Tunable Semiconductor Laser

TSL-550

Operation Manual

santec

Notes to Users

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3) Information of this Operation Manual is prepared with careful examination, however, in the event of any mistake, please contact us.

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1) When this product is brought out of Japan, some laws or regulations of a destination country may prohibit this product from being used there. In such countries, the use of this product may lead to being punished, but the Company shall not be responsible for such a case at all, which please note.

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Introduction

Thank you very much for your having purchased our product, Tunable Semiconductor Laser TSL Series. This Operation Manual contains information necessary for the operation of TSL-550, and it is intended for those with sufficient knowledge enough to of laser danger and its safe control. Before operating TSL-550, you should first read thoroughly through this Operation Manual and become familiar to its contents. After reading this Operation Manual, keep it at your fingertip for easy reference at any time.

NOTE

The packing materials and box of this product are needed for long-term storage or transportation, therefore, keep them even after unpacking this product.

How to Read the Manual

Before operating TSL-550, please read carefully this instruction manual.

This Operation Manual consists of 12 Chapters:

Chapters 1 to 4 illustrate the outline of this product, safety precautions, and installation of the product.

Chapters 5 to 6 describe how to operate the product. Santec recommends that Chapter 1 to 4 be read carefully before proceeding to this chapter.

Chapter 7 explains information on the communication functions such as external control of TSL-550.

Chapter 8 describes the operating principles.

Chapter 9 explains the specifications.

Chapter 10 describes the maintenance and storage methods of this product.

Chapter 11 explains the packing instruction and shipping.

Chapter 12 describes the troubleshooting in operation.

NOTE

Before using this product, please carefully read this Operation Manual.

Explanation of Terms

The meanings of the following terms used in this Operation Manual are defined as below:

(1) Meaning

	**DANGER**	This indicates pressing DANGER, and if it is not avoided, personnel death or serious injury results, therefore, it is the most emphasized special information.
	**WARNING**	This indicates potential danger, and if it is not avoided, personnel death or serious injury may result, therefore, it is special information.
	**CAUTION**	This indicates potential danger, and if it is not avoided, mild or slight injury may result, therefore, it is special information. It also indicates potential danger leading to only physical damage.
	**NOTE**	This indicates supplementary explanation of the text, and thus other information than DANGER, WARNING, and CAUTION.

(2) Importance of Information

From the above meanings, the priority of the terms here are as shown below:

DANGER > WARNING > CAUTION > NOTE

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Safety Notes

1-1 Intended use

This product is designed to measure the optical characteristics.
Do not use this product for anything other than as an optical measuring instrument.
If this product is used in a manner not specified in this manual, the protection provided by this product may be impaired.

1-2 Safety Markings



This product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.



This warning symbol is marked on products which have a laser output.

1-3 Operational notes

Do not remove the product cover, replace parts, or modify this product. If there is necessary to improve or repair, please return this product to us.
The product that has sign of repairs or modifications made by parties other than our company is out of warranty.

1-4 Laser Class

This product is classified class 1M laser product according to IEC 60825-1 (2014).

Laser Type	: External Cavity Diode Laser
Laser Class	: 1M IEC60825-1(2014)
Output Power	: < 50 mW
Laser Diameter	: 10 μm
Numerical aperture	: 0.1
Wavelength	: 1200 to 1700 nm

Laser Safety Labels



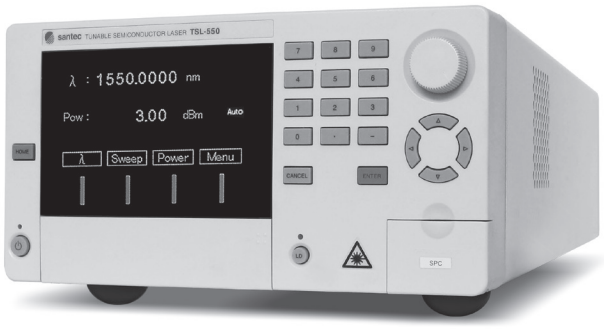




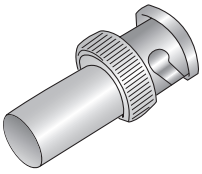
This product radiates class 1M invisible laser. Do not look at the tip of optical output connector using optical instruments like magnifiers or microscopes. The laser radiation can seriously damage your eyesight. Please pay attention to handling of laser.

2 Product Composition

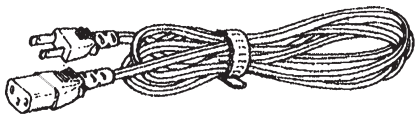
This product is composed of the TSL-550 body and accessories.
Check to make sure that all the following items are included.



TSL-550 body (1)



Interlock terminator (1)
* Option



Power cord (1)



Operation Manual & Software (1)

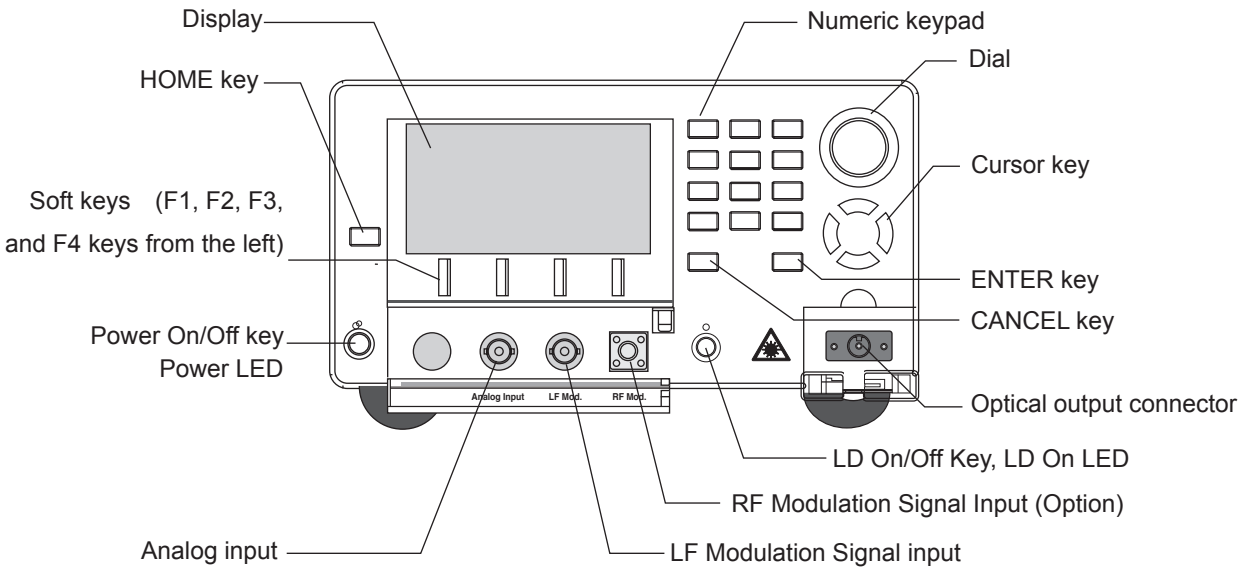


Inspection report

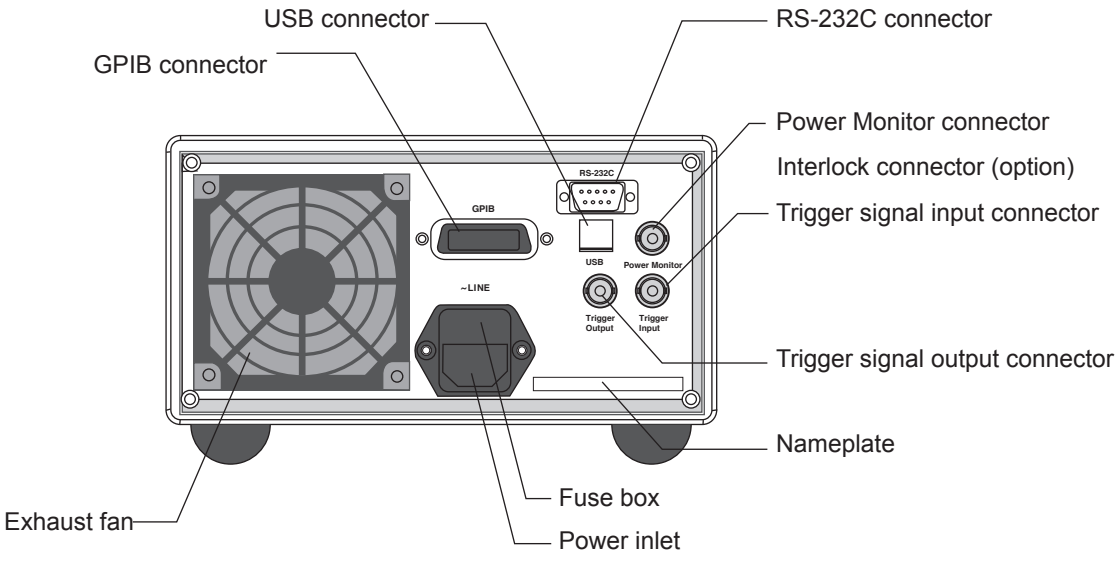
Check to make sure that the product body and the accessories have no scratches or stains. If any item is found to have scratches or stains, please contact us.

