FLS-2100

Optical Light Source

Instruction Manual

Second Edition

P/N: MAN-101-I .2ACE

If the equipment described herein bears the CE *symbol, the said equipment complies with the European Community Directive and Standards found in the Declaration of Conformity.*

If the equipment described herein bears an **FCC** *statement, the said equipment complies with the relevant Federal Communications Commission standards.*

September 1999

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Certification Information

F.C.C. Information to User

This unit has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 (Subpart B) of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This unit generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this unit does cause harmful interference to radio or television reception, which can be determined by turning the unit off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the unit and receiver.
- Connect the unit into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning

Changes or modifications not expressly approved by EXFO Electro-Optical Engineering, Inc. could void the user's authority to operate the unit.

- This unit is equipped with a shielded 3-wire power cord and plug. Use this power cord in conjunction with a properly grounded electrical outlet to avoid electrical shock and to reduce radio frequency interference which may emanate from the power cord.

- Shielded remote I/O cables, with properly grounded shields and metal connectors, are recommended to be used in order to reduce radio frequency interference which may emanate from these cables.
- When the GPIB option is present, this unit is equipped with a shielded GPIB cable.

INDEPENDENT LABORATORY TESTING

This unit has undergone extensive CE certification testing both internally, at EXFO, and externally, at an independent, qualified laboratory. All pre-qualification tests were performed at EXFO while all final tests were performed at UltraTech Engineering Labs, Inc., a renowned test laboratory from Mississauga, Canada. This guarantees the unerring objectivity and authoritative compliance of all test results.

CE INFORMATION TO USER

This unit has been tested and found to comply with the limits for a Class B digital device. Please see the Declaration of Conformity.

1 Introduction

EXFO Electro-Optical Engineering, Inc. (EXFO) is pleased to introduce the FLS-2100. EXFO's commitment to superior design in all its fiber-optic instrumentation is respected throughout the industry and is based on the following four goals:

- reliable and accurate performance
- simple operation
- extensive features
- dedicated interest in customer needs

The FLS-2100 will provide many years of reliable operation. To benefit fully from the many features offered by the FLS-2100, it is important to read the following instructions thoroughly.

Unpacking and Inspection

The FLS-2100 is delivered with the following standard items:

- FLS-2100 Instruction Manual
- Warranty Validation Card
- Declaration of Conformity
- Certificate of Compliance
- cleaning kit
- GPIB interface cable

The FLS-2100 has been thoroughly inspected before shipment. If any damage occurred during transportation or if any item is missing, please notify EXFO immediately. Retain the original packing material in case you need to return the FLS-2100.

Transportation and Storage

Maintain a temperature range within specifications when transporting or storing the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- ➤ Pack the unit in the original packing material when shipping.
- ➤ Store unit at room temperature in a clean and dry area.
- ➤ Avoid high humidity or large temperature fluctuations.
- ➤ Keep the unit out of direct sunlight.
- ➤ Avoid unnecessary shock and vibration.

Safety Conventions

The following conventions should be understood before operating the unit:

WARNING

Refers to a potential *personal* hazard. It requires a procedure which, if not correctly followed, may result in bodily harm or injury. Do not proceed beyond a **WARNING** unless the required conditions are understood and met.

CAUTION

Refers to a potential *product* hazard. It requires a procedure which, if not correctly followed, may result in component damage. Do not proceed beyond a **CAUTION** unless the required conditions are understood and met.

IMPORTANT

Refers to any information regarding the operation of the product which should not be overlooked.

General Safety Information

The FLS-2100 Light Source is a single- or dual-wavelength LED or laser source. The light source, which contains semiconductor diode lasers, is classified as a 21 CFR Class I laser product that comply with 21 CFR 1040.10 and 1040.11. Laser radiation may be encountered at the source port.

Figure 1-1. *Laser Warning Label*

The level of radiation is below that known to cause eye injury through accidental short-term exposure. However, avoid prolonged exposure to light emitted from the fiber, and do not stare directly at a light beam, whether it is visible or not.

Safety Precautions

While manipulating optical fibers, laser radiation may be encountered at source output ports and at fiber ends. Avoid long-term exposure to laser radiation.

WARNING

Do not install or terminate fibers while a laser source is active. Never look directly into a live fiber and ensure that your eyes are protected at all times.

CAUTION

Controls, adjustments and procedures for operation and maintenance other than those specified in this manual may result in hazardous radiation exposure.

CAUTION

Using optical instruments with this product will increase eye hazard.

The following safety precautions must be observed while operating and servicing the units. Failure to comply with these precautions or with specific indications elsewhere in this manual violates safety standards for intended use. EXFO assumes no liability for the user's failure to comply with these requirements.

- Use unit indoors only.
- Do not remove unit covers during operation.
- Before powering on the unit, all grounding terminals, extension cords, and devices connected to it should be connected to a protective ground via a ground socket. Any interruption of the protective grounding is a potential shock hazard and may cause personal injury.
- Whenever the protective grounding is impaired, do not use the unit, and secure it against accidental or unintended operation.
- Only fuses with the required rated current and specified type (IEC, 250 V, 2 A, fast blow, 0.197in x 0.787in /5 mm x 20 mm) may be used for replacement. Do not use repaired fuses or short-circuited fuse holders.
- Avoid adjustments, maintenance, and repair of opened units under voltage. These should only be carried out by skilled personnel aware of the hazards involved. Do not attempt internal service or adjustment unless another person qualified in first aid is present. Do not replace any components while power cable is connected.
- Operation of any electrical instrument around flammable gases or fumes constitutes a major safety hazard.
- Installation of replacement parts or modification of the unit should be carried out by authorized personnel only.
- Capacitors inside the unit may be charged even if the unit has been disconnected from its electrical supply.

AC Requirements

The FLS-2100 can operate from any single-phase AC power source between 100 V and 240 V (50/60 Hz). The maximum input current is 2 A.

Power Cable

This unit uses a three-wire power cable that meets international safety standards. This cable serves as a ground when connected to an appropriate AC power receptacle. The type of power cable supplied with each unit is determined according to the country of destination.

Only qualified electricians should attach a new plug if needed. The color coding used in the electric cable depends on the cable. New plugs should meet local safety requirements and include the following features:

- adequate load-carrying capacity
- ground connection
- cable clamp

WARNING

To avoid electrical shock, do not operate the unit if there are signs of damage to any part of the outer surface (covers, panels, etc.).

To avoid serious injury, the following precautions must be observed before powering on the unit:

- **If the unit is to be powered via an automatic transformer for voltage reduction, the common terminal must be connected to the grounded power source pole.**
- **Insert the plug into a power outlet with a protective ground contact. Do not use an extension cord without a protective conductor.**
- **Before powering on the unit, the protective ground terminal of the unit must be connected to a protective conductor using the unit power cord.**
- **Do not tamper with the protective ground terminal.**

Contacting the Customer Service Group

If you encounter any difficulty while operating this product, please call EXFO at one of the offices listed below. Our Customer Service Group is available in North America from 7:30 a.m. to 8:00 p.m. (Eastern Standard Time), Monday to Friday.

EXFO Electro-Optical Engineering (Corporate Headquarters)
465 Godin Avenue
Vanier QC G1M 3G7
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EXFO Europe
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78353 Jouy-en-Josas, France

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2 General Description

The FLS-2100 Light Source is a single- or dual-wavelength LED or laser source. With its impressive stability and its 10-dB variable output, the FLS-2100 is particularly well-suited to the most demanding laboratory and manufacturing qualification applications. The FLS-2100 can be remotely controlled through a GPIB or RS-232 interface.

