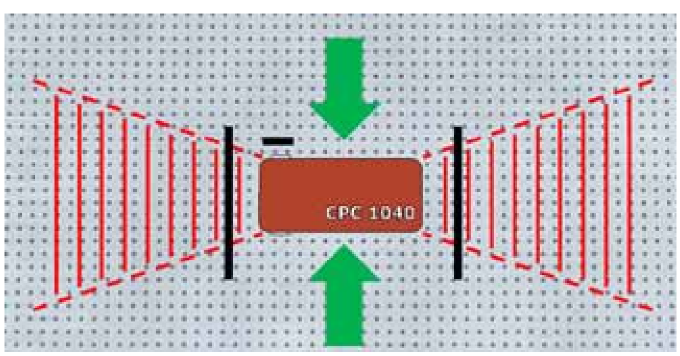


Figure 1.3-2. CPC 1040 Adjustment Area

Installation

Cover Removal

Remove the thumbscrews (A) and lift off the top cover. The main cover (B) should now slide up and off.

Figure 1.3-3. CPC 1040 Cover Removal

Alignment

The beam follows a circular path into and out of the CPC. Input/output prism → NDM assembly → Retro reflecting mirrors → NDM assembly → Input/output prism. See Figure 1.3-4. The input path is shown in red and output path is shown in yellow.

1. The CPC should be approximately positioned on the table in front of the laser source.
2. Move the CPC left ↔ right so that the beam hits the input prism approximately center.
3. Rotate the CPC until a series of spots can be seen on the NDM.
4. Fine-tune the alignment as much as possible by moving the CPC body, before attempting to adjust any of the mirrors or clamping the module to the table.

The CPC 1040 is factory set for 3 steps = 12 bounces in total on the NDM mirrors, as shown in Figure 1.3-4.

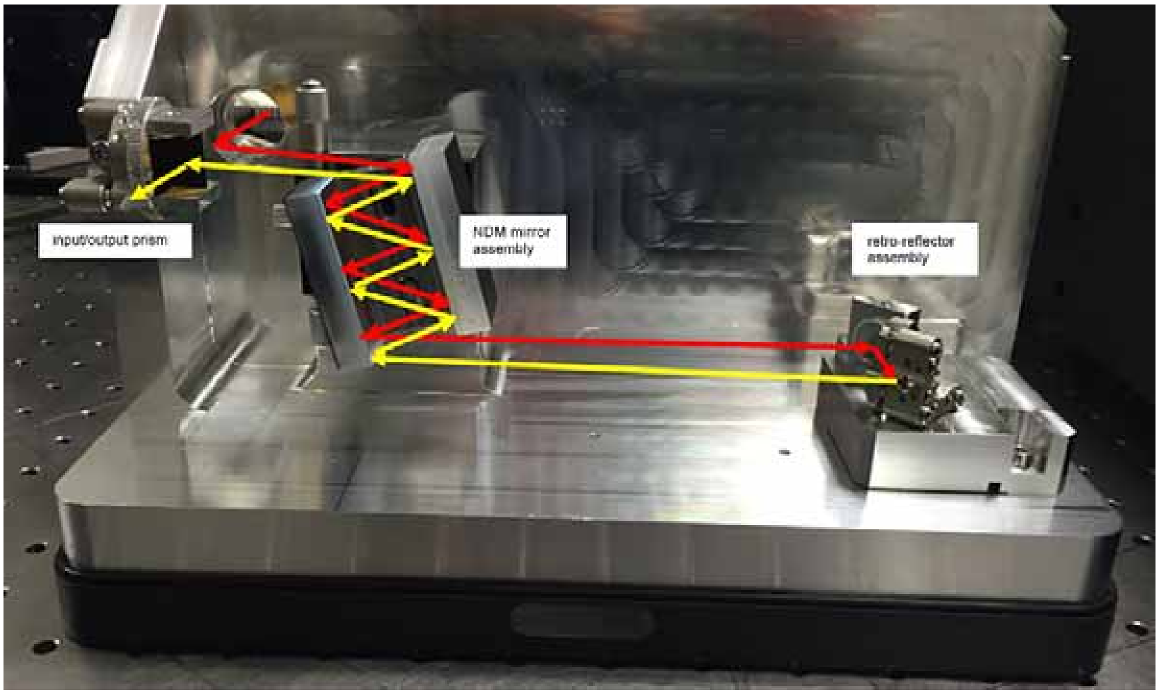


Figure 1.3-4. CPC 1040 Internal Alignment Path

When the CPC is aligned correctly, a series of 6 spots should be visible on each mirror.

See Figure 1.3-5 for examples of the alignment.

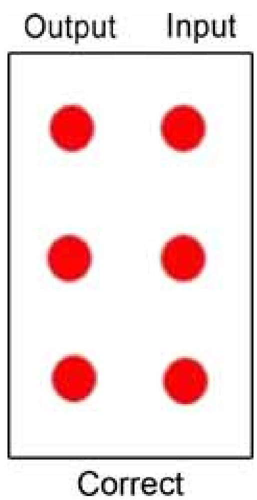
Adjustment of the Precompensation

The CPC1040 is factory set for 3-step (12 bounces) on the NDM mirrors. This causes a specified amount of negative dispersion to the pulse. Refer to the product datasheet at coherent.com for the current specifications.

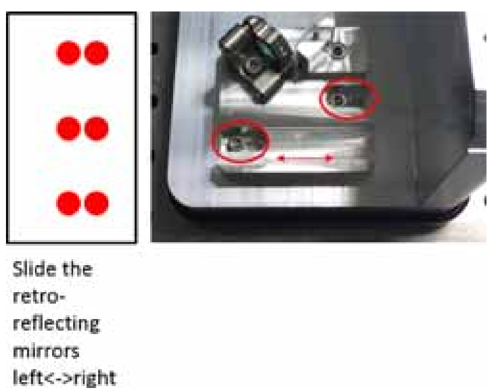
The factory set configuration should be correct for most customer situations. However, it is possible to adjust the negative dispersion setting by changing the number of bounces on the mirrors. The adjustment is not continuous, but step-wise with the number of bounces, as shown below in Table 1.3-1 where 2-step = 8 bounces, 3-step = 12 bounces and etc...

The procedure to change the number of steps (bounces):

1. First align the unit in the factory configuration,



Correct Alignment



Adjustment of the retro-reflecting mirrors needed

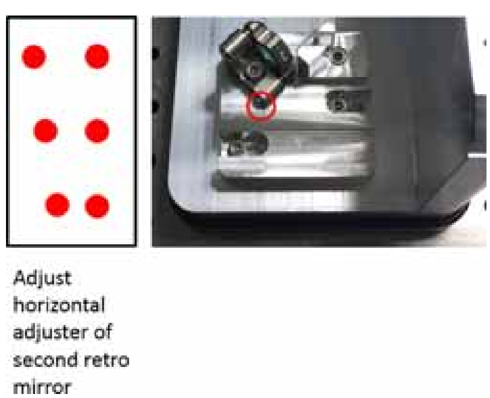
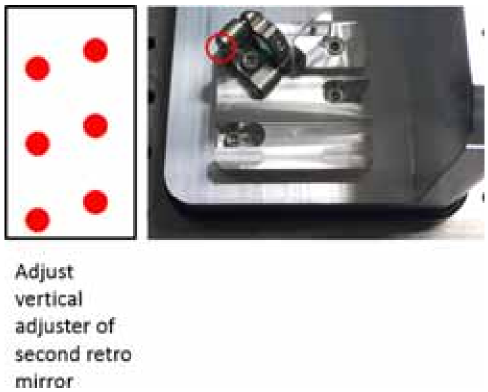
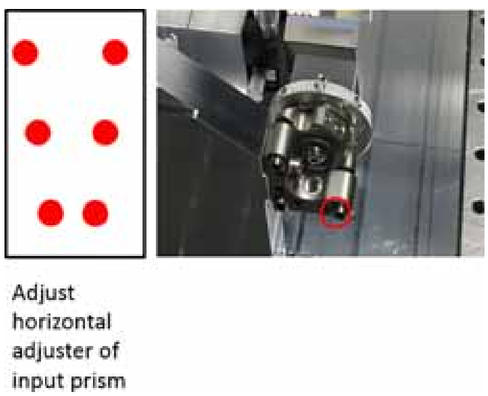


Figure 1.3-5. Alignment Examples

Adjustment of the horizontal second retro mirror needed



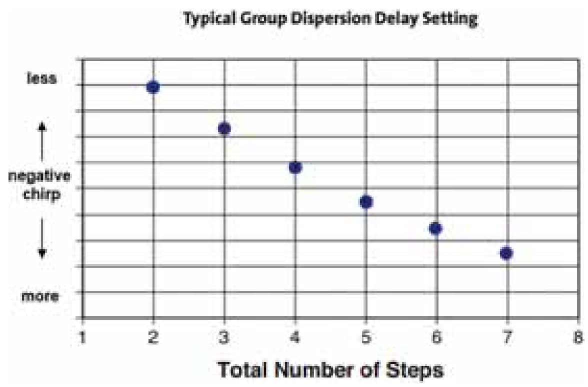
Adjustment of the vertical second retro mirror needed



Adjustment of the horizontal input prism

Figure 1.3-5. Alignment Examples (Continued)

Table 1.3-1. Dispersion Delay Setting



2. Then rotate the NDM mirror assembly using the rotary stage.

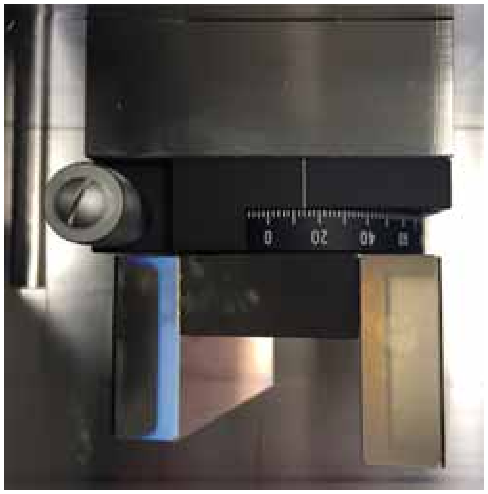


Figure 1.3-6. CPC 1040 Rotary Stage

The approximate angle settings for different step/bounce settings are shown in Table 1.3-2.

Table 1.3-2. Angle Setting for Steps or Bounces

ROTATION STAGE ANGLE	NUMBER OF STEPS	NUMBER OF BOUNCES
29°	2	8
19°	3	12
14°	4	16
11°	5	20
9°	6	24
8°	7	28

3. The in/out alignment should then be checked as instructed in the previous section.

This section gives troubleshooting information for the specified numerical listing of the Chameleon Discovery and Chameleon Discovery NX software fault messages.

NOTICE
In general with any fault code or troubleshooting process, commands `?f` and `?fh` should be sent BEFORE a key-cycle.

Discovery Classic and NG Fault Messages

The following fault messages are for the Classic and NG Discovery.

Fault 1 - Laser Powered Up in Keyed On Position

General Description: PSU has been switched on when the Key switch is in the ON position

Action:

- Move Key to OFF position and the fault will clear. The system can then be turned on as normal.
- If fault is persistent contact Coherent Scotland

Fault 2 - Laser Diode 1 Driver Over Current

General Description: This is a hardware fault and indicates that the seed pump diode (within the seed module) has exceeded the hardware current limit. A hardware shutdown has then taken place.

Action:

- Check connection between Seed module and pump board is secure
- If fault is persistent contact Coherent Scotland

Fault 3 - Laser Diode 1 Driver over Temperature

General Description: This is a hardware fault and indicates that the seed pump diode (within the seed module) has exceeded its safe operating temperature

Detailed Description: This is a fault triggered by CPLD and originated from the DIODE 1 OTP line that comes from the SEED module. Diode 1 OTP signal originates from the power amplifier IC on the Seed head board.

Action:

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 4 - OSC TEC 1 Driver over Current

General Description: This is a hardware fault and indicates that the thermo electric cooler (TEC) on the seed pump diode is being driven too hard, causing the TEC to go over current.

Detailed Description: Two fault signals are generated by the TEC driver IC on the Seed headboard. These signals a help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over current Fault 1 is 0 and Fault 0 is 0.

Action:

- Check connection between Seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 5 - OSC TEC 1 Driver Over Temperature

General Description: This is a hardware fault and indicates that the thermo-electric cooler (TEC) on the seed pump diode over temperature.

Detailed Description: Two fault signals are generated by the TEC driver IC on the Seed headboard. These signals a help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over Temperature Fault 1 is 1 and Fault 0 is 0.

Action:

- Check connection between Seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 6 - OSC TEC 1 Driver Under Voltage

General Description: This is a hardware fault which occurs when the thermo electric cooler (TEC) on the seed pump diode is under the hardware defined minimum voltage level.

Input of the Pump board goes through the transceiver again.

Action:

- Check connection between seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 7 to 9 - Unknown Fault

General Description: Not implemented.

Fault 10 - OSC Threshold Over Voltage

General Description: This is a software generated fault and occurs when the oscillator photodiode value `?PUMP:PD1VADC` goes above the set over voltage value `?PUMP:PD1OVPADC`. If this fault occurs there is an immediate shut down of the system to prevent damage to the pump laser.

Action:

- **Ensure the over voltage threshold values are correct.**
  To check if the PD1 over voltage threshold value is correct, the following procedure can be carried out:
  a. Ensure the system is keyed off.
  b. Type command `PUMP:ON=1` to switch only the oscillator ON
  c. Query `?PUMP:PD1VADC` and take a note of the response `(PD1VADC(OFF))`

d. Key ON the system and wait until the oscillator is in light loop (query `?PUMP:STATE`)

e. Query `?PUMP:PD1VADC` and `?PUMP:PD1OVADC`

f. Key system OFF

g. The over voltage value should have been calculated so that

```
PD1OVADC = PD1VADC(ON) + ((PD1VADC(ON)-PD1VADC(OFF)) *0.15)
```

If `PD1OVADC` is not correct, the value will need to be updated.
To update, change `PD1OVP=xxx` until the under voltage `(?PD1OVADC)` is correct

h. Type command `PUMP:ON=4` to switch all modules back ON

i. If the fault continues confirming that `PD1OVADC` is correct, contact factory

- Check the value for `?PUMP:LLI:1`. This should be 0.5, but previously was 2 and some units may have this still set. This is part of the light loop PID, which if not stable can cause this fault, even after many hours of operation.

Fault 11 - OSC Threshold Under Voltage

Fault 11 will occur if the laser is shut down suddenly because of another fault. If fault 11 is displayed along with another fault, investigate the other fault first. Continue with the steps below if fault 11 occurs in isolation or nothing is found while investigating the other fault.

General Description: This is a software generated fault and occurs when the oscillator photodiode value `?PUMP:PD1VADC` goes below the set under voltage value `?PUMP:PD1UVADC`. If this fault occurs there is an immediate shut down of the system to prevent damage to the pump laser.

Action:

- **Ensure the under voltage threshold values are correct.** To check if the PD1 over voltage threshold value is correct, the following procedure can be carried out:

a. Ensure the system is keyed OFF

b. Type command `PUMP:ON=1` to switch only the oscillator on

c. Query ?PUMP:PD1VADC and tale a note of the response (PD1VADC(OFF))

d. Key the system wait until the oscillator is in light loop (query ?PUMP:STATE)

e. Query ?PUMP:PD1VADC and ?PUMP:PD1UVADC

f. Key system OFF

g. The over voltage value should have been calculated so that

PD1UVADC = PD1VADC(ON) - ((PD1VADC(ON)-PD1VADC(OFF)) *0.15)

If PD1UVADC is not correct, the value will need to be updated.
To update, change'PD1UVP=xxx until the under voltage (?PD1UVADC) is correct

h. Type command PUMP:ON=4 to switch all modules back on

i. If the fault persists, call the factory noting the frequency of the fault (sporadic versus every time?)

- Check the value for ?PUMP:LLI:1. This should be 0.5, but previously was 2 and some units may have this still set. This is part of the light loop PID, which if not stable can cause this fault, even after many hours of operation.

Fault 12 - OSC Light Loop Out Of Lock

General Description: This is a software generated fault. It occurs when the oscillator pump diode (within the seed module) fails to lock to the light loop set point ?PUMP:LLSP:1. This fault only occurs when it comes out of lock FROM already being in light loop. The fault occurs if the laser comes out of lock for 20 ms.

If the system is just turned on and cannot lock, the status will just remain in Ramping up status

Action: Check connection between Seed module and pump board is secure.

Check both the wiring within the connector blocks and that the connector blocks are fully seated.

Fault 13 - OSC Current Loop Out Of Lock

General Description: This is a software generated fault. It occurs when the oscillator pump diode (within the seed module) fails to lock to the set current `?PUMP:IDL:1`. The fault occurs if the current falls out of lock for 2 seconds.

Action: Check connection between Seed module and pump board is secure.

Fault 14 - OSC Diode Current Exceeds IDL1MAX

General Description: This is a software generated fault. It occurs if the oscillator pump diode tries to exceed the maximum current limit that is set in the EEPROM `?PUMP:IDLMAX:1` .

Action:

This is a fault that generally occurs only when the seed is in light loop. Here, the diode current is dependent upon the photodiode voltage `?PUMP:APD:1` reaching the light loop set point `?PUMP:LLSP:1`.

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the seed into current loop and measuring the photodiode signal at the expected operating current.

a. Key system OFF
b. Allow only the oscillator to turn on `PUMP:ON=1`
c. Put the oscillator into current mode `PUMP:MODE:1=1`
d. Check the set current `?pump:idl:1`
this should ~120 mA
e. Key system ON and query the seed photodiode `?PUMP:APD:1`
f. Compare this value with the light loop set point `?PUMP:LLSP:1`
g. These to values should be close to each other. If they are not, contact the factory to discuss further recovery steps.
h. Key system OFF
i. Put the oscillator back into Light loop `PUMP:MODE:1=2` and turn all modules back on `PUMP:ON=4`

Fault 15 - OSC Diode Temperature Out of Lock

General Description: This is a software generated fault. It occurs when the thermo-electric controller (TEC) on the oscillator pump diode (within the seed module) fails to lock to the set temperature. The fault occurs if the temperature falls out of lock for 2 seconds.

Action:

- Check connection between Seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C. On the Discovery NG and TPC models, the baseplate temperature can be confirmed using ?bt. During constant laser running, expect ~ 25°C. If the laser is OFF, expect 20°C. The chiller should be set to 20°C.
- Check the temperature values of the diode temperature. `?pump:atdl:1`. If this value is false, suspect loose connection or pump board failure. Contact factory for confirmation.

Fault 16 - Requires Seed Upgrade for Module 1 Compatibility

General Description: This is a software generated fault. It occurs if the seed has been configured using a newer firmware version than is currently on the pump board.

Action: Upgrade the PUMP and OPO head boards firmware to the latest build.

Fault 17 - AMP1 Diode Driver Over Current

General Description: This is a hardware fault that indicates the pre-amp 1 pump diode (within the seed module) has exceeded the hardware current limit.

Actions:

- Make sure the connection between seed module and pump board is secure
- If fault is persistent contact Coherent Scotland

Fault 18 - AMP1 Diode Driver Over Temperature

General Description: This is a hardware fault that indicates the pre-amp 1 pump diode (within the seed module) has exceeded its safe operating temperature.

Action:

- Make sure the temperature of the pre-amp 1 pump diode is valid by sending query `?PUMP:ATDL:2`. If not switch OFF the system, remove the head cover and check the connector blocks are seated and the wires within the connector blocks are secure.

- Make sure the chiller is switched ON and operating at 20 °C
- Make sure flow IN and flow OUT are connected the correct way

Fault 19 - AMP1 TEC Driver Over Current

General Description: This is a hardware fault that indicates the TEC on the pre-amp 1 pump diode is being driven too hard, causing the TEC to go over current.

Action:

- Check connection between seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 20 - AMP1 TEC Driver Over Temperature

General Description: This is a hardware fault that indicates the TEC on the pre-amp 1 pump diode is over temperature.

Action:

- Check connection between seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 21 - AMP1 TEC Driver Under Voltage

General Description: This is a hardware fault that indicates the TEC on the pre-amp 1 pump diode is under voltage.

Action:

- Check connection between seed module and pump board is secure
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 22 - AMP1 Light-loop Out of Lock

General Description: This is a software generated fault. It occurs when the pre-amp 1 pump diode (within the seed module) fails to lock to the light-loop setpoint `?PUMP:LLSP:2`. This fault only occurs when it comes out of lock FROM being in light-loop. The fault occurs if the laser comes out of lock for 20 ms.

If the system is turned on and cannot lock, the status will remain in a ramp-up state.

Action: Switch OFF and remove head cover. Check the connection between the seed module and pump board is secure.

Fault 23 - AMP1 Current Loop Out of Lock

General Description: This is a software generated fault. It occurs when the pre-amp 1 pump diode (within the seed module) fails to lock to the set current `?PUMP:IDL:2`. The fault occurs if the current falls out of lock for 2 seconds.

Action: Switch OFF and remove head cover. Check the connection between the seed module and pump board is secure.

Fault 24 - AMP1 Diode Current exceeds IDL2MAX

General Description: This is a software generated fault. It occurs if the pre-amp 1 pump diode tries to exceed the maximum current limit that is set in the EEPROM `?PUMP:IDLMAX:1`.

Action: This is a fault that generally occurs only when pre-amp 1 is in light loop. Here, the pump diode current is dependent upon the photodiode voltage `?PUMP:APD:2` reaching the light loop set point `?PUMP:LLSP:2`.

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the pre-amp 1 into current loop and measuring the photodiode signal at the expected operating current.

a. Key OFF the system
b. Allow only the oscillator and pre-amp 1 to turn on `PUMP:ON=2`
c. Put the pre-amp 1 into current mode `PUMP:MODE:2=1`
d. Check the set current `?PUMP:IDL:2` - the value ~760 mA
e. Key the system ON and query the pre-amp 1 photodiode `?PUMP:APD:2`

- Check that the value is sensible - it should read some level of noise, even if there is no light.
- If it reads 0, switch OFF the laser power and open the head cover. Check the connector blocks and wiring between the boards and modules.

f. Compare this value with the light-loop setpoint `?PUMP:LLSP:2`

g. These values should be close to each other

h. Key OFF the system

i. Place the pre-amp 1 into light-loop and turn on all the modules `PUMP:MODE:2=2` and `PUMP:ON=4`

Fault 25 - AMP1 Diode Temperature Out of Lock

General Description: This is a software generated fault. It occurs when the TEC on the pre-amp 1 pump diode (within the seed module) fails to lock to the set temperature. The fault occurs if the set temperature falls out of lock for 2 seconds. This fault does not occur when the system is in standby mode.

Action:

- Ensure the chiller is switched ON and operating at 20°C. On the Discovery NG and TPC models, the baseplate temperature can be confirmed using `?bt`. During constant laser running, expect ~ 25°C. If the laser is OFF, expect 20°C. The chiller should be set to 20°C.
- Check the temperature and temperature stability of the amp 1 diode `?PUMP:ATDL:2`. Query repeatedly to gauge stability.
- Ensure flow IN and flow OUT are connected the correct way

Fault 26 - OSC Seed Output Low

General Description: This is a software generated fault. The fault occurs when the oscillator pump diode ramps up and moves into current loop. The oscillator photodiode `?PUMP:APD:1` is compared against `?PUMP:PD1MIN` (an EPPROM value). If the current photodiode value is less than this minimum value, this fault is created.

Action:

- Check that `?PUMP:PD1MIN` is set to the correct value

Fault 27 - AMP1 Open Circuit

General Description: This is a software generated fault. Before pre-amp 1 pump diode starts ramping there is a safety check to ensure the output from the oscillator is passing through pre-amp 1. This is done by ensuring some light is detected on the pre-amp 1 photodiode `?PUMP:APD:2` and ensuring it is above a threshold that is defined by the EEPROM value `?PUMP:PDMIN:2`.

Software Description:

This fault can only occur when:

1. Diode 1 is enabled
2. Laser on ON
3. Status is in Current loop state
4. Diode stage 2 or greater are enabled

Actions:

- `PUMP:PDMIN:2` is set as half way between the value read by pre-amp 1 photodiode when the system is keyed OFF, and the value read when the system is keyed ON.
  Set the system to `PUMP:ON=1` and check the value of `?PUMP:PDMIN:2` and compare it to the value calculated using:
  a + (a-b)

  Where:

  a=`?PUMP:APD:2` [when the laser is keyed OFF]
  b=`?PUMP:APD:2` [when the laser is keyed ON]

- Key OFF the system. Send command `ON=1` (to only switch oscillator on) and key back ON
- Measure the pre-amp 1 photodiode signal `?PUMP:APD:2` and compare with the EEPROM value `?PUMP:PDMIN:2`
- The photodiode signal should be greater than the EEPROM value
- Key OFF the system and send command `ON=4` to switch all the modules on
- Contact Scotland factory in unable to resolve the issue

Fault 28 - AMP2 Diode Driver Over Current

General Description: This is a hardware fault that indicates the pre-amp 2 pump diode (within the power-amp module) has exceeded the hardware current limit. A hardware shutdown has then taken place.

Actions:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board
- Try changing pump headboard

Fault 29 - AMP2 Diode Driver Over Temperature

General Description: This is a hardware fault that indicates the pre-amp 2 pump diode (within the power-amp module) has exceeded its safe operating temperature.

Action:

- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 30 - AMP2 TEC Driver Over Current

General Description: This is a hardware fault that indicates the TEC on the pre-amp 2 pump diode is being driven too hard, causing the TEC to go over current.

Action:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board
- Check the fuses on the power distribution board for continuity
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way
- Try changing pump headboard.

Fault 31 - AMP2 TEC Driver Over Temperature

General Description: This is a hardware fault that indicates the TEC on the pre-amp 2 pump diode is over temperature.

Action:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board
- Check the fuses on the power distribution board for continuity
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 32 - AMP2 TEC Driver Under Voltage

General Description: This is a hardware fault that indicates the TEC on the pre-amp 2 pump diode is under voltage.

Actions:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board
- Check the fuses on the power distribution board for continuity
- Make sure the chiller is switched on and operating at 20 °C
- Make sure flow IN and flow OUT are connected the correct direction

Fault 33 - AMP2 Light-loop Out of Lock

General Description: This is a software generated fault. It occurs when the pre-amp 2 pump diode (within the power-amp module) fails to lock to the light-loop setpoint `?PUMP:LLSP:3`. This fault only occurs when it comes out of lock from being in light-loop. The fault occurs if the laser comes out of lock for 20 ms.

If the system is turned on and cannot lock, the status will remain in a ramp-up state.

Action:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board

Fault 34 - AMP2 Current Loop Out of Lock

General Description: This is a software generated fault. It occurs when the pre-amp 2 pump diode (within power-amp module) fails to lock to the set current `?PUMP:IDL:3`. The fault occurs if the current falls out of lock for 2 seconds.

Action:

- Switch OFF and remove head cover. Check the connections between the power-amp module and the pump head board

Fault 35 - AMP2 Diode Current exceeds IDL3MAX

General Description: This is a software generated fault. It occurs if the pre-amp 2 pump diode tries to exceed the maximum current limit that is set in the EEPROM `?PUMP:IDLMAX:3`.

Action: This is a fault that normally occurs when pre-amp 2 is in light-loop. The pump diode current is dependent on the photodiode voltage `?PUMP:APD:3` to reach the light-loop setpoint `?PUMP:LLSP:3`.

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the pre-amp 2 into current loop and measuring the photodiode signal at the expected operating current.

a. Key OFF the system
b. Allow only the oscillator, pre-amp 1 and pre-amp 2 to turn on `PUMP:ON=3`
c. Put the pre-amp 2 into current mode `PUMP:MODE:3=1`
d. Check the set current `?PUMP:IDL:3` - the value ~760 mA. This will be used when the preamp is in current mode. If it is more than 100 mA difference, set the current to 760 mA.
e. Key the system ON and query the pre-amp 2 photodiode `?PUMP:APD:3`
f. Compare this value with the light-loop setpoint `?PUMP:LLSP:3`
g. The values should be approximately equal. If the photodiode value is much less, it could indicate a failed pre-amp. If the value is 0, it could indicate a photodiode issue.
h. Contact the factory for further troubleshooting, noting the photodiode value when the current is set to 760mA
i. Key OFF the system
j. Place the pre-amp 2 into light-loop and turn on all the modules `PUMP:MODE:3=2` and `PUMP:ON=4`

Fault 36 - AMP2 Diode Temperature Out of Lock

General Description: This is a software generated fault. It occurs when the TEC on the pre-amp 2 pump diode (within the power-amp module) fails to lock to the set temperature. The fault occurs if the set temperature falls out of lock for 2 seconds. This fault does not occur when the system is in standby mode.

Action:

- Ensure the chiller is switched ON and operating at 20°C
- Switch OFF the laser system and open head cover. Check all block connectors and wires within the block connector.
- Ensure flow IN and flow OUT are connected the correct way
- Try replacing the pump board to resolve the fault

Fault 37 - Not Used

Not used.

Fault 38 - AMP2 Open Circuit

General Description: This is a software generated fault. Before pre-amp 2 pump diode starts to ramp, there is a safety check to make sure the output from pre-amp 1 is sent through the pre-amp 2. The safety check is performed by detecting some light at pre-amp 2 photodiode `?PUMP:APD:3` and verifying it is above a threshold that is defined by the EEPROM value `?PUMP:PDMIN:3`.

Actions:

- `PUMP:PDMIN:3` is set as half way between the value read by pre-amp 2 photodiode when the system is at `ON=1`, and the value read when the system is `ON=2`.
  Set the system to `PUMP:ON=2` and check the value of `?PUMP:PDMIN:3` and compare it to the value calculated using:
  a + ((b-a)/2)

  Where:

  a=`?PUMP:APD:3` [when the laser is keyed ON at `on=1`]
  b=`?PUMP:APD:3` [when the laser is keyed ON at `on=2`]
- The photodiode signal should be greater than the EEPROM value to operate. If the difference is marginal, a small adjustment can be made.

- Key OFF the system and send command `ON=4` to switch all of the modules on.
- If the fault persists, contact the factory.

Fault 39 - PowerAMP Diode Driver Over Current

General Description: This is a hardware generated fault that occurs if the Wavelength Electronics driver (see Figure 2.1-1) reaches its set maximum current, defined by an adjustable pot on the side of the driver.

Action: If the diode driver is set up correctly, this fault should not be seen as the software current limit `IDLMAX:4` is set less than the hardware limit.

If this fault occurs you should ensure the Limit O ADJ multi turn pot has been rotated fully clockwise. Keep rotating clock wise until clicking is heard. Clear the fault and try to run the laser again.

Figure 2.1-1. Wavelength Electronics Diode Driver

Fault 40 - PowerAMP Diode Driver Over Temperature

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 41 - PowerAMP TEC 1 Driver Over Current

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 42 - PowerAMP TEC 1 Driver Over Temperature

General Description: This is hardware generated fault that indicates that the power-amp pump diode 1 is overheating.

On a classic Discovery, there is a separate TEC driver.

Action:

- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way
- Check that the temperature of the diode is valid `?pump:atdl:4`. If it is valid, continue to test points below. If not, suspect connections within head. Power OFF and remove head cover. Confirm PDB fuses, block connectors, wiring to pump board and pump board to head board.

  If connections are confirmed to be good, replace pump board and then head board. Contact the factory.
- If the temperature is valid, continue to test points

Test Points: There is no specified test point to check the temperature reading from the TEC driver. Although it is possible to look at the signal on U61 pins 4 or 7.

Headboard - U61

Figure 2.1-2. PowerAMP Pump TEC Driver and Test Points

This value on U61 pins 4 or 7 can then be compared with the max and min (pins 5 and 6 on U61). The voltage from the thermistor should be between the max and min voltage.

Another test point to check is TP44, the setpoint going to the TEC driver (defined as TEC 5 setpoint). See Figure 2.1-2. This should be the same voltage measured at Therm 5 Meas IN that was previously measured at U61 pins 4 or 7. See Figure 2.1-2.

Fault 43 - PowerAMP TEC 1 Driver Under Voltage

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 44 - PowerAMP TEC 2 Driver Over Current

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 45 - PowerAMP TEC 2 Driver Over Temperature

General Description: This is hardware generated fault that indicates that the power-amp pump diode 2 is overheating. .

Action:

- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way
- Check that the temperature of the diode is valid `?pump:atdl:5`. If it is valid, continue to test points below. If not, suspect connections within head. Power OFF and remove head cover. Confirm PDB fuses, block connectors, wiring to pump board and pump board to head board.

  If connections are confirmed to be good, replace pump board and then head board. Contact the factory.
- Look at the appropriate test points

Test Points: There is no specified test point to check the temperature reading from the TEC driver. Although it is possible to look at the signal at U61 pins 8 or 11. See Figure 2.1-2.

The value at U61 pins 8 or 11 can be compared with the max and min (U61 pins 9 and 10). The voltage from the thermistor should be between the max and min voltage.

Another test point to check is TP27, the setpoint going to the TEC driver (defined as TEC 6 setpoint). See Figure 2.1-2. This should be the same voltage measured at Therm 6 Meas IN that was previously measured at U61 pins 8 or 11.

Fault 46 - PowerAmp TEC 2 Driver Under Voltage

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 47 - PowerAmp Threshold Over Voltage

General Description: To prevent damage to the laser system, there are various fail safe mechanisms. One of these safety mechanisms is linked with the power-amp photodiode (PD4).

This fault occurs when too much IR power is being produced to generate the 8 W green pump.

Action:

1. Troubleshoot the LBO spot:
   - If IR is sufficient, key OFF and change LBO spot to a number numerically distant from the current spot (eg. +10 spots) if possible. Use the commends:
     `?pump:shg:spotidx` to check the current spot position (xx)
     `?pump:shg:spotgood:(xx+10)`
     If it is good, change the current spot to the new value of [xx+10]
     `pump:shg:spotidx=[xx+10]`
     If not, or if `XX+10` does not exist choose a suitable alternative.
   - If the green power has not improved, the LBO temperature optimization should be confirmed. The objective is to produce maximum green power `?p2` from the available IR power by changing the LBO setpoint `pump:tlbo`. Query current LBO temperature set point, green power, `?pump:tlbo` and follow the temperature optimization method to maximize `?p2` changing by no more than 2° at a time
2. If the amplifier seems to be behaving normally and the IR power produced at P1<5W, check the photodiode limit settings PD4OVP is set correctly.
   a. Set `IDL:4` to a value that gives 8000 mw of SHG light `?P2`.
   b. Measure TP11 when the laser system is on and working normally.
   c. Measure TP5. If required, adjust VR2 to set at 140 % of the voltage measured from TP11..
3. If the issue is still not resolved, put the pump into current mode (key OFF, `pump:mode:4=1`). Set the current to 8 A (`pump:idl:4=8`) key back ON and observe the stability of the IR power using a power meter at the fixed output.
4. If IR stability is confirmed, observe the power and stability of the signal on the green photodiode by monitoring the TP11

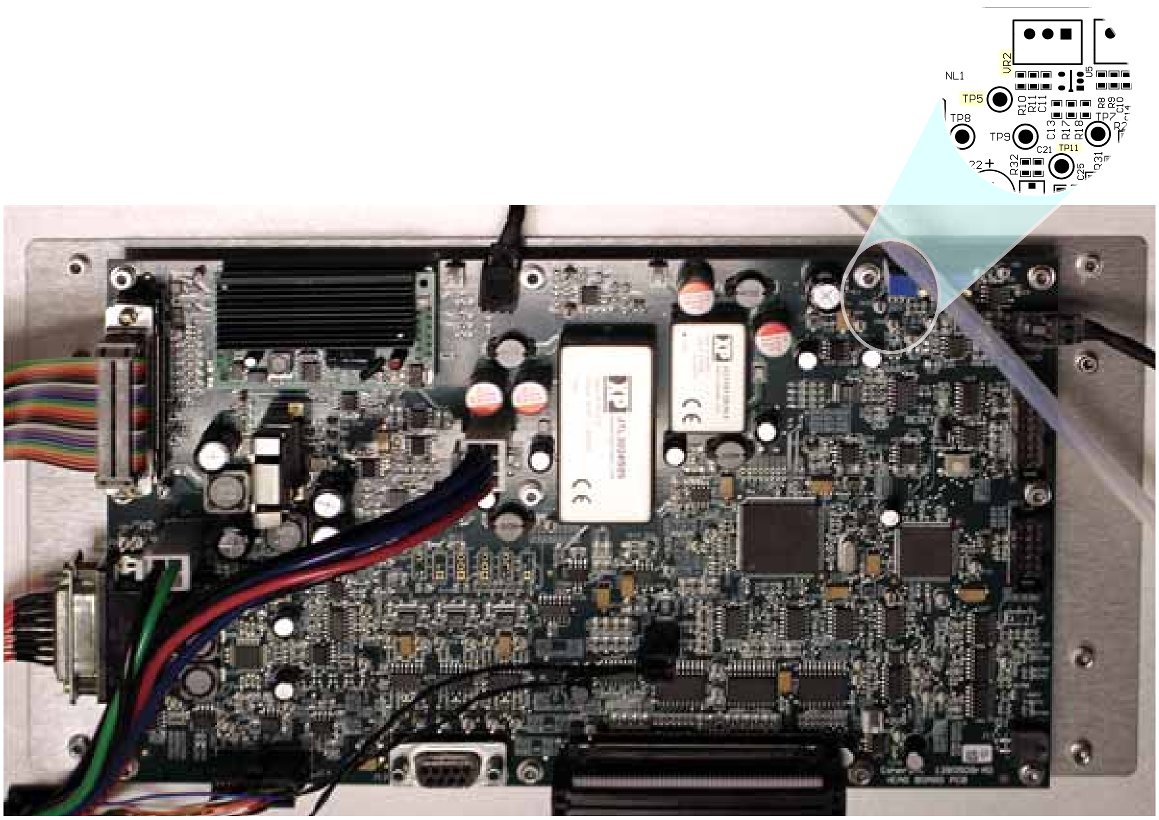


Figure 2.1-3. TP5, TP11 and VR2 Locations

signal on an oscilloscope. Alternatively slower variations can be observed by repeatedly querying `?p2`. If this is unstable (changing by hundreds of mW) and spot change does not improve, check the stability of the OPO signal. If the green power is changing, the OPO power will follow. If the tunable power is stable and as expected, suspect the green photodiode.

Switch off power, open the cover and check the connections (block connectors and wiring).

5. Alternatively if the OPO power is also changing similarly to the green power, check the LBO temperature stability by repeatedly querying `?pump:atlbo`.

   Switch OFF and open the head cover. Check connections from the PSU to the head and pump boards.

Fault 48 - PowerAmp Threshold Under Voltage

General Description: To prevent damage to the laser system, there are various fail safe mechanisms. One of these safety mechanisms is linked with the power-amp photodiode (PD4).

Once activated (using the RS-232 command `PD4=1`) and when the system has ramped up and locked successfully, the photodiode will be continuously monitored. If the voltage falls or increases a defined amount, the system will switch off and a fault is generated.

Figure 2.1-4. TP11 and VR1 Locations

Action:

- Check the PD4UVP is set correctly.
  a. Measure TP11 (see Figure 2.1-2) when the laser system is on and working normally.
  b. Measure TP2 (see Figure 2.1-2). If required adjust VR1 to set to 85 % of the voltage measured from TP11.

Fault 49 - PowerAmp Light-loop Out Of Lock

General Description: This is a software generated fault. It occurs when the power-amp fails to lock to the light-loop setpoint `?PUMP:LLSP:5`. This fault only occurs when it comes out of lock from being in light-loop. The fault occurs if the laser comes out of lock for 20 ms.

If the system is turned on and cannot lock, the status will remain in a ramp up state.

Action: Switch OFF and remove head cover. Check the connection between power-amp module and pump board is secure.

Restart the laser and continuously monitor LBO temperature, IR power and green power during operation. Look for fluctuations or creep.

Fault 50 - PowerAmp Current Loop Out Of Lock

General Description: This is a software generated fault. It occurs when the power-amp fails to lock to the set current `?PUMP:IDL:4`. The fault occurs if the current falls out of lock for 2 seconds.

Action: Switch OFF and remove head cover. Check the connection between power-amp module and pump board is secure.

Fault 51 - PowerAmp Diode current exceeds IDL4MAX

General Description: This is a software generated fault. It occurs if the power-amp pump diodes try to exceed the maximum current limit that is set in the EEPROM `?PUMP:IDLMAX:4`.

Action: This is a fault that normally occurs when power-amp is in light-loop. Here, the pump diode current is dependent on the photo-diode voltage `?PUMP:APD:5` to reach the light-loop setpoint `?PUMP:LLSP:5`.

If there is no signal measure on the photodiode or the signal does not reach the light loop set point, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by placing the power-amp into current loop and measuring the photodiode signal at the expected operating current.

a. Key OFF the system
b. Make sure all modules will turn on `PUMP:ON=4`
c. Put the power-amp into current mode `PUMP:MODE:4=1`
d. Set current `?PUMP:IDL:4 –` the value 8 A
e. Key the system ON and query the power-amp photodiode `?PUMP:APD:5`
f. Compare this value with the light-loop setpoint `?PUMP:LLSP:5`
g. The values should be approximately equal if the system is working normally
h. If the pump is behaving as expected (the values were approximately equal), confirm that the chiller is running properly, connected in the correct sense and set to 20°.

   Query `?p2`. 8000 mW should be achievable well within the maximum drive current `pump:idlmax:4`. Change the drive current in <0.3 A steps to test this `pump:idl:4`.
   On a classic system, the 8000 mW current is typically <8.5 A. On an NG or TPC system, this is typically <10.5 A. If these conditions are met and the cause of the fault is unclear, put the system into light loop and test. Go to the step m to investigate double pulsing.

If 8000 mW at p2 is achieved at a current close to IDLMAX:4 (< 0.5 A difference), then try to improve the green conversion efficiency using the steps below, as the current ramp overshoot can still trigger the fault even if 8 W is achievable within the allowable current range.

   If not, proceed with troubleshooting in current loop.

i. Check the baseplate temperature `?BT` on NG and TPC systems. This should be approximately 25°after stabilization. If the temperature differs significantly (± 4°), it suggests that there could be a cooling issue.
j. Confirm that there is sufficient IR power `?p1`. A Discovery classic should produce ~1.5-2W, NG

~3.5-5W, TPC ~2.8-4W. If not, contact factory suspecting pump module

k. If IR is sufficient, key OFF and change LBO spot to a number numerically distant from the current spot (eg. +10 spots) if possible. Use the commends:
`?pump:shg:spotidx` to check the current spot position (xx)
`?pump:shg:spotgood:(xx+10)`
If it is good, change the current spot to the new value of [xx+10]
`pump:shg:spotidx=[xx+10]`
If not, or if `XX+10` does not exist choose a suitable alternative.

l. If the green power has not improved, the LBO temperature optimization should be confirmed. The objective is to produce maximum green power `?p2` from the available IR power by changing the LBO setpoint `pump:tlbo`. Query current LBO temperature set point, green power, `?pump:tlbo` and follow the temperature optimization method to maximize `?p2` changing by no more than 2° at a time.

If at any stage green power has been significantly improved, key OFF the laser and set back into light loop mode (`pump:mode:4=3`, while the system is keyed OFF. It might take some tens of seconds after key OFF for the command to be accepted by the system. Query `?pump:mode:4` after sending the command to confirm.)

Double pulsing Seed

m. Another cause of this fault is the seed is double pulsing. If this occurs, the SHG efficiency will significantly drop making it impossible for the SHG power level to reach the light-loop setpoint. The current will ramp up to its maximum and fault. Post Baseline 4.5 (pump board software version 4.32) should prevent this from happening. To see if the problem is occurring:

- Try repeatedly keying the system OFF and ON (5-10 times). If the system generally works but occasionally faults after ramp up, it can indicate double pulsing.
- Attach a fast oscilloscope to the sync out and view the pulse train. An 80 MHz pulse train should be observed. This can be confirmed by running the laser in current mode to avoid faulting out the monitoring the IR pulse train.

Fault 52 - PowerAmp Diode 1 Temperature Out Of Lock

General Description: This is a software generated fault. It occurs when the TEC for the power-amp pump diode 1 (within the pump diode module) fails to lock to the set temperature. The fault occurs if the set temperature falls out of lock for 2 seconds. This fault does not occur when the system is in standby mode.

Action:

- Check the electrical connections between pump diode module, pump head board and power distribution board
- Check the fuses on the power distribution board for continuity
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 53 - PowerAmp Diode 2 Temperature Out Of Lock

General Description: This is a software generated fault. It occurs when the TEC for the power-amp pump diode 2 (within the pump diode module) fails to lock to the set temperature. The fault occurs if the set temperature falls out of lock for 2 seconds. This fault does not occur when the system is in standby mode.

Action:

- Check the electrical connections between pump diode module, pump head board and power distribution board
- Check the fuses on the power distribution board for continuity
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 54 - PowerAmp Base Plate Temperature Out Of Range

This fault occurs when the baseplate temperature reaches 30 degrees. This should not happen if the baseplate is properly cooled.

Check the baseplate temperature reading when the laser is off and ensure that it is a physically feasible value.

Check chiller temperature setting, flow and function/fan working.

Check chiller hoses are not kinked and that the fan at the back of the chiller is unobstructed.

Check that Coolflow IGE is being used and that it is clean - if not, flush through system and chiller with fresh Coolflow IGE coolant until it runs clear.

Key on the laser and monitor:

- The baseplate temperature with the chiller running (?bt)
- Monitor the coolant temperature of the chiller to confirm that its cooling (front panel of chiller)
- If issue cannot be identified, the coolant looks clean, the baseplate readings are feasible but rise after switch on, try changing chiller
- Contact factory

Fault 55 - Not Used

Not used.

Fault 56 - PowerAmp Open Circuit

General Description: This is a software generated fault. Before the power-amp pump diode starts to ramp, there is a safety check to verify the output from pre-amp 2 is sent through the power-amp. The safety check is performed by detecting light on the power-amp photodiode `?PUMP:APD:4` and verifying it is above the threshold that is defined by the EEPROM value `?PUMP:PDMIN:4`.

Action:

- Key OFF the system. Send command `ON=3` (to only switch oscillator and pre-amp 1 + 2 on) and key the system ON.

System will stay in a ramping state.

- Measure the power-amp photodiode signal `?PUMP:APD:4` and compare with the EEPROM value `?PUMP:PDMIN:4`.
- The photodiode signal must be more than the EEPROM value to operate.
- Key OFF the system and send command `ON=4` to switch all the modules on.

Fault 57 - SHG Heater Over Current

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 58 - SHG Heater Drive Over Temperature

General Description: This is a software generated fault that will shut the system down if the temperature of the SHG crystal `?PUMP:ATLBO` goes above a set maximum temperature that is defined by `?TLBO`.

Actions:

- Query `?PUMP:ATLBO`.
- Query `?PUMP:TLMAX` and compare with the original EEPROM value.
- Query `?PUMP:TLBO` and compare with the original EEPROM value.

If the system is operating correctly, the actual temperature `ATLBO` should equal the set temperature `TLBO` and should not be above the maximum set temperature `TLMAX`.

If the temperatures match, it could indicate that there is laser absorption on the crystal. Follow ATLBO=TLBO procedure.

- Clear the fault, key the laser on and query the current oven temperature continually.
- `?pump:atlbo`
- If the temperature increases significantly once the pump ramps up, key off and change LBO spot to a number significantly different to the current number and retry. Contact the factory.

If the ATLBO value is false without keying ON the system, it suggest a bad connection or PDB fuse issue. Proceed to the recommendations below:

- Switch system OFF, check the ribbon cable from pump headboard to OPO headboard.
- Check the ribbon cable from OPO headboard to bulkhead connector.
- Check PDB connections to pump board and PDB fuses.

Fault 59 - SHG Heater Supply Under voltage

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 60 - SHG Oven Temperature Out Of Lock

General Description: This is a software generated fault. After the initial warm-up state when the SHG assembly has locked to the set temperature `?TLBO`, the LBO is continuously monitored. If its actual temperature `?ATLBO` deviates away from the set temperature by ± 2 °C for more than 2 seconds it is defined as being out of lock. A fault is generated and the system will shut down.

Action:

- Query `?PUMP:ATLBO`.
- Query `?PUMP:TLMAX` and compare with the original EEPROM value.
- Query `?PUMP:TLBO` and compare with the original EEPROM value.

  If the value is false, switch OFF the system. Confirm the connections from the power amp module to the pump board and from the pump board to the OPO board. Also check the fuses and connections on the PDB board.

If the system is operating correctly, the actual temperature `ATLBO` should equal the set temperature `TLBO` and should not be above the maximum set temperature `TLMAX`.

- Query
  `?PUMP:LBOTP`
  `?PUMP:LBOTI`
  `?PUMP:LBOTD`
  and compare with the original EEPROM settings.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way
- If everything appears to be normal, clear the fault and key ON. Continually query the actual LBO temperature as the power amp ramps up. Monitor for heating of the LBO crystal with the power amp on. If this occurs, change LBO spot to a numerically distant spot and try again. Contact the factory.

Fault 61 - SHG Light-loop Out Of Lock

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 62 - I2C Read Retry Fail

General Description: This is a software generated fault. The fault occurs after a communication with the I2C bus 5 times in a row.

Action:

The components that communicate by I2C are:

a. The SHG stepper
b. EEPROM (both head boards)
c. Digipots (Seed module)
d. ADC (both head boards)

Possible causes of this fault include:

1. **Damaged ribbon cable:** This can be any one of the four ribbon cables that are used in the Discovery.
   a. Seed to pump board
   b. Power-amp module to pump board
   c. Pump headboard to OPO pump headboard
   d. OPO headboard to cavity
2. **The SHG stepper assembly:** The daughter-board connected to the pump headboard controls the SHG stepper assembly. If the board is damaged, there is a potential for this fault to be generated. To confirm the stage is in operation, move the SHG spot and listen for a distinctive high-pitched noise from the stage. If there is no noise, make sure that the daughter-board is installed correctly on the pump head board.

Fault 63 - CPLD Fault #xxxxxxxx

Description: This fault has not been implemented in the firmware and will never be generated. If there is a need to look at the CPLD fault, it is possible to use the RS-232 command `?CPLD`.

Fault 64 - Supply Seed Over Voltage

Description: This is a hardware generated fault that causes a software shutdown. It occurs if the voltage regulator detects over voltage.

Action: Contact the Scotland factory.

Fault 65 - Supply Seed Under Voltage

Description: This is a hardware generated fault that causes a software shutdown. It occurs if the voltage regulator detects under voltage.

Action: Contact the Scotland factory.

Fault 66 - OSC Tec1 Drive

General Description: This is a software generated fault. It occurs if thermo-electric controller PID servo for the seed pump diode reaches a maximum or minimum (0 or 65535).

Action:

- Monitor the seed TEC drive using the query `?PUMP:AITEC:1`. When the laser is first powered on and is in the warm-up state, the value will oscillate slightly until the set temperature is reached. When in standby mode, the value should be stable and in between the maximum and minimum values.
- Monitor the seed temperature using the query `?PUMP:ATDL:1`. This value needs to be stable and locked at the set temperature `PUMP:TDL:1`.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 67 - OSC Tec2 Drive

General Description: This is a software generated fault. It occurs if thermo-electric controller PID servo for the pre-amp 1 pump diode reaches maximum or minimum (0 or 65535).

Action:

- Monitor the pre-amp 1 TEC drive using the query `?PUMP:AITEC:2`. When the laser is first powered on and is in the warm-up state, the value will oscillate slightly until the set temperature is reached. When in standby mode, the value should be stable and in between the maximum and minimum values.

  If the temperature ATDL:2 is false, suspect connection. Check the PDB fuses and connections.

  On Discovery classic, check the connections to the Wavelength TEC driver. Check all connections and wires within connector blocks from pump board to PDB. Check fuses on the PDB.

If those are all confirmed to be good, replace

- Monitor the pre-amp 2 temperature using the command `?PUMP:ATDL:2`. This value needs to be stable and locked at the set temperature `PUMP:TDL:2`.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 68 - OSC SBR Drive

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 69- AMP2 Tec1 Drive

General Description: This is a software generated fault. It occurs if thermo-electric controller PID servo for the power-amp pump diode 1 reaches maximum or minimum (0 or 65535).

Action:

- Monitor the power-amp pump diode 1 TEC drive using the query `?PUMP:AITEC:4`.

  When the laser is first powered ON and is in a warm-up state, this value should oscillate slightly until the set temperature is reached. When in standby mode, the value should be stable and within the maximum and minimum values.

  If the value is railed to maximum, check the temperature reading. If this is false, check all connections and wires within connector blocks from pump board to PDB. Check fuses on the PDB.
- Monitor the power-amp pump diode 1 temperature using the query `?PUMP:ATDL:4`. This value needs to be stable and locked at the set temperature `PUMP:TDL:4`.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 70 - PWR Tec1 Drive

General Description: This is a software generated fault. It will occur if the drive to the external Wavelength Electronics TEC driver 1 is set to 0 or 65535. In practice, this will never occur given that TEC drive is only for control of the temperature setpoint going into Wavelength Electronics TEC driver. This value is a constant and when set will not change. (Not applicable to CV > 4 NG and TPC).

Fault 71 - PWR Tec2 Drive

General Description: This is a software generated fault. It will occur if the drive to the external Wavelength Electronics TEC driver 2 is set to 0 or 65535. In practice, this will never occur given that TEC drive is only for control of the temperature setpoint going into Wavelength Electronics TEC driver. This value is a constant and when set will not change. (Not applicable to CV > 4 NG and TPC).

Fault 72 - OSC Diode Drive

General Description: This is a software generated fault. It occurs if oscillator drive voltage reaches a maximum (not minimum). This fault can occur in both current loop and light-loop.

Action: Contact the Scotland factory.

Fault 73 - AMP1 Diode Drive

General Description: This is a software generated fault. It occurs if the pre-amp 1 drive reaches maximum or minimum value (65536 and 0). This fault can occur in both current loop and light-loop.

Action: Contact the Scotland factory.

Fault 74 - AMP2 Diode Drive

General Description: This is a software generated fault. It occurs if the pre-amp 2 drive reaches maximum or minimum value (65536 and 0). This fault can occur in both current loop and light-loop.

Action: Contact the Scotland factory.

Fault 75 - PWR Diode Drive

General Description: This is a software generated fault. It occurs if the power-amp drive reaches maximum or minimum value (65536 and 0).

Action:

- Check fuses on the power distribution board.
- Replace the pump module.
- Contact the Scotland factory.

Fault 76 - CPLD Write IO

General Description: This is a software generated fault. It occurs if the firmware cannot get a CPLD fault code from the CPLD. It is the internal equivalent of querying `?CPLD` and not getting a response.

Action: Replace the pump head board.

Fault 77 - Supply Head Over Voltage

General Description: This is a hardware generated fault that occurs when the headboard detects that the supply voltage is more than the specified value.

Actions: There are voltage regulators on both headboards and on the OVP/ UVP of the power supply. If only the fault 77 occurs, the problem is probably located at the pump head board and/or the power distribution board. Confirm the following:

- Check the seating of the connector blocks and wiring within between the power distribution board to the fiber board.
- Probe the voltages on the power distribution board to make sure the correct voltages are present. See Figure 2.1-5. If the voltages are with in range, then it would suggest there is an issue with pump head board.
- If all voltages look normal, replace pump headboard.

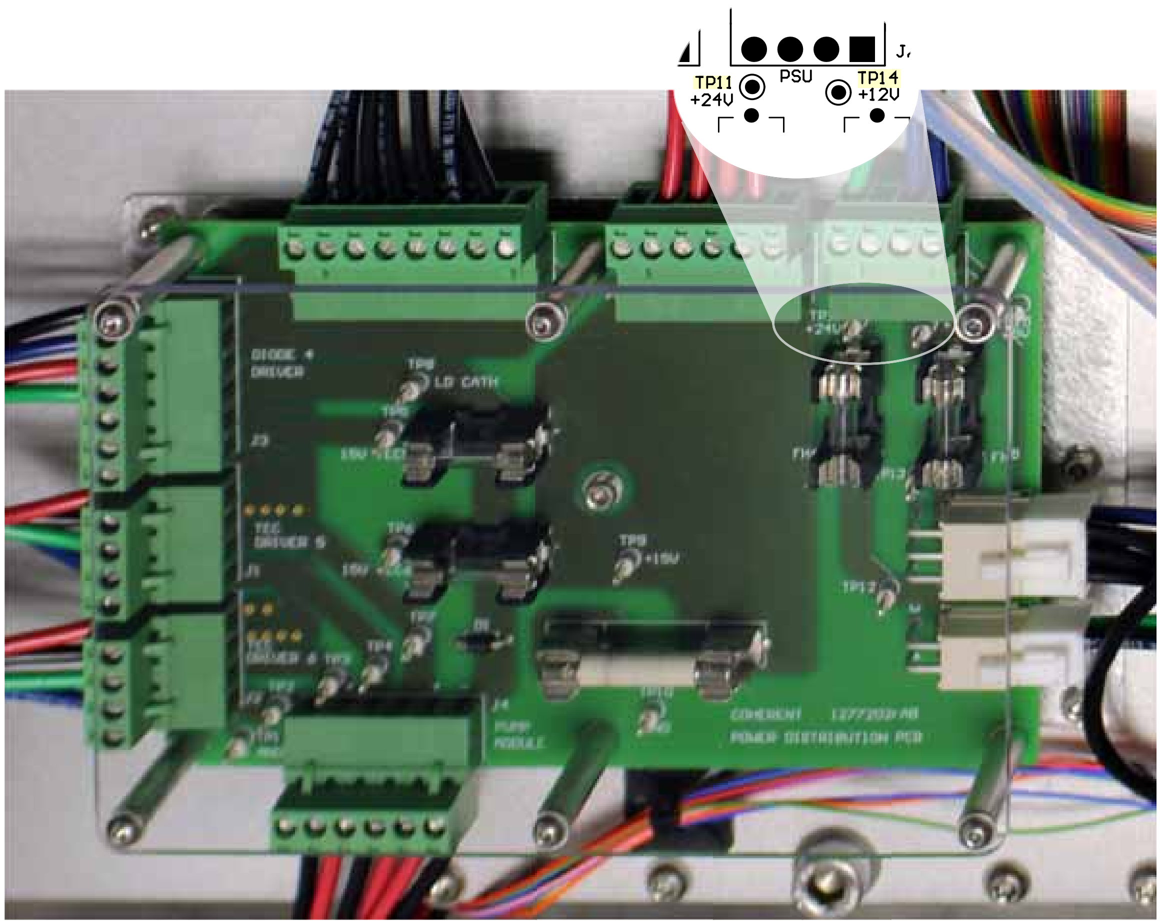


Figure 2.1-5. TP 11 and TP 14 Locations

Fault 78 - Supply Head Under Voltage

General Description: This is a hardware generated fault and occurs if the headboard detects that the supply voltage is lower than it should be.

Actions: There are voltage regulators on both headboards and on the OVP/ UVP of the power supply. If only the fault 78 occurs, the problem is probably located at the pump head board and/or the power distribution board. Confirm the following:

- Check the wiring between the power distribution board to the fiber board.
- Check the fuses on the power distribution board for continuity.