3 Panel Descriptions

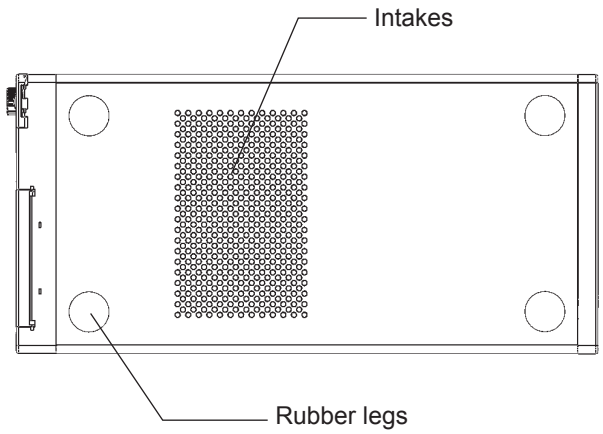
3-1 Front Panel



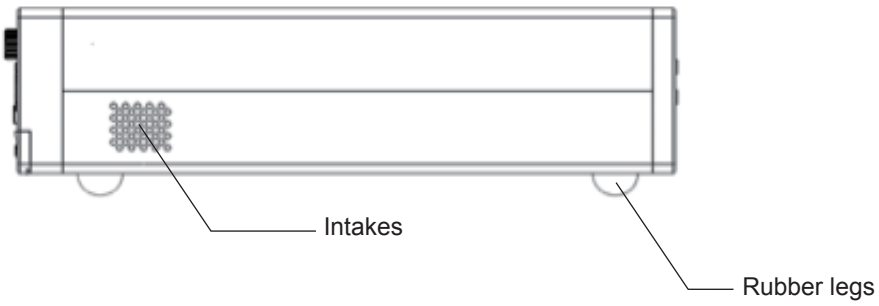
3-2 Rear Panel

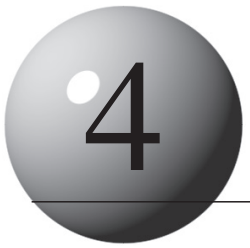


3-3 Bottom Panel



3-4 Side Panel





Installation

4-1 Operating Environments

Pay attention to the following guidelines for safe, trouble-free operation.

This product is a high-precision device and be designed to be used indoors (Pollution Degree 2).

- Do not place over a height of 2,000 meter.
- Do not place in direct sunlight.
- Do not place under high temperature and high humidity.
- Do not place in an environment with dust, dirt, salt, or corrosive gas.
- Do not place in an area subject to large vibrations.
- Do not place in an area subject to noise by electric field, magnetic field, etc.
- Do not place in an area where the unit is subject to falling objects landing on it.
- Do not place with possible exposure to water.

Be sure to install the TSL-550 in a level place (less than 5 degree). It is recommended to install this product on a vibration-proof base. The unit may not operate correctly if the device is set in an inclined position.

The mainframe of the TSL-550 weighs about 7.0 kg. Please ensure that the table or shelf upon which it is installed has sufficient strength. Clearance of 5 cm at the rear and the side of the unit should be allowed for proper ventilation. And the air intakes are located at the bottom and the side of the device. Please do not remove the rubber legs, in order to secure airflow.

4-2 Power Supply

This product uses a 3-line power cord and plug with a protective ground line. Power cord may be attached and detached, Connect it to the power source socket at the rear panel. Use the power cord supplied with the unit. Do not use the inappropriate power code.

This product complies with overvoltage category II and can operate between 100 to 240 Volts, and 50 to 60Hz AC Line. Temporary over voltage (TOV) is 1,500 Volts.

Use two surge resistant type fuses. T1.6A/250V(100 ～ 240V) (Refer to "10-3. Replacing Fuses"). The Power LED above the Power ON/OFF key turns orange, while power cable is connected.

CAUTION

This product is grounded by the ground line in the supplied power cable. This product must be properly grounded to avoid electrical shock and other dangers. Please make sure that this product is properly grounded to avoid electrical shock. In addition, please place this product in a location that allows the user to easily unplug the power cable, in case of any device malfunction.

4-3 Interlock

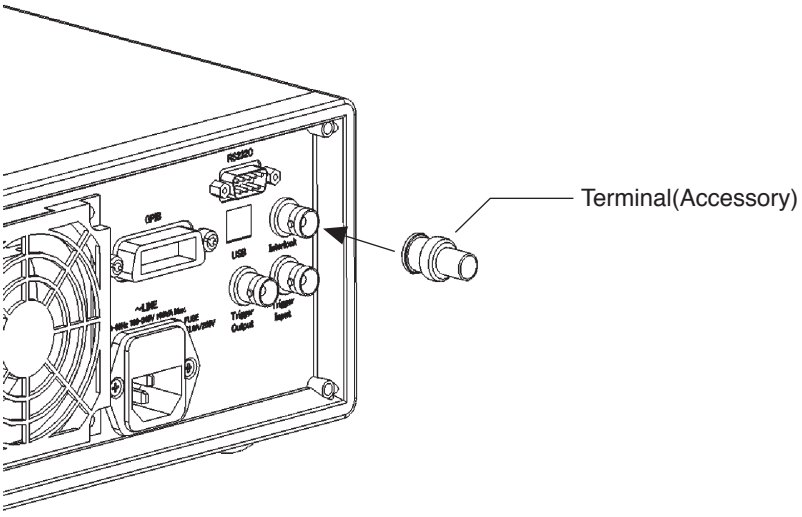
NOTE

The interlock function is option.

This product is equipped with a terminal for connecting an external interlock circuit.

A terminator is connected to the interlock terminal at the time of factory shipment (or included as an accessory). If an external interlock is used, remove the terminator and connect a circuit to the interlock terminal. The LD LED lights up only when there is a short circuit. The LD LED turns off when the circuit is open. If you want the LD LED to light up again, short the circuit, and then perform an LD output operation (Refer to “5-2. LD output”). Keep the removed terminator so it does not become lost.

If you don’t use your own interlock circuit, please connect the terminator to the terminal(BNC) indicated as “Interlock”. If you use your own interlock circuit, please connect the interlock circuit to the terminal indicated “Interlock”



NOTE

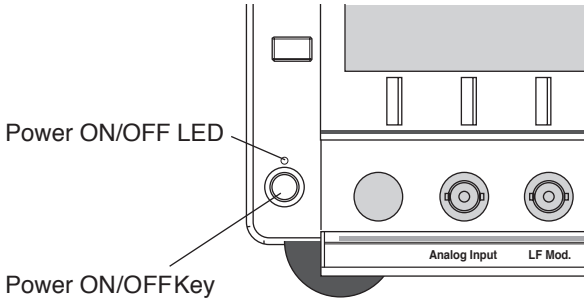
Make sure to use this product only with the terminator connected when an external interlock is not used. The LD does not light up unless the terminator is connected.

When "IntLock" is indicated in the display of the front panel, the interlock circuit is in open state. There is no laser output.

5 Basic Operation

5-1 Turning on the Unit

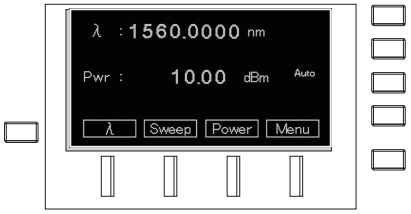
1. Press the power ON/OFF key at the lower left of the front panel.



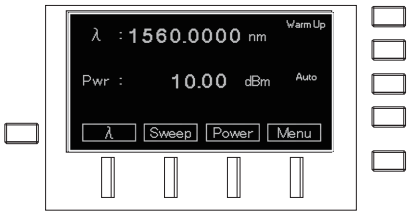
2. The LED above the power ON/OFF key will turn green, and initialization will last for about 15 seconds.



3. The main screen appears, displaying the wavelength and the power.



4. It may take several minutes for the internal temperature to stabilize after the power is turned on. “Warm Up” is displayed on the main screen during this period. Normal operation can still be conducted while “Warm Up” is displayed. (However, it will take longer for the temperature to stabilize if LD output is on. There may be some deviation from the specification values while “Warm Up” is displayed.)

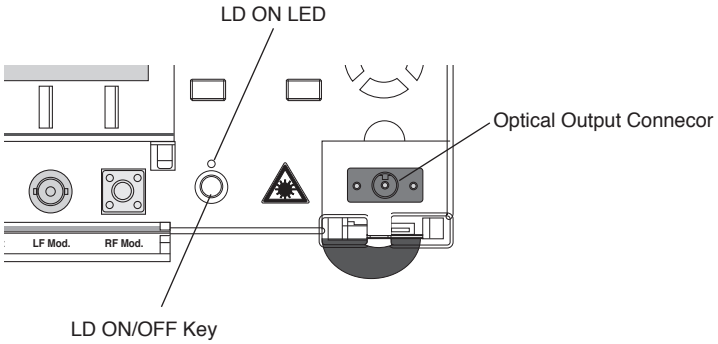


5-2 LD Output

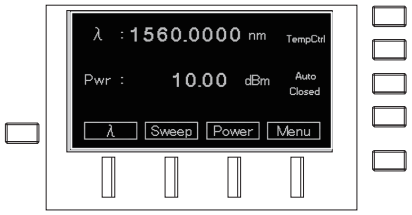
CAUTION

Make sure that the optical fiber is connected correctly to the optical output connector before performing LD output.
Also, be careful that high power light does not enter the optical output connector from the outside of the product. If light exceeding 100 mW enters the optical output connector, internal equipment may be damaged.

1. Press the LD ON/OFF key. The LED turns green and the current is fed to the LD. The light intensity is set to the intensity just before LD output is turned off.



It takes from 1 to 2 minutes to turn on LD output. During this period, the LD ON indicator LED blinks, and “TempCtrl” is displayed on the main screen. Light is output from the optical output connector after the LED status switches from blinking to illuminated.

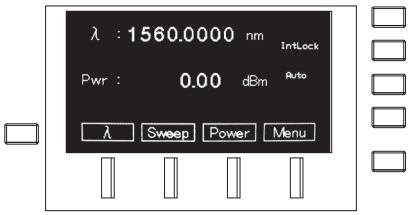


NOTE

After turning the power on or the LD output off, we recommend that you wait at least 30 seconds before turning on LD output. Operation of the keys on the front panel and operation by communication command are not possible while the LD ON indicator LED is blinking.