The *Setup* button to the right of the display gives access to a single-level menu. The following diagram shows the menu and its items.

Figure 2-1. *Menu Display*

To move (in a loop) between the menu items, use the left/right arrows. To exit the menu,

- press the *Setup* button; or
- scroll (left/right arrows) until *EXIT* is displayed, then press *ENTER*.

Front Panel

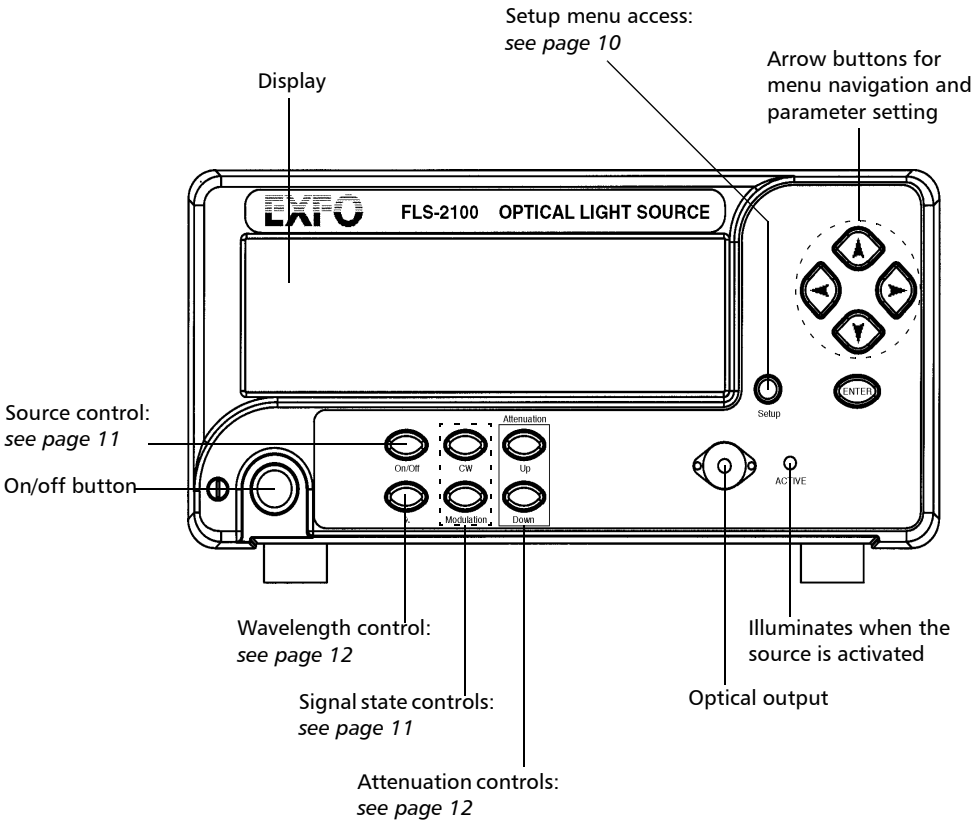


Figure 2-2. *Front Panel*

Note: *Your FLS-2100 may differ slightly from the illustration.*

Back Panel

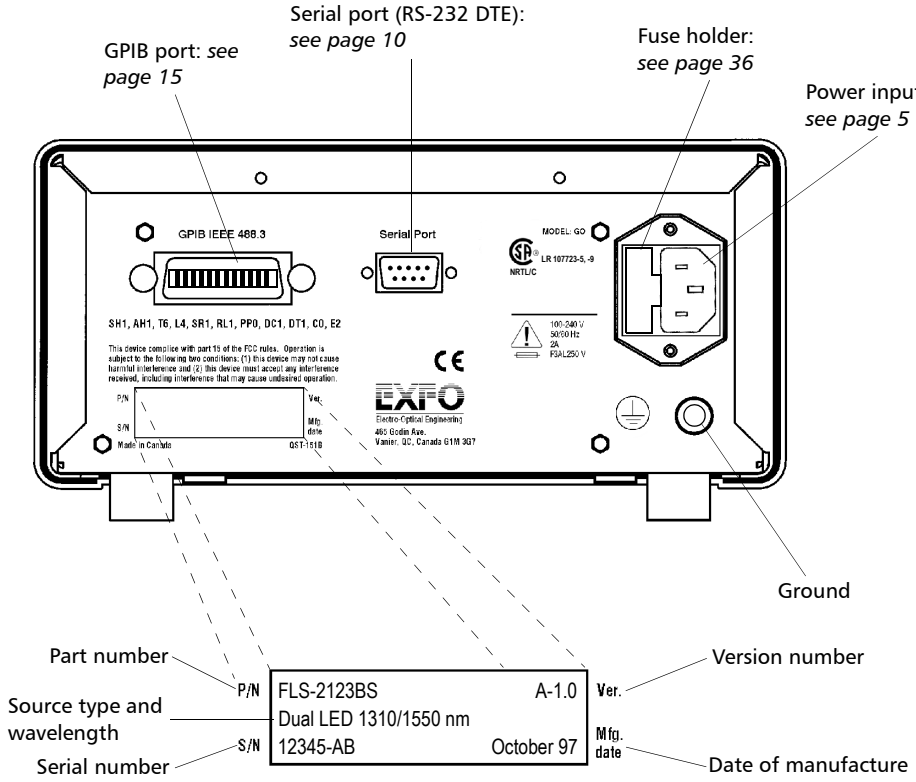


Figure 2-3. *Back Panel*

Note: *Your FLS-2100 may differ slightly from the illustration.*

RS-232 Connector Pinout

The RS-232 connector (serial port) at the back of the FLS-2100 uses a DTE pinout configuration.

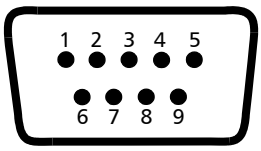


Figure 2-4. *RS-232 Connector Pinout*

Pin	Description	Direction
2	Receive (Rx)	Input
3	Transmit (Tx)	Output
5	Signal ground (Gnd)	—

Table 2-1. *RS-232 Pinout Configuration*

3 Operation

Turning the FLS-2100 On and Off

Before turning on the FLS-2100, please read *General Safety Information,* on page 3. To turn the unit on and off, use the red button in the lower left corner of the front panel.

When turned on, the unit beeps twice, performs a self-test, and then waits for commands to be entered; the source is deactivated and no attenuation is introduced (ATT. = 0.0 dB). When the unit is turned off, the following items remain in non-volatile memory:

- step size
- remote control settings

Note: *The power cord is the most effective disconnect device. To ensure the power is completely turned off, disconnect the power cord.*

Activating and Deactivating the Source

To activate and deactivate the source, press *On/Off.* When the source is activated, *source On* is displayed and a marker indicates the source output status: CW, 270 Hz modulation, 1 kHz modulation, or 2 kHz modulation.

Note: *For optimum stability, a laser source requires a 30 minute warm-up period.*

Continuous or Modulated Output

Once the source is activated (*source On* is displayed), press *CW* for a continuous wave signal or press *Modulation* for a modulated signal. Pressing *Modulation* toggles between the available modulation states. A marker displays the source output status: CW, 270 Hz, 1 kHz, or 2 kHz.