- Probe the voltages on the power distribution board to make sure the correct voltages are present. See Figure 2.1-5. If the voltages are with in range, then it can suggest there is an issue with pump head board.
- If all voltages look normal, replace pump headboard.

Fault 79 - SHG Oven Drive

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 80- Seed TEC HW

General Description: This is normally a hardware fault which occurs when the TEC on the seed pump diode is more than the hardware defined maximum level of 50 °C. Software limits the setpoint temperature between the ranges of 10 to 40 °C. This fault is for both the oscillator and the pre-amp 1.

Action:

- Check the temperature of the oscillator pump diode is true by querying `?PUMP:ATDL:1`. This should be near the value `?PUMP:TDL:1`.
  - If actual temperature is different, check the connection between the oscillator module and the pump head board.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Test Points: There are no test points for the thermistor inputs but U47 pins 4 or 7 can be probed.

This value can then be compared with the max and min on U47 pins 5 and 6. The voltage from the thermistor should be between the max and min voltage.

Figure 2.1-6. Headboard - U47

Fault 81 - AMP2 TEC HW

General Description: This is a hardware fault which occurs when the TEC on the pre-amp 2 pump diode is over the hardware defined maximum level of 50 °C. Software restricts the setpoint temperature between the ranges of 10 to 40 °C.

Action:

- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Test Points: TP33 on the pump headboard can be used to measure the voltage from the pre-amp 2 thermistor. This value can then be compared with the max and min U50 pins 8 and 10. The voltage from the thermistor should be between the max and min voltage. See Figure 2.1-7.

Fault 82, PWR TEC HW

General Description: This is a hardware fault has which occurs when the power-amp pump diodes (within the pump module) are out with its normal operating temperature (defined is between 10°C and 50°C).

Figure 2.1-7. Headboard - U50

Action: Measure the resistance of the thermistors which should give around 10 k at room temperature. Access to this can be obtained from two pin connector on top of the Wavelength Electronic TEC Drivers (red wires on the classic).

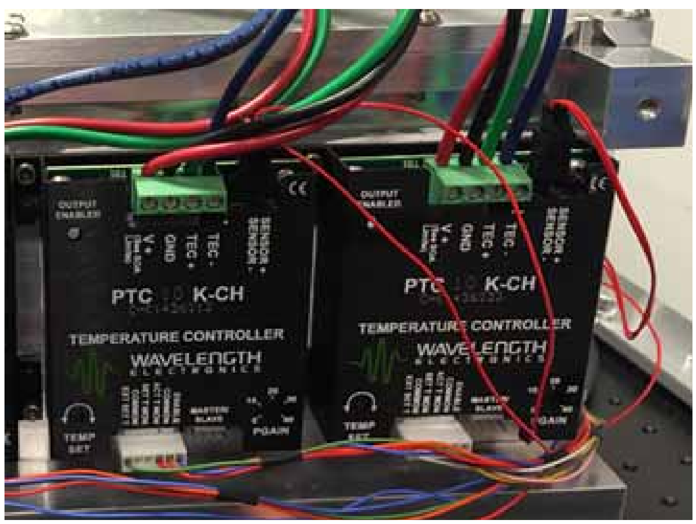


Figure 2.1-8. TEC Drivers

Fault 83 - SHG Oven HW

General Description: This is a hardware fault which occurs when the SHG oven is out of the normal operating temperature (0 °C to 100 °C).

Action:

- See "Fault 58 - SHG Heater Drive Over Temperature" on page 2.1-29.This fault will occur before Fault 83.
- Check the ribbon cable from the pump headboard to OPO headboard.
- Check the ribbon cable from the OPO headboard to bulkhead connector.
- Ensure the chiller is switched ON and operating at 20°C
- Ensure flow IN and flow OUT are connected the correct way

Fault 84 - Pump Interlock

Description: This is a hardware generated fault that occurs if the pump headboard detects an interlock fault. There are two interlock switches that are part of the pump interlocks.

- The cover over the pump fiber connectors.
- The cover over the seed module output fiber port.

Action:

1. Check both fiber connector covers are secure.
2. Check the interlock loom is connected correctly to the pump head board.
3. Use a multimeter to verify the micro-switches are operating correctly. Check the integrity between:
    a. pins 1 and 3 while the cover is removed for the pump fiber connectors.
    b. pins 2 and 4 while the cover is removed for the seed connectors.

Fault 85 - Head Interlock

Description: This is a hardware generated fault. It is generated by the pump headboard when it detects the OPO headboard has an interlock fault.

The head interlock fault originates from the OPO headboard. It is the combination of a number of interlock faults that can occur and require an immediate hardware shutdown. The interlock faults are:

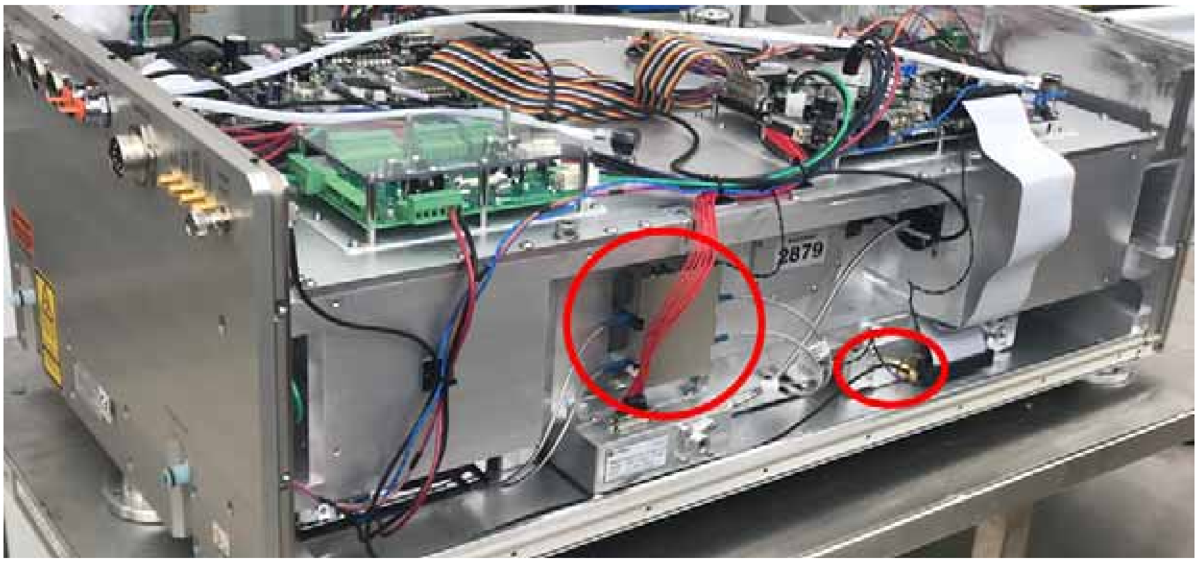


Figure 2.1-9. Fiber Connector Cover Locations

- Emission LED fault
- PSU Emission LED fault
- External interlock
- PSU supply fault
- Shutter fault

Action: If this fault occurs, it will normally come with a secondary fault from the OPO headboard (a fault >1000). This is the fault that should be investigated.

Fault 86 - Head

Description: This is a software generated fault that occurs if pump board receives information through the CAN bus that a fault has occurred on the OPO headboard. If this occurs, a controlled software shutdown will occur.

Action: Check for a fault originating from the OPO head board using `?F` or `?FH`.

Fault 87 - Pump Service Required

Description: This fault occurs when all SHG spots have been marked as bad. This should only occur on systems that have been running for a long period of time. The system will still operate but indicates to the user that the system can start to slowly degrade if there is no intervention from service.

Action: Contact the Scotland factory.

Fault 1001 - Pump Not Available

General Description: If the CAN messages are not returned from the pump headboard for 5 seconds, then the OPO head board will send this fault.

Action:

- Check the pump board is powered up.
- Check the software baseline versions match: possible failure in CAN communication if the versions are different.
- Make sure OPO board J11 and pump board J4 are connected.
- Change the cable between pump headboard and OPO headboard.

Fault 1002 - Key State Mismatch

General Description: Not implemented.

Fault 1003 - Tuning Stepper Home Fail

General Description: The fault indicates that the tuning stepper has not correctly completed the home procedure.

Detailed Description: When the stepper carries out a relative home `STP1HM=1` the stepper will rotate backwards until it passes the home switch, making the home signal high. At this point the stepper will stop, move forward 1000 steps, define zero position and then move to the desired position. If the firmware detects that the stepper is still high after moving forward 1000 steps a fault is generated. It indicates that something may be wrong with the stepper and that it is not moving correctly.

Action: Perform an absolute home procedure.

- Query `?STP1SPOT` – this indicates the current OPO spot position.

- Perform an absolute home `STP1HMABS=1`. The status `?st` should read **Please Wait** while the tuning stepper is homing.
- An absolute home has the potential to take up to 15 minutes if the system is using a large spot number. After 2 to 3 minutes, the stepper can be checked for movement by sending the query `?STP1POSABS`. This is the absolute position and should change after the stepper has completed the home procedure.

If the procedure does not work, it is possible to probe the home switch using R269 on the OPO board. If the signal is high, it is an indication that the stepper is not moving.

Figure 2.1-10. OPO Board - R269

Fault 1004 - GDD Stepper Home Fail

General Description: The fault indicates that the GDD stepper has not correctly completed the home procedure.

Detailed Description: This fault occurs once the stepper has moved to its homing switch and has tried to move 20 steps forward. In normal operation, these 20 steps should make the home switch go low. A fault is created if this signal remains high. It indicates that something may be wrong with the stepper and that it is not moving correctly.

Action: Manually home the stepper by sending the command `STP2HM=1`.

Fault 1005 - Seed Wrong Version

General Description: This fault has not been implemented by the firmware and will never be generated.

Fault 1006 - Failed to Read PCBA

General Description: This fault has not been implemented in the firmware and will never be generated.

Fault 1007 - Not Used

Not Used

Fault 1008 - PID Last Limit (check)

Description: This is a software generated warning that only appears when the OPO board is in Service mode. **The USER should never see this fault.** It occurs when the OPO can not lock at the 95 % power level and the system has automatically done a rescan to find the new 95 % power level.

Action: This is a warning that the system had to rescan itself. Normally a rescan will only occur if the output power of the system has decreased. If the power drop by 5 %, then it is impossible for the OPO to lock at the original 95 % level and results in the system needing to rescan to find a new lower 95 % level. Below are some reasons why this can occur.

1. Environmental changes:
   If the ambient temperature has rapidly changed, there is a potential of the OPO power to fluctuate.
2. Chiller is not operating correctly.
3. Pump mirror not optimized:
   If the pump mirrors are optimized correctly, an increase in power should be seen. This is why rescanning/retuning the system 30 minutes after keying the system ON should result

in the 95 % power being reset to a higher power.
If the power decreases while the system is in warm-up, it can indicate the pump mirrors are not optimized. This indicates that the pump map optimization routing should be performed when the system is stable.
Take careful note of the original pump position before carrying out an optimization. If an optimization is carried out ensure that stable running and spec power is achievable at operation wavelengths.

Fault 1009 - Lid interlock

Description: This fault has not been implemented in the firmware and will never be generated.

Fault 1010 - External Interlock

Description: This is a hardware driven fault caused by the OPO headboard detecting an external interlock fault.

Action:

- Make sure the interlock defeat is fully inserted into the back of the MRU.
- Make sure the MRU is switched on.
- Make sure the interlock cable between the MRU and the PSU are connected correctly.
- If the USER supplies their own interlock, confirm that the interlock is not causing the problem. Insert the Coherent supplied interlock defeat into the back of the MRU.
- Check there is continuity between pins 1 and 4 of the MRU interlock defeat.

Fault 1011 - PSU Supply Fault

Description: This is a hardware generated fault which occurs if the PSU detects a problem. The fault can be caused by the following issues:

- Problem with shutter 1 LED (the actual light on the shutter button).
- Problem with shutter 2 LED (the actual light on the shutter button).
- Problem with the fault LED.

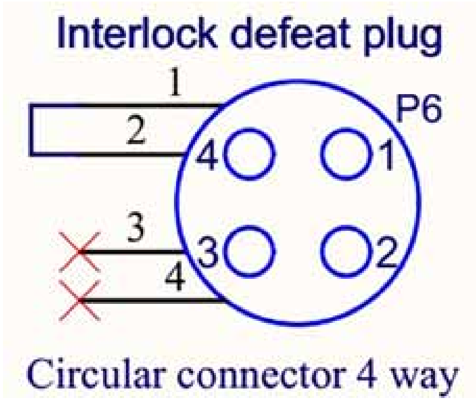


Figure 2.1-11. Interlock Defeat

- PSU is gives an over voltage warning (OVP).
- PSU is gives an under voltage warning (UVP).

Action: Replace the PSU

Test Points: To determine which of the 5 possible issues have caused the fault, the PSU headboard can be probed using the test points outlined below: See Table 2.1-1 for the different test points.

Table 2.1-1. PSU Headboard - Test Points

Fault	Test Point	Normal Operation	Active Fault
Shutter LED 1 Fault	TP8	High	Low
Shutter LED 1 Fault	TP7	High	Low
Fault LED	TP2	High	Low
OVP	TP4	High	Low
UVP	TP6	High	Low

Fault 1012 - PSU Emission LED

General Description: This is a hardware generated fault that occurs if there is a problem with the emission LED that is on the PSU.

Action: Replace the PSU.

Fault 1013 - Emission LED1

General Description: This is a hardware generated fault that occurs if a problem is detected with the head emission LED.

Action: Make sure the emission LED is correctly connected to J9. If the fault continues to occur, the emission LED may need to be changed.

If fault persists after inspecting wiring (and even if the emission LED appears to be working) change the emission LED anyway.

Fault 1014 - Emission LED2

General Description: This fault should never occur because a second emission LED is not on Chameleon Discovery.

Fault 1015 - Illegal Code Restart

General Description: This fault indicates that the OPO firmware has unexpectedly crashed and has restarted.

Action: Send feedback to the Coherent Scotland on the status of laser system when the fault occurred.

Fault 1016 - Key On at Power Up

General Description: This fault has not been implemented in the firmware and will never be generated. Fault 1 should appear if the Key is left in the ON position during power up.

Fault 1017 - Low Power

General Description: This is a software generated warning which occurs after the system had 5 attempts to make the OPO lase. One attempted scan is specified as a fine scan, followed by a coarse scan with the last step being a complete scan of the OPO piezo stage. If the system is retuned and lasing is found, the fault is moved to the fault history.

Action:

- Make sure the pump is producing the correct power (`?P2` should equal ~8000).

- Change SHG spot and retune. Use `PUMP:SHG:SPOTCH+` to move to the next good spot when the system is keyed off.
- Change BBO spot and retune. Use `STP1SPOT+` to move to the next good spot when the system is keyed off.
- Perform a pump map to check the pump position is optimized.

Fault 1018 - Wavelength Setup Error

General description: This is a software generated fault that can occur for two reasons:

1. The firmware tries to interpolate corrupted data from the cavity look-up table.
2. The OPO piezo stage cannot lock properly to the requested strain gauge position.

Action:

- Use the Service GUI EEPROM tool to check for corrupted data within the cavity look-up table. If necessary, reload the cavity look-up table from a previous EEPROM image.
- Recalibrate the piezo stage using `STAGESGCAL`. Before this is done, the watchdog jumper (W1) on the OPO headboard must be removed (only required for Release builds 2, 3 and 4).

Fault 1019 - Service required

General Description: This is a software generated warning prompt for the user to contact Coherent support. The warning indicates that all spots on the OPO crystal are used. This should only occur on systems that run for long periods of time. If this is not the case, confirm the spot lifetime in the EEPROM (?STP1:SPOTLTMIN (800) and ?STP1:SPOTLTMAX (1200)).

The system will operate, but this an indication to the user that the system can start to slowly degrade of there is no intervention from service.

Action: Be suspicious if the laser is less than several years old.

Check ?STP1:SPOTLTMAX is at least 800.

Check the BBO spotlist.

Contact the Scotland Factory Support.

Fault 1020 - Tunable shutter fault

General Description: This is a software generated fault (release build 5 onwards) that is created when the firmware detects the shutter is not operating correctly.

Action: Replace the tunable shutter

Fault 1021 - Fixed shutter fault

General Description: This is a software generated fault (release build 5 onwards) that is created when the firmware detects the shutter is not operating correctly.

Action: Replace the fixed shutter

Fault 1022 - Tuning stepper at rear limit

General Description: This is a software generated fault (release build 5 onwards) which occurs if the firmware cannot detected the rear limit switch on the tuning stepper and has prevented to stepper from moving any further to prevent damage.

Action:

- Check the 50-way loom ribbon cable between the OPO head-board and the bulkhead
- If fault continues, contact Coherent Scotland

Fault 1023 - Tuning stepper timeout

General Description: This is a software generated fault (release build 5 onwards) which occurs if the tuning stepper is not able to complete an absolute home.

Action:

- Check the 50-way loom ribbon cable between the OPO head-board and the bulkhead
- If possible, try exchanging the PSU and umbilical cables
- If fault continues, depot repair for stepper replacement is likely. Contact Coherent Scotland.

Discovery NX Fault Messages

The Discovery NX has a different board structure and hence the command structure has changed. However, using an alias system, old commands valid on Discovery are also valid on Discovery NX, negating the need to learn a new command set.

Fault 1 - MCU CALCULATION ISSUE

Description

This is a critical software generated fault that occurs when there is floating point error within the firmware causing a calculation to fail. It is generally caused when there is a bug in the firmware.

Action

Report the issue to Coherent Scotland, outlining, if possible the how and when the fault occurs

Fault 2 - MCU BAD COMMUNICATION

Description

This is a critical software generated fault that occurs when the communication lines (I2C or SPI) fail to communicate properly.

Action

- Switch off mains power at PSU and open laser head cover
- Check cables to and from the controller board are connected properly
- Replace the Controller board

Fault 3 - MCU UNKNOWN INTERLOCK SOURCE

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the controller board detects that the MCU Interrupt line goes Low (fault state).

This specific fault means although the MCU interrupt has been triggered, when the firmware goes to query what fault line has been latched it finds nothing has in fact been latched.

Summary Description

The system has 2 levels of interlock fault reporting. The first is a global interlock fault, which is triggered when any of the numerous interlocked modules break the interlock circuit. The second report specifies which of the modules or components triggered the global interlock fault and it is normally the second that is investigated. This fault arises when there is a global interlock fault, but the specific origin of the fault has not been identified. This has been observed when the system is exposed to a large electrical noise spike.

Electronic Description

An MCU Interlock line can be pulled low by a number of faults outlined in the figure below. When one of these faults occur the interlock line gets pulled low.

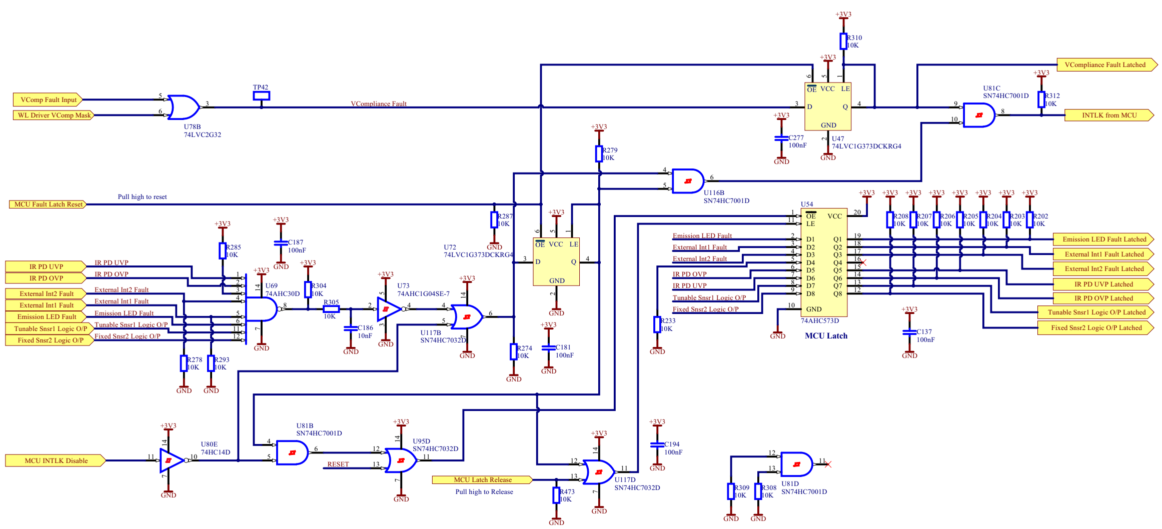


Figure 2.1-12. MRU Interlock Line

The MCU Interlock signal then gets latched and at the same time pulls down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

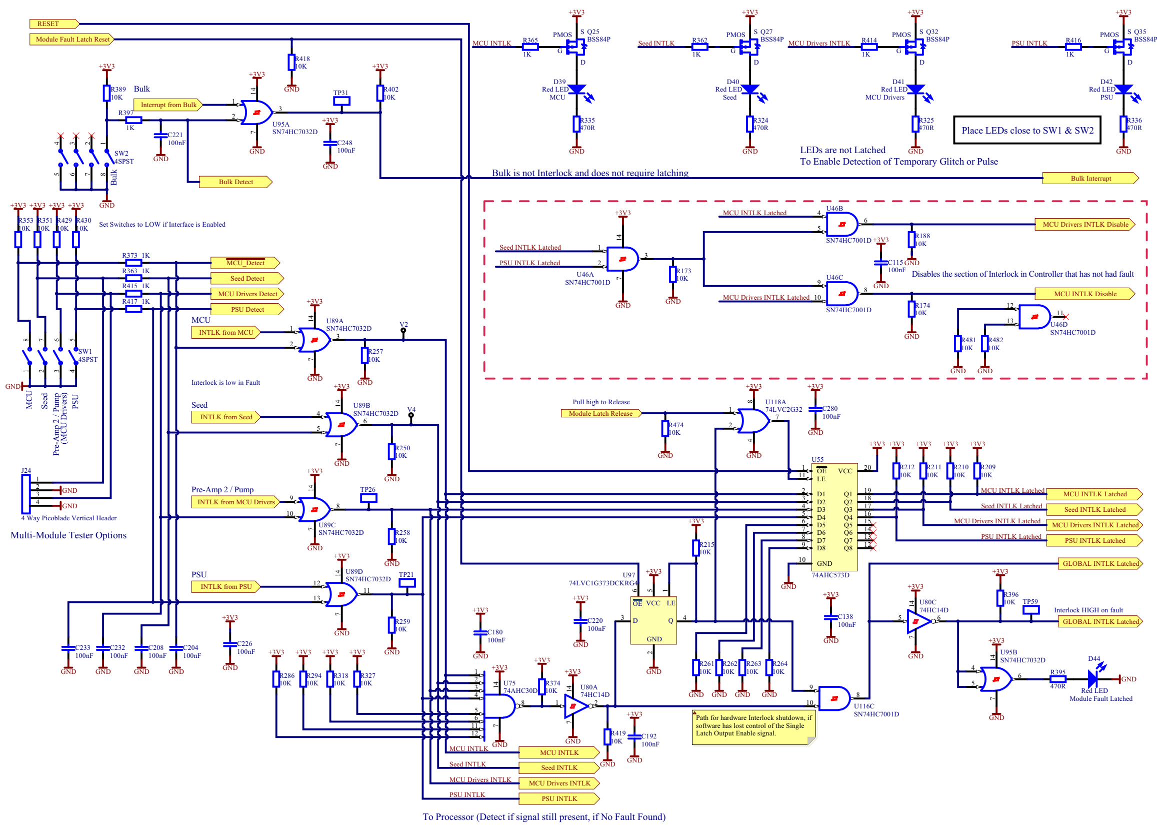


Figure 2.1-13. Global Interlock Line

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock line will be latched. The firmware will then query the MCU latching circuit via the I2C GPIO expander to determine the fault. In this case, nothing will have been latched and results in this specific fault.

Action

- Check if any large pieces of equipment were being switched off/on at the time of the laser faulting out.

- Ensure that the customer has adequate surge protection in place and try to ensure that the Discovery is not plugged in along with a high power appliance.
- The fault should be able to be cleared by typing “FC”
- If it persists, contact Coherent Scotland

Fault 4 - COMPLIANCE VOLTAGE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the Controller PCBA detects a problem with the Compliance Voltage. The compliance voltage is related to the power amp diode supply voltage.

Electronics Description

The Controller PCBA detects if there is a problem with the compliance voltage using the circuit below:

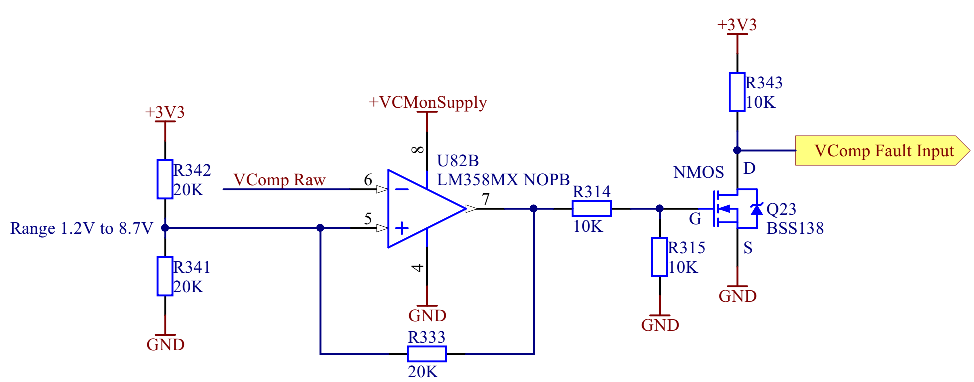


Figure 2.1-14. VComp Fault Line

The VComp Fault Line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down, see Figure 2.1-12 "MRU Interlock Line".

The MCU Interlock signal gets latched and at the same time pulls down the Global Interlock line, see Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the Compliance Voltage fault line will have been latched resulting in the firmware flagging up this specific fault.

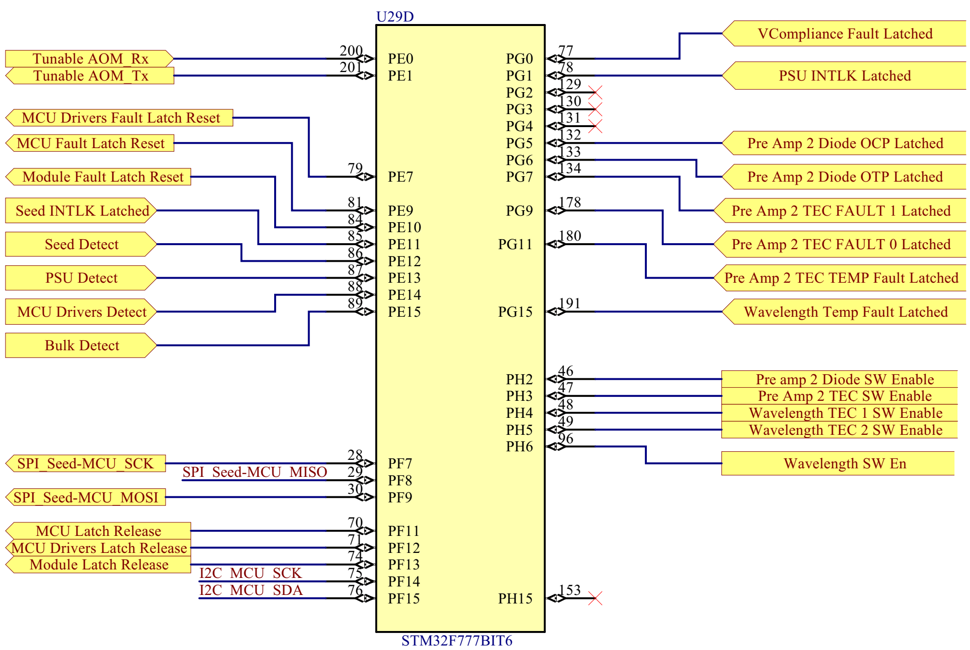


Figure 2.1-15. Micro-Controller for MCU Latching Circuit (U29D)

Action

While the system is on, the compliance voltage should measure ~2.5V. This can be measures either probing TP 44 on controller board or querying **?MCU:VCOMP**

If the voltage is not 2.5V, check the connections between the controller board and the diode driver.

Sometimes this fault can trigger if the unit is especially sensitive. It can be possible to reduce sensitivity to this fault by effectively reducing the ramp rate in current mode by reducing the integral gain.

Key off the system, query ?LLI, set LLI to 0.25 of its original value. Key on the system and confirm that it ramps successfully. Look at the data and compare ramp time before and after the change.

If the fault continues after the LLI change and only occurs on key on, suspect the diode driver. Onsite visit replacement required. Notify GDP factory

Fault 5 - MCU EMISSION LED FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the Controller PCBA detects a problem with the Emission LED (attached to the front panel).

Electronics Description

The Controller PCBA detects if there is a problem with the Emission LED using the circuit below.

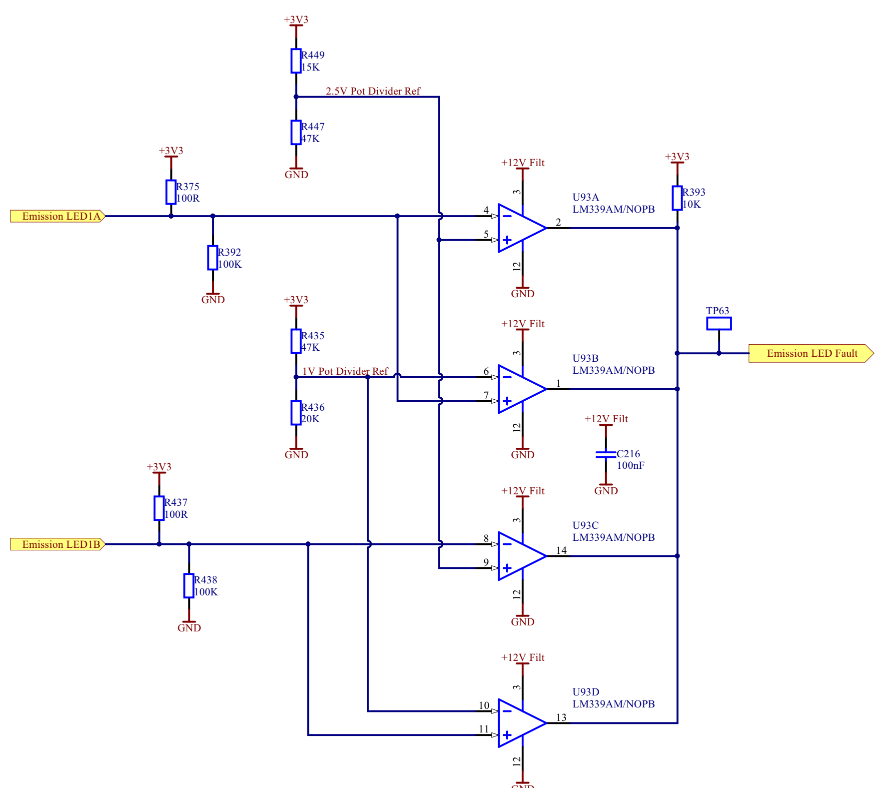


Figure 2.1-16. Emission LED Circuit

The Emission LED Fault Line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See Figure 2.1-12 "MRU Interlock Line".

The MCU Interlock signal gets latched and at the same time pulls down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.See Figure 2.1-13 "Global Interlock Line".

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the Emission LED fault line will have been latched resulting in the firmware flagging up this specific fault.

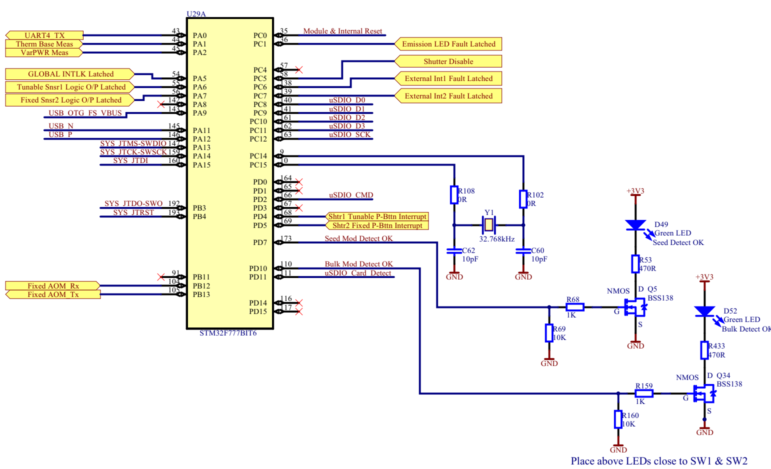


Figure 2.1-17. Micro-controller for MCU (U29A)

Action

Investigate the Emission LED connections. If repaired, test system.

If connections were not at fault, or the issue is intermittent. Replace the Emission LED.

Note that the emission LED can be at fault even if it is observed to be lighting.

Fault 6 - MCU EXTERNAL INTERLOCK OPEN

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the Controller PCBA detects a problem with the safety interlock switch situated next to the pump diode connectors. Not to be confused with external interlock (customer).

Electronics Description

The Interlock switches for the pump diode connectors and the seed come into the controller PCBA via J35.

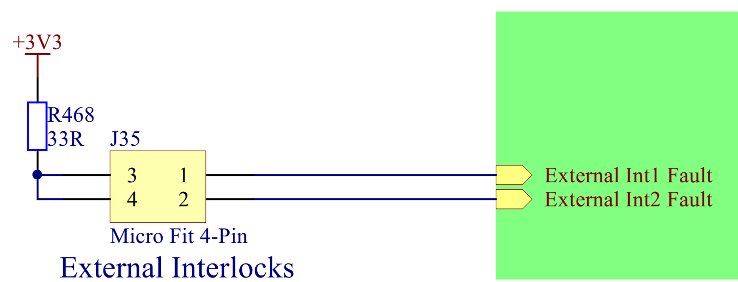


Figure 2.1-18. J35 Circuit - External Interlocks

External Int2 fault refers to the switch attached next to the pump diode connectors. This fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See Figure 2.1-12 "MRU Interlock Line".

The MCU Interlock signal gets latched and at the same time pulls down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention. See Figure 2.1-13 "Global Interlock Line".

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the External Int 2 fault line (pump diode connectors) will have been latched resulting in the firmware flagging up this specific fault. See Figure 2.1-15 "Micro-Controller for MCU Latching Circuit (U29D)".

Action

- Check both fiber connector covers are secure
- Check the interlock loom is connected correctly to the controller PCBA
- Using a multimeter check the micro-switches are working correctly by checking the integrity between;
    a. pins 1 and 3 while removing the cover for the seed connectors
    b. pins 2 and 4 while removing the cover for the pump fibre connectors

Fault 7 - EXTERNAL SEED INTERLOCK OPEN

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the Controller PCBA detects a problem with the safety interlock switch situated next to the seed input.

Electronics Description

The Interlock switches for the pump diode connectors and the seed come into the controller PCBA via J35. See Figure 2.1-18 "J35 Circuit - External Interlocks".

External Int1 fault refers to the switch attached next to the seed fibre output. This fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See Figure 2.1-12 "MRU Interlock Line".

The MCU Interlock signal gets latched and at the same time pulls down the “Global Interlock Line” on page 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the External Int 1 fault line (seed) will have been latched resulting in the firmware flagging up this specific fault. See Figure 2.1-17 "Micro-controller for MCU (U29A)".

Action

- Check both fiber connector covers are secure
- Check the interlock loom is connected correctly to the controller PCBA
- Using a multimeter check the micro-switches are working correctly by checking the integrity between;
  a. pins 1 and 3 while removing the cover for the seed connectors
  b. pins 2 and 4 while removing the cover for the pump fibre connectors

Fault 8 - EXTERNAL PSU INTERLOCK OPEN

General Description

This is fault that will never occur – please refer to "Fault 407 - PSU EXTERNAL INTERLOCK OPEN" on page 2.1-121.

Fault 9 - MCU IR PHOTODIODE UVP ISSUE

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. To prevent damage to the laser system there are various fail safe mechanisms. One of these safety mechanisms is linked with the IR photodiode (PD4). When activated (using the RS232 command **PD4=1**), once the system has ramped up and locked successfully, the photodiode will continually be monitored. If the voltage falls or increases a defined amount, the system will switch off and generate a fault.

Electronics Description

The determination whether or not the IR PD is at the correct value is carried out on the controller PCBA with the circuit below.

The external IR PD UVP fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down, Figure 2.1-19.

The MCU Interlock signal gets latched and at the same time pulls down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention. See Figure 2.1-12 "MRU Interlock Line".

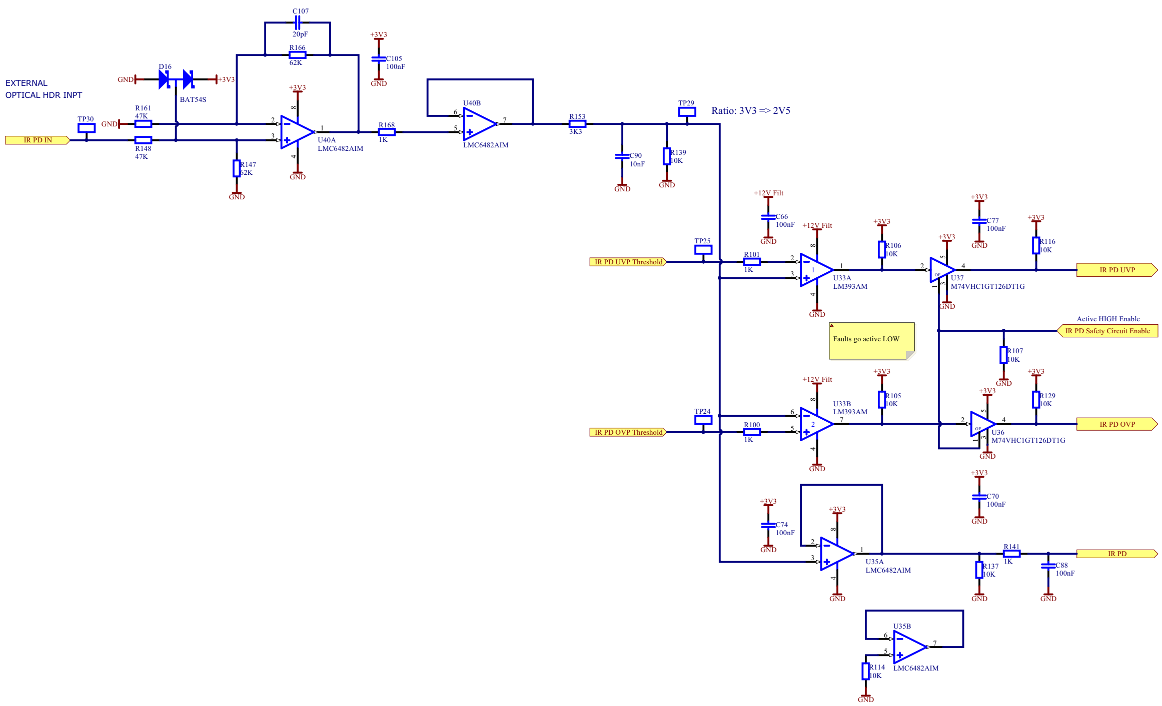


Figure 2.1-19. IR PD

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the IR PD UVP fault will have been latched resulting in the firmware flagging up this specific fault, Figure 2.1-20 "Micro-controller for MCU (U29B)".

Action

This fault only occurs when the system is ramped up and locked AND the PD4 safety circuit is enabled. It is possible to switch off this safety circuit by sending the command “**PD4=0**”. The system will now ramp up, enabling the IR PD voltage (?apd:4) to be compared to the PD4UVP value (?PD4UVP). If this fault has been occurring, the photodiode voltage should be lower than the PD4UVP value.

- Key off the system
- Send the command PD4=0

Note that as of firmware **REV X** the safety circuit cannot be disabled in service mode. Thus factory intervention will

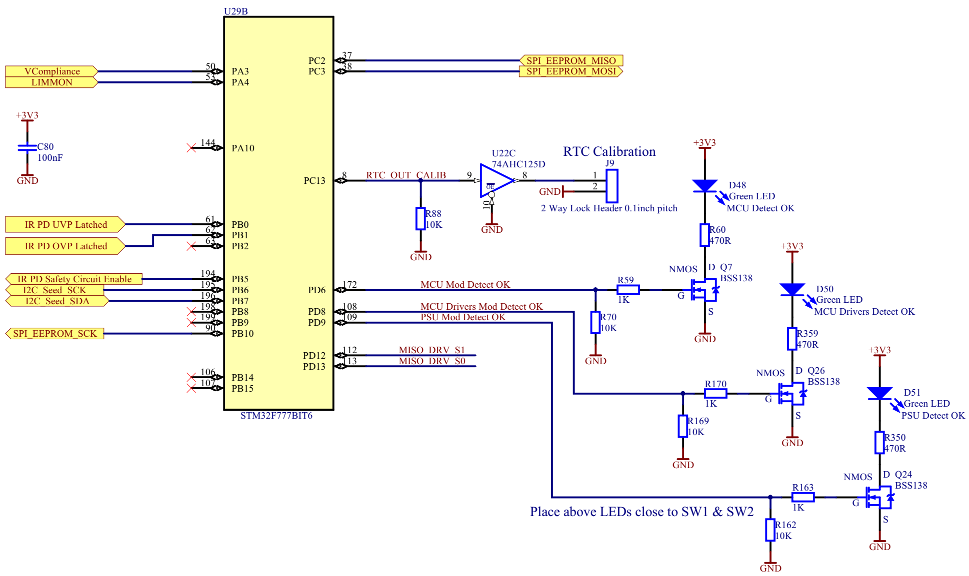


Figure 2.1-20. Micro-controller for MCU (U29B)

be necessary. However as a preliminary investigation, ?PD4UVP can be queried and ?apd:4 can also be observed in the data plotting view of the SVC GUI. It is possible to make a custom profle that queries ?apd:4 more frequently than the default.

- Key the system back on and monitor the IR photodiode (?apd:4) using the graphing in the SVC GUI after it has ramped up. Compare plot to PD4UVP threshold
- If the PD4UVP seems stable within a few %, check that PD4UVP is set to 85% of the IR-PD voltage when the system is locked at 16W of green

Fault 10 - MCU IR PHOTODIODE OVP ISSUE

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. To prevent damage to the laser system there are various fail safe mechanisms. One of these safety mechanisms is linked with the IR photodiode (PD4). When activated (using the RS232 command **PD4=1**), once the system has ramped up and locked successfully, the photodiode will continually be monitored. If the voltage falls or increases a defined amount, the system will switch off and a fault generated.

Electronics Description

The determination whether or not the IR PD is at the correct value is carried out on the controller PCBA with the circuit below. See Figure 2.1-19 "IR PD".

The external IR PD OVP fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See Figure 2.1-12 "MRU Interlock Line".

The MCU Interlock signal gets latched and at the same time pulls down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention. See Figure 2.1-13 "Global Interlock Line".

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the IR PD OVP fault will have been latched resulting in the firmware flagging up this specific fault, see Figure 2.1-20 "Micro-controller for MCU (U29B)".

Action

This fault only occurs when the system is ramped up and locked AND the PD4 safety circuit is enabled. It is possible to switch off this safety circuit by sending the command “PD4=0”. The system will now ramp up, enabling the IR PD voltage (?apd:4) to be compared to the PD4OVP value (?PD4OVP). If this fault has been occurring, the photodiode voltage should be higher than the PD4OVP value.

PD4OVP should be set to 140% of the IR-PD voltage when the system is locked at 16W of green:

- Key off the system
- Send the command PD4=0

  Note that as of firmware **REV X** the safety circuit cannot be disabled in service mode. Thus factory intervention will be necessary. However as a preliminary investigation, ?PD4UVP can be queried and ?apd:4 can also be observed in the data plotting view of the SVC GUI. It is possible to make a custom profle that queries ?apd:4 more frequently than the default.

- Key the system back on and monitor the IR photodiode (?apd:4) using the graphing in the SVC GUI after it has ramped up. Compare plot to PD4UVP threshold

- If the PD4OVP seems stable within a few %, check that PD4OVP is set to 140% of the IR-PD voltage when the system is locked at 16W of green

Fault 11 - PRE-AMP 2 TEC TIMEOUT

General Description

This is a critical software generated fault that occurs when the pre-amp 2 TEC is not able to lock after 60 seconds

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Check the diode temperature readings and confirm whether they seem valid ?ATDL:3. If not, check connections between controller board and pump module

Fault 12 - PRE-AMP2 TEC SOFTWARE LIMIT REACHED

General Description

This is a critical software generated fault that occurs when the Pre-amp 2 TEC temperature goes above the software defined limit.

	Alias query	Full query
Software limit	?tdlmax:3	?mcu:pre2:tec:pid:limit

Action

Once the TEC is locked, this fault should never occur given the TEC lock range should always be small enough as to prevent the temperature ever being able to reach the software limit.

- Check that the maximum temperature software setting is reasonable using ?tdlmax:3
- **Check the PID settings** – if they have been changed accidentally away from the default values then potentially, when trying to lock, the TEC temperature could overshoot and hit the software limit. The default settings are;
  - ***DTP:3=1.6***
  - ***DTI:3=8.0***
  - ***DTD:3=0***

Fault 13 - PRE-AMP2 TEC OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the pre-amp 2 TEC, once locked at the set temperature, deviates away from the setpoint for more than 20ms by an amount defined by the lock range.

	PID (in °C)	
	Alias query	Full query
Setpoint	?tdl:3	?mcu:pre2:tec:pid:sp
Lock range	?dtlr:3	?mcu:pre2:tec:pid:lr

Action

- Check connection between the seed module and controller board is secure
- Monitor the diode temperature by plotting in real-time when the laser is on ?atdl:3. If it is spurious (a value that is unlikely to be real), change the controller board

Fault 14 - PRE-AMP2 TEC TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the thermo electric cooler (TEC) on the Pre-amp 2 pump diode is over the hardware defined maximum level of 50°C.

Electronics Description

The controller PCBA directly gets pre-amp 2 thermistor inputs from the power amp module. This goes into a comparator to determine if it is over or under temperature. The max and min are determined by the voltages created by the potential divider resistors. The min is set to 10°C and the max to 50°C. If the temperature goes out of this range then the pre-amp 2 temperature fault line gets pulled low.

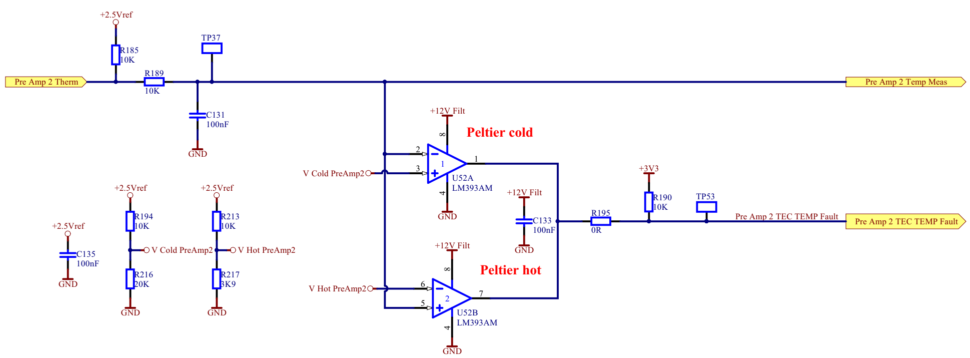


Figure 2.1-21. Pre-amp 2 Thermistor

The Pre-amp 2 temperature fault line gets passed onto the MCU driver latching circuit which results in the signal being latched as well as pulling the MCU driver interlock signal down.

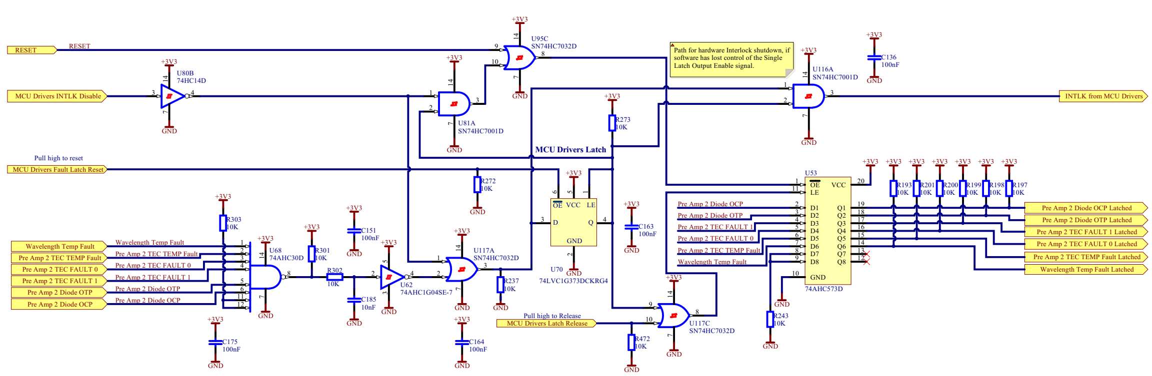


Figure 2.1-22. MRU Driver Latching Circuit

The MCU Driver Interlock signal gets latched and at the same time pulls down the “Global Interlock Line”. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the micro-controller to determine the fault. In this case, the Pre-amp 2 temperature fault will have been latched resulting in the firmware flagging up this specific fault. See “Micro-Controller for MCU Latching Circuit (U29D)”.

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 15 - PRE-AMP 2 TEC OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 2 pump diode is being driven too hard, causing the TEC to go over current.

Detailed Description

Two fault signals are generated by the pre-amp 2 TEC driver IC on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over current Fault 1 is 0 and Fault 0 is 0.

FAULT1	FAULT0	
0	0	Overcurrent
0	1	Undervoltage
1	0	Overtemperature
1	1	Normal operation

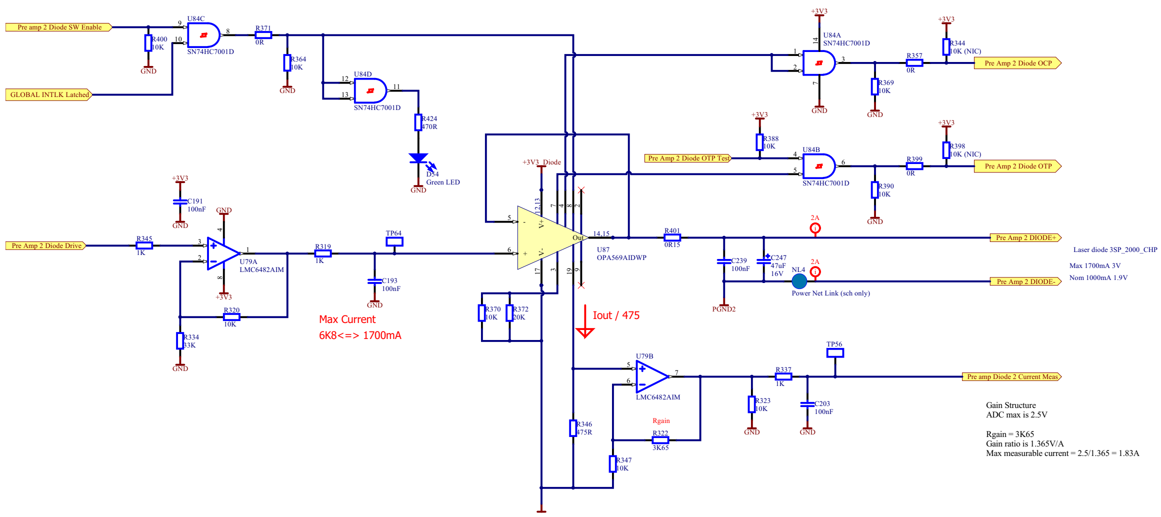


Figure 2.1-23. Pre-amp 2 TEC Driver IC

The pre-amp 2 TEC fault lines gets passed onto the MCU driver latching circuit which results in the signal being latched as well as pulling down the seed interlock line, see Figure 2.1-22 "MRU Driver Latching Circuit".

The MCU Driver Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the pre-amp 2 driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the micro-controller to determine the exact fault. In this case, because both oscillator TEC fault 0 and oscillator TEC fault 1 occur simultaneously, unusually, both fault lines will be latched (see table above). The firmware can then determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C

- Ensure Flow in and flow out are connected the correct way round
- Monitor the diode temperature by plotting in real-time when the laser is on ?atdl:3. If it is spurious (a value that is unlikely to be real), change the controller board

Fault 16 - PRE-AMP 2 TEC OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 2 pump diode has exceeded its safe operating temperature.

Detailed Description

Two fault signals are generated by the “Pre-amp 2 TEC Driver IC”, pg. 2.1-67 on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over temperature Fault 1 is 1 and Fault 0 is 0.

FAULT1	FAULT0	
0	0	Overcurrent
0	1	Undervoltage
1	0	Overtemperature
1	1	Normal operation

The pre-amp 2 TEC fault lines gets passed onto the “MRU Driver Latching Circuit”, pg. 2.1-65 which results in the signal being latched as well as pulling down the seed interlock line.

The MCU Driver Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the pre-amp 2 driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the micro-controller to determine the exact fault. In this case, only Pre-amp 2 TEC fault 0 line will be latched.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Monitor the diode temperature by plotting in real-time when the laser is on ?atdl:3. If it is spurious (a value that is unlikely to be real), change the controller board.

Fault 17 - PRE-AMP 2 TEC UNDER VOLTAGE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 2 pump diode has an under voltage issue.

Detailed Description

Two fault signals are generated by the “Pre-amp 2 TEC Driver IC”, pg. 2.1-67 on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For under voltage, Fault 1 is 0 and Fault 0 is 1.

FAULT1	FAULT0	
0	0	Overcurrent
0	1	Undervoltage
1	0	Overtemperature
1	1	Normal operation

The pre-amp 2 TEC fault lines gets passed onto the “MRU Driver Latching Circuit”, pg. 2.1-65 which results in the signal being latched as well as pulling down the seed interlock line.

The MCU Driver Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the pre-amp 2 driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the micro-controller to determine the exact fault. In this case, only Pre-amp 2 TEC fault 1 line will be latched

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Monitor the diode temperature by plotting in real-time when the laser is on ?atdl:3. If it is spurious (a value that is unlikely to be real), change the controller board

Fault 18 - PRE-AMP2 DIODE TIMEOUT

General Description

This is a critical software generated fault that occurs when the pre-amp 2 diode driver is not able to lock within 60 seconds

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Contact Coherent Scotland

Fault 19 - PRE-AMP2 DIODE CURRENT EXCEEDS SOFTWARE LIMIT

General Description

This is a critical software generated fault that occurs if the Pre-amp 2 pump diode tries to exceed the maximum current limit that is set in the EEPROM (?IDLMAX:3).

Action

This is a fault that generally occurs only when Pre-amp 2 is in light loop. Here, the pump diode current is dependent upon the photodiode voltage (?APD:3) reaching the light loop set point (?LLSP:3).

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the Pre-amp 2 into current loop and measuring the photodiode signal at the expected operating current.

1. Key system off

2. Allow only the oscillator, Pre-amp 1 and Pre-amp 2 to turn on 'ON=3'
3. Put the Pre-amp2 into current mode 'MODE:3=1'
4. Check the set current (?idl:3)
5. Key system on and query the Pre-amp 2 photodiode (?APD:3)
6. Compare this value with the light loop set point (?LLSP:3)
7. These two values should be close to each other
8. Key system off
9. Place pre-amp 2 back into light loop (ON=4) and turn on all the modules (MODE:3=2)

Fault 20 - PRE-AMP2 DIODE OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the pre-amp 2, once locked, deviates away from the setpoint for more than 20ms by an amount defined by the lock range. It can occur in both light loop and current loop.

Action

- Check connection between the power amp and he controller PCBA is secure

Fault 21 - PRE-AMP2 DIODE NOT ENOUGH LIGHT

General Description

This is a critical software generated fault that will shut the system down. Before Pre-amp 2 pump diode starts ramping there is a safety check to ensure the output from Pre-amp 1 is passing through pre-amp 2. This is done by ensuring some light is detected on the Pre-amp 2 photodiode (?APD:3) and ensuring it is above a threshold that is defined by the EEPROM value ?PDMIN:3.

Action

PDMIN:3 is set as half way between the value read by preamp2 photodiode when the system is at ON=1, and the value read when the system is at ON=2.

Set the system to PUMP:ON=2 and check the value of ?PUMP:PDMIN:3 and compare it to the value calculated using:

a + ((b – a)/2)

Where:

a=?PUMP:APD:3 [when the laser is keyed on at **ON=1**]

b=?PUMP:APD:3 [when the laser is keyed on at **ON=2**]

Fault 22 - PRE-AMP2 DIODE OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the pre-amp 2 pump diode is being driven too hard, causing the diode driver to go over current (where maximum current is defined by hardware). It should be noted that this fault should never really occur as the software limit (idlmax:3) should switch the system off before this hardware limit has the chance to fault the system out.

Detailed Description

The maximum current is defined by a resistor value within the controller PCBA (R370 and R372), see “Pre-amp 2 TEC Driver IC”, pg. 2.1-67.

If the diode driver tries to exceed this current (1700mA), the pre-amp 2 Diode OCP line gets pulled down. This signal goes into the MCU Control latching circuit which results in it being latched as well as pulling down the MCU Control interlock line, see “MRU Driver Latching Circuit”, pg. 2.1-65.

The MCU Driver Interlock signal gets latched and at the same time pulls down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the “Micro-Controller for MCU Latching Circuit (U29D)”, pg. 2.1-54 to determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 23 - PRE-AMP2 DIODE OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the pre-amp 2 pump diode has exceeded its safe operating temperature.

Detailed Description

If the oscillator diode driver exceeds its safe operating temperature (defined within the diode driver IC), the OTP interlock line on the controller PCBA gets pulled low. See Figure 2.1-23 "Pre-amp 2 TEC Driver IC".

This OTP signal goes into the MCU driver latching circuit which results in it being latched as well as pulling down the MCU driver interlock line. See Figure 2.1-22 "MRU Driver Latching Circuit".

The MCU Driver Interlock signal gets passed onto the global latching circuit also on the controller PCBA. It gets latched and at the same time pulls down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU driver Interlock will be latched. The firmware will then query the MCU driver latching circuit via the micro-controller to determine the exact fault. See “Micro-Controller for MCU Latching Circuit (U29D)”, pg. 2.1-54.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 24 - POWER AMP DIODE TIMEOUT

General Description

This is a critical software generated fault that occurs when the firmware is unable to lock the wavelength diode driver to the desired current within 60 seconds

Action

- Ensure all connections to the Wavelength Electronics diode driver is correct

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Contact Coherent Scotland

Fault 25 - POWER AMP DIODE CURRENT EXCEEDS SOFTWARE LIMIT

General Description

This is a software generated fault. It occurs if the Power-amp pump diodes try to exceed the maximum current limit that is set in the EEPROM (?IDLMAX:4)

Action

This fault only occurs when in light loop mode. It occurs when the signal from the photodiode remains less than the light loop set point (which corresponds to 16W green), despite the current having been ramped through to its maximum current limit. The issue falls into one of three possible broad root causes:

- Not enough IR power is produced to achieve 16W green before the current limit is reached,
- The conversion efficiency of the IR power is not sufficient to generate 16 W of green
- If there is no signal measured on the photodiode (?apd:5) during ramp at all, or the signal oscillates in an abnormal way, the issue can be related to the photodiode.