NOTE

1. When “IntLock” is displayed on the main screen of the front panel, the interlock circuit is open and the LD will not illuminate. * with Interlock option
2. “IntLock” is not displayed on the main screen because there is not the interlock function in standard model.



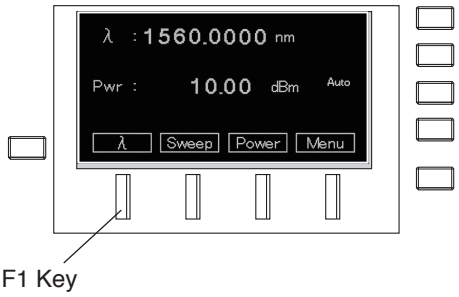
2. Press the LD ON/OFF key again to turn off the LD output. LD current is interrupted and the LED turns off.

5-3 Setting the Wavelength

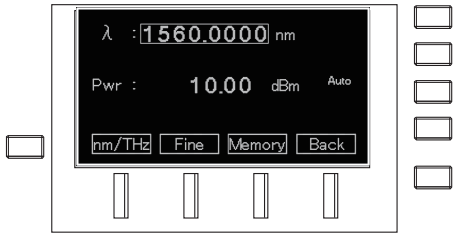
NOTE

Setting of the wavelength cannot be executed when LD output is OFF.

1. Press [λ] (F1 key) on the main screen



2. The wavelength setting screen appears, and the cursor blinks in the wavelength display area.



3. Input values according to “How to input values” (Refer to next page.).

Range: Wavelength ranges specified in the specifications

(Example: C+L band = 1500 to 1630 nm)

Unit: 0.0001 nm

〈Reference:〉

Power can be set on the same screen by moving the cursor to the power display area with the ▽ cursor key.

NOTE

When the "WL.Err" status is displayed, closed-loop wavelength control using the built-in wavelength monitor is not working properly. Please refer to "12 Troubleshooting“ (Page 12-1).

■ How to input values

Using the numeric keypad

(1) Input the value directly. Input all digits of integral numbers.

(2) Press ENTER to accept the new value.

(3) The main screen appears after setting.

Using the dial

(1) Press the ENTER key or the dial to enter input mode.

(2) Select the digit to change with the ◁▷ cursor keys. The default digit is the first digit.

(3) Turn the dial to change the value. The setting value is reflected immediately.

(4) Press the ENTER key or the dial to exit input mode.

Using the cursor keys

(1) Press the ENTER key or the dial to enter input mode.

(2) Select the digit to change with the ◁▷ cursor keys. The default digit is the first digit.

(3) Change the value with the △▽ keys. The setting value is reflected immediately.

(4) Press the ENTER key or the dial to exit input mode.

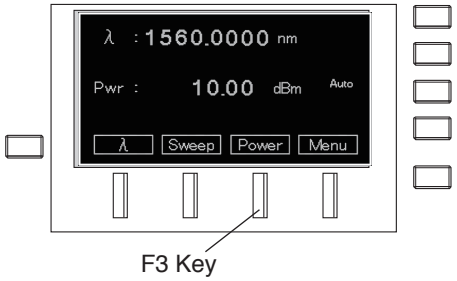
If using the dial or cursor keys to input a value, the screen does not go back to the main screen after the setting is complete. Press Back (F4 key) or the Home key to go back to the main screen.

〈Reference:〉

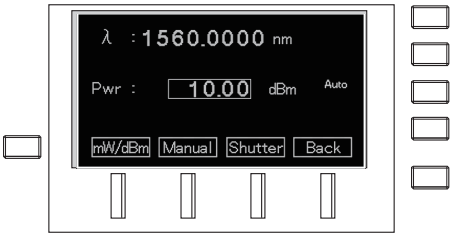
> Numeric keypad input is convenient for one-time settings; dial input or cursor key input is convenient for continuous settings.

5-4 Setting the Optical Power

1. Press Power (F3 key) on the main screen.



2. The power setting screen appears, and the cursor blinks in the power display area. (Switch the optical power control mode to “Auto” when it is “Manual”. Refer to “6-3. Switching the optical power control mode”.)



3. Input a value according to “How to input values”.

Range: 30dB up to peak power
Typical value
-17 ~ +13dBm (0.02 ~ 20mW)
The available range of output power depends on the product characteristics.

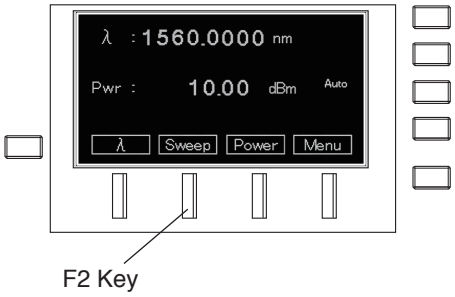
Unit : 0.01dB (0.01mW)

NOTE

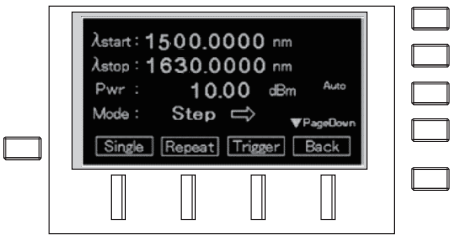
It is possible to set a value greater than the maximum power determined by the light source characteristics. However, power in excess of the maximum will not be output. When a value is set that is greater than the maximum power, “OverLD” is displayed to show that the set power is not the same as the output power. When the set power value is low and out of the control range of the attenuator, “Low Pwr” appears on the main screen. The wavelength and power accuracy are not guaranteed while “Over LD” or “Low Pwr” is displayed.

5-5 Setting the Wavelength Sweep

1. Press Sweep (F2 key) on the main screen.



2. Sweep setting screen 1 appears. There are two sweep setting screens in all.



3. Setting is possible on the item on which the cursor is blinking. Move the cursor with the △ ▽ keys and select the item to set. When the cursor is at the bottom item on the first page and the ▽ key is pressed once more, the cursor moves to the top item on the second page. When the cursor is at the top item on the first page and the △ key is pressed once more, the cursor moves to the bottom item on the second page.

4. The setting items are as follows:

Sweep Setting (1/2)

λ start Sets the sweep start wavelength

Range:

Wavelength ranges specified in the specifications

(Example: C+L Band = 1500 to 1630 nm)

Unit: 0.0001 nm

λ stop Sets the sweep end wavelength

Range:

Wavelength ranges specified in the specifications

(Example: C+L Band = 1500 to 1630 nm)

Unit: 0.0001 nm

Pwr Sets the optical power during sweep

Range: 30dB up to peak power

Typical value

-17 ~ +13dBm (0.02 ~ 20mW)

The available range of output power depends on the product characteristics.

Unit : 0.01dB (0.01mW)

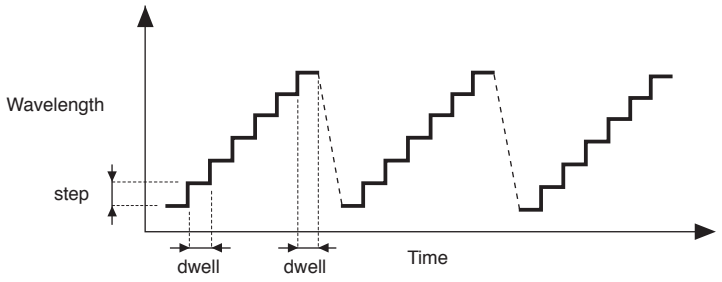
* The optical power cannot be changed, if power control mode is manual.
(Refer to 6-3. Switching the optical power control mode)

NOTE

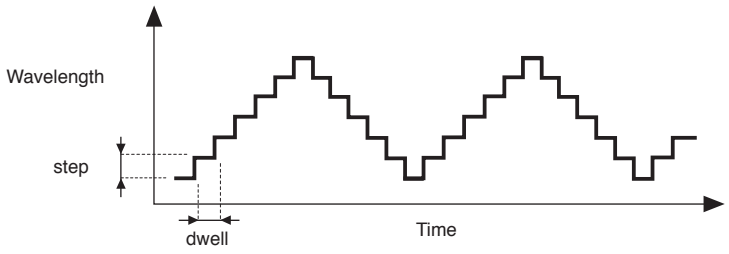
The value can be set to a value more than the maximum power determined by the light source characteristics. However, a power level higher than the maximum is not output. If the setting value is more than the maximum power, ”OverLD” is displayed to issue an alarm that the setting power is not the same as the output power.

Mode Sets the sweep operation mode. Select from the following four modes:

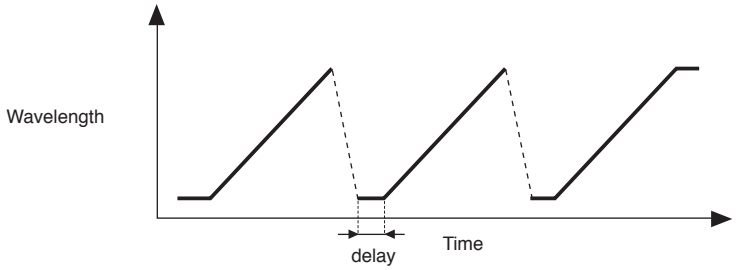
(A) Step ⇨ Perform one-way sweep with step operation. Change the wavelength from the start wavelength to the end wavelength with the wavelength interval set by STEP and the wait time set by Dwell. When the wavelength returns to the start wavelength, the speed and time are not controlled.