Note: *The internal modulation is full on/off modulation at 50% duty cycle.*

Changing Wavelength (optional)

Some FLS-2100 units may be configured with two source wavelengths. To toggle between the available wavelengths, press λ. The current wavelength is always indicated in the lower portion of the display.

Attenuating the Output Power

Once the source is activated, you can attenuate the output power up to 10 dB below the maximum output power level. The maximum output power level depends on the configuration of the FLS-2100 (see *Optical Specifications,* on page 41). The attenuation is an absolute value and is displayed in the upper portion of the display.

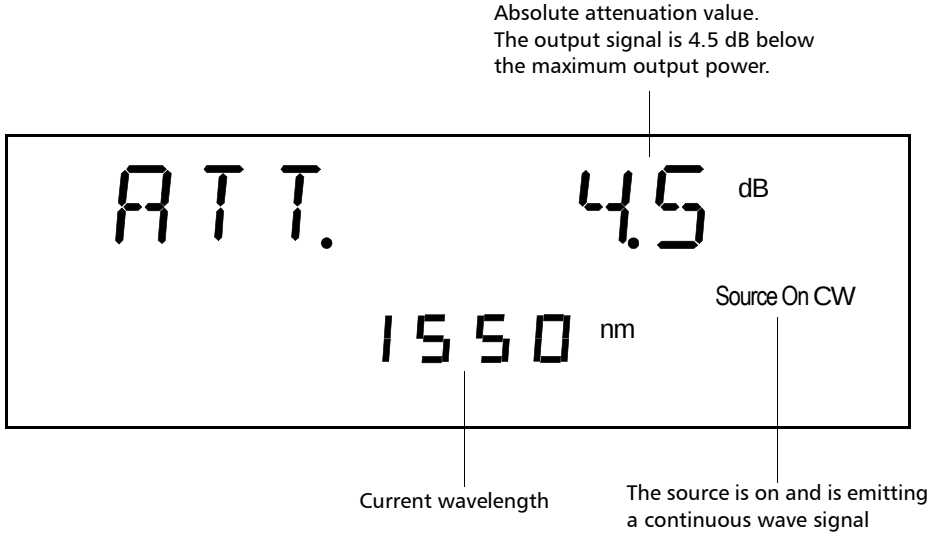
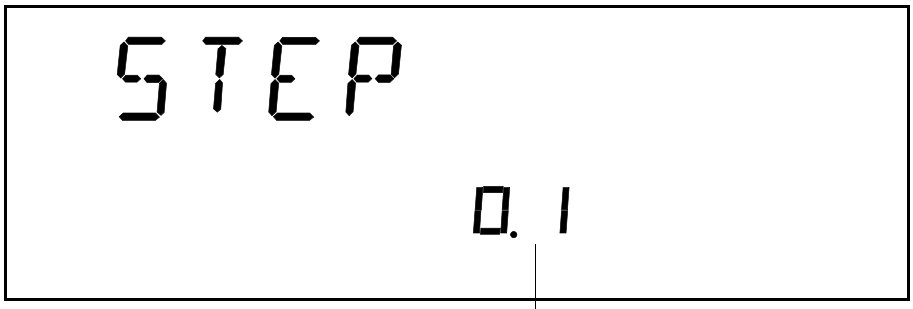


Figure 3-1. *Typical Display*

Note: *0.0 dB attenuation indicates maximum output power (no attenuation).*

To increase attenuation to the output power, press *Up.* To decrease attenuation to the output power, press *Down.* The attenuation is increased or decreased by one step (a choice of 0.1, 0.5, or 1.0 dB). To change the attenuation step size,

1. Press *Setup.*
2. Scroll (left/right arrows) to *STEP.*



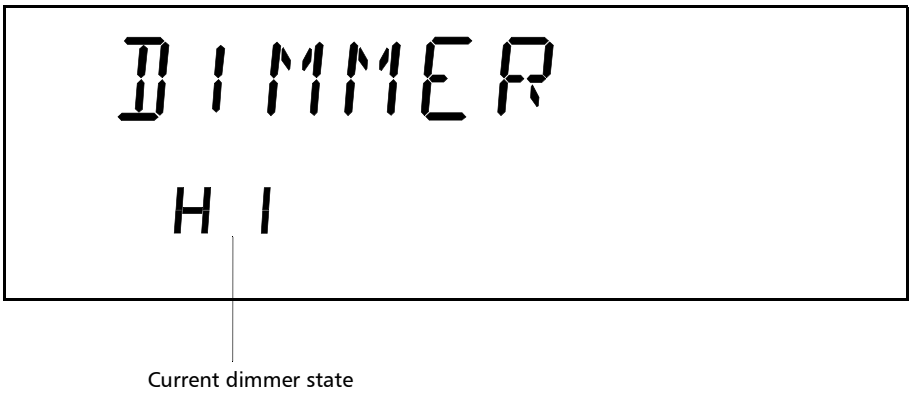
Current step size (in dB)

3. Press *ENTER.* The current step size will start flashing.
4. Use the up/down arrows to select a new step size (0.1, 0.5, or 1.0 dB).
5. Press *ENTER.*
6. To exit the *Setup* menu, press *Setup.*

Setting the Display Intensity

Display intensity may be set to high or low. You can also turn off the display without turning off the unit.

1. Press *Setup.*
2. Scroll (left/right arrows) to *DIMMER*.



3. Press *ENTER*. The current dimmer state will start flashing.

4. Use the up/down arrows to modify the dimmer: LO, HI, or OFF.

5. Press *ENTER*.

Note: *Setting the dimmer to* OFF *turns off the display. Press any key to turn the display back on.*

6. To exit the *Setup* menu, press *Setup*.

4 Remote Control

The FLS-2100 can be remotely controlled either by

- a GPIB interface (through a GPIB cable connected to the GPIB port), or
- an RS-232 interface (through a serial cable connected to the serial port).

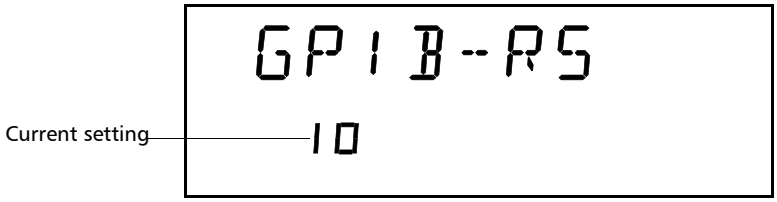
The commands used in both protocols are the same and are described in the following pages. When the FLS-2100 is being remotely controlled, *Remote* appears in the lower left corner of the display.

Note: *If you have already designed a GPIB program to control a light source from EXFO's IQ Series (IQ-2100), you can reuse sections of the program to control the FLS-2100.*

Setting the FLS-2100 for Remote Control

To remotely control the FLS-2100, you need to set a GPIB address or activate the RS-232 port.

1. Press *Setup*.
2. Scroll (left/right arrows) to *GPIB-RS*.



3. Press *ENTER*. The current setting will start flashing.
4. Using the up/down arrows, enter a new setting.
   - a numbered setting represents a GPIB address (between 1 and 30)
   - for RS-232 control, scroll (up/down arrows) to *RS-232* (before setting 1 or after setting 30).
5. Press *ENTER*.
6. To exit the *Setup* menu, press *Setup*.

