Operator's Manual
DUO FAP-System ™

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In the US:

Should you experience any difficulties with your laser or need any technical information, please visit our web site **www.Coherent.com**. Additional support can be obtained by contacting our Technical Support Hotline at 800-367-7890 (408-764-4557 outside the U.S.) or E-mail (**clg.tech.services@Coherent.com**). Telephone coverage is available Monday through Friday (except U.S. holidays and company shutdowns).

If you call outside our office hours, your call will be taken by our answering system and will be returned when the office reopens.

If there are technical difficulties with your laser that cannot be resolved by support mechanisms outlined above, please E-mail or telephone Coherent Technical Support with a description of the problem and the corrective steps attempted. When communicating with our Technical Support Department, via the web or telephone, the model and Laser Head serial number of your laser system will be required by the Support Engineer responding to your request.

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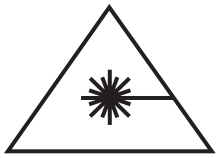
Preface

This manual contains user information for the DUO FAP-System™.

Read this manual carefully before operating the laser for the first time. Special attention should be given to the material in Section Two: Laser Safety.

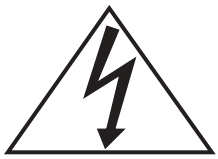


Performance of procedures other than those specified in this manual may result in hazardous radiation exposure. It is the policy of Coherent to comply strictly with U.S. export control-laws.

U.S. Export Control Laws Compliance

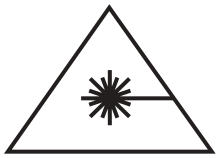
Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations. The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification should be obtained from Coherent or an appropriate U.S. Government agency.

Symbols Used in This Manual



This symbol is intended to alert the operator to the presence of dangerous voltages associated with the laser that may be of sufficient magnitude to constitute a risk of electric shock.

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 danger of Electro-Static Discharge (ESD) susceptibility.

SECTION ONE: DESCRIPTION AND SPECIFICATIONS

System Description

The DUO FAP System is a turn-key, fiber-delivered laser diode system. The system consists of a single enclosure (Figure 1-1), including two integrated fiber array (FAP-I) packaged laser diode bars mounted on an air-cooled heat sinks, with all the required drive and control electronics. The FAP-I packages have been assembled with thermoelectric coolers in sealed packages to control laser diode temperature control below the dew point. The electronics support diode temperature control and continuous wave (CW) diode operation. The DUO FAP System is table- or rack-mountable, plugs into a standard wall socket, and requires no water cooling. The maximum output optical power and system wavelength varies with the specifications of the FAP-I laser diodes installed in the system.

Figure 1-1. DUO FAP System

In the DUO FAP System, optical radiation is delivered via either rear- or front-panel-mounted, with a 3-meter, rugged armored fiber. The fiber end can be assembled with an SMA-type connector. Various accessories are available to image or collimate the optical output of the output fiber.

An integrated low power aiming beam laser diode module is available in the DUO FAP System. The DUO FAP System FAP-I laser diode modules are field-replaceable by the user; however, Coherent recommends that factory-trained personnel perform the service.

The DUO FAP System uses sophisticated microprocessor control. The digital control signals can be generated locally using the user interface or remotely using a personal computer or other device capable of sending and receiving ASCII via RS-232 or RS-485 interface.

Front panel indicator LEDs and user interface LCD display shows DUO FAP System status and various operational parameters.

It is possible to connect several DUO FAP System together using RS-485 network. Up to ten devices can be operated from a single user interface or host computer.

Specifications

Specifications for the DUO FAP System are listed in Table 1-1. Figure 1-2 shows a mechanical drawing of the DUO FAP System.

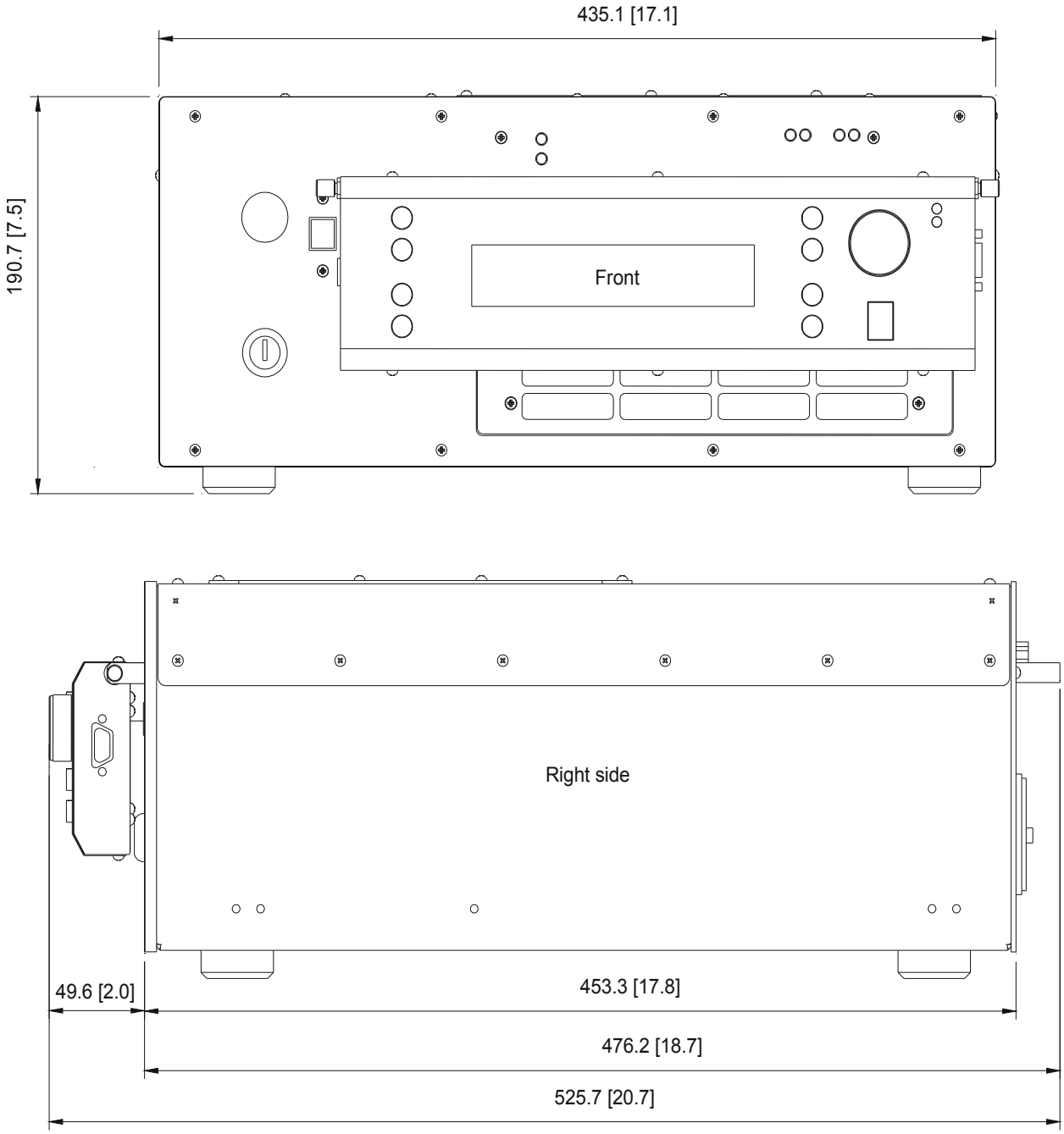
Table 1-1. Specifications

PARAMETER	SPECIFICATION
OPTICAL SPECIFICATIONS	
Wavelength	785 to 820 nm, 940 nm and 980 nm
Optical power	Refer to FAP-I package laser data sheet
Spectral width	< 3 nm
Beam divergence	< 0.20 NA
Beam diameter	2 X 800 µm or 1 X 1700 µm fiber bundle
Power stability	± 5%
Noise	< 1% rms
Fiber optical cable	5 m, armored or 3 m, armored cable
Fiber optic cable termination	SMA905

Table 1-1. Specifications (Continued)

PARAMETER	SPECIFICATION
LASER DIODE CONTROL SPECIFICATIONS	
Operating temperature range	0°C to 40°C
Temperature stability	± 0.5°C
Operating mode	CW
Operating current	0 to 60 A per laser diode (maximum)
Output current accuracy	± (0.1% + 10 mA)
Temperature control range	10°C to 40°C
Temperature control accuracy	± 0.1°C
SYSTEM SPECIFICATIONS	
Input devices	User interface buttons, RS-232, RS-485, foot pedal
Operating temperature	0°C to 30°C
Cooling requirements	Internal fan, 10 cm clearance fan inlet and exhaust
Operating humidity	5% to 95%, non-condensing
Storage temperature	–20°C to 65°C
Operating voltage (auto sensing)	96 VAC to 264 VAC, 50/60 Hz
Power consumption	< 2000 W (< 1000 W typical)
Altitude limitations	Use below 2000 m (6500 ft.) altitude
Dimensions	435 mm wide x 178 mm high x 451 mm deep
Weight	26 kg (57 lbs.)
The above specifications subject to change without notice. This device is intended for indoor use only.	

Dimensions



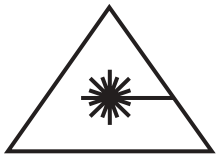
Note: [inches]

Figure 1-2. DUO FAP System Mechanical Layout

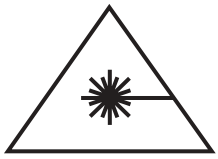
SECTION TWO: LASER SAFETY

Laser Safety

The DUO FAP System emits Class IV laser radiation. Extreme care must be exercised during operation. Only persons familiar with the safety precautions and practises in this manual should operate the laser products.



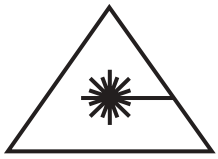
DANGER
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION



WARNING
THE DUO FAP System IS A CLASS IV LASER PRODUCT.
AVERAGE POWERS OF UP TO 100 W COULD BE
ACCESSIBLE. ALWAYS WEAR PROPER
EYE PROTECTION WHEN OPERATING.

Optical Safety

Because of its special properties, laser light poses safety hazards not associated with light from conventional sources. The safe use of lasers requires that all laser users—and everyone else near the laser system—are aware of the dangers involved. The safe use of the laser depends upon the user becoming familiar with the instrument and the properties of intense and coherent beams of light.

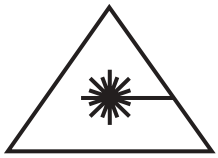


Direct eye contact with the output beam from the laser will cause serious damage and possible blindness.

Laser beams can ignite volatile substances such as alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers and photodiodes. Reflected beams may also cause damage. For these reasons, the user is advised to follow the precautions below.

1. Observe all safety precautions in the operator's manual.

2. Exercise extreme caution when using solvents in the area of the laser.
3. Limit access to the laser to qualified users who are familiar with laser safety practices and who are aware of the dangers involved.
4. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
5. Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.



Laser safety glasses can present a hazard as well as a benefit while they protect the eye from potentially damaging exposure; they block light at the laser wavelengths, that prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

6. As a precaution against accidental exposure to the output beam or its reflection, those using the system should wear laser safety glasses as required by the wavelength being generated.
7. Avoid direct exposure to the laser light. The intensity of the beam can easily cause flesh burns or ignite clothing.
8. Use the laser in an enclosed room. Laser light will remain collimated over long distances and therefore presents a potential hazard if not confined.
9. Post warning signs in the area of the laser beam to alert those present.
10. Advise all those using the laser of these precautions. It is good practice to operate the laser in a room with controlled and restricted access.

Safety Features and Compliance to Government Requirements

The laser electronics are designed to meet UL, CE, and IEC-1010 safety standards. The system is complaint with CDRH and CE safety standards.

The following features are incorporated into the instrument to conform to several government requirements. The applicable United States Government requirements are contained in 21 CFR, subchapter], part II administered by the Center for Devices and Radiological Health (CDRH). The European Community requirements for product safety are specified in the Low Voltage Directive

(LVD) (published in 73/23/EEC and amended in 93/68/EEC). The Low Voltage Directive requires that lasers comply with the standard EN 61010-1 “Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use” and EN60825-1 “Radiation Safety of Laser Products”.Compliance of this laser with the (LVD) requirements is certified by the CE mark.

Laser Classification

The governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The DUO FAP System is classified as Class IV based on 21 CFR, subchapter J, part II, section 1040-10 (d). According to the European Community standards, the DUO FAP System laser is classified as Class 4 based on EN 60825-1, clause 9. In this manual, the classification will be referred to as Class 4.

Protective Housing

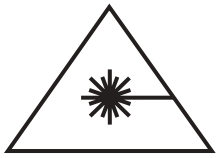
The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class I radiation as specified in the Federal Register, July 31, 1975, Part II, Section 1040.10 (f) (1) and Table l-A/EN 60825-1, clause 4.2 except for the output beam, which is Class IV.

Laser Radiation Emission Indicators

The appropriately labelled lights on the DUO FAP System front panel illuminate when the laser is set to the “LASER ENABLED” state. Green lights are used and are visible while wearing safety glasses. [CFR 1040.10(f)(5)/ EN 60825-1, clause 4.6].

Operating Controls

The laser controls are positioned so that the operator is not exposed to laser emission while manipulating the controls [CFR 1040.10(f)(7)/EN 60825-1, clause 4.8].



Use of controls or adjustments or performance of procedures other than those specified in the manual may result in hazardous radiation exposure.

Use of the system in a manner other than that described herein may impair the protection provided by the system.

Electromagnetic Compatibility

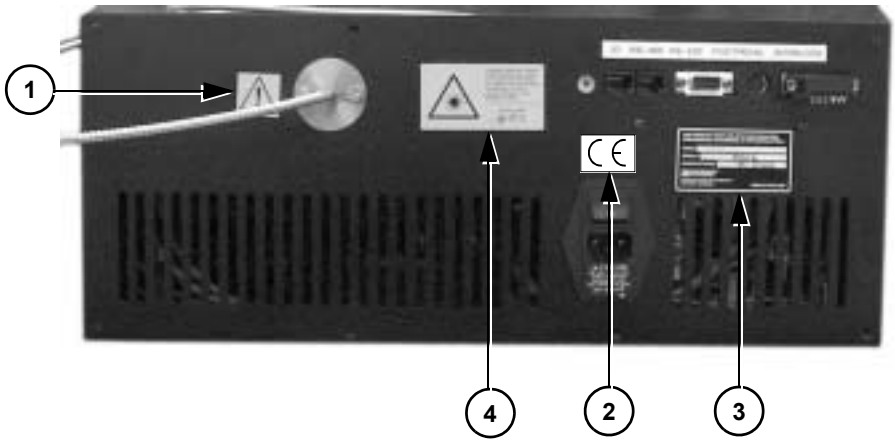
The DUO FAP System has been tested for radiated and conducted electromagnetic effects. The European requirements for Electromagnetic Compliance (EMC) are specified in the EMC Directive (published in 89/336/EEC). Conformance is achieved through compliance with the following harmonized standards:

Radiated radio-frequency electromagnetic field, Immunity test,
ENV 50140
Radio interference field strength,
EN 55022
Power supply failure
IEC 61000-4-11
Conducted high frequency interference
IEC 1000-4-6 (IEC 801-6)
Electrical fast transient,
IEC 1000-4-4 (IEC 801-4)
Electrostatic discharge test,
IEC 801-2
Surge immunity test,
IEC 1000-4-5 (IEC 801-5)

These standards indicate that the DUO FAP System is suitable for use in a residential or light industrial, class B, environment. Operation in a different electromagnetic environment may compromise system operation. Compliance of the DUO FAP System with the EMC requirements is certified by the CE mark.

Location of Safety Labels

Refer to Figure 2-1 for a description and location of all safety labels. These include warning labels indicating removable or replaceable protective housings, apertures through which laser radiation is emitted and labels of certification and identification [CFR 1040.10(g), CFR 1040.2, and CFR 1010.3/ EN 60825-1, Clause 5]].



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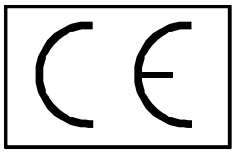
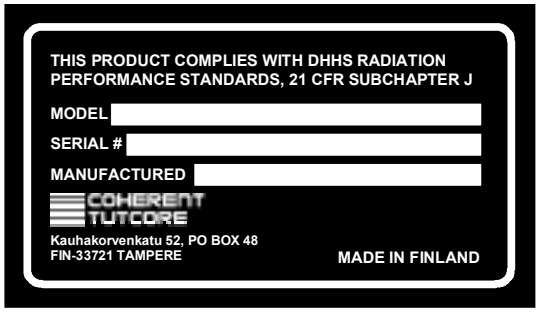


2.

Figure 2-1. Safety Features and Labels (Sheet 1 of 2)



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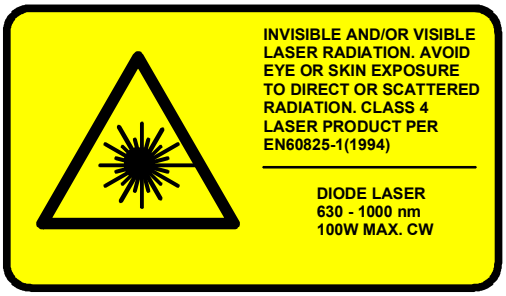


4.