1. Key the system off
2. Diagnosis can be performed in current mode (pump:mode:4=1) or alternatively in lightloop mode.
   a. Current mode:
      i. check the set current (idl:4) - this should ~8 ±1.5A.
      ii. Key the system on and compare the signal with the light loop setpoint.
      iii. If at any point during the following steps the power is recovered, key the laser off and attempt to resume light loop operation.
      iv. Check that there is sufficient IR power: check ?p1 and ensure it reads >4000mW. If not, confirm with power meter at fixed output and contact factory.
      v. Optimise LBO temperature by maximizing green power for the given current using Pump:TLBO

parameter. The target is 16W, or as close as possible.

vi. If no signal/noise only on ?APD:5/?p2, suspect the green photodiode.

vii. If significant recovery not made through temperature tune, key off and change LBO spot.

viii. If recovery still not made, change LBO spot +10 spots

ix. If recovery has not been made, contact the factory providing as much detail of recovery steps and results as possible

b. Light loop mode: Where current mode is unavailable or undesirable, diagnosis can be conducted in light loop mode.

i. To prevent faulting, reduce the light loop set point by a factor of 0.5 (?llsp:5; set llsp:5 = [?llsp:5]/2)

ii. Key the system on. If Fault 25 occurs again, but the photodiode is not reading noise/very low, proceed to '3'

iii. Check that there is sufficient IR power: check ?p1 and ensure it reads >2000mW (assuming power amp current (?aidl:4) is >3A). If not, confirm with power meter at fixed output and contact factory.

iv. If at any point during the following steps, improved performance appears to have been achieved, key off the laser and set the light loop set point back to the original value, key the laser back on, confirming absence of the fault and making a note of the current level at which the light loop set point is reached

v. Optimize LBO temperature by minimizing the current ((?aidl:4) at which the reduced light loop set point is reached and varying the temperature using the 'pump:tlbo' command. The target is ?aidl:4 ~3-4A. Green power will stay constant since it is locked, but ?p1/IR power will reduce.

vi. If a significant increase in efficiency/reduction in current drawn to reach the reduced light loop set point has not been realized through temperature tuning, key the laser off and change spot

vii. If recovery still not made, change LBO +10 spots

viii. If recovery has not been made, contact the factory providing as much detail of recovery steps and results as possible

Fault 26 - POWER AMP DIODE OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the power amp pump module, once locked using the wavelength electronics diode driver, deviates away from the setpoint for more than 20 ms by an amount defined by the lock range. It can occur in both light loop and current loop.

	Current Loop (in mA)		Green Light Loop (in V)	
	Alias query	Full query	Alias query	Full query
Setpoint	?idl:4	?mcu:pamp:diode:cl:sp	?llsp:5	?mcu:pamp:diode:gll:sp
Lock range	?dcilr:4	?mcu:pamp:diode:cl:lr	?lllr:5	?mcu:pamp:diode:gll:lr

Action

- Switch off, remove the lid and check connection between the wavelength electronics diode driver and the controller PCBA are secure.
- Key back on and monitor current, P1 and P2 and observe whether fault persists.

  If so, change to either current mode (Pump:mod:4=1) or fixed alignment mode (alignfixed=1). Observe whether stability is improved. If it is, then this suggests an issue with either the photodiode or the PID settings for the lightloop. Try reducing the 'I' value by a factor of 2 ([?lli - lli'] set "lli=lli'/2")

  If the issue cannot be resolved through settings, contact the factory and prepare to change diode driver
- Clear the fault and key back on. Monitor the current and green power ?p2. If trace is noisy and the faulting is intermittent, key off and change to current loop (pump:mode:4=1). If noise is reduced in current mode reduce P of light loop PID by 0.01 only once (llp:4=x.xx-0.01). Switch back to light loop (pump:mode:4=3). Monitor the green signal (p2).
- Call Scotland factory.

Fault 27 - POWER AMP DIODE NOT ENOUGH LIGHT

General Description

This is a critical software generated fault. The fault occurs once pre-amp2 is locked and the system is about to move to ON=4. The IR photodiode (?APD:4) is compared against a ?PDMIN:4 (an EEPROM value) and if the current photodiode value is less than this minimum value, this fault is created.

Action

Generally this fault should never occur as PDMIN:4 is defaulted to 0, effectively turning the feature off.

- Check PDMIN:4 value is 0

Fault 28 - POWER AMP DIODE TEMPERATURE FAULT

General Description

This is a critical software generated fault that will only be active if 3rd party TECs are added to the Discovery NX build. Switch off, open lid and check to see if TECs are present. If not, re-establish the head EPROM using data from the service drive. If they are present, check connections.

Fault 29 - TUNABLE SHUTTER LOGIC FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the firmware has detected an issue with tunable shutter.

Electronics Description

Sensors and inputs to control the shutter enter a logic circuit below to determine if there is an issue with the tunable shutter. If an error is detected the Tunable sensor Logic fault line will get pulled down.

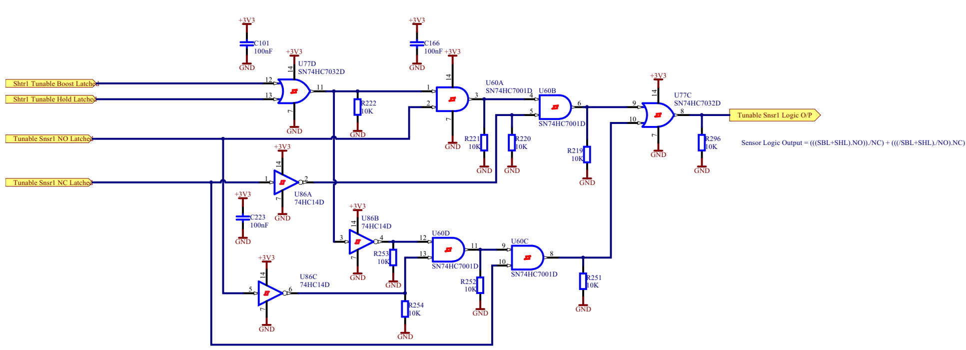


Figure 2.1-24. Tunable Sensor Logic Fault Line

The Tunable sensor Logic fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See “MRU Interlock Line”, pg. 2.1-51.

The MCU Interlock signal gets latched and at the same time pulls down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the Tunable sensor Logic fault will have been latched resulting in the firmware flagging up this specific fault. See “Micro-controller for MCU (U29A)”, pg. 2.1-56.

Action

- It is possible to attach the shutter connector incorrectly to the Controller board (see image below). **Please ensure all 6 pins are connected properly.**

- Replace Tunable shutter

Issue 30 - FIXED SHUTTER LOGIC FAULT

General Outline

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the firmware has detected an issue with fixed shutter.

Electronics Description

Sensors and inputs to control the shutter enter a logic circuit below to determine if there is an issue with the tunable shutter. If an error is detected the Fixed sensor Logic fault line will get pulled down.

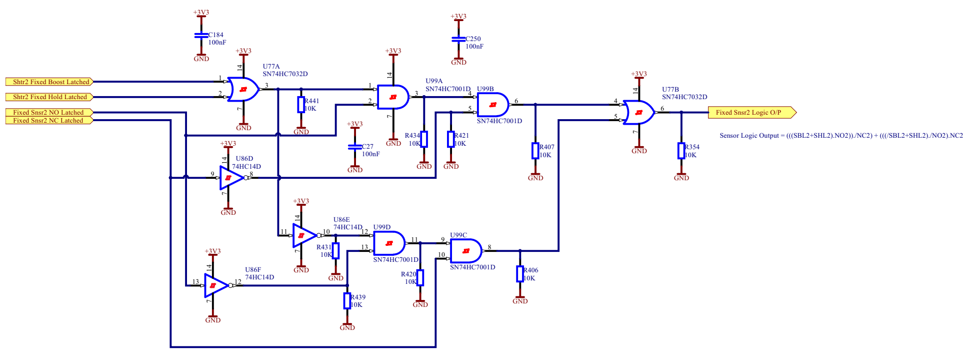


Figure 2.1-25. Fixed Sensor Logic Fault Line

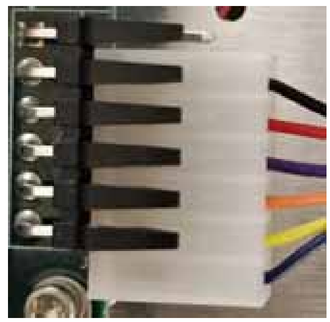
The Fixed sensor Logic fault line gets passed onto the MCU latching circuit which results in the signal being latched as well as pulling the MCU interlock signal down. See “MRU Interlock Line”, pg. 2.1-51.

The MCU Interlock signal gets latched and at the same time pulls down the “Global Interlock Line”, pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the MCU Interlock will be latched. The firmware will then query the MCU latching circuit via the micro-controller to determine the fault. In this case, the fixed sensor Logic fault will have been latched resulting in the firmware flagging up this specific fault. See “Micro-controller for MCU (U29A)”, pg. 2.1-56.

Action

- It is possible to attach the shutter connector incorrectly to the Controller board (see image below). **Please ensure all 6 pins are connected properly .**



- Replace Fixed shutter

Fault 100 - SEED CALCULATION FAULT

Description

This is a critical software generated fault that occurs when there is floating point error within the firmware causing a calculation to fail. It is generally caused when there is a bug in the firmware.

Action

Report the issue to Coherent Scotland, outlining, if possible the how and when the fault occurs

Fault 101 - SEED BAD COMMUNICATION

Description

This is a critical software generated fault that occurs when the communication lines (I2C or SPI) fail to communicate properly.

Action

- Check / replace the cable between the seed and the controller board
- Contact Coherent Scotland

Fault 102 - SEED UNKNOWN INTERLOCK SOURCE

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the controller board detects that the Seed Interrupt line has gone Low (fault state).

This specific fault means although the Seed interrupt has been triggered but when the firmware goes to query what fault line has been latched it finds that nothing has in fact been latched.

Electronic Description

A Seed interlock (Interlock out) line can be pulled low by a number of different faults within the seed module. When one of these faults a active, it simultaneously pulse the interlock out to low as well as being latched within the latching circuit (U35 and U13).

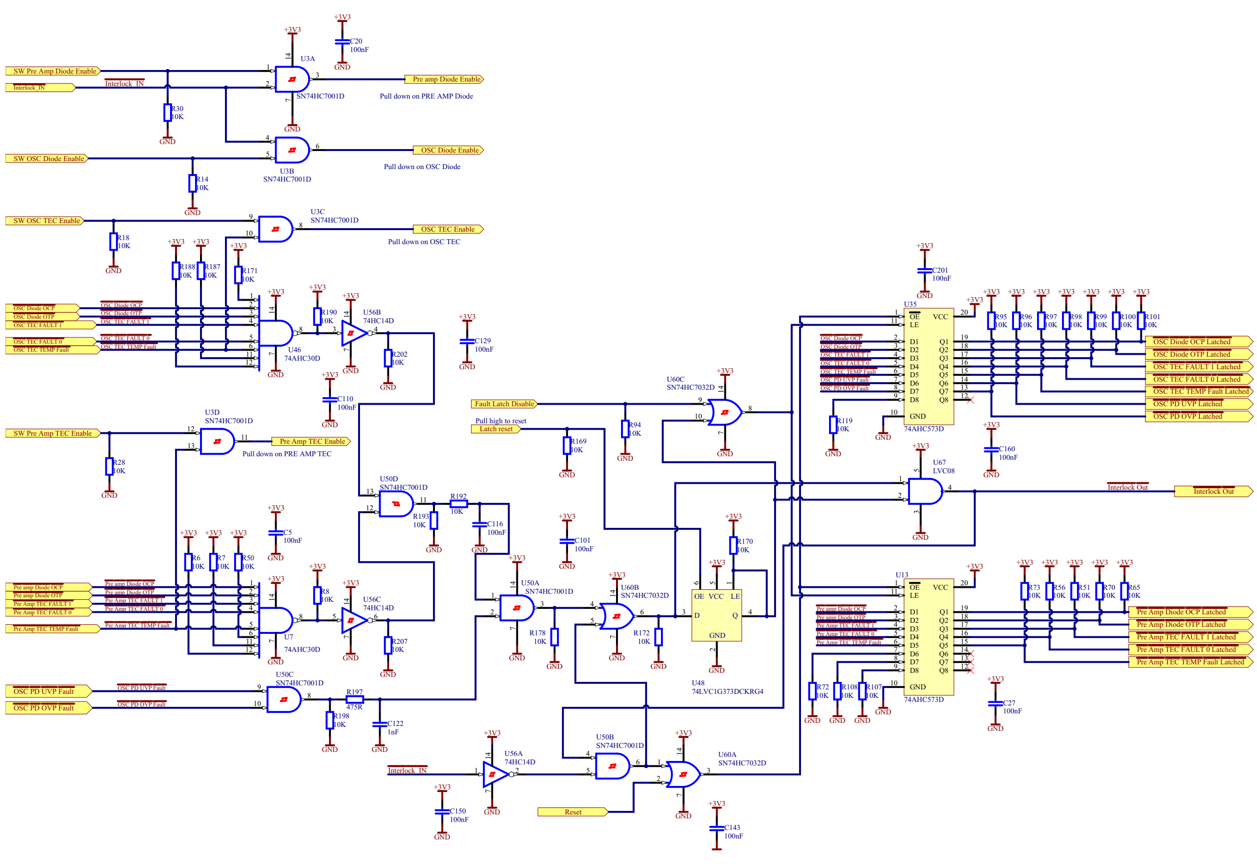


Figure 2.1-26. Seed Latching Circuit

The Seed Interlock signal is directly linked to the Controller board and immediately gets latched while, and at the same, pulling down the "Global Interlock Line", pg. 2.1-52. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed Interlock line will be latched. The firmware will then query the MCU latching circuit via the I2C GPIO expander (U14) to determine the fault. In this case, nothing will have been latched and results in this specific fault.

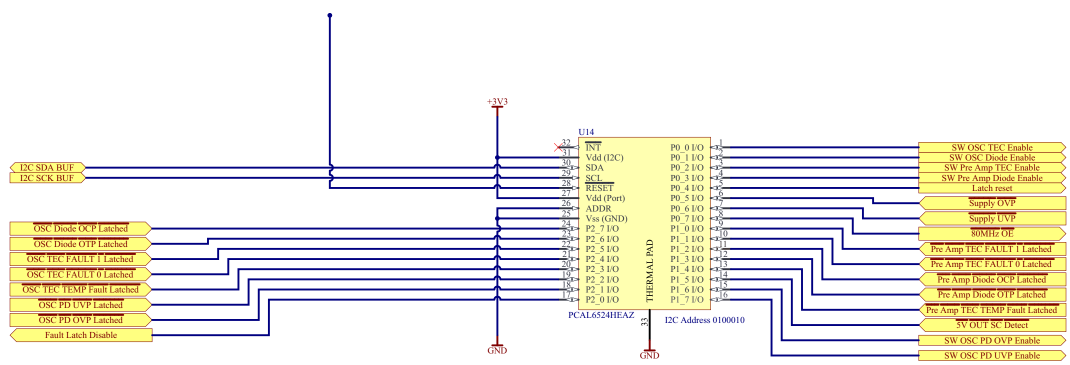


Figure 2.1-27. I2C GPIO Expander (U14)

Action

Unknown interlock faults such as this have been observed by inducing a large electrical noise spike to the system. This potentially causes the interlock line to glitch resulting in the controller board to shut the system down. If this occurs nothing will be latched and the firmware will not show this by giving this specific fault

- Check if any large pieces of equipment were being switched off/on at the time of the laser faulting out.
- Ensure the customer is using a surge protector and is not sharing a socket with a large appliance
- The fault should be able to be cleared by typing "FC"

Fault 103 - OSCILLATOR TEC TIMEOUT

General Description

This is a critical software generated fault that occurs when the oscillator TEC is not able to lock after 60 seconds

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Observe/monitor by plot in SVC GUI the temperature of the oscillator diode (ATDL:1) with key off and then on, compare with the set temperature (TDL:1). This might indicate the source of the inability to lock
- Contact Factory

Fault 104 - OSCILLATOR TEC SOFTWARE LIMIT FAULT

General Description

This is a critical software generated fault that occurs when the oscillator TEC temperature goes above the software defined limit.

	Alias query	Full query
Software limit	?tdlmax:1	?seed:osc:tec:pid:limit

Action

Once the TEC is locked, this fault should never occur given the TEC lock range should always be small enough as to prevent the temperature ever being able to reach the software limit.

- **Check the PID settings** – if they have been changed accidentally away from the default values then potentially, when trying to lock, the TEC temperature could overshoot and hit the software limit. The default settings are;
- ***DTP:1=1.6***
- ***DTI:1=8.0***
- ***DTD:3=0***

Fault 105 - OSCILLATOR TEC OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the oscillator TEC, once locked at the set temperature, deviates away from the setpoint for more than 20ms by an amount defined by the lock range.

	Alias query	Full query
Setpoint	?tdl:1	?seed:osc:tec:pid:sp
Lock range	?dtlr:1	?seed:osc:tec:pid:lr

Action

Check connection between the Seed module and the controller board is secure

Fault 106 - OSCILLATOR TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the thermo electric cooler (TEC) on the oscillator pump diode is over the hardware defined maximum level of 50°C.

Electronics Description

The Seed PCBA received the oscillator thermistor input and goes into a comparator to determine if it is over or under temperature. The max and min are determined by the voltages created by the potential divider resistors. The min is set to 10°C and the max to 50°C. If the temperature goes out of this range then the oscillator temperature fault line gets pulled low.

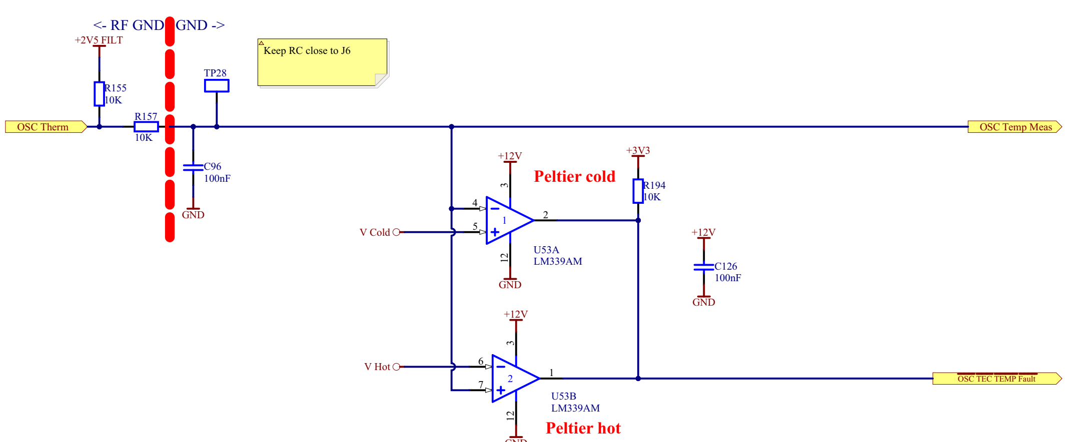


Figure 2.1-28. Oscillator Thermistor Circuit

The oscillator temperature fault line gets passed onto the seed PCBA Figure 2.1-26 "Seed Latching Circuit" which results in the signal being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed Interlock will be latched. The firmware will then query the seed PCBA latching circuit via I2C GPIO expander (U35) to determine the fault. In this case, the oscillator temperature fault will have been latched resulting in the firmware flagging up this specific fault.

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 107 - OSCILLATOR TEC OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the oscillator pump diode is being driven too hard, causing the TEC to go over current.

Detailed Description

Two fault signals are generated by the oscillator TEC driver IC on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over current Fault 1 is 0 and Fault 0 is 0.

FAULT1	FAULT0	
0	0	Overcurrent
0	1	Undervoltage
1	0	Overtemperature
1	1	Normal operation

Figure 2.1-29. Oscillator TEC Driver IC

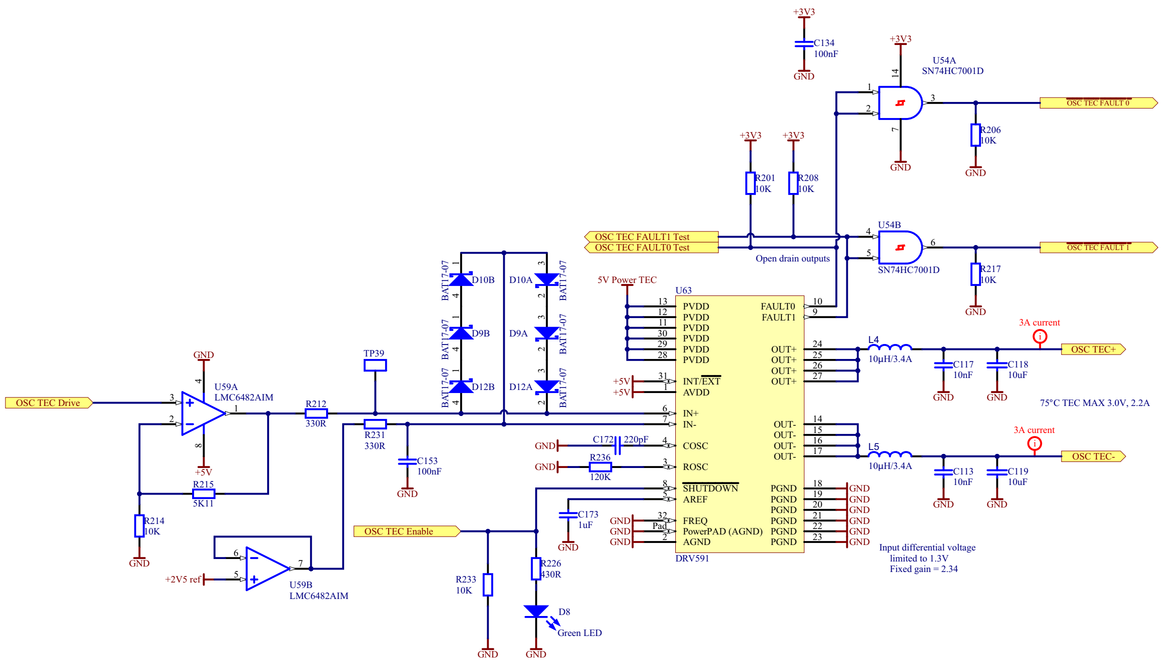


Figure 2.1-29. Oscillator TEC Driver IC (Continued)

The oscillator TEC fault lines gets passed onto the seed latching circuit which results in the signal being latched as well as pulling down the seed interlock line, see Figure 2.1-26 "Seed Latching Circuit".

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the fault. In this case, because both oscillator TEC fault 0 and oscillator TEC fault 1 occur simultaneously, unusually, both fault lines will be latched (see table above). The firmware can then determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Monitor the temperature of the oscillator diode using the plot function in the GUI (ATDL:1)
- Contact Factory

Fault 108 - OSCILLATOR TEC UVP FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the oscillator pump diode has an under voltage issue.

Detailed Description

Two fault signals are generated by the oscillator TEC driver IC on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For under voltage, Fault 1 is 0 and Fault 0 is 1, see Figure 2.1-29 "Oscillator TEC Driver IC".

The oscillator TEC fault lines gets passed onto the seed latching circuit which results in the signal being latched as well as pulling down the seed interlock line, see Figure 2.1-26 "Seed Latching Circuit".

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the fault. In this case, only oscillator TEC fault 1 line will be latched. The firmware can then determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 109 - OSCILLATOR TEC OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo-electric cooler (TEC) on the oscillator pump diode has exceeded its safe operating temperature.

Detailed Description

Two fault signals are generated by the oscillator TEC driver IC on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over temperature Fault 1 is 1 and Fault 0 is 0, see Figure 2.1-29 "Oscillator TEC Driver IC".

The oscillator TEC fault lines gets passed onto the seed latching circuit which results in the signal being latched as well as pulling down the seed interlock line, see Figure 2.1-26 "Seed Latching Circuit".

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the fault. In this case, only Pre-amp 2 TEC fault 0 line will be latched. The firmware can then determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 110 - OSCILLATOR DIODE TIMEOUT

General Description

This is a critical software generated fault that occurs when the oscillator diode is not able to lock at the desired current after 60 seconds

Fault 111 - OSCILLATOR DIODE CURRENT EXCEEDS SOFTWARE LIMIT

General Description

This is a software generated fault. It occurs if the oscillator pump diode tries to exceed the maximum current limit that is set in the EEPROM (?IDLMAX:1)

Action

This is a fault that generally occurs only when the seed is in light loop. Here, the diode current is dependent upon the photodiode voltage (?APD:1) reaching the light loop set point (?LLSP:1).

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the seed into current loop and measuring the photodiode signal at the expected operating current.

1. Key system off
2. Allow only the oscillator to turn on ‘ON=1’
3. Put the oscillator into current mode ‘MODE:1=1’
4. Check the set current (?idl:1)
5. Key system on and query the seed photodiode (?APD:1)
6. Compare this value with the light loop set point (?LLSP:1)
7. These to values should be close to each other
8. If they are not, there could be a seed issue. Contact the factory

9. Key system off
10. If issue persists, switch off, open the lid and check connections between the controller board and the seed module
11. Put the oscillator back into Light loop (MODE:1=2) and turn all modules back on (ON=4) and confirm the issue is resolved

Fault 112 - OSCILLATOR DIODE OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the seed, once locked, deviates away from the setpoint for more than 20ms by an amount defined by the lock range. It can occur in both light loop and current loop.

	Current Loop (in mA)		Light Loop (in V)	
	Alias query	Full query	Alias query	Full query
Setpoint	?idl:1	?seed:osc:diode :cl:sp	?llsp:1	?seed:osc:diode :ll:sp
Lock range	?dclr:1	?seed:osc:diode :cl:lr	?lllr:1	?seed:osc:diode :ll:lr

Action

- Check connection between Seed module and pump board is secure
- Switch on module 1 exclusively (on=1)
- Compare the stability of the oscillator photodiode reading ?APD:1 in light loop and current loop modes
- If light loop is significantly noisier than current loop, reduce P of light loop PID (LLP:12=x.xx-0.01)

Fault 113 - OSCILLATOR DIODE NOT ENOUGH LIGHT

General Description

This is a software generated fault. The fault occurs when the oscillator pump diode ramps up and moves into current loop. The oscillator photodiode (?APD:1) is compared against a ?PDMIN:1 (an EEPROM value) and if the current photodiode value is less than this minimum value, this fault is created.

Action

Check the value of ?PDMIN:1 is set correctly

Fault 114 - OSCILLATOR DIODE OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the seed pump diode is being driven too hard, causing the diode driver to go over current (where maximum current is defined by hardware). It should be noted that this fault should never really occur as the software limit (idlmax:1) should switch the system off before this hardware limit has the chance to fault the system out.

Detailed Description

The maximum current is defined by a resistor value within the seed PCBA (Rset).

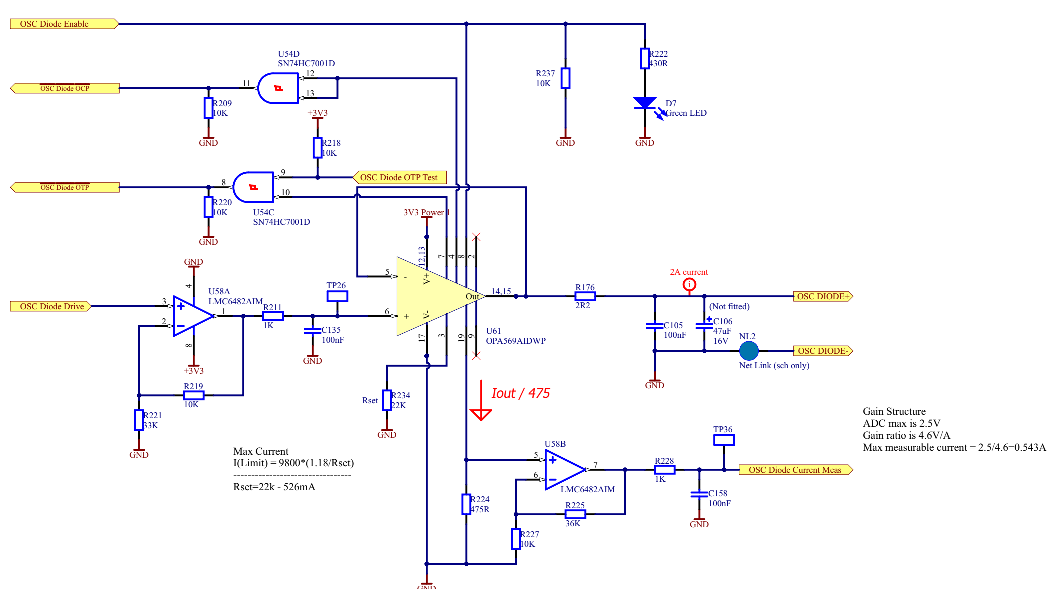


Figure 2.1-30. Seed PCBA (Rset)

If the diode driver tries to exceed this current (526mA), the oscillator Diode OCP line gets pulled down. This signal goes into the Figure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the exact fault.

Action

- Check ?idlmax:1 value (should be less than 526)
- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round
- Follow actions in Fault 117 if faults persist

Fault 115 - OSCILLATOR DIODE OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the seed pump diode has exceeded its safe operating temperature.

Detailed Description

If the oscillator diode driver exceeds its safe operating temperature (defined within the diode driver IC), the OTP interlock line on the seed PCBA gets pulled low, see Figure 2.1-30 "Seed PCBA (Rset)".

This OTP signal goes into the Figure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the exact fault.

Action

- Confirm whether the diode temperature is realistic (?atdl:1)
- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 116 - OSCILLATOR PHOTODIODE OVER VOLTAGE FAULT

General Description

This is a critical software generated fault that will immediately shut down the laser system. It occurs when the oscillator photodiode value (?PD1VADC) goes above the set over voltage value (?PD1OVP), which would suggest too much light coming from the oscillator.

Electronics description

Associated boards and connections:

Seed PCBA; seed PCBA – seed module connections

The value for the oscillator OVP is defined by software and is generated via an SPI DAC on the seed board.

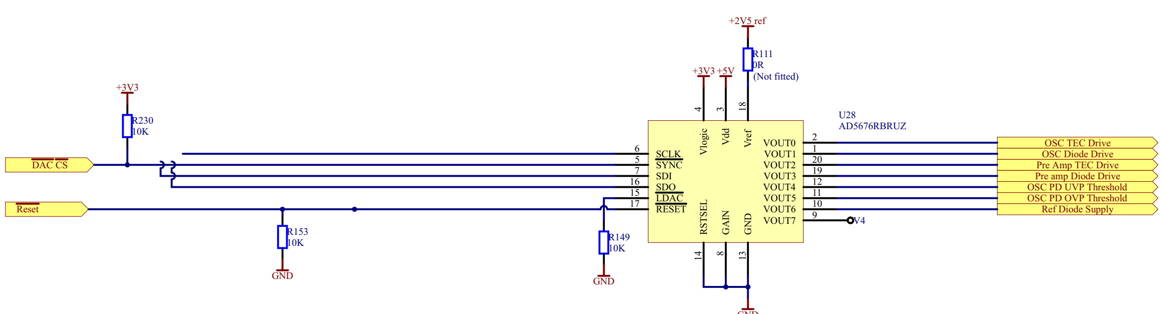


Figure 2.1-31. SPI DAC

This then enters a comparator circuit which checks to see if the OVP voltage is higher than the seed photodiode signal. If it is then the OSC PD OVP line goes high.

The OVP signal then gets passed through some logic to ensure that an OVP fault can only be generated so long as the OVP/UVP protection has been enabled. It should be noted that the enabling / disabling of the protection is solely handled by the firmware, there is not RS232 command to change this value.

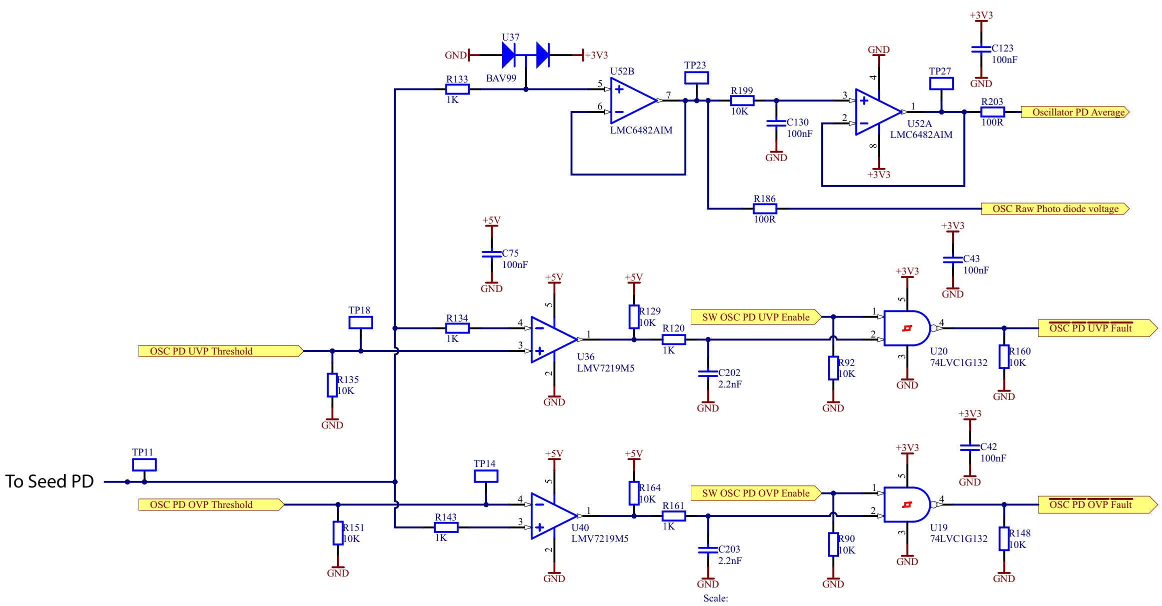


Figure 2.1-32. Comparator Circuit for Seed PD

If OVP/UVP protection is High AND the OVP line is HIGH then the OVP fault line is pulled low. This fault line then goes into the sFigure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the exact fault

Action

- ***Ensure the over voltage threshold values are correct***

To check if the PD1 over voltage threshold value is correct, the following procedure can be carried out

1. Ensure the system is keyed off.
2. Type command “PUMP:ON=1” to switch only the oscillator on
3. Key on the system and wait until the oscillator is in light loop
4. Query “?PD1VADC” and ‘?PD1OVP’ take a note of the responses
5. The over voltage value should have been calculated so that PD1OVP = PD1VADC *1.15
   i. If PD1OVADC is not correct, the value will need to be updated.
      To update, change ‘PD1OVP=xxx’ to the correct value
6. If values were not changed and fault is persistent/intermittent check the stability of the seed by plotting ?apd:1 while in light loop and current loop and comparing. If significantly noisier in lightloop mode contact factory and change P of PID by 0.01 once (pump:llp=x.xx-0.01). Confirm seed is more stable and can still lock by keying off and then on again
7. Type command ‘PUMP:ON=4’ to switch all modules back on

Fault 117 - OSCILLATOR PHOTODIODE UVP FAULT

General Description

This is a critical software generated fault that will immediately shut down the laser system. It occurs when the oscillator photodiode value (?PD1VADC) goes below the set under voltage value (?PD1UVP).

Electronics description

The value for the oscillator UVP is defined by software and is generated via an Figure 2.1-31 "SPI DAC" on the seed board.

This then enters a Figure 2.1-32 "Comparator Circuit for Seed PD" which checks to see if the UVP voltage is lower than the seed photodiode signal. If it is then the OSC PD UVP line goes high.

The UVP signal then gets passed through some logic to ensure that an UVP fault can only be generated so long as the OVP/UVP protection has been enabled. It should be noted that the enabling / disabling of the protection is solely handled by the firmware, there is not RS232 command to change this value.

If OVP/UVP protection is HIGH AND the UVP line is HIGH then the UVP fault line is pulled low. This fault line then goes into the Figure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the exact fault.

Action

- Ensure the under voltage threshold values are correct

To check if the PD1 under voltage threshold value is correct, the following procedure can be carried out

1. Ensure the system is keyed off.
2. Type command “PUMP:ON=1” to switch only the oscillator on
3. Key on the system and wait until the oscillator is in light loop
4. Query “?PD1VADC” and ‘?PD1UVP’ take a note of the responses
5. The over voltage value should have been calculated so that PD1UVP = PD1VADC *0.85
    - If PD1OVADC is not correct, the value will need to be updated.
      To update, change ‘PD1UVP=xxx’ to the correct value
6. If values were not changed and fault is persistent/intermittent check the stability of the seed by plotting ?apd:1 while in light

loop and current loop and comparing. If significantly noisier in lightloop mode contact factory and change P of PID by 0.01 once (pump:llp=x.xx-0.01). Confirm seed is more stable and can still lock by keying off and then on again

7. Type command 'PUMP:ON=4' to switch all modules back on

Fault 118 - SOFTWARE PRE-AMP TEC TIMEOUT

General Description

This is a critical software generated fault that occurs when the Pre-amp 1 TEC is not able to lock after 60 seconds

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 119 - PRE-AMP TEC SOFTWARE LIMIT FAULT

General Description

This is a critical software generated fault that occurs when the Pre-amp 2 TEC temperature goes above the software defined limit.

	Alias query	Full query
Software limit	?tdlmax:2	?seed:pre:tec:pid:limit

Action

Once the TEC is locked, this fault should never occur given the TEC lock range should always be small enough as to prevent the temperature ever being able to reach the software limit.

- **Check the PID settings** – if they have been changed accidentally away from the default values then potentially, when trying to lock, the TEC temperature could overshoot and hit the software limit. The default settings are;
  - ***DTP:2=1.6***
  - ***DTI:2=8.0***
  - ***DTD:2=0***

Fault 120 - PRE-AMP TEC OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the pre-amp 1 TEC, once locked at the set temperature, deviates away from the setpoint for more than 20ms by an amount defined by the lock range.

	PID (in °C)	
	Alias query	Full query
Setpoint	?tdl:2	?seed:pre:tec:pid:sp
Lock range	?dtlr:2	?seed:pre:tec:pid:lr

Action

Check connection between the power amp module and controller board is secure.

Fault 121 - PRE-AMP TEC TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It occurs when the thermo electric cooler (TEC) on the pre-amp 1 pump diode is over the hardware defined maximum level of 50°C.

Electronics Description

The Seed PCBA received the pre-amp 1 thermistor input and goes into a comparator to determine if it is over or under temperature. The max and min are determined by the voltages created by the potential divider resistors. The min is set to 10°C and the max to 50°C. If the temperature goes out of this range then the oscillator temperature fault line gets pulled low.

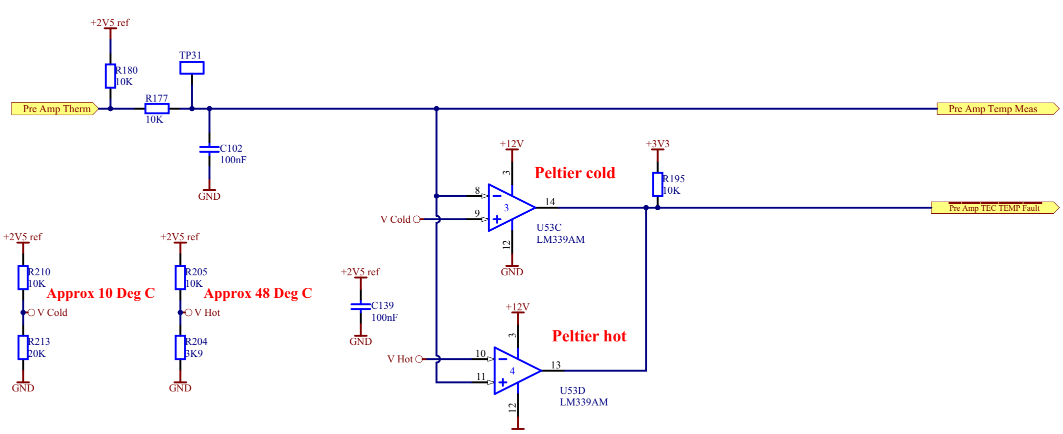


Figure 2.1-33. Pre Amp Thermistor Circuit

The pre-amp 1 temperature fault line gets passed onto the Figure 2.1-26 "Seed Latching Circuit" which results in the signal being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed Interlock will be latched. The firmware will then query the seed PCBA latching circuit via I2C GPIO expander (U13) to determine the fault. In this case, the pre-amp 1 temperature fault will have been latched resulting in the firmware flagging up this specific fault.

Action

- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 122 - PRE-AMP TEC OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 1 pump diode is being driven too hard, causing the TEC to go over current.

Detailed Description

Two fault signals are generated by the pre-amp 1 TEC driver IC on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over current Fault 1 is 0 and Fault 0 is 0.

FAULT1	FAULT0	
0	0	Overcurrent
0	1	Undervoltage
1	0	Overtemperature
1	1	Normal operation

Figure 2.1-34. Pre-amp 1 TEC Driver IC

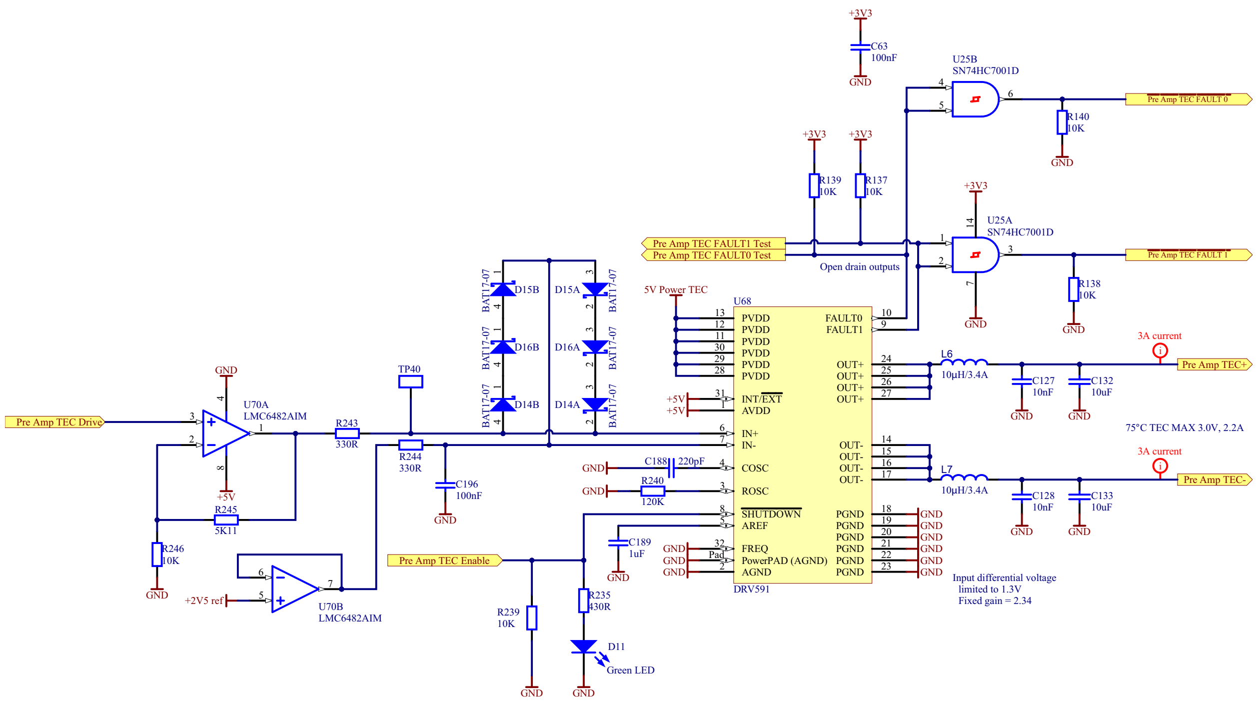


Figure 2.1-34. Pre-amp 1 TEC Driver IC (Continued)

The pre-amp 1 TEC fault lines gets passed onto the Figure 2.1-26 "Seed Latching Circuit" which results in the signal being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Global Interlock line. This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U35) to determine the fault. In this case, because both pre-amp 1 TEC fault 0 and oscillator TEC fault 1 occur simultaneously, unusually, both fault lines will be latched (see table above). The firmware can then determine the exact fault.

Action

- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 123 - PRE-AMP TEC UVP FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 1 pump diode has an under voltage issue.

Detailed Description

Two fault signals are generated by the Figure 2.1-34 "Pre-amp 1 TEC Driver IC" on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For under voltage, Fault 1 is 0 and Fault 0 is 1.

The pre-Amp 1 TEC fault lines gets passed onto the Figure 2.1-26 "Seed Latching Circuit" which results in the signal being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U13) to determine the fault. In this case, only Pre-amp 1 TEC fault 1 line will be latched. The firmware can then determine the exact fault.

Action

- Check connection between power amp module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 124 - PRE-AMP TEC OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the thermo electric cooler (TEC) on the pre-amp 1 pump diode has an over temperature issue.

Detailed Description

Two fault signals are generated by the “Pre-amp 1 TEC Driver IC” on the Seed PCBA. These signals help determine if the TEC is working normally or whether there is a fault. The fault can be determined by the table below. For over temperature, Fault 1 is 1 and Fault 0 is 0.

The pre-Amp 1 TEC fault lines gets passed onto the Figure 2.1-26 "Seed Latching Circuit" which results in the signal being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U13) to determine the fault. In this case, only Pre-amp 1 TEC fault 0 line will be latched. The firmware can then determine the exact fault.

Action

- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 125 - PRE-AMP DIODE TIMEOUT

General Description

This is a critical software generated fault that occurs when the pre-amp 1 diode is not able to lock at the desired current after 60 seconds

Action

- Put the preamp into current mode and turn on amp up to preamp1 (on=2 and pump:mode:2=1)
- Check fuses on the PDB and the PDB itself.
- Check that connections are secure between the Controller Board and the pump module.

Fault 126 - PRE-AMP 1 DIODE CURRENT EXCEEDS SOFTWARE LIMIT

General Description

This is a software generated fault. It occurs if the Pre-amp 1 pump diode tries to exceed the maximum current limit that is set in the EEPROM (?IDLMAX:2)

Action

This is a fault that generally occurs only when Pre-amp 1 is in light loop. Here, the pump diode current is dependent upon the photodiode voltage (?APD:2) reaching the light loop set point (?LLSP:2).

If there is no signal or voltage measured on the photodiode, the current will continue to ramp up until it reaches the limit. The photodiode signal can be checked by putting the Pre-amp 1 into current loop and measuring the photodiode signal at the expected operating current.

a. Key system off
b. Allow only the oscillator and Pre-amp 1 to turn on ‘ON=2’
c. Put the Pre-amp 1 into current mode ‘MODE:2=1’
d. Check the set current (?idl:2)
e. Key system on and query the Pre-amp 1 photodiode (?APD:2)
f. Compare this value with the light loop set point (?LLSP:2)
g. These to values should be close to each other
h. Switch the system off
i. Place the pre-amp 1 back into light loop (MODE:2=2) and turn on all the modules (ON=4)

Fault 127 - PRE-AMP DIODE OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the pre-amp 1, once locked, deviates away from the setpoint for more than 20ms by an amount defined by the lock range. It can occur in both light loop and current loop.

	Current Loop (in mA)		Light Loop (in V)	
	Alias query	Full query	Alias query	Full query
Setpoint	?idl:2	?seed:pre:diode :cl:sp	?llsp:2	?seed:pre:diode :ll:sp
Lock range	?dclr:2	?seed:pre:diode :cl:lr	?lllr:2	?seed:pre:diode :ll:lr

Action

- Check connection between Seed module and pump board is secure

Fault 128 - PRE-AMP DIODE NOT ENOUGH LIGHT

General Description

This is a software generated fault. Before Pre-amp 1 pump diode starts ramping there is a safety check to ensure the output from the oscillator is passing through pre-amp 1. This is done by ensuring some light is detected on the Pre-amp 1 photodiode (?APD:2) and ensuring it is above a threshold that is defined by the EEPROM value ?PDMIN:2

Actions

PDMIN:2 is set as half way between the value read by preamp1 photodiode when the system is keyed off, and the value read when the seed is keyed on.

Set the system to ON=1 and check the value of PDMIN:2 and compare it to the value calculated using:

$$a + ((b - a)/2)$$

Where:

a=?PUMP:APD:2 [when the laser is keyed OFF]

b=?PUMP:APD:2 [when the laser is keyed ON]

Call the factory if b is similar to a

Fault 129 - PRE-AMP DIODE OVER CURRENT FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the pre-amp 1 pump diode is being driven too hard, causing the diode driver to go over current (where maximum current is defined by hardware).

Detailed Description

The maximum current is defined by a resistor value within the controller PCBA (Rset).

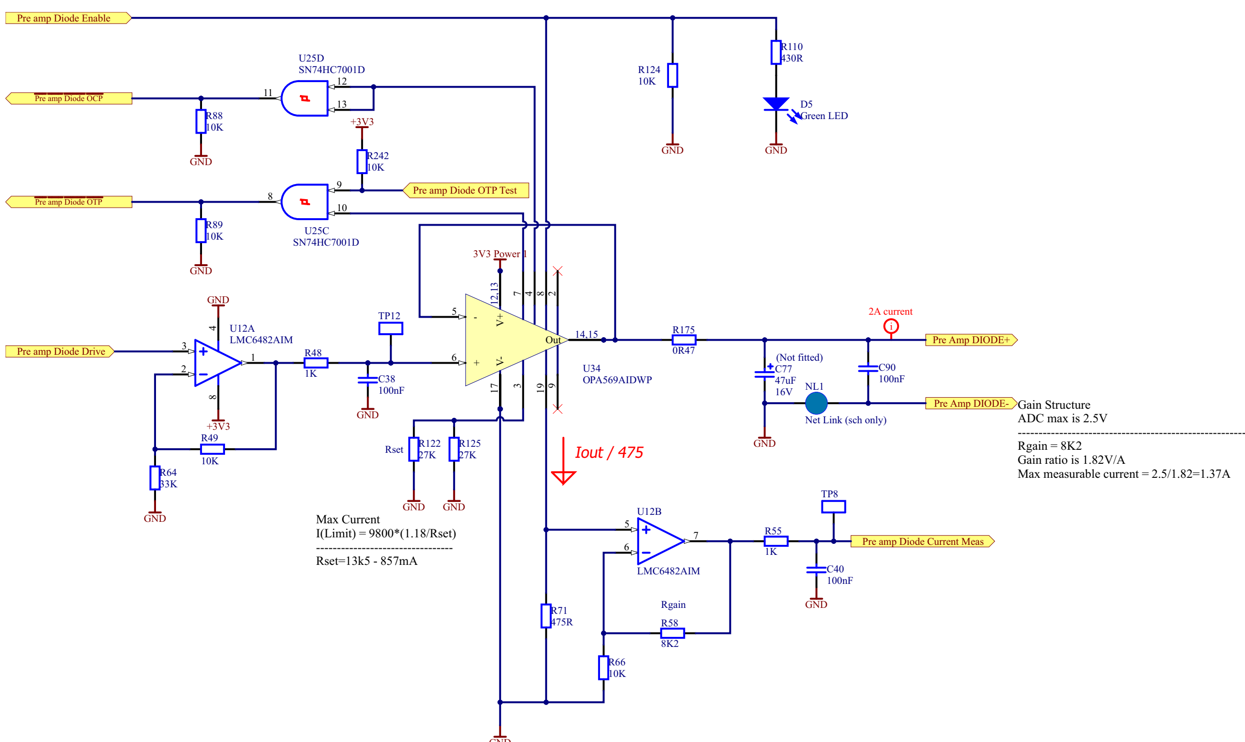


Figure 2.1-35. Controller PCBA (Rset)

If the diode driver tries to exceed this current (857mA), the pre-amp 1 Diode OCP line gets pulled down. This signal goes into the Figure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver Interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U13) to determine the exact fault.

Action

- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 130 - PRE-AMP DIODE OVER TEMPERATURE FAULT

General Description

This is a critical hardware generated fault that will immediately shut down the laser system. It indicates that the seed pump diode has exceeded its safe operating temperature.

Detailed Description

If the pre-amp 1 diode driver exceeds its safe operating temperature (defined within the diode driver IC), the OTP interlock line on the seed PCBA gets pulled low.

This OTP signal goes into the Figure 2.1-26 "Seed Latching Circuit" which results in it being latched as well as pulling down the seed interlock line.

The seed Interlock line is directly linked the controller PCBA latching circuit. It will get latched at the same time as pulling down the Figure 2.1-13 "Global Interlock Line". This has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the seed driver interlock will be latched. The firmware will then query the seed latching circuit via the I2C GPIO expander (U13) to determine the exact fault.

Action

- Check connection between seed module and controller PCBA is secure
- Ensure Chiller is switched on and operating at 20°C
- Ensure Flow in and flow out are connected the correct way round

Fault 300 - BULK BOARD TEMPERATURE FAULT

General Description

This is a non-critical software generated warning that occurs if the temperature sensor on the Bulk PCBA (***?BULK:TEMP:BOARD***) goes above a set temperature (***?BULK:TEMP:ALERTON***). The fault will clear itself if the temperature goes below a temperature defined as (***?BULK:TEMP:ALERTOFF***).

This specific fault is non-critical which means the system will show the fault but will not shut the system – the system should be able to run normally.

Electronic Description

There is an I2C IC on the bulk PCBA which handles which generated the temperature alert.

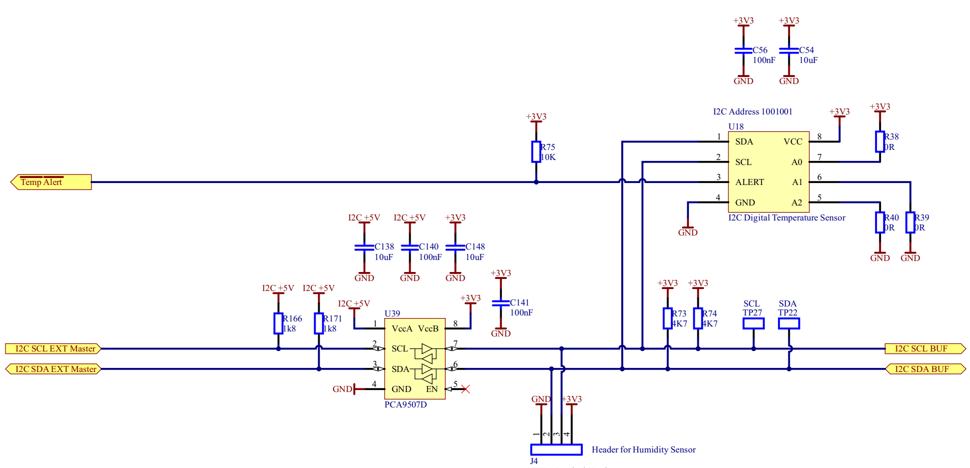


Figure 2.1-36. I2C Bulk PCBA

This warning gets passed into an I2C IO expander and read by the Controller board (via I2C bus).

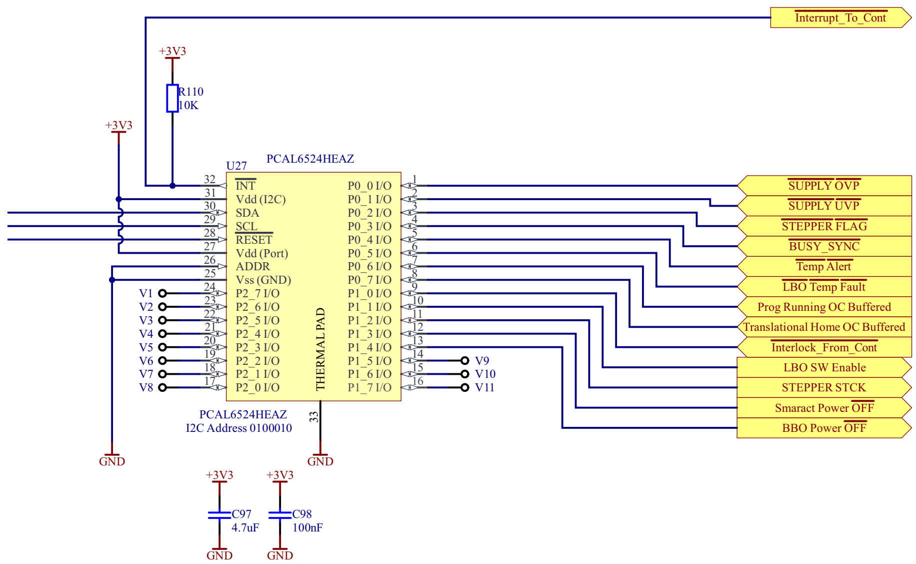


Figure 2.1-37. I2C IO Expander (U27)

Action

Query ?BULK:TEMP to see check the temperature values and observe if the temperature is below the 'Alerton' value. If everything looks normal try clearing the fault ("FC"). If the fault remains or the temperature is abnormal then the PSU may need to be changed.

Fault 301 - BULK BAD COMMUNICATION

General Description

This is a critical software generated fault that occurs when there is floating point error within the firmware causing a calculation to fail. It is generally caused when there is a bug in the firmware.

Action

Report the issue to Coherent Scotland, outlining, if possible the how and when the fault occurs.

Fault 302 - BULK CALCULATION FAULT

General Description

This is a critical software generated fault that occurs when the communication lines (I2C or SPI) fail to communicate properly.

Action

- Check / replace the cables between the bulk and the controller board
- Contact Coherent Scotland

Fault 303 - OVEN TEMPERATURE FAULT

General Description

This is a critical software generated fault that will shut down the laser system if software polling detects that the LBO oven is out with the hardware defined operating temperature range (0°C -100°)

Electronic Description

The LBO thermistor is connected directly to the bulk PCBA. There is an I2C IC on the bulk PCBA which handles which generated the temperature alert. This goes into a comparator to determine if it is over temperature or under temperature. The maximum and minimum are determined by the voltages created by the potential divider resistors. The min is set to 0°C and the max to 100°C. If the temperature goes out of this range then the LBO Thermistor fault line gets pulled low.

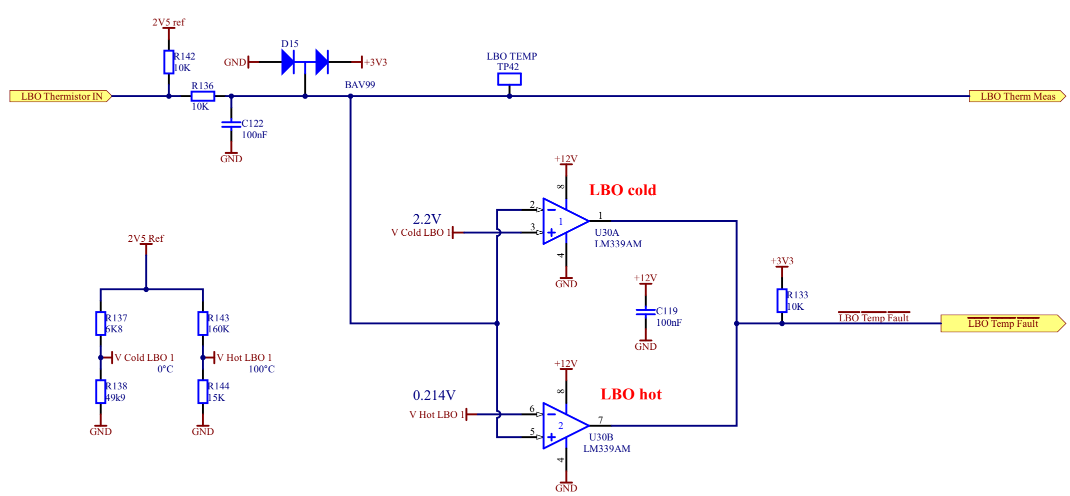


Figure 2.1-38. LBO Thermistor

This fault line then gets passes to an Figure 2.1-37 "I2C IO Expander (U27)".