Communication Parameters

For GPIB Communication	
Terminate Read on EOS	Yes
Set EOI with EOS on Writes	Yes
Type of compare on EOS	8 bits
EOS byte	0Ah
Sens EOI at end of Writes	Yes
GPIB Primary address	see *Setting the FLS-2100 for Remote Control,* on page 15
GPIB Secondary address	None

Table 4-1. *GPIB Communication Parameters*

For RS-232 Communication	
EOS bytes	0Ah
Baud rate	9600 bps
Parity	None
Data bits	8 bits
Stop bits	1 bits
Flow Control	None
Activation	see *Setting the FLS-2100 for Remote Control,* on page 15

Table 4-2. *RS-232 Communication Parameters*

Note: *EOS means "End of String". EOI means "End or Identify".*

Data Structure for Standard Status

Figure 4-1 on the following page illustrates the four common status and enable registers as defined by lEEE-488.2. This diagram is a useful aid in understanding the general commands and how a service request (SRQ) is generated. The four registers are

- Standard Event Status Register (ESR)
- Standard Event Status Enable Register (ESE)
- Status Byte Register (STB)
- Service Request Enable Register (SRE)

Bit	ESR	ESE	STB	SRE
0	Operation Complete	Operation Complete	Source Status	Source Status
1	Request Control	Request Control		
2	Query Error	Query Error	Error Bit	
3	Device Dependent Error	Device Dependent Error	Questionable Status	Questionable Status
4	Execution Error	Execution Error	Event Status Bit	Event Status Bit
5	Command Error	Command Error	Message Available	Message Available
6	User Request	User Request	Master Summary Status	Request Service/Master Summary Status
7	Power On	Power On	Operation Status	Operation Status

Table 4-3. *Standard Registers*

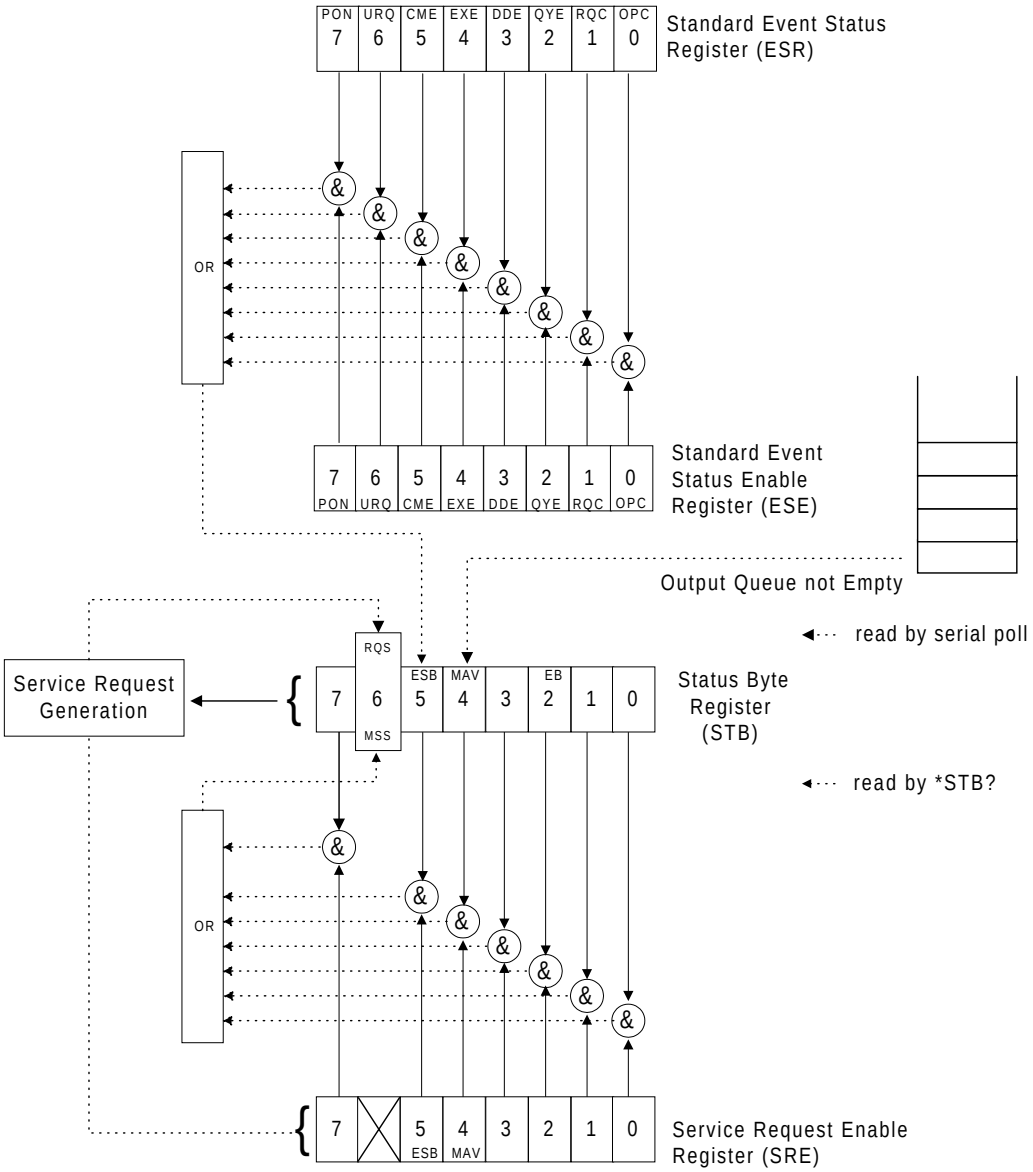


Figure 4-1. *Data Structures Standard Status (IEEE 488.2)*

An SRQ is forced when a bit is set in the STB and at the same time the corresponding SRE bit is set. When the SRQ is generated, the RQS bit is set to 1 and remains set until read by a serial poll. Once the RQS is read, it returns to 0.

Command Structure

The GPIB and RS-232 commands follow the guidelines determined by the Standard Commands for Programmable Interface (SCPI) consortium. For example, the command syntax

SOUR:AM[:INT]:FREQ<space><value>[<space><units>]

is used to select the source modulation frequency of an FLS-2100.

In this particular example,

- SOUR identifies that the command is a part of the SOURce subset of commands;
- AM, INT, and FREQ are keywords that define the function of the command;
- [ ] indicates that a keyword or a parameter is optional;
- <space> indicates that a space is required; and
- <value> is the command parameter.

All keywords must be UPPERCASE characters separated by a colon. A typical command would be

SOUR:AM:INT:FREQ 270 HZ (set modulation to 270 Hz)

This command sets the FLS-2100 source modulation to 270 Hz.

Note: *We recommend that you fetch the response immediately after each query.*

General Commands

The FLS-2100 recognizes the main commands identified in IEEE-488.2.

Command	Function
*CLS	Clear status command
*ESE	Standard event status enable command
*ESE?	Standard event status enable query
*ESR?	Standard event status register query
*IDN?	Identification query
*OPC	Operation complete command
*OPC?	Operation complete query
*RST	Reset command
*SRE	Service request enable command
*SRE?	Service request enable query
*STB?	Read status byte query
*TRG	Trigger command
*TST?	Self test query
*WAI	Wait to Continue Command

Table 4-4. *Summary Common Commands Summary*

These commands are explained fully on the following pages.