Figure 2-1. Safety Features and Labels (Sheet 2 of 2)

SECTION THREE: INSTALLATION

Installation

The DUO FAP System is designed for easy user installation. No special tools or training are required. However, the DUO FAP System is a complex instrument that can generate high- powered laser light. Please read and follow the instructions carefully to avoid damage to the unit or possible personal injury.

Receiving and Inspection

Inspect the shipping container for signs of rough handling or damage. Indicate any such signs on the bill of lading. Report any damage immediately to the shipping carrier and to your local Coherent representative. In the U.S., contact Coherent Order Administration at 1-800-438-6323.

The shipping carton contains:

- DUO FAP System main enclosure
- Optical transport fiber
- Operator's manual and ancillary data sheets
- A kit containing miscellaneous connectors and hardware

The shipping carton may also contain any system accessories that were ordered with the system.

The DUO FAP System weighs approximately 26 kg (57 lbs.); exercise care in removing it from the shipping container.

Retain shipping containers. The containers will be required if the system is returned to the factory for service. The containers may also be needed to support a shipping damage claim.

The device must used below 2000 m (6500 ft.) altitude and is intended for indoor use only.

Installing the Main Enclosure

Before installing the DUO FAP System, observe these procedures.

Place the unit in its intended location, away from any heat-producing sources. The DUO FAP System enclosure relies on internal cooling fans to control the temperature of its internal components. In order for these fans to function effectively, a 10-cm (4-in.) clearance must be observed on both the fan inlet and exhaust ports. A 2.2-cm (1-in.) clearance must also be observed on the top panel to facilitate cooling of the system electronics. If the DUO FAP System is mounted inside of a separate enclosure, the enclosure must be ventilated adequately to prevent heat build-up.

The DUO FAP System is designed to be plugged into a standard wall outlet. The internal power supply automatically adjusts to the local line voltage. After verifying the correct connections to the local power grid, simply plug the power cord into the wall socket.

External Interlock

The unit is shipped with the rear panel interlock/status connector already connected to the rear panel. If the connector is not in place, install it. (The unit will not operate without the interlock connection installed.) The interlock status is monitored by the internal microprocessor. If the interlock is open, a message will be displayed on the unit front panel.

To incorporate an external safety interlock circuit into the laser system, turn the laser off and remove the jumper from the interlock connector on the rear. Attach a user-furnished external interlock circuit to this connector.

Any external interlock circuit must be equivalent to a mechanical closure of the circuit. When the interlock is opened, the unit will stop laser emission and display the error message on the user interface display. The unit must be returned to the "laser on" operational state for emission to resume. Refer to Section Four: Operation for more information on use of the interlock.

Optical Output Fiber

The optical transport fiber is shipped separately and must be installed. If the fiber end becomes contaminated, refer to the paragraph titled "Fiber Optic Cleaning" on page 6-20.

The unit is shipped with clean optical end faces will not require cleaning before installation.

When the DUO FAP System is energized, the fiber can transport many watts of optical radiation, which will be emitted at the distal

end of the fiber. This radiation is both an eye safety hazard and a potential heat source to ignite combustibles. An adequate beam dump (Thor Labs, Model #BT500 or equivalent) must be in place to capture the optical radiation emitting from the fiber end. The fiber must not be bent smaller than a 15-cm (6-in.) radius. Doing so will cause permanent damage to the fiber, and radiation may leak from the fiber at the bend, locally heating and possibly igniting the fiber cable assembly.

Excessively tight optical transport fiber bends (less than a 15-cm (6-in.) radius) can permanently damage and possibly ignite the fiber.

The unit is now ready to be turned on. Refer to Section Four: Operation for the turn-on procedures and operating instructions.

Keep the transport fiber distal end covered when the system is not in use. Ensure that the protective cover has been removed before turning the system on.

Serial Interfaces

A standard RS-232 direct (not nullmodem) modem cable can be used to connect the laser interface to a personal computer or any adequate control device. (This cable is not included with the system.) No further connections, such as handshake signals, are necessary. Connect the RS-232 cable to the user interface RS-232 port. If the user interface is not present, connect serial cable to system rear panel RS-232 connector.

When the user interface is connected to system, use the RS-232 port for host computer control.

RS-485 ports are intended to use for multiple device networking. They also can be used to computer control. Never connect the host computer simultaneously to the RS-232 and RS-485 ports. This will result to conflict and serial control won’t work.

Do not connect a personal computer simultaneously to both the RS-232 and RS-485 ports. This will result in an inability for the computer to communicate with the system.

Configuration of the Serial Interfaces

The settings of the laser's RS-232 and RS-485 serial interface are:

- 9600 baud
- No parity
- 8 data bits, 1 stop bit

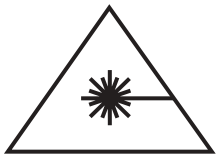
SECTION FOUR: OPERATION

Operation

The following chapter has been written with the assumption that the laser has been installed in accordance with installation procedures described in Section Three: Installation. The user must also be familiar with digital control signals as described in the paragraph titled "DUO FAP System FAP-System Control" on page 4-9.

At the factory, preset operating parameters appropriate to the FAP-I packages installed in the DUO FAP System have been loaded into memory. Typically, these parameters will operate the FAP-I packages at its rated power and at a 25°C operating temperature. In special cases, different operating parameters may be loaded into memory.

During operation, system messages or fault messages may appear on the display. Refer to Table 4-9 for a list of system messages.



Wear laser safety glasses to protect against the radiation generated from the laser. The operator must read Section Two: Laser Safety, and be familiar with laser safety practices and the dangers involved. Ensure that all personnel in the area are wearing laser safety glasses.

Turn-On

The DUO FAP System is equipped with a main power on/off switch. The switch is integral to the line cord power entry module on the rear panel. For operation, this switch needs to be placed in the ON position. This switch need not be turned off and can be left in the ON position for extended periods of time. Furthermore, main power can be turned on and off with a keyswitch located in the bottom left corner of the front panel. In the normal operation, the keyswitch has to be turned to the ON state.

The DUO FAP System has four operational states:

- Off
- Power On
- Laser-Enabled
- Laser On

The user can move between these operational states using the control features described in this section.

In the OFF state, the front panel keyswitch or rear panel on/off switch is in the OFF position. Power is supplied to the unit by turning both of these switches into the ON position, placing the unit in the POWER ON state.

Once the unit is in the POWER ON state, the user can set the operational parameters using the user interface buttons. Alternatively, digital control signals can be supplied remotely using a personal computer or other device capable of sending and receiving ASCII via an RS-232 or RS-485 interface.

The user interface display, buttons, and wheel control can be used to view, select, and control the desired operational parameters. Once the desired operating conditions have been established, pressing the front panel mounted laser on/off switch will place the system in the LASER ENABLED operation state. In the LASER ENABLED state, the laser on indicator LEDs will start to blink slowly. The green LED mounted in the laser on/off switch will also blink. After a short period of time, the blinking will speed up and the system will be ready to go to the LASER ON operational state.

Pressing the laser on/off switch again will place the system in the LASER ON operational state, in which laser emission will be generated. At that point, there is a CDRH-required two-second delay before laser light emits from the aperture. The green LED mounted in the laser on/off switch will also be illuminated steadily.

The laser emission can be turned off by pressing the laser on/off switch once more, which returns the system to a POWER ON state.

Table 4-1 summarizes the system operation. If any other buttons are pressed during the LASER ENABLED state, the system will return to the POWER ON state.

Turn-Off

A described above, laser emission is turned off using the laser on/off switch. The unit can then be left in the POWER ON state. However, Coherent recommends placing the unit in the OFF operational state if no emission is required for several hours (for example, overnight). Turning the keyswitch to the "0" position will place the unit in the OFF operational state.

Emergency Turn-Off

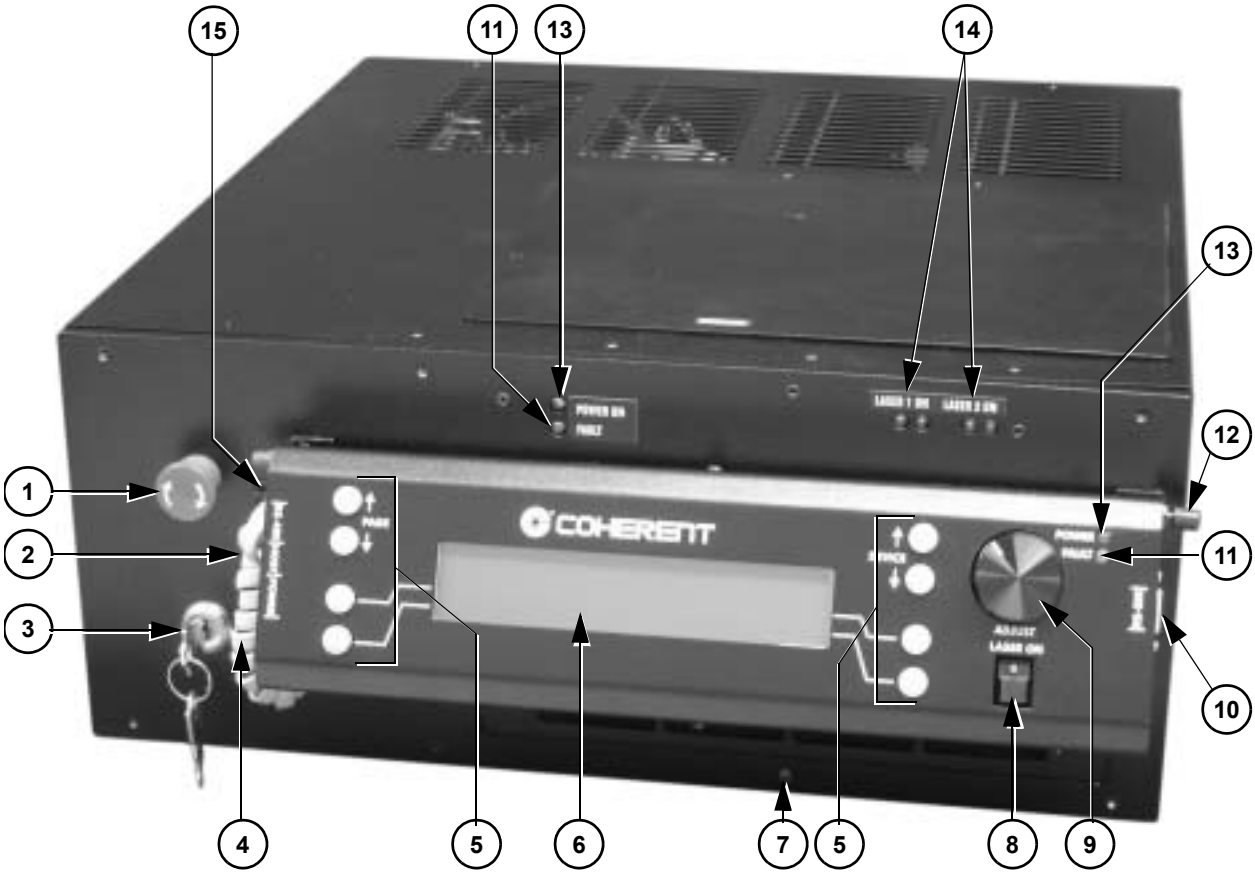
In the event of an emergency, a large red emergency turn-off switch is provided on the unit's front panel. Pressing this switch will immediately place the unit in the OFF operational state, terminating the

laser emission. After use, the emergency OFF switch must be reset by twisting it, which will cause the switch to pop out to its armed position.

Table 4-1. Summary of DUO FAP System Operational States

OPERATIONAL STATE	DESCRIPTION	VISUAL STATE INDICATOR	HOW TO GET THERE
Off	AC power is disconnected at rear panel on/off switch or front panel keyswitch.	AC power light is off.	Plug the unit into facility power. Turn rear panel on/off switch or front panel keyswitch to OFF position.
Power On	AC power is supplied to the unit. No laser emission at this point.	AC power light is on. Laser emission indicators are off.	Turn rear panel on/off switch. Switch front panel keyswitch to ON position.
Laser Enabled	Possibility for laser emission exists.	Laser emission indicators blinking Laser on/off switch indicator blinking	Press laser on/off switch while system is in POWER ON state.
Laser On	Laser emission is present or will be present within two seconds.	Laser emission indicators on Laser on/off switch indicator on	Press laser on/off switch while system in LASER ENABLED state.

Controls, Indicators, and Features

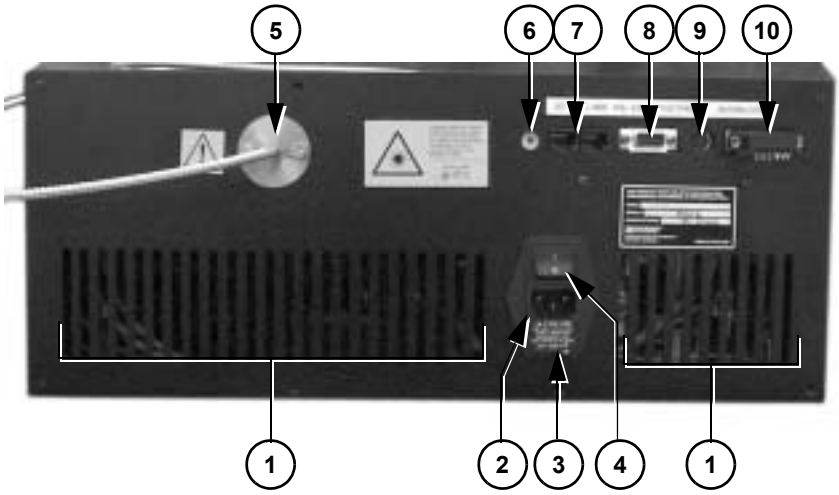


1. Emergency OFF switch
2. User interface RS-485 port
3. Keyswitch
4. User interface power input
5. Control buttons
6. LCD display
7. Ventilation holes and air filter
8. Laser ON/OFF switch
9. Parameter wheel
10. User interface RS-232 port
11. Fault LED (yellow)
12. User interface mounting screws
13. POWER ON indicator light (blue)
14. Redundant LASER ON indicators
15. User and Main System interface host ports

Figure 4-1. Front Panel Controls, Indicators, and Features

Table 4-2. Front Panel Controls, Indicators, and Features

ITEM	CONTROL	FUNCTION
1	Emergency off switch	Turns the main line power to the unit off Overrides all other controls Must be manually reset (rotated clock-wise) to resume operation
2	User interface RS-485 port	Connects user interface to main system over long distance
3	Keyswitch	Turns power on or off. Can be removed in the OFF position to prevent unauthorized usage.
4	User interface power input	Connects the user interface to the power supply when user interface is removed from main system and operated from a distance
5	Control buttons	Used to select and adjust operational parameters
6	LCD display	Main display
7	Ventilation holes and air filter	Cooling air inlet.
8	Laser ON/OFF switch	Allows the user to switch between LASER ENABLED and LASER ON operating modes
9	Parameter wheel	Used to adjust operational parameters, such as current and temperature
10	User interface RS-232 port	Connects the system to the host computer
11	Fault LED (yellow)	Indicates an error condition
12	User interface mounting screws	Removes the user interface from the main system when the screws are removed
13	POWER ON indicator light (blue)	Lights when the keyswitch or rear panel ON/OFF switch or emergency OFF switch is in the ON position. Indicates that the unit has line power and is capable of operation
14	Redundant laser emission indicators	Lights when laser emission is possible. Both indicators should light simultaneously; if not, refer to Section Six: Maintenance and Troubleshooting
15	User and main system interface host ports	Connects the user interface and the main system