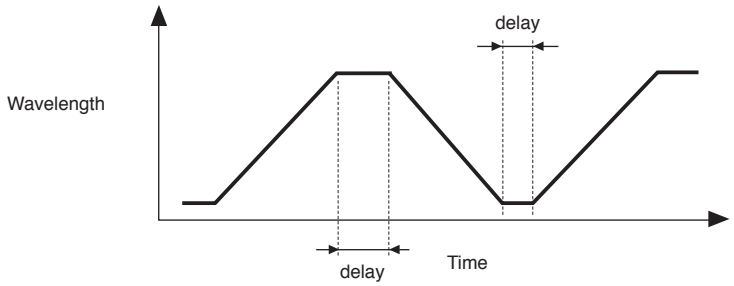
(B) Step ⇔ Perform two-way sweep with step operation. Change the wavelength from the start wavelength to the end wavelength with the wavelength interval set by STEP and the wait time set by Dwell. Afterwards, change the wavelength from the end wavelength to the start wavelength in the same manner.



(C) Sweep ⇨ Perform one-way sweep by changing the wavelength continuously. Change the wavelength from the start wavelength to the end wavelength with the speed set by Speed and return to the start wavelength. The wait time between each sweep is set by Delay. It does not include the time to return to the start wavelength.



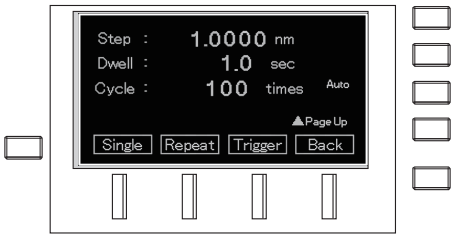
(D) Sweep ⇔ Perform two-way sweep by changing the wavelength continuously. Change the wavelength from the start wavelength to the end wavelength with the speed set by Speed. Afterwards, change the wavelength from the end wavelength to the start wavelength in the same manner. The wait time between each sweep is set by Delay.



Sweep Setting (2/2)

Setting items on the second page depends on which mode was selected on the first page.

〈If Step mode is selected:〉



Sweep Setting (2/2, Step mode)

Step Sets the wavelength interval of the step

Range: 0.0001 to 160.000 nm

Unit: 0.0001 nm

Dwell Sets the amount of time spent for each step

Range: 0.0 to 999.9 s

Unit: 0.1 s

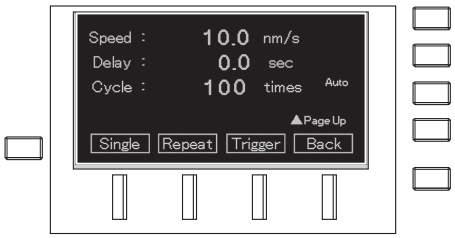
Cycles Sets the number of times the sweep is repeated

Range: 0 to 999 times

Unit: 1

If the value is set to 0 (zero), the number of times is infinite.

〈If Sweep mode is selected〉



Sweep Setting (2/2, Sweep mode)

Speed Sets the sweep speed

Range: 1.0 to 100.0 nm/s

Unit: 0.1 nm/s

Delay Sets the wait time between each sweep

Range: 0.0 to 999.9 s

Unit: 0.1 s

In one-way operation, Delay does not include the time to return to the start wavelength.

Cycles Sets the number of times the sweep is repeated

Range: 0 to 999 times

Unit: 1

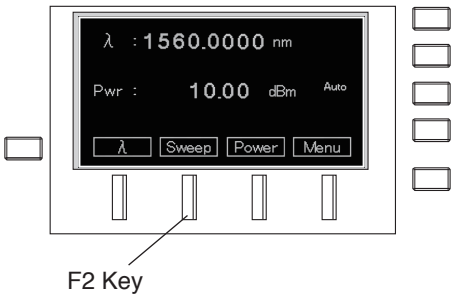
If the value is set to 0 (zero), the number of times is infinite.

5-6 Executing the Wavelength Sweep

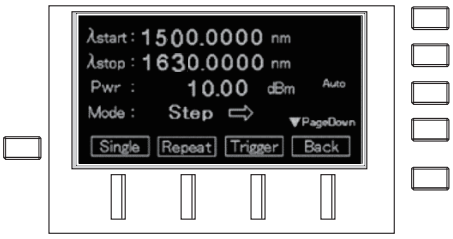
NOTE

Sweep cannot be executed when LD output is OFF.

1. Press Sweep (F2 key) on the main screen.



2. The Sweep setting screen appears. Perform operations according to the soft key menu on the sweep setting screen



3. One-time sweep operation

Press Single (F1 key) to execute a series of operations.

(1) Sets to the start wavelength (λ start).

(2) Sweep operation

Sweep mode:

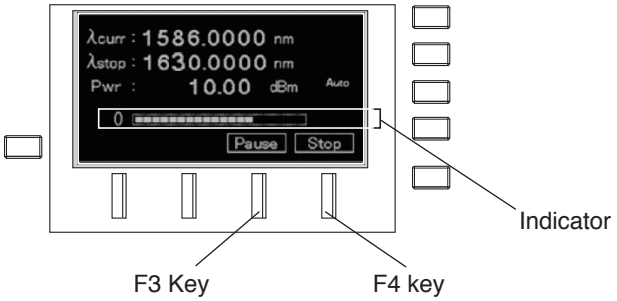
Changes the wavelength continuously following the set sweep speed (Speed).

Step mode:

Sets the wavelength in sequence following the set wavelength interval (Step) and wait time (Dwell).

(3) Stops the sweep at the end wavelength(λ stop).

The current wavelength is displayed at λ curr in the first line during sweep operation. An indicator showing the sweep progress is displayed on the bottom line.



4. Multiple sweep operations

Press Repeat (F2 key) to execute a series of the following operations:

(1) Sets to the start wavelength(λ start).

(2) Sweep operation

Sweep Mode：

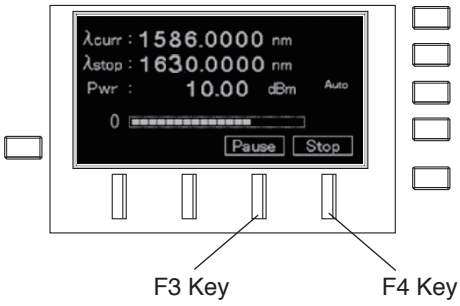
Changes the wavelength continuously following the set sweep speed (Speed).

Step Mode:

Sets the wavelength in sequence following the set wavelength interval (Step) and wait time (Dwell).

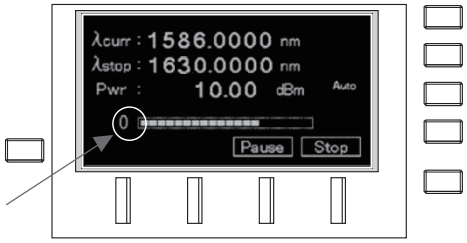
(3) After reaching the end wavelength(λ stop), returns to the start wavelength and repeats the above-mentioned wavelength sweep for the number of times selected.

(4) Stops sweep at the end wavelength.



If the value is set to 0 (zero), the number of times is infinite. Press Stop (F4 key) to stop.

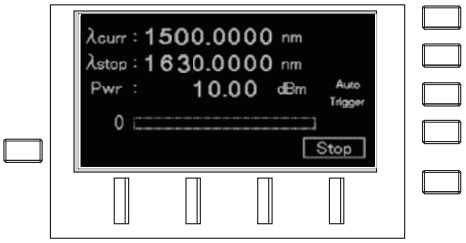
The current wavelength is displayed at λ curr in the first line during sweep operation. Indicators showing the progress of the sweep and the completed number of sweeps are displayed at the bottom. The display of the number of sweeps returns to 0 after 999.



Completed cycles

5. Executing a sweep at the timing of trigger input

Press Trigger (F3 key) to enter trigger standby mode. "Trigger" lights up on the screen.



Execute the sweep by inputting any of the following triggers in trigger standby mode.

- BNC input on the rear panel
- Key operation on the front panel. △ key, or ▷key.
- Dial operation on the front panel. Turn clockwise.
- Soft trigger using a communication command

Refer to "6-4-2. Setting the trigger input" on how to select or operate trigger input.

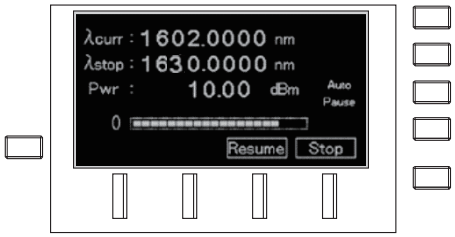
Operation by trigger signals depends on the sweep mode setting.

Sweep Mode: One sweep is executed at trigger input.

Step Mode: The wavelength moves to the next step at trigger input.

6. Stop and Pause a sweep

Press Pause (F3 key) to pause a sweep. “Pause” lights up on the screen.
Press Resume (F3 key) to resume a sweep. If you cancel a sweep, press Stop (F4 key).



NOTE

Pause is not displayed when a fast sweep speed is set. In this case, pause will not function.

Press Stop (F4 key) to stop a sweep in progress. The motion is different which mode is selected.

Sweep mode:

The sweep is continued to the stop wavelength, and stop.

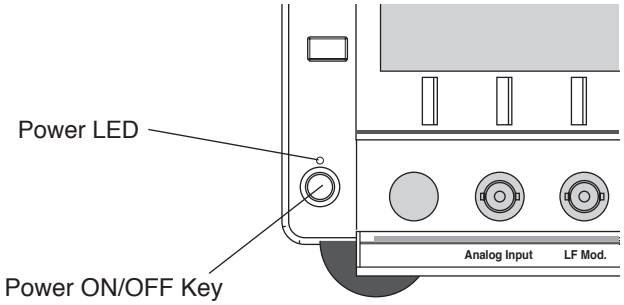
Step mode:

The sweep is stopped immediately.