*CLS

Description	This command sets the contents of the Standard Event Register (ESR), the Status Byte Register (STB), and the Error Queue (ERR) to zero. This command is commonly used to clear the status registers before enabling SRQ. Note that the output queue, Standard Event Status Enable Register (ESE), and Service Request Enable Register (SRE) are not affected.
Syntax	*CLS
Note	The command CLR is equivalent to the command *CLS. Both give the same result.

*ESE

Description	This command is used to set bits in the Standard Events Status Enable Register (ESE) to a new value (default value is 255). The contents of the ESE register are logically ANDed with the ESR register. A non-zero result will set the Event Summary Bit (ESB) of the Status Byte Register. This command is useful for selecting which events may generate an SRQ.
Syntax	*ESE<space><value>
Parameter	The <value> parameter must be between 0 and 255.

*ESE?

Description	This query reads the contents of the Events Status Register.
Syntax	*ESE?
Response	Binary integer with a value between 0 and 255.

*ESR?	
Description	This query reads the contents of the Standard Events Register.
Syntax	*ESR?
Response	Binary integer with a value between 0 and 255.

*IDN?	
Description	This query reads the FLS-2100 identification string.
Syntax	*IDN?
Response	“EXFO E.O. Engineering FLS-2100 Vxx.xx” where xx.xx is the current product version.
Note	The commands SYST:VERS? and IDN? are equivalent to the command *IDN?. They give the same result.

*OPC	
Description	This command causes the FLS-2100 to generate the operation complete message in the Standard Event Status Register (ESR) when all pending selected FLS-2100 operations have been finished.
Syntax	*OPC
Example	*OPC,*IDN?

*OPC?

Description This query puts an ASCII 1 in the output queue when the contents of the input queue has been processed.

Syntax *OPC?

Response “1”

Note The command OPC? is equivalent to the command *OPC?. Both give the same results.

*RST

Description This command empties the step response list. It is only seen when it is part of another multiple command. In the example below, by adding this command after *IDN?, you will not be able to access the answer. The *RST, in this instance, erases the identification string. In addition, this command performs the following operations:

- Return to initial state before command was sent, and not necessarily to previous settings.
- Force the device to enter into an Operation Complete Command Idle State (OCIS).
- Force the device to enter into an Operation Complete Query Active State (OQIS).
- Initialize previous responses unless there has been a program message terminator preceded by an *RST.

Syntax *RST

Example *IDN?,*RST<NL>

*SRE	
Description	This command sets bits in the Service Request Enable Register (default value is 255) and enables the corresponding bit in the Status Register. The command can be used to select which events can initiate a service request.
Syntax	*SRE<space><value>
Parameter	The <value> parameter must be between 0 and 255.

*SRE?	
Description	This query returns the contents of the Service Request Enable Register.
Syntax	*SRE?
Response	Binary integer with a value between 0 and 255.

*STB?	
Description	This query returns the contents of the Status Byte Register.
Syntax	*STB?
Response	A binary integer between 0 and 255
Note	The command STB? is equivalent to the command *STB?. Both give the same results.

*TRG

Description	This command will trigger any event that was suspended and is waiting for a trigger.
Syntax	*TRG
Parameters	None
Note	This command has no effect on the FLS-2100.

*TST?

Description	This query initiates an internal self test and returns a binary value indicating the results of the test.
Syntax	*TST?
Response	A binary value “0” if the test is complete with no errors “1” if the test is complete with errors

*WAI

Description	This command prevents the FLS-2100 from processing any further commands until the No-Operation-Pending-Flag is set. All pending operations must be complete before processing another command.
Syntax	*WAI
Parameters	None
Note	This command has no effect on the FLS-2100.

SYSTem:ERRor?

Description	This command returns the next error in the list. The commands ERR? and LERR? give the same result. When an error is generated, an error number is sent to the error list. The error list can be accessed with the commands SYST:ERR?, ERR?, or LERR?.
Syntax	SYST:ERR?
Response	See error list and descriptions in *Error Messages,* on page 33.

SYSTem:VERSion?

Description	This command returns the FLS-2100 identification string.
Syntax	SYST:VERS?
Response	“EXFO E.O. Engineering FLS-2100 Vxx.xx” where xx.xx is the current product version.
Note	The commands *IDN? and IDN? are equivalent to the command SYST:VERS?. They give the same result.

Specific Commands

DISPlay:DIMMer

Description	This command is used to adjust the intensity of the FLS-2100 display (high or low) or to turn off the display without turning off the unit.
Syntax	DISP:DIMM<space><data>
Parameters	The <data> parameter can be “HI”, “LO”, or “OFF”.
Example	DISP:DIMM OFF
Note	When the display is turned off by this command, any key pressed on the FLS-2100 keypad will return the display to high intensity. To prevent this, lock the FLS-2100 keypad with the command *LOK.
See also	DISP:DIMM?, *LOK, and *LOK?

DISPlay:DIMMer?

Description	This query returns the intensity of the FLS-2100 display (high, low, or off).
Syntax	DISP:DIMM?
Response	“HI” if the intensity is high “LO” if the intensity is low “OFF” if the display is off
Example	DISP:DIMM?

***LOK**	
Description	This command is used to lock and unlock the FLS-2100 keypad. Once the FLS-2100 keypad is locked, no external input can interfere with the GPIB communication. The only way to unlock the keypad is to use the *LOK command again or turn off the unit.
Syntax	*LOK <space><data>
Parameters	The <data> parameter can be “1” to lock the keypad or “0” to unlock the keypad.
Example	*LOK 1
Note	When the keypad is locked, the unit will beep twice if any key is pressed on the keypad. The indicator *Remote* appears in the lower left corner of the display while the unit is being controlled remotely.

***LOK?**	
Description	This query reads the FLS-2100 keypad lock state.
Syntax	*LOK?
Response	“1” if the FLS-2100 keypad is locked “0” if the FLS-2100 keypad is unlocked
Example	*LOK?

SOURce:AM[:INTernal]:FREQuency

Description This command selects the internal modulation frequency. The internal modulation is 50% duty cycle at the selected frequency.

Syntax SOUR:AM[:INT]:FREQ<space><value>[<space><units>]

Parameters The available modulation frequencies are
270 Hz, 1 kHz (or 1000 Hz), 2 kHz (or 2000 Hz), and CW (for no modulation)
The <units> parameter is optional and must be entered in the format “HZ” or “KHZ”.
Entering an invalid parameter sets the FLS-2100 to CW.

Example SOUR:AM:INT:FREQ 270 HZ (set modulation to 270 Hz) or
SOUR:AM:INT:FREQ CW (set modulation to none)

SOURce:AM[:INTernal]:FREQuency?

Description This query returns a value indicating the current internal modulation frequency.

Syntax SOUR:AM[:INT]:FREQ?

Response The current internal modulation frequency in the format “270 Hz”, “1 kHz”, “2 kHz”, or “CW” (for no modulation).

Example SOUR:AM:FREQ?

SOURce:POWer:ATTenuation

Description	This command changes the source internal attenuation. The source power is at its maximum when the attenuation is set to 0.0 dB.
Syntax	SOUR:POW:ATT<space><value>[<space><units>]
Parameters	The <value> parameter is between 0.0 and 10.0 for laser sources and between 0.0 and 5.0 for LED sources. The attenuation is a positive value. The <units> parameter is “DB” and optional. Entering a value below 0 sets the attenuation to zero. Entering a value above the maximum attenuation (10.0 for laser sources and 5.0 for LED sources) sets the FLS-2100 to maximum attenuation.
Example	SOUR:POW:ATT 5.2 DB

SOURce:POWer:ATTenuation?