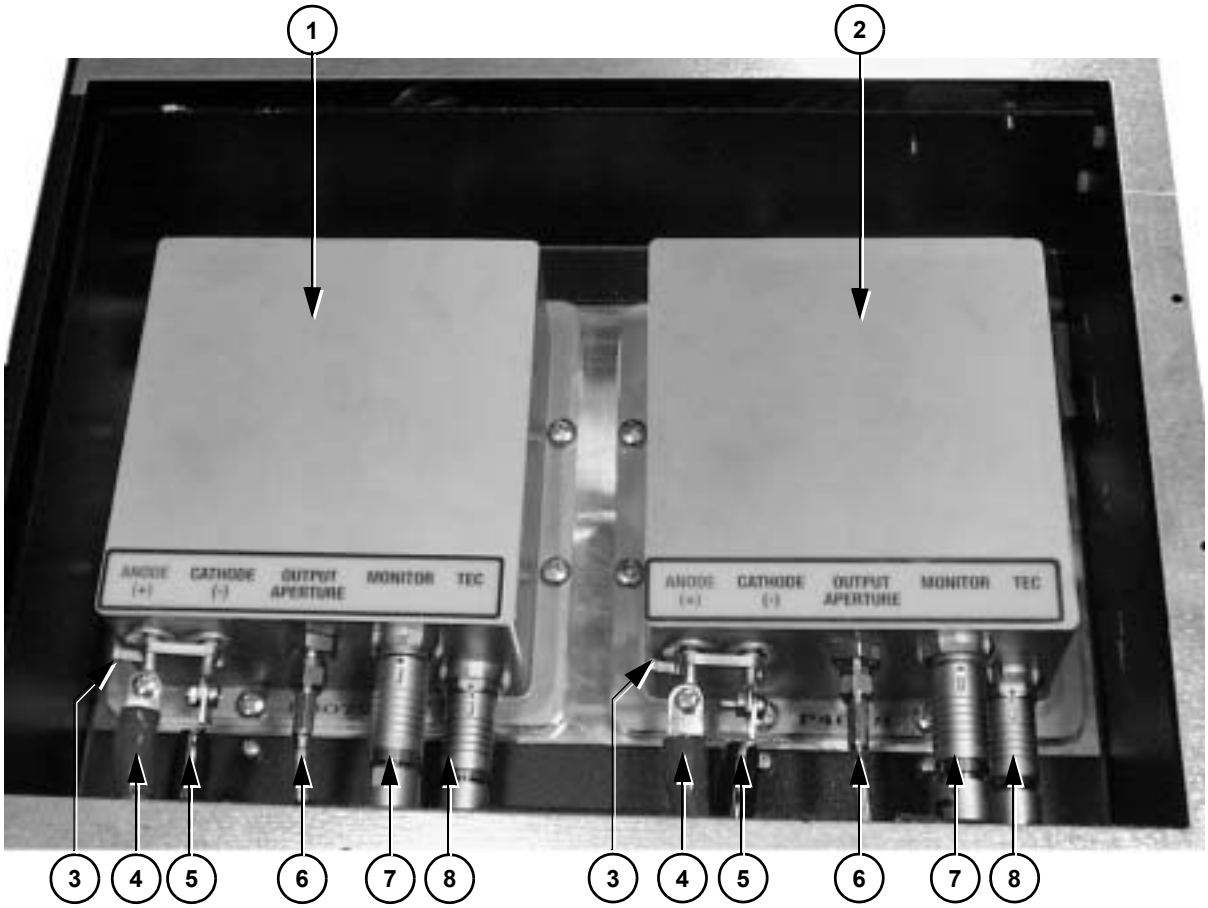


1. Cooling air exhaust
2. Line cord
3. Fuse
4. Main power on/off switch
5. Fiber output
6. ID select switch
7. RS-485 connectors for device daisy chaining
8. Serial port connector (Normally NOT used)
9. Footpedal connector
10. Interlock/Accessory connector

Figure 4-2. Rear Panel Controls, Indicators, and Features

Table 4-3. Rear Panel Controls, Indicators, and Features

ITEM	CONTROL	FUNCTION
1	Cooling air exhaust	Cooling air exhaust.
2	Line cord	Connects the unit to the facility AC power.
3	Fuse	250 V, 5 A
4	Main power on/off switch	
5	Fiber output	Applies/removes all power from the unit.
6	ID select switch	
7	RS-485 connectors for device daisy chaining	
8	Serial port connector (normally not used)	Allows connection to a user furnished digital control device (Personal Computer) via an RS-232 cable. Refer to Section Five: External Computer Control, for additional information on the RS-232 interface.
9	Footpedal connector	
10	Interlock/Accessory connector	



1. FAP-I 1
2. FAP-I 2
3. Laser diode shorting clip
4. Laser power + (red cable)
5. Laser power – (black cable)
6. Fiber optic cable
7. FAP-I monitor cable
8. FAP-I TEC control cable

Figure 4-3. FAP-I Lasers

Table 4-4. FAP-I Lasers

ITEM	CONTROL	FUNCTION
1	FAP-I 1	Contains the laser Diodes
2	FAP-I 2	
3	Laser diode shorting clip	Shorts laser anode and cathode. MUST BE REMOVED BEFORE USE!
4	Laser power + (red)	Laser power cable (positive)
5	Laser power -- (black)	Laser power cable (negative)
6	Fiber optic cable	Transport fiber
7	FAP-I monitor cable	Connects the FAP-I to the front display, which controls the diode output
8	FAP-I TEC control cable	Connects the diode temperature monitor to the front display panel

DUO FAP System FAP-System Control

The DUO FAP System uses sophisticated microprocessor control. The digital control signals can be generated locally, using the user interface buttons; or remotely, using a personal computer or other device capable of sending and receiving ASCII via a RS-232 or RS-485 interface.

User Interface Module

Main system operation is performed via a user interface module. The user interface module is removable from main system front panel. This module can be placed wherever is most convenient,.

The user interface module is connected to main system front panel by a 6-way cable. Main system control signals and power to user interface are supplied via this cable. Maximum length of this cable is 5 m. If a longer cable is needed, a suitable replacement cable is a 6-core FCC-68/data cable, and the connectors are 6-way FCC-68 modular plugs.

The user interface module can be removed from the main system front panel by loosening the two knurled screws (see Figure 4-1).

If the user interface is removed from the main system and must be operated from more than 5 m away, an interface must be used with a separate low-voltage AC/DC power supply and RS-485 data connection.

The power supply is connected to the user interface module power input. The power input rage is 10 to 15 VAC/DC.

Data connection to main system via an RS-485 serial port. The data cable connects to the user interface RS-485 port and rear panel RS-485 connector of the main system.

Never use a separate power supply and main system 6-way cable at the same time.

Output Intensity Adjustment Modes

The output light level can be adjusted in two ways. The user can either adjust the laser diode current, or adjust laser diode power. System adjustment depends on the selected adjustment mode. The mode can changed using user interface or serial port control, using the “d” command.

In current adjustment mode, user sets the laser diode operating current as milliamps. The user interface display shows current

values in milliamps and appropriate serial port commands can be used to read or write the desired current value.

In the power adjustment mode, user sets the laser diode operating power as milliwatts. The mapping from power values to current is made by using the pre-programmed look-up table. In this mode, the front panel current display shows power values in milliwatts. Before using this power mode, the pre-programmed table must be loaded.

Output Current Adjustment

When the device is in current adjustment mode, the laser diode drive current can be changed using the knob, even when the laser output is active. The adjustment unit is in milliamps. The current adjustment mode is typically used when no power calibration data is available. The selection between current and power adjustment modes can be changed via user interface or serial command.

Output Power Adjustment

In power adjustment mode, the laser output power is adjusted, not the drive current. This is possible using a calibration look-up table made by measuring the power-to-current curve and uploading it to the DUO FAP System. The adjustment unit is in milliwatts. To select between current and power adjustment, the "power mode" field can be selected or serial command can be used.

A table of 50 entries is used to convert power to current. The available power range is divided by the number of entries. Each entry represents a point in an X/Y-chart, where X-axis contains the power and Y-axis contains the current.

After setting the correct current values for each of the 50 power-to-current curve entries, the power adjustment mode can be used. In-between values are linearly interpolated.

Shipped units contain the necessary calibration data for installed FAP-I lasers and are in the current adjustment mode by default.

Power Curve Calibration

In order to use the DUO FAP System in power adjustment mode, a power-to-current calibration curve must be downloaded to the device. This curve is stored in a non-volatile memory and must be updated only when the laser diode has aged significantly (≥5000 hours) or has been replaced.

The curve is updated using the DUO FAP System serial command interface and can be prepared using a PC with suitable software. See Section Five: External Computer Control for a description of the DUO FAP System serial command interface.

Temperature Adjustment

Temperatures can be adjusted using the user interface or serial port control. The adjustment unit is in tenths of degrees of Celsius.

Remote Personal Computer Control

All functionality of the DUO FAP System is available via the serial command interface. The computer control is always available, once the front panel keyswitch is in the ON position. The user can enter any of the parameters, change them, and start or stop laser emission using the external computer control. More specialized description of the serial control can be found from Section Five: External Computer Control.

User Input/ Output Features

The DUO FAP System is equipped with user input/output features that allow the user to control the DUO FAP System. The features include:

- Rear panel interlock/accessory connection
- Rear panel serial port connectors (RS-232, RS-485)
- Foot-pedal control

The rear panel interlock/accessory connector allows the user to provide external safety interlocks for the DUO FAP System. The interlock pins must be closed for normal operation. The interlock input is controlled using an on/off type switch or relay.

Optical interlock allows a current loop-to-control interlock. When current is present, the interlock is disabled and the system works normally. Suitable interlock drive current is 5- to 20 mA and 5- to 15 V. When the optical interlock is not used as an external interlock, the optical interlock positive pin must be connected to +5 V (pin 9) and negative pin to ground (pin 10).

Furthermore, the connector has also a +5 V voltage output, which can output up to 100 mA current to an external load. The pinout for this connector is listed in Table 4-5.

The rear panel serial port connector is a D9 female connector designed for a RS-232 interface. It can be used to communicate with any RS-232-compatible computer. The communication parameters are 9600 bps, 8N1. The pinout for this connector is listed in Table 4-6.

RS-485 serial port connections are made using standard RJ45 connectors. RS-485 serial ports are intended for multiple system networking or computer control. It can also be used for single device control directly from personal computer. Communication parame-

ters are 9600 bps, 8N1. The pinout for this connector is listed in Table 4-7. Suitable control cable is standard twisted pair (10 Base-T or 100 Base-T) ethernet cable. Ready-made cables are easily obtained from nearest computer store.

Foot-pedal Control

When the system is set to foot-pedal mode, output can be switched on and off using a foot pedal.

Before using foot-pedal mode, the system must be set to foot-pedal mode from the device settings menu, and the foot pedal must be connected to rear panel foot-pedal connector. Then set the system to a "laser on" state.

Footpedal control input can also be used for remote control. Closing pins 1-3 turns the laser on when the system is in foot-pedal mode.

Table 4-5. Footpedal Connector Pinout

PIN #	FUNCTION	DESCRIPTION
1	Foot pedal –	Foot-pedal input
3	Foot pedal +	Foot-pedal input

Table 4-6. Rear Panel Interlock/Accessory Connector Pinout

PIN #	FUNCTION	DESCRIPTION
1	Optical Interlock+	Positive input of optical type interlock, when not used connect to pin 9
2	Optical Interlock–	Negative input of optical type interlock, when not used connect to pin 10
3	Interlock+	Positive input of normal switch-type interlock
4	Interlock–	Negative input of normal switch-type interlock
5	LD_ON1	FAP 1 First laser diode on LED indicator cathode
6	LD_ON2	FAP 1 Second laser diode on LED indicator cathode
7	LD_ON3	FAP 2 First laser diode on LED indicator cathode
8	LD_ON4	FAP 2 Second laser diode on LED indicator cathode
9	+5 V	+5 V power supply (maximum 100 mA)
10	GND	Ground and FAULT LED negative
11	FAULT LED	FAULT condition LED positive output
12,13	Not connected	Not connected, leave open

Table 4-6. Rear Panel Interlock/Accessory Connector Pinout (Continued)

PIN #	FUNCTION	DESCRIPTION
14	LD_LED_VOLT_1	LD1 and LD2 led power supply
15	LD_LED_VOLT_2	LD1 and LD2 led power supply

Table 4-7. Rear Panel RS-232 Pinout

PIN #	FUNCTION	DESCRIPTION
2	TxD	Serial data transmit
3	RxD	Serial data receive
5	GND	Ground for RS-232

Table 4-8. Rear Panel RS-485 Connector Pinout

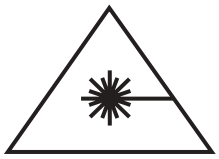
PIN #	FUNCTION	DESCRIPTION
4	DATA –	RS-485 data, negative
5	DATA +	RS-485 data, positive

Optical Transport Fiber

The DUO FAP System comes equipped with a standard 3 m long armored fiber. The fiber is terminated in an SMA 905-type connector. Before energizing the laser, ensure that the transport fiber cable is not kinked or excessively bent and the fiber end is clean. Excessively tight bends (less than a 15 cm radius) will cause light to leak from the fiber at the bend, locally heating the transport fiber cable assembly. Ensure that the fiber distal end protector is removed and the fiber is clean.

Contaminated fiber ends may cause damage to the fiber, the laser, and ultimately, the entire system. The fiber end can be cleaned using spectroscopic-grade ethanol and lens tissue. Refer to “Fiber Optic Cleaning” on page 6-20 for instructions about how to clean the optical fiber end. To protect the fiber end when not in use, use a protective cover or cap.

WARNING: Excessively tight fiber bends (less than 15-cm radius) will permanently damage the fiber.



Possibility of hazardous exposure: Optical radiation emanating from the fiber end can cause eye damage and ignite combustibles. Control scattered light and wear appropriate eye gear.

When the laser is energized, the fiber end can emit tens of watts of optical radiation. This radiation is both an eye safety hazard and a potential heat source to ignite combustibles. Ensure that the transport fiber cable output is properly terminated. The protective covering on the fiber connector must be removed and an adequate beam dump (for example, Thor Labs Model #BT500 or equivalent) must be in place to capture the optical radiation emanating from the fiber end.

Wavelength Tuning

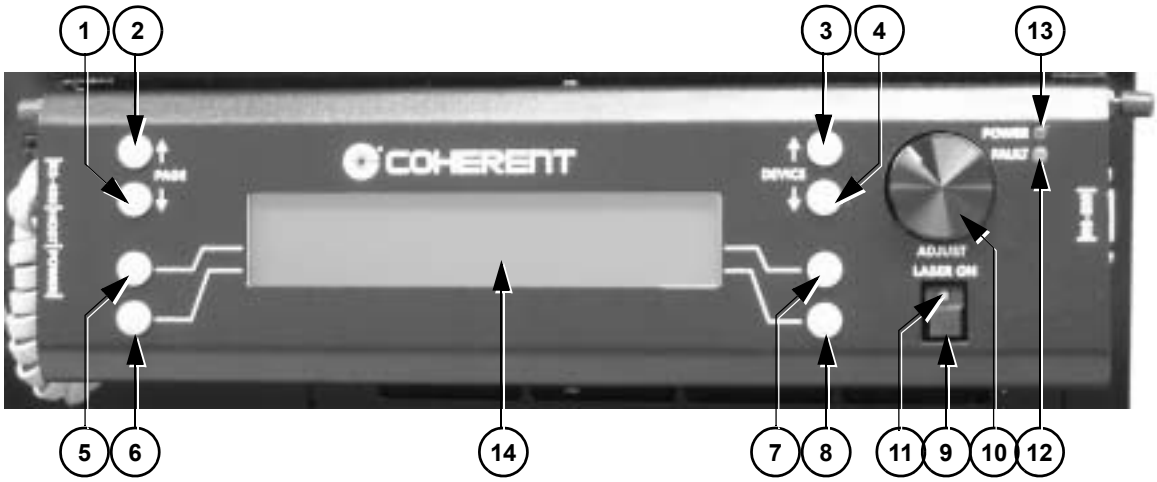
The DUO FAP System emitted wavelength can be changed over a several nanometer range by adjusting the laser diode temperature. This temperature can be set using controls as discussed in previous sections. The system output wavelength will shift by approximately 0.28 nm/°C. Changing the laser temperature will also result in a change in output power of approximately l% per °C. The laser diode output will shift to longer wavelengths and lower output powers as the diode temperature is increased. The preceding values are only approximate values, with the exact values depending on the laser diode being used and its operating conditions. If high-precision values are required, Coherent suggests that the user measure the wavelength shift and power change with temperature over the user's range of interest.

Using the User Interface

The user interface consists of 9 buttons and a wheel.

The main display (14) consists of several pages of information. Moving between pages is done by using the page selection buttons (1-2). Some pages are for information only, some contain adjustable parameters.

Field selection buttons (5-8) select a field which value is to be modified. In case of a on/off-type field (**[X]** = *ON* or **[ ]** = *OFF*) its state changes as soon as the button is pressed. On other fields a selection cursors **>.....<** are displayed around field. A COARSE indicator on the top right corner of the screen shows, when a coarse adjustment is active. Field selection buttons are used to turn the coarse adjustment on and off.



1-2. Page selection buttons
3-4. Device selection buttons
5-8. Field selection buttons
9. On/off button
10. Wheel
11. On/off lights (green)
12. Fault light (yellow)
13. Power on-light (blue)
14. Main display

Figure 4-4. User Interface Controls and Indicators

It is possible to control up to 255 individual devices using the DUO FAP System User Interface Module. To indicate which devices are attached to the module, a device scan must be carried out. See “System” on page 4-20 for details. Device selection buttons (3-4) are used to select a device among the ones found in the scan.

Any device can be made to ignore the on/off button (9) presses. This feature enables a selective usage of devices. Fault reports from a device can be ignored to allow using other devices even if one is failing. See “Interface Settings” on page 4-18 for details.

To turn on any selected devices the on/off button (9) has to be pressed twice. The first key press instructs devices to go into an “enabled” state, indicated by a blinking on/off light (11). After a minimum of a two-second pause, when the on/off button is pressed again, devices are allowed to go to the “active” state and start emitting light. This state is indicated by a continuously lit on/off light. One more press of the on/off button turns the selected devices off (“disabled”) again.