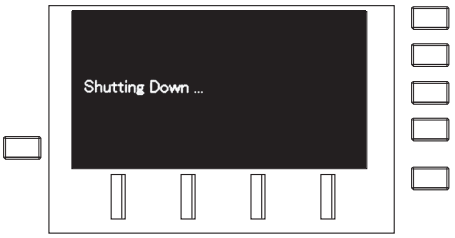
Press Pause (F3 key) and then Stop (F4 key) to stop a sweep before reaching the end wavelength while in Sweep mode.

5-7 Turning off the Unit

1. Turn off LD output. (Refer to "5-2. LD output")
2. Press the power ON/OFF key for at least 2 seconds.



The unit is shut down, and LED above the power ON/OFF key will turn orange. “Shutting Down ...” is displayed on the main screen during power shut down.



CAUTION

Do not unplug the power cord from the rear panel before power shut down is complete (the LED will turn orange). The data stored in the memory will not be saved if the power cord is unplugged during shut down operation. Furthermore, power shut down will not complete properly.

CAUTION

Damage of the device may be caused by the vibration under transportation if the power supply is not shut down properly. Make sure the power is shut down completely before transportation.

CAUTION

Abnormal Operation
If for some reason a fault occurs which prevents the instrument from being switched off by the normal procedure described above, the instrument can be switched off by holding the Power On/Off key for at least 10 seconds.

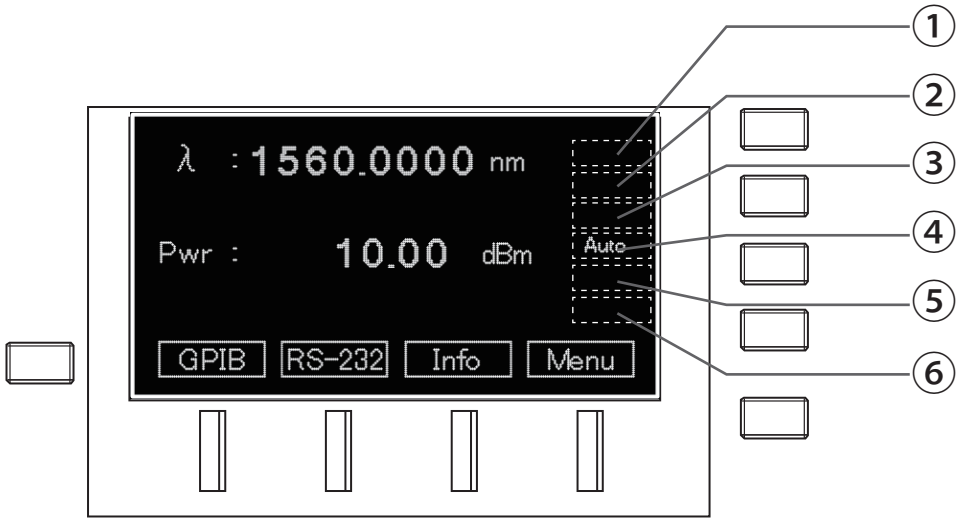
If the power supply is shut down under abnormal conditions or due to events such as power failures while LD is illuminated, turn the power back on (once) after power distribution is restored, and then turn off the power using the normal procedure.

NOTE

Unplug the power cord from the rear panel to completely shut down power supply.

5-8 Status Display

The display shows the status of the product. For more information please check the contents of each page.



Display position	Status	Description	Page
1	Warm Up	It is displayed when the internal temperature is unstable immediately after power on.	5-2
	TempErr	It is displayed when the internal temperature of LD is outside the control range.	12-1
2	TempCtrl	It is waiting that the temperature of LD is steady before LD lights.	5-3
	IntLock	It is displayed when the interlock circuit is in open state.	4-2
	Over LD	It is displayed when the set power value is greater than the maximum power.	5-7
	Low Pwr	It is displayed when the set power value is low and out of the control range of the attenuator.	5-7
	WL.Err	It is displayed when closed-loop wavelength control is not working properly.	5-5
3	Coh.Ctrl	It is displayed when the coherence control function is ON.	6-3
4	Ext.Mod	It is displayed when the modulation signal can be input from the outside.	6-8
	Auto	It is displayed when power control mode is Auto.	6-5
	Manual	It is displayed when power control mode is Manual.	6-4
5	Full Log	It is displayed when the number of triggers of sweep inside of one time exceeds 65535 and the data of all points is not recorded.	6-8
	Closed	It is displayed when the internal shutter is close.	6-17
	Trigger	It is displayed when "Trig" key is pressed and in trigger stanby mode.	5-15
	Pause	It is displayed when stopping temporarily in the sweep mode.	5-16
6	Remote	It is displayed at communication control.	7-2

6 Detailed Operation

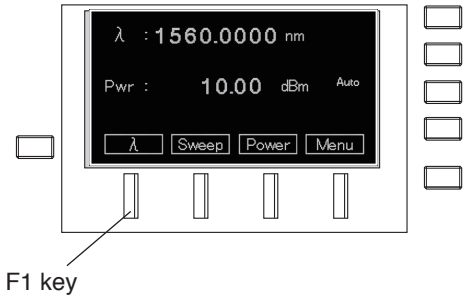
6-1 Fine-tuning

A function for fine-tuning the oscillation wavelength with a resolution under 10MHz. The adjustable wavelength range is about 10 GHz (about 80 pm around 1550 nm). The setting value is indicated with a relative value, and can be set within the range -100.00 to +100.00 in 0.01 increments.
Wavelength is shifted to shorter wavelength as FT value is increased.

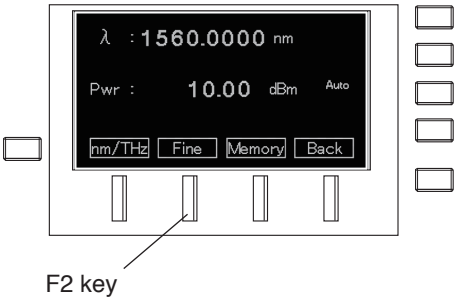
Fine-tuning can be also performed with an external analog signal. Refer to “6-6. Analog signal input” for details.

■ How to set on the front panel

1. Set the wavelength generally according to the wavelength setting procedure.
2. Press [λ] (F1 key) on the front panel to change to the wavelength setting screen.



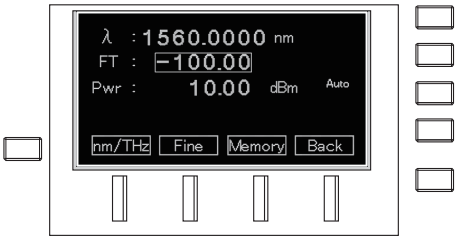
3. Press [Fine] (F2 key) to select fine-tuning mode.



4. The input line of the FT value is displayed on the second line. Input a value with the numeric keypad, the dial, or the △▽ keys. (Refer to “How to input values” in “5-3. Setting the wavelength”.)

   Range: –100.00 to +100.00

   Unit: 0.01



5. Fine-tune the wavelength to the desired wavelength while monitoring the output wavelength with an instrument such as a wavemeter.

■ How to cancel on the front panel

In fine-tuning mode, press Fine (F2 key) or set the wavelength to the reference value to cancel fine-tuning mode.

NOTE

Closed-loop wavelength control is stopped when Fine-tuning function is active. To restart Closed-loop wavelength control, cancel Fine-tuning mode.

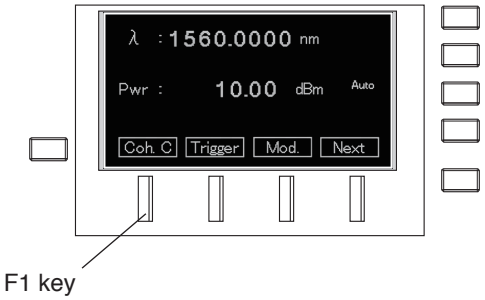
6-2 Coherence Control

A function used to increase the spectral linewidth of the output light. The coherence of the light is reduced by increasing the linewidth, and the fluctuation of the optical power by interference can be suppressed.

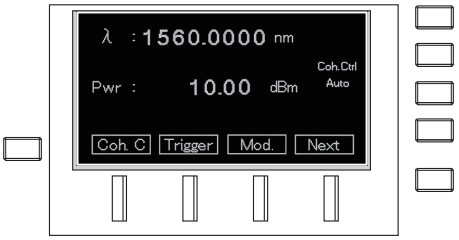
If the fluctuation of the optical power becomes a problem due to influence from the reflecting point in the system using this device, use this function.

■ How to set

1. Press Menu (F4 key) → Coh. C (F1 key) on the main screen.



2. The coherence control function turns ON, and “Coh.Ctrl” lights up on the right edge of the screen.



NOTE

Coherence control cannot be changed to ON, when modulation setting is “Ext.”. Please check modulation setting is set to “Disable”, before using coherence control.

■ How to cancel

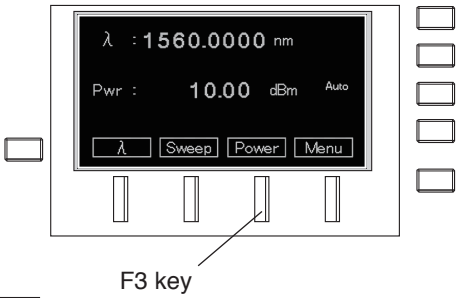
1. Press Coh. C (F1 key).
2. The coherence control function turns OFF, and “Coh.Ctrl” turns off on the screen.