Description	This query returns the value of the power attenuation of the internal source.
Syntax	SOUR:POW:ATT?
Response	A dB value between 0.0 and 10.0 (dB units) in the format “99.9”
Example	SOUR:POW:ATT?

SOURce:POWer:STATe

Description	This command activates or deactivates the optical source. When the source is activated, “Source On” appears on the FLS-2100 display.
Syntax	SOUR:POW:STAT<space><boolean>
Parameters	The <boolean> value can be “0” or “OFF” to deactivate the source “1” or “ON” to activate the source
Example	SOUR:POW:STAT ON

SOURce:POWer:STATe?

Description	This query returns a value indicating the status of the optical source, ON or OFF.
Syntax	SOUR:POW:STAT?
Response	“0” if the source is OFF “1” if the source is ON
Example	SOUR:POW:STAT?

SOURce:POWer:WAVElength

Description	This command selects a wavelength when using a dual-wavelength model (FLS-2112 or FLS-2123).
Syntax	SOUR:POW:WAVE<space><value>
Parameters	The <value> parameter can be “UPP” to switch to the highest available wavelength “LOW” to switch to the lowest available wavelength
Example	SOUR:POW:WAVE UPP

SOURce:POWer:WAVElength?

Description	This query returns a value indicating the currently selected wavelength.
Syntax	SOUR:POW:WAVE
Response	The response is a four-digit number identifying the current wavelength (nm units) in the format “9999”
Example	SOUR:POW:WAVE?

Quick Reference Command Tree

Command				Parameter/ Response	Description
DISP	DIMM			<LO | HI | OFF>	adjust display intensity
	DIMM?			<LO | HI | OFF>	obtain display intensity
*LOK				<0 | 1>	lock device keypad
*LOK?				(0 | 1)	lock device keypad query
SOUR	AM	[:INT]	FREQ	<value> [HZ | KHZ] | CW	set internal modulation
			FREQ?	(9999)	read internal modulation
	POW	ATT		<value>[0..10] [DB]	set attenuation
		ATT?		(99.9)	read attenuation
		STAT		[value] | [ON | OFF]	turn source ON or OFF
		STAT?		(0 | 1)	read source state
		WAVE		UPP | LOW	set wavelength
		WAVE?		(9999)	read wavelength

Table 4-5. *Quick Reference Command Tree*

Error Messages

System and device specific errors are managed by the FLS-2100. The generic format for error messages is illustrated in Figure 4-2.

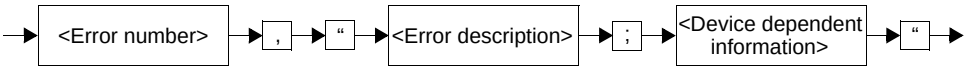


Figure 4-2. *Generic Format for GPIB Error Messages*

As shown in the above figure, the message contains three parts: the error number, error description, and device dependent information. All error messages are stacked in a FIFO buffer. When there is at least one message in the buffer, bit 2 of the Status Byte Register is set to 1. Use the command

SYST:ERR?, ERR?, or *LERR?* to read the most recent message. The error message buffer is initialized when starting the FLS-2100, when executing the command **CLS,* or by reading the last message stored in the buffer.

Error Number	Description	Probable Cause
-100	“Command Error.”	An error occurred while validating a command.
-101	“Undefined Header.”	Unknown command.
-102	“Missing Parameter.”	A command parameter is missing.
-103	“Parameter not allowed.”	An extra parameter is present.
-104	“Data Type Error.”	Invalid parameter format.
-200	“Execution Error.”	An error occurred while executing a command.
-300	“Device Dependent Error.”	A command has taken longer than expected to complete execution.
-400	“Query Error.”	An error occurred while accessing the output queue.
-500	“System Error.”	System is out of memory.

Table 4-6. *Error Messages*

5 Maintenance and Troubleshooting

General Maintenance

To help ensure long, trouble-free operation, follow these guidelines:

- Keep the unit free of dust.
- If the unit should get wet, turn off the power immediately and let the unit dry completely.
- Clean the unit casing with a cloth that is slightly damp with water.

Cleaning the Output Port

Regularly cleaning the source and VFL output ports will help maintain optimum performance. The cleaning swabs supplied with EXFO test equipment are specially designed to clean inside the ports without having to disassemble the unit. No cleaning solution is required as the tips are used dry.

1. Take a swab from the package without touching the soft end.
2. Slowly insert the swab into the port until it reaches the ferrule inside (a slight clockwise rotating movement may help).
3. Applying moderate pressure, rotate the swab one full turn.
4. Continue to turn as you withdraw the swab.
5. Dispose of the used swab after 5 uses or as soon as it is visibly dirty.

IMPORTANT

To help keep the source port clean, we recommend that you install the protective cap when the unit is not in use and that you always clean the fiber ends before connecting them to the source port.

The cleaning swabs can also be used to clean adapters before inserting connectors.

Note: *Individual connectors still need to be cleaned according to standard cleaning methods.*

Fuse Replacement

The FLS-2100 contains two fuses of type IEC, 250 V, 2 A, fast blow 0.197" x 0.787"/5 mm x 20 mm. The fuse holder is located at the back of the FLS-2100, just beside the power inlet.

The following symbol, found at the back of the FLS-2100, indicates that the user should refer to the instruction manual for fuse replacement.

This symbol, found at the back of the FLS-2100, indicates that the user should refer to the instruction manual for fuse replacement and power rating.

Figure 5-1. *Fuse Warning Label*

To replace the fuses,

1. Unplug the power cord from the FLS-2100.
2. Pull the fuse holder out of the FLS-2100.

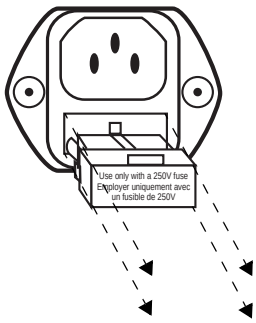


Figure 5-2. *Pulling out the Fuse Holder*

3. Check and replace the fuses if necessary.

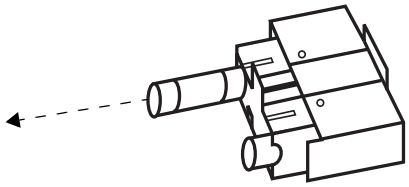


Figure 5-3. *Replacing the Fuses*

4. Make sure the fuses are firmly in the holder prior to reinsertion.

5. Firmly push the holder into place.

Periodic Source Verification

To ensure that the FLS-2100 remains within the published specifications, EXFO recommends that the unit be sent back to the factory every year for verification and adjustment. Please contact EXFO for further information.

Software Upgrade

To upgrade the FLS-2100 embedded software using floppy disks, you must connect your FLS-2100 to a computer through a null modem cable.

Note: *The software upgrade may be performed in DOS, Windows 3.1, or Windows 95. If problems occur, refer to the plaintext file on the floppy disk.*

IMPORTANT

When using a notebook computer to upgrade the FLS-2100 software, you should do so in a DOS environment.

Proceed with the software upgrade only if the version indicated on the floppy disk is more recent than the software version currently installed on your unit. To check the software version currently installed on your unit, press and hold the up and right arrow keys simultaneously.