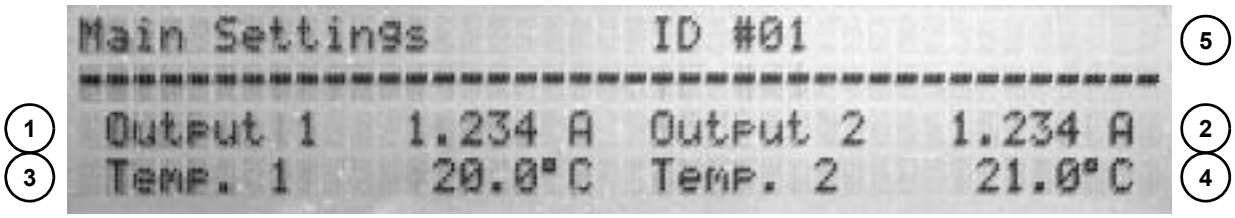
Fault conditions are indicated by a fault light (12) and a descriptive message on the main display (14). Page selection buttons (1-2) are used to clear the message. If the error condition persists the message is immediately redisplayed. See “Fault” on page 4-21 for details about the fault page.

Pages

There are six normal pages of information and a special fault condition page. Use the page selection buttons to switch between normal pages.

The upper right corner of the display contains the selected device ID. Device selection buttons move between available devices. If a device is no longer available "N/A" is displayed on the upper right corner, next to the device ID.

Main Settings



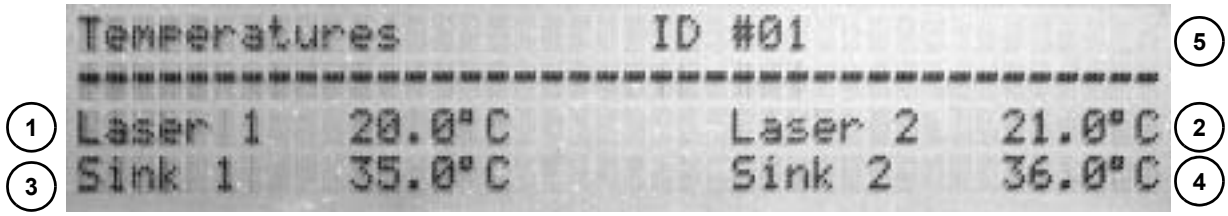
1. FAP-I 1 current/power
2. FAP-I 2 current/power
3. FAP-I 1 temperature adjustment
4. FAP-I 2 temperature adjustment
5. Selected device ID

Figure 4-5. Main Settings Display

The "Main Settings" page contains the most essential adjustable parameters for the FAP-Is. Depending on the selected mode (see "Device Settings" on page 4-17), either current or power can be adjusted here. Temperature adjustment for the FAP-Is is also present.

Currents and powers have coarse and fine adjustment capability. First press of the field selection button selects coarse adjustment (indicated by COARSE text on the top right corner); another press selects fine adjustment. Temperature fields only have the fine adjustment capability.

Temperatures

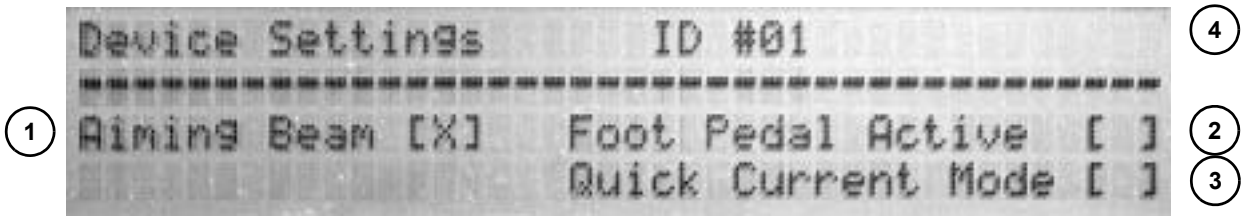


1. FAP-I 1 measured diode temperature
2. FAP-I 2 measured diode temperature
3. FAP-I 1 measured heat sink temperature
4. FAP-I 2 measured heat sink temperature
5. Selected device ID

Figure 4-6. Temperature Display

Temperature measurements are available in the "Temperatures" page. This page contains no adjustable fields.

Device Settings

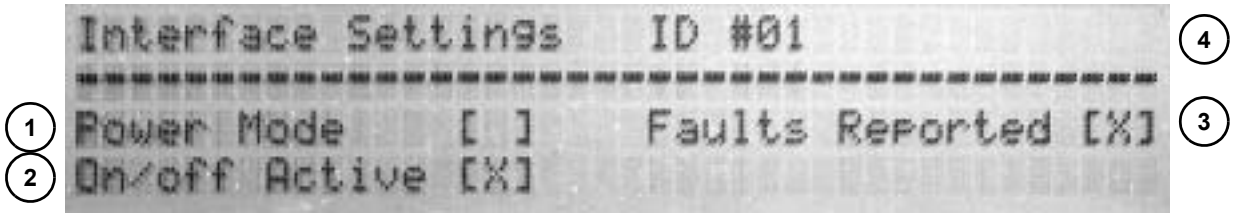


1. Aiming beam
2. Footpedal mode
3. Quick current mode
4. Selected device ID

Figure 4-7. Device Settings Display

To turn an aiming beam on or off, foot-pedal mode or select a quick current mode for a device. (The "Device settings" page has the necessary fields.) Simply pressing the field selection button changes a field's state (**[X]** = ON or **[ ]**= OFF).

Interface Settings



1. Power mode
2. On/off active
3. Faults reported
4. Selected device ID

Figure 4-8. Interface Settings Display

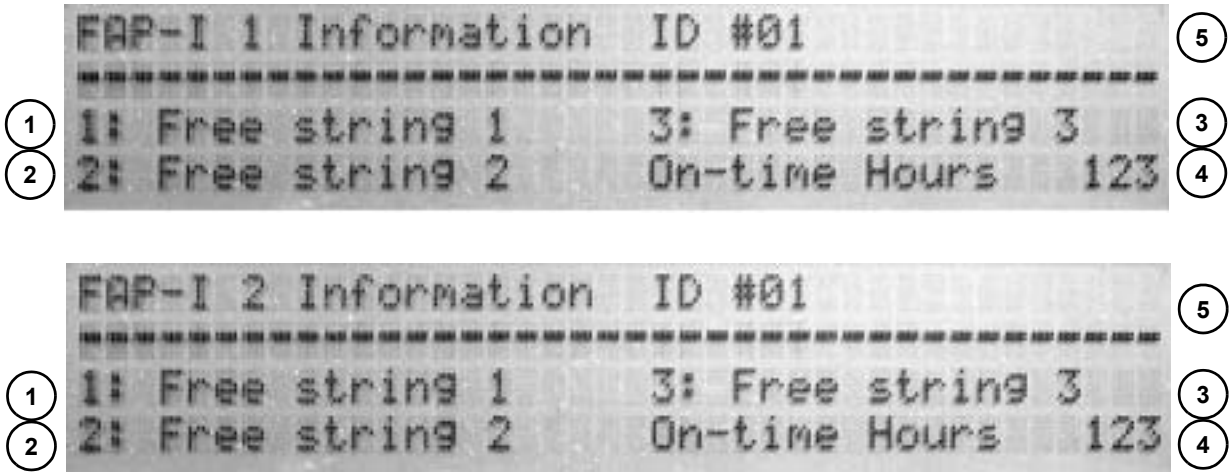
The "interface settings" page is for parameters that control how the user interface reacts to and controls the devices. Selecting the field selection button changes a field's state (**[X]** = ON or **[ ]** = OFF).

"Power mode" switches the "Operation" page fields to use milli-watts instead of milliamperes. Note: A power calibration curve must have been uploaded to a device prior to switching to power mode.

"On/off active" selects whether a device can be controlled by the on/off button. If deactivated, the device no longer turns on or off with the rest of the devices.

"Faults reported" controls the reporting of faults from a given device. In the case that the fault condition persists, it is still possible to use other devices by turning fault reporting off.

FAP-I 1 and FAP-I 2 Information

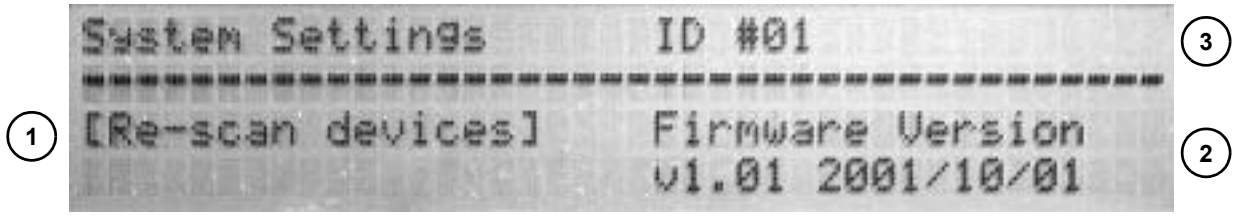


1. Free-form field 1
2. Free-form field 2
3. Free-form field 3
4. FAP-I on-time hours
5. Selected device ID

Figure 4-9. FAP-I Information Display

The information pages contain any free-form strings entered to FAP-Is. Also the FAP-I on-time hours is displayed. These pages contain no adjustable fields.

System



1. Re-scan
2. Firmware version
3. Selected device ID

Figure 4-10. System Display

To start using the DUO FAP System User Interface Module, available devices must be scanned. Pressing the field selection button for the re-scan field, the scan begins. A complete scan takes about ten seconds. To stop a scan in progress, the field selection button can be pressed again. Stopping a scan after all available devices are found saves time.

Firmware version of the selected device is also displayed here.

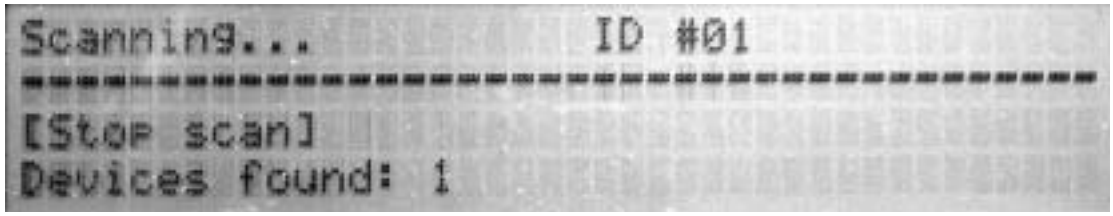


Figure 4-11. Scanning Display

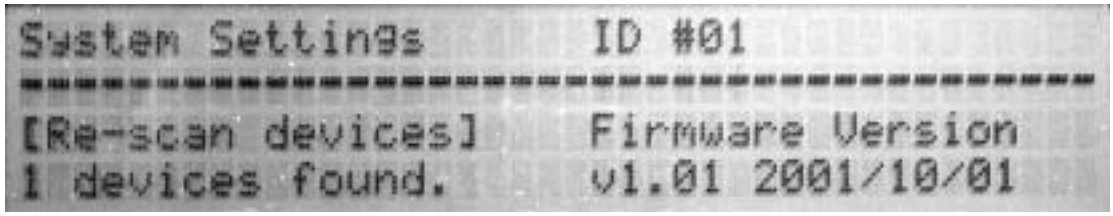
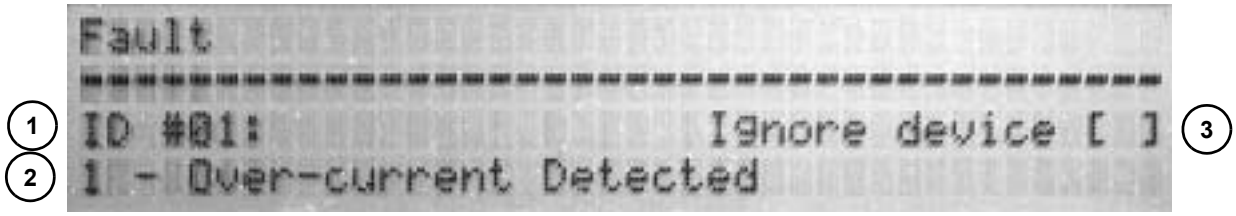


Figure 4-12. Devices Found Display

Fault



1. Failing device ID
2. Fault description
3. Ignore device

Figure 4-13. Fault Display

When a device reports a fault condition the "Fault" page is displayed. To clear a fault condition and return the display to normal, page selection buttons are used.

In case the device persistently reports a fault, the fault reporting can be disabled for the offending device. This option is also available in "Interface settings" page under "Faults reported".

Error Messages

Several error conditions can rise during the operation of the DUO FAP System. Each these conditions have its own code, which is displayed on-screen and can be queried using the serial command interface.

In case of an error, the output is disabled and an error code is displayed on display also yellow fault led is lit. The code remains displayed until it is cleared by pressing the page selection button or using the serial command interface. In case of multiple simultaneous errors, only the first one in the order below is displayed.

Table 4-9. Error Messages

MESSAGE	MEANING	WHAT TO DO
1 - Over-current Detected	Excess current in the laser diode circuit is detected.	Contact service
1 - Over-current Detected	Measured current exceeds the set point value by at least 1 A.	Contact service
3 - Power Limits Exceeded	Maximum power dissipation is over than 500 W.	Contact service
4 - Interlock Open	One of the interlocks is left open.	Check the interlocks
5 - Laser Diode Over-Temperature	Laser diode temperature exceeds the limits: -10° - 50° degrees Celsius.	Decrease output power or cool down the environment.
6 - Heat Sink Over-temperature	Heat sink temperature exceeds the limits: -10° to 60° degrees Celsius.	Decrease output power or cool down the environment.
7 - Auto-off time elapsed	Auto-off timer turned the output off. There was no activity in serial ports in defined time.	Increase time or disable timer.

SECTION FIVE: EXTERNAL COMPUTER CONTROL

How to Interface to the DUO FAP System

The DUO FAP System can be controlled externally with an RS-232 or RS-485 interface. The serial interface is a female DB9 connector on the user interface. A set of commands controls the unit. Some commands return information back to the serial line while others silently perform actions and modify operational parameters.

The DUO FAP System can be controlled entirely with the serial interface. However, error conditions which arise during the pulse output are not reported, so the state of the DUO FAP System must be periodically polled using a suitable command.

Introduction

The DUO FAP System is operated via serial interface using a simple command protocol. The interface is meant to be operated using a dedicated interface software running on a host PC and the serial command protocol reflects that purpose. It is, however, possible to operate the interface by hand by loading a terminal emulator program on the host PC and setting the connection parameters as explained below.

In addition to the RS-232 interface, the same command protocol is also available in RS-485 form. The DUO FAP System echoes all characters from its RS-232 port to the RS-485 port and vice versa. This allows multiple devices to be chained together while only one serial port is in use on the host PC. Alternatively, it is possible to connect the host PC directly to the RS-485 bus with an appropriate interface card.

Do not connect the host computer simultaneously to RS-232 and RS-485 ports.

The command protocol supports up to 255 individual devices (IDs). However, due to hardware constraints, the DUO FAP System can only be jumpered to use any of the first ten available device IDs.

Serial parameters for the command interface (both RS-232 and RS-485) are 9600 bps, 8 data bits, no parity and no handshaking.

Commands consist of printable 8-bit ISO-8859-1 characters only, except for the end of command character which is a carriage return (CR) (character number 13). The only other control character recog-

nized is the backspace (character number 8), which causes the previous character in command buffer to be erased. All other control characters are ignored.

The DUO FAP System acknowledges each received command. The acknowledge message is a single line starting with an "R", containing the response for the command, and is then followed by a CR (character number 13) and line feed (LF) (character number 10) pair. Responses range from a simple error message ("???" for an unknown command, "err" for anything else), to the result of a query command, or nothing at all when the command is executed silently. The user must wait for the device to acknowledge the previous command before sending a new one.

A special no-op command is available for testing, if a particular device is responding or not.

Table 5-1. Serial Cable Pin Description

PC DB9	DUO FAP System Female DB9	Description
2	2	TXD
3	3	RXD
5	5	GND

Command Syntax

A valid command consists of several parts:

```
>     01u0;20;6000<CR>
```

The first two digits are the hexadecimal ID for the device. There are 255 possible IDs (01 to FF), although the DUO FAP System only supports the first ten. ID 00 is reserved for broadcast purposes. Each device responds to broadcast address regardless of its own ID.

The character after the ID is the actual command. See the Table 5-2, "List of Commands," on page 5-4 below for more details.

After the command character, there is a list of parameters separated by semicolons (";"). There is no semicolon between the command character and the first parameter. Also, the semicolon after the last parameter is optional. Invalid integer parameters (such as current, power, etc.) are treated silently as zero.

A command is terminated with a CR (character number 13). After the CR, the device checks if the ID matches and performs the given command. A command is acknowledged with a line beginning with

a capital letter “R” and ending in a CR (character number 15), and LF (character number 10) pair. Actual contents between the letter “R” and the end-of-line characters depend on the command.

A response “R???” is given if a command couldn't be recognized. Any other error condition (such as wrong number of parameters, invalid parameters, etc.) is responded with “Rerr”.

No extra white space is allowed in the command. The characters between CRs are buffered and considered as part of a command. To ensure that the device is in sync with the host, it is possible to send extra CRs before sending any commands. A CR character will clear the internal buffer.

Commands

Brackets (“[]”) denote optional parameters and results. Angle brackets (“<>”) denote mandatory parameters or results. Text in italics means description of contents, non-italics text is taken literally. Value ranges are denoted with a hyphen (“–”), choices are denoted with a forward slash (“/”).