Which is then read by the Controller board (via I2C bus), which will shut the system down if the fault is detected.

Fault 304 - OVEN SOFT LIMIT FAULT

General Description

This is a critical software generated fault that occurs when the SHG oven temperature goes above the software defined limit.

	Alias query	Full query
Software limit	?tlbomax	?bulk:oven:pid:limit

Action

Once the oven is locked, this fault should never occur given the lock range should always be small enough as to prevent the temperature ever being able to reach the software limit. If the oven PID settings are incorrect there is a small chance, when the oven is first warming up, to overshoot

- Check PID settings are correct. The default values are;
  - LBOTP=-30.00
  - LBOTI=-1.00
  - LBOTD=0.00

Fault 305 - OVEN OUT OF LOCK

General Description

This is a critical software generated fault that will shut down the laser system. It occurs if the SHG oven, once locked at the set temperature, deviates away from the setpoint for more than 20ms by an amount defined by the lock range.

	PID (in °C)	
	Alias query	Full query
Setpoint	?lbot	?bulk:oven:pid: sp
Lock range	?lbotlr	?bulk:oven:pid:l r

Action

- If this fault only occurs when the laser is on and at ON=4, try changing the spot
- Repeatedly query the LBO temperature (?ATLBO) to determine if the temperature is behaving normally. The temperature equal the set temperature (?TLBO)

Ensure Chiller is switched on and operating at 20°C

Ensure Flow in and flow out are connected the correct way round

- Check PID settings are correct. The default values are;
    - LBOTP=-30.00
    - LBOTI=-1.00
    - LBOTD=0.00

Fault 306 - COOL MUSCLE FIRMWARE FAULT

General Description

This is a critical software generated fault that will shut the system down. The fault is generated by the cool muscle controller board within the BBO stepper assembly and indicates there is a problem with its firmware.

Action

- Cycle the power to determine if the fault goes away
- Try clearing the fault (‘FC’)
- On the Bulk PCBA, check the BBO 24V rail (TP21), see schematic below

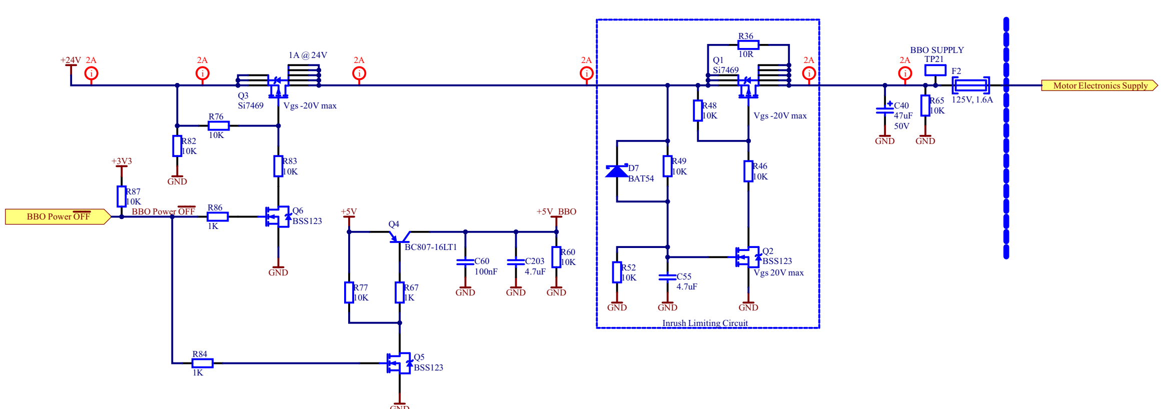


Figure 2.1-39. BBO 24V Rail (TP21)

- Check the BBO fuse (F2) for continuity
- Check the 50-way loom ribbon cable between the Bulk PCBA and the bulkhead
- Note: the firmware is able to switch off the power to the BBO stepper but this is only ever carried out when the system first boots up. There is no EEPROM or RS232 command that is able to accidentally switch this voltage off.
- If everything looks normal then the BBO stepper is most likely to have failed and will need to be replaced – please contact Coherent Scotland

Fault 307 - COOL MUSCLE MOTOR FAULT

General Description

This is a critical software generated fault that will shut the system down. The fault is generated by the cool muscle controller board within the BBO stepper assembly and indicates there is a problem with its motor.

Action

- Cycle the power to determine if the fault goes away
- Try clearing the fault ('FC')
- On the Bulk PCBA, check the Figure 2.1-39 "BBO 24V Rail (TP21)"
- Check the BBO fuse (F2) for continuity
- Check the 50-way loom ribbon cable between the Bulk PCBA and the bulkhead
- Note: the firmware is able to switch off the power to the BBO stepper but this is only ever carried out when the system first boots up. There is no EEPROM or RS232 command that is able to accidentally switch this voltage off.
- If everything looks normal then the BBO stepper is most likely to have failed and will need to be replaced – please contact Coherent Scotland

Fault 400 - PSU BOARD TEMPERATURE FAULT

General Description

This is a non-critical software generated warning that occurs if the temperature sensor on the PSU PCBA (***?PSU:TEMP:BOARD***) goes above a set temperature (***?PSU:TEMP:ALERTON***). The fault will clear itself if the temperature goes below a temperature defined as (***?PSU:TEMP:ALERTOFF***).

This specific fault is non-critical which means the system will show the fault but will not shut the system – the system should be able to run normally.

Electronic Description

There is an I2C IC on the PCBA which handles which generated the temperature alert.

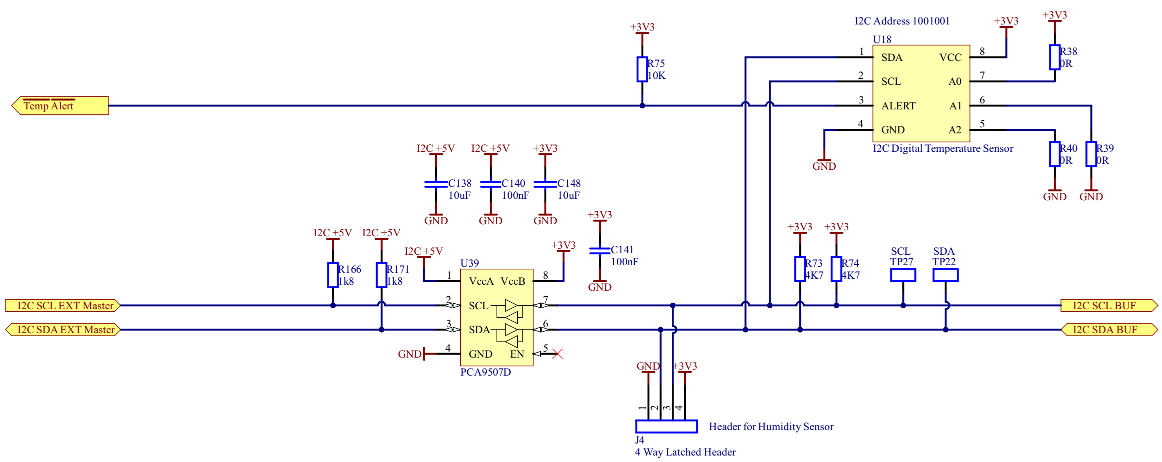


Figure 2.1-40. I2C IC Temp Alert

This warning gets passed into an I2C IO expander.

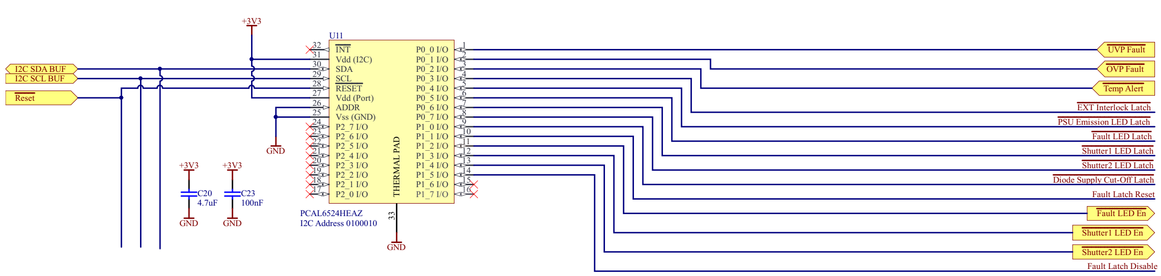


Figure 2.1-41. I2C IO Expander (U11)

Which is then read by the Controller board (via I2C bus).

Action

Query ?PSU:TEMP to see check the temperature values and observe if the temperature is below the 'Alerton' value. If everything looks normal try clearing the fault ("FC"). If the fault remains or the temperature is abnormal then the PSU may need to be changed.

Fault 401 - PSU UNKNOWN INTERLOCK FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the controller board detects that the PSU Interrupt line go Low (fault state).

This specific fault means although the PSU interrupt has been triggered, when the firmware goes to query what in the PSU has triggered the fault, the PSU indicates there is no known fault.

Electronics Description

An Interlock out from the PSU PCBA can be generated from a number of faults within the PSU. When one of these faults occur, the PSU Interlock line gets pulled low.

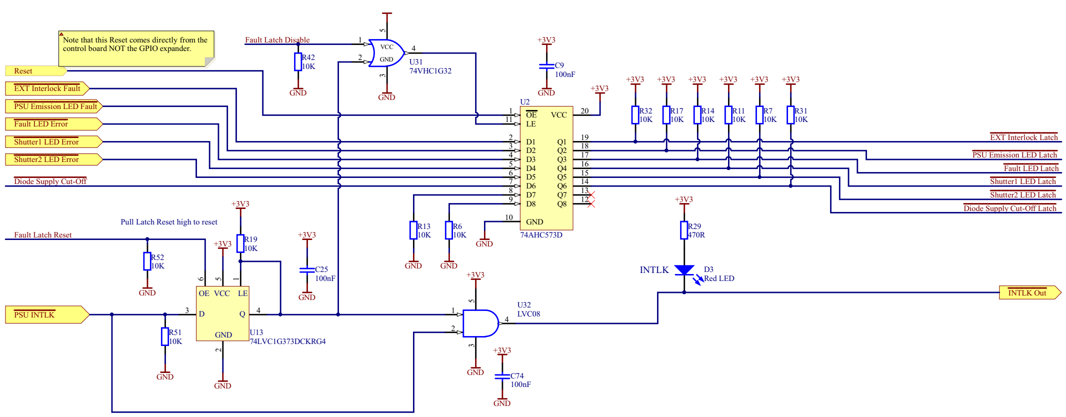


Figure 2.1-42. PSU Interlock Line

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, nothing will have been latched and results in this specific fault.

Action

During NGX development this kind of fault was observed by inducing a large electrical noise spike. This caused the PSU interlock line to glitch resulting in the controller board to shut the system down. If this occurs nothing will be latched and the firmware will not show this by giving this specific fault

- Check if any large pieces of equipment were being switched off/on at the time of the laser faulting out.
- The fault should be able to be cleared by typing "FC"

Fault 402 - PSU LED FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the PSU PCBA detects a problem with the Fault LED.

Electronics Description

The PSU PCBA detects if there is a problem with the Fault LED using the circuit below

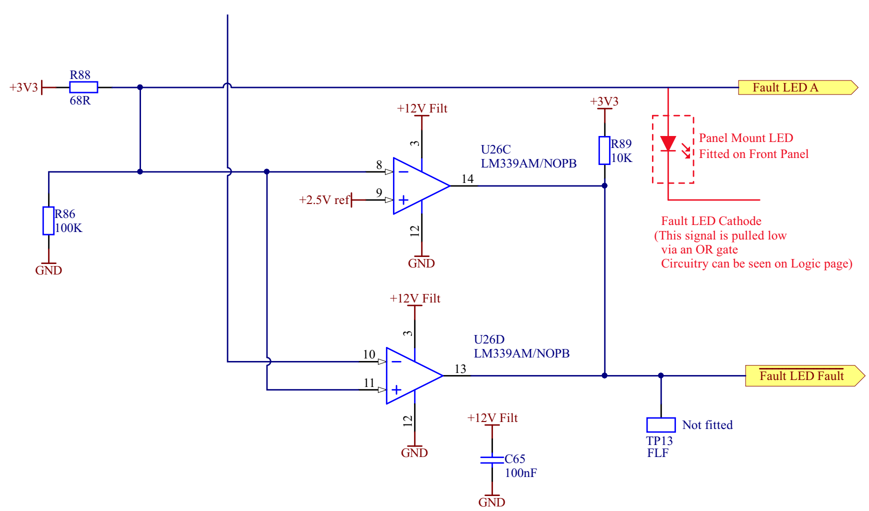


Figure 2.1-43. Fault LED

The Fault LED Fault Line then gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line" signal down.

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, the fault LED will have been latched resulting in the firmware flagging up this specific fault.

Action

The Fault LED has been determined not to be working.

- Observe if the Fault LED is on or flashing when the system is powered up
- Look at the connection of this LED onto the PSU PCBA

If there is nothing obvious wrong with the connections and the fault can not be cleared the PSU may need to be changed.

Fault 403 - TUNABLE SHUTTER LED FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the PSU PCBA detects a problem with the LED within the Tunable Shutter Button.

Electronics Description

The PSU PCBA detects if there is a problem with the LED within the Tunable shutter button using the circuit shown in Figure 2.1-44 "Shutter LED Fault".

The Tunable LED Fault Line gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line" signal down.

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

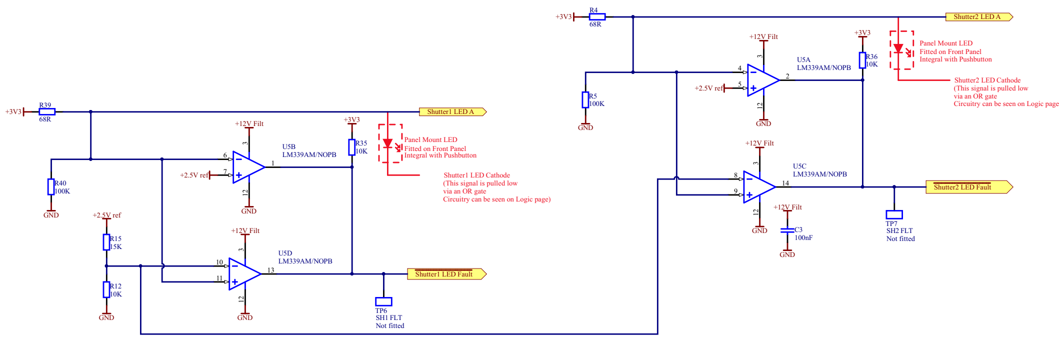


Figure 2.1-44. Shutter LED Fault

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, the Tunable shutter LED will have been latched resulting in the firmware flagging up this specific fault.

Action

The LED within the Fixed Shutter button is deemed to not be working.

- Observe if the Shutter LED can lit when pressed (key will need to be to ON position)
- Look at the connection of tunable Shutter button onto the PSU PCBA

If there is nothing obvious wrong with the connections and the fault cannot be cleared the PSU may need to be changed.

Fault 404 - FIXED SHUTTER LED FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the PSU PCBA detects a problem with the LED within the Fixed Shutter Button shown in Figure 2.1-44 "Shutter LED Fault".

Electronics Description

The PSU PCBA detects if there is a problem with the LED within the fixed shutter button using the circuit below

The Fixed LED Fault Line gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line" signal down.

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, the fixed shutter LED will have been latched resulting in the firmware flagging up this specific fault.

Action

The LED within the Fixed Shutter button is deemed to not be working.

- Observe if the Shutter LED can lit when pressed (key will need to be to ON position)
- Look at the connection of tunable Shutter button onto the PSU PCBA

If there is nothing obvious wrong with the connections and the fault cannot be cleared the PSU may need to be changed.

Fault 405 - DIODE SUPPLY CUTOFF FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the PSU PCBA detects a problem with the voltage being asked for by the variable power supply. The Wavelength Electronics diode driver is able to cope with wide range of Voltages (+5V - +30V). The variable power supply is able to go higher than this voltage so there is protection to ensure that the control signal used by the firmware to control the PSU voltage is not able to accidentally request more that the driver can cope with. If this control voltage is too high, this fault is occurs.

Electronics Description

The Diode supply control voltage is controlled by the controller PCBA via an I2C DAC on the PCU PCBA.

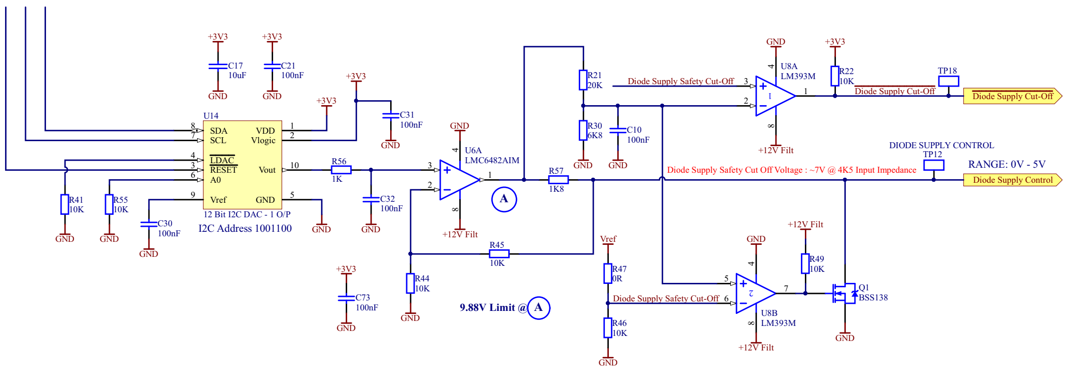


Figure 2.1-45. Diode Supply via I2C DAC

If this voltage from this goes above 5.28V, the Diode supply cut-off fault line will go low. This signal gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line" down.

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, the Diode supply cut-off line will have been latched resulting in the firmware flagging up this specific fault.

Fault 406 - PSU EMISSION LED FAULT

General Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the PSU PCBA detects a problem with the PSU Emission LED.

Electronics Description

The PSU PCBA detects if there is a problem with the PSU Emission LED using the circuit below.

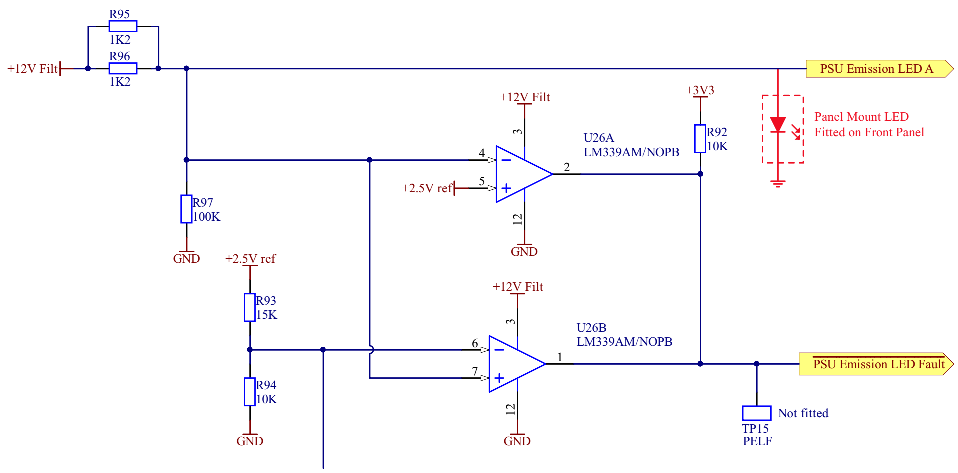


Figure 2.1-46. PSU LED Fault

The PSU Emission LED Fault Line gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line" down.

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit via the Figure 2.1-41 "I2C IO Expander (U11)" to determine the fault. In this case, the PSU Emission LED will have been latched resulting in the firmware flagging up this specific fault.

Action

The PSU Emission LED is deemed to not be working.

- Observe if the Emission LED is lit when the system is powered up (LED should always be on)
- Look at the connection of tunable Shutter button onto the PSU PCBA

If there is nothing obvious wrong with the connections and the fault cannot be cleared the PSU may need to be changed.

Fault 407 - PSU EXTERNAL INTERLOCK OPEN

Description

This is a critical hardware generated Fault that will immediately shut down the laser system. It occurs when the External interlock is triggered

Electronic Description

The route of the external interlock starts at the MRU where there is an external interlock connector that, by default, has the supplied interlock defeat plug inserted into it. There is a 3pin mini-DIN connector that takes this external interlock line over to the PSU. From the diagram below, it can be seen that if the MRU is switched off, the solid state relay within the MRU will cause and open circuit. This ensures that the MRU is switched on before the Discovery can be keyed on.

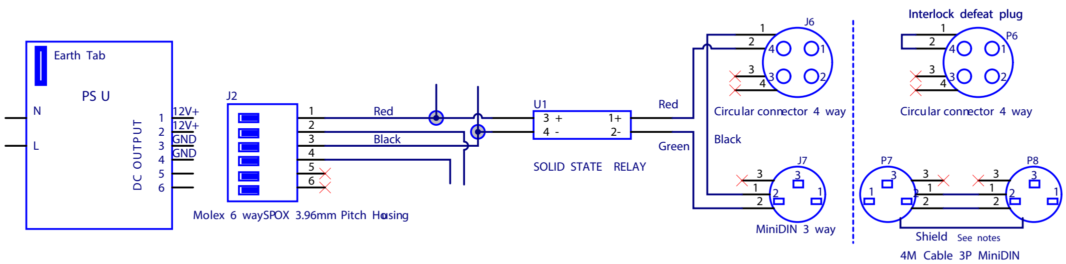


Figure 2.1-47. MRU External Interlock

The interlock output from the MRU gets plugged into the PSU using a socket connector.

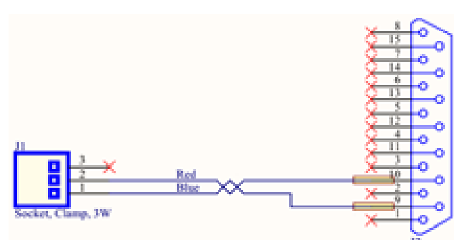


Figure 2.1-48. MRU Interlock Socket Connector

This gets plugged into the PSU PCBA (J1). The PSU PCBA has a current source (U5) of 26.5mA which is passed down the 'Ext interlock Out' line. If this line is unbroken (ie. a working interlock as indicated by the red line) then the 26.5mA will come through 'Ext Interlock In' powering the opto-coupler (U8) and making the EXT INTERLOCK +/- become High. If the interlock is broken, there will be not current going into the opto-coupler, making the EXT INTERLOCK signal go Low.

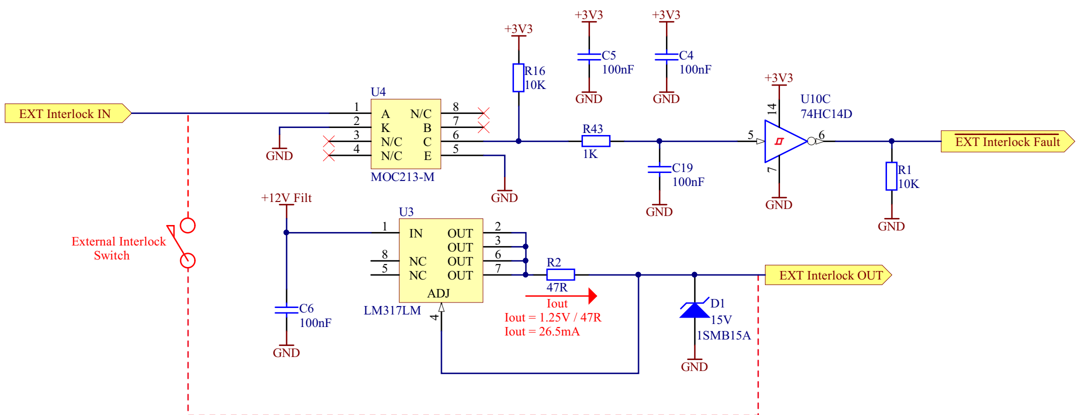


Figure 2.1-49. PSU External Interlock

The External interlock fault Line gets passed onto the PSU latching circuit which results in the signal being latched as well as pulling the Figure 2.1-42 "PSU Interlock Line".

The PSU interlock signal is directly connected to the controller PCBA. This signal pulls down the Figure 2.1-13 "Global Interlock Line" and has the effect of immediately shutting down the whole system. This is all done without firmware intervention.

Once the firmware detects a shutdown, it is then able to look at the controller board latching circuit to determine which interlock line has caused the fault. In this case, the PSU Interlock will be latched. The firmware will then query the PSU latching circuit to determine the exact fault. In this case, the PSU Emission LED will have been latched resulting in the firmware flagging up this specific fault.

Action

- Ensure the interlock defeat is full inserted into the back of the MRU
- Ensure the MRU is switched on
- Ensure the interlock cable between the MRU and the PSU are connected properly
- If the User is using their own interlock, ensure it is not their interlock causing the fault by inserting the supplied interlock defeat into the back of the MRU
    - Check there is continuity between pins 1 and 4 of the MRU interlock defeat

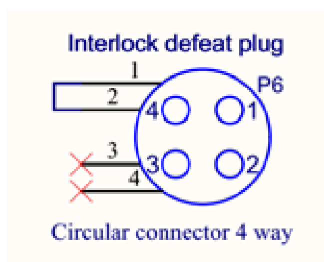


Figure 2.1-50. MRU Interlock Defeat Plug

Fault 500 - PORT INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs if the Controller board does not detect the expected PCBA's.

Action

- Ensure power and communication cables from the Bulk board to the controller board are attached and secured
- Ensure the communication cable from the seed to the Controller board is attached and secured
- Ensure the DIP switches on the controller board are set up correctly.

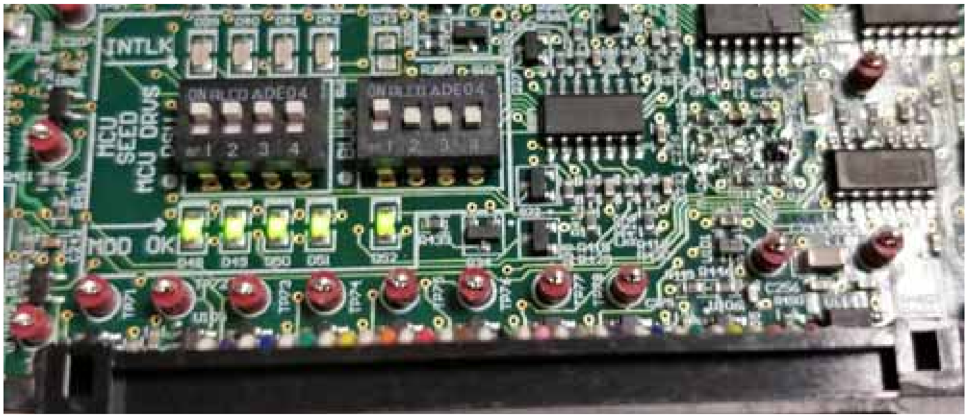


Figure 2.1-51. DIP Switches on Controller Board

Fault 501 - PORT HARDWARE DIP SWITCH FAULT

General Description

This is a critical software generated fault that occurs when DIP switches on the controller board are incorrectly set up.

Action

- Ensure the Figure 2.1-51 "DIP Switches on Controller Board" board are set up correctly

Fault 502 - PORT ENABLED, BAD COMMS FAULT

General Description

This is a critical software generated fault that occurs when the firmware is able to communicate with the board but it has difficulty in reading its EEPROM. It would normally suggest that there is something wrong with the EEPROM integrated circuit.

Action

- Ensure all cables are connected and secure
- Query the system information screen ('?SYS:INFO) and the error log (?ERRLOG) to help determine which board is creating the fault. An example of the system information screen is outlined below. It should be possible to see the
    - Seed PCBA
    - Bulk PCBA
    - PSU PCBA
    - MCU PCBA (part of the controller board)

```
CHAMELEON> ?sys:info
-------------------------------------------------------------------System Information ----
{PORT}       {BNAME}                   {PROMPT}      {BID}        {REVA}       {BTLV}

0            DNGX_MCU                  MCU           13           TBD          20.020
1            DNGX_SEED                 SEED          10           TBD
3            BULK                      BULK          19           TBD
4            DNGX_PSU                  PSU           14           TBD

------------------------------------------------------------------------------------------
```

- Communicate the issue to Coherent Scotland / Quality
- Replace PCBA

Fault 503 - PORT IDENTIFICATION IMAGE EMPTY

General Description

This is a critical software generated fault that occurs when the firmware detects that a connected board has not been configured. This configuration procedure should occur before it enters the factory as a tested PCBA.

Action

- Query the system information screen ('?SYS:INFO) and the error log (?ERRLOG) to help determine which board is creating the fault. An example of the system information screen is outlined below. It should be possible to see the
    - Seed PCBA
    - Bulk PCBA
    - PSU PCBA
    - MCU PCBA (part of the controller board)

```
CHAMELEON> ?sys:info
--------------------------------------------------------------------System Information ----
{PORT}        {BNAME}                    {PROMPT}     {BID}        {REVA}        {BTLV}

0             DNGX_MCU                   MCU          13           TBD           20.020
1             DNGX_SEED                  SEED         10           TBD
3             BULK                       BULK         19           TBD
4             DNGX_PSU                   PSU          14           TBD

--------------------------------------------------------------------------------------------
```

- Communicate the issue to Coherent Scotland / Quality
- Replace PCBA

Fault 504 - PORT IDENTIFICATION IMAGE FORMAT FAULT

General Description

This is a critical software generated fault that occurs when the firmware detects a PCBA, it is able to read the EEPROM but the values within the EEPROM are in an unexpected format. It suggests that the board has not been configured correctly.

Action

- Query the system information screen (‘?SYS:INFO) and the error log (?ERRLOG) to help determine which board is creating the fault. An example of the system information screen is outlined below. It should be possible to see the
    - Seed PCBA
    - Bulk PCBA
    - PSU PCBA
    - MCU PCBA (part of the controller board)

```
CHAMELEON> ?sys:info
--------------------------------------------------------------------System Information ----
{PORT}        {BNAME}                    {PROMPT}     {BID}        {REVA}        {BTLV}

0             DNGX_MCU                   MCU          13           TBD           20.020
1             DNGX_SEED                  SEED         10           TBD
3             BULK                       BULK         19           TBD
4             DNGX_PSU                   PSU          14           TBD

--------------------------------------------------------------------------------------------
```

- Communicate the issue to Coherent Scotland / Quality
- Replace PCBA

Fault 505 - PORT IDENTIFICATION IMAGE CRC FAULT

General Description

This is a critical software generated fault that occurs when the firmware detects a PCBA, it is able to read the EEPROM but the values within the EEPROM are corrupted. It suggests that the board has not been configured correctly.

Action

- Query the system information screen ('?SYS:INFO) and the error log (?ERRLOG) to help determine which board is creating the fault. An example of the system information screen is outlined below. It should be possible to see the
    - Seed PCBA
    - Bulk PCBA
    - PSU PCBA
    - MCU PCBA (part of the controller board)

```
CHAMELEON> ?sys:info
---------------------------------------------------------------------System Information ----
{PORT}        {BNAME}                    {PROMPT}      {BID}         {REVA}        {BTLV}

0             DNGX_MCU                   MCU           13            TBD           20.020
1             DNGX_SEED                  SEED          10            TBD
3             BULK                       BULK          19            TBD
4             DNGX_PSU                   PSU           14            TBD

---------------------------------------------------------------------------------------------
```

- Communicate the issue to Coherent Scotland / Quality
- Replace PCBA

Fault 506 - BOARD IDENTIFICATION FAULT

General Description

This is a critical software generated fault that occurs when the firmware detects a PCBA, it is able to read the EEPROM but the values within the EEPROM are unexpected. It suggests that either the board has not been configured correctly or the wrong board has been installed.

Action

- Query the system information screen ('?SYS:INFO) and the error log (?ERRLOG) to help determine which board is creating the fault. An example of the system information screen is outlined below. It should be possible to see the

- Seed PCBA
- Bulk PCBA
- PSU PCBA
- MCU PCBA (part of the controller board)

```
CHAMELEON> ?sys:info
---------------------------------------------------------------------System Information ----
{PORT}        {BNAME}                     {PROMPT}      {BID}        {REVA}        {BTLV}

0             DNGX_MCU                    MCU           13           TBD           20.020
1             DNGX_SEED                   SEED          10           TBD
3             BULK                        BULK          19           TBD
4             DNGX_PSU                    PSU           14           TBD

---------------------------------------------------------------------------------------------
```

- Communicate the issue to Coherent Scotland / Quality
- Replace PCBA

Fault 600 - APPLICATION INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there has been an issue in initialising a board device (eg. Failed to setup BBO correctly). This applies to all connected boards.

Action

- Ensure all boards are connected to the controller board correctly
- View the errorlog (?ERRLOG) and start up screen (?SYS:STARTINFO) to help determine any specific issues
- Investigate any other specific faults that are active, resolving these faults may make this fault clear also.

Fault 601 - OVEN INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there is a problem in enabling the SHG Oven

Action

- If system is being manufactured, check all connections from the SHG oven to the bulk headboard
- If outside of Coherent Scotland check the 50-way bulkhead ribbon cable
- Try replacing the bulk headboard

Fault 602 - BBO STEPPER INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there is a problem in enabling the BBO stepper spot movement logic.

Action

- If system is being manufactured, check all connections from the BBO stepper to the bulk headboard
- If outside of Coherent Scotland check the 50-way bulkhead ribbon cable
- Try replacing the bulk headboard

Fault 603 - SHG STEPPER INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there is a problem in enabling the SHG stepper spot movement logic.

Action

- If system is being manufactured, check all connections from the SHG stepper to the bulk headboard
- If outside of Coherent Scotland check the 50-way bulkhead ribbon cable
- Try replacing the bulk headboard

Fault 604 - GDD STEPPER INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there is a problem performing the pre-comp stepper movement with respect to wavelength and requested GDD.

Action

- Check the EEPROM for erroneous GDD calibration data

Fault 605- MIRRORS INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when there is an error in performing the initial mirror movement to the EEPROM position

Action

- If system is being manufactured, check all connections from the Active mirrors to the bulk headboard
- If outside of Coherent Scotland check the 50-way bulkhead ribbon cable
- Try replacing the bulk headboard

Fault 606 - AOM INITIALISATION FAULT

General Description

This is a critical software generated fault that occurs when an error is detected when setting up the AOM

Action

- Check all connections to the AOM drivers from the controller board

Fault 607 - APPLICATION CALCULATION FAULT

General Description

This is a critical software generated fault that occurs when firmware detects a calculation error.

Action

This fault can be caused in a number of ways.

1. If an ADC on any of the PCBA's are not working properly the firmware could be getting incorrect information and can result in a calculation error. Analysis of the error log can be used to look for any electronic issues.

- Read through the error log '?ERRLOG' to determine if there are any ADC errors. If errors are found then replace the PCBA that is producing the PCBA.

2. A bug in the firmware could potentially be producing calculation error. If no electronics issues were observed then information will need to be gathered to aid the software Engineers in debugging the issue
    - Write down the steps carried out to replicate the issue or if it cannot be replicated, outline what state the system was in when the fault occurred,
    - Obtain an EEPROM image
    - Obtain the Error log (?ERRLOG)
    - Obtain the Fault history (?FH)

Pass this information onto Coherent Scotland or the Engineering department

Fault 608 - APPLICATION WATCHDOG TIMEOUT

General Description

This is a critical software generated fault that occurs when the firmware is running a task within an application and is incorrectly patting the watchdog at the correct frequency

Action

This fault should really never occur as software testing should ensure the firmware can handle all scenarios. If the issue does appear the following steps should be carried out

- Ensure the laser system is upgraded to the latest version
- Write down what was being done (if anything) to the system when the fault occurred
- Query the error log (?ERRLOG) and copy the information to a text file
- Query the fault history (?FH) and copy the information to a text file
- Contact Coherent Scotland and pass on the collected data

Fault 609 - PAMP INSUFFICIENT FEEDBACK CURRENT

General Description

This is a critical software generated fault that will shut the laser system down. It occurs when the power amp pump module ramps up in current mode but the firmware detects there is no feedback from the wavelength Electronics diode driver. It prevents the system ramping up uncontrollably.

Action

- Check all connection from the wavelength Electronics diode driver to the controller board are correct
- Swap all looms coming from the Wavelength Electronics driver
- Replace wavelength Electronics driver

Fault 610 - BASEPLATE TEMPERATURE FAULT

General Description

This is a critical software generated fault that will shut the system down. It occurs when the baseplate temperature (?BT) (a thermistor placed within the pump module) goes out with a temperature range defined by BTMIN and BTMAX.

Action

- Ensure the chiller is connected, on and set to 20°C
- Ensure the hoses are connected the correct way round.
- Query ?BT to see if the temperature reading in sensible
- Query ?BTMIN to ensure the value is correct (default is 15°C)
- Query ?BTMAX to ensure the value is correct (default is 30°C)
- Check the thermistor cable is connected to the controller board. The thermistor cables are the thin black cables that are attached to the controller board on J26.

Figure 2.1-52. Thermistor Cables at J26 Controller Board

Fault 611 - APPLICATION USER RAISED FAULT

General Description

This is a critical software generated fault that will shut the laser system down. It occurs when it detects something unexpected.

Action

This fault should really never occur as software testing should ensure the firmware can handle all scenarios. If the issue does appear the following steps should be carried out

- Ensure the laser system is upgraded to the latest version
- Write down what was being done (if anything) to the system when the fault occurred
- Query the error log (?ERRLOG) and copy the information to a text file
- Query the fault history (?FH) and copy the information to a text file
- Contact Coherent Scotland and pass on the collected data

Fault 612 - STRAIN GAUGE COMMUNICATION FAULT

General Description

This is a critical software generated fault that will shut the laser system down. It occurs when the firmware is having difficulty in communicating with the ADC and DAC required to control the piezo stage and its strain gauge.

Action

- Check the connection between the bulk PBA and the controller PCBA
- Replace Bulk PCBA

Fault 613 - STRAIN GAUGE MOVE SOFTWARE LIMIT REACHED

General Description

This is a software generated fault. It occurs if the strain gauge value from the ADC exceeds maximum software limit that is set in the EEPROM (?STAGEMAX)

Action

This fault should never occur as the default value for the limit 65535, and the ADC is not able to go above this value.

- Ensure STAGEMAX is equal to 65536

Fault 614 - STRAIN GAUGE POWER LOCK SOFTWARE LIMIT REACHED

General Description

This is a software generated fault. It occurs if the power lock value from the ADC exceeds maximum software limit that is set in the EEPROM (?PLOCKMAX)

Action

This fault should never occur as the default value for the limit 65535, and the ADC is not able to go above this value.

- Ensure PLOCKMAX is equal to 65536

Fault 615 - PRECOMP FAILED TO HOME

General Description

This indicates that the GDD stepper has failed to home correctly.

Detailed Description

This fault occurs once the stepper has moved to its homing switch and has tried to move 20 steps forward. In normal operation, these 20 steps should make the home switch go low. A fault is created if this signal remains high. It indicates that something may be wrong with the stepper and that it is not moving correctly

Action

- Manually home the stepper by sending the command ‘STP2HM=1’

Fault 616 - OSCILLATOR DIP UNABLE TO LOCK

General Description

This is a non-critical software generated warning that occurs if the Dip setpoint (D1DIPSP) has increased to a current which is 3mA lower than the actual setpoint (IDL:1).

Action

- **Reset D1DIPSP to 90mA and turn the laser back on.** When this is done, the DIP algorithm will continue to dip until the seed is lasing after the dip - this may take a few minutes. It is possible to track the progress by querying the most recent value of the setpoint (?D1DIPSP). Lasing is defined as when the seed photodiode voltage is equal or greater than the voltage defined as D1DIPMLT. D1DIPMLT is automatically defined by the firmware as being 0.05V above the photodiode voltage when the laser is off.

  If the D1DIPSP returns to its original value (3mA below IDL:1) then it indicates either

1. The value of IDL:1 has is incorrect – check the original EEPROM

2. **D1DIPMLT has been incorrectly calculated by the firmware**
   Ensure the D1DIPMLT has been set correctly. This can be done by querying the seed photodiode voltage (**?APD:1)** when the seed is off and adding 0.05V. This value should be the same as the value calculated by the firmware (**?D1DIPMLT**)
3. The system is slowly degrading and will likely need to be replace in the near future. Contact Coherent Scotland or Engineering.

Fault 617 - COMPLIANCE FIRMWARE WARNING

General Description

This is a non-critical software generated warning that indicates the firmware has detected something wrong with ADC or DAC that regulates the pump module voltage. It is likely that this fault will be accompanied with other fault.

Action

- If the warning continues to appear, a change of the controller board is advised.

Fault 618 - PUMP SERVICE REQUIRED

General Description

This is a non-critical software generated warning that prompts the user to contact Coherent support. The warning indicates that there is only one remaining good spot on the SHG crystal This will normally only occur on systems that have been running for a long period of time. The system will still operate but indicates to the user that the system may start to slowly degrade of there is no intervention from service.

Action

- Contact Coherent Scotland

Fault 619 - SERVICE REQUIRED

General Description

This is a non-critical software generated warning that prompts the user to contact Coherent support. The warning indicates that there is only one remaining good spot on the OPO crystal This will normally only occur on systems that have been running for a long period of time. The system will still operate but indicates to the user that the system may start to slowly degrade of there is no intervention from service.

Action

- Contact Coherent Scotland

Fault 621 - LOW POWER

General Description

This is a non-critical software generated fault that occurs when the system is unable to the OPO to lase. The system will have carried out 5 consecutive routines to get the system up and running. If, after the 5th attempt no light is detected from the OPO it will generate this warning and put the laser to 'Ready' state.

Action

- Ensure the pump is producing the correct power (?P2 should equal ~16000)
- Change SHG spot and retune (use **SHGSPOTCH+** to move to next good spot when the system is keyed off)
- Change BBO spot and retune (use **STP1SPOT+** to move to next good spot when system is keyed off)
- Carry out a pump map to check the pump position is optimized
- Try re-calibrating the piezo stage to ensure this is working ok (type **STAGESGCAL**

Fault 65535 - FAULT LIMIT REACHED

General Description

This is a critical software generated fault that occurs if the incorrect fault code is generated.

Action

This fault should never occur but is present to ensure the system can handle an incorrect fault code request.

Classic NG Faults to Equivalent NX Faults

Table 2.1-2. Equivalent Faults

ORIGINAL NG FAULT	NX EQUIVALENT
Fault 2 - Laser Diode 1 Driver over Current	Fault 114
Fault 3 - Laser Diode 1 Driver over Temperature	Fault 115
Fault 4 - OSC TEC 1 Driver over Current	FAULT 107
Fault 5 - OSC TEC 1 Driver Over Temperature	FAULT 109
Fault 6 - OSC TEC 1 Driver Under Voltage	FAULT 108
Fault 10 - OSC Threshold Over Voltage	FAULT 116
Fault 11 - OSC Threshold Under Voltage	FAULT 117
Fault 12 - OSC Light Loop Out Of Lock	FAULT 112
Fault 13 - OSC Current Loop Out Of Lock	FAULT 112
Fault 14 - OSC Diode current exceeds IDL1MAX	Fault 111
Fault 15 - OSC Diode Temperature Out of Lock	FAULT 105
Fault 17 - AMP1 Diode Driver Over Current	FAULT 129
Fault 18 - AMP1 Diode Driver Over Temperatur	FAULT 130
Fault 19 - AMP1 TEC Driver Over Current	FAULT 122
Fault 20 - AMP1 TEC Driver Over Temperature	FAULT 124
Fault 21 - AMP1 TEC Driver Under Voltage	FAULT 123
Fault 22 - AMP1 Light Loop Out Of Lock	FAULT 127

Table 2.1-2. Equivalent Faults (Continued)

ORIGINAL NG FAULT	NX EQUIVALENT
Fault 24 Pre-amp 1 diode current exceeds software limit	FAULT 126
Fault 25 - AMP1 Diode Temperature Out of Lock	FAULT 120
Fault 26 - OSC Seed Output Low	FAULT 113
Fault 27 - Amp1 Open Circuit	FAULT 128
Fault 28 - AMP2 Diode Driver Over Current	FAULT 22
Fault 29 - AMP2 Diode Driver Over Temperature	FAULT 23
Fault 30 - AMP2 TEC Driver Over Current	FAULT 15
Fault 31 - AMP2 TEC Driver Over Temperature	FAULT 16
Fault 32 - AMP2 TEC Driver Under Voltage	FAULT 17
Fault 33 - AMP2 Light Loop Out Of Lock	FAULT 20
Fault 34 - AMP2 Current Loop Out Of Lock	FAULT 20
Fault 35 - AMP2 Diode current exceeds IDL3MAX	FAULT 19
Fault 36 - Amp2 Diode Temperature Out of Lock	FAULT 13
Fault 38 - Amp2 Open Circuit	FAULT 21
Fault 47 - PowerAmp Threshold Over Voltage	FAULT 10
Fault 48 - PowerAmp Threshold Under Voltage	FAULT 9
Fault 49 - PowerAmp Light Loop Out Of Lock	Fault 26
Fault 50 - PowerAmp Current Loop Out Of Lock	Fault 26
Fault 51 - PowerAmp Diode current exceeds IDL4MAX	FAULT 25
Fault 54 - PowerAmp Base Plate Temperature Out Of Range	FAULT 610
Fault 56 - PowerAmp Open Circuit	FAULT 27
Fault 58 - SHG Heater Drive Over Temperature	FAULT 304

Table 2.1-2. Equivalent Faults (Continued)

ORIGINAL NG FAULT	NX EQUIVALENT
Fault 60 - SHG Oven Temperature Out Of Lock	Fault 305
Fault 64 - Supply Seed Over Voltage	OBSERVED IN ERROR LOG
Fault 65 - Supply Seed Under Voltage	OBSERVED IN ERROR LOG
Fault 77 - Supply Head Over Voltage Fault	OBSERVED IN ERROR LOG
Fault 78 - Supply Head Under Voltage Fault	OBSERVED IN ERROR LOG
Fault 80 - Seed TEC HW Fault	FAULT 106
Fault 81 - AMP2 TEC HW Fault	FAULT 14
Fault 83 - SHG Oven HW Fault	FAULT 303
Fault 84 - Pump Interlock Fault	FAULT 6 and 7
Fault 87 - Pump Service required	FAULT 618
Fault 1003 - Tuning Stepper Home Fail	FAULT 306 + 307
Fault 1004 - GDD Stepper Home Fail	FAULT 615
Fault 1010 - external interlock	FAULT 407
Fault 1011 - PSU supply fault	FAULT 402,403,404,405
Fault 1012 - PSU emission LED fault	FAULT 406
Fault 1013 - Emission LED1 fault	FAULT 5
Fault 1017 - Low Power	FAULT 621
Fault 1019 - Service required	FAULT 619
Fault 1020 – Tunable shutter fault	FAULT 29
Fault 1021 – Fixed shutter faul	FAULT 30
Fault 1022 – Tuning stepper at rear limit	FAULT 306, 307
Fault 1023 - Tuning stepper timeout	FAULT 306, 307

Flowcharts for Classic and NG

The following flowcharts provide troubleshooting steps on the Classic Discovery for data collection and reduced variable output power.

Initial Data Collection

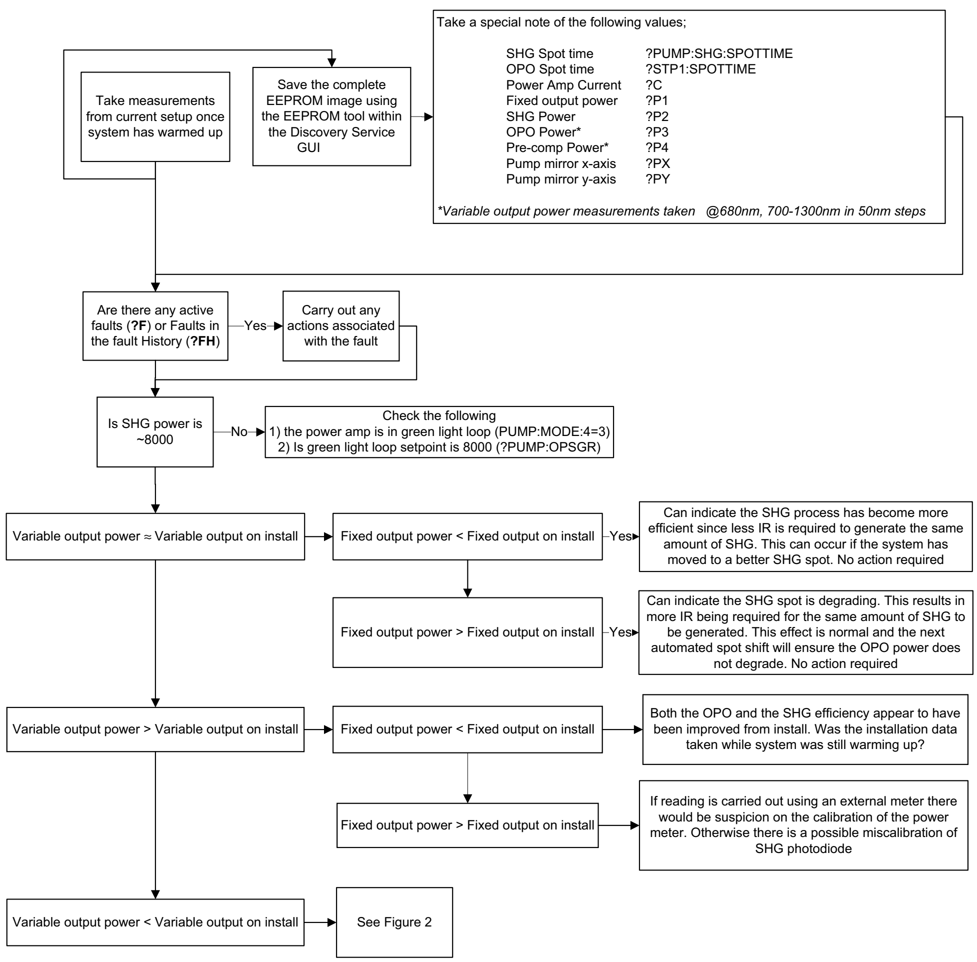


Figure 2.2-1. Initial Data Collection

Reduction in Variable Output Power

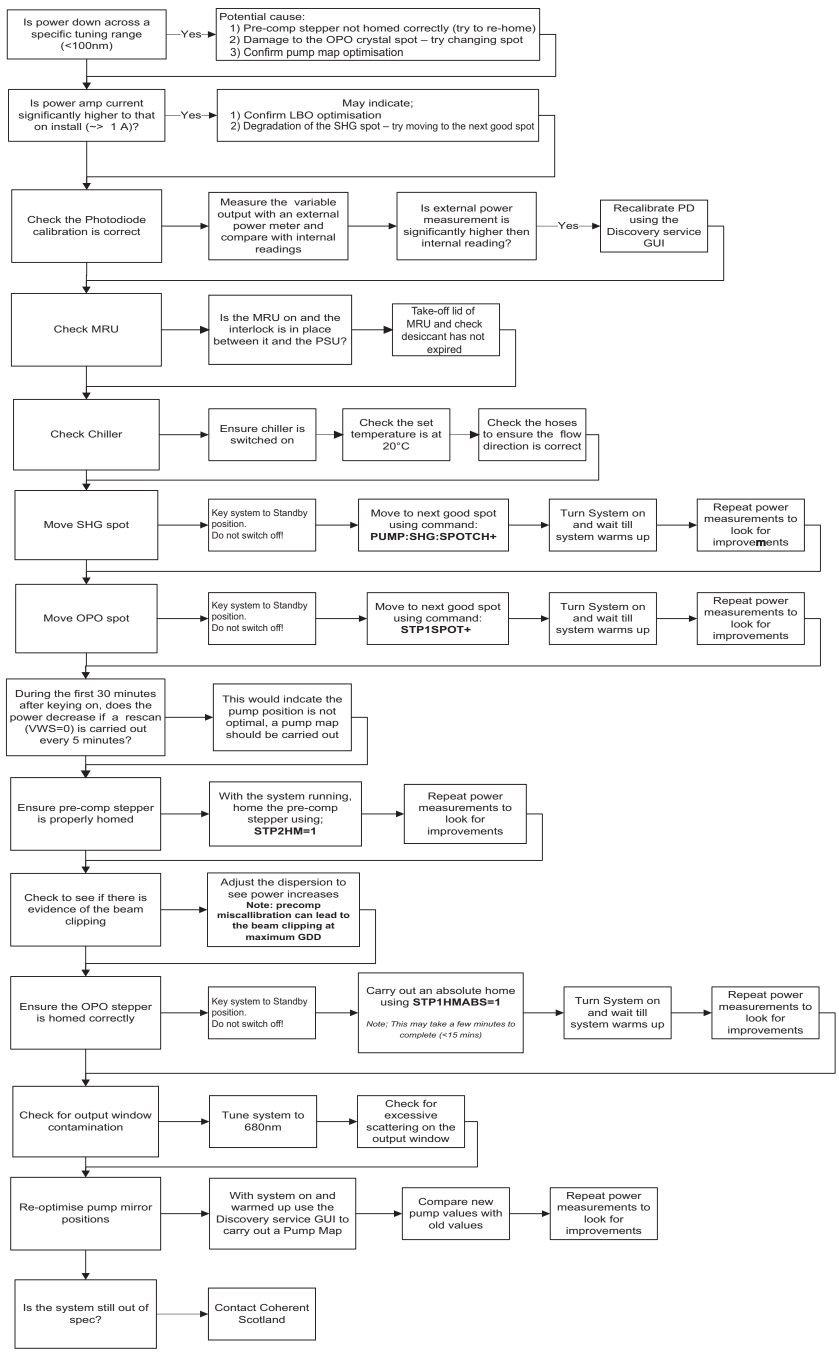


Figure 2.2-2. Reduction in Variable Output Power

Flowcharts for NX

The following flowcharts provide troubleshooting steps on the Discovery NX for data collection and reduced variable output power.