6-3 Switching the Optical Power Control Mode

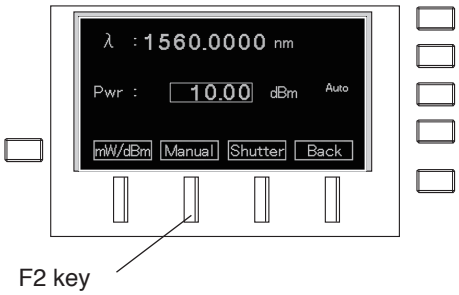
The power control of the optical output can be switched between Auto and Manual. In auto control mode (Auto), the power of the output light is kept constant by feedback from the output power value measured at the self-contained power meter. The attenuator is controlled automatically.
In manual control mode (Manual), the injection current to the LD is controlled to be kept constant.

■ How to set manual control mode

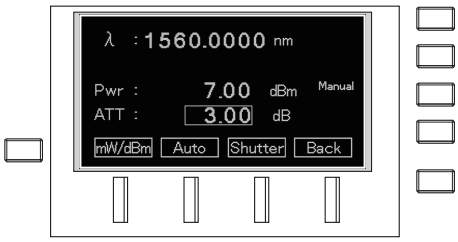
1. Select Power (F3 key) on the main screen to change to the power setting screen.



2. Press Manual (F2 key).



3. The mode switches to manual control mode. The setting value of the self-contained attenuator is displayed and the status display changes from “Auto” to “Manual”. The power indicator changes from the setting value to the monitored value of the output power.



■ How to cancel manual control mode

1. Press Auto (F2 key) on the power setting screen.
2. The mode switches to auto control mode. The setting value of the self-contained attenuator is not displayed and the status display changes from “Manual” to “Auto”. The power indicator changes from the monitored value of the output power to the setting value.

6-4 Setting the Trigger Output

Trigger signals can be used for synchronizing with external instruments. Output signals are at the TTL level.

Specifications

Signal Voltage : 3.3V

Signal width : 27+/-5µs

Signal figure does not depend on sweep speed.

The TTL signal is same at any time.

Sampling rate : 1kHz

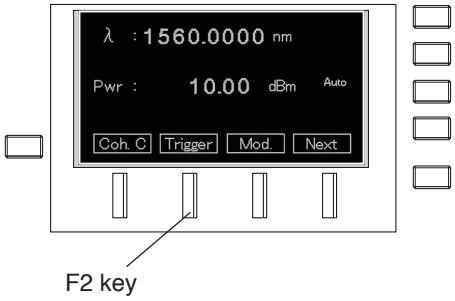
Minimum trigger step : Dependence on sweep speed

See table below as reference.

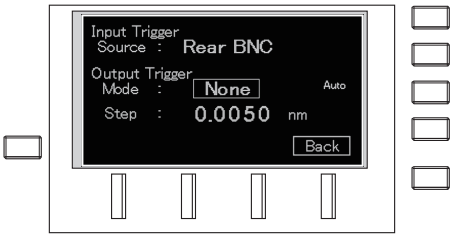
Sweep speed	Minimum trigger step
1nm/s	5pm (Type A) 1pm (Type C)
5nm/s	5pm
10nm/s	10pm
25nm/s	25pm
50nm/s	50pm
100nm/s	100pm

■ 6-4-1 Setting the Trigger Output

1. Press [Menu] (F4 key) → [Trigger] (F2 key) on the main screen.



2. Move the cursor to “Output Trigger Mode” on the trigger signal setting screen with the dial, or the △▽ keys.



3. Press the ENTER key or the dial to enter input mode.

Select the mode with the◁ ▷keys, or the dial.

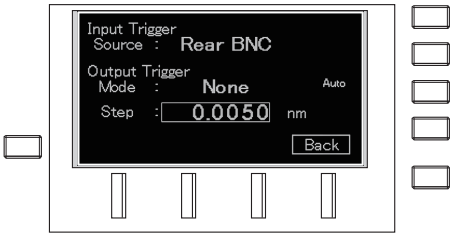
Select the mode from the following 4 modes:

Trigger mode	Sweep mode	
	Sweep	Step
None	Trigger signal is not output.	Trigger signal is not output.
Stop	Trigger signal is output at sweep completion.	Trigger signal is output at one-step completion.
Start	Trigger signal is output when sweep starts.	Trigger signal is output when one-step starts.
Step	Trigger signal is output at a certain wavelength interval during sweep.	Same as the Stop Trigger mode.

4. After selecting the mode, press the ENTER key to accept the mode.

When the mode is set to Step, set the wavelength interval to output the trigger signal at the “Step” field just below.

5. Move the cursor to “Step”.



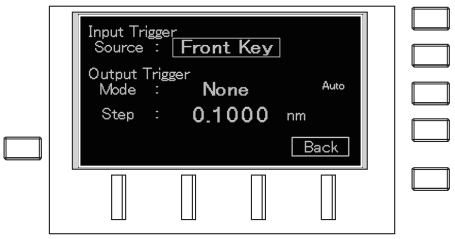
6. Press the ENTER key to enter input mode.

Input the value with the △▽ keys, or the dial.

7. Press the ENTER key to exit input mode.

■ 6-4-2 Setting the Trigger Input

1. Move the cursor to “Input Trigger Source” on the trigger input setting screen with the dial, or the △▽ keys.



2. Press the ENTER key or the dial to enter input mode.
3. Select the source with the △▽ keys, or the dial.
4. Select one from the following two sources:

   Front Key: The ▷ key, △ key, and turning the dial on the front panel clockwise are recognized as a trigger signal.

   Rear BNC: The TTL signal input into Trigger Input on the rear panel is recognized as a trigger signal. Timing is taken on the rising edge of the signal.

5. Press the ENTER key to exit input mode.

■ 6-4-3 Wavelength Logging

Recording of the wavelength data to internal memory is synchronized with the output trigger during wavelength sweep. When the sweep mode is set to “Sweep” and the trigger mode is set to “Step”, the data is automatically recorded for each sweep. The current data is overwritten when the next sweep is executed. The recorded wavelength data can be read by communication commands. Refer to “7-4. Command reference” for the commands.

NOTE

The maximum recordable data is 65535 points.
Only the first 65535 data points of the wavelength logging data are recorded, even if in the sweep condition that outputs more than 65535 triggers.
When “Full Log” is displayed on the front display, the logging data is larger than 65535 points and all data is not recorded to the memory.

6-5 External Modulation

This product is equipped with a function for modulating the intensity of optical power using external modulation signals. The modulations are classified as either low-frequency or high-frequency according to the frequency band of the modulation signal.

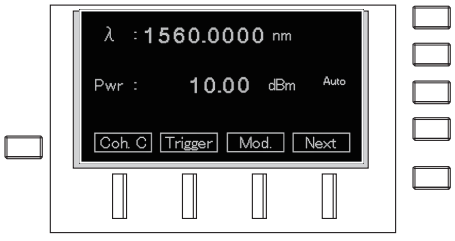
■ 6-5-1 Low-frequency Modulation

Modulating the intensity of optical power is performed at relatively low frequency from DC to 400 kHz.

■ How to set

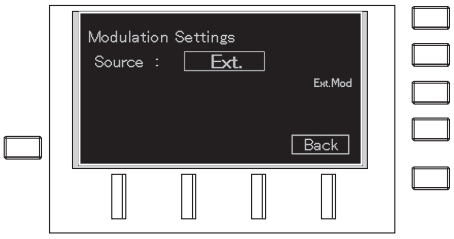
1.Set the power control mode to manual
(refer to “6-3 Switching the optical power control mode”).

2. Move to the screen for various settings from the main screen using Menu (F4key) → Mod. (F3 key).

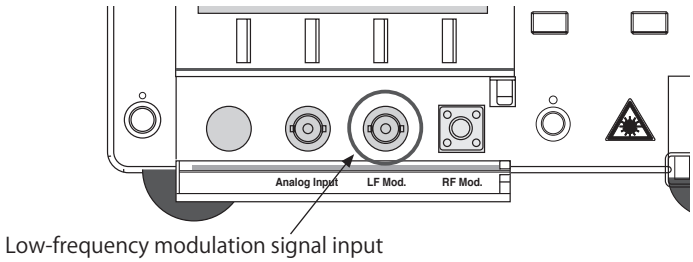


3. Put cursor to “Source” in “Modulation Settings” section, and press ENTER key.

4. Set the source to Ext. with the ◁▷ keys, or the dial.
Modulation bandwidth is expanded and “Ext. Mod” lights up at the right side on the screen.



5. Input the modulation signal into the BNC connector labeled “LF Mod.” inside the cover at the bottom of the front panel.



Specifications

Modulation bandwidth:	DC to 400kHz
Input level:	0 to –2V
Modulation depth:	>50%/V (Typ.)
Input impedance:	4.7 kΩ

CAUTION

Never apply voltage out of the input level range. Doing so may damage the device.

NOTE

External modulation setting cannot be changed to “Ext.”, when coherence control is ON. Please check coherence setting is set to OFF, before using external modulation. (Refer to “6-2Coherence Control”)

■ How to cancel

1. Remove the external modulation signal.

Inside the cover at the bottom of the front panel.