IDs are in two digit hex notation (e.g., “01” for ID 1, “0A” for ID 10). Note that case is not significant.

Currents are in integer mA (e.g., “1234” for 1234 mA) without the unit attached. Powers are similarly in integer milliwatts without the unit.

Temperatures are in nn.n format, in degrees Celsius (e.g., “24.5” for 24.5°C). The decimal part is optional and only the first digit after the decimal point is used. Also, no unit it attached.

Status code is an integer. “0” means no error has occurred after the last time the error status was cleared. See “Report (and Optionally Clear) Error Status” on page 5-8 for a list of status codes.

Free-form strings are just that: a string of whatever printable characters necessary (except the semicolon (;), which is used as a parameter separator). Maximum length for a free-form string is 20 characters.

Light measurement is an unspecified integer value ranging from 0 to 65535. The actual dynamic range is unknown as of this writing.

Laser diode on-time hours is a value starting from 0 to about 12,000 hours. After 12,000 hours pass, the count does not advance further.

Auto-off is an integer value from 0 to 65535 seconds. A value of zero disables the automatic shutdown.

Table 5-2. List of Commands

COMMAND	PARAMETERS	RESULT	DESCRIPTION
unrecognized	any	R???	Unrecognized command
recognized	faulty	Rerr	A command with faulty parameters
none	none	R	No operation, check device presence
i	none	R<ID>	Query device ID
o	[0-2]	R[0-2]	Set/query output state
c	<0/1>[;mA]	R[mA]	Set/query output current
m	<0/1>[;mA]	R[mA]	Set/query maximum output current
p	<0/1>[;mW]	R[mW]	Set/query output power
w	<0/1>[;mW]	R[mW]	Set/query maximum output power
t	<0/1>[;degrees °C]	R[°C]	Set/query laser diode temperature
u	<0/1;0-49>[;mA]	R[mA]	Set/query power-to-current curve points
e	<0/1;0/1>	R<°C>	Report measured temperature
s	[0]	R<status code>	Report (and optionally clear) error status
f	<0/1;0-2>[;string]	R[string]	Set/query free-form strings
k	<0/1>	R<mA>	Report measured current
g	<0/1>	R<value>	Report measured light
n	<0/1>	R<hours>	Report laser diode on-time hours
b	[0/1]	R[0/1]	Set/query aiming beam state
q	[0/1]	R[0/1]	Set/query quick current mode state
z	[seconds]	R[seconds]	Set/query auto-off timer setting
x	[0/1]	R[0/1]	Set/query foot-pedal mode
v	none	R<version information>	Report firmware version information

Version information is in the form "vn.nn yyyy/mm/dd", where *n.nn* is the version number; *yyyy* is year; *mm* is month; and *dd* is day of month.

No Operation, Check Device Presence

Supplying a no-op command to the device causes it to acknowledge with an empty response; *i.e.* a “R” followed by a CR, LF pair. This can be used to probe all devices in an RS-485 bus.

Query Device ID

Using this command it is possible to query an ID of a given device. This query is only useful when the device in question is the only one in the bus and it is addressed using the broadcast ID.

This command takes no parameters. The result is the two-character hexadecimal ID number.

Set/Query Output State

Laser diode output is controlled with this command. There are three possible states:

- 0 = disabled, no laser emission possible
- 1 = enabled, no laser emission possible
- 2 = active, laser emission possible

The DUO FAP System incorporates a safety feature that only allows the output to be activated after a two-second delay. After changing the output state from 0 (disabled) to 1 (enabled), changing the state to 2 (active) can happen only after the safety delay period has exceeded. All other state changes (1 to 0, 2 to 0, and 2 to 1) can happen freely.

The parameter is the desired state. Without any parameters, the current state is reported.

The device switch back to disabled state (0) automatically if there is an error condition present. See “Report (and Optionally Clear) Error Status” on page 5-8 for a description about status codes.

See also “Set/Query Quick Current Mode State” on page 5-9 for description of the quick current mode.

This parameter defaults to 0 (disabled) after boot-up.

Set/Query Output Current

The two current sources in the DUO FAP System can be controlled separately. Using this command it is possible to set the current for each of the FAP-Is.

The first parameter specifies the FAP-I. It can be either 0 or 1. The other parameter is optional and specifies the desired current. If no current is given, the previously set current for the specified FAP-I is

reported. Currents are in mA, integer digits only (no unit nor decimal values are reported).

If the given current exceeds the maximum current set for the FAP-I, an error is reported.

Measured currents are available with a separate command (see: "Report Measured Current" on page 5-9). See also "Set/Query Quick Current Mode State" on page 5-9 for description of the quick current mode.

This parameter defaults to 0 after boot-up.

Set/Query Maximum Output Current

With this command, it is possible to limit the maximum current available for the current set command (see "Set/Query Output Current" on page 5-5). Each FAP-I has its own maximum output current.

As with the current set command, the first parameter specifies the FAP-I and it can be either 0 or 1. The other parameter is optional and specifies the desired current. If no current is given, the previously set maximum current for the specified FAP-I is reported. Currents are in mA, integer digits only (no unit nor decimal values are reported).

If the given current exceeds the specifications for the DUO FAP System, an error is reported.

Set/Query Output Power

Instead of current (see "Set/Query Output Current" on page 5-5), the output power can be specified with this command.

The first parameter is the FAP-I, either 0 or 1. The second and optional parameter is the power in integer milliwatts. Without the power parameter, the previously set power is reported.

Before using this command, a sensible power-to-current calibration table must be loaded. See "Set/Query Power-to-Current Curve Points" on page 5-7 for details.

If the given power exceeds the maximum power set for the FAP-I, an error is reported.

While changing the power with this command affects the current reported with the set current command, the reverse is not true. Modifying the output current does not update the reported output power.

This parameter defaults to 0 after boot-up.

Set/Query Maximum Output Power

This command sets the maximum available power for the power set command (see "Set/Query Output Power"). It also sets the maximum power the power-to-current calibration table represents (see "Set/Query Power-to-Current Curve Points" on page 5-7).

The first parameter is the FAP-I, either 0 or 1. The second and optional parameter is the power in integer milliwatts. Without the power parameter, the previously set maximum power is reported.

Set/Query Laser Diode Temperature

Laser diode temperature for the FAP-Is can be set independently with this command.

As always, the first parameter is the FAP-I, either 0 or 1. The second and optional parameter is the desired temperature in degrees Celsius, with one optional decimal place. Without the temperature parameter, the previously set temperature for the specified FAP-I is reported.

Measured temperatures are available with a separate command (see "Report Measured Temperature" on page 5-7).

Set/Query Power-to-Current Curve Points

A table of 50 entries is used to convert power to current. The available power range (see "Set/Query Maximum Output Current" on page 5-6) is divided by the number of entries. Each entry represents a point in an X/Y-chart, in which the X-axis represents the power and the Y-axis represents the current.

After setting correct current values for each of the 50 power-to-current curve entries, the set power command (see "Set/Query Output Power") can be used. In-between values are linearly interpolated.

This command is used to set a point in the power-to-current table. Each FAP-I contains its own table. The first parameter specifies the FAP-I (0 or 1), the second parameter is the step from 0 to 49. The current is set with the third parameter. If it is missing, the previously set current for the specified step in the specified FAP-I is reported.

Report Measured Temperature

Measured laser and heat sink temperatures can be checked with this command.

The first parameter specifies the FAP-I (0 or 1) and the second specifies the desired measurement: 0 for laser diode temperature, 1 for heat sink temperature.

Report (and Optionally Clear) Error Status

The DUO FAP System serial protocol does not allow the devices to report error conditions automatically. Instead, each device must be polled to find out if a run-time error has occurred. By using the output state command (see "Set/Query Output State" on page 5-5) and this command, information of each device's status can be determined.

This command reports the status code. The optional parameter must be 0 if present. It clears the status back to 0 after reporting it. If an error condition persists, the status code is immediately changed back by the device.

If many simultaneous error conditions are present, only the one with the lowest status code is reported.

Table 5-3. Error Codes

STATUS CODE	DESCRIPTION
0	No error
1	Current detected even while the output is supposed to be disabled
2	Measured current is higher than the set-point value
3	Internal power dissipation limits exceeded
4	One or more of the interlocks are open
5	Laser diode temperature outside bounds (-10.0-50.0°C)
6	Heat sink temperature outside bounds (-10.0-60.0°C)
7	Auto-off timer turned the output off

Set/Query Free Form Strings

Each FAP-I can hold three 20-character strings. These strings can be used to store information about dates, serial numbers and so forth. The DUO FAP System does not specify or enforce the contents of these strings.

Using this command, the strings can be queried and changed. The first parameter specifies the FAP-I (0 or 1). The second parameter is the string number in the FAP-I, either 0, 1 or 2. The last parameter is the string to write. Without it the previously set string is reported.

The free-form strings may contain any ISO-8859-1 printable characters, except semicolon (;), which is used as a parameter separator.

Report Measured Current

Measured laser diode currents can be checked with this command.

The parameter specifies the FAP-I (0 or 1). A current in mA is reported.

Report Measured Light

Measured laser diode light output can be monitored with this command.

The parameter specifies the FAP-I (0 or 1). A value between 0 and 65535 is reported. The actual dynamic range of the value depends on maximum laser power

Report Laser Diode On-Time Hours

FAP-I characteristics change when the diodes age. This command reports the cumulated hours of use of the laser diodes. The hours are stored in the non-volatile memory inside each FAP-I, so changing the individual FAP-I resets this parameter automatically.

The parameter specifies the FAP-I (0 or 1). An integer number of hours is reported. Because of implementation dependent limitations, the maximum value reported is 11930. After 11,930 hours pass, the value stops increasing.

Set/Query Aiming Beam State

The DUO FAP System incorporates a visible aiming beam that can be turned on and off with this command.

The parameter specifies the desired state; 0 for off, 1 for on. If no parameter is indicated, the state of the aiming beam is simply reported.

This parameter defaults to 0 (off) after boot-up.

Set/Query Quick Current Mode State

Normally, the laser currents are changed gradually. It is possible to disable this behavior and to make the changes in laser current to happen immediately by setting on the quick current mode.

The parameter specifies the desired state for the quick current mode; 0 for off, 1 for on. If no parameter is indicated, the state of the current mode is simply reported.

This parameter defaults to 0 (off) after boot-up.

Set/Query Auto-Off Timer Setting

The DUO FAP System incorporates a feature to turn off the device if no commands are received within a given time. If the set time limit is exceeded, the output is turned off and a status code is set to indicate the situation.

The parameter given is an integer number of seconds between 0 and 65535. A value of 0 disables the auto-off feature.

This parameter is stored in a non-volatile memory, so it is not necessary to re-apply the command each time the power to the DUO FAP System is turned on.

Set/Query Foot-Pedal Mode

Footpedal mode allows external on (1) or off (0) control using foot-pedal or other contact closure connected to foot-pedal connector. Parameters specify the desired state for the foot-pedal mode: 0 for off, 1 for on. Without any parameters the state is of the foot-pedal mode is reported.

Report Firmware Version Information

Sometimes the serial protocol must change as the hardware and firmware evolves. This command makes the firmware version information available, so that the dedicated user interface running in the host PC can determine a valid command set for each device attached.

This command takes no parameters. A version information string is reported.

SECTION SIX: MAINTENANCE AND TROUBLESHOOTING

Troubleshooting the DUO FAP System is designed to give thousands of hours of trouble-free operation. In the event of a problem refer to Table 6-1 below which list possible problems and error messages with a reference to the associated troubleshooting location in this section.

Table 6-1. Troubleshooting Reference Guide

PROBLEM	TROUBLESHOOTING REFERENCE
Laser shuts down	Chart 1
Power on indicator light does not light when key turned	Chart 2
Laser does not start	Chart 3
LASER EMISSION indicator(s) do not light when laser is activated	Refer to note 1
Low Power	Chart 4
Distorted or widely diverging beam profile	Chart 5
Numeric entry from user interface not accepted	Value exceeds the limits. Refer to specification or user set limits.
ERROR MESSAGES	
1. Current detected even while the output is supposed to be disabled	Refer to note 1
2. Measured current is higher than the set-point value	When current adjustment is turned very fast this error can be also generated, if error generates continuously refer to note 1
3. Internal power dissipation limits exceeded	Refer to note 1
4. Interlock error	Check front panel interlock
5. Laser diode temperature outside bounds (-10.0-50.0°C)	Chart 6
1. Contact Coherent (1-800-367-7890) or a local authorized representative.	

Table 6-1. Troubleshooting Reference Guide

PROBLEM	TROUBLESHOOTING REFERENCE
6. Heat sink temperature outside bounds (-10.0-60.0°C)	Chart 6
7. Auto-off timer turned the output off	Automatic off timer turned output off, if there is no activity in serial ports in user specified time. See serial command list from Section Five: External Computer Control.
1. Contact Coherent (1-800-367-7890) or a local authorized representative.	

Chart 1. Laser Shuts Down (No Light Output)

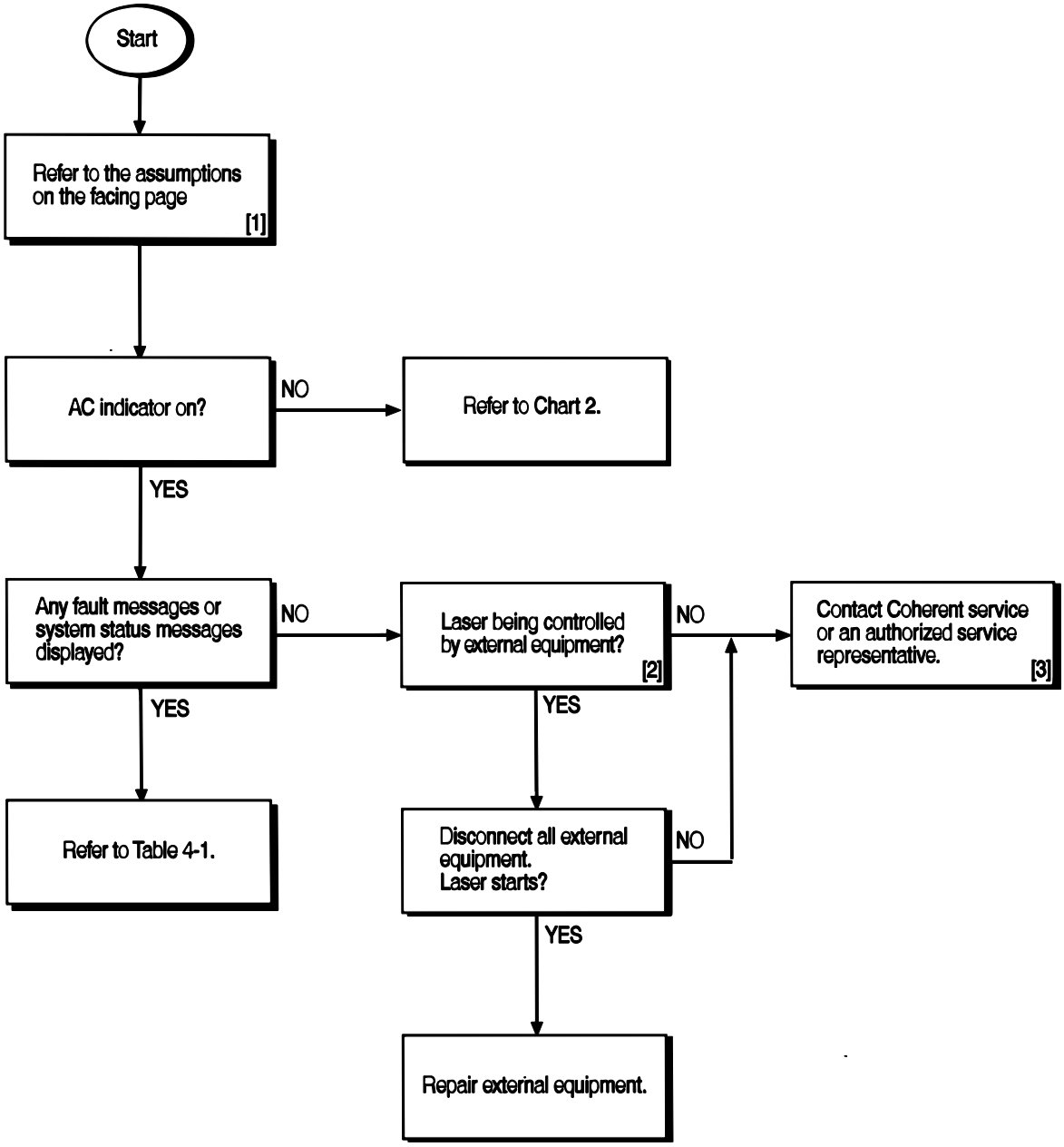


Chart 1. Laser Shuts Down (No Light Output) (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] ASSUMPTIONS:

The laser system has been installed in accordance with the installation procedures in Section Three: Installation.

The power cord is connected to an active facility power source and the power switch on the power supply rear panel is on.

[2] External equipment consists of any equipment connected to the serial port.