Initial Data Collection

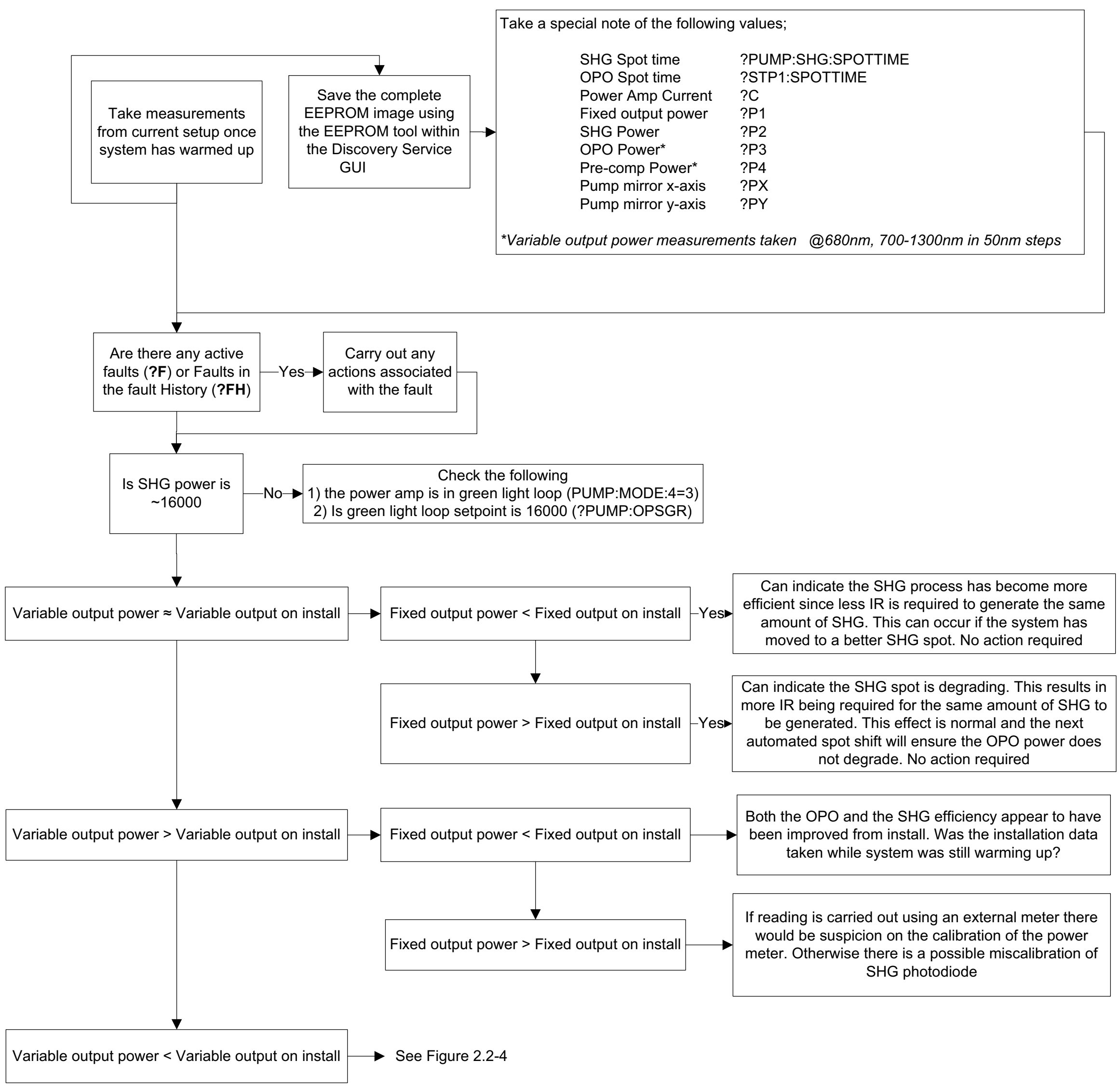


Figure 2.2-3. Initial Data Collection

Reduction in Variable Output Power

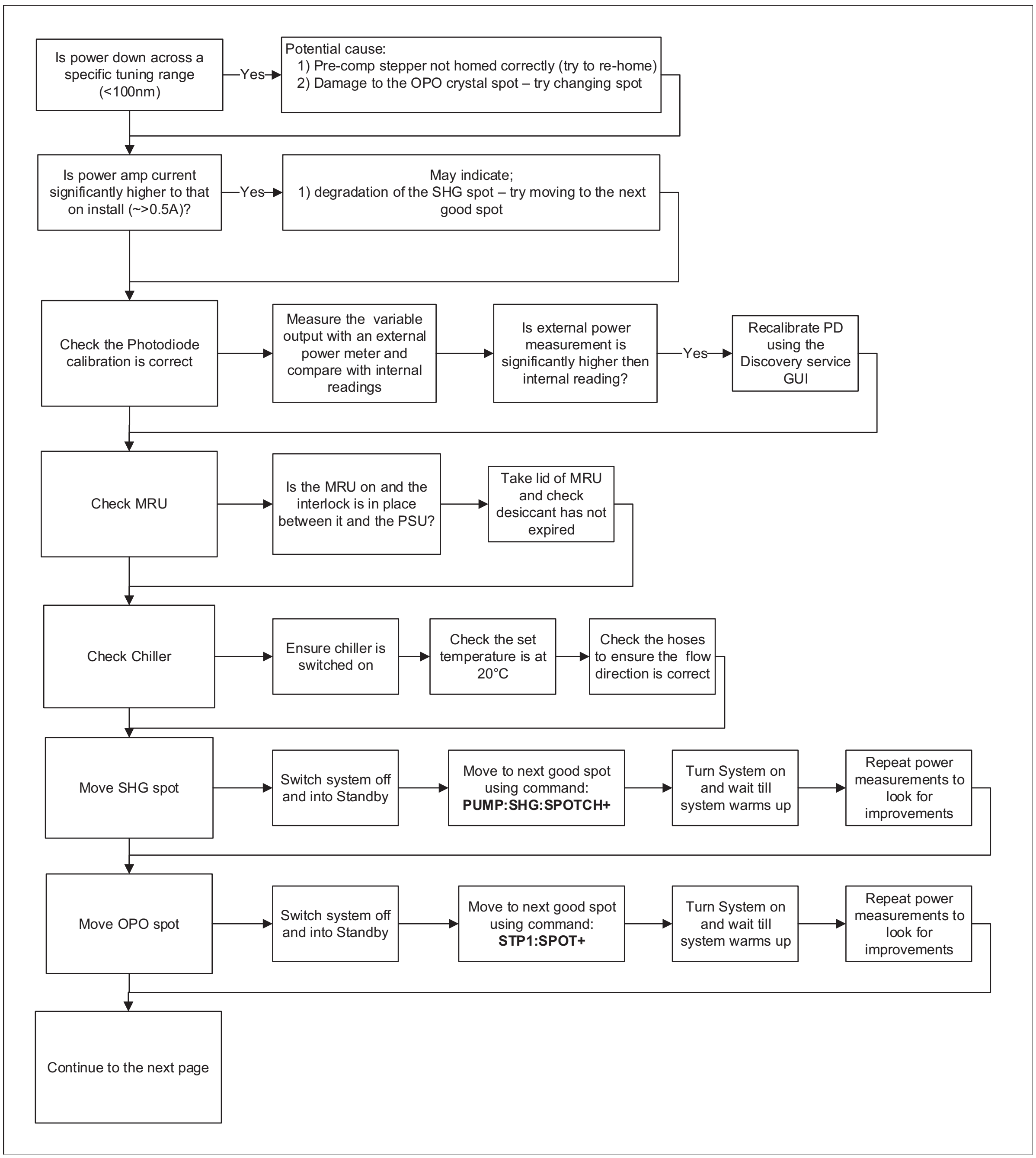


Figure 2.2-4. Reduction in Variable Output Power

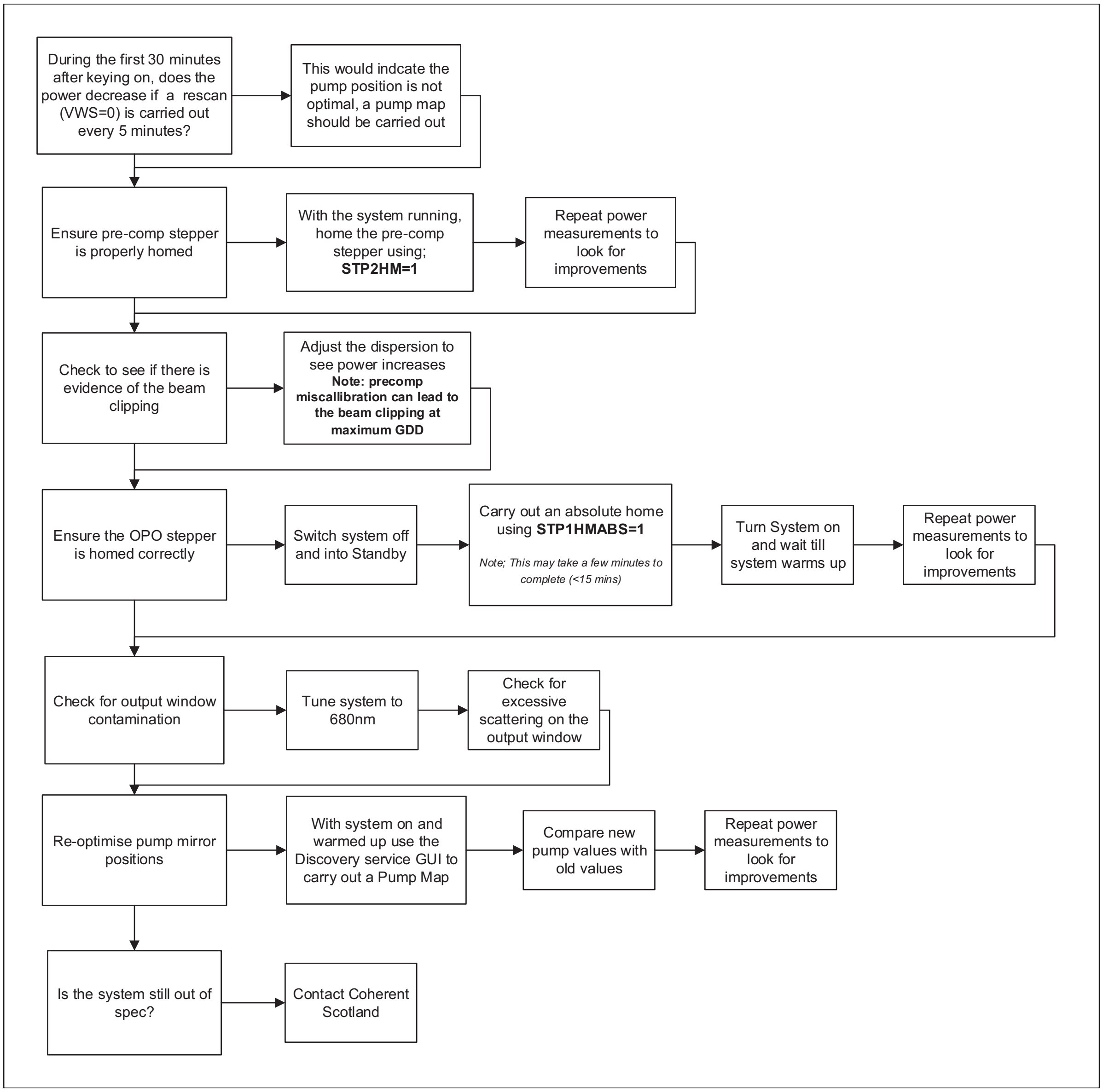


Figure 2.2-4. Reduction in Variable Output Power (Continued)

This Page Intentionally Left Blank

Introduction

In the Discovery TPC, the light from the fixed and variable beamlines is modulated via the AOM attenuators. The transmission of light is dependent upon the RF signal amplitude applied to the AOMs via the RF drivers. The RF drivers apply the electrical RF signal in accordance with settings supplied either through their serial connections and the calibration file (internal mode) or through a combination of serial and analogue voltage (External Mode). When using a combination of commands and analogue signal voltages, the maximum achievable output power available through the DC signal voltage modulation is capped by the level selected via serial command. If there is an issue with any part of this, there will be problems obtaining light from one of more of the beamlines.

Preliminary Check

Perform the following steps before diagnosis of the attenuator system using the Coherent Discovery GUI.

- Internal power meters P1 and P4 are reading non-zero power levels.
  All internal power meters are placed before the AOM attenuator.
- The AOMs are in internal mode.
- The shutter is open.
- **NG ONLY** - The required serial port parameters have been observed and implemented in the relevant input configuration (see Table 2.3-1).
- **NG ONLY** - Ensure connection established to both attenuators and the RF drivers are properly assigned (to fixed and variable in the GUI).Refer to Table 2.3-1with the required connection protocols for each serial port.
- **NX ONLY** - Put the modulators into “Laser Control” mode.

NOTICE

The fixed beamline RF driver is adjacent to the variable output window and vice-versa.

Table 2.3-1. TPC Connections

CONNECTION	SPECIFICATION	DESCRIPTION
Mod- Tunable	• USB type-B • Data bits:8 • Parity bits:0 • Baud: 57600 • Handshake: No	Serial connection to the Tunable AOM driver. **(NG or NX in Legacy Mode) or direct connection to RF driver**
Mod-Fixed		Serial connection to the Fixed (1040 nm) AOM driver. **(NG or NX in Legacy Mode) or direct connection to RF driver**
RF In Tunable	• SMA plug • Input impedance: 50 Ohm • Maximum input power: < 2.5 W • Frequency range: 73-147 MHz • VSWR: < 1.2:1	RF input sent directly to the Tunable AOM.
RF In Fixed		RF input sent directly to the Fixed (1040 nm) AOM.
Analog Tunable	• SMA plug • Input impedance: 10 kOhm • Maximum input: 10 Vdc	0-10 Vdc input to set/modulate Tunable laser power.
Analog Fixed		0-10 Vdc input to set/modulate Fixed laser power.

Unable to Connect

If a connection can not be established to the attenuator, ensure that the Coherent GUI with the associated USB-device-drivers are installed.

- Open the device manager and disconnect and reconnect the driver serial USB cable to the PC while the laser PSU is powered on.
- Ensure that the device is recognized.

Before progressing:

- Try changing to another, known good USB port on the control PC, or excluding any USB hubs, USB repeaters, extensions, serial adapters or anything other than a single 3 m USB cable between the AOM USB port and the computer.

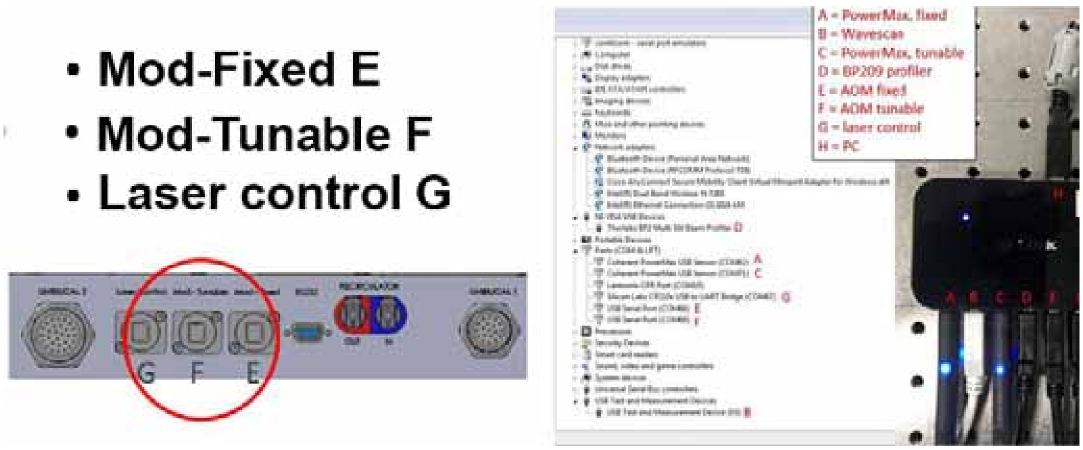


Figure 2.3-1. Device Manager with Driver Connection

- Try using a known good USB cable to confirm that the issue is not external.

If nothing is registered in the device manager and the above checks have been take into account, it suggests that the driver is not active. This could be a driver fault, or a wiring problem particularly if one driver can connect a RF driver and the other cannot. The communications connections should be checked first and then the power second.

1. Power off the laser PSU and remove the outer cover as shown in Figure 5.1-1.
2. Disconnect the “serial input USB” patch from the driver side indicated in Figure 2.3-2 and connect the PC USB directly to the driver in its place. Power on the PSU.
   If there is no device registered on the device manager, continue to the next step of 24 V troubleshooting.

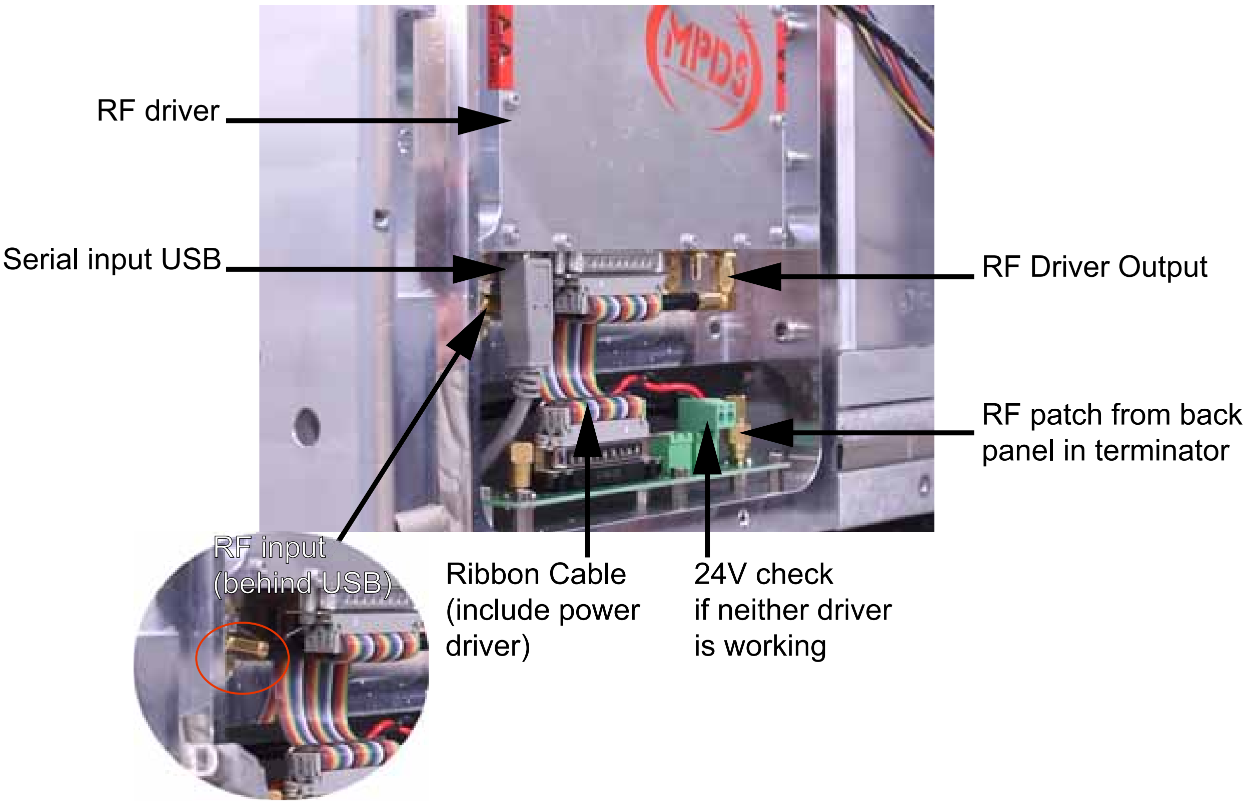


Figure 2.3-2. Driver Components

24 V Troubleshooting

1. Test the 24 V connector on the board of the non-working driver. If neither driver is working, trace 24V connection at driver boards back to the power distribution board.
2. If all 24V are present at the boards, suspect the driver board, ribbon cable or driver.
   a. Power OFF PSU.
   b. Swap ribbon cables, power on and try to connect to driver with computer. See if issue moves to other driver.
   c. Repeat with driver and then driver board to deduce faulty component.
   d. If fault remains on same side after changing all parts above, suspect 24V connection cable between boards. Replace 24V cable.
   e. Trace 24 V back to the PDB.

Unable to Connect

1 Exclude external influences

General

In addition to the preliminary checks performed for the NG TPC, all troubleshooting using the NX TPC should begin with the AOMs in “Laser Control” mode and connect using the SVC GUI:

AOMTCTRL=0

AOMFCTRL=0

(this sets the tunable and fixed AOMs to laser control limiting the external factors that can impact the function of the AOM(s))

Send the queries ?aomctrl[0] and ?aomctrl[1]

These queries return the settings from the tunable and fixed RF drivers respectively. If there is a response other than expected values from one or more of the RF drivers, this indicates that there could be a problem with the laser's ability to communicate with that driver. Otherwise it will return the RF parameters and other settings from the driver, from which issues might be apparent. Example of failed COMs timeout below. (USB/Legacy mode was not enabled).

2 Diagnose Issue Internally

Connection Issue: If one or more of the drivers are returning time-outs as above, its not communicating with the laser. Follow the below methodology. Additionally if Laser Control can be used, but Legacy Mode does not work, troubleshooting should follow the same path, but suspecting the other connection to the driver.

Each RF driver is connected separately to the controller board through 2 different communication channels, one for USB control/Legacy mode and the other (D Connector) for laser control. Both connections originate from the Controller Board.

If the laser is unable to communicate with the RF driver (via laser control), it may still be possible to communicate through Direct USB/Legacy Mode and vice versa. If either of the drivers are not responding as expected

```
CHAMELEON> ?aomctrl[0]
---------------------- Module Query: AOM control commands ---------

{QUERY}             {VALUE}

?USB                1
?TRANS              Error: AOM, AOM USB Control in use
?FREQ               Error: AOM, AOM USB Control in use
?RFP                Error: AOM, AOM USB Control in use
?ON                 Error: AOM, AOM USB Control in use
?PRODID             Error: AOM, Bus Timeout
?EXTMODE            Error: AOM, AOM USB Control in use
?VMODE              Error: AOM, AOM USB Control in use
?RFLUT              1

-------------------------------------------------------------------
CHAMELEON> aomtusbctrl=0 Error: AOM, Bus Timeout
CHAMELEON> aomfusbctrl=0
CHAMELEON> aomtusbctrl=0 Error: AOM, Bus Timeout
CHAMELEON>
```

Figure 2.3-3. Failed COMs Timeout

when in Laser Control, change that driver's control configuration to legacy mode (USB control).

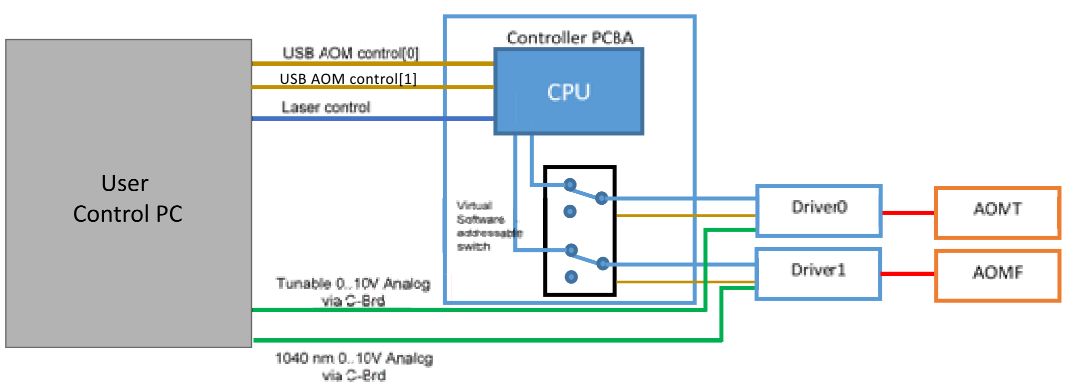


Figure 2.3-4. Legacy Mode Driver Control Configuration

AOM[T/F]CTRL=1

Connect serial cable to the back of the laser head in the port corresponding to that driver.

Connect the GUI to the driver by uploading the calibration file to the GUI and selecting the appropriate serial port from the dropdown in the connection panel, see Table 2.3-1.

Attempt to control the AOM using this USB control using the AOM tab in the service GUI. If connection was possible, open the lid and check the connections between the controller board and the troublesome RF driver. If the issue remains, open the lid and create a connection directly between the laptop and the RF driver itself. Connect using Tera Term, see “Tera Term Set-up” on page 6.1-1 for more details.

If connection is not possible using Tera Term and direct connection to the RF driver USB port, the issue is either the RF driver itself, or its not getting any power through the D Connector from the Controller Board.

If one driver is working and the other is not, change the RF drivers around and see if the fault follows the RF driver. If the issue remains only on the same side, replace the cabling. If it follows the driver, change the driver. If neither driver is working, suspect the Controller Board and contact the factory.

If a connection is possible when connecting directly, it suggests an issue with the cabling or the controller board. Try exchanging cables between drivers if the issue was only on one side. If the issue remains on the same side, change the controller board. If it moves, replace the D connector cables (Or USB if the issue is only in Legacy Mode).

No Light Output Despite Connection

This troubleshooting path assumes the attenuator communication has been established but there is no light available from the attenuator. Connect the **Coherent GUI and use the factory-supplied calibration file.**

Prior to starting the troubleshooting below, refer to the preliminary checks described in “Preliminary Check” on page 2.3-1.

1. Test in internal mode, transmission 100%.
2. No light out of the attenuators - The issue is with the driver or cabling (between the driver and AOM).
3. Light out observed - The issue is from the customer control, external voltage source or the cables carrying the external signal to the driver from the source up to the driver.

No Light Out Troubleshooting

If there is no light from the attenuators using the Coherent GUI, this indicates that there is a problem internal to the attenuator setup. Possible failures include connection issues, board failures or driver failures or the calibration files is not setup properly.

1. **NX Only** - The modulator should be in laser control for NX as per “Preliminary Check” on page 2.3-1. Check EEPROM using the EEPROM tool in the SVC GUI and ensure tables are populated with reasonable values.
2. Power OFF the system and remove the cover (see Figure 5.1-1).
3. On appropriate driver (tunable or fixed), check that the input bulkhead on the laser head and RF driver output SMA cable are connected securely to RF input. If correction made, power on and re-test (see Figure 2.3-2). If not, continue.
4. Replace the driver (see Figure 2.3-2) or swap the driver from the other beamline.
5. If light output still cannot be achieved using the Coherent GUI and internal mode, contact the factory for support.

Light Observed in Internal Mode with GUI but NOT in Customer Control Troubleshooting

Some troubleshooting of the customer set-up is required to differentiate between Coherent module failures, customer supplied equipment failure or connectivity issues. This section assumes that the laser works in internal mode using the Coherent GUI and Coherent calibration file.

Use customer control software in internal mode. **Is there light out of the laser AOMs? Proceed to the troubleshooting below based on the results.**

1. No but there was light out with Coherent GUI + calibration file.

   Customer control is not interacting properly with the AOM RF driver.

   Recommendation to the customer:

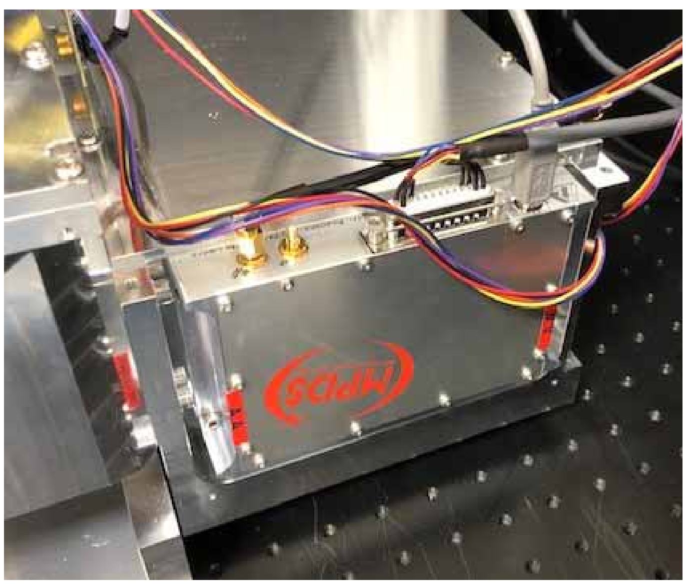
   - Revert to Coherent GUI until they can troubleshoot software.

- If the customer uses external mode, check that external mode works using the Coherent GUI by applying a test voltage to the corresponding analogue-in SMA connector at the back of the head while in external mode. Observe whether there is light out when the test voltage is applied. If not, follow the troubleshooting for external mode listed in step 2 below but only use the Coherent GUI.
  In summary, if the frequency calibration is incorrect, there will be no output. If the RF power is set incorrectly, there will be the wrong optical power or no optical power for the setting.
- **NG ONLY** - Check connection protocol against table (Table 2.3-1) and calibration file values in customer software (RF power and frequency for given transmission powers at given wavelengths). See "AOM Calibration Introduction" on page 5.9-1 for more details.

2. There is light out in internal mode with customer control software but not in external mode.
   a. Test external mode function in the Coherent GUI using external mode toggle (reference the Discovery GUI User's Guide for details on the toggle) and an external voltage source.
   b. The issue is with external modulation configuration. Test the set-up in external mode with the customer's dc supply which can be a 10 V supply or connections. (This troubleshooting path assumes the customer is using and having issues with the external mode).
      i. Test dc voltage source on oscilloscope (couple to dc) using the customer SMA cable if possible
      ii. Confirm impedance matching between customer voltage supply and laser
      iii. **NG ONLY** - If OK, connect dc input directly to RF driver board as circled below in Figure 2.3-5, bypassing the back panel and patch.Continue to step b.

      NX ONLY - Test customer external voltage with other modulator. If OK, check internal cabling from back panel (SMAs to Controller Board by swapping them around).

NG Laser Head



NX Laser Head

Figure 2.3-5. "dc in" patch from Discovery back panel

c. **NG ONLY** - No light out but there is 10 V on the cable at the correct impedance in external mode

i. Switch off PSU

ii. Replace ribbon cable

iii. Power on PSU

iv. If there is 10 V present but still no light out, replace the driver

v. If there is no 10 V present, change driver board

NX Only - If neither test voltage nor customer signal voltage affects power but modulator works in internal mode, try swapping D-connector cables and RF drivers between sides. See if the fault follows the driver or cable. If it remains, change the Controller Board.

If still no light in external after driver replacement, contact Coherent Scotland for support.

Pointing Changes with Wavelength Setting

This indicates that the AOM calibration file needs to be updated (Frequency/y-axis) if the calibration file cannot be completed because the beam moves too much.

Output Power Does Not Correspond to Transmission Settings

The power display and attenuator settings are indicative only and expectations of precision should be reasonable. If the precision is not reasonable, this indicates that the corresponding RF Power calibration section might need updating.

Note that the photodiode is placed before the AOM.

Try replacing or swapping the fixed and tunable drivers and see if the issue follows the drive or the input configuration. If the issue follows the driver, replace the driver.

In external mode only, this indicates an issue with the customer-supplied external voltage, or their expectation. Optical power output is not linear with DC voltage input. Furthermore, there is interplay between the attenuation setting and the dc voltage applied, where the RF power setting determines the maximum optical power achievable with 10 Vdc into the analogue input.

If external control is not behaving as expected, isolate system by removing as much 3rd party equipment if possible and check signal voltage on scope. Look for additional and unusual customer-supplied apparatus, such as an analogue DC amplifier for the 0-10 V signal, check signal levels correspond to what customer thinks they are and check impedance.

Output Power is Noisy

- Check if noisy in internal mode.
- If there is no noise in internal mode, suspect customer voltage supply or amplifier, RF cable, external pickup.
- If there is noise in internal mode, check internal photodiode to confirm stable laser power.
- Confirm noise on Coherent thermopile power meter? If so, continue to troubleshoot the laser system.
- If photodiode indicate stable performance but the thermopile power meter reading indicates noisy output, troubleshoot ribbon cables and RF driver. Contact factory for more instructions.

Discovery Block Diagram

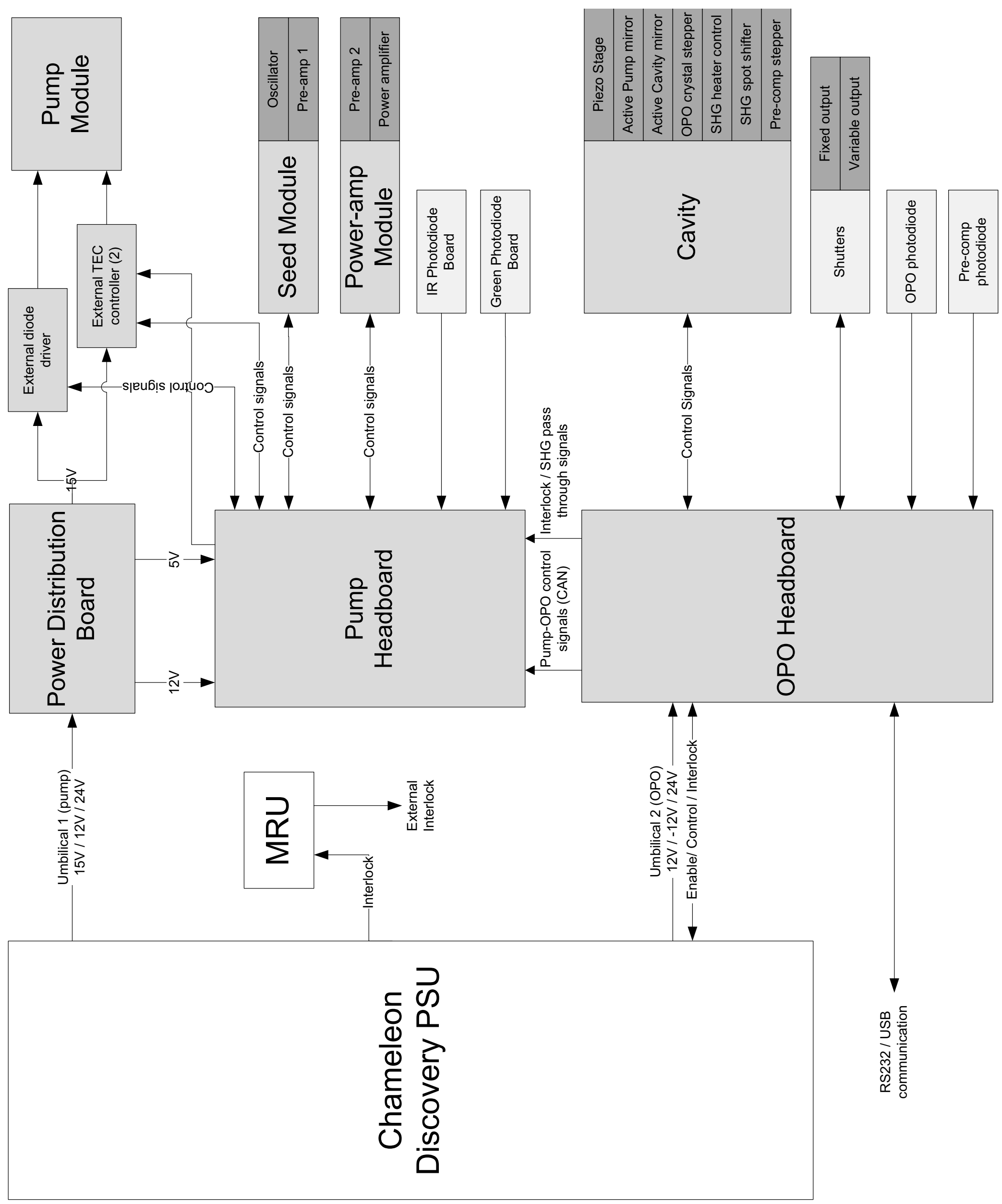


Figure 3.1-1. Classic Discovery Block Diagram

Discovery AOM Block Diagram

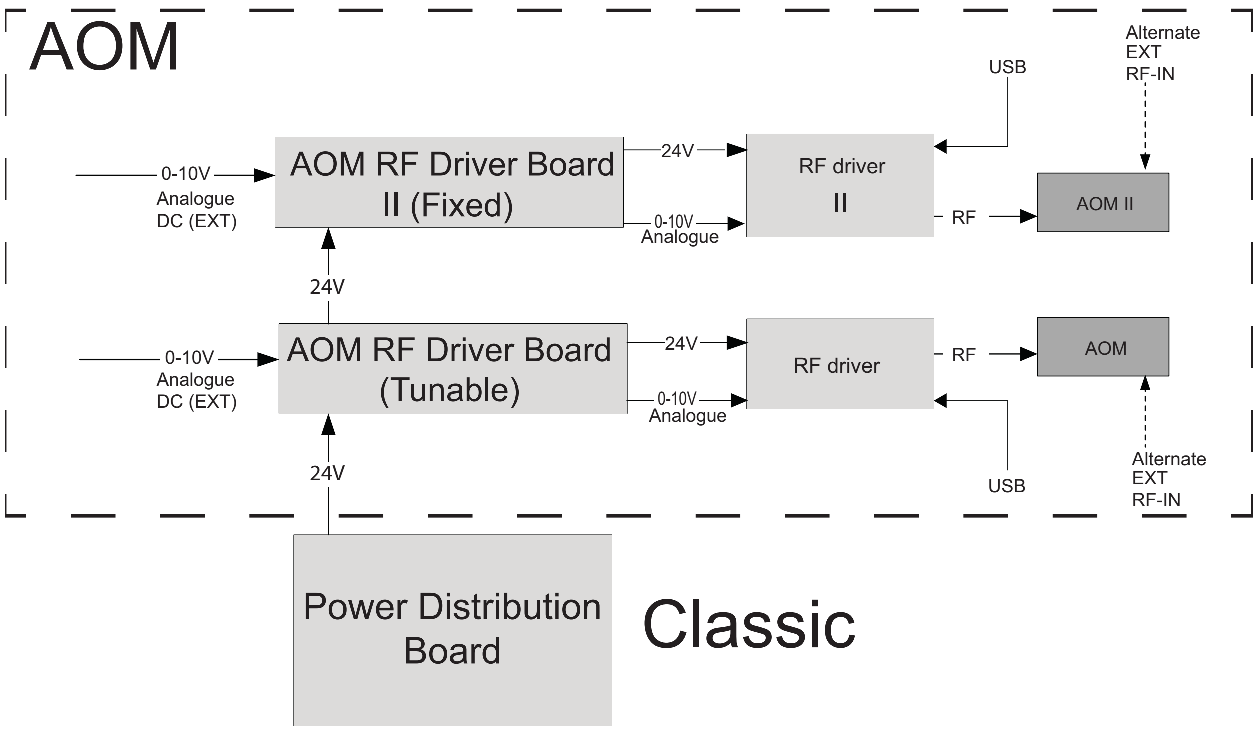


Figure 3.1-2. AOM Block Diagram

Test Points for Classic and NG

The information in Table 3.2-1 and Table 3.2-2 provides additional test points for the OPO and Pump headboards. Figure 3.2-1 and Figure 3.2-2 gives the location of the additional test points for OPO and Pump headboards.

OPO Headboard Test Points

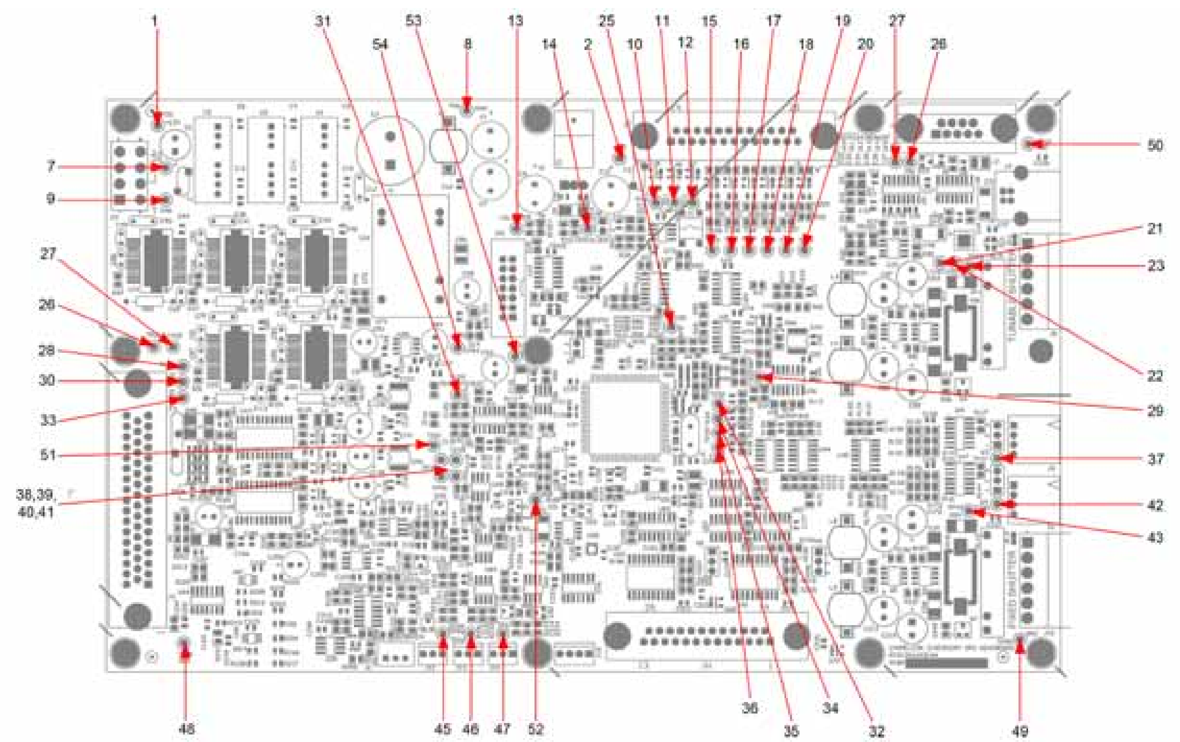


Figure 3.2-1. OPO Headboard - Test Points

Pump Headboard Test Points

Table 3.2-1. OPO Headboard Test Point Description

TEST POINT	DESCRIPTION	TEST POINT	DESCRIPTION	TEST POINT	DESCRIPTION
TP1	+12 V	TP21	USB RS232 TX	TP37	Not used (Emission LED 2)
TP2	+5 V test point (regulator)	TP22	USB RS232 RX	TP38	CX DAC output
TP5	EXT RS232 TX	TP23	Shutter 1 Coil	TP39	CY DAC output
TP6	EXT RS232 RX	TP24	+3.3 V test point (regu- lator)	TP40	PY DAC output
TP7	-12 V	TP25	UVP Voltage	TP41	Piezo stage DAC output
TP8	GND	TP26	PY high voltage output	TP42	Emission LED Fault
TP9	+24 V	TP27	PX high voltage output	TP43	Shutter 2 Coil
TP10	PSU Shutter 2 LED	TP28	Piezo stage high voltage output	TP45	Pre-comp Photodiode Raw voltage
TP11	PUS Shutter 1 LED	TP29	OVP Voltage monitor	TP46	Not Used
TP12	PSU Fault LED	TP30	CX high voltage output	TP47	OPO Photo- diode Raw voltage
TP13	Watchdog Reset	TP31	PX DAC output		
TP14	Interlock	TP32	Strain Gauge output	TP48	GND
TP15	External Inter- lock	TP33	CY high voltage output	TP49	GND
TP16	PSU Emission LED Fault	TP34	Not Used	TP50	GND

Table 3.2-1. OPO Headboard Test Point Description (Continued)

Test Point	Description	Test Point	Description	Test Point	Description
TP17	PSU Supply Fault	TP35	Pre-comp photodiode input into processor	TP51	Pre-comp rear limit
TP18	Shutter 2 Push Button			TP52	BBO home complete
TP19	Shutter 1 Push Button	TP36	OPO PD input into processor	TP53	TX1
TP20	Key on/ Key off			TP54	RX1

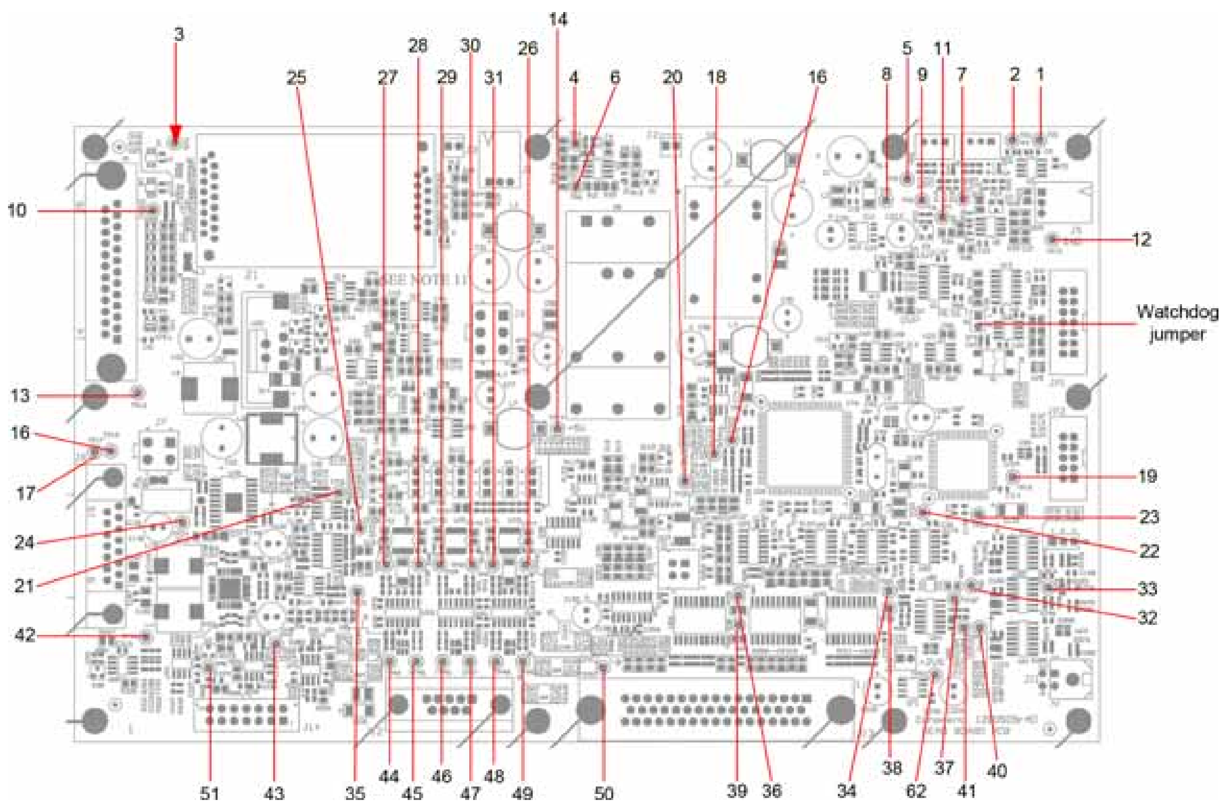


Figure 3.2-2. Pump Headboard - Test Points

Table 3.2-2. Pump Headboard Test Point Description

TEST POINT	DESCRIPTION	NOTES
TP1	Power-amp PD signal to CPU	Power-amp photodiode voltage going into processor (0-2.5)
TP2	Power-amp Under voltage	The lower voltage at which the CPLD will switch off if the PD4 signal (TP11) goes below. This value can be changed by varying VR1
TP3	AGND	Analogue ground
TP4	PD5 Voltage	520nm photodiode voltage to processor (0-2.5V)
TP5	Power-amp over voltage	The upper voltage at which the CPLD will switch off if the PD4 signal (TP11) goes above. This value can be changed by varying VR2
TP6	Green PD raw voltage	520nm photodiode raw voltage (0-3.3V)
TP7	Power-amp PD raw voltage	Not relevant
TP8	+4V ref	+4V
TP9	AGND	Analogue Ground
TP10	HV out B	
TP11	Power-amp PD raw voltage	(0-5 V)
TP12	AGND	Analogue ground
TP13	LBO Drive	(0-24v) vary depending on drive
TP14	+5V (regulator)	+5V
TP15	+3.3V	+3.3V
TP16	Pin 7 pre-amp diode 2 D-type	Spare
TP17	Pin 7 pre-amp diode 2 D-type	Spare
TP18	+3.3V	+3.3V
TP19	Service test pin (I/O=4)	Only required for hardware/software testing
TP20	+3.3V (regulator)	+3.3V
TP21	Diode 3 Measurement	Pre-amp 2 - Vout=1.82V/Amp (2.5 max)

Table 3.2-2. Pump Headboard Test Point Description (Continued)

TEST POINT	DESCRIPTION	NOTES
TP22	Service test pin (I/O=44)	Only required for hardware/software testing
TP23	Service test pin (I/O=27)	Only required for hardware/software testing
TP24	Diode 3 Setpoint	Pre-amp 2 drive from PSU (0-3.3V)
TP25	AGND	Analogue Ground
TP26	TEC 3 Set point	Pre-amp 1 TEC set point
TP27	TEC 6 Setpoint	Power-amp pump diode 2 TEC set point going to wave-length electronics TEC controller 2
TP28	Diode 4 Setpont	Voltage going to wavelength electronics for power-amp diode driver
TP29	Diode 3 Setpoint	Pre-amp 2 drive from PSU (0-3.3V)
TP30	Not used	Spare DAC
TP31	TEC 2 Setpoint	Not used
TP32	Multiplex A0	Selecting one of four inputs
TP33	Thermistor 4 in	Pre-amp 2 thermistor value
TP34	Multiplex A1	Selecting one of four inputs
TP35	TEC 4 setpoint	Pre-amp 2 input
TP36	Spare	Spare
TP37	Therm base meas in	External thermistor not used
TP38	Resistor value for version control	
TP39	Spare	Not used
TP40	Thermistor 5 input	Wavelength electronics Tec Driver input for power-amp diode 1
TP41	Thermistor 6 input	Wavelength electronics Tec Driver input for power-amp diode 2
TP42	PD3 signal to processor	Pre-amp 2 photodiode

Table 3.2-2. Pump Headboard Test Point Description (Continued)

TEST POINT	DESCRIPTION	NOTES
TP43	Diode 4 enable	Power-amp enable (3.3V logic) (high = enable)
TP44	TEC 5 Set point	Power-amp pump diode 1 TEC set point going to wavelength electronics TEC controller 1
TP45	LBO Set point	Voltage output to define LBO setpoint
TP46	Diode 2 Setpoint	Pre-amp 1 set point
TP47	TEC 4 Setpoint	Pre-amp 2 TEC set point
TP48	Diode 1 Setpoint	Oscillator pump set point
TP49	TEC 1 Setpoint	Oscillator pump diode TEC set point
TP50	AGND	Analogue ground
TP51	Power-amp measurement in	Voltage coming back from the PowerAmp - A direct indication of the power-amp current
TP52	+2.5V (regulator)	+2.5V

Test Points for NX

The information in Table 3.2-3 and Table 3.2-4 provides additional test points for the NX headboards. Figure 3.2-3 and Figure 3.2-4 gives the location of the additional test points for Controller and Bulk headboards.

Controller Board (1403693rAB)

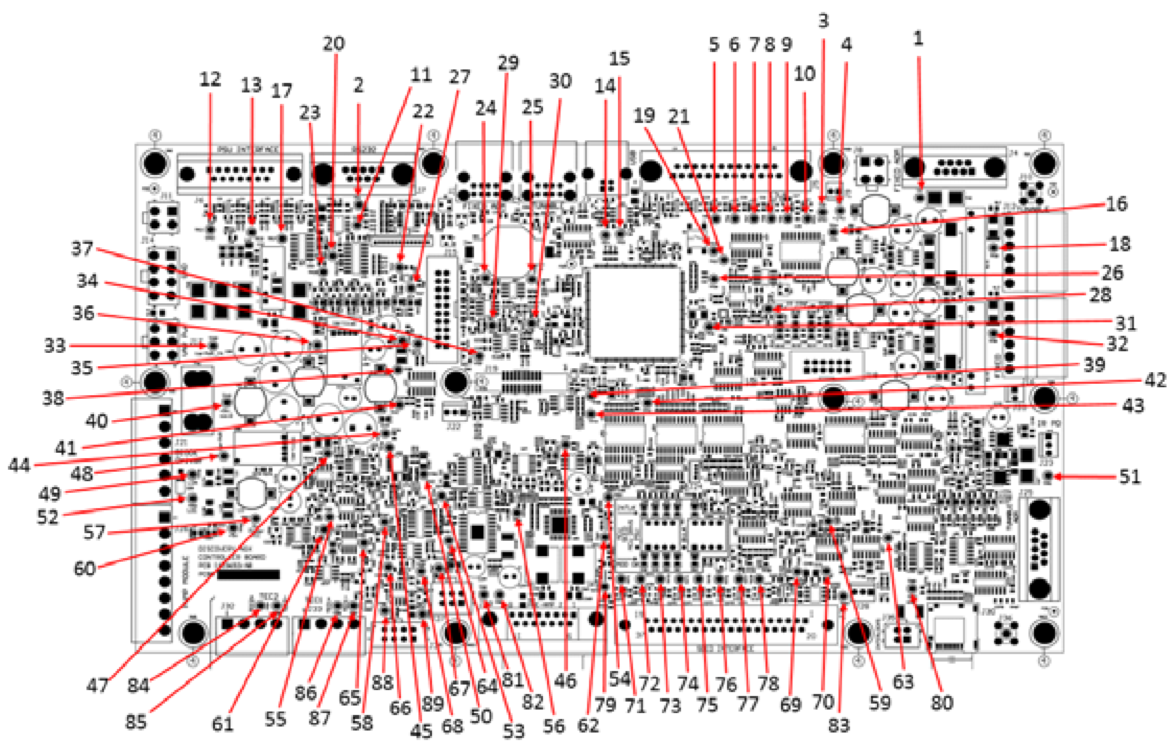


Figure 3.2-3. Controller Board - Test Points

Table 3.2-3. Controller Board Test Point Description

Test Point	Description	Test Point	Description	Test Point	Description
TP1	+24V Fixed AOM (after fuse FH1)	TP31	Interrupt from Bulk (after DIP switch)	TP62	Wavelength Electronics TEC 1 Enable
TP2	I2C PSU SCK	TP32	Fixed shutter coil	TP63	Emission LED Fault
TP3	GND	TP33	Variable Power IN (J17)	TP64	Pre-amp 2 Diode Drive
TP4	+24V	TP34	+3.3V (to VDDA ADC)	TP65	Wavelength Electronics Diode Driver Setpoint OUT (**3A/V**)
TP5	Decoder – Bit 5 (Bulk I/O inter-face)	TP35	+2.5 Vref	TP66	Wavelength Electronics TEC 2 Temperature Measurement
TP6	Decoder – Bit 4 (Bulk I/O inter-face)	TP36	+12V	TP67	Wavelength Electronics TEC 1 Temperature Measurement
TP7	Decoder – Bit 3 (Bulk I/O inter-face)	TP37	Pre-amp 2 Temperature	TP68	Wavelength Electronics Current Limit Monitor (6A/V)
TP8	SPI Bulk MOSI	TP38	+3.3V (power to pre-amp 2 diode driver)	TP69	Interlock from Seed Module
TP9	SPI Bulk MISO	TP39	Pre-amp 2 TEC drive	TP70	I2C Seed SCK

Table 3.2-3. Controller Board Test Point Description (Continued)

Test Point	Description	Test Point	Description	Test Point	Description
TP10	SPI Bulk SCK	TP40	+5V for Wavelength Electronics Drivers	TP71	SPI Seed SCK
TP11	I2C PSU SDA	TP41	Wavelength Electronics TEC Temperature Fault (both)	TP72	SPI Seed MISO
TP12	GND	TP42	Compliance Voltage Fault	TP73	SPI Seed MOSI
TP13	Interlock from PSU	TP43	Pre-amp 2 TEC Drive	TP74	Decoder Bit 0 (Seed I/O interface)
TP14	I2C Bulk SDA	TP45	Pre-amp 2 PD signal	TP75	Decoder Bit 1 (Seed I/O interface)
TP15	I2C Bulk SCK	TP46	Wavelength Electronics TEC 1 Setpoint OUT	TP76	Decoder Bit 2 (Seed I/O interface)
TP16	+12V (after fuse FH3)	TP47	Variable Power Measurement into processor	TP77	Reset (Seed I/O interface)
TP17	Fixed Shutter Push Button Interrupt	TP48	Variable Power IN (after fuse FH6)	TP78	Global Interlock latched (Seed I/O interface)
TP18	Tunable shutter coil	TP49	LDA (to pump module)	TP79	Wavelength Electronics TEC 2 Enable
TP19	Interrupt from Bulk (at I/O interface)	TP50	GND	TP80	GND

Table 3.2-3. Controller Board Test Point Description (Continued)

Test Point	Description	Test Point	Description	Test Point	Description
TP20	Keyswitch	TP51	+24V Tunable AOM (after fuse FH1)	TP81	Unused Pin 8 on pre-amp 2 connector (J29)
TP21	Interlock from PSU	TP52	LDC (to pump module)	TP82	Unused Pin 7 on pre-amp 2 connector (J29)
TP22	Supply OVP Fault	TP53	Pre-amp 2 TEC Temperature Fault	TP83	I2C Seed SDA
TP23	Tunable Shutter Push Button Interrupt	TP54	Wavelength Electronics TEC 2 Set point OUT	TP84	Not Populated
TP24	IR PD OVP Threshold	TP55	Green PD Signal	TP85	Not Populated
TP25	ID PD UVP Threshold	TP56	Pre-amp 2 Current Measurement	TP86	Not Populated
TP26	Interlock from MCU drivers (pre-amp 2 and power amplifier)	TP57	+5V for Pre-amp 2 TEC Drivers	TP87	Not Populated
TP27	Supply UVP Fault	TP58	Wavelength Electronics Diode Driver Setpoint from processor (6A/V)	TP88	IMON (from Wavelength Electronics Diode driver 6A/V)
TP28	+3.3V	TP59	Global Interlock (Latched)	TP89	Wavelength Electronics Diode driver ENABLE

Table 3.2-3. Controller Board Test Point Description (Continued)

TEST POINT	DESCRIPTION	TEST POINT	DESCRIPTION	TEST POINT	DESCRIPTION
TP29	IR PD into processor and into protection circuit	TP60	+5V for Logic Devices		
TP30	IR PD in (raw voltage)	TP61	Base plate temperature		

Bulk Headboard (1400166rAA)

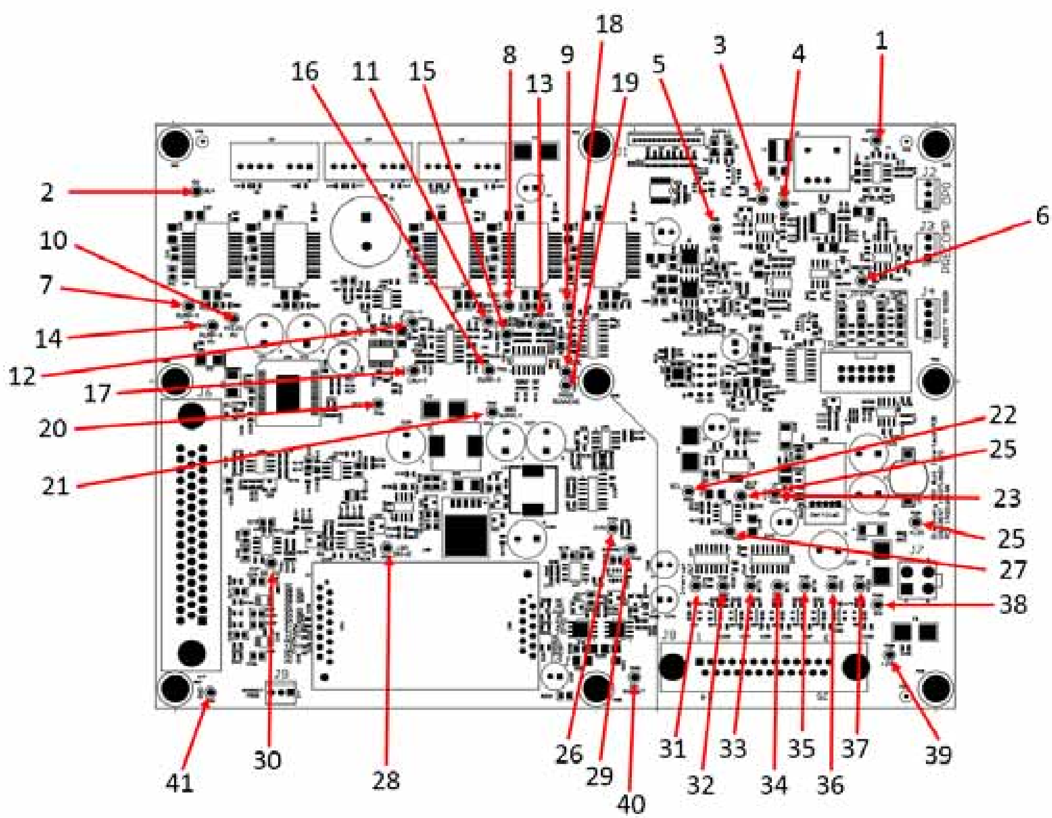


Figure 3.2-4. Bulk Headboard - Test Points

Table 3.2-4. Bulk Headboard Test Point Description

Test Point	Description	Test Point	Description	Test Point	Description
TP1	OPO PD	TP15	BBO TX	TP29	5V Smaract
TP2	HV+	TP16	PUMP X	TP30	SG IN
TP3	-12V	TP17	CAV Y	TP31	Interrupt Out
TP4	SG OUT	TP18	HOME	TP32	Reset
TP5	GND	TP19	PROG RUNNING	TP33	Bit 2
TP6	Precomp PD	TP20	PIEZO	TP34	Bit 1
TP7	PY HV	TP21	BBO SUPPLY	TP35	Bit 0
TP8	CX HV	TP22	SCL	TP36	MOSI
TP9	CY HV	TP23	+5V	TP37	MISO
TP10	PIEZO HV	TP24	3V3	TP38	SCK
TP11	PUMP Y	TP25	+12V	TP39	+24V
TP12	CAV X	TP26	2V5	TP40	+24V Smaract
TP13	BBO RX	TP27	SDA	TP41	GND
TP14	PX HV	TP28	LBO Drive		

Introduction

Table 3.3-1, Table 3.3-2 and Table 3.3-3 give the pin descriptions of connectors at the Pump Headboard, OPO Headboard and the Power Distribution board. See “Test Points for Classic and NG” on page 3.2-1 information on the test points and “Discovery Block Diagram” on page 3.1-1 for the system diagram.

Figure 3.3-1 provides the connector details for the MRU Interlock connector.