To perform a software upgrade,

1. Turn off the FLS-2100.
2. Connect one end of a null modem cable to the RS-232 serial port of the FLS-2100 and the other end to an unused communication port on your computer (e.g. COM2).
3. Insert the first upgrade floppy disk into the computer floppy disk drive.
4. Create a new directory on the computer hard drive, then copy the contents of the floppy disk into the new directory.
5. Execute the file “lo0006.exe” to start the software upgrade.
6. Highlight the command “SELECT COM PORT” and then press *Enter*.
7. Select the COM port to which the null modem cable is connected on your computer and then press *Enter*.
8. Highlight the command “PROGRAM DEVICE FLASH” and then press *Enter*.
9. Once you see the message “Waiting for device handshake”, turn on the FLS-2100. The FLS-2100 screen will remain off; the unit will beep once and programming will start automatically. A progress bar on the computer screen will indicate the status of the software upgrade.

Once the software upgrade is complete, the message “Reboot device for selftest” will appear.

10. Turn off then turn on the FLS-2100 and then on again to use the upgraded software.

Recalibration

To ensure that the unit remains within the published specifications, EXFO recommends that an annual calibration be performed. Please contact EXFO for further information.

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6 Technical Specifications

All applicable specification tests were performed with a two-meter long fiber (specified type) with FC/SPC (Singlemode) and FC/PC (Multimode) connectors and with 0.0 dB attenuation. Specifications are subject to change without notice.

Optical Specifications

Single-Wavelength Models

Model	FLS-2101 C/D	FLS-2102 C/D	FLS-2102 BS	FLS-2103 BS
Emitter type	LED	LED	LED	LED
Wavelength[a] (nm)	850 ±25	1300 +45/-60	1310 +20/-25	1550 +10/-40
Spectral width[b] (nm)	≤50	≤145	>40	>70
Power output (dBm)	C ≥ -17 D ≥ -14	C ≥ -21 D ≥ -17	-13.5	> -17
Stability[c] (dB) 15 min. (T=constant) 8 hr. (T=0° to 50°C ±1°C)	 ±0.003 ±0.03	 ±0.003 ±0.03	 ±0.005 ±0.03	 ±0.005 ±0.03
Modulation	270 Hz, 1 kHz, 2 kHz (50% duty cycle)			
Temperature stability[d] (dB)	≤0.4	≤0.4	≤0.4	≤0.4

Table 6-1. *Single-Wavelength Models (LED)*

a. Valid over the operating temperature range.
b. FWHM
c. Valid after an active source 1-hour warm-up period: valid after 30 minutes if the unit has been stored at operating temperature.
d. Measured in 0°C to 50°C/32°F to 122°F temperature range.

Model	FLS-2102 BLC	FLS-2102 BLD	FLS-2103 BLC	FLS-2103 BLD	FLS-2104 BLC
Emitter type	TEC-LSR	DFB-LSR	TEC-LSR	DFB-LSR	TEC-LSR
Wavelength[a] (nm)	1310 ±20	1310 ±10	1550 ±20	1550 ±10	1625 ±20
Spectral width[b] (nm)	≤2.5	≤0.2	≤4	≤0.2	≤2
Power output[c] (dBm)	≥0	≥0	≥0	≥0	-5
Stability[d] (dB) 15 min. (T=constant) 8 hr. (T=0° to 50°C ±1°C)	 ±0.003 ±0.03	 ±0.003 ±0.03	 ±0.003 ±0.03	 ±0.003 ±0.03	 ±0.01 ±0.03
Modulation	270 Hz, 1 kHz, 2 kHz (50% duty cycle)				
Temperature stability[e] (dB)	≤0.25	≤0.25	≤0.25	≤0.25	≤0.25

Table 6-2. *Single Wavelength Models (LSR)*

a. Valid over the operating temperature range.
b. Rms value
c. Maximum power output is within limits of a clacc 1 laser product according to FDA CFR21.
d. Valid after an active source 1-hour warm-up period: valid after 30 minutes if the unit has been stored at operating temperature.
e. Measured in 0°C to 50°C / 32°F to 122°F temperature range.

Dual-Wavelength Models

Model	FLS-2112 C/D	FLS-2123 BS	FLS-2123 BLC	FLS-2134 BLC
Emitter type	LED	LED	TEC-LSR	TEC-LSR
Wavelength[a] (nm)	850 ±25 1300 +45/-60	1310 +20/-25 1550 +10/-40	1310 ±20 1550 ±20	1550 ±20 1625 ±20
Spectral width (nm)	≤50/≤145[b]	>40/>70[b]	≤2.5/≤4[c]	≤4/≤2[c]
Power output[d] (dBm)	C ≥ -18/-22 D ≥ -15/-18	-14.5/-18	≥-1	-5/-5
Stability[e] (dB) 15 min. (T=constant) 8 hr. (T=0° to 50°C ±1°C)	 ±0.005 ±0.05	 ±0.005 ±0.03	 ±0.005 ±0.05	 ±0.01 ±0.03/±0.05
Modulation	270 Hz, 1 kHz, 2 kHz (50% duty cycle)			
Temperature stability[f] (dB)	≤0.4	≤0.4	≤0.25	≤0.25

Table 6-3. *Dual-Wavelength Models*

a. Valid over the operating temperature range.
b. FWHM
c. Rms value
d. Maximum power output is within limits of a clacc 1 laser product according to FDA CFR21.
e. Valid after an active source 1-hour warm-up period: valid after 30 minutes if the unit has been stored at operating temperature.
f. Measured in 0°C to 50°C / 32°F to 122°F temperature range.

General Specifications

The FLS-2100 is intended for indoor use only.

General Specifications	
Dimensions (W × H × L)	21.8 × 11.1 × 28.5 cm/ 8.575 × 4.575 × 11.25 in
Operating temperature	0° to 40°C/32° to 104°F
Storage temperature	-40° to 70°C/-40° to 158°F
Relative humidity[a]	0 to 80% non-condensing
Maximum operation altitude	6150 ft./2000 m
Pollution degree	2
Installation category	II
Power supply rating	100 to 240 V (50/60 Hz)
	maximum 2 A

Table 6-4. *General Specifications*

a. Measured in 0°C to 40°C / 32°F to 104°F temperature range.

7 Warranty

General Information

EXFO Electro-Optical Engineering, Inc. (EXFO) warrants this equipment against defects in material and workmanship for a period of one year from the date of original shipment. EXFO also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, EXFO will, at its discretion, repair, replace, or issue credit for any defective product. This warranty also covers recalibration during two years if the equipment is repaired or if the original calibration is erroneous.

IMPORTANT

The warranty can become null and void if

- **the equipment has been tampered with, repaired, or worked upon by unauthorized individuals or non-EXFO personnel,**
- **the warranty sticker has been removed,**
- **case screws, other than those specified in this manual, have been removed,**
- **the case has been opened, other than as explained in this manual,**
- **the equipment serial number has been altered, erased, or removed,**
- **the equipment has been misused, neglected, or damaged by accident.**

This warranty is in lieu of all other warranties expressed, implied or statutory, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event shall EXFO be liable for special, incidental, or consequential damages.

Liability

EXFO shall not be liable for damages resulting from the use of the purchased product, nor shall be responsible for any failure in the performance of other items to which the purchased product is connected or the operation of any system of which the purchased product may be a part.

EXFO shall not be liable for damages resulting from improper usage or unauthorized modification of the product, its accompanying accessories and software.

Exclusions

EXFO reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligation to make changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps and batteries used with EXFO's products are not covered by this warranty.