[3] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

Chart 2. Power Indicator Does Not Light

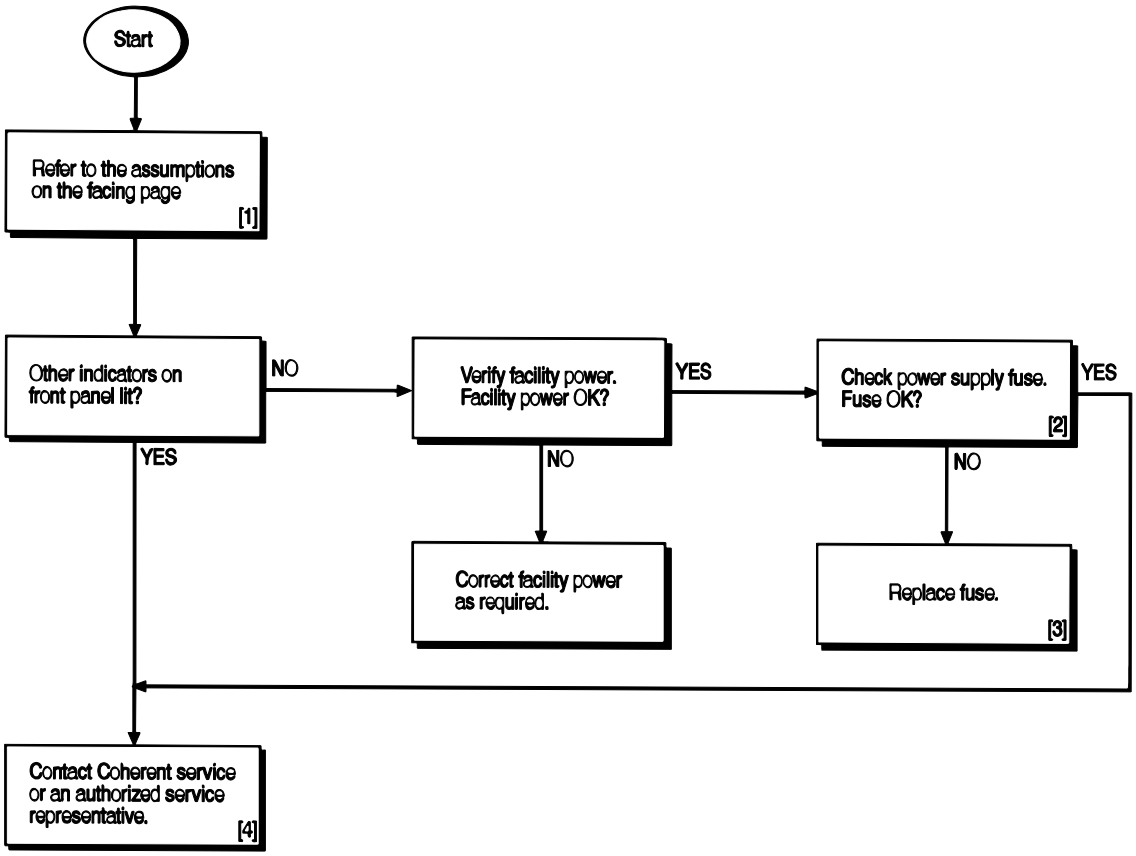


Chart 2. Power Indicator Does Not Light (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] ASSUMPTIONS:

The laser system has been installed in accordance with the installation procedures in Section Three: Installation.

The power cord is connected to an active facility power source and the power switch on the power supply rear panel is on.

Key installed and keyswitch turned to the ON position.

[2] After performing the Turn-Off procedures located in Section Four: Operation, disconnect the laser system from facility power and remove the fuse (Figure 4-3, item 4) using the fuse replacement procedures located in this section. Verify continuity (closed circuit) between the two fuse terminals.

[3] Refer to the fuse replacement procedures located in this section. If the fault persists, contact Coherent or an authorized representative.

[4] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

Chart 3. Laser Does Not Start (No Light Output)

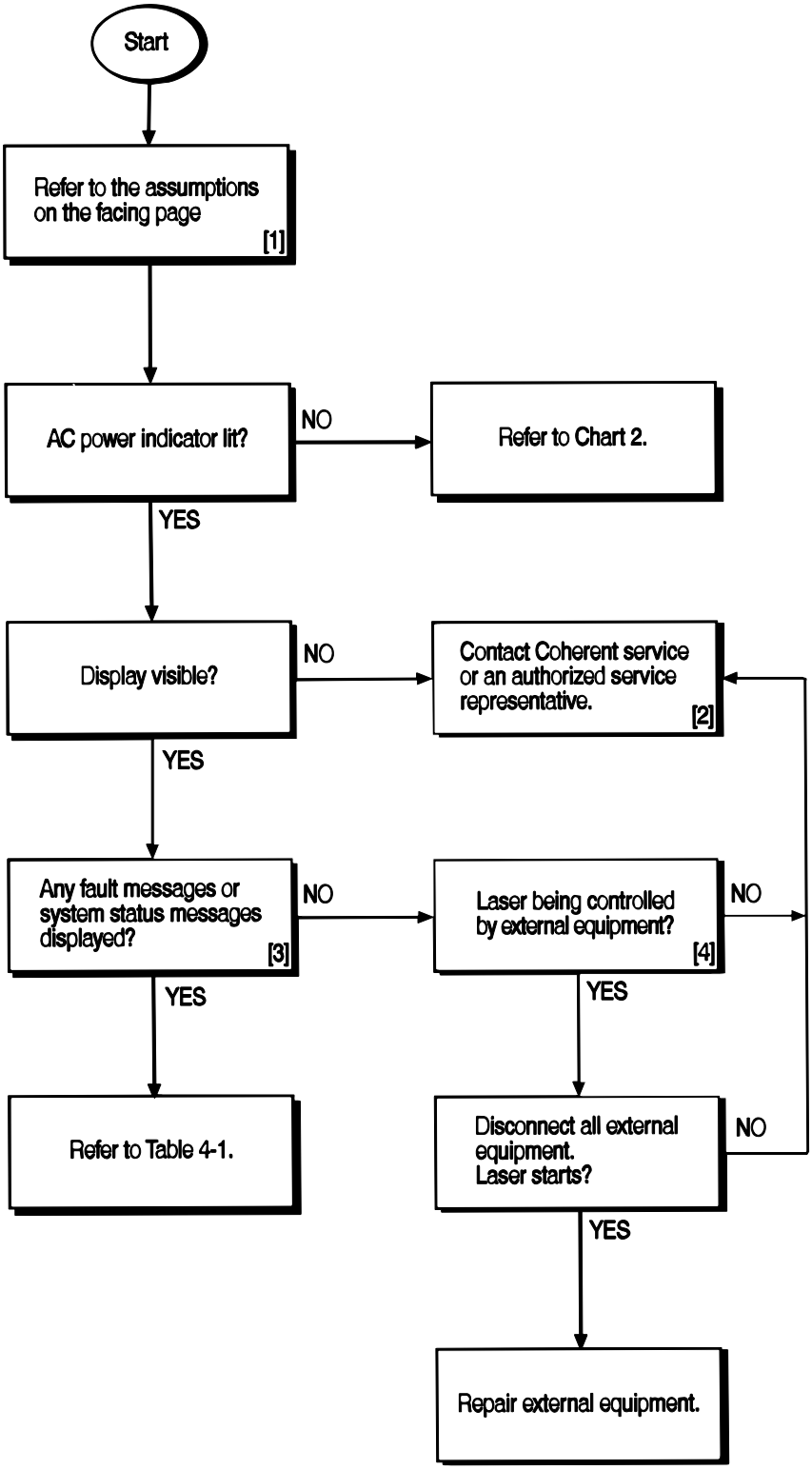


Chart 3. Laser Does Not Start (No Light Output) (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] ASSUMPTIONS

The laser system has been installed in accordance with the installation procedures in Section Three: Installation.

The appropriate turn-on procedures for the corresponding operating mode have been performed.

The operating parameters are correctly set for the corresponding operating mode as described in Section Four: Operation, and in Section Five: External Computer Control.

[2] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

[3] Refer to Table 6-1.

[4] External equipment consists of any equipment connected to the serial port.

Chart 4. Low Power

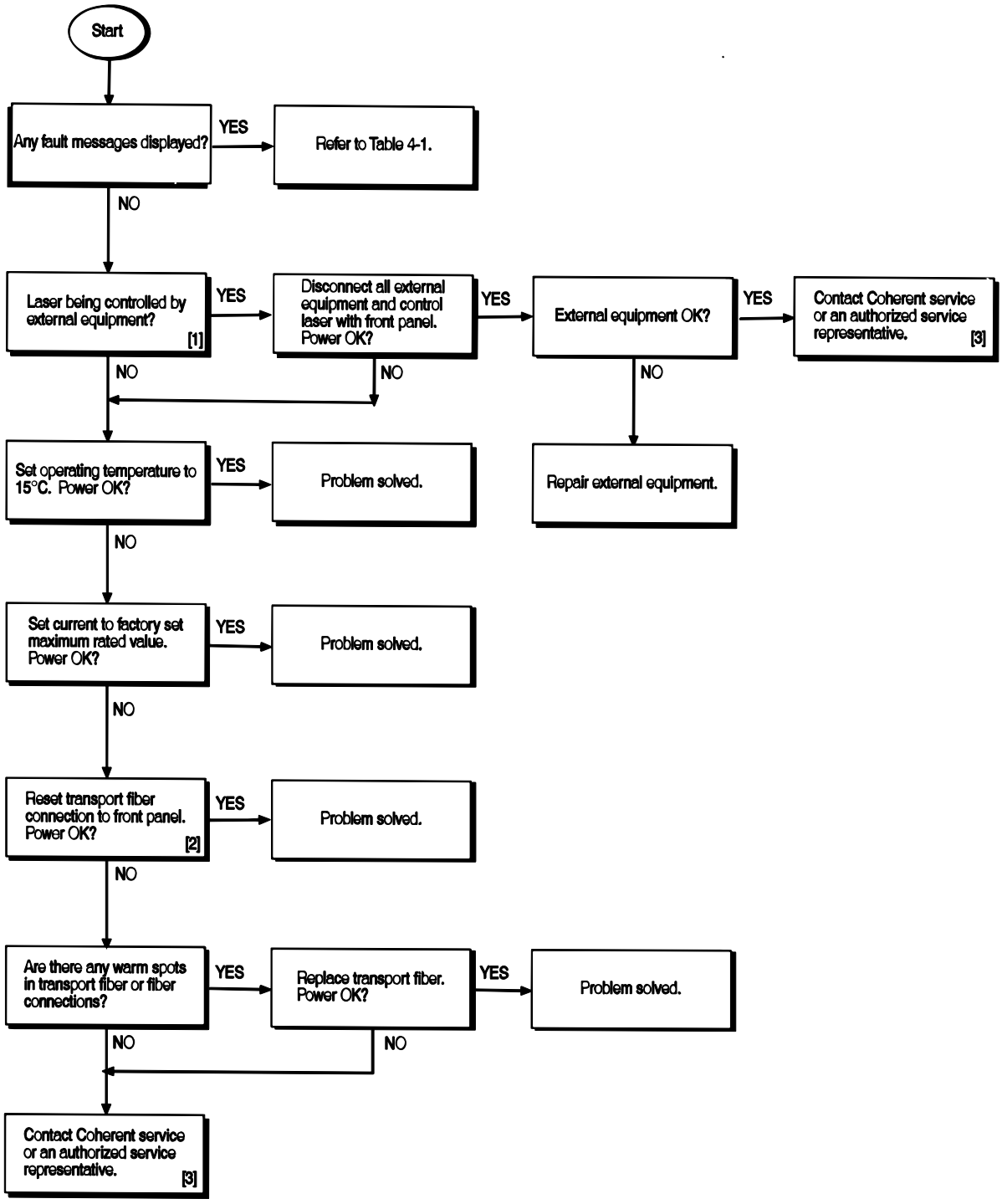


Chart 4. Low Power (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] External equipment consists of any equipment connected to the serial port.

[2] If the fault persists, contact Coherent or an authorized representative. If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

Chart 5. Distorted or Widely Diverging Beam Profile

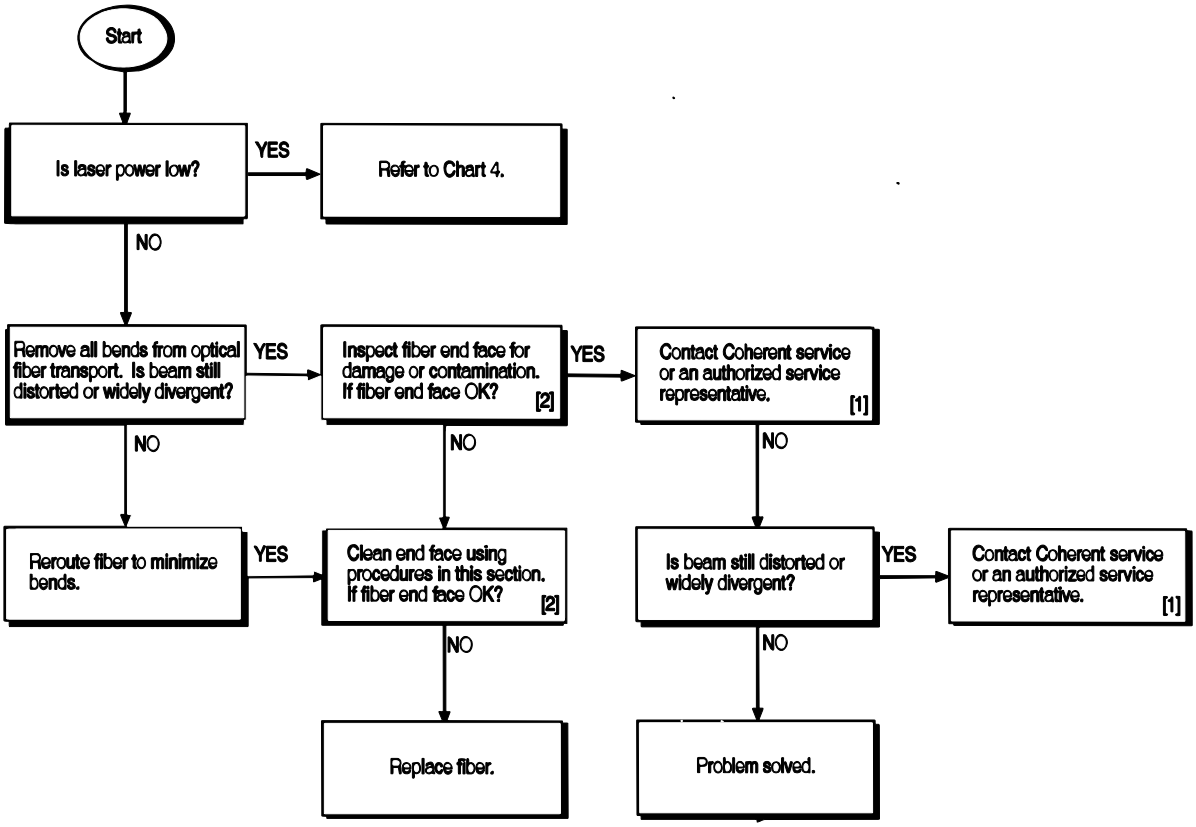


Chart 5. Distorted or Widely Diverging Beam Profile (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

[2] Refer to paragraph titled "Fiber Optic Cleaning" on page 6-20.

Chart 6. Temperature Limits Exceeded

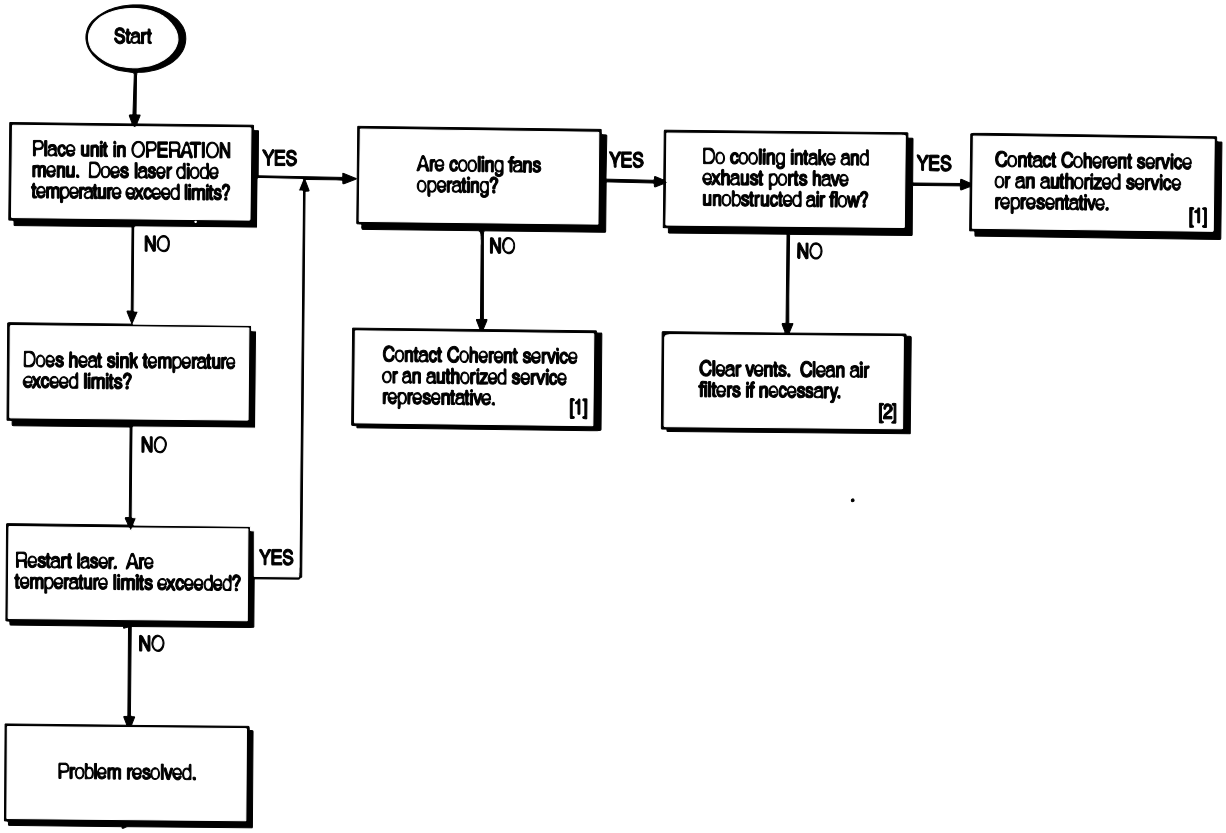


Chart 6. Temperature Limits Exceeded (Continued)

THE NUMBERED PARAGRAPHS BELOW ARE KEYED TO, AND SUPPLEMENT THE FLOWCHART FOR THIS CHART.