Pump Headboard Pin Description

Table 3.3-1. Pump Headboard Pin Description

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J8 15-way D-type	Pump headboard to Power amp module	1=Pre-amp 2 TEC + 2=Pre-amp 2 TEC + 3=Pre-amp 2 - 4=Pre-amp 2 - 5=Pre-amp 2 PD Input 6=AGND 7=Not used 8=Not used 9=pre-amp 2 diode drive + 10=pre-amp 2 diode drive + 11=pre-amp 2 diode drive - 12=pre-amp 2 diode drive - 13=pre-amp 2 thermistor IN 14=AGND 15=Not used

Table 3.3-1. Pump Headboard Pin Description (Continued)

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J14 14-way Microfit	Pump headboard to Pump board	1=Power amp pump diode 1 TEC Enable out (Blue) 2=Power amp pump diode 1 Thermistor (Red) 3=Power amp pump diode 2 TEC Enable out (Pink) 4=Power amp pump diode 2 Thermistor (Grey) 5=Power amp diode Enable (Blue) 6=Power amp diode Setpoint (Green) 7=Power amp diode feedback (Blue) 8=Power amp pump diode 1 TEC Setpoint (Green) 9=AGND (Orange) 10=Power amp pump diode 2 TEC Setpoint (White) 11=AGND (Yellow) 12=Not used 13=Power amp diode over current protection (Orange) 14=AGND (Red)
TEC 1 6 way Molex	Pump headboard to Power amp pump diode 1 TEC	1=TEC Enable (Blue) 2=AGND (Orange) 3=Themister (Red) 4=Not used 5=Not used 6=Setpoint (Green)
TEC 2 6 way Molex	Pump headboard to Power amp pump diode 2 TEC	1=TEC Enable (Pink) 2=AGND (Yellow) 3=Themister (Grey) 4=Not used 5=Not used 6=Setpoint (White)
Driver 4 way Molex	Pump headboard to Power amp diode driver	1=Not used 2=Not used 3=Not used 4=Diode current meas output (Blue)

Table 3.3-1. Pump Headboard Pin Description (Continued)

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
Driver 6 way Molex	Pump headboard to Power amp diode driver	1=AGND (Red) 2=Not used 3=Power amp diode over current protection (orange) 4=Power amp diode Enable (Blue) 5=Power amp diode Setpoint 6=Not used
J1 3-way latched header	Pump headboard to SHG PD	1=+5V (Blue) 2=AGND (Green) 3=PD signal (Red)
J5 3-way latched header	Pump headboard to IR PD	1=+5V (Blue) 2=AGND (Green) 3=PD signal (Red)

Table 3.3-1. Pump Headboard Pin Description (Continued)

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J4 25-way D-type	Pump headboard to OPO headboard (J11)	1=CANL 2=RS232 Rx 3=AGND 4=Interlock IN - 5=Key switch IN+ 6=AGND 7=LBO stage signal 8=AGND 9=+5V 10=LBO stage signal 11=PGND 12=HV Out A 13=HV Out B 14=CANH 15=RS232 Tx 16=Interlock IN+ 17=AGND 18=Keyswitch IN- 19=LBO stage signal 20=LBO stage signal 21=LBO stage signal 22=LBO stage signal 23=PGND 24=LBO Thermister 25=LBO Drive
J9 3-way Microfit	Pump board (J9) to micro-switches	1=Micro-switch 2 NO 2=Micro-switch 1 NO 3=Micro-switch 2 COM 4=Micro-switch 1 COM

OPO Headboard Pin Description

Table 3.3-2. OPO Headboard Pin Description

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J1 9-way D-type	OPO headboard to Back panel	1=Not used 2=RS232 Tx (Blue) 3=RS232 Rx (Red) 4=Not used 5=AGND (Green) 6=Not used 7=Not used 8=Not used 9=Not used
J14 3-way lock header	OPO headboard (J14) to OPO PD	1=PD signal (Blue) 2=GND (Green) 3=+12V (Red)
J12 3-way lock header	OPO headboard (J12) to pre-comp PD	1=PD signal (Blue) 2=GND (Green) 3=+12V (Red)
J3 8-way Minifit	OPO headboard to bulk-head umbilical connector 2	1=Not used 2=GND (Black) 3=+12V (Blue) 4=GND (Black) 5=+24V (Green) 6=Not used 7=-12V (Brown) 8=Not used

Table 3.3-2. OPO Headboard Pin Description (Continued)

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J2 25-way D-type	OPO headboard to bulk-head umbilical connector 2	D-Type 25-way (OPO J2) 1=GND 2=GND 3=Shutter2 LED- (Black) 4=Shutter1 LED- (Black) 5=PSU Emission LED- (Black) 6=GND 7=Ext Interlock+(Green) 8=PSU Emission LED Fault+ (Yellow) 9=PSU Supply Fault- (Black) 10=Shutter2 Push Button- (Black) 11=GND 12=Shutter1 Push Button+ (Red) 13=Key ON/OFF+ (Brown) 14=Not used 15=Shutter LED+ (White) 16=GND 17=Shutter1 LED+ (Orange) 18=PSU Emission LED+ (Violet) 19=Ext Interlock- (Black) 20=PSU Emission LED Fault-(Black) 21=GND 22=PSU Supply Fault+ (Grey) 23=Shutter2 Push Button+ (Blue) 24=Shutter1 Push Button- (Black) 25=Key ON/OFF+ (Black)

Table 3.3-2. OPO Headboard Pin Description (Continued)

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
Amphenol 28-pin bulk-head connector	OPO headboard to bulk-head umbilical connector 2	A=+12V (Blue) B=GND (Black) C=+24V (Green) D=GND (Black) E=-12V (Brown) F=Not used G=Key ON/OFF+ (Brown) H=Key ON/OFF+ (Black) J=Shutter1 Push Button+ (Red) K=Shutter1 Push Button- (Black) L=Shutter2 Push Button+ (Blue) M=Shutter2 Push Button- (Black) N=PSU Supply Fault+ (Grey) P=Shutter2 Push Button- (Black) R=PSU Emission LED Fault+ (Yellow) S=PSU Emission LED Fault-(Black) T=Ext Interlock+(Green) U=Ext Interlock- (Black) V=PSU Emission LED+ (Violet) W=PSU Emission LED- (Black) X=Shutter1 LED+ (Orange) Y=Shutter1 LED- (Black) Z=Shutter LED+ (White) a=Not used b=Not used c=Not used d=Not used e=Shutter2 LED- (Black)

Power Distribution Headboard Pin Description

Table 3.3-3. Power Distribution Board Pin Descriptions

CONNECTOR	GENERAL DESCRIPTION	PIN DESCRIPTION
J9 Minifit 5 way	Power Distribution Board to Pump Headboard (J6)	1=+12V (Blue) 2=+12V (Blue) 3=+5V (Red) 4=AGND (Black) 5=AGND (Black) 6=AGND (Black)
J8 Minifit 5 way	Power Distribution Board to Pump Headboard (J7)	1=+24V (Green) 2=Not used 3=AGND (Black) 4=Not used
J3 Terminal block 6 way	Power Distribution Board to External diode driver	1=GND (Black) 2=+5V (Blue) 3=Laser Diode anode,+15V (Red) 4=Laser diode cathode (Green) 5=Not used 6=Not used
J1 Terminal block 4 way	Power Distribution Board to TEC 1	1=+15V(Blue) 2=GND (Green) 3=TEC+VE (Black) 4=TEC-VE (Red)
J2 Terminal block 4 way	Power Distribution Board to TEC 2	1=+15V(Blue) 2=GND (Green) 3=TEC+VE (Black) 4=TEC-VE (Red)

MRU Interlock Connector

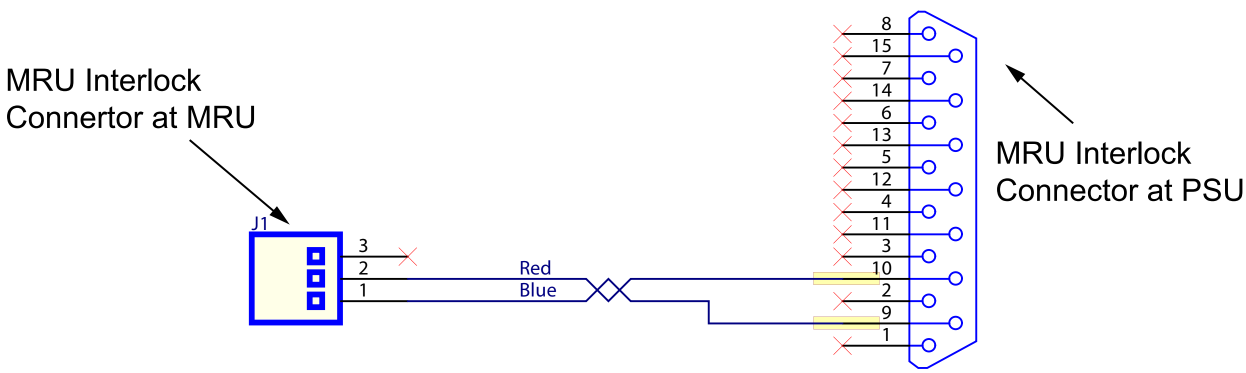


Figure 3.3-1. MRU Interlock Connector

This Page Intentionally Left Blank

Service GUI Introduction

The DiscoveryServiceGUI is a Windows application intended for Coherent Field Service. The Service GUI can communicate with the Coherent Discovery laser system and the laser pump module.

The Service GUI primary functions are:

- Communication by a command prompt
- Laser firmware upgrading
- Laser EPROM management
- Automatic Laser calibration (for Discovery OPO connection)

The Service GUI secondary functions are:

- Logging laser and instrument readings
- Scripting
- Graphing

Installation

The DiscoveryServiceGUI is available in a 32Bit or 64Bit version.

Users must verify and execute the following information for software installation.

- Check the Windows OS before selecting which version of the DiscoveryServiceGUI to install.
- Have administrative rights for both installation and execution.
- Double click the **Setup.exe** application to execute the GUI installers and USB drivers.

The Discovery Service GUI can communicate with some third party instruments, but the device drivers and software for the instruments must be installed separately.

After the installation is complete, the following icons will appear on the Windows Desktop and Start Menu.

Figure 4.1-1. Icon Shortcuts

Discovery Service GUI Layout

Figure 4.1-2 is a view of the Service GUI main screen.

Menu Items

The menu consist of four items: Connections, Profiles, Service Meters and About. The following information gives a description of the Connections, Profiles, and Service Meters.

Connection Menu

The Discovery laser is connected to the Service GUI by RS-232. The default connections parameters for the RS-232 are shown in Figure 4.1-4 of the Connections tab. When the Discovery Service GUI finds a working connection, it will record the connection settings and try to use the same settings for the next start-up.

Prompt Tab

Laser commands and queries can be added in the Prompt tab. The prompt tab uses the same method as third part console application for example Tera Term or HyperTerminal.

- When the Service GUI connects to the laser, the command prompt is displayed.
- `CHAMELEON>` is the command prompt for the Discovery OPO.

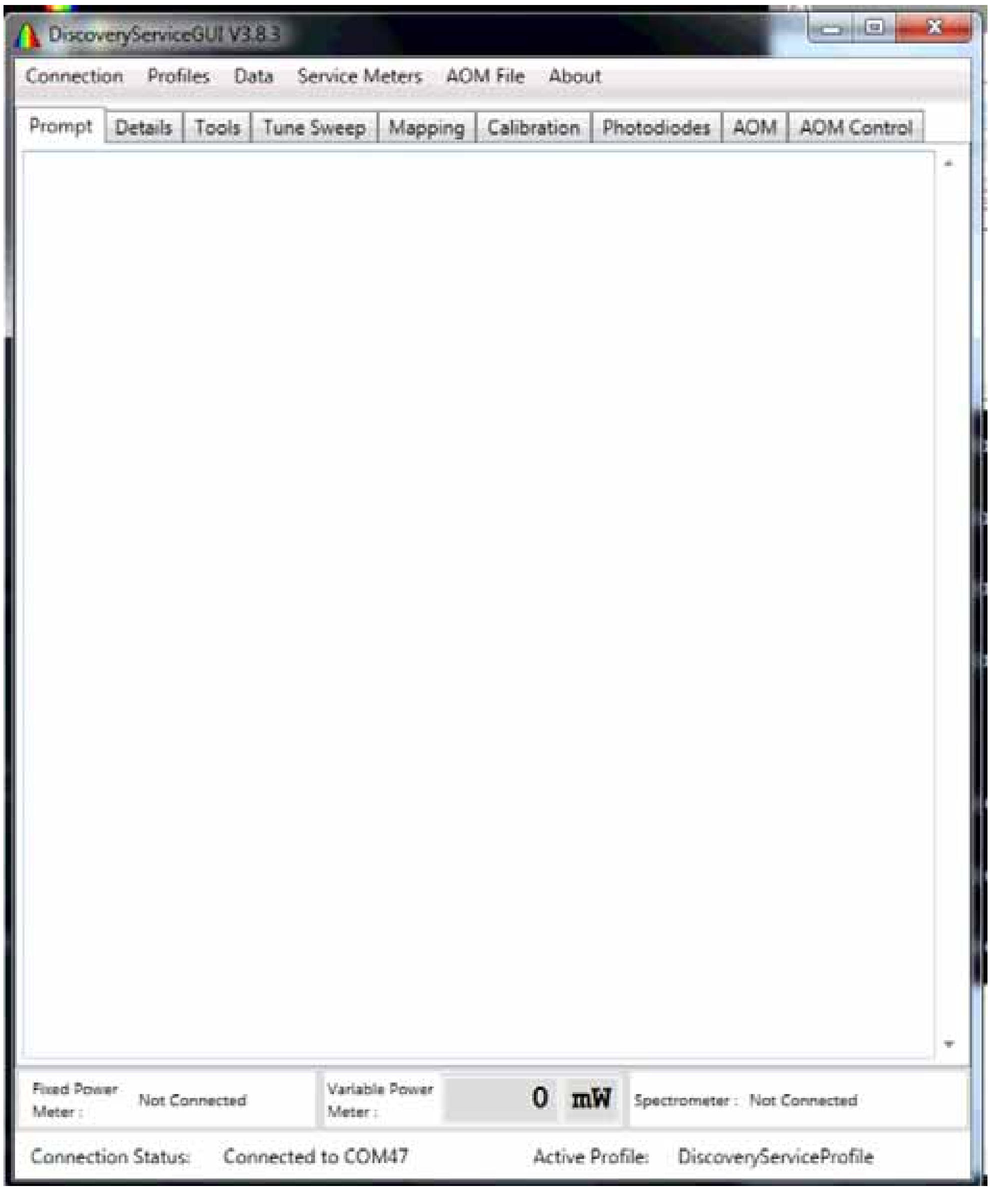


Figure 4.1-2. Service GUI Main Screen

- Commands are typed at the command prompt and transmitted to the laser when the return key is pressed.
- Previous commands used are retrieved using the up and down arrow keys.
- Text can be highlighted by using the left mouse button click.

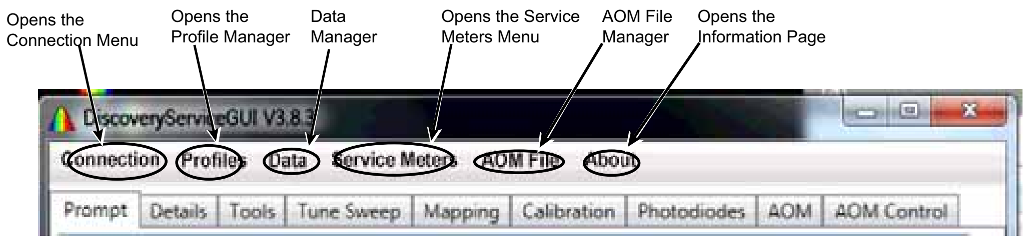


Figure 4.1-3. Menu Items

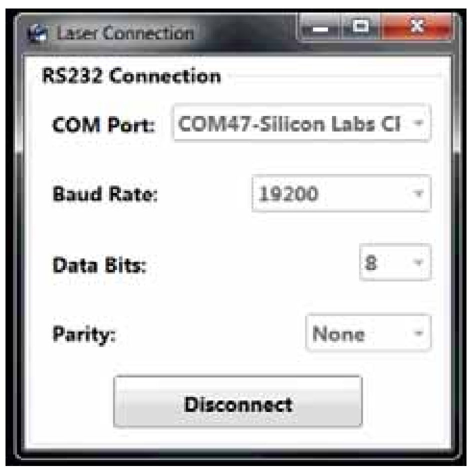


Figure 4.1-4. Connections Menu

- Text can be copied to the system clipboard and pasted into the command prompt area using the right mouse button click.

Logging Parameter

A new logging parameter is created using the right click anywhere in the command prompt area. If the active profile is user defined, this action will open a menu similar to Figure 4.1-5.

The contents of the system clipboard will automatically fill the Function field. Other fields can be modified in the open menu. This ability lets the user highlight query text from the command prompt area and quickly add the information to the active profile without opening the Profile Manager.

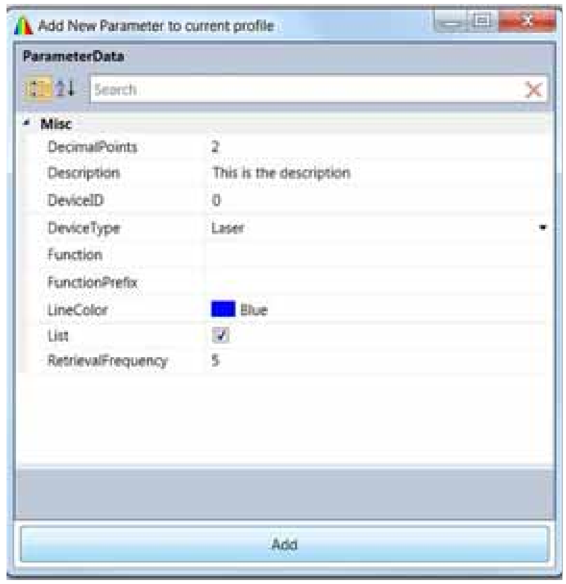


Figure 4.1-5. Logging Parameters Menu

When **Add** is pressed, the logging parameter is added to the active profile. The operation can be canceled by closing the menu without pressing **Add**.

Details Tab

The Details tab displays a list of the parameters in the active Profile. Each entry has the fields shown in Figure 4.1-6.

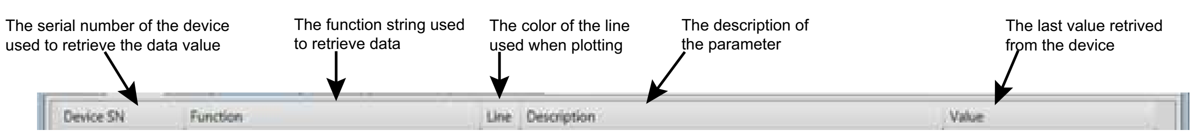


Figure 4.1-6. Details Tab

Items in the Details table can be plotted on a graph. The graph plot is achieved in two ways:

1. By double clicking the item.

2. By using the Ctrl and Shift keys in conjunction with a left mouse button click to select multiple items. Then right click any of the selected items and choose **Send To Graph**.

Graphing

When an item is selected for graphing, a menu similar to Figure 4.1-7 will appear.

Figure 4.1-7. Graphing Menu

Service Tools (OPO connections only)

The Service Tools are the functions under the three tabs, shown in Figure 4.1-8, of the Service GUI main screen. These tools give the user the ability to perform service functions on the laser.

Figure 4.1-8. Service Menus

Service Meters Menu

Before using the service tools, the Service GUI must be configured with the external meters through the Service Meter menu.

Open the Service Meters menu shown in Figure 4.1-9

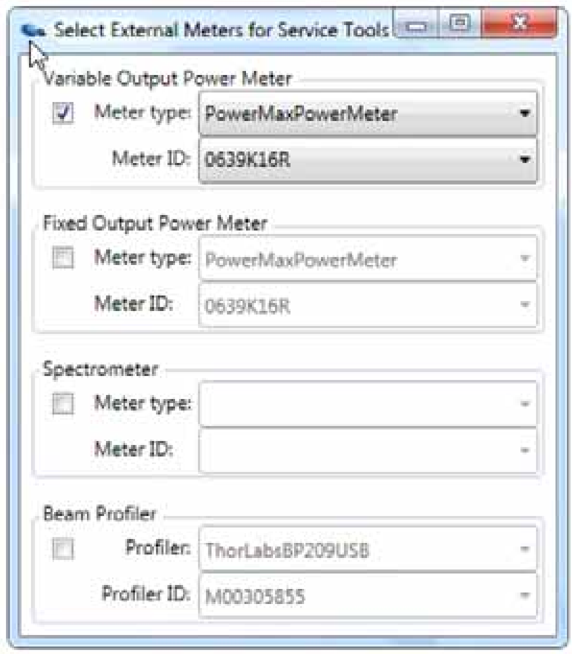


Figure 4.1-9. Service Meters Menu

The user can select which external meters are used for the three service tools. The external meters must be configured before the relevant Service Tool is used.

Some tools do not require all the meters to be enabled. Table 4.1-1 describes which meters are used. See "Connect Measurement Devices within Service GUI" on page 1.2-21 for more information on the external meter requirements for installation.

Table 4.1-1. Required Meters

	OPO Power Meter	IR Power Meter	Spectrometer	Beam Profiler
Tune Sweep	X	Optional	X	
Mapping	X			

Table 4.1-1. Required Meters (Continued)

	OPO POWER METER	IR POWER METER	SPECTROMETER	BEAM PROFILER
CALIBRATION	X		X	
AOM CALIBRATION	X		X	X

Tune Sweep Menu

The Tune Sweep menu has two main functions, **Data Run Function** and **Sweep and Record Function**.

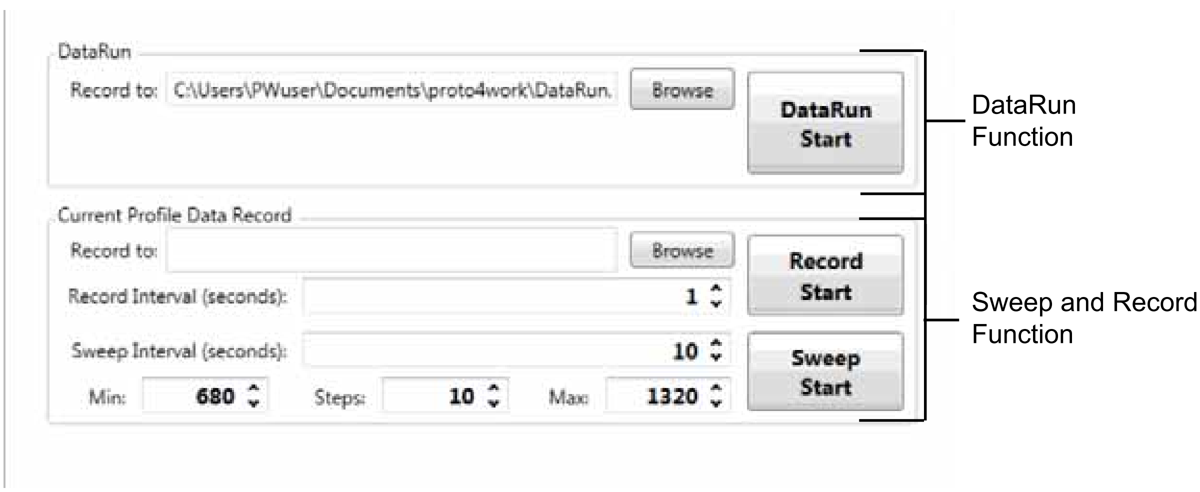


Figure 4.1-10. Tune Sweep Menu

NOTICE
Do not send commands via the Command Prompt while any of the Tune Sweep functions are in progress. This can affect the collected data results .

Data Run Function

The purpose of the Data Run function is to generate a CSV file containing laser and external meter readings during a controlled wavelength sweep.

- The location and name of the CSV file must be specified in the Record To field.
- The status of the external meter and spectrometer connections are displayed. Readings will not update until the Data Run process starts.
- When the Data Run function starts, any sweep and record functions will immediately stop.
- When the Data Run function starts, the GUI will try to connect to the meters enabled in the Service Meters menu.
- During the Data Run operation, the GUI will stop any logging actions. The logging will resume when the Data Run operation is complete or is stopped manually.
- The Data Run can be manually stopped by clicking the **DataRun Stop** button.

Sweep and Record Function

The sweep and record features are two independent functions that can be started and stopped independently. When the sweep or record function start, the GUI will display the readings from the meters enabled in the Service Meters menu. The values will not be recorded unless the meters appear in the active profile.

The sweep function uses the Sweep Interval, Min, Max and Steps fields to change the Discovery wavelength.

- When **Sweep Start** is pressed the wavelength sweep starts at the set Min value and increases toward the Max value.
- The wavelength is moved in set Steps increments.
- The Sweep Interval value sets the time period between each increment.
- When the set Max value is reached, the operation reverses and the wavelength decreases.
- The cycle repeats until the sweep is manually stopped by clicking the **Sweep Stop** button.

The record function uses the parameters specified in the active Logging Profile to record the data to a CSV file.

- The record function records a CSV file to the location and name specified in the Record To field.
- The record function will collect and record the data at the frequency set in the Record Interval field.

NOTICE
The Retrieval Frequency set value in each logged parameter is overridden during the record function. The data is collected and recorded at the set frequency in the Record Interval field.

- The record function can be manually stopped by clicking the **Record Stop** button.

Mapping Menu

The mapping menu allows the user plot a map of the internal and external power readings for each pump piezo position. See “Pump Map Routine” on page 1.2-23 for more information on the mapping menu.

Calibration Menu

The Calibration menu uses the external spectrometer to collect wavelength readings for widely spaced BBO stepper positions. The information is then used to calculate an accurate set of stepper positions that are saved to the laser memory. See “Service GUI” on page 1.2-15, “Wavelength Calibration” on page 5.2-1 and “Photodiode Calibration” on page 5.3-1 for more information on the calibration information.

Profile Manager

When the GUI connects to a laser, it will immediately start to record readings from the laser in a process called Logging. The logging cycle is set to 1 second. The GUI uses a Logging Profile to determine the behavior of the Logging process.

The Logging Profile allows the users to change how the GUI logs the data by importing a file. The file must have the settings necessary to inform the GUI what parameters to log, where to get the data, how frequently to get the data, how frequently to log the data and where to log the data.

The Logging Profile is used to store general GUI information for example the last known working communication link and the location of firmware upgrade files.

Logging Profiles are used to:

1. Define the configuration of user options in the GUI.
2. Define the paths for storage of files.
3. Define the logging behavior of the GUI.

Profile Format

The Profile file is written in a language called XML (Extensible Mark-up Language). This language is readable by both humans and computer applications. The language structure allows users to edit the XML file using a utility such as NotePad. If the syntax is correct, the GUI application can use the resulting Profile.

The profiles are located in the following folders:

WINDOWSXP C:\Documents and Settings\All Users\Applications Data\Coherent\GlasgowGUI

WINDOWS 7 C:\ProgramData\Coherent\GlasgowGUI

WINDOWS 8-10 C:\ProgramData\Coherent\GlasgowGUI

Regarding the profiles when SVC GUI is installed on customer machines, there is a known conflict between some of the service instrumentation and some other software from the same vendors. In particular Thorlabs scope software interferes with the GUI's ability to communicate with a BP209 and will cause crashing upon GUI startup.

See troubleshooting appendix 'X'

Default Profiles

Before the user creates a profile, the GUI must start with a default profile. The one default profile supplied with the application is shown in Figure 4.1-11.

Figure 4.1-11. Default Profile

When the GUI starts it will import this profile. The default profile becomes the Active Profile. The GUI will use the file content to connect to a Discovery laser and start the data logging system.

Profile Manager Layout

A menu tool called Profile Manager is available for easy management of the profile system.

When the GUI is started, a menu item appears called Profiles.

Click the **Profiles** tab to open the Profile Manager menu. See Figure 4.1-12.

There are 4 regions in the Profile Manager.

- **Active Profile** - Shows the Profile that is currently active
- **Left Panel** - Shows an overview of the Discovery Profiles found on the host PC. By clicking the symbol, the profile logging parameters are displayed in a hierarchical structure. Clicking on a node in the Left Panel will populate the Right Panel.
- **Right Panel** - Shows the details of the Profile or Parameter node selected in the Left Panel.
- **Selected Profile** - Shows the Profile currently being edited in the Profile Manager.
- **Activate This Profile** - Click the **Active This Profile** to apply the selected profile. The applied profile becomes the Active Profile. This action will close the Profile Manager. Closing the Profile Manager without activating a profile will not affect the currently Active Profile.

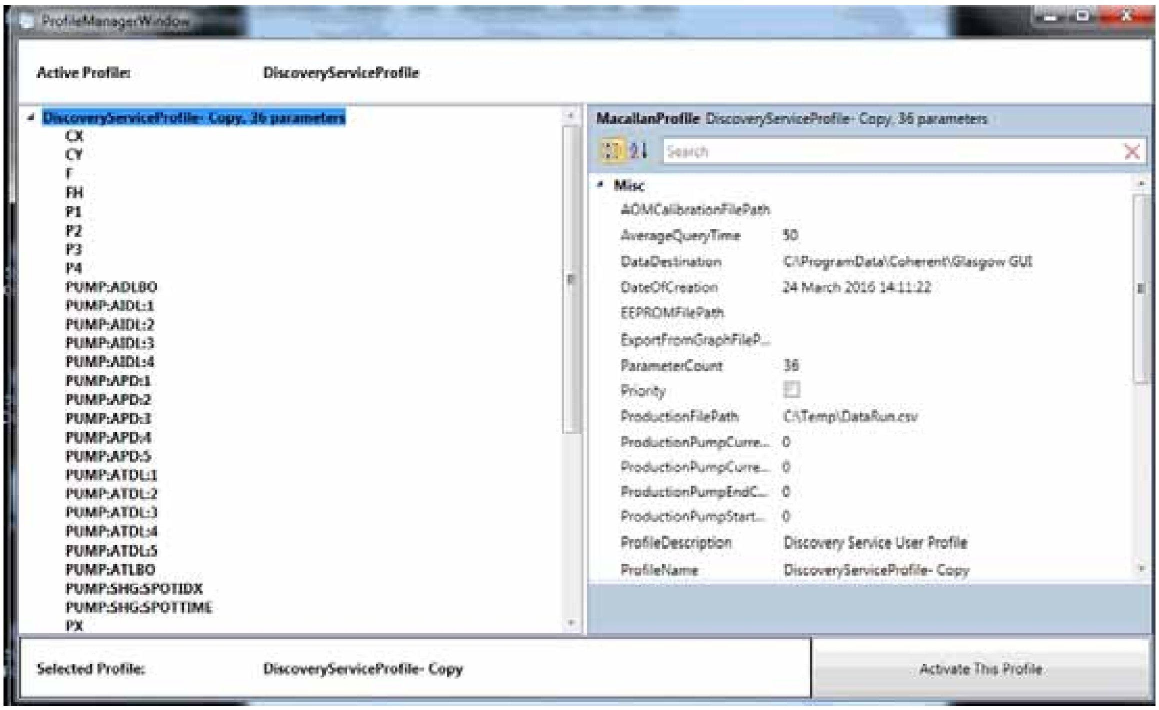


Figure 4.1-12. Profile Manager Menu

Left Panel

This panel shows the list of available Profiles on the host PC.

Default Profiles are grayed out. They can only be viewed, not edited.

Adding, Copying and Deleting user profiles using right click

- Right click on the Profile nodes in the Left Panel to add, delete, copy or paste the profiles.
- Right click the whitespace in the Left Panel to add new Profiles.
- A single Profile is selected with the left click. Multiple Profile selection is not possible.

Right Panel

The right panel displays the content and allows the editing of the node selected on the Left Panel.

When a user Profile is selected, the fields can be edited. A description of each field is displayed at the base of the panel.

The details of the Profile fields are found in Table 4.1-2.

Table 4.1-2. Profile Field

FIELD	PURPOSE
AverageQueryTime	The average time in milliseconds for the laser system to respond to parameter queries
DataDestination	The path to be used to store the GlaLogData.h5 file
DataDestination	The Date and Time the Profile was originally created
Parameters	A collection of parameter objects contained within the Profile
ProductionFilePath	The path to be used to store the production data file
ProfileDescription	A description of the Profile
ProfileName	The Profile name This is used by the GUI to identify this Profile. The GUI expects the *ProfileName* to match the name of the XML file (without the filename extension)
SearchForPort	Not Used
StorageDisabled	If 'true' no data is recorded to the file specified at the *DataDes-tination*
StorageFormat	Only 'HDF5' is available
StorageOverwrite	Defines the behavior of the GUI if the *StorageSizeLimit* is reached If 'True' the existing file (as defined in the *DataDestination*) will be deleted and a new file of the same name and path will be created If 'False' the GUI will rename the existing file with a timestamp and will create a new file with the name specified in the *Data-Destination*
StorageSizeLimit	Defines the size limit of the storage destination file in Mega-Bytes If the size limit is reached, the GUI will behave as defined in the *StorageOverwrite* field
UpgradeBootLoaderFilePath	The last path used to locate the laser system bootloader file
UpgradeFilePath	The last path used to locate the laser system application file

Table 4.1-2. Profile Field (Continued)

FIELD	PURPOSE
UpgradeSeedBootLoaderFilePath	The last path used to locate the laser seed bootloader file
UpgradeSeedFilePath	The last path used to locate the laser seed application file

When the ProfileName field is changed, the name of Profile will change in the Left Panel. Also, the name of the related XML file will change in the file system.

When a parameter node is selected in the Left Panel, the Right Panel displays the fields related to the parameter.

When the parameter is part of a user Profile, the parameter fields can be edited.

The details of the parameter fields are found in Table 4.1-3.

Table 4.1-3. Parameter Fields

FIELD	PURPOSE
DecimalPoints	Defines the name of the parameter
Description	Describes the purpose of the parameter to be displayed in the Details panel
DeviceID	A reference to an instance of the DeviceType
Function	A string that will be passed to the device instance in order to select the correct function for the parameter This field will be used by the GUI to identify this parameter
FunctionPrefix	A string that will be prefixed immediately before the Function string
LineColor	The color of the line used in any graphs
List	When set to “true” the parameter will appear in the Details panel
RetrievalFrequency	Defines the number of iterations of the logging loop to wait between the retrieval of data from the DeviceID

Managing Logging Parameters

Each Profile has a set of parameters that determine the logging behavior.

By clicking next to the Profile, the parameter nodes can be viewed. See Figure 4.1-13 for a view of the Profile Manager with the parameters opened.

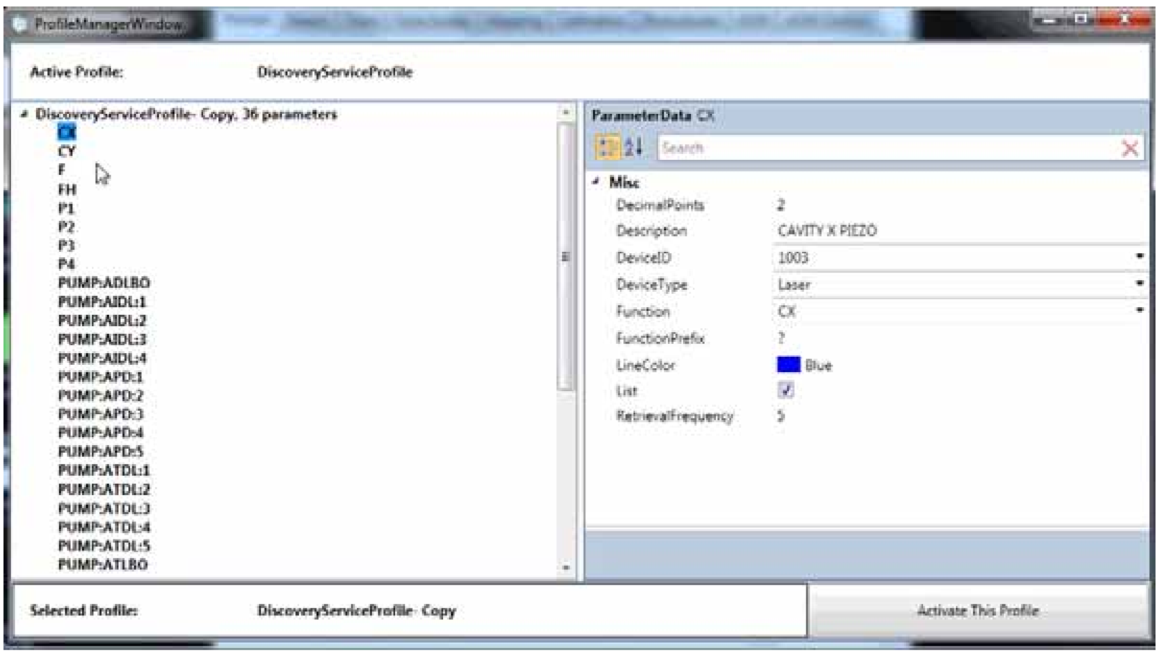


Figure 4.1-13. Profile Manager Menu

Adding, Copying and Deleting user parameters using right click

- New parameters are added to a Profile by right clicking the Profile node.
- Parameters can be selected by a single left mouse button click.
- Select multiple parameters by using the Shift and Ctrl keys in conjunction with the left mouse button click.
- Right click to copy and delete the selected parameters.
- Right click on the selected parameters to paste in the Profile nodes.

Introduction

The following information provides the Chameleon Discovery service commands and queries. It is assumed that the engineer has read the Software section of the Chameleon Discovery Operator's Manual.

Note that the Service GUI also has a full list of queries and commands using the 'command' button at the top right as shown in Figure 4.2-1.

Figure 4.2-1. Command Button

To place the system into service mode, enter the command: `ACCESS=CLG5182.`

NOTICE

The *Service GUI* invokes Service access automatically. It follows therefore that customers should *NOT* have access to the Service GUI.

General

Table 4.2-1. General Command and Query

COMMAND / QUERY	DESCRIPTION
E=n ECHO=n ?E ?ECHO	A change in echo mode takes effect with the first command sent after the echo command. n=0 turns echo OFF. Characters transmitted to the laser are not echoed to the host. n=1 turns echo ON. Characters transmitted to the laser are echoed to the host. Returns the terminal echo state.
PROMPT=n ?PROMPT	Turns “CHAMELEON>” prompt on/off 0=off, 1=ON, 2=Prompt is MacOPO, 3=Prompt is Chameleon Returns the prompt setting
ACCESS= ?ACCESS	The command to enter or exit service mode (access=0 returns to user mode). Returns the access level.
CV=xxx ?CV	A command to set the Chameleon Version number Returns Chameleon Version 0=Ultra, 1=Vision, 2=Vision-S, 3=Discovery
SN=*nnnn* ?SN	Sets the unit serial number [1000;9999] Returns the unit serial number [1000;9999]
SYS:CR=n ?SYS:CR	Set terminal carriage return. Query carriage return setting. 1=On (default), 0=Off
EOT=*n* ?EOT	Enable / disable end of text character 1=Enable, 0=Disable (default) Query state of end of text character
NOISEFLOOR= ?NOISEFLOOR	Sets Threshold value that defines the system is lasing Query Threshold value that defines the system is lasing
BOOT=1	A command to let the watchdog reboot the OPO system
PUMP:MOD1SN ?PUMP:MOD1SN	Set the serial number of the seed module Query the serial number of the seed module

Table 4.2-1. General Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
HB= ?HB	Sets the state of the heartbeat Query the state of the heartbeat
HBR= ?HBR	Sets the heartbeat rate Query the heartbeat rate

Timer

Table 4.2-2. Timer Command and Query

COMMAND / QUERY	DESCRIPTION
?UPTIME	Returns time since last boot (seconds)
?HH	Returns head hours
?HUP	Returns the number of hours that the head software has been running for

System Operation

Table 4.2-3. System Operation Command and Query

COMMAND / QUERY	DESCRIPTION
L=*n* Laser=n ?L PRINT Laser	Sets the soft key state n=0 is off, n=1 is on Returns status of laser 0=off (Standby), 1=On, 2=Off due to a fault (check faults or fault history)
?K PRINT KEYSWITCH	Returns status of keyswitch 0=Off, 1=On

System

Table 4.2-4. System Query

COMMAND / QUERY	DESCRIPTION
?F PRINT FAULTS	Returns a list of number codes of all active faults
?FT	Return the active fault with text description
?FH PRINT FAULT HISTORY	Returns a list of number codes of all faults that have occurred since the last laser on command.
?FHT	Return the historic fault with text description
?F:*n*	Returns description of system fault number '*n*'
?TS PRINT TUNING STATUS	Returns the tuning status 1=tuning, 0=competed tune (both stepper and stage locked)
?SV PRINT SOFTWARE	Returns the version number of the power supply software
?ST	Returns the current operating status string, such as "Tuning" or "OK"
?REV	A query for the board revisions
?PUMP:CPLDVER	A query for the CPLD Version (If =0, CPLD version is less than 2.43)
?TSTIME	Query the time period (in minutes) since the last OPO re-scan (RB5 onwards)
?PIDVARS	Query PID variables
?IMAGE	Query the EPROM contents
TMAX=nnn TUNING LIMIT MAX=nnn ?TMAX PRINT TUNING LIMIT MAX	Sets Maximum tuning limit (within the calibrated tuning range) Returns value of maximum available wavelength in nm
TMIN=nnn TUNING LIMIT MIN=nnn ?TMIN PRINT TUNING LIMIT MAX	Sets Minimum tuning limit (within the calibrated tuning range) Returns value of minimum available wavelength in nm

Photodiode

Table 4.2-5. Photodiode Command and Query

COMMAND / QUERY	DESCRIPTION
?APDP4	Query the Pre-comp photodiode raw voltage into CPU (TP35) Voltage range [0-2.5]
P4CAL=xxxx	Set prepower scaling factor for wavelength xxxx=Measured power in mW
?APDP3	Query the OPO photodiode raw voltage into CPU (TP36) Voltage range [0-2.5]
?PUMP:APD:1	Query the oscillator photodiode raw voltage
?PUMP:APD:2	Query the pre-amp 1 photodiode raw voltage
?PUMP:APD:3	Query the pre-amp 2 photodiode raw voltage
?PUMP:APD:4	Query the IR photodiode raw voltage
?PUMP:APD:5	Query the green photodiode raw voltage
?P1	Query the IR output power (mW)
?P2	Query the green output power (mW)
?P3	Query the OPO output power (mW)
?P4	Query the pre-comp output power (mW)

Alignment Mode

Table 4.2-6. Alignment Mode Command and Query

COMMAND / QUERY	DESCRIPTION
ALIGN=n ?ALIGN	Access to the variable output alignment mode Returns the status of the variable output alignment mode 1=Enabled, 0=Disabled
ALIGNP=xxxx ?ALIGNP	Set the variable output alignment power in mW Returns the laser power available in mW with variable output alignment mode enabled
ALIGNW=xxxx ?ALIGNW	Set the wavelength in nm of the variable output alignment mode Returns the variable output alignment mode laser wavelength in nm
ALIGNFIXED=1 ?ALIGNFIXED	Access to the fixed alignment mode Returns status of the fixed alignment mode
ALIGNFIXEDP=xxxx ?ALIGNFIXEDP	Set the power in mw of the fixed output alignment mode Query the power in mw of the fixed output alignment mode

Shutter

Table 4.2-7. Shutter Command and Query

COMMAND / QUERY	DESCRIPTION
SVAR=*n* S=n SHUTTER=n ?SVAR ?S PRINT SHUTTER	Changes state of the tunable output external shutter Returns the state of the tunable output external shutter 0=Closed, 1=Open
SFIXED=*n* ?SFIXED	Changes state of the fixed output external shutter Returns the state of the fixed output external shutter 0=Closed, 1=Open

Active Mirrors

Table 4.2-8. Active Mirrors Command and Query

COMMAND / QUERY	DESCRIPTION
CX= PZTXC ?CX ?PZTXC	Sets / Returns cavity x value Range [0;65535]
CY PZTYC ?CY ?PZTXC	Shows x results for both x & y Sets / Returns cavity x value Range [0;65535]
PX= PZTXP PX ?PZTXP	Sets / Returns pump x value
PY= PZTYP ?PY ?PZTXP	Shows x results for both x & y Sets / Returns pump x value

Tuning Stepper

Table 4.2-9. Tuning Stepper Command and Query

COMMAND / QUERY	DESCRIPTION
STP1HM=1 HOME STEPPER=1 HM=1	Carries out a rotational home [0;1]
STP1HMABS=1 ?STP1HMABS	Carries out a translational home [0;1]

Table 4.2-9. Tuning Stepper Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
?STP1TS	Returns the Stepper 1 tuning status 1=moving, 0=not moving
STP1POS=nnn STEPPER POSITION=nnn STPRPOS= ?STP1POS ?STPRPOS	Move the tuning motor to the specified absolute position count Display Tuning stepper position
?STP1POSABS	Queries the absolute position (in steps) with respect to the absolute home position
STP1POSW:xxxx=nnnn ?STP1POSW:xxxx	A command define the BBO position (nnnn) at a given wavelength (xxxx) Query the BBO position at a given wavelength (xxxx)
STP1SPOTTIME:x=yyyy.y ?STP1SPOTTIME:x	Sets the amount of time (in hours) that BBO spot x has been used Returns the amount of time (in hours) that BBO spot x has been used
STP1SPOTGOOD:x=n ?STP1SPOTGOOD:x	Sets whether BBO spot *x* is a good or bad Returns whether BBO spot *x* is a good or bad 1=Good, 0=Bad
STP1SPOT+	Move the BBO spot to the next good spot
STP1SPOT-	Move the BBO spot to the previous good spot
STP1SPOT=xx ?STP1SPOT	Move to BBO spot x Query current BBO spot number
STP1SPOTLTMIN ?STP1SPOTLTMIN	Sets / Returns the time (in hours) when the BBO spot will shift once the shutters are closed
STP1SPOTLTMAX ?STP1SPOTLTMAX	Sets / Returns the time (in hours) when the BBO spot will be forced to shift (CURRENTLY NOT ACTIVE)
STP1DEL_LUT	Resets the BBO look up table to default
STP1SAVE_LUT	Forces the BBO look up table that is held in memory to by saved to the EEPROM

Table 4.2-9. Tuning Stepper Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
?STP1TS	Returns the Stepper 1 tuning status 1=moving, 0=not moving
STP1POS=nnn STEPPER POSITION=nnn STPRPOS= ?STP1POS ?STPRPOS	Move the tuning motor to the specified absolute position count Display Tuning stepper position
?STP1POSABS	Queries the absolute position (in steps) with respect to the absolute home position
STP1POSW:xxxx=nnnn ?STP1POSW:xxxx	A command define the BBO position (nnnn) at a given wavelength (xxxx) Query the BBO position at a given wavelength (xxxx)
STP1SPOTTIME:x=yyyy.y ?STP1SPOTTIME:x	Sets the amount of time (in hours) that BBO spot x has been used Returns the amount of time (in hours) that BBO spot x has been used
STP1SPOTGOOD:x=n ?STP1SPOTGOOD:x	Sets whether BBO spot *x* is a good or bad Returns whether BBO spot *x* is a good or bad 1=Good, 0=Bad
STP1SPOT+	Move the BBO spot to the next good spot
STP1SPOT-	Move the BBO spot to the previous good spot
STP1SPOT=xx ?STP1SPOT	Move to BBO spot x Query current BBO spot number
STP1SPOTLTMIN ?STP1SPOTLTMIN	Sets / Returns the time (in hours) when the BBO spot will shift once the shutters are closed
STP1SPOTLTMAX ?STP1SPOTLTMAX	Sets / Returns the time (in hours) when the BBO spot will be forced to shift (CURRENTLY NOT ACTIVE)
STP1DEL_LUT	Resets the BBO look up table to default
STP1SAVE_LUT	Forces the BBO look up table that is held in memory to by saved to the EEPROM

Table 4.2-9. Tuning Stepper Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
STP1OFFSET ?STP1OFFSET	Sets / Returns the number of steps that the BBO Stepper will deviate from the value in the look up table
?STP1SPOTLIST	GUI query for the BBO Spot table
?STP1SPOTVIEW	Viewable version of BBO Spot table
?STP1POSLIST	View BBO position look up table

Piezo Stage

Table 4.2-10. Piezo Stage Command and Query

COMMAND / QUERY	DESCRIPTION
?STAGEW=	Returns the cavity position for a specific wavelength
STAGEPOS= ?STAGEPOS	Sets / Returns the exact position of the cavity stage
STAGEDAC= PZTZC= ?STAGEDAC ?PZTZC	Sets / Returns DAC reference for piezo stage driver
STAGEP= ?STAGEP	Sets / Returns proportional gain for strain gauge PID Range [-500.0;500.0]
STAGEI= ?STAGEI	Sets / Returns integral gain for strain gauge PID Range [-500.0;500.0]
STAGED= ?STAGED	Sets / Returns differential gain for strain gauge PID Range [-500.0;500.0]
STAGET= ?STAGET	Sets / Returns differential gain for strain gauge PID Range [1.0;10000.0]

Table 4.2-10. Piezo Stage Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
STAGESTEPMAX= ?STAGESTEPMAX	Sets / Returns maximum corrective step for the strain gauge PID
?STAGEOFFSET	Query the offset between prediced and actual stage position Range [0;65535]
STAGECALREF= ?STAGECALREF	Sets / Returns strain gauge offset reference Range [0;65535]
STAGESGGAIN ?STAGESGGAIN	Sets / Returns strain gauge Gain reference
STAGESGCAL	Command to automatically calibrate the strain gauge
STAGECAL	Sets the stage position into the cavity look up table for the current wave-length

OPO

Table 4.2-11. OPO Command and Query

COMMAND / QUERY	DESCRIPTION
WV=nnn WAVELENGTH=nnn VW=nnn ?WV PRINT WAVELENGTH ?VW	Sets / Returns the wavelength to the specific value in nanometers.
WVS=nnn WAVELENGTH STEP=nnn ?VWS=nnn	Sets the wavelength by the specified amount in nanometers
MAXPC	Maximize power using coarse scan
MAXPF	Maximize power using fine scan

Table 4.2-11. OPO Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
?MAXP	Returns max power observed during the last scan
MAXPCSTEP ?MAXPCSTEP	Sets / Returns coarse step size Range [1;2000]
MAXPFSTEP ?MAXPFSTEP	Sets / Returns fine step size Range [1;2000]
MAXPCRANGE ?MAXPCRANGE	Sets / Returns coarse scan range Range [1000;16000]
MAXPFRANGE ?MAXPFRANGE	Sets / Returns fine scan range Range [500;8000]
PLOCK=n ?PLOCK	Sets / Returns power lock to setpoint 1=Enabled, 0=Disabled
PLOCKP= ?PLOCKP	Sets / Returns proportional gain for photodiode PID Range [-500.0;500.0]
PLOCKI= ?PLOCKI	Sets / Returns integral gain for photodiode PID Range [-500.0;500.0]
PLOCKD= ?PLOCKD	Sets / Returns differential gain for photodiode PID Range [-500.0;500.0]
PLOCKT= ?PLOCKT	Sets / Returns differential gain for photodiode PID Range [1.0;10000.0]
PLOCKSTEPMAX= ?PLOCKSTEPMAX	Sets / Returns maximum corrective step for the photodiode PID
PLOCKFDL ?PLOCKFDL	Sets / Returns the Power Lock Fail Detection Limit (number of consequative times the system can drive while power goes down) Range [1;65535]
PLOCKR ?PLOCKR	Sets / Returns lock range for the Tuning PID before a rescan occurs
PLOCKWARMUP=xxx ?PLOCKWARMUP	Sets / Returns the number of warm up minutes, with 0 meaning that it will not attempt to retune

Pre-comp Stepper

Table 4.2-12. Pre-comp Stepper Command and Query

COMMAND / QUERY	DESCRIPTION
STP2=x COMP=x ?STP2 ?COMP	Sets / Returns the state of the pre-comp stepper 0=Disable, 1=enable
STP2HM=1 HMCOMP=1 ?STP2HM ?HMCOMP	Sets / Returns the pre-comp stepper to home Returns 0 if not homed, 1 if homed
?STP2TS	Returns the pre-comp stepper tuning status 1=moving, 0=not moving
STP2POS= COMPPOS= ?STP2POS ?COMPPOS	Sets / Returns the pre-comp stepper position
STP2POSW= ?STP2POSW=	Sets / Returns the pre-comp stepper for a given wavelength Range [650.0;1350.0]
STP2SPEED STP2TSMIN= ?STP2SPEED ?STP2TSMIN	Sets / Returns the constant / minimum speed of the pre-comp stepper
STP2TSMAX= ?STP2TSMAX	Sets / Returns the maximum speed of the pre-comp stepper

Pre-comp Calibration

Table 4.2-13. Pre-comp Calibration Command and Query

COMMAND / QUERY	DESCRIPTION
COMPWCAL:yy=zzzz ?COMPWCAL:yy	Sets / Returns wavelength for calibration curve point:yy=zzzzz
COMPGCALH:yy=zzzz ?COMPGCALH:y	Sets / Returns GDD max for calibration curve point:yy=zzzzz
COMPGCALL:yy=zzzz ?COMPGCALL:y	Sets / Returns GDD min for calibration curve point:yy=zzzzz
COMPSCALH:y=yy ?COMPSCALH:y	Sets / Returns stepper max value for calibration curve point:y=zzzzz
COMPSCALL:yy=zzzz ?COMPSCALL:y	Sets / Returns stepper min value for calibration curve point:y=zzzzz
?GDDVIEWCAL	Returns a table of all the pre-comp calibration data
RESETPRE	Reset the precomp data

Pre-comp User Curves

Table 4.2-14. Pre-comp User Curves Command and Query

COMMAND / QUERY	DESCRIPTION
GDDCURVE=xx ?GDDCURVE	Sets / Returns the GDD calibration curve. This switches the system into auto GDD. Curve 0 is reserved for zero dispersion curve. Range [0;32] xx=Curve number
GDDCURVEN=xxxxxx ?GDDCURVEN	Sets/ Returns the GDD curve by name xxxxxx

Table 4.2-14. Pre-comp User Curves Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
GDD=xxxxx ?GDD	Sets / Returns the GDD value. This switches the system into manual GDD. xxxxx=GDD in fs^2 Returns yyyyy where yyyyy is the GDD in fs^2 or yyyyy X, where the character X denotes that the value has been extrapolated from limited calibration data
SETCURVEN:x=yyyyy ?CURVEN:x	Sets / Returns the name of the calibration curve. Note: All curve names are automatically converted to upper case.
SETCUR-VEPT:ww=x:yyyy:zzzzz ?CURVEPT:ww=x ?CURVE:ww=x	Sets the curve ww point x where zzzzz fs^2 at yyyy nm Returns:zzzzz yyyy where zzzzz is GDD, yyyy is wavelength
?CURVEPTGDD:x	Query GDD of current curve at point x
?CURVEPTW:	Query wavelength of current curve at point x
?CURVE:ww	Returns the calibration values of curve ww Returns calibration values for curve ww, returns array of calibration points: x1 yyy1 zzzzz1, x2 yyyy2 zzzzz2. x3 yyyy3 zzzzz3
?GDDMAX	Returns the maximum GDD value available at the current wavelength
?GDDMIN	Returns the minimum GDD value available at the current wavelength
?GDDMAX:xxxx	Returns the maximum GDD value available at wavelengths xxxxnm
?GDDMIN:xxxx	Returns the minimum GDD value available at wavelengths xxxxnm
DELCURVE=xx	Deleted curve number xx
DELCURVEPT=x	A command to delete the last point in a curve
?GDDLIST	Returns a list of all GDD curves
GDD:RESETCURVES	Resets all User GDD curves back to default (zero GDD remains)

Cavity Look-up Table

Table 4.2-15. Cavity Look-up Table Command and Query

COMMAND / QUERY	DESCRIPTION
CAVSET=	Set cal: wavelength, stage, BBO, power, 3 x scale, ADC
?LUT_ALL	Returns entire Lookup table
?CAVLUTVIEW	Returns Cavity look up table in a readable format
CAVDEL_LUT	
LUTDELW=	Delete entry for the specified wavelength
CAVP3PWR:x=y ?CAVP3PWR:x	Records / Returns P3 power of Y against wavelength X
CAVP3ADC:x=y ?CAVP3ADC:x	Records / Returns P3 ADC of Y against wavelength X
CAVP4PWR:x=y ?CAVP4PWR:x	Records / Returns P4 power of Y against wavelength X
CAVP4ADC:x=y ?CAVP4ADC:x	Records / Returns P4 ADC of Y against wavelength X
CAVSTAGEPOS:x=y ?CAVSTAGEPOS:x	Records / Returns strain gauge position of Y against wavelength X
?CAVWV:x	View row from the cavity look up table for a given wavelength x
?CAVID:x	View row from the cavity look up table for a given row x

EPPROM

Table 4.2-16. EEPROM Command and Query

COMMAND / QUERY	DESCRIPTION
EPROMRESETPRE	Reset Pre-comp EEPROM values to factory default
?PUMP:EPROM	Query pump EEPROM values

SHG Spot Shifting

Table 4.2-17. SHG Spot Shifting Command and Query

COMMAND / QUERY	DESCRIPTION
PUMP:SHG:SPOT-TIME:x=yyyy.y ?PUMP:SHG:SPOTTIME:x	Sets / Returns the amount of time (in hours) that SHG crystal spot x has been used
?PUMP:SHG:SPOTTIME	Returns the amount of time (in hours) that the current SHG spot has been used
PUMP:SHG:SPOT-GOOD:x=n ?PUMP:SHG:SPOTGOOD:x	Sets / Returns whether SHG spot *x* is a good or bad 1 = Good 0 = Bad
PUMP:SHG:SPOTIDX=xx ?PUMP:SHG:SPOTIDX	Moves / Returns to SHG spot x
PUMP:SHG:SPOTCH+	Move the SHG spot to the next good spot
PUMP:SHG:SPOTCH-	Move the SHG spot to the previous good spot
PUMP:SHG:SPOTLT ?PUMP:SHG:SPOTLT	Sets / Returns the time (in hours) that the SHG spot should be shifted
PUMP:SHG:SPOTSHIFT ?PUMP:SHG:SPOTSHIFT	Sets / Returns the distance (in microns) between each spot shift position
PUMP:SHG:SPOTPOS1 ?PUMP:SHG:SPOTPOS1	Sets / Returns the absolute position (in microns) from home for SHG spot 1
?PUMP:SHG:SPOTPOS:x	Returns the absolute position of SHG spot *x*
PUMP:PSCALB	Initial calibration of stepper (used for initial setup)
PUMP:PSRESB	Moves stepper to '0' position
PUMP:PSPOSN= ?PUMP:PSPOSN	Moves / Returns to absolute stepper position (closed loop)
PUMP:PSSTEP=	Move specified number of steps (open loop)
PUMP:PSMOVE=	Move to relative position (closed loop)

Table 4.2-17. SHG Spot Shifting Command and Query (Continued)

COMMAND / QUERY	DESCRIPTION
PUMP:SHG:GRCALV ?PUMP:SHG:GRCALV	Sets / Returns the voltage level required of Green PD during spot calibration
?PUMP:SHG:SPOTLIST	Returns the SHG Spot table

Light-loop

Table 4.2-18. Light-loop Command and Query

COMMAND / QUERY	DESCRIPTION
PUMP:MODE:n=x ?PUMP:MODE:n	Sets / Returns mode of operation in current mode (x= 1) or light loop (x=2) for the oscillator (n=1), pre-amp 1 (n=2), pre-amp 2 (n=3).
PUMP: MODE:4=n	Puts pump into current mode (n=1), IR light loop (n=2) or green light loop (n=3)
?PUMP:MODE:4	Returns the light-loop state (1=current mode, 2=IR light loop, 3=green light loop)
PUMP:OPSGR=xxxx ?PUMP:OPSGR	Sets / Returns the green light-loop set power
PUMP:OPSIR=xxxx ?PUMP:OPSIR	Sets / Returns the IR light-loop set power
PUMP:IDL:n=	Current loop set point for stage <n>; n=1 (oscillator), 2 (pre-amp 1), 3 (pre-amp 2), 4 (power amp).
PUMP:IDLMAX:n= ?PUMP:IDLMAX:n	Maximum current for stage <n>; n=1 (oscillator), 2 (pre-amp 1), 3 (pre-amp 2)
PUMP:LLSP:n= ?PUMP:LLSP:n	Light-loop set point for stage <n>; n=1 (oscillator), 2 (pre-amp1), 3 (pre-amp2), 4 (power-amp)

Pump Photodiodes

Table 4.2-19. Pump Photodiodes Commands and Query

COMMAND / QUERY	DESCRIPTION
?P1 ?PFIXED ?PUMP:OPIR	Query the power from the fixed output (in mW)
?P2 ?P ?PUMP:OPGR	Query the Green power (in mW)
PUMP:OPLIR=xxxx	Calibrate Photodiode 1 (IR) (where xxxx is the current power in mW)
PUMP:OPLGR=xxxx	Calibrate Photodiode 2 (Green) (where xxx is the current power in mW)
PUMP:OPCIR=XXXX ?PUMP:OPCIR	Sets/ Returns the IR PD conversion factor (mW per Volt)
PUMP:OPCGR=XXXX ?PUMP:OPCGR	Sets/ Returns the Green PD conversion factor (mW per Volt)
PUMP:PDIROFFSET=X.XXX ?PUMP:PDIROFFSET	Sets / Returns the IR PD Offset
PUMP:PDGROFFSET=X.XX X ?PUMP:PDGROFFSET	Sets / Returns the Green PD Offset
?PUMP:PDOFFSET:4	Query the Raw IR PD voltage with the offset voltage applied
?PUMP:PDOFFSET:4	Query the Raw green PD voltage with the offset voltage applied
PUMP:PDMIN:n= ?PUMP:PDMIN:n	Minimum photodiode voltage to be exceeded before stage <n> gets turned on; n=2 (pre-amp 1), n=3 (pre-amp 2), n=4 (power-amp)

LBO Oven

Table 4.2-20. LBO Oven Commands and Query

COMMAND / QUERY	DESCRIPTION
?PUMP:ADLBO	Query Drive rate for LBO oven
?PUMP:ATLBO	Query LBO temperature
PUMP:TLBO ?PUMP:TLBO	Sets / Returns temperature set point for LBO
PUMP:TDL:n ?PUMP:TDL:n	Temperature set point for TEC <n>; n=1 (oscillator), 2 (pre-amp 1), 3 (pre-amp 2), 4 (power-amp, diode 1), 5 (power-amp, diode 2)
PUMP:TLMAX ?PUMP:TLMAX	Maximum temperature for LBO

Oscillator PD

Table 4.2-21. Oscillator PD Command and Query

COMMAND / QUERY	DESCRIPTION
PUMP:PD1OVP= ?PUMP:PD1OVP	Sets / Returns OVP Digipot value to / from EEPROM
?PUMP:PD1OVADC	Reads the actual OVP voltage from ADC
PUMP:PD1UVP= ?PUMP:PD1UVP	Sets / Returns UVP digipot value to / from EEPROM
?PUMP:PD1UVADC	Reads the actual UVP voltage from ADC
PUMP:PD1VOS= ?PUMP:PD1VOS	Sets / Returns offset to / from EEPROM
?PUMP:PD1VADC	Reads voltage from ADC

Pump Monitoring

Table 4.2-22. Pump Monitoring Query

QUERY	DESCRIPTION
?PUMP:AIDL:n	Actual drive current for stage <n>; n=1 (oscillator), 2 (pre-amp 1), 3(pre-amp 2), 4 (power amp)
?C	Alternative way to query the actual power-amp drive current
?PUMP:APD:n	Actual voltage detected on photodiode <n>; n=1 (oscillator), 2 (pre-amp1), 3 (pre-amp2), 4 (power-amp), 5 (SHG)
?PUMP:AITEC:n	Actual drive rate for TEC <n>; n=1 (oscillator), 2 (pre-amp 1), 3 (pre-amp 2), 4 (power-amp, diode 1), 5 (power-amp, diode 2)
?PUMP:ATDL:n	Actual temperature of thermistor <n>; n=1 (oscillator), 2 (pre-amp 1), 3 (pre-amp 2), 4 (power-amp, diode 1), 5 (power-amp, diode 2)
?PUMP:ADLBO	Actual drive rate for LBO oven
?PUMP:ATLBO	Actual LBO temperature
?PUMP:STATE	Laser state, returned as string
?PUMP:TECLK:n	Query lock state of TEC <n>, 0=unlocked, 1-locked; n=1 (oscillator), 2 (pre-amp11), 3 (pre-amp 2), 4 (power-amp, diode 1), 5 (power-amp, diode 2) ; used by GUI

Pump Seed PID SHG Feedback Control Parameters

Table 4.2-23. SHG Feedback Control Parameter Command and Query

COMMAND / QUERY	DESCRIPTION
PUMP:LBOTP= ?PUMP:LBOTP	Overall gain for temperature control of LBO
PUMP:LBOTI= ?PUMP:LBOTI	Integral time for temperature control of LBO
PUMP:LBOTD= ?PUMP:LBOTD	Derivative time for temperature control of LBO

TPC Commands

Table 4.2-24. TPC Commands

<table>
<tr><th>PREFIX</th><th>COMMAND</th><th>DESCRIPTION</th></tr>
<tr><td rowspan="5">All commands must have a prefix to designate the fixed or tunable modulator:

AOMF - for fixed

AOMT - for tunable</td><td>T</td><td>Change % Transmission (0 -100%)</td></tr>
<tr><td>USBCTRL</td><td>Direct USB/Laser AOM control (1/0)</td></tr>
<tr><td>ON</td><td>Switch Driver On/Off (1/0)</td></tr>
<tr><td>EXTMODE</td><td>Enables external modulation mode (1/0)</td></tr>
<tr><td>VMODE</td><td>See the Operator’s Manual for details on optical power control.
Toggles between 0 - 10 V and 0 - 5 V range for analog voltage input (0/1).</td></tr>
</table>

This Page Intentionally Left Blank

Discovery Firmware Table

Follow the guide in the table shown below for matching the versions.