2. Set the source to Disable. “Ext. Mod” turns off on the screen.

NOTE

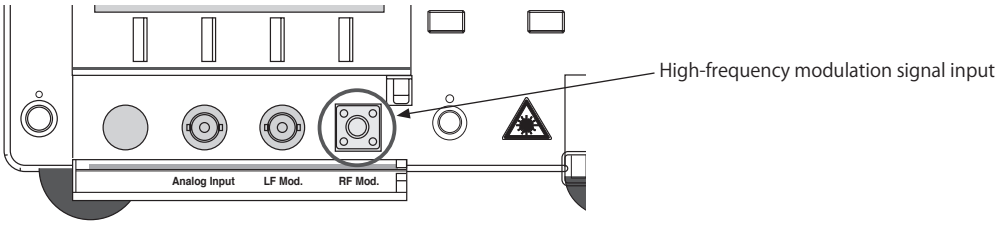
Set the source to Disable when modulation function is not used, in order to narrow the spectral linewidth.
If coherence control is active, modulation setting is always set to “Ext.” and cannot be changed to “Disable”. (Refer to “6-2 Coherence Control”)

NOTE

It is recommended to use this function with closed loop wavelength control stopped. Closed-loop wavelength control can be stopped by setting "0.00" with the fine tuning function. Refer to "6-1. Fine-tuning” to cancel closed-loop wavelength control”. When using this function without stopping the closed-loop wavelength control, "WL.Err" may be displayed on the right side of the display. The wavelength accuracy in this state is outside the product specifications.

■ 6-5-2 High-frequency Modulation (Option)

Modulating the intensity of optical power is performed at relatively high frequency from 2 to 100 MHz.
Input the modulation signal into the SMA connector labeled ”RF Mod.” inside the cover at the bottom of the front panel.



For your safety and to avoid damaging the device, be careful of the following points when using this device.

WARNING!

・Never apply voltage out of the input level range. Doing so may cause damage.
・Input the high-frequency modulation signal with the current being injected to the LD. If no current is injected to the LD, it may cause damage the LD.

CAUTION

If high-frequency modulation is not used, make sure to connect the terminator to the input terminal. Failure to do so may degrade the stability of the light intensity.

The high-frequency modulation terminal is connected directly to the LD through matching resistors and capacitors. Be careful of the input level since it is not particularly protected. Bias to the LD is fed from the LD drive circuit through a coil.

When using high-frequency modulation, keep the following steps in mind:

(1) Make sure that the power of this device and the signal source are shut off, and then connect the cable for modulation signal input.

(2) Turn ON the power of the body and the signal source.

(3) Turn the LD key ON to feed current to the LD.

(4)Set the power control mode to manual (refer to “6-3 Switching the optical power control mode”).

(5) After current is fed to the LD, input the external signal.

(6) Stop the external signal before interrupting the injection current to the LD.

Specifications

Modulation bandwidth:	2 to 100 MHz
Input level:	5Vp-p
Modulation depth:	>10% (Typ.)
Input impedance:	50 Ω

6-6 Analog Signal Input

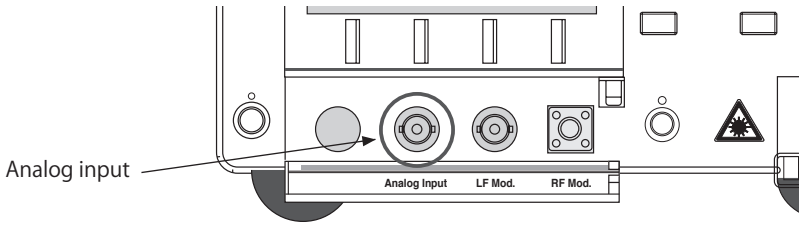
A function used to fine-tune the wavelength according to the external input voltage. Input the signal into the BNC connector labeled ”Analog Input” inside the cover at the bottom of the front panel.

Specifications

Input voltage range:	–1.5 to +1.5 V
Rate of wavelength change:	-40pm/V(Typical)

CAUTION

Never apply voltage out of the input level range. Doing so may damage the device.

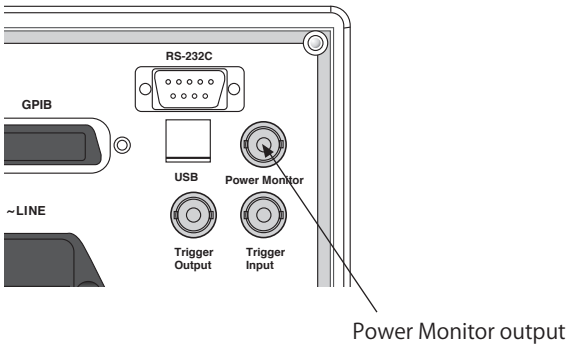


NOTE

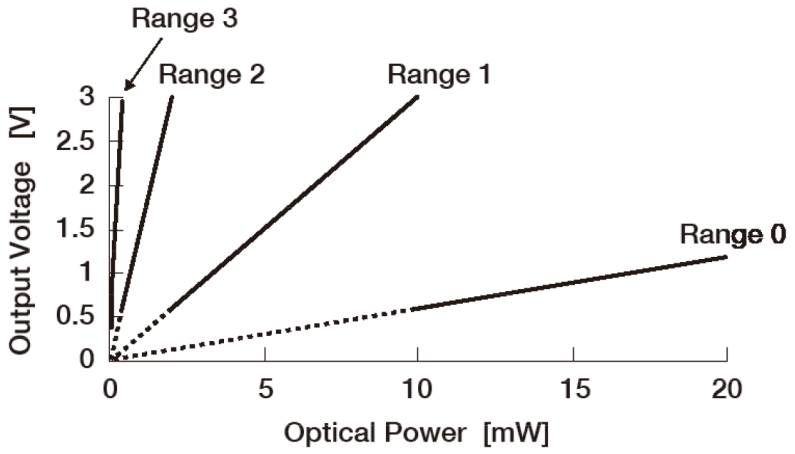
Please cancel the closed-loop wavelength control when using analog input function. Refer to “6-1. Fine-tuning” to cancel closed-loop wavelength control.

6-7 Power Monitor Signal Output

This feature outputs the voltage according to integrated power monitor.
It can be used to compensate output power fluctuation in real time, for example.
(This feature is best recommended to be used with Santec’s SPU-100 as WDL/PDL measurement solution, Santec’s Swept Test System)



Output voltage changes according to measurement range of power monitor, as shown below. Measurement range is adjusted automatically.

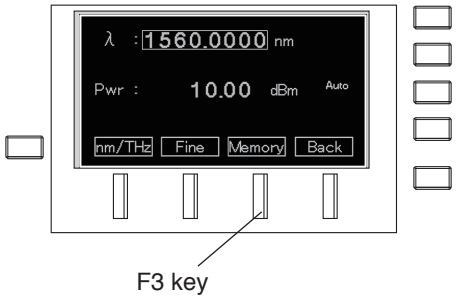


Output voltage value against optical output power is not calibrated.
Typical voltage over output power correlation for each measurement range is shown below.

Range0: 0.06 V/mW (> 10 mW)
Range1: 0.3 V/mW (2 to 10 mW)
Range2: 1.5 V/mW (0.4 to 2 mW)
Range3: 7.5 V/mW (< 0.4 mW)

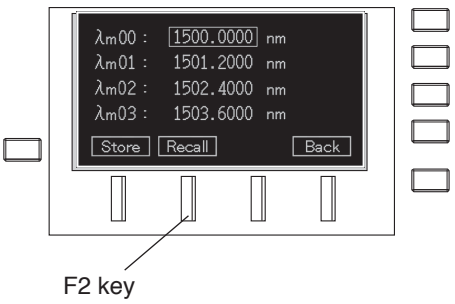
6-8 Wavelength Memory Function

A function used to set the oscillation wavelength to a wavelength stored in memory. A total of 100 wavelength values can be stored.



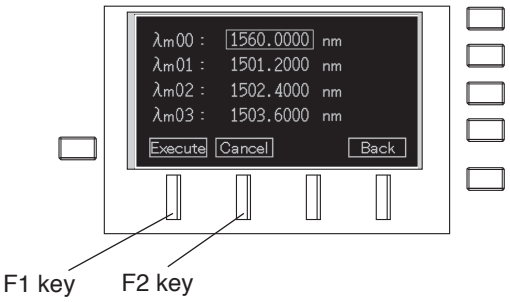
■ 6-8-1 Wavelength Readout

1. Press Memory (F3 key) on the wavelength setting screen.
2. The wavelength memory screen appears.
3. Move the cursor to the desired wavelength with the △▽ keys, or the dial. Scroll with the △▽ keys, or the dial. The page can be changed with the ◁▷ keys. (Each key press scrolls the page by 4 lines.)
4. Press Recall (F2 key) to accept the wavelength and go back to the main screen.



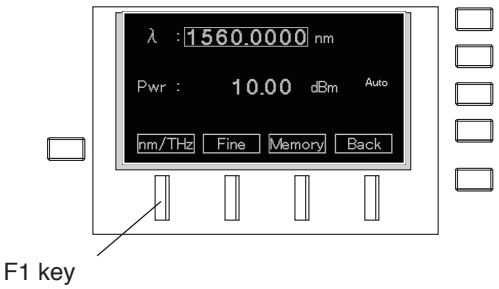
■ 6-8-2 Wavelength Registration

1. Set the desired wavelength following general wavelength setting steps. (Refer to "5. Basic operation".)
2. Press Memory (F3 key) on the wavelength setting screen.
3. The wavelength memory screen appears.
4. Move the cursor to the desired number with the △ ▽ keys, or the dial. Press Store (F1 key) to change the wavelength at the cursor position to the desired wavelength.
5. Press Execute (F1 key) to register the wavelength and go back to the wavelength memory screen. Press Cancel (F2 key) to go back to the wavelength memory screen without performing registration.

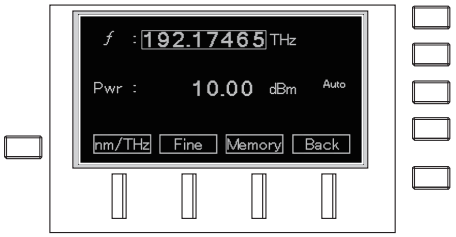


6-9 Changing the Unit of the Wavelength

1. Change the screen to the wavelength setting screen. See ”5-3. Setting the wavelength” on how to change.
2. Press nm/THz (F1 key).