[1] If the fault persists, contact Coherent or an authorized representative. If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent (1-800-367-7890) or a local authorized representative.

[2] Ensure the cooling air exhaust (Figure 4-1, item 10) and the air filter (Figure 4-3, item 1) are not blocked or obstructed. Refer to the paragraph titled "Cleaning the Air Filter" on page 6-19 to inspect and clean (if required) the air filter.

Replacing FAP-I Lasers

1. Set the keyswitch to 0.
2. Turn the main power on the rear panel off.
3. Disconnect the power cord from facility power.
4. Open the laser diode mounting rack locking screws. The screws located in the top cover (Figure 6-1).

The laser diode (FAP-I) can be damaged by electro-static discharge (ESD). To avoid ESD, a personal grounding strap must be used at all times.

The end of the fiber optic cable constitutes an optical surface. Do not allow the end of the fiber optic cable to contact any surface, including the fingers. To minimize exposure to the environment, the protective plastic cap must be installed whenever the fiber is disconnected. When removing or installing the fiber optic cable, do not allow the fiber optic cable to rotate while loosening the ferrule connector.

5. Remove the fiber optic cable from the FAP-I assembly.
6. Immediately install a protective plastic cap over the FAP-I optical output aperture and the end of the fiber optic cable to protect them from accidental damage or contamination. (See Figure 6-2 for photograph showing location of the various components.)
7. While wearing a personal grounding strap, install a shorting clip between the anode and cathode (Figure 6-2) on the old FAP-I. Ground straps are available from Thor Labs (#WS02) or other suppliers.
8. Disconnect the anode and cathode leads.
9. Disconnect the monitor and TEC connectors from the old FAP-I.
    - Note the alignment dots and separation points for these connectors.
    - Remove the connectors by pulling straight back.
10. Remove the old FAP-I.

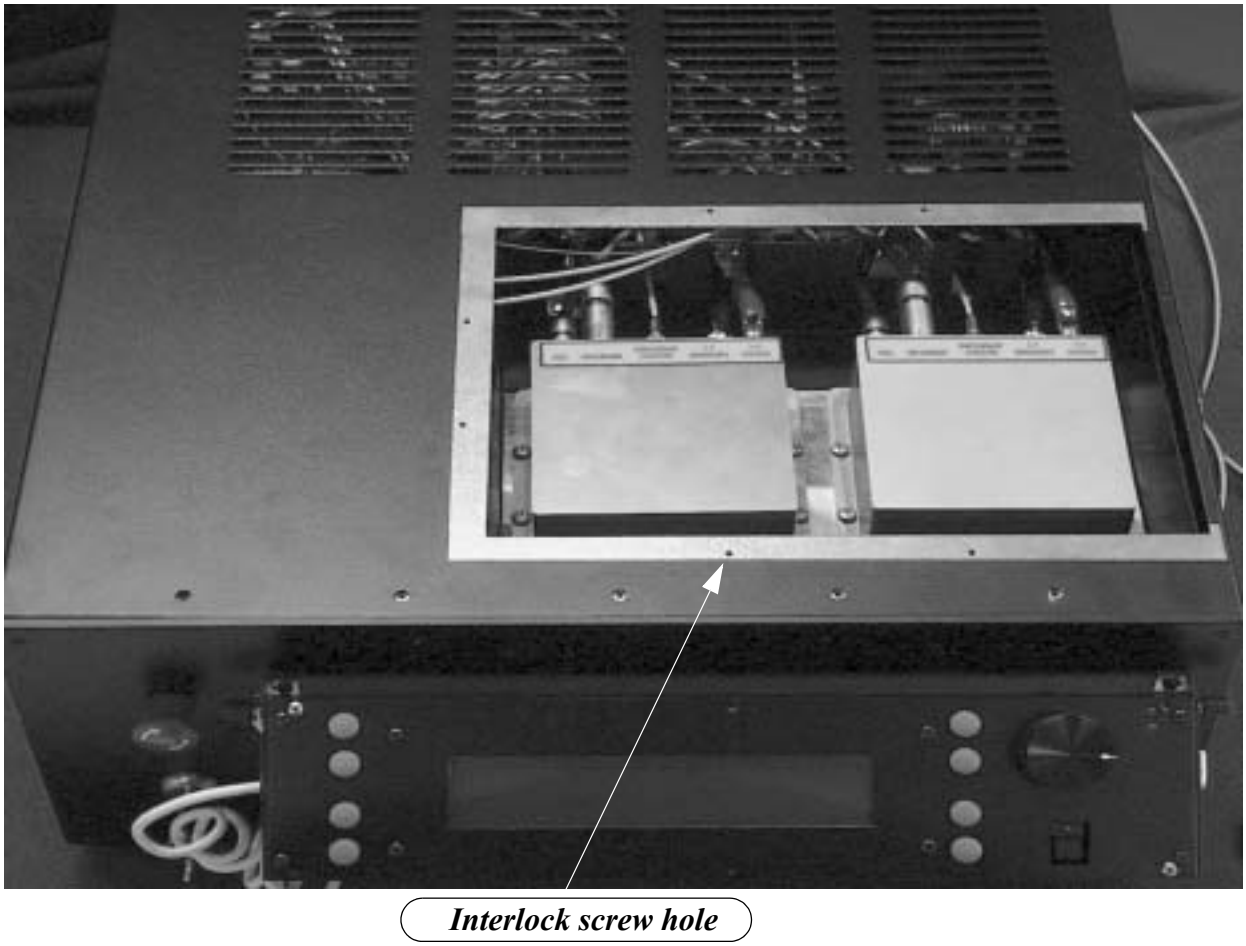
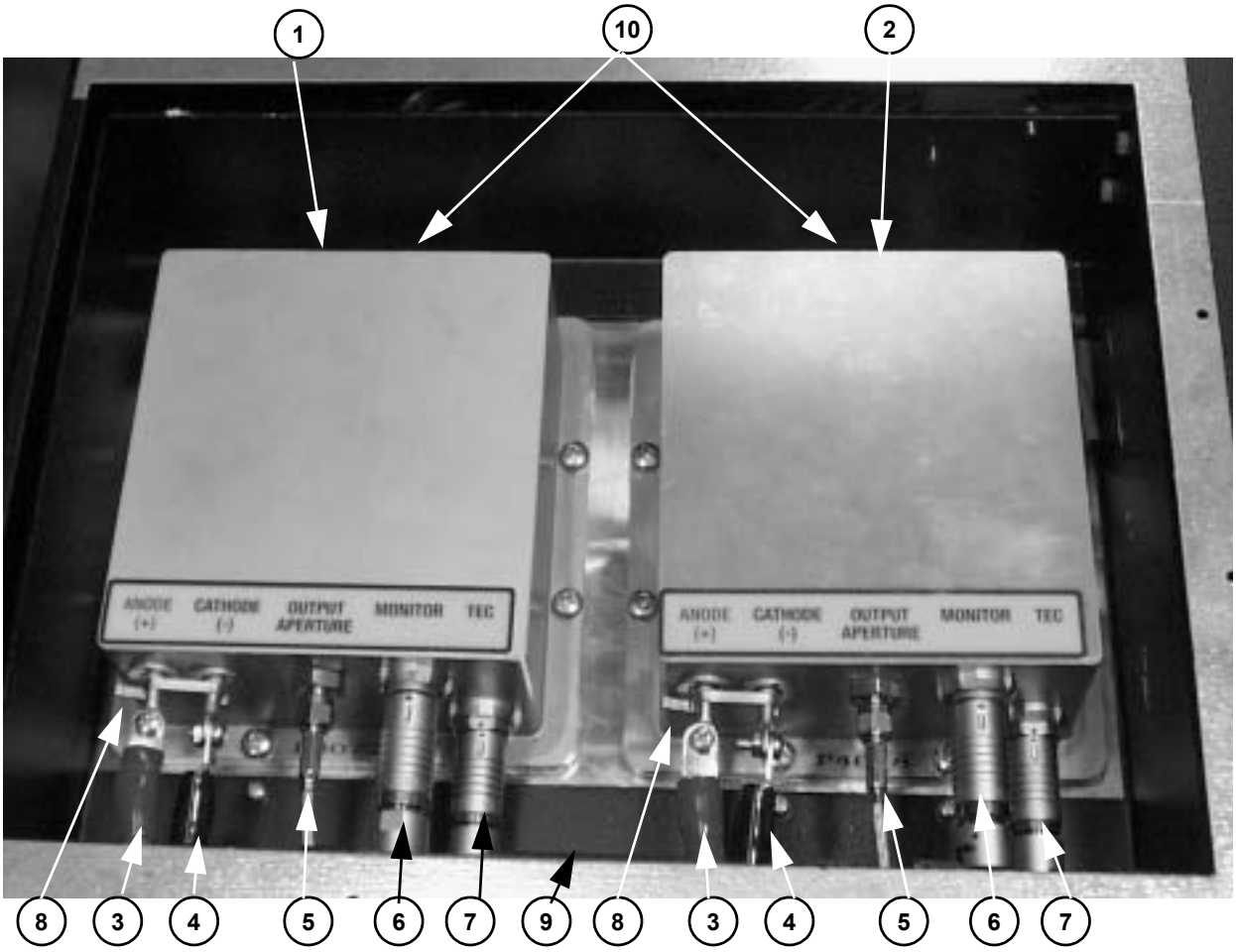


Figure 6-1. Laser Diode Mounting Rack Cover and Locking Screws

- The FAP-I may be difficult to move because of the thermal grease. Try twisting the FAP-I back and forth while lifting upward.
- If necessary, insert a 10-32 screw (supplied with the FAP-I replacement kit) into the tapped release hole and tighten, breaking the thermal grease bond.
- Note that not all FAP-I units have the release hole.

11. After removal of the FAP-I, clean the thermal grease from the FAP-I base and the heat sink mounting surface with methanol or isopropyl alcohol and paper towels.
12. Remove the new FAP-I from the shipping container.
13. Leave the shorting clip and protective plastic cap over output aperture connector to avoid possible ESD and fiber contamination.



1. FAP-I 1
2. FAP-I 2
3. Laser power + (red cable)
4. Laser power – (black cable)
5. Fiber optic cable
6. FAP-I monitor cable
7. FAP-I TEC control cable
8. Laser diode shorting clip
9. Storage location for protective caps and shorting clip
10. Tapped release hole

Figure 6-2. FAP-I Lasers

14. Inspect the FAP-I base and clean if necessary with methanol or isopropyl alcohol and paper towels.
15. Apply an even coating of thermal grease to the entire bottom of the FAP-I.
    - The grease film should be a thin, uniform layer.
    - Use a clean wooden or plastic applicator to apply the thermal grease.
16. Position the FAP-I on the heat sink

17. Secure the FAP-I to the heat sink using the eight mounting screws.
18. Torque all screws snugly.
19. Remove any excess thermal grease from around the edges of the FAP-I.
20. Re-connect the laser diode anode and cathode connections.
21. Remove shorting clip from anode and cathode leads. (The personal ground strap is now no longer needed.)

Observe the correct polarity on the anode and cathode connections. The anode (+) is connected to the red wire and the cathode (–) is connected to the black wire.

Reversing the polarity will destroy the unit!

22. Re-connect the monitor and TEC cables.
23. Remove protective caps from the FAP-I and fiber optic cable.
24. Carefully insert the fiber ferrule into the FAP-I connector. Ensure that the fiber is fully seated and the nut is snugly tightened.

Do not allow the fiber optic cable to rotate while tightening the ferrule connector. Ensure that the fiber is seated and that the retaining nut is tightened snugly. Failure to do so will damage the FAP-I and fiber optic cable.

25. Place protective caps and shorting clip in the provided storage location as shown in Figure 6-2.
26. Perform final check on anode and cathode polarity (red wire to anode [+]; black wire to cathode [–]).
27. Reattach access cover. Remember to put longest screw to marked hole.
28. Reconnect the main power.
29. Perform the turn-on procedures as detailed in the section titled "Turn-On" on page 4-1.

Fuse Replacement

1. Turn the power switch on the unit rear panel off.
2. Disconnect the line cord from the facility power.

A fuse that repeatedly fails is an indication of a more serious problem. In this case, the system should be returned to the factory. Contact Coherent (1-800-367-7890) or a local authorized representative.

3. The location of the fuse is shown on Figure 4-1. Insert a small screwdriver and twist to remove the fuse holder.
4. Replace the fuse with a 4 A, 250 V, time-delay fuse and install the fuse holder.
5. Re-connect the unit to facility power.

Cleaning the Air Filter

The air filter is located on the rear panel as shown in Figure 4-2. It should be inspected on a periodic basis. Inspect more frequently if the operating environment has high airborne concentrations of dust, hydrocarbons, or other contaminants. Clean the filter if visual contamination is noted or air flow through the system is impeded.

Do not remove air filter unless the main power switch is off and the unit is disconnected from main power source.

Removal

1. Turn the main power switch on the rear panel off.
2. Unplug the unit line cord from the local AC power source.
3. Loosen the two screws (Figure 4-2) and remove the air filter.
4. Clean the air filter by rinsing with water and dry with a blower.
   - If the filter is contaminated with a hydrocarbon film, use an appropriate solvent and follow with a water rinse and air dry.
5. Reinstall the air filter.
6. Visually inspect installed filter to verify cleanliness and unimpeded air flow through unit.

Fiber Optic Cleaning

Before performing the cleaning procedure, observe the fiber optic surface with a fiberscope or magnifier to determine the extent to which the fiber might be damaged or dirty. Only perform the cleaning procedure if the fiber optic surface shows imperfections; if performed on an otherwise clean surface, the procedure may introduce dust, dirt, or damage to the fiber optic.

Equipment Needed

The following materials are required to perform this procedure:

- Lens-cleaning tissue
- Fresh spectroscopic-grade methanol
- Fiber microscope (fiberscope)
- Latex (or equivalent) gloves or fingercots

Important: Do not use acetone! Acetone will dissolve adhesives used in the manufacture of the fiber optic, and will destroy the fiber optic cable.

Procedure

Always wear latex gloves or fingercots (or the equivalent) while performing this procedure. Fingerprints, dust, condensation, and oils can damage the fiber optic surface.

1. Put two or three drops of methanol on the surface of a single lens-cleaning tissue (Figure 6-3).
2. Holding the fiber vertically so the lens surface points to the ceiling, carefully place the tissue so the optical surface rubs against the underside of the tissue (Figure 6-4).
3. In a single movement, gently drag the fiber surface against the underside of the wet tissue in a circle, spiraling out, taking care not to go over the same part of the tissue twice (Figure 6-5).
4. Drag the fiber out from the saturated part of the edge of the tissue to across dry parts of the tissue. This dries the fiber surface.
5. Re-check the fiber with the fiberscope. If imperfections remain, repeat the procedure using a new tissue.
6. If imperfections still remain, compare the image in the fiberscope with Figure 6-6, Figure 6-7, and Figure 6-8 to determine

Figure 6-3. Methanol Drop

Figure 6-4. Placement of the Optical Fiber Against the Lens Tissue

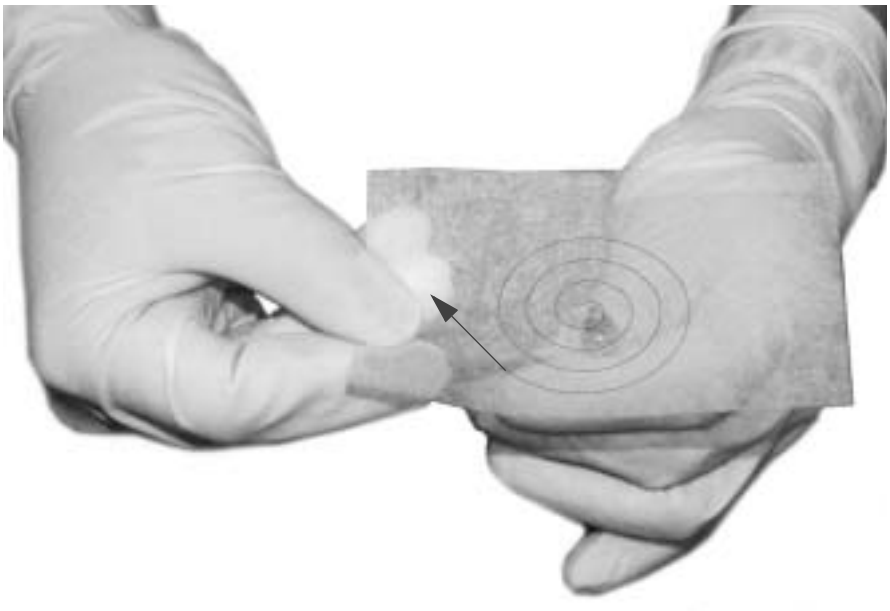


Figure 6-5. Movement of Fiber Against the Tissue

whether the fiber optic surface must be replaced. Contact Coherent Service if the imperfections are ambiguous and you need further guidance.