Table 4.3-1. Software Compatibility Table

BASELINE VERSION	PUMP BOARD FIRMWARE VERSION	OPO BOARD FIRMWARE VERSION
CLASSIC ONLY		
2.0	2.07 (bootloader 2.20)	2.16 (bootloader 2.02)
3.0	3.09 (bootloader 3.02)	3.14 (bootloader 3.02)
4.0	4.24 (bootloader 3.02)	4.27 (bootloader 3.02)
4.5	4.32 (bootloader 3.02)	4.27 (bootloader 3.02)
5.0	5.21 (bootloader 3.02)	5.29 (bootloader 3.02)
NG ONLY		
6.0	6.06	6.02
NX only takes a single firmware, so matching is not necessary.		

Consult factory before attending any firmware change event.

Firmware Upgrade Procedure for Classic and NG

Factory Support must be consulted prior to performing the upgrade procedure.

1. Verify the laser is stable, in specification and without any other initial problems.
2. Record the standard troubleshooting data-points and performance measurements to use for later reference if required.
3. Check the USB/serial interface port for later reference before switching off User GUI.
4. Confirm remote PC operating system version: 32bit or 64bit.
5. Transfer the latest revision Service GUI and the firmware files to the PC in use. Make note of where the files are saved.
    - Grouse
    - MacOPO
6. Open the Service GUI
7. Open EPROM Tool and save a copy of the data.
8. Put laser in RS-232 Standby, `L=0`.
9. Query `?st` to confirm ramp to standby is complete before continuing.
10. Open the Tools menu.
11. Open Upgrade Firmware tab:
    - Uncheck the OPO enable upgrade check-box
    - Check the pump upgrade check-box to run the pump firmware upgrade first
12. Browse to the previously transferred stored Grouse software location. Refer to step 5.
13. Click the upgrade tab to start the upgrade. The upgrade takes approximately 15 mins.
14. Close upgrade tab.

15. Open the upgrade tab to run the OPO upgrade:
    - Uncheck the pump upgrade enable check-box
    - Check the OPO upgrade enable check-box
16. Browse to the previously transferred stored MacOPO software location. Refer to step 5.
17. Click the upgrade tab to start the upgrade. The upgrade takes approximately 5 mins.
18. Close upgrade firmware tab.
19. Send `?sv` to confirm the upgrade was successful showing new firmware versions.
20. Send `?stp1offset` command to verify that there is currently no active wavelength calibration offset (=0).
21. Send `stp1:offset=320` to add 10 nm offset to the calibration table.
    - The firmware upgrade offsets the WL Cal by 10 nm
22. Send `stp2:park=1000` to prepare for future use of precomp park location.
23. Send `stp2parkon=0`.
24. Send `stp1spotmax=38` to define tuning stepper end-location.
25. Send `boot=1` to remotely power-cycle the OPO, could take several minutes (?st)
26. Confirm that there are no active faults or in the fault history:
    - `?f`
    - `?fh`
    - it's normal to observe a key-on fault at this point
27. Confirm the commands sent in steps 20, 21, 22, 23 are stored after the boot cycle.
28. After the boot cycle completes send:
    - `L=0`
    - `L=1`
    - The commands are the remote key-cycle to clear the key-on fault and ramp the laser remotely.
29. Confirm specifications and performance.
30. Save final EEPROM data.

Baseline 4 and Customer GUI Fault for Classic and NG

Baseline 4 and the customer GUI revisions < 1.5.5 have an issue with the laser ramping to Standby intermittently.
The problem is caused by the polling frequency from the GUI to the laser. GUI revision ≥ 1.5.5 slows down the traffic but does not eliminate the problem completely, however it can be a useful tool for troubleshooting the issue. The ultimate fix is to upgrade to baseline 5.

Software Upgrade Procedure for NX

Factory Support must be consulted prior to performing the upgrade procedure.

---

1. Verify the laser is stable, in specification and without any other initial problems.
2. Record the standard troubleshooting data-points and performance measurements to use for later reference if required.
3. Check the USB/serial interface port for later reference before switching off User GUI.
4. Confirm remote PC operating system version: 32bit or 64bit.
5. Transfer the latest revision Service GUI and the firmware files to the PC in use. Make note of where the files are saved (Controller Board NX).
6. Open the Service GUI
7. Open EPROM Tool and save a copy of the data.
8. Put laser in RS-232 Standby, `L=0`.
9. Query `?st` to confirm ramp to standby is complete before continuing.
10. Open the Tools menu.
11. Open Upgrade Firmware tab.

12. Browse to the previously transferred stored firmware location. Refer to step 5.
13. Click the upgrade tab to start the upgrade.
14. When finished, close upgrade tab.
15. Send `?sv` to confirm the upgrade was successful showing new firmware versions.
16. There may be some items of the EEPROM that need to be reinstated manually. Consult factory.
17. Send `boot=1` to remotely power-cycle the OPO, could take several minutes (?st)
18. Confirm that there are no active faults or in the fault history:
    - `?f`
    - `?fh`
    - it's normal to observe a key-on fault at this point
19. After the boot cycle completes send:
    - `L=0`
    - `L=1`
    - The commands are the remote key-cycle to clear the key-on fault and ramp the laser remotely.
20. Confirm specifications and performance.
21. Save final EEPROM data.

This Page Intentionally Left Blank

Discovery and Discovery NX Cover Removal

To remove the outer-head cover on the Discovery, first loosen and remove all of the bottom screws. Then remove the top screws as the last step.

To replace the cover, first attach all of the top screws. Then attach all of the bottom screws. This will prevent unnecessary screw tension on the laser head cover.

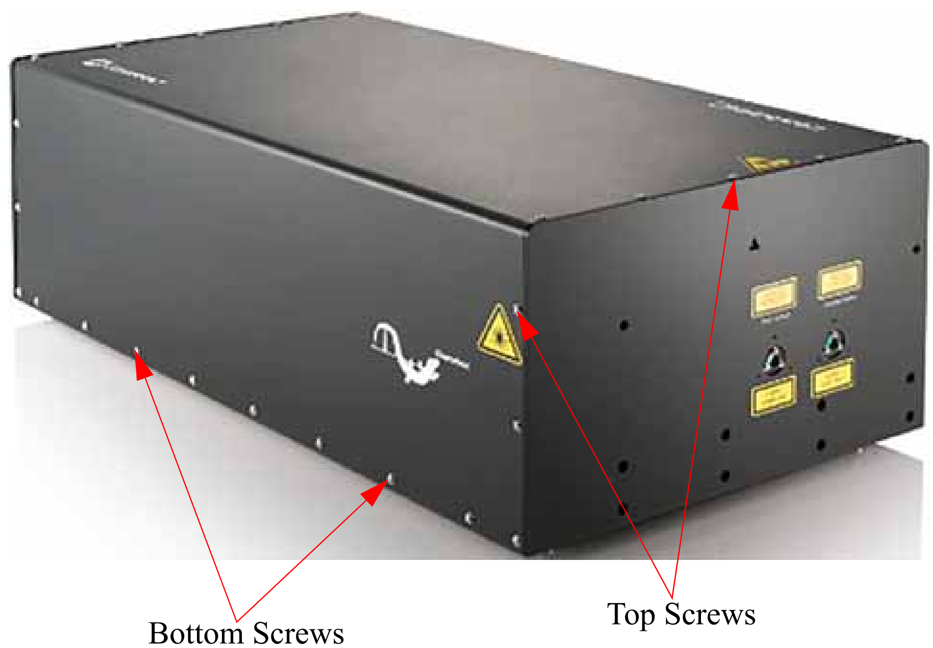


Figure 5.1-1. Discovery Laser Head - Screw Location

This Page Intentionally Left Blank

Wavelength Calibration

If the wavelength accuracy differs > ± 5 nm, a wavelength calibration must be performed. Four different calibrations are available based on how much the wavelength differs.

If the partial range > 15 nm is unsuccessful or the EPPROM Look-up table has been corrupted proceed to the procedure “Full Range” on page 5.2-3.

The WaveScan must be connected to the APE software and Service GUI for the calibration procedures. See “APE WaveScan” on page 1.2-19 and “Connect Measurement Devices within Service GUI” on page 1.2-21 for details on connecting the WaveScan.

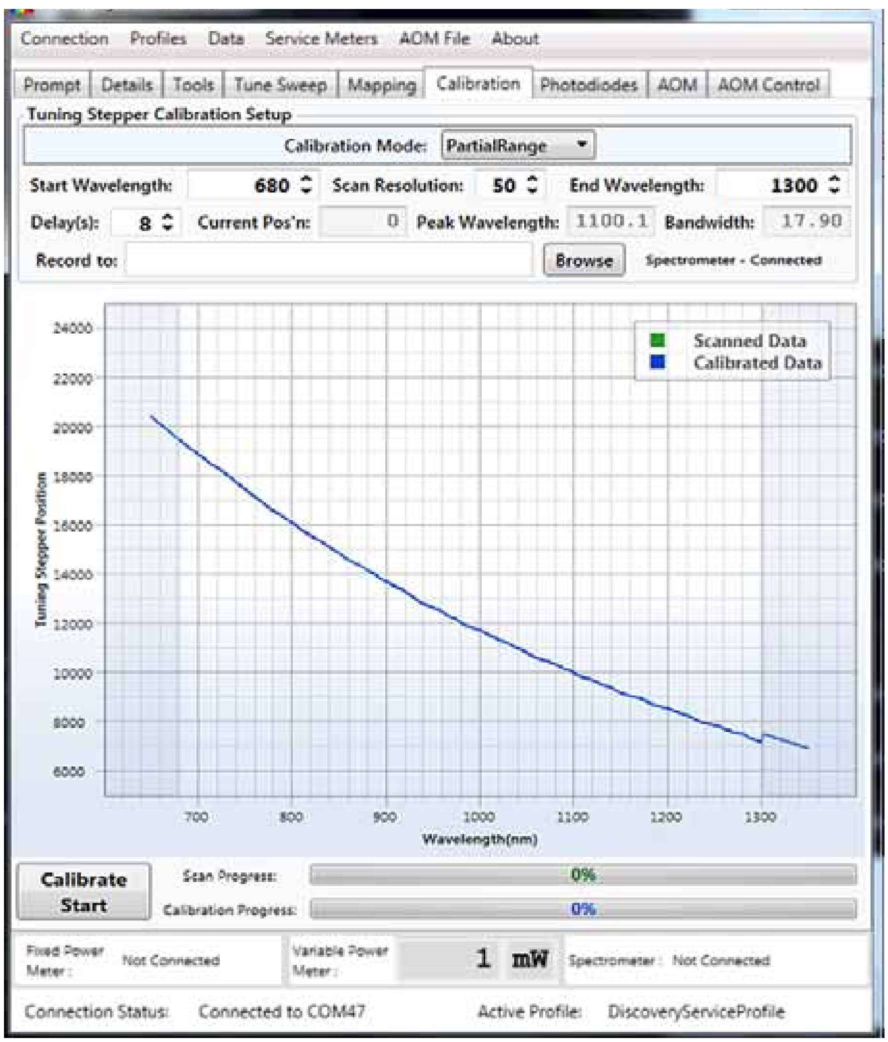


Figure 5.2-1. Partial Range Calibration Mode

Single-point Calibration

1. Open the **Prompt** tab.
2. Identify the wavelength points that need calibration from data run file.
3. Use command `?stp1pos` to find position.
4. Use `Plock=0` to switch off power lock.
5. Look at the WaveScan while sending command `stp1pos=xxxx` (where xxxx=stepper position) to change wavelength by stepper counts.
6. Make adjustments from 50 to 200 steps at a time until desired wavelength is found.
7. Send command `Plock=1`.
8. Check the wavelength on the WaveScan to verify the wavelength specification.
9. Repeat steps 3 to 5 if the position needs to be readjusted.
10. Once stepper position is found use command `stp1posw:wavelength=stepper value` to calibrate the spot.
11. Once the all of positions have been calibrated, send command `stp1save_lut` to save the data to the look-up table.

Partial Range "user entry" < 15 nm Discrepancy

1. Open the **Calibration** tab.
2. Switch the Calibration Mode tab to PartialRange. See Figure 5.2-1.
3. Allow 30 s for the laser to collect the current calibration data and create the Tuning Stepper / Wavelength graph.
4. Enter the desired Start Wavelength and End Wavelength points.
5. Browse to a desktop location to store the file.
6. Click on the Calibrate Start button to begin the procedure.

Partial Range "660 to 1320" > 15 nm Discrepancy

1. Open the **Calibration** tab.
2. Switch the Calibration Mode tab to PartialRange. See Figure 5.2-1.
3. Allow 30 s for the laser to collect the current calibration data and create the Tuning Stepper / Wavelength graph.
4. Enter the desired Start Wavelength as 660 and End Wavelength as 1320.
5. Browse to a desktop location to store the file.
6. Click on the Calibrate Start button to begin the procedure.

Full Range

1. Open the **Prompt** tab.
2. Send `tmin=650` and `tmax=1350` to widen the tuning range.
3. Tune to 655 nm.
4. Send command `?stp1pos` to find the actual stepper position. Record this value.
5. Use the command `plock=0` to switch off power lock.
6. Send the command `stp1pos=xxxx` in 50-100 steps up or down to identify the exact stepper location on the Wavescan for 655 nm ± 1 nm. Send the `plock=1` command after each change to switch power lock on.
7. Make a note of the stepper value for 655 nm ± 1 nm
8. Go to Calibration tab and switch the calibration mode to FullRange.
9. Store the actual stepper value for 655 nm into the Start Position (@655 nm) box to the nearest 50 steps.
10. Go back to the prompt tab and tune to 1340 nm.
11. Repeat steps 4 to 7 exactly to find the stepper position for 1340 nm ± 1 nm.
12. Enter the 1340 nm position in the End Position (@1340 nm) box.
13. Tune the laser to 655 nm and set the stepper position `stp1pos=X` to the correct stepper position for 655 nm ± 1 nm. The wavelength calibration must start at 655 nm.

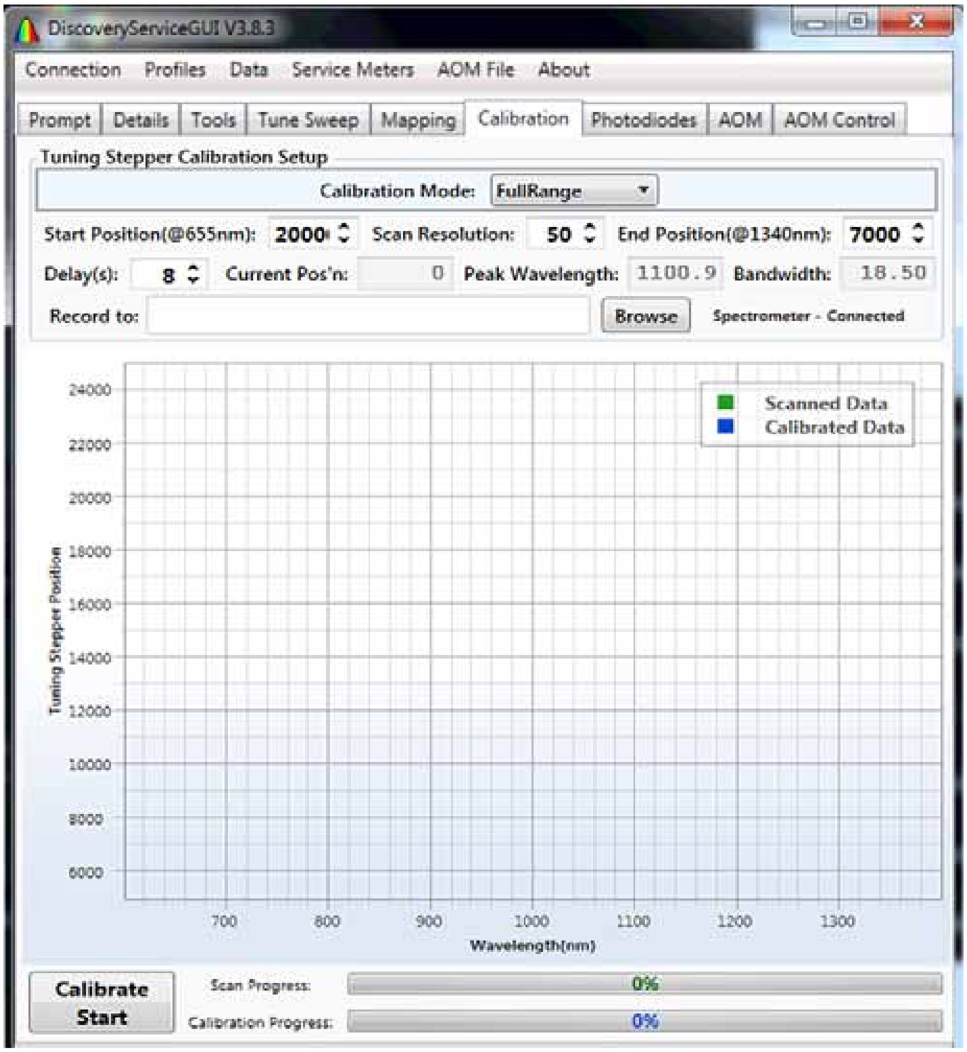


Figure 5.2-2. Full Range Calibration Mode

14. Browse to a desktop location and store the file.
15. Click the Calibrate Start button to begin the procedure.
16. The procedure will take approximately 2 hours. The stepper position is checked and adjusted for accuracy from 655 nm to 1340 nm in 1 nm increments.
17. The Scan Progress bar will display progress in motion. The Calibration Progress bar will update the EEPROM with the

new stepper calibration positions at the end as shown in the graph created.

18. At the end of the procedure the tuning min & max should automatically return 680 nm / 1300 nm. Send the commands `?tmin` and `?tmax` to confirm the tuning range.

19. Run the DATA RUN program to confirm calibration accuracy across the full tuning range.

This Page Intentionally Left Blank

Photodiode Calibration

Two photodiode calibration modes are available:

- The fixed 1040 nm line calibration
- The tunable wavelength range calibration

If a photodiode calibration is required to match the power meter value in the fixed or tunable range, follow the procedures described below.

Fixed Calibration

Follow the steps below to calibrate the fixed 1040 nm line.

1. Make sure the system has been keyed on for at least 10 minutes.
2. Place a power meter in front of the fixed output port.
3. In the **Prompt** tab, open fixed shutter, `Sfixed`=1
4. Take power reading from the power meter.
5. In the **Prompt** tab, send the command: `P1cal=xxxx`, where xxxx equals external power measurement in milliwatts.
6. The Fixed photodiode should now be calibrated with `?P1` matching the power meter.

Tunable Calibration

Follow the instructions below to calibrate the photodiode for the tunable wavelength range.

The PowerMaxUSB must be connected to the Service GUI for the tunable calibration procedure. See “PowerMaxUSB” on page 1.2-20 and “Connect Measurement Devices within Service GUI” on page 1.2-21 for the connection procedure.

1. Make sure the system has been keyed on for at least 10 minutes.
2. Place the PowerMaxUSB in front of the tunable output port.

3. Verify the PowerMaxUSB is connected to the service GUI under the **Service Meters** tab.
4. Open the **Photodiodes** tab.
5. Enter the necessary wavelength range in the Min / Max boxes.
6. Click the **Calibrate Start** button to begin the procedure.

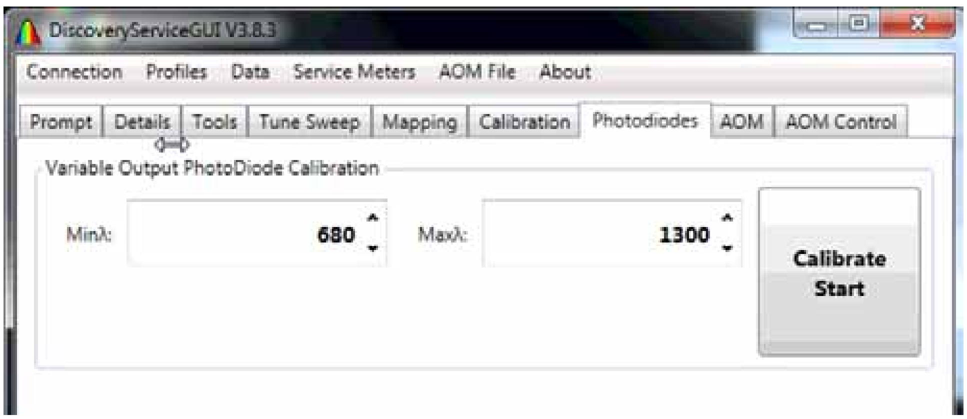


Figure 5.3-1. Tunable Photodiode Calibration

Photodiode Replacement

Prior to exchanging out any of the photodiode PCBAs, verify PD cabling has continuity and is connected properly.

CAUTION!
Electronic components can be damaged by electrostatic discharge. Make sure properly grounded wrist straps are worn when handling printed circuit board assemblies. Use ESD packaging as necessary.

WARNING!
Make sure mains power is in the OFF position before you use an ESD wrist strap. Grounding yourself with power applied can cause an electric shock.

SHG PD (P2) for Classic and NG

1. Start the laser system with the key in standby mode.
2. From the **Prompt** tab, place the system into current mode `pump:mode:4=1`.
3. Key-on the laser system.
4. Wait for system to ramp-up, then confirm specified OPO performance.
5. If the OPO specifications are not reached:
   a. Identify the existing drive current, `?pump:idl:4`
   b. Increase the drive current in small increments until the system meets the OPO specifications, `pump:idl:4=xxx` where xxx is the queried value plus < 0.5, see Table 5.3-1 for approximate values.
      - Set the current: typical range between 7 to 9 A
      - Tune the laser across the tuning range and verify that the system is in specification
      - If the power is too low, the current should be increased in small increments until all wavelengths are in specification
   c. Once the system meets OPO specifications and the power amp current is determined, it is assumed that the Green is producing 8 W.
6. Key to standby mode. Let the system ramp down, then power OFF.
7. Disconnect and remove back panel. Remove the following connections:
   - J1
   - J2
   - J3
   - USB
   - MRU hoses
   - Chiller hoses
   - BNC

8. Remove the PCB from the mount. **<u>Only remove the PCB, not the mount.</u>**

Figure 5.3-2. SHG Photodiode

9. Install the new PD 2 PCB.
10. Install back panel and reconnect electrical, MRU and chiller lines.
11. Start and key ON the laser system.
12. Check the PD2 value, `?p2`.
13. Calibrate PD using the command `pump:oplgr=8000`.
14. Key OFF the laser system.
15. Return system to green light-loop mode `pump:mode:4=3`.
16. Key ON the system.
    - The system should ramp up to 8 W. Send the command `?p2` to confirm specified performance. `?p2` should return 8000.

Table 5.3-1. Approximate NG PD Values

NG PARAMETERS	
Green set point	8 W
Expected current range	7 to 9 A
Fixed	~ 4 W

SHG PD (P2) for NX

1. Start the laser system with the key in standby mode.
2. From the **Prompt** tab, place the system into current mode `pump:mode:4=1`.
3. Key-on the laser system.
4. Wait for system to ramp-up, then confirm specified OPO performance.
5. If the OPO specifications are not reached:
    a. Identify the existing drive current, `?pump:idl:4`
    b. Increase the drive current in small increments until the system meets the OPO specifications, `pump:idl:4=xxx` where xxx is the queried value plus < 0.5, see Table 5.3-2 for approximate values.
        - Set the current: typical range between 7 to typically > 6000 mA
        - Tune the laser across the tuning range and verify that the system is in specification
        - If the power is too low, the current should be increased in small increments until all wavelengths are in specification
    c. Once the system meets OPO specifications and the power amp current is determined, it is assumed that the Green is producing 16 W.
6. Key to standby mode. Let the system ramp down, then power OFF.
7. Disconnect and remove back panel connections.
8. Remove the PCB from the mount. **<u>Only remove the PCB, not the mount.</u>**
9. Install the new PD 2 PCB.
10. Install back panel and reconnect electrical, MRU and chiller lines.
11. Start and key ON the laser system.
12. Check the PD2 value, `?p2`.
13. Calibrate PD using the command `pump:oplgr=16000`.
14. Key OFF the laser system.
15. Return system to green light-loop mode `pump:mode:4=3`.
16. Key ON the system.

- The system should ramp up to 8 W. Send the command `?p2` to confirm specified performance. `?p2` should return 16000.

Table 5.3-2. Approximate NX PD Values

NX PARAMETERS	
Green set point	16 W
Expected current range	6000 to 7500 mA
Fixed	~ 4 to 5 W

Fixed Output PD (P1)

1. Start the laser system with the key in standby mode.
2. Send `?alignfixedp` to identify the fixed output alignment power level.
3. Power OFF the laser system.
4. Remove the laser head front panel.
5. Remove and replace Fixed Output PD board.

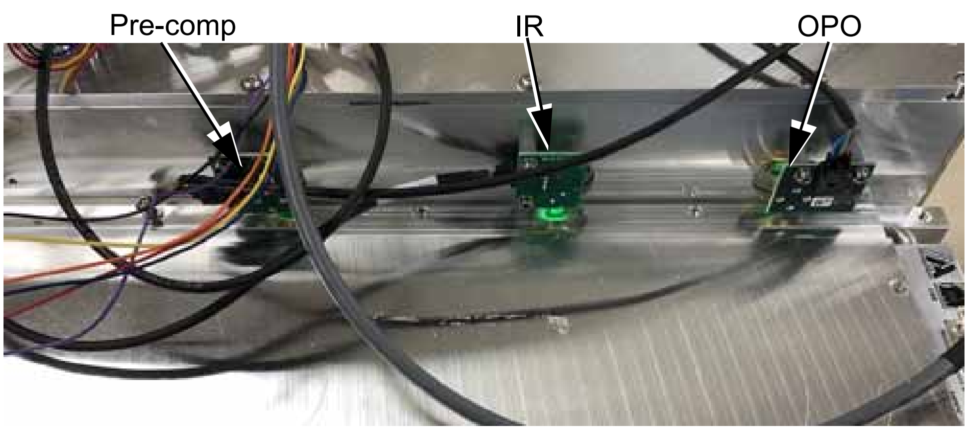


Figure 5.3-3. PD Locations

6. Start the laser system.

7. Measure TP11 on the pump board and maximize the voltage on TP11 by using the slop of the screws to translate the board. See “Pump Headboard Test Points” on page 3.2-1 for location and information on TP11.
8. Measure the IR output power using external power meter.
9. Use the command `P1cal=xxxx` to calibrate the PD in mW with the laser in service mode.
10. Send `?p1` to confirm PD matches external value.
11. Enter the command `alignfixedp=xxxx` where xxxx = value measured in step 2 in mW.
12. Enter fixed alignment mode by command `alignfixed=1` or through the customer GUI. Make sure the measured power equals the value in step 2.
13. Increase or decrease fixed-alignment power using `alignfixedp=xxxx` to match power meter.

Dual Color PD (P3)

If P3 PD is defective, the OPO will not run. The laser will not have any output as the value generated from this PD forms part of the feedback loop to calibrate the OPO light-loop. If there is no lasing, this PD should be replaced as a last step for field recovery. See Figure 5.3-3 for PD location.

1. Power OFF the laser system.
2. Remove the PCB from the mount. **Only remove the PCB, not the mount.**
3. Replace PD P3.

Dual Color PD (P4)

1. Access PD P4 through the side panel.
2. Remove and replace PD P4.

NOTICE

When accessing the photodiode and cable, try not to bend or stress the armored fiber coming from the power-amplifier module. If possible avoid touching this at all.

Figure 5.3-4. Dual Color PD (P4)

3. Run tunable calibration procedure. See “Tunable Calibration” on page 5.3-1.

CAUTION!
Electronic components can be damaged by electrostatic discharge. Make sure properly grounded wrist straps are worn when handling printed circuit board assemblies. Use ESD packaging as necessary.

WARNING!
Make sure mains power is in the OFF position before you use an ESD wrist strap. Grounding yourself with power applied can cause an electric shock.

Classic and NG PCBA Board Replacements

Use the following procedures to replace the Discovery Classic or NG PCBA Boards:

- "Pump Board" on page 5.4-1
- "OPO Board" on page 5.4-6
- "Power Distribution Board " on page 5.4-9
- "Controller Module Shifter" on page 5.4-9

Pump Board

1. Place the laser into Standby.
2. Open the Discovery Service GUI. Verify the GUI is in service mode, `?access`.
3. Record the software version `?sv`.
4. Save EEPROM information. See "EEPROM Tool" on page 1.2-16.
5. Record the SHG spot position `?pump:shg:spotidx`.
6. Measure the UVP (TP2) & OVP (TP5) voltages to ground. See "Pump Headboard Test Points" on page 3.2-1 for location and information on TP2 and TP5.
7. Power OFF the laser system.
8. Remove the connectors and the original pump board.

Figure 5.4-1. Pump Board

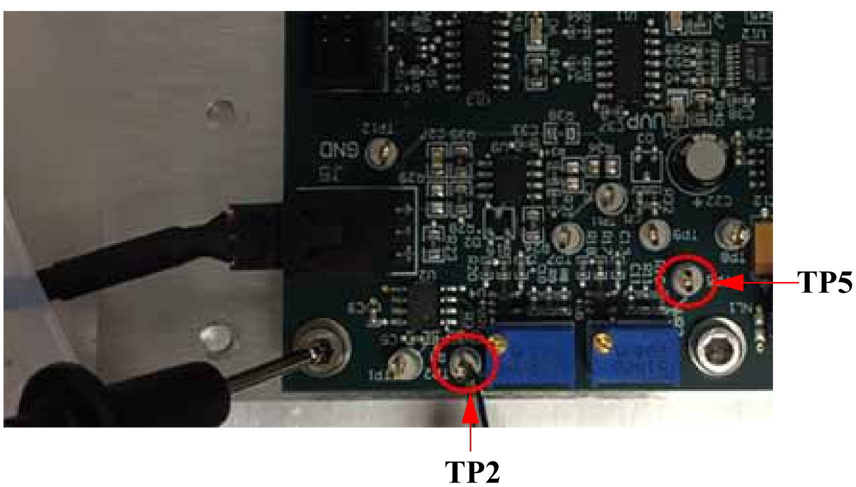


Figure 5.4-2. TP2 and TP5

a. J3 = SHG Photodiode connector P2
b. J4 = 25-way D-type ribbon cable connecting to the OPO board
c. J5 = IR photodiode connector P1

Figure 5.4-3. Pump Board with Connectors Removed

   d. J6 = white Molex connector to the power distribution board PDB
   e. J7 = white Molex connector to the PDB
   f. J8 = 15-way D-type connector to the poweramp
   g. J9 = black Molex interconnect cable
   h. J13 = 50-way D-type connector to seed
   i. J14 = black Molex connector to wavelength TEC & diode electronic drivers

9. Remove SHG piezo stage daughter board.

NOTICE
The daughter board is tightly seated to the pump board. Use caution when removing the board.

10. Remove the 11 M2.5 screws that hold the PCB in place.
11. Install the new pump board.
12. Replace the 11 M2.5 screws.
13. Install SHG piezo stage daughter board on the new/replacement pump board. Make sure both ends are carefully and fully inserted into the home position (listen for an audible click).

14. Only connect J6, J7 and a standard R-S232 serial cable. Connect the RS-232 cable from the board to the service engineer's laptop. See Figure 5.4-4 "J6, J7 and RS-232".

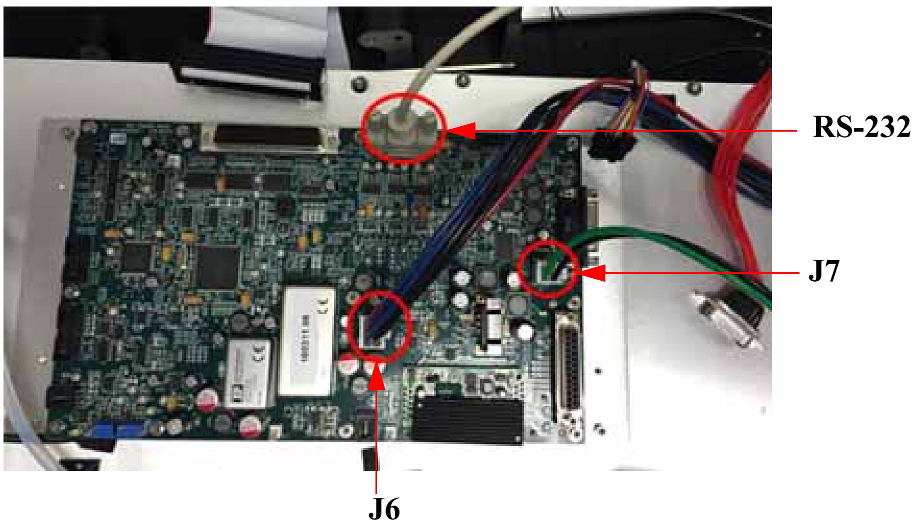


Figure 5.4-4. J6, J7 and RS-232

15. Start the laser system with the key in standby mode.
16. Refer to the data collected in step 5. Reset the UVP & OVP voltages using a potentiometer trim-tool. Adjust VR1 for UVP (measure the voltage on TP2), adjust VR2 (check TP5). See Figure 5.4-5 "Pump PCB Potentiometer Adjustment".
17. Open Discovery Service GUI prompt window. The prompt should display `GROUSE>`. This is the pump laser system.
18. Upload the same version of base code software as the original PCB unless a software upgrade is planned for both the pump board and OPO board immediately following this procedure. See "Discovery Firmware Table" on page 4.3-1.

NOTICE

When the software version `?SV` is queried over the pump board, 2 numbers are given eg. 4.32, 3.02. The first number relates to the pump board software version and the second number relates to the pump board bootloader version.

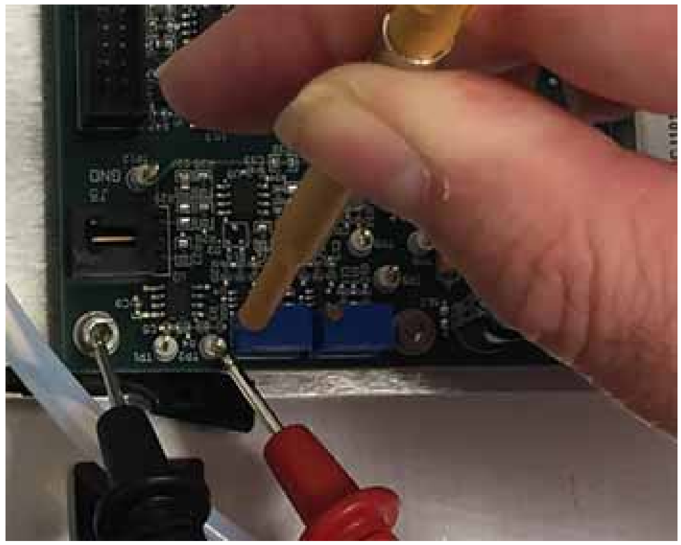


Figure 5.4-5. Pump PCB Potentiometer Adjustment

19. Power OFF and connect the remaining connectors, remove RS-232 cable.
20. Power ON the laser system.
    - Listen for a high-frequency noise. This is the SHG stage.
    - If the high-frequency noise is not heard, proceed to step 23.
21. Load the EEPROM data.
22. Refer to step 4 for the recorded data. Send the query `?pump:shg:spotidx` to verify the SHG spot is at the same position prior to exchanging out the board.
23. If the spot position is not correct, send command `pump:shg:spotidx = x` (where x is the needed spot position).
24. Verify the board has been properly programmed and initialized. Enter the following queries:
    a. ?pump:MF:1
       - The query should return a suffix of 1 (?pump:MF:1 1)
       - This allows the headboard to control the seed module

b. `?pump:MF:3`
   - The query should return a suffix of 1 (?pump:MF:3 1)
   - This allows the headboard to control the power amp and pump modules

c. `?pump:MF:4`
   - The query should return a suffix of 1 (?pump:MF:4 1)
   - This allows the headboard to control the LBO

d. `?pump:SMF:2`
   - The query should return a suffix of 1 (?pump:SMF:2 1)
   - This enables the SHG stepper motor

If any of the queries do not return the correct information, the settings will need to be changed by entering the command.

- `pump:MF:x=1`, where x is the number of the module that needs to be updated
- `pump:SMF:2=1` for the SHG stepper command

If the settings are updated, the power must be cycled to set the parameters.

25. Verify all the modules are switched on and the power amp is in light-loop.
    - `pump:on=4`
    - `pump:mode:4=3`
26. Key ON and check the specified performance of the laser system before the outer-head cover is replaced. Refer to “Discovery and Discovery NX Cover Removal” on page 5.1-1.

OPO Board

1. Place the laser in Standby.
2. Open the Discovery Service GUI. Verify the GUI is in service mode, `?access`.
3. Record the software version `?sv`.
4. Save EEPROM information. See “EEPROM Tool” on page 1.2-16.
5. Record the BBO spot position `?stp1spot`.

6. Power OFF the laser system.
7. Remove the connectors.

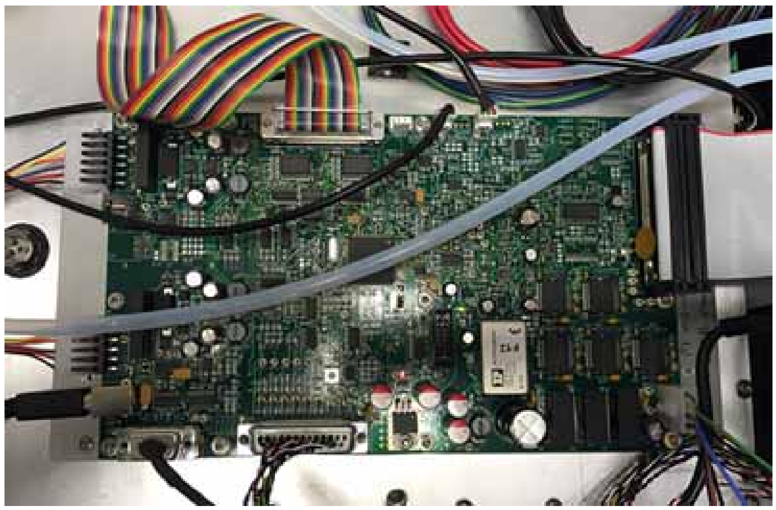


Figure 5.4-6. OPO Board

   a. J1 = RS-232 connector
   b. J2 = Umbilical 2 D-type connector
   c. J3 = Umbilical 2 Molex connector
   d. J4 = USB connector
   e. J5 = Tunable shutter molex connector
   f. J6 = 50-way D-type ribbon-cable to bulkhead
   g. J8 = Emission LED
   h. J10 = Fixed shutter Molex connector
   i. J11 = 25-way D-type ribbon cable to pump board
   j. J12 = Precomp photodiode connector P4
   k. J14 = OPO photodiode connector P3
8. Remove the 11 M2.5 screws and the OPO board.
9. Install the new OPO board, screws and connections shown in step 7.
10. Power ON the laser system with the key in standby mode.

The laser will make a high-frequency noise, this is normal behavior. During warm-up the power supply Fault LED will flash.

11. Open Discovery Service GUI. Verify the GUI is in service mode. Choose the needed COM Port.
12. Confirm the correct software is loaded. See “Discovery Firmware Table” on page 4.3-1 for software compatibility.
13. If the software version is not correct, upload the needed software unless a software upgrade is planned for both the pump board and OPO board immediately following this procedure.
14. Upload the EEPROM data.
    a. Open file
    b. Select all
    c. Save to the laser
15. Run the absolute home procedure for BBO stepper `stp1hmabs=1`. This will take from 10 seconds to 15 minutes to run depending on stepper position related to spot position.

NOTICE
The absolute home procedure can only be run in standby mode, query the status to confirm `?st`.

16. Send `?st` through the GUI prompt window. The system will respond with “Please Wait” if the stepper is moving. Once the procedure is complete the system will respond with “Standby”.
17. Check BBO spot position `?stp1spot`. Refer to step 5 for the recorded data. Set the BBO to the correct position `stp1spot=x`.
18. Key ON and check the specified performance of the laser system before the outer-head cover is replaced. Refer to “Discovery and Discovery NX Cover Removal” on page 5.1-1.

Power Distribution Board

Prior to replacing the power distribution board, check the 5 fuses on board for continuity.

The board replacement is a straight swap that requires no configuration. Make sure all of the connections are reconnected correctly. Do not confuse J1 and J2.

Figure 5.4-7. Power Distribution Board (PDB)

Controller Module Shifter

1. Key the laser OFF.
2. Save the head EEPROM if communication with the Controller board is still possible.
3. Switch the laser OFF at the PSU.
4. Remove the top cover screws and lift the top cover off.
5. Locate the Pump Board as shown in Figure 5.4-1 "Pump Board" and remove the module shown in Figure 5.4-8 "Controller Module Shifter".
6. Fit the new module.
7. Switch ON laser as PSU and confirm no faults. If there are faults, switch OFF and confirm connections.
8. Check stepper moves and returns positional information by entering the following commands:
    a. Pump:PSCALB (calibrates stepper moving to one end)

Figure 5.4-8. Controller Module Shifter

b. Pump:PSRESB (sets zero position at end of stepper travel)

c. Pump:PSPOSN=8000 (sets stepper to 8000 steps)

d. ?Pump:PSPOSN (returns stepper position. Should be 8000)

e. Pump:shg:spotidx=[x] (sets the shg spot to a good spot position, where x is the number of a known good spot)

f. ?pump:PSPOSN (returns the stepper position now that the stepper is at a known good spot.

9. Key laser ON and confirm function and no faults.

NX PCBA Board Replacements

Use the following procedures to replace the Discovery Classic or NG PCBA Boards:

- “Controller Board” on page 5.4-11
- “Controller Module Shifter” on page 5.4-12
- “Bulk Board” on page 5.4-13

Controller Board

Contact factory before making the replacement to confirm firmware and EEPROM compatibility.

1. Key the laser OFF.
2. Save the head EEPROM if communication with the Controller board is still possible.
3. Switch the laser OFF at the PSU.
4. Remove the top cover screws and lift the top cover off.
5. Locate the Controller Board as shown in Figure 5.4-9 and disconnect all of the connectors carefully, avoiding pulling on the wires. A thin screw driver might be helpful in removing tight connectors.
6. Unscrew the controller board from the laser head and remove it.
7. Mount the replacement board to the laser head.
8. Remake all of the connections to the new board.
9. Switch the laser ON at the PSU and look for faults that might indicate a bad connection (communication faults for example). If they are thrown, switch OFF and reconfirm connections and switch back ON.
10. Upload the old EEPROM using the EEPROM manager.
11. Key ON the laser and confirm performance.

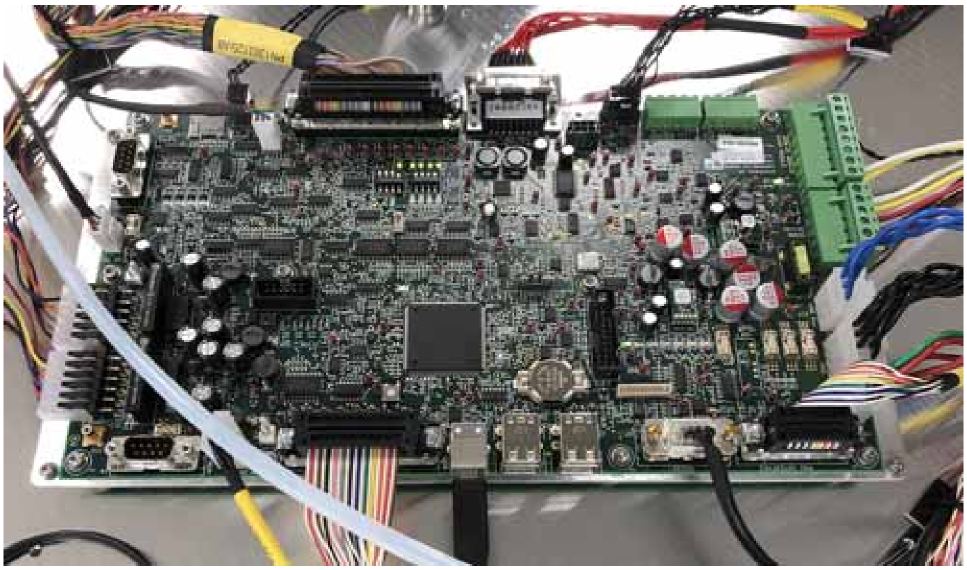


Figure 5.4-9. Controller Board

Controller Module Shifter

1. Key the laser OFF.
2. Save the head EEPROM if communication with the Controller board is still possible.
3. Switch the laser OFF at the PSU.
4. Remove the top cover screws and lift the top cover off.
5. Locate the Bulk board as shown Figure 5.4-10 "Bulk Board" and remove the Controller Module Shifter.
6. Fit the new module.
7. Switch ON laser as PSU and confirm no faults. If there are faults, switch OFF and confirm connections.
8. Check stepper moves and returns positional information by entering the following commands:
   a. Pump:PSCALB (calibrates stepper moving to one end)
   b. Pump:PSRESB (sets zero position at end of stepper travel)
   c. Pump:PSPOSN=8000 (sets stepper to 8000 steps)
   d. ?Pump:PSPOSN (returns stepper position. Should be 8000)

e. Pump:shg:spotidx=[x] (sets the shg spot to a good spot position, where x is the number of a known good spot)

f. ?pump:PSPOSN (returns the stepper position now that the stepper is at a known good spot.

9. Key laser ON and confirm function and no faults.

Bulk Board

1. Key the laser OFF.
2. Save the head EEPROM.
3. Switch the laser OFF at the PS.
4. Remove the top cover screws and lift the top cover off.
5. Locate the Bulk Board as shown in the Figure 5.4-10 and disconnect all of the connectors carefully, avoiding pulling on the wires. A thin screw driver might be helpful in removing tight connectors.

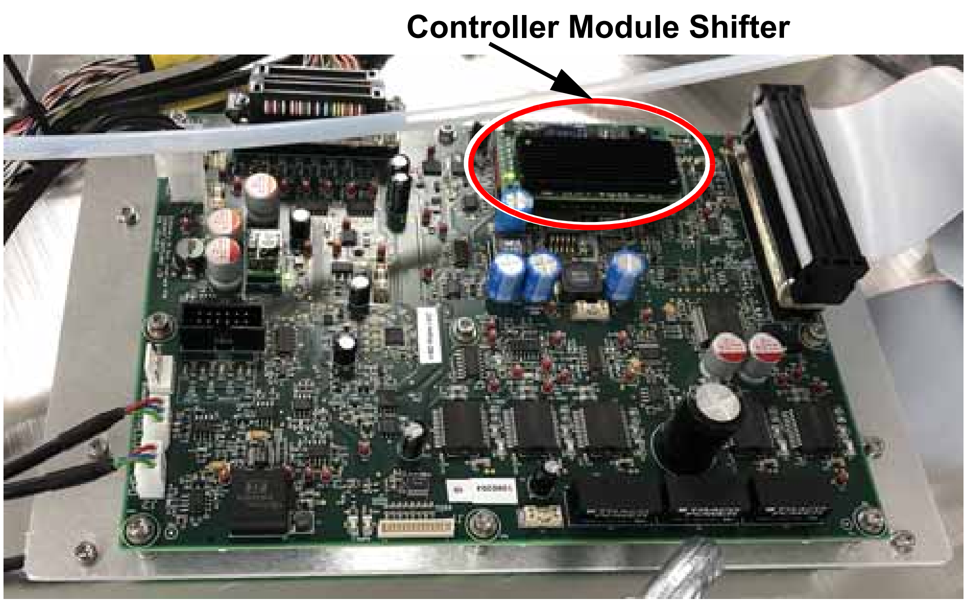


Figure 5.4-10. Bulk Board

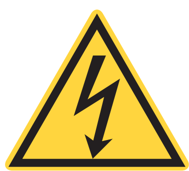
6. Unscrew the Bulk board from the laser head and remove it.
7. Remove the Controller Module Shifter from the Bulk board.
8. Fit the Controller Module Shifter to the new Bulk board.

9. Mount the replacement Bulk Board to the laser head.
10. Remake all of the connections to the new board.
11. Switch the laser ON at the PSU and look for faults that might indicate a bad connection (communication faults for example). If they are thrown, switch OFF and reconfirm connections and switch back ON.
12. Upload the old EEPROM using the EEPROM manager.
13. Key ON the laser and confirm function.

Introduction

Use the following procedures to replace the Discovery diode and TEC drivers.

CAUTION!
Electronic components can be damaged by electrostatic discharge. Make sure properly grounded wrist straps are worn when handling printed circuit board assemblies. Use ESD packaging as necessary.

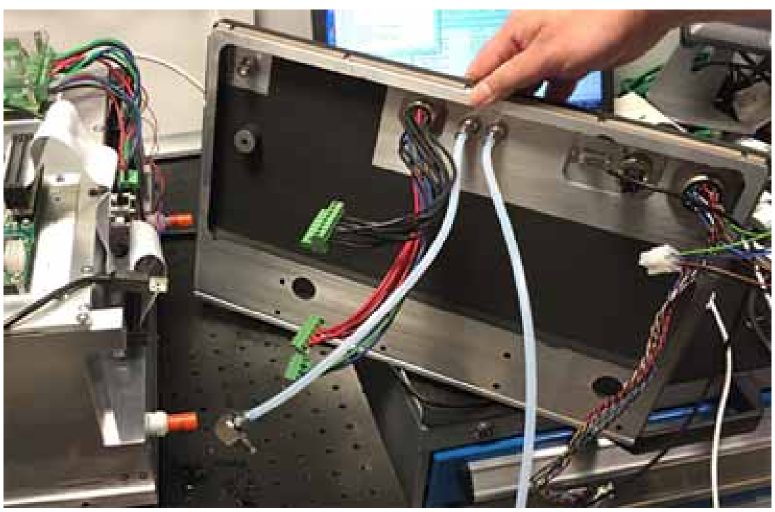


WARNING!
Make sure mains power is in the OFF position before you use an ESD wrist strap. Grounding yourself with power applied can cause an electric shock.

Diode Driver Replacement

1. Power OFF the power supply.
2. Power OFF the chiller.
3. Power OFF the MRU.
4. Disconnect umbilicals, chiller hoses and MRU hoses from laser head rear panel.
5. Remove the back panel (10 M4 bolts).
6. Disconnect internal connectors and MRU hoses to completely disconnect the back panel from the laser head. See Figure 5.5-1.

Back Panel



Connections

Figure 5.5-1. Back Panel

7. Disconnect the black, blue, red & green cables from the diode driver. See Figure 5.5-1.
8. Disconnect J2 D-Sub and J3 white Molex connector.
9. Remove the diode driver.
10. Clean thermal paste from the back of the diode driver block.

Figure 5.5-2. Diode Driver

11. Apply a small amount of heat sink compound (0.1 mm thick) and spread evenly along the new diode driver block.
12. Install the new diode driver.
13. Replace the connectors and back panel.

NOTICE

When replacing the back panel, verify the cabling is not pinched between the housing and back panel.

TEC Driver (Temperature Controller) Replacement - Classic Only

The temperature controller TEC Drivers are not present on current and future Discovery builds.

1. Power OFF the power supply.
2. Power OFF the chiller.
3. Power OFF the MRU.
4. Disconnect umbilicals, chiller hoses and MRU hoses from laser head rear panel.
5. Remove the back panel (10 M4 bolts).
6. Disconnect internal connectors and MRU hoses to completely disconnect the back panel from the laser head. See Figure 5.5-1.
7. Disconnect:
    a. J1 = Diode 1 poweramp TEC
    b. J2 = Diode 2 poweramp TEC
8. Install the new TEC driver.
9. Replace the connectors and back panel.

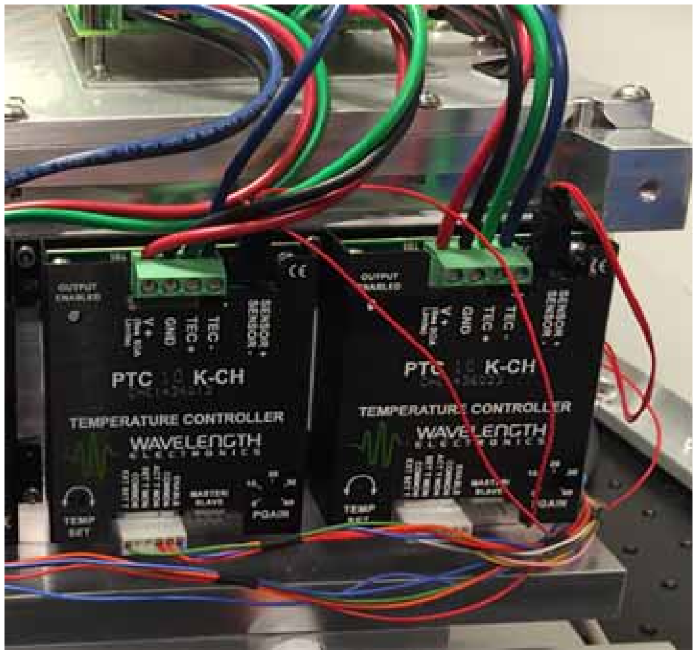


Figure 5.5-3. TEC Drivers

This Page Intentionally Left Blank

Shutter Assemblies Replacement

1. Power OFF the laser system.
2. Remove the front panel.
   (Current systems have 10 x M4 Allen bolts)
   (Earlier systems had 8 x M5 Allen bolts and 2 x M4 Allen bolts)
3. Replace the required shutter. (3 x M3 Allen bolts)
   Both shutter assemblies are interchangeable. The connectors are in sequence left to right.