Certification

EXFO certifies that this equipment met its published specifications at the time of shipment from the factory.

Service and Repairs

EXFO commits to providing product service and repair for five years after the date of purchase.

To obtain service or repair for any equipment, follow the procedure below:

1. Call EXFO Customer Service Group. Support personnel will determine if the equipment requires service, repair, or calibration.
2. If the equipment must be returned to EXFO or an authorized service center, support personnel will issue a Return Merchandise Authorization (RMA) and an address for return.

IMPORTANT

Never send any unit or accessory back to EXFO without a Return Merchandise Authorization (RMA).

3. If the unit has an internal storage device, do a backup of your data before sending the unit for repairs.
4. Pack the equipment in its original shipping material. Be sure to include a statement or report fully detailing the defect and the conditions under which it was observed.
5. Return the equipment, prepaid, to the address given by the support personnel. Be sure to write the RMA on the shipping slip. EXFO will refuse and return any package which does not bear an RMA.

Note: *A test setup fee will apply to any returned unit which, after test, is found to meet published specifications.*

After repair, the equipment will be returned with a repair report. If the equipment is not under warranty, the customer will be invoiced for the cost appearing on this report. Return-to-customer shipping costs will be paid by EXFO for equipment under warranty. Shipping insurance is at the customer's expense.

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Glossary

adapter	A device for coupling two connectors.
amplitude	The distance between high and low points of a waveform or signal.
ASCII	American Standard Code for Information Interchange. A system used to represent letters, numbers, symbols, and punctuation as bytes of binary signals.
attenuation	The diminution of average optical power. Attenuation results from absorption, scattering, and other radiation losses. Attenuation is generally expressed in dB without a negative sign.
attenuation coefficient	A factor expressing attenuation per unit length, expressed in dB/km.
attenuator	An optical device, either fixed or adjustable, that reduces the intensity of light propagating through it.
backscattering	That portion of scattered light that returns in a direction generally opposite to the direction of propagation.
baud rate	Measurement of data transmission speed, expressed in bits per second or bps.
Bellcore	Bell communications research, an organization that contains much of the former Bell labs. It specializes in telephone network technology, standards and interfaces.
BER	Bit error rate. On a transmission link, the number of digital “highs” that are interpreted as “lows”, and vice versa, divided by the total number of bits received. In modern networks, BERs much better than 10^{-9} are expected.
c	Velocity of light in a vacuum = 2.997925 x 10^8 m/s
°C	Degree Celsius. To convert to Fahrenheit: $F = \frac{9}{5}C + 32$.
CFR	Code of Federal Regulations

connector	A junction that allows an optical fiber or cable to be repeatedly connected or disconnected to a device such as a source or detector.
coupler	A device whose purpose is to distribute optical power among two or more ports or to combine optical power from two or more fibers into a single port.
CW	Abbreviation for continuous wave. Refers to non-modulated, constant-intensity light.
dB	Decibel
dBm	Decibel referenced to a milliwatt.
DDE	Dynamic Data Exchange
decibel (dB)	The standard unit used to express gain or loss of optical power. A standard logarithmic unit for the ratio of two powers.
directivity	In a 3-port optical circulator, the ratio of power launched into port 1 that exits via port 2 vs. the fraction that exits via port 3.
DLL	Dynamic Link Library
DMA	Direct Memory Addressing
DUT	Device under test
EDFFA	Erbium doped fluoride fiber amplifier
EDFSA	Erbium doped silica fiber amplifier
EIA	Electronics Industries Association
electromagnetic interference	Any electrical or electromagnetic interference that causes degradation, failure in electronic equipment, or undesirable response. Optical fibers neither emit nor are affected by EMI.
EMI	Electromagnetic interference.
EOI	End of Image Marker
EOS	Effective Opening Size

ESB	Event Summary Bit
ESE	Standard Event Status Enable Register
ESR	Standard Event Status Register
f	Abbreviation for femto, which indicates 10^{-15} units.
f	Frequency, often also designated by ν.
FCC	Federal Communications Commission. A U.S. government body overseeing and regulating national electrical and radio communications. The FCC, formed in 1934, also deals with licences, tariffs, and limitations. The members of the commission are appointed by the U.S. president.
FIFO	First In First Out
frequency	The number of cycles per second, denoted by hertz (Hz).
G	Abbreviation for giga, which indicates 10^{9} units.
Ge	Germanium
GeX	High power germanium
GPIB	General Purpose Interface Bus
hr	Hour
Hz	Hertz. Denotes number of cycles per second.
IEC	International Electrotechnical Commission. A standardization body at the same level as ISO.
IEE	Institute of Electronic Engineering. It is a professional body covering all aspects of electronics and electrical engineering, including software, network, and computer engineering.
IEEE	Institute of Electrical and Electronics Engineering. It is a professional body very active, among other things, in many fiber-optic and opto-electronic related fields.
index matching material	A material, often a liquid or a cement, whose refractive index is nearly equal to the core index, used to reduce Fresnel reflections from a fiber's endface.

index of refraction	The ratio of the group velocity of light in a vacuum to the group velocity of light in a given medium.
InGaAs	Indium gallium arsenide.
ISA	Industry Standard Architecture
ISO	International Organization for Standardization. Commonly believed to stand for International Standards Organization. In fact, ISO is not an abbreviation—it is intended to signify uniformity (derived from the Greek *iso* meaning “equal”). ISO is responsible for many standards including those for data communications and computing.
ITU	International Telecommunications Union. The ruling body for telecommunications and the source of many network standards.
jumper	Fiber-optic cable that has connectors terminated on both ends. Used to connect two pieces of equipment, modules, or components.
LD	Laser diode
LED	Light emitting diode
loopback	Type of diagnostic test in which the transmitted signal is returned to the sending device after passing through a communications link or network.
M	Abbreviation for mega, 10^6 units.
m	Abbreviation for milli, 10^{-3} units.
min	Minute
n	Abbreviation for nano, 10^{-9} units.
n	Refractive index. For the silica glass used in optical fibers, $n \approx 1.465$.
NIST	National Institute of Standards and Technology. U.S. governmental body that provides the assistance in developing standards. It was formerly the National Bureau of Standards.

noise figure	A measure of the quality of an amplifier, defined as the ratio of output to input SNRs.
p	Abbreviation for pico, 10^{-12} units
P	Power
PCS	Plastic-clad silica (fiber)
RMA	Return merchandise authorization
s	Second
SCPI	Standard Commands for Programmable Instruments
sensitivity	For an optical instrument, the smallest signal that can be detected in the absence of any other signal.
Si	Silicon
SNR	Signal-to-noise ratio. The ratio of the received optical power, divided by the noise floor for the optical system.
SRE	Service Request Enable Register
SRQ	Service Request
STB	Status Byte Register
t	Time
T	Abbreviation for tera, 10^{12} units.
V	volt
VA	volt-ampere
W	watt
wavelength	For monochromatic light, the distance between two successive peaks (or troughs) of the sinusoidally-varying electric-field amplitude. Note that, unlike frequency, the wavelength of light is inversely proportional to the refractive index of the medium through which it propagates. It is for this reason that accurate wavelength measurements are generally specified as being determined in “air” or in “vacuum”.

λ	lambda. Greek letter used to denote wavelength.
μ	Abbreviation for micro, 10^{-6} units.
ν	nu. Greek letter used to denote frequency. Traditionally, the physics community uses “ν” to denote frequency whereas the engineering community uses “*f*”.

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