7. Immediately place the protective cap over the fiber optic surface or install the fiber optic connector to protect the surface from contamination.

Examples of Good and Bad Fibers

Figure 6-6 shows images of fibers through a fiberscope with no or slight imperfections that can be used successfully in the FAP-I assembly.

Figure 6-7 shows images of fibers through a fiberscope with imperfections that can impair the function of the assembly. The image on the left is clearly a damaged fiber. Severely damaged fibers must not be used in the FAP-I assembly, or permanent and severe damage to the assembly may occur.

The image on the right shows a fiber that is questionable. If the power output is acceptable, then the fiber can be used with little concern for damaging the assembly. If the power output is unstable or not up to acceptable standards, however, the fiber must be considered damaged and must not be used.

Figure 6-8, Figure 6-9, and Figure 6-10 shows further criteria for accepting or rejecting a fiber because of damage.

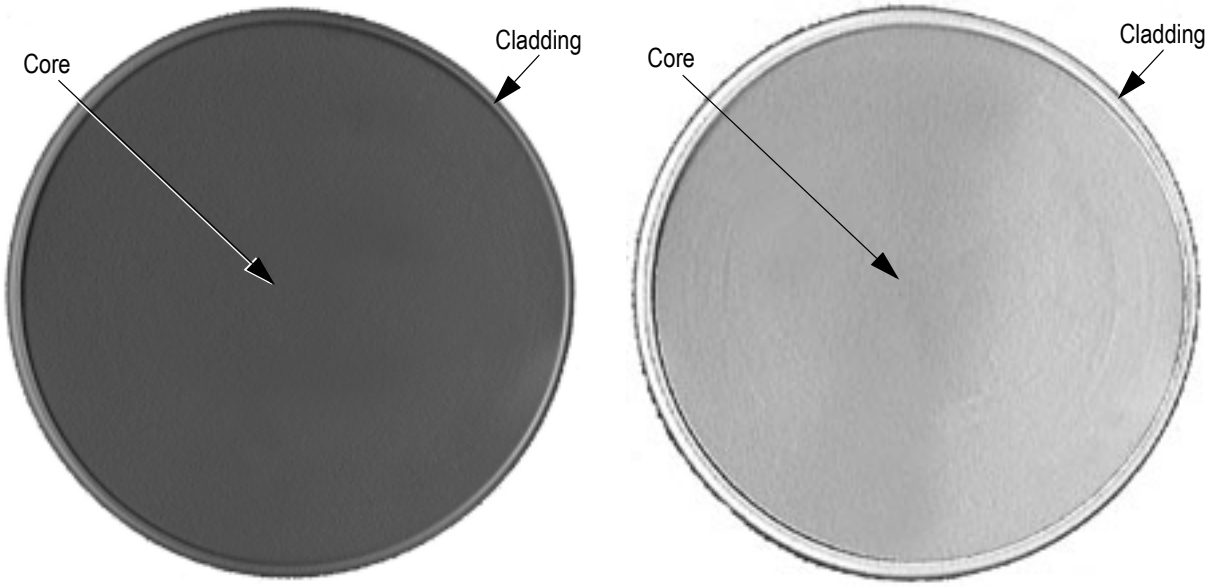


Figure 6-6. Good Fibers

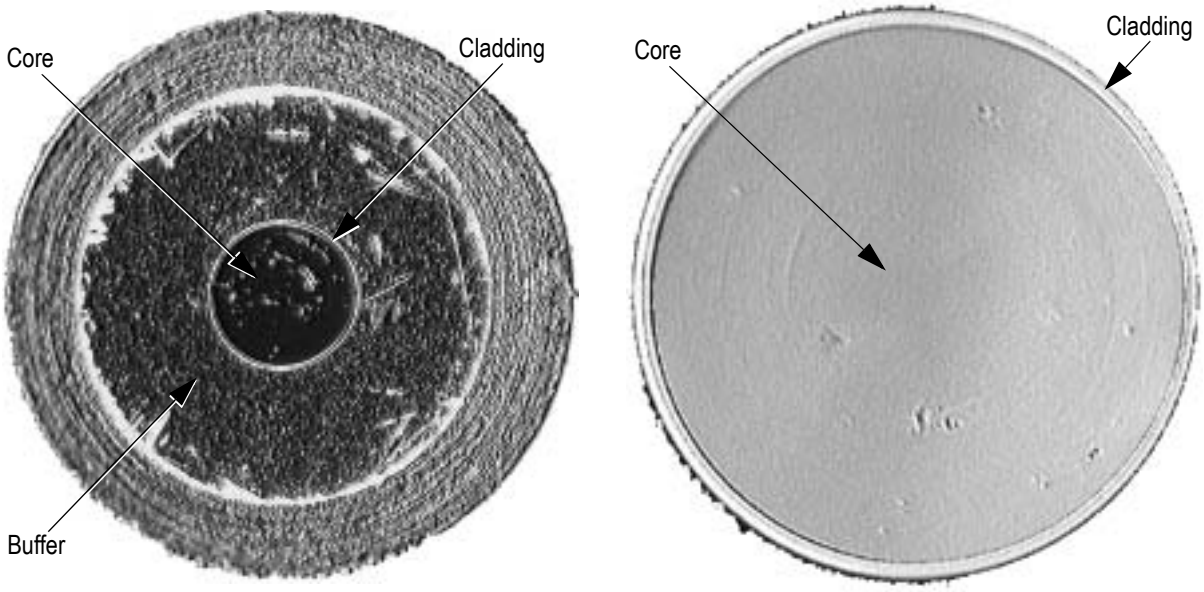


Figure 6-7. Bad or Questionable Fibers

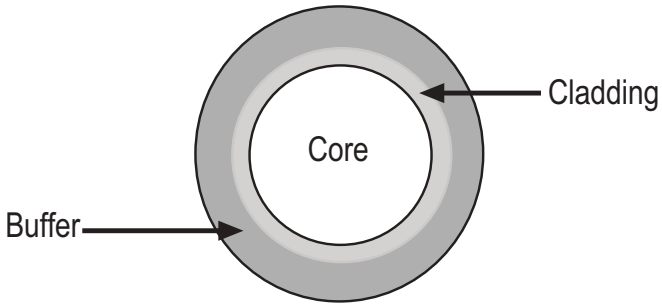


Figure 6-8. Ideal Fiber

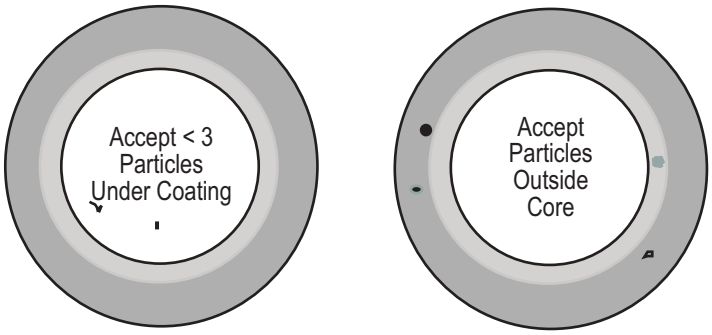


Figure 6-9. Acceptable Imperfections

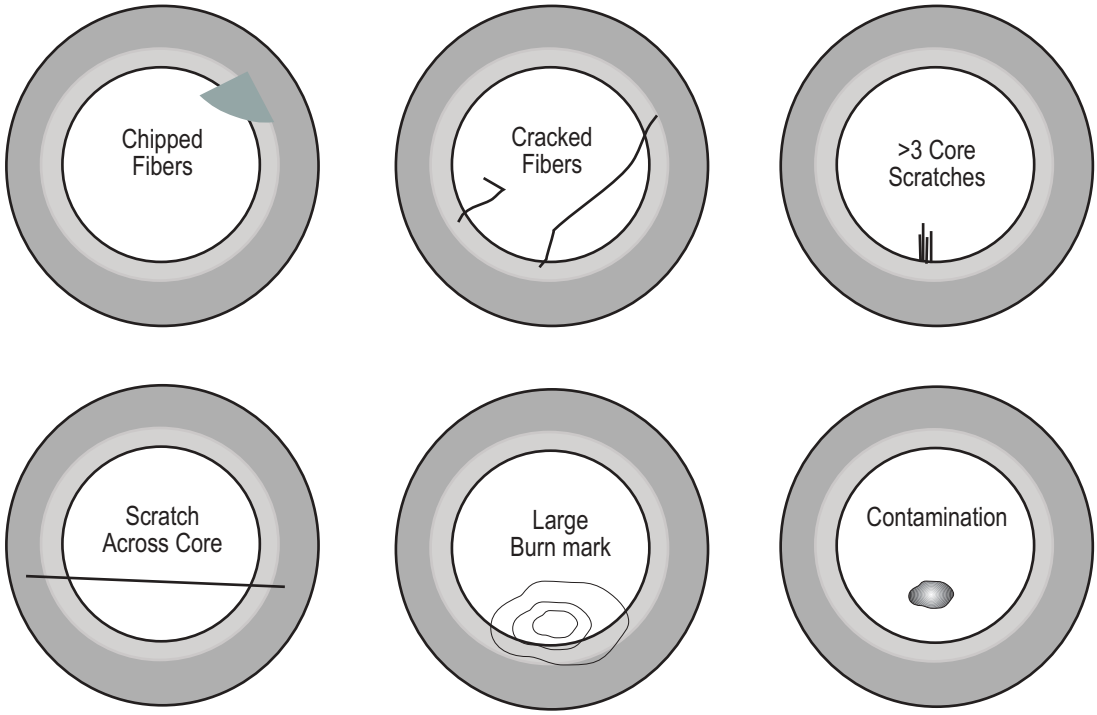


Figure 6-10. Criteria for Rejection

Returning the System

If the system must be returned, use the original shipping carton for shipping. The supplier is not responsible for shipping damage. A replacement shipping carton is available. Refer to Appendix A: Accessories and Parts List for the shipping carton part number.

If the laser is being returned directly to Coherent, an RMA (Return Material Authorization) number is required. An RMA number can be obtained by calling 1-800-367-7890 or by contacting your local Coherent representative.

ACCESSORIES AND PARTS LIST

Coherent produces accessories to the basic DUO FAP System designed to facilitate user applications. Several of these accessories are described below. Coherent is committed to expanding this product line. Please contact your Coherent representative for a list of the latest available accessories. If you require an accessory that is currently not offered, please allow Coherent to quote on a custom accessory.

Table A-1. Parts List

DESCRIPTION	PART NUMBER
Foot Pedal	0618-432-01
Fuse	5110-0072

Table A-2. Recommended Spare Parts

DESCRIPTION	PART NUMBER
Spares on hand (1 set per 25 systems)	
1 FAP/system, complete	0172-674-00
Spares on hand (1 set per 5 systems)	
FAP-I module	Varies w/System Configuration
5M armored fiber, 800 µm 5 ma/nut	1005804
2:1 armoned fiber ass'y.	1005798
Keys, 2 each	5107-0170
Interlock connector – front, 2 each	N/A
Interlock connector – rear, 2 each	N/A
Power cord	6005-0054
Spares on hand (1 set per system)	
Fuses, 10 A 250 VAC, 2 each	
FAP shorting clips, 2 each	0171-199-00

Table A-2. Recommended Spare Parts

DESCRIPTION	PART NUMBER
SMA cap, female, 2 each	0615-452-01
1M, 800 µm fiber jumper	1005810

Table A-3. Specifications for OIA's

	1:1			1.8:1
Typ working dist	37 mm*	33 mm*	30 mm*	13 mm*
Magnification	1.25	1	0.87	0.56
Transmission	90%	90%	90%	90%
Spot size w 800 µm fiber (90% encircled energy)	1000 µm	800 µm	700 µm	450 µm
Dimensions				
Diameter	22.3 mm	22.3 mm	22.3 mm	22.3 mm
Length	59.2 mm	59.2 mm	59.2 mm	59.2 mm
Weight	1.1 kg (1 oz.)	1.1 kg (1 oz.)	1.1 kg (1 oz.)	1.1 kg (1 oz.)
Part number	0172-675-00	0172-675-01	0172-675-01	0175-679-01

* Effective working dist / mag is user adjustable by changing supplied spacer element.
OIA's with integrated LED aiming beam are also available.

Table A-4. Specifications for Fiber Tapers

	1200 µM – 800 µM (2:1 LONG BUNDLE)	**800 µM – 600 µM**	**800 µM – 400 µM**
Input beam waist [1]	1200 µm	800 µm	800 µm
Output beam waist [2]	800 µm	600 µm	400 µm
Input N.A. [3]	<0.16	<0.16	<0.16
Output N.A. [3]	<0.28	<0.25	<0.38
Transmission Efficiency	95%	98%	80%
Dimensions			
Length	100.0 mm	68.0 mm	68.00 mm
Weight	7 gm (.05 oz.)	7 gm (.05 oz.)	7 gm (.05 oz.)
Part number	PV	1005815	1005912

1 Source dia

2 Distal end delivery dia

3 Numerical aperture of output beam is defined as 1/2 angle

Note: The transmission efficiency of 80% is being reviewed as too low and expect an update.

Note: These configurations represent standard product offerings. We are happy to entertain custom requests with the knowledge that custom offerings are more expensive. Please consult factory for quote and lead times.

WARRANTY

Coherent, Inc. warrants the DUO FAP System™ to the original purchaser (the Buyer) only. Coherent warrants that the laser system, that is the subject of this sale, (a) conforms to Coherent's published specifications and (b) is free from defects in materials and workmanship.

The DUO FAP System is warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of 1 year or 3000 hours of operation, whichever comes first.

Responsibilities of the Buyer

The buyer is responsible for providing the appropriate of the Buyer utilities and an operating environment as outlined in the product literature. Damage to the unit caused by failure of Buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the Buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

Limitations of the Warranty

The foregoing warranty shall not apply to defects resulting from:

- Components and accessories manufactured by Companies, other than Coherent, which have separate warranties,
- Improper or inadequate maintenance by the buyer,
- Buyer-supplied interfacing,
- Operation outside the environmental specifications of the product,
- Unauthorized modification or misuse,
- Improper site preparation and maintenance, or
- Opening the housing.

Coherent assumes no responsibility for customer-supplied material. The obligations of Coherent are limited to repairing or replacing, without charge, equipment which proves to be defective during the

warranty period. Replacement sub-assemblies may contain reconditioned parts. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of system warranty is ninety (90) days. Our warranty does not cover damage due to misuse, negligence or accidents, or damage due to installations, repairs or adjustments not specifically authorized by Coherent.

Warranty applies only to the original purchaser at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. Warranty is transferable to another location or to another customer only by special agreement which will include. additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALL DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

GLOSSARY

°C	Degrees centigrade or Celsius
°F	Degrees Fahrenheit
µ	Microns
µrad	Microradian(s)
µsec	Microsecond(s)
$1/e^2$	Beam diameter parameter
AC	Alternating current
Amp	Amperes
CDRH	Center for Devices and Radiological Health
cm	Centimeter(s)
CW	Continuous wave
DC	Direct current
ESD	Electro-static Discharge
GHz	Gigahertz
Hz	Hertz
I/O	Input/output
IR	Infrared
kg	Kilogram(s)
LCD	Liquid crystal display
LD	Laser diode
LED	Light emitting diode
m	Meter(s)
mAmp	Milliampere(s)
MHz	Megahertz
mm	Millimeter(s)
mrad	Milliradian(s)
msec	Millisecond(s)
mV	Millivolt(s)
mW	Milliwatt(s)
Nd:YAG	Neodymium doped yttrium aluminum garnet
nm	Nanometer(s)
OEM	Original equipment manufacturer
rms	Root mean square
Rx	Receive
TEM	Transverse electromagnetic (cross-sectional laser beam mode)
Tx	Transmit
VAC	Volts, alternating current
VDC	Volts, direct current
W	Watt(s)

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DUO FAP-System Operator's Manual

Coherent Part Number: 1007964, RevAA