Figure 5.6-1. Shutter Assemblies

This Page Intentionally Left Blank

AOM RF Driver Replacement

The following procedure only applies to the old style NG TPC system.

The AOM attenuators are controlled and driven by RF drivers (one per beamline). The drivers provide RF electrical power at the required frequency and magnitude to the attenuators. In response to the RF power applied to them, the AOMs diffract light from their beamline to the laser output. If there is a problem with the RF driver, it might not be possible to enable output since the AOM must be active for this to happen. For reference throughout this section, the RF driver and its connections are shown below.

Driver Replacement Procedure

1. Power OFF the laser system.
2. Remove cover per the instructions in “Discovery and Discovery NX Cover Removal” on page 5.1-1.

Tunable driver is on the right, fixed on the left if standing behind the laser head.

3. Carefully disconnect ribbon cable, avoiding pulling on wires, then remove serial and SMA connectors as shown in Figure 5.7-1 for Discovery TPC and Figure 5.7-2 for Discovery NX TPC.

Care should be used when disconnecting SMA cables.
A flat screwdriver can be used to help create a gap between the socket and the connector. Avoid pulling on cable.

4. Remove the 4 mounting screws on driver and replace module.
5. Remake connections shown Figure 5.7-1 and Figure 5.7-2.

Test New Driver

1. Power the system ON at the PSU.

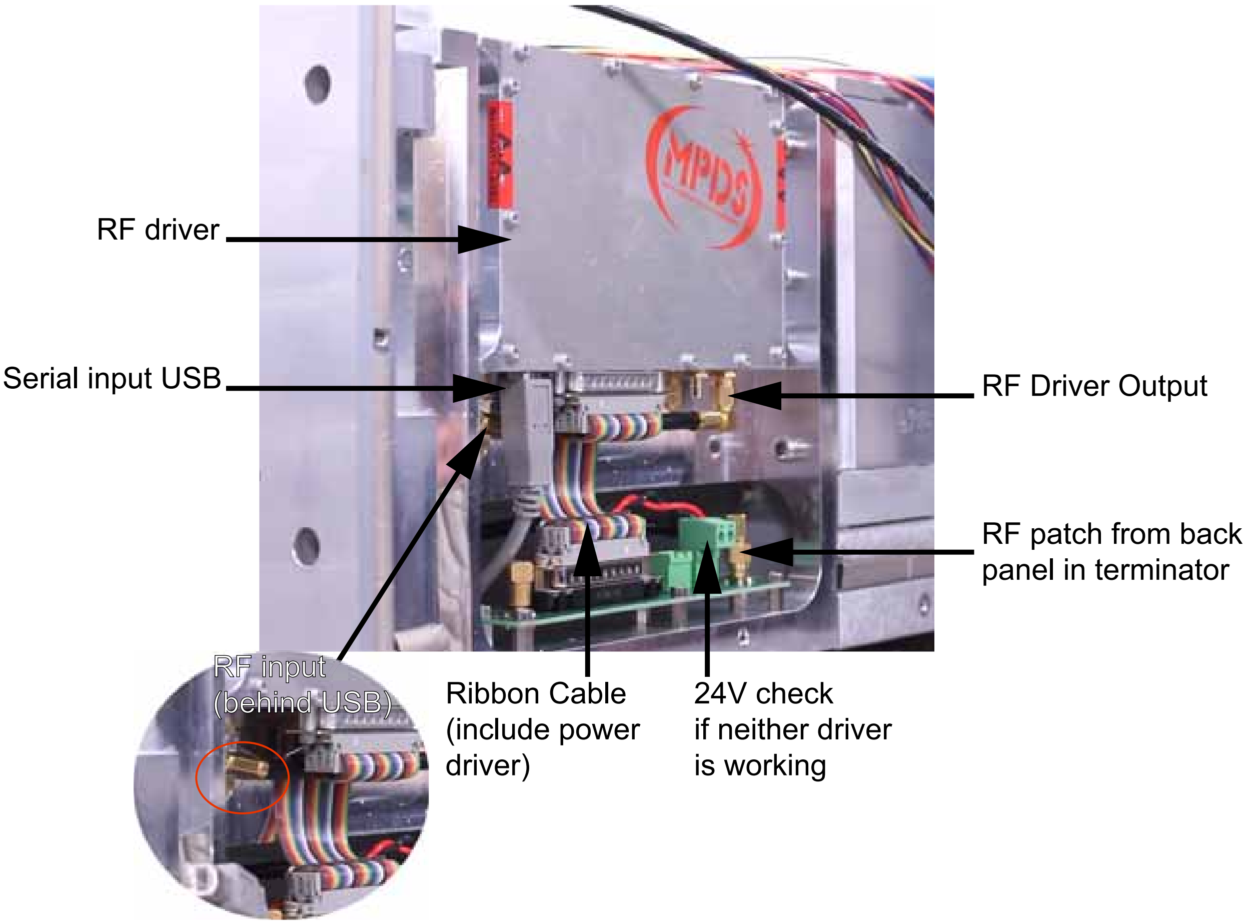


Figure 5.7-1. RF Driver for Discovery TPC

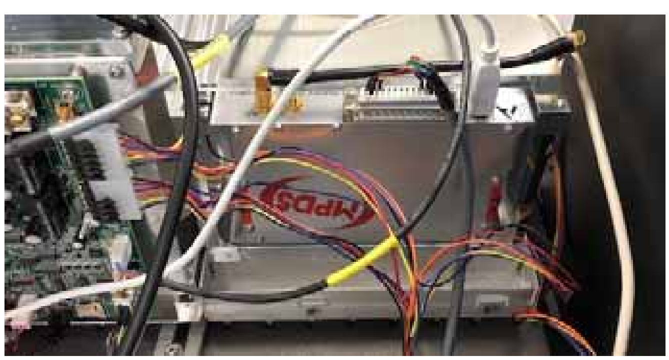


Figure 5.7-2. RF Driver for Discovery TPC NX

2. Connect to driver with the service GUI.
   Use the old calibration file to get light out of the laser.
3. Test the output with an external power meter.
   If the repair was successful, a new, optimized calibration file should be produced.
4. Replace the cover.

This Page Intentionally Left Blank

AOM Calibration Introduction

The calibration file contains the RF power and frequency values that the RF drivers need to be set to in order to provide the user set output optical transmission at a given wavelength. It comprises three tables:

- RF power in dBm for a given percentage transmission in the fixed output
- RF power vs transmission vs wavelength for the variable
- RF frequency in MHz for a given wavelength on the variable

The latter is the RF frequency at a given wavelength required to keep the pointing of the beam out of the AOM constant throughout the tuning range and RF power for a given percentage transmission for the fixed output. Therefore there are 3 corresponding calibrations to populate the three lookup tables.

The full set of calibration file values can take up to 3 hours to complete. The longest single calibration is the 'variable' RF power run at approximately 2 hours, next is the 'Y axis' at approximately 30 minutes (at 10 nm stepping intervals) and the 'Fixed' RF power takes approximately 15 minutes. They can be completed in any order to generate the finalized calibration file. And not all calibrations necessarily need to be run, if they are not required to produce a working calibration file.

Each time one of the three calibrations is run, a new, full calibration file is produced and adopted by the GUI. The file consists of the values uploaded from the calibration that has just taken place. The other two tables are populated with existing values from the currently utilized calibration file and remain unchanged.

In the case of the NG TPC, the calibration file is always an external text file, which is consulted by control software, such as the Coherent GUI. In the case of the Discovery NX TPC, the calibration file is held within the EEPROM and updated automatically during calibration procedures, see Figure 5.9-1. In addition, an external calibration.txt file is also and simultaneously created for use with USB control (Legacy Mode).

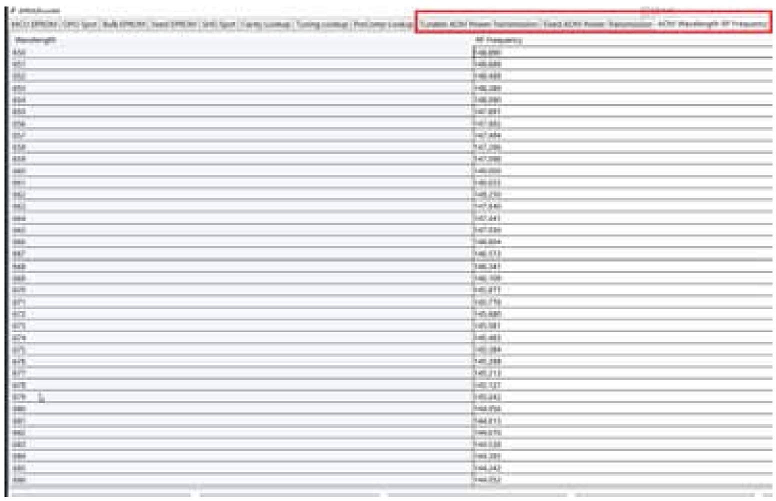


Figure 5.9-1. AOM Wavelength - RF Frequency GUI Tab

Creating Calibration File

1. Set up the beam profiler, variable and fixed output power meter as shown in Figure 5.9-2.

- Beams are aligned into 2 power meters (or 1 at a time).
- First pickoff from main beam (variable) to BP209IR profiler. **Note that there should be a path-length of 1.2 m.**
- 2nd pickoff from main beam (variable) to WaveScan.
- USBs from instruments connected to DC supplied USB hub.
- The laser is allowed to warm-up for > 30 minutes.

On the PC, locate the calibration file folder
C:\ProgramData\Coherent\Glasgow GUI\AOM Files
and clear out (or archive) any old files in the folder. Having old files in the folder from other lasers will cause file naming confusion. **Note that this folder is a 'Hidden' folder and will not be visible unless 'show hidden folders' selected in windows settings.**

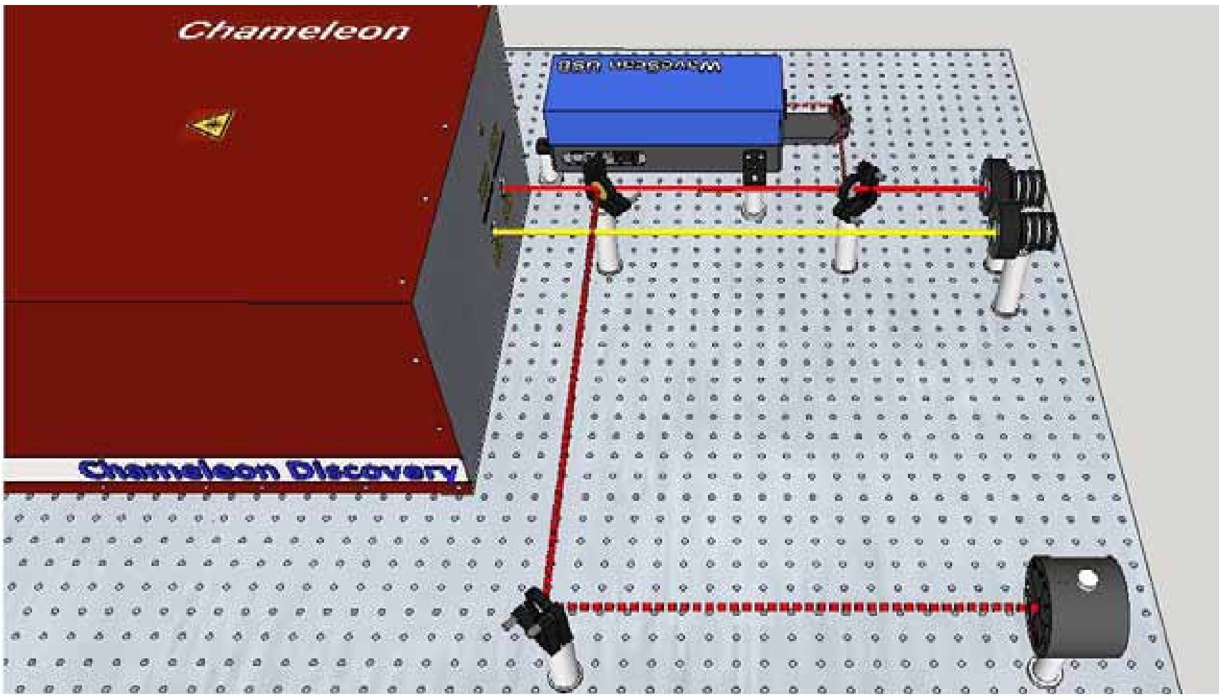
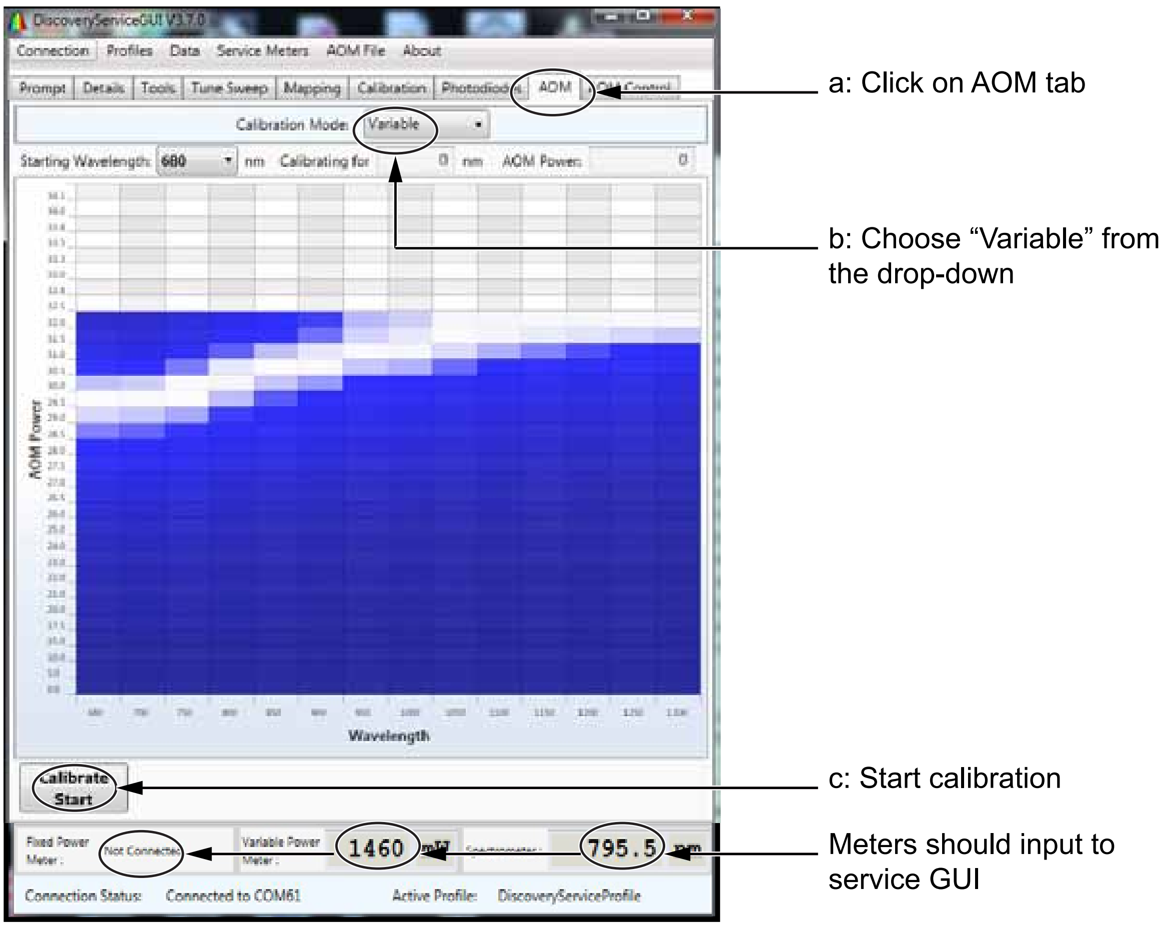
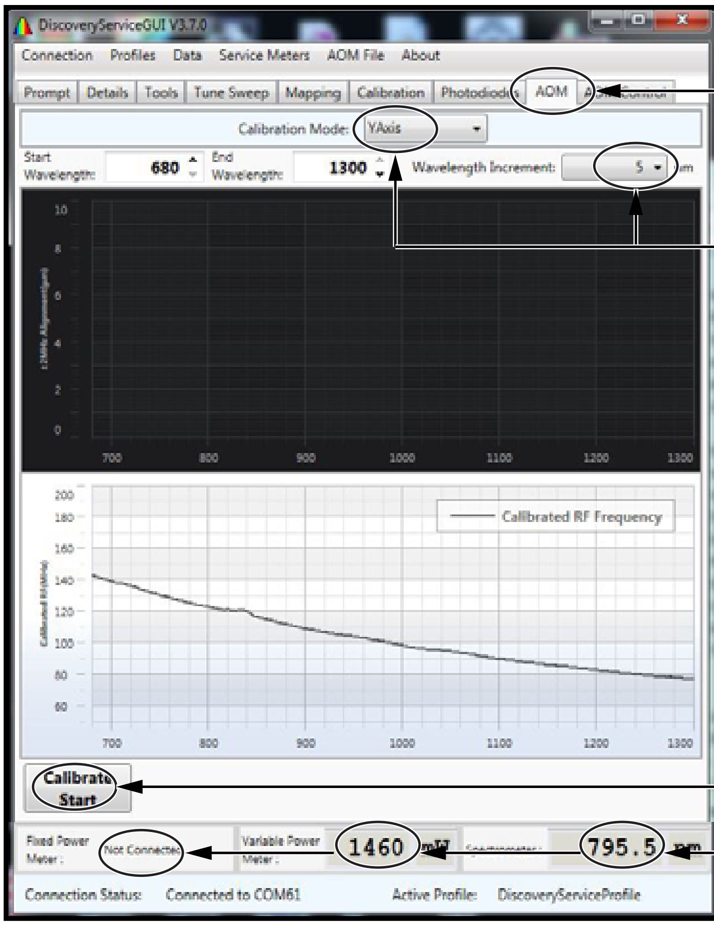


Figure 5.9-2. TPC Calibration Set-up

2. Perform a variable wavelength- AOM/RF power calibration. Using the thermopile power meter connected as “variable” and the WaveScan, update the variable calibration profile using the service GUI. Follow steps a to c shown below.



3. Update the frequency calibration using steps a to c shown below.



a: Click on AOM tab

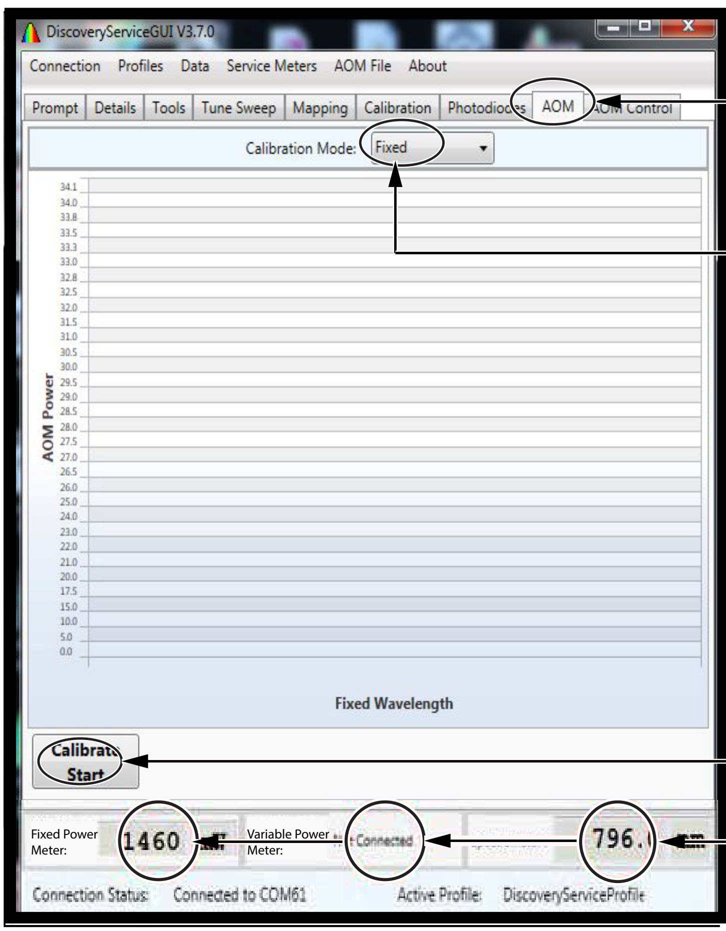
b: Choose “Y-Axis” from the drop-down,
10nm increments

c: Start calibration

Wavelength and pointing (via BP209 read during the calibration)

4. Update the fixed RF Power/Transmission table. Follow steps a to c shown below.

   If there is only one power meter, disconnect it in “Service Meters” and reconnect it as “Fixed Power Meter”.
   Physically move the power meter to the fixed output



a: Click on AOM tab

b: Choose “Fixed” from the drop-down

c: Start calibration

Meters should input to service GUI

5. External calibration text files are stored in the calibration file folder defined in step 1 with the latest file being the fully updated file, in addition to the other two partially updated files. Keep the latest one for your records - the GUI will automatically adopt and be currently using the newest version. This will match the one in the EEPROM on NX TPC systems. Label the final file with 'final' in addition to the automatic date-stamp to avoid getting confused with the two other partial calibrations and the original.
The 'final' calibration file must be transferred to the customer's PC at the end of the service visit. Older TPC models (CV=4) require that the customer GUI (or equivalent) has access to the calibration file. This is also the case if the customer is using the NX TPC in Legacy Mode.

If the calibration values have been updated in order to counteract an issue, such as those stated above, the system should be retested.
If there has been a significant change in the calibration file in order to re-establish performance, please inform Coherent Scotland, providing as much detail as possible.

This Page Intentionally Left Blank

Introduction

Direct RF means that the customer is supplying the AOM RF drive directly to the AOM, bypassing the on-board drivers. The RF power is patched directly from the laser head back panel SMA socket to the corresponding AOM input SMA. Therefore, the Coherent driver must be disconnected and disabled and the RF patch must be established in its place.

Configuring the Direct RF

1. Power OFF the system.
2. Remove cover per the instructions in “Discovery and Discovery NX Cover Removal” on page 5.1-1.

Note that the fixed driver is on the left side and the tunable on the right side if you are standing behind the laser head

3. Follow the directions as indicated in Figure 5.8-1.
   a. Disconnect the ribbon cable from the driver and tape/cover end.
   b. Disconnect the RF output from the bulkhead, situated behind the USB serial input cable going to the driver.
   c. Disconnect the SMA patch cable currently in the terminator and insert this into the bulkhead, where you've just disconnected the RF from the Coherent driver.
   d. Terminate the RF cable from the Coherent driver into the terminator, where you have just disconnected the patch.
   e. Repeat if necessary for a second driver.
   f. Replace the cover.

Only the “RF in” SMA sockets are now functional in terms of attenuation inputs on the back panel. The customer should check that their RF matches the socket protocols stated in Table 2.3-1 on page 2.3-2.

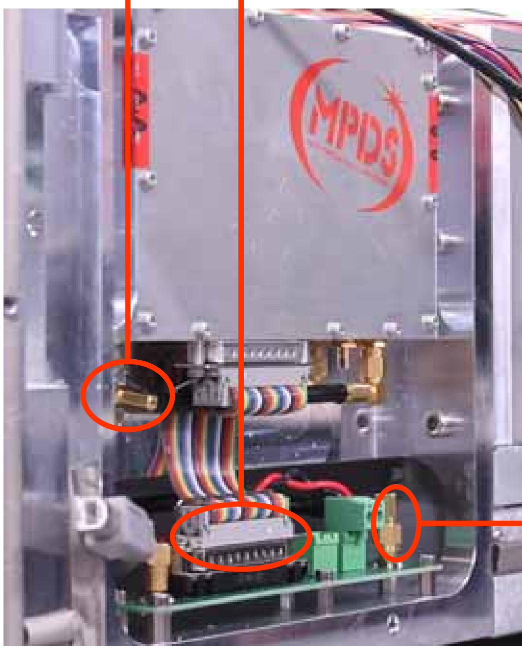


Figure 5.8-1. Direct RF Driver Configuration

Pump Module Replacement

The pump module replacement can be utilized on all versions of the Discovery laser systems. After completing the replacement, the Classic version of the Discovery laser will need a temperature optimization. Proceed to "Classic Tune Diode Temperatures" that provides additional instructions for temperature tuning.

The pump modules for the Discovery versions are different. Verify part numbers are correct for the system that is being serviced.

Table 5.10-1. Pump Module Part Numbers

System	System Part #	Pump Module Part #
Classic	1260938	1270784
NG	1323389	1392093
TPC	1342400	1392093
NX	NA	NA
NX TPC	NA	NA

Tools

Parts used: Pump Module FRU

Tools:

- Fiber inspection scope (JDSU P5000i and software installed on laptop, or equivalent)
- Standard hex keys and screw drivers
- Fresh IPA Cleaning fluid
- Cletop S fiber end cleaner
- Dummy connection E2000 fiber inspector
- Silicon thermal paste (included in pump module)
- Nitrile-free rubber gloves
- Sticklers
- IPA wipes

Pump
Module

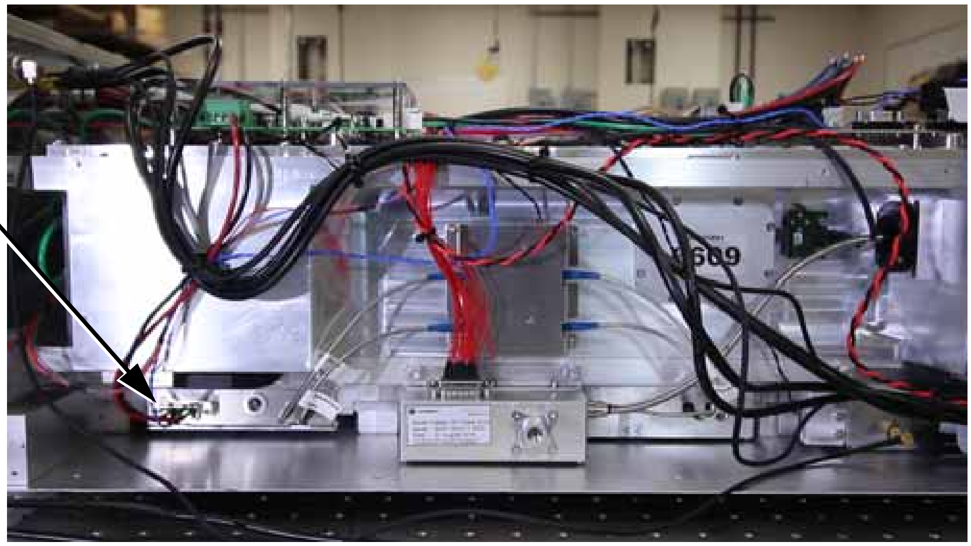


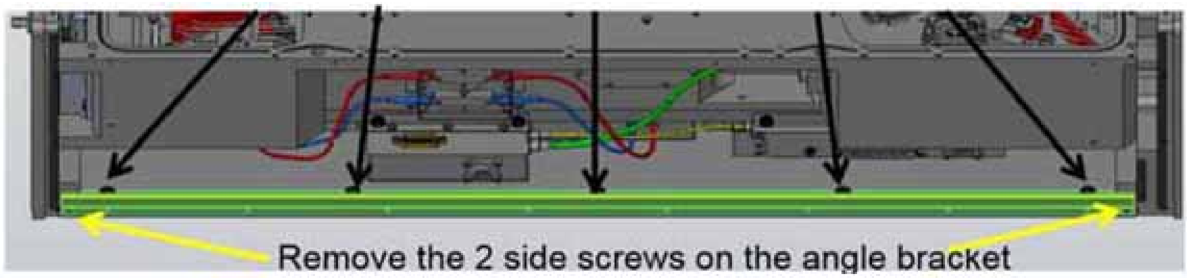
Figure 5.10-1. Pump Module Location

Removing the Pump Module

Care should be taken when removing the original pump module; there is a considerable amount of thermal paste, which can be messy and presents the risk of fiber contamination.

The pump module can be seen in Figure 5.10-1.

1. Loosen the captive screws on the angle bracket.
2. Remove the bracket.
3. Disconnect the electrical cables from pump module.
4. Remove fiber cover.
5. Press down on the black release clip, and gently pull the fiber out of the housing shown in Figure 5.10-5. The cap should



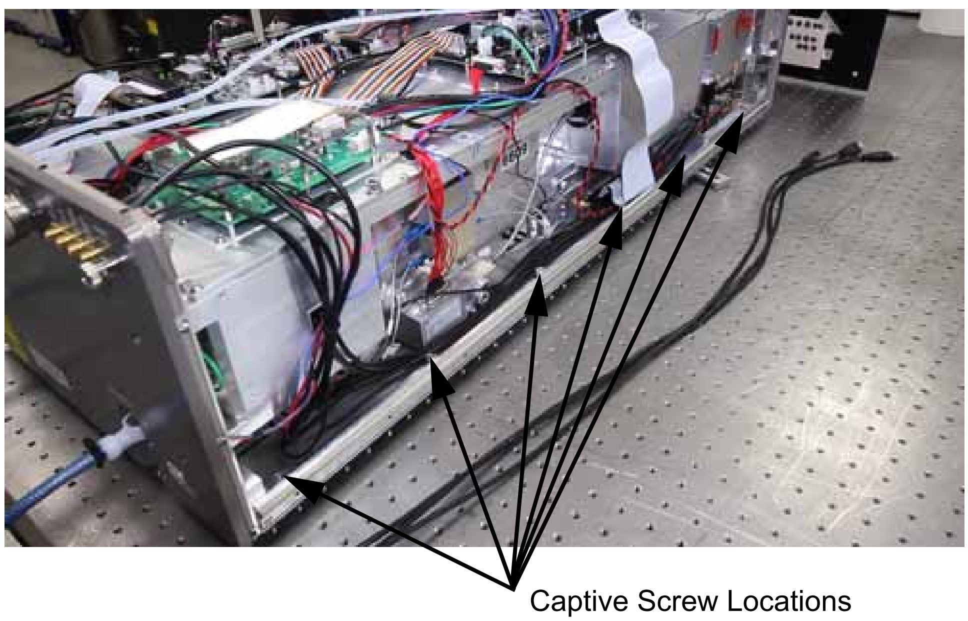


Figure 5.10-2. Screw Location for Angle Bracket

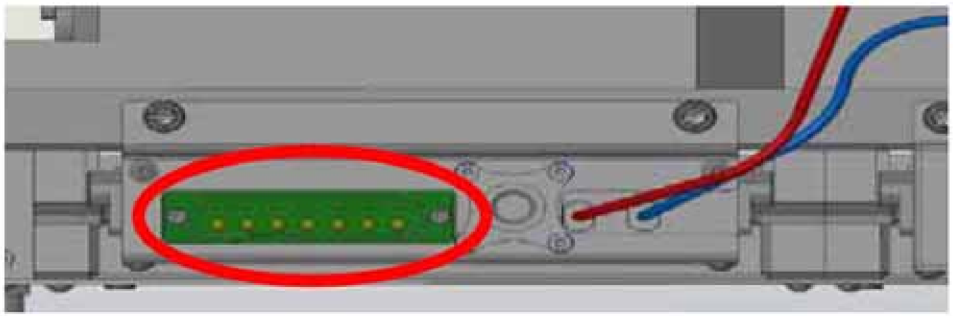
automatically cover the fiber end. Do this for both connectors coming from the pump module.

6. Loosen the captive screws on the pump module.
7. Locate the pump module handle. Gently pull the module out.

The pump module uses heat sink paste, and may be sticky to remove.

---

8. Use IPA wipes to remove the thermal paste.



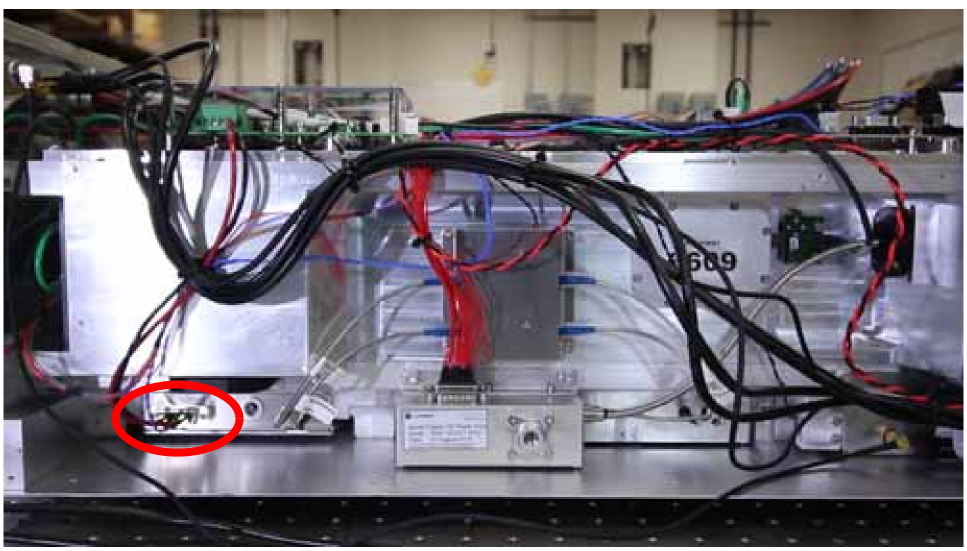
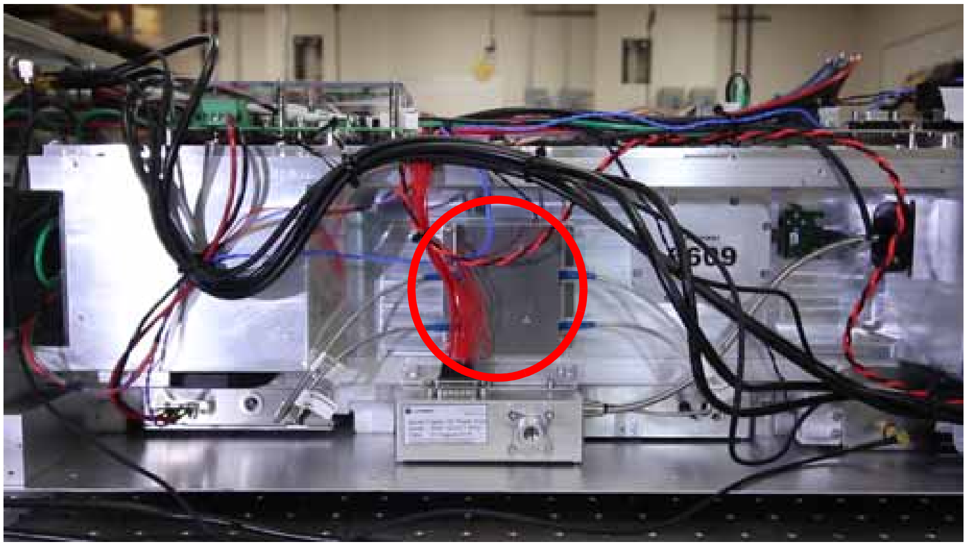


Figure 5.10-3. Electrical Cable Location

Fiber Cleaning and Inspection

The pump Module and power amp are connected by Diamond E2000 connectors with self-closing dust covers. Before fitting the pump module, the fiber ends must be inspected and cleaned if necessary.

As a precaution, the fiber ends of the old pump module should also be inspected. If signs of burning, contamination or damage is present on the old pump module's fibers, the fibers on the power amp side must also be inspected and cleaned if necessary. If they cannot be cleaned, the module replacement should not take place, as it will destroy the new pump module.



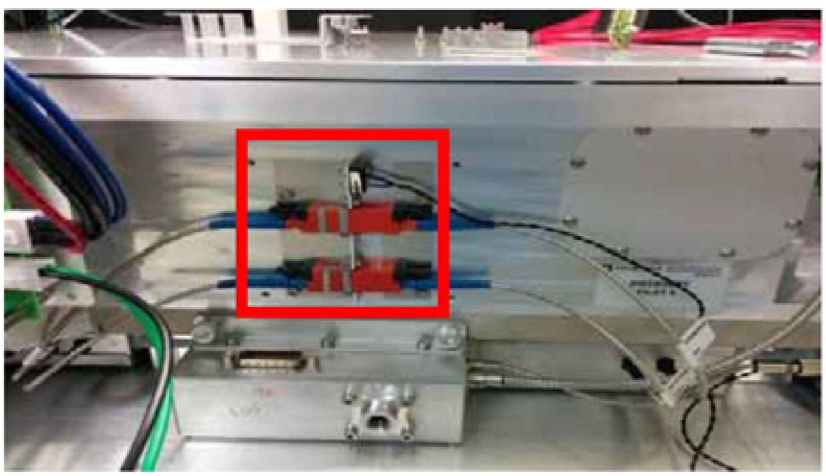


Figure 5.10-4. Fiber Cover Location

Fibers should NOT be inspected while the module is connected.

1. Use the JDSU P5000i camera and fit the FBPT-U25M tip. Load up the Fiber Check Pro software.

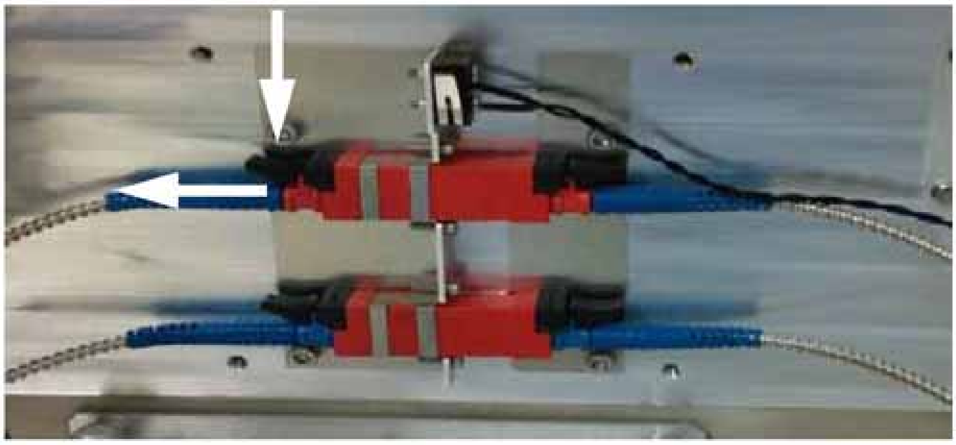


Figure 5.10-5. Removing Fiber

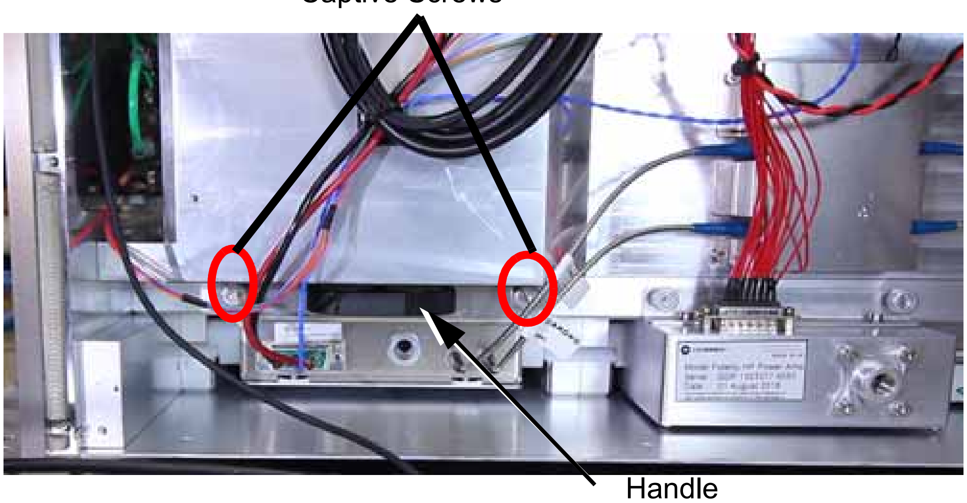


Figure 5.10-6. Captive Screws and Handle Location

2. Take the dummy socket and push over the connector to expose the fiber end.
3. Carefully insert the fiber end into the tip until it is fully located.

Figure 5.10-7. FBPT-U25M Tip

Dummy Socket

Dummy Socket on Exposed Fiber

Figure 5.10-8. Using Dummy Socket

Aligning fiber to tip

Fiber inserted into tip

Figure 5.10-9. Inserting Fiber to Tip

Inspection Guidelines

Light level

Too Bright Target Too Dark

Figure 5.10-10. Light Level

Cleanliness

Pass Fail

Figure 5.10-11. Fiber Cleanliness

Cleaning

Cletop: Slide on red inspection clip to expose the fibre. Hold down the blue ‘switch’ to expose a new area of clean tissue. Drag the fibre tip along the surface of the tissue in parallel lines.

Figure 5.10-12. Cletop

Sticklers: If the contaminants cannot be removed using the Cletop, use the white MCC-XMT sticklers. Dip the cleaning end in IPA or Stickler cleaning fluid then press the tip onto the end of the fiber with enough force to gently indent the Stickler. Rotate the Stickler along the fiber axis up to 10 rotations. Dispose of the Stickler after 1 use. Use the Cletop to wipe the fiber free from any residue and re-inspect.

Note that IPA residue, if not properly removed can also contaminate the fiber.

If the fiber end cannot be cleaned, contact the factory before continuing with the procedure – do not proceed to make the fiber connections and test. Contaminants burn and cause permanent damage to the fiber end.

Remove the dummy connector so that covers are closed while putting the new module in.

Figure 5.10-13. Sticklers

Fitting the Pump Module

Thermal paste needs to be added to this module before fitting. The most important area to cover is close to the diodes, however covering the whole surface is beneficial to heat transfer. The purpose of the thermal paste is to fill the microscopic air gaps in between the baseplate and the module.

1. Apply a thin, even layer of thermal paste.

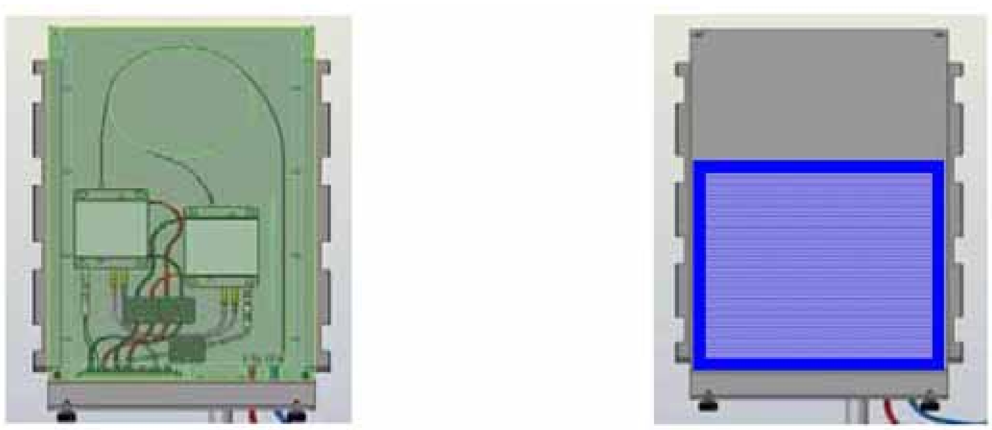


Figure 5.10-14. Thermal Paste Location

2. Slide the module into position and tighten the screws as shown in Figure 5.10-15.

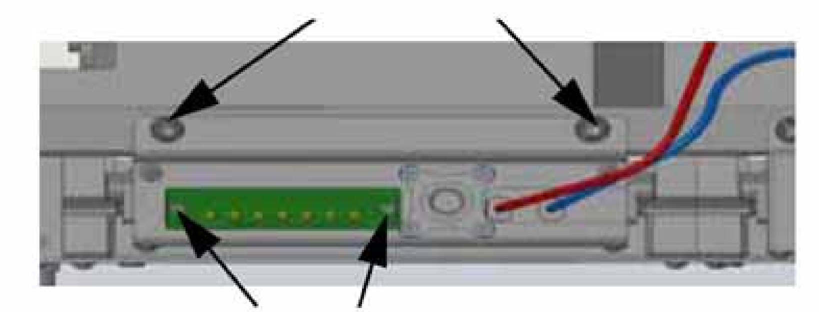


Figure 5.10-15. Screw Locations

3. Connect the two Diamond connectors (make sure the color matching is correct as below) and reconnect the electrical connection. Refit the interlock shield.

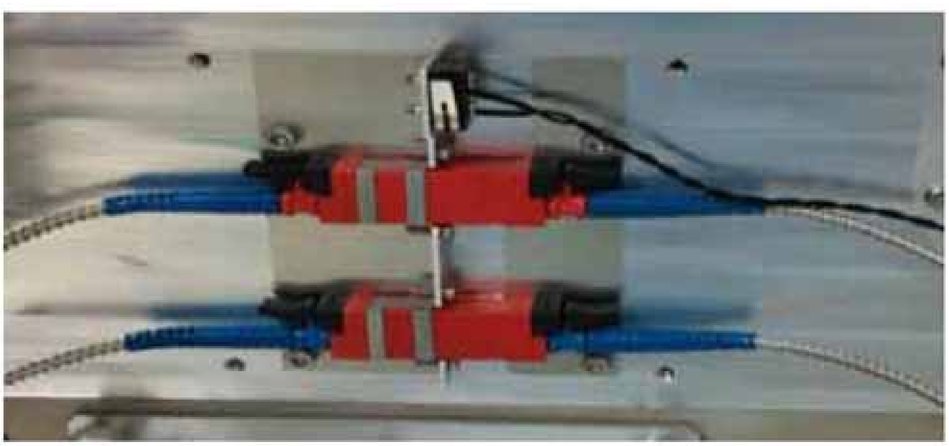


Figure 5.10-16. Diamond Connectors

4. Replace the bracket and outer cover.
5. For the Classic version, proceed to “Classic Tune Diode Temperatures” for additional steps on temperature tuning.

Classic Tune Diode Temperatures

This procedure is to be carried out *only* on Discovery Classic systems upon which the pump module has been replaced in the field.

Determine Discovery Version

This procedure is only necessary on the classic Discovery model. On NG and TPC Discovery the pump module replacement does not include a temperature optimization because there are no TEC drivers or need to set diode temperature manually on newer models. First check whether the unit is a “Classic” Discovery or NG/TPC.

Query `?CV` and if the response is 5 or greater, this indicates that it's a TPC and thus this part of the procedure is unnecessary.

The check can also be made physically, by inspecting for the presence of the TEC controllers found under the cover, just behind the rear panel.

1. Check that the pump is in green light loop mode (2) as below.

   ```
   ?pump:mode:4
   ```

   ```
   Pump:mode:4=3
   ```

2. Switch on the laser and allow to ramp to set point.
3. If it faults out with F51, go to F51 method below. This fault occurs when the diode current cannot be set at a value that provides 8 W of green power, which can be because the diode temperatures are too far from their optimal set point to use the standard optimization method.

Optimize Diode Temperature Using Pump Diode Drive Current in Light Loop

1. Once laser has stabilized after > 30 minutes, observe the temperature set points of the pump diodes.

   ```
   ?pump:tdl:4
   ```

   ```
   ?pump:tdl:5
   ```

2. Observe the diode current used to maintain 8 W green in light-loop.

   ```
   ?pump:aidl:4
   ```

3. The objective is to find the pump diode temperature at which the **pump current** required to reach 8 W green pump power is **minimum**. Find the minimum current by changing diode 4 and 5 temperatures using `Pump:tdl:4` and `Pump:tdl:5` while monitoring the actual temperature of the diodes using `?pump:atdl:4` and `?pump:atdl:5`. The “Temperature Set-Point Optimization Procedure” can be referenced for more details.

Optimize Diode Temperature Using Green Power Level in Current Loop (Fault 51 Case)

There is a possibility that the diodes will be so far from their optimal temperature set point that 8 W of green pump power will not be achievable within the permissible current range, resulting in a fault-out at “key ON”. In such cases, the diode temperature optimization should take place in current loop. The laser will be set to run in current loop and the diode temperatures will be optimized to provide the highest green power possible at the input current.

1. Key OFF the laser.
2. Change the “set current” to 6.5 A. Note that is this current it is unlikely that 8 W of green will be realized at `?p2` - this is not a problem.
3. Change the pump mode to “current loop” (`pump:mode:4=1`).
4. Key the laser ON and wait for it to ramp up.
5. Observe the green and IR powers (`?p2` and `?p1`)
6. Wait for >30mins.
7. Observe the green power (`?p2`).
8. The objective will be to maximize green power by changing the diode temperatures. Note that the fault will also arise if the pump module change has not resolved the issue of low power, but effort should be made to improve power through diode tuning while monitoring green power (`?p2`). The “Temperature Set-Point Optimization Procedure” can be referenced for more details.

Temperature Set-Point Optimization Procedure

Note that if conducting the diode temperature optimization while still in green light loop, the green power level will not change with diode temperature. Observe current in that case and only use green power as an indicator if in current loop while following the "Optimize Diode Temperature Using Green Power Level in Current Loop (Fault 51 Case)"procedure.

Increase the diode temperatures by 1 °each.

```
Pump:tdl:4 = (xx+1)
Pump:tdl:5 = (xx+1)
```

The current diode temperature can be monitored using `?pump:atdl:4` and `?pump:atdl:5`.

Continually query and observe the diode current (or if using green power to optimize with the diode current set in "current loop mode", monitor the green power instead of diode drive current) while the temperature is changing. If the diode current is decreasing (or green power increasing) up to the new temperature setting, repeat, increasing temperature another degree at a time until a minimum current, or maximum green power is reached. If the current is increasing with diode temperature (or green power decreasing), then reduce the diode temperatures (or 1 ° relative to the original set temperature). Remember to change both diode temperatures (`pump:tdl:4` and `pump:tdl:5`). Continue to observe the diode current or green power as appropriate and the diode temperature until an optimal temperature is found.

Once the optimum temperature has been found, change one diode temperature relative to the other, as they might have a slightly different optimum operating temperature.

Decrease diode 4 by 0.5 °, observing the pump current or green power.

`Pump:tdl:4=`(optimal temperature - 0.5 °)

Observe current:

```
?Pump:aidl:4
```

If the current decreases, keep changing the temperature in the same way in 0.5 degree steps. If the current increases, try increasing the temperature by 0.5 degree steps. Once a minimum current has been found, repeat the same procedure for diode 5.

`PumpLtdl:5 =`(optimal temperature - 0.5 °)

Observe current

```
?Pump:aidl:4
```

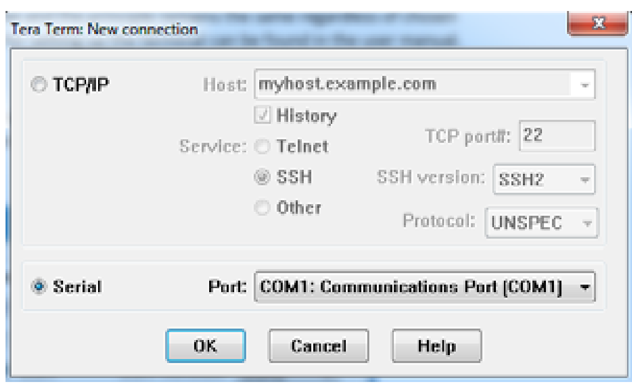
This Page Intentionally Left Blank

Tera Term Set-up

Tera Term is a terminal program that can be used to interface with the Discovery laser. Any can be used, but this is free and the principle remains the same regardless of chosen program. More general guidance for setting up the terminal can be found in the operator's manual.

Open a Communications Port

On starting, Tera Term returns two windows. One the command prompt, in which you will enter all commands and the port selection window as shown Figure 6.1-1.



PORT SELECTION WINDOW

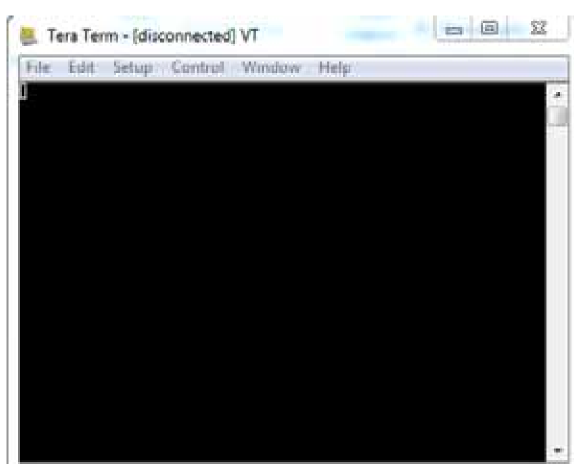


Figure 6.1-1. Tera Term Connection Windows

COMMAND PROMPT WINDOW

Figure 6.1-1. Tera Term Connection Windows

Using the “New connection” or port selection window shown in Figure 6.1-1 “Port Selection Window”, select “Serial” and find the port you have used physically to connect the Discovery. If you have trouble finding the port you have used, you can disconnect it and wait for a few moments. The disconnected port will then not be shown in the drop down list. When you are satisfied that you have the correct port, press OK.

Set-up the Port

The communications protocols must be chosen to match those of the laser or device in order that the PC can communicate with it. Note they are not selected or detected automatically.

Using the Tera Term Command Prompt window as shown in Figure 6.1-1 “Command Prompt Window”, select “Serial Port…” from the Setup drop-down menu on the toolbar. The following menu appears with default parameters as shown in Figure 6.1-2.

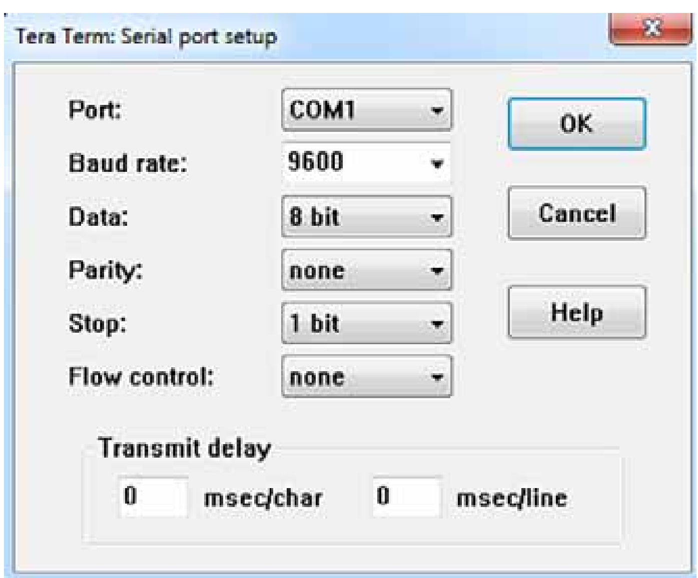


Figure 6.1-2. Default Serial Port Set-up Window

Change the Baud rate to 115200. Optionally you can improve communications robustness by applying a transmit delay of 10 ms per character and 100 ms/line in the windows at the bottom, although this is not strictly necessary. The corrected set-up should look like Figure 6.1-3 and when it does, press OK.

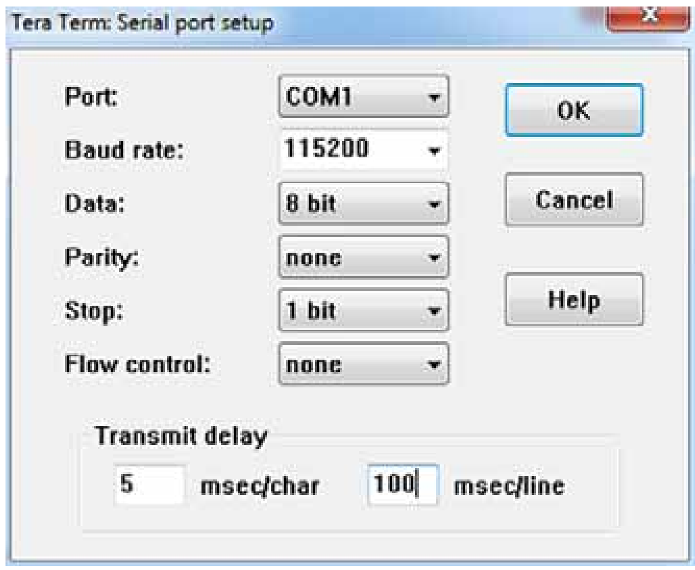


Figure 6.1-3. Correct Serial Port Set-up Window

Furthermore, the Terminal needs setting up correctly. From the Setup dropdown menu on the Command Prompt screen (Figure 6.1-1), select “Terminal…” to access the terminal setup page as shown in Figure 6.1-4.

In the “New Line” box at the top right, choose line feed and carriage return for both receive and transmit and press OK.

Test and Troubleshoot

This should conclude the set up for Tera Term. You may return to the command prompt screen and press the return key. If the terminal is set up correctly, it is expected that there will be a response DISCOVERY>.

If there is no response, it is worth checking that the correct communications port has been set up from the initial stage, that there is power to the Discovery and the connection is complete. If you are using a USB to serial converter, it is worth checking that this device has been recognized by the PC prior to use.

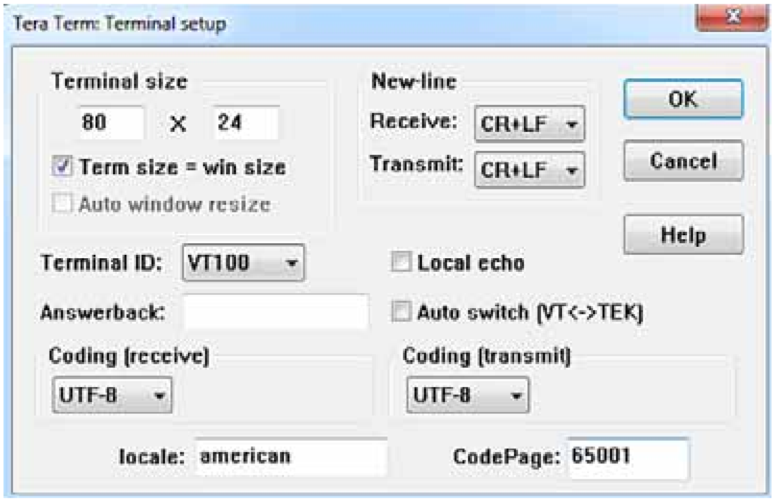


Figure 6.1-4. Terminal Set-up Window

FRU Part List

FSB 812 provides a continuously updated FRU list. FSB 812 can be found on the PIC Share Point site at:

Product Information Center → UltraFast Oscillators for Science → Chameleon Family → Service → FSBs → 812

This Page Intentionally Left Blank

Manual History

<table>
<tr><th>DATE</th><th>MANUAL UPDATE/CHANGE FORM HISTORY STATEMENT</th></tr>
<tr><td rowspan="2">9/29/2020</td><td>Release of rev AE. Updated original Discovery Service Manual with the NX information.</td></tr>
<tr><td>Safety 1.1
Installation 1.2
Fault Messages 2.1
Flow Charts 2.2
Attenuator (AOM) 2.3
Block Diagrams 3.1
Test Points 3.2
Connector Description 3.3
Software Rev and Upgrade 4.3
Cover Removal 5.1
Photodiode Calibration and Replacement 5.3
PCBA 5.4
AOM Cal 5.9
dPump module repl 5.10
FRU info 7.1
Added in universal procedures ~ tera term 6.1</td></tr>
<tr><td rowspan="2">4/19/2022</td><td>Release of Rev AF</td></tr>
<tr><td>Updated the schematics in section 2.1
Added a screenshot into section 4.1 for the command interface</td></tr>
</table>

This Page Intentionally Left Blank