3. The display/input unit is changed.

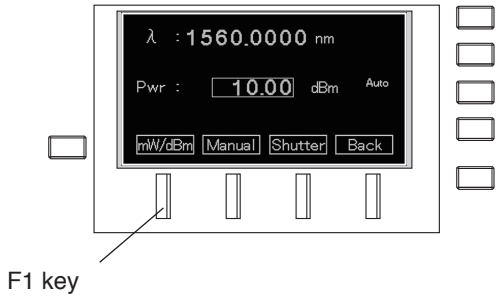


4. Do the same operation when switching back to the original setting.

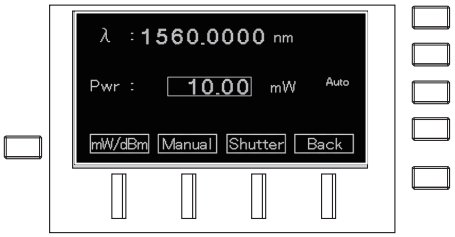
If the unit is set to frequency, another setting is displayed for the frequency. However, only the sweep speed remains to be indicated in wavelength [nm/s].

6-10 Changing the Unit of the Power

1. Press mW/dBm (F1 key) on the power setting screen.



2. The display/input unit is changed. All units will be changed on all screens, including this screen.

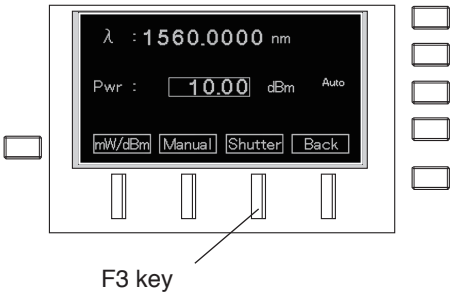


3. Do the same operation when switching back to the original setting.

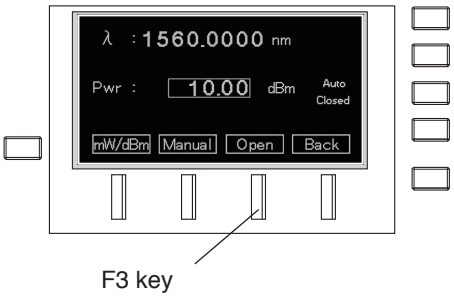
6-11 Internal Shutter

Internal shutter is used to temporarily interrupt the optical power. Turn the LD OFF when interrupting for a long time. (Refer to “5-2. LD output”.)

1. Press Shutter (F3 key) on the power setting screen.



2. The internal shutter will close and ”Closed” will display on the screen. When the actual measured power is indicated, the value becomes –40 dBm or 0mW.

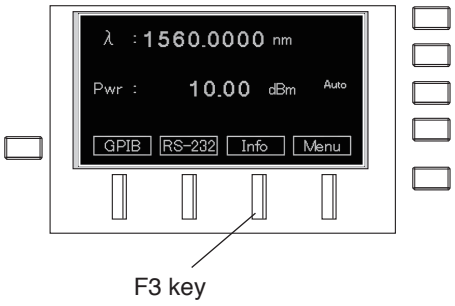


3. Press Open (F3 key) to open the shutter. The internal shutter opens and the output power returns.

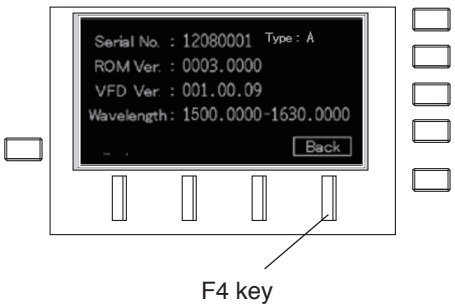
6-12 Displaying the Product Information

Display the various product information.

1. Move to the screen for various settings from the main screen using Menu (F4 key) → Next (F4 key).
2. Press Info (F3 key).



3. The following information is displayed:
   - Serial number of the device
   - Revision number of the firmware
   - Firmware version of the display
   - Wavelength range
4. Go back to the previous screen with Back (F4 key).



7 Operation by Communication

CAUTION

Before inserting and extracting the connectors for the communication cables, make sure to turn off the power to the device to avoid damaging the device.

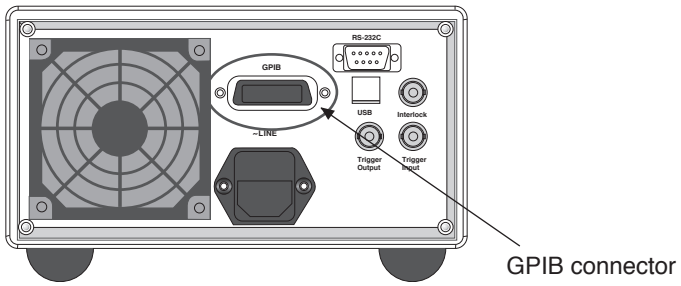
This device supports GP-IB, RS-232C, and USB as means of communication. Available commands vary according to the communication method used. Echo back at command input, and the data retrieval method are also different. The setting method, characteristics, and differences of each method are described below.

7-1 GPIB

A communication function based on standards specified in IEEE-488.

■ 7-1-1. Connection

Connect the 24-pin GPIB cable to the GPIB connector on the rear panel.
The total extension of the connected cable shall be 20 m or less. The cable length between each device must be 2 m or less. At most, 15 devices can be connected.



CAUTION

Do not disconnect or connect a cable from and to devices connected with GP-IB cable, do not short-circuit connector, and do not turn ON/OFF the devices. Otherwise, action may be stopped, error may occur, causing a failure. In the event of trouble owing to these causes, reset all the connected devices, and then activate the system once again.
When configuring a system, remove the unused device or unnecessary cable and return to the original setup.

■ 7-1-2. GP-IB Function

GP-IB has 10 kinds of interface functions, each of which has its grade that is called its subset. A "0" after the symbol of each function shows that support is not made, and each numeric value represents grade.

Symbol	Function	TSL-550 Subset
SH	Source handshake	SH1: All functions
AH	Acceptor handshake	AH1: All functions
T	Talker	T8: Basic talker, talker release by MLA
L	Listener	L4: Basic listener, listener release by MTA
SR	Service request	SR1: All functions
RL	Remote/Local	RL2: Remote/local function, no local lockout function
PP	Parallel poll	PP0: none
DT	Device trigger	DT0: none
DC	Device clear	DC1: All functions
C	Controller	C0: none

1) GPIB address

GP-IB address of this product can be changed to refer to " 7-1-3 Setting the address, delimiter, and command set". The changed address will be available after setting. The changed address are saved in internal memory.

2) LOCAL

LOCAL is a state that this product is controlled by a key operation. This state is valid for all key operations.

3) REMOTE

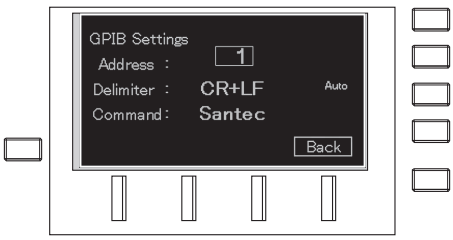
REMOTE is a state that this product is controlled from other controllers through GPIB bus. In this state, the all key operations is disable except for LOCAL key and LD key.

4) Device Clear(DCL)

When this product receives the universal command "DCL" in REMOTE state, the transmit and receive buffers are cleared.

■ 7-1-3. Setting the Address, Delimiter, and Command set

1. Press [Menu] (F4 key) → [Next] (F4 key) →[GPIB] (F1 key) soft keys from the main screen. The GPIB setting screen appears.



2. Set Address, Delimiter, and Command in order from top to bottom.

Address: Set a unique value from 0 to 30. The default value is 1.

Delimiter: Select one from ”CR”, ”LF”, ”CR+LF”, and ”EOI “.

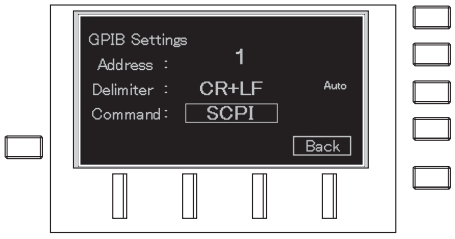
Set the end character of the command string.

When “CR”, ”LF” or ”CR+LF” is selected, the command is accepted and analysis begins when the set delimiter is received. At sending time, the delimiter is added to the end of the response string and sent, and an EOI signal is asserted. When “EOI” is selected, the command is accepted and analysis begins when the EOI is received. At sending time, an EOI is asserted when the last character is sent.

Command: Select the ”SCPI” or ”santec” command set.

Select “SCPI” when using commands complying with the standards specified by the SCPI consortium (Command set 1).

This command set has high compatibility with other companies’ instruments. Select “santec” when using commands based on our existing original commands (Command set 2). This command set has high compatibility with our existing products.



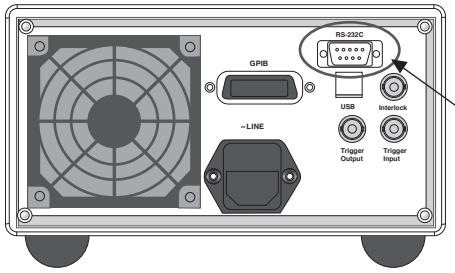
Refer to “7-4-1. Command set 1”.

3. Go back with the Back or Home key after setting.

7-2 RS-232C

■ 7-2-1. Connection

Connect the crossover cable with D-sub 9 pins to the RS-232C connector on the real panel.



RS-232 connector

Communication conditions are as follows.

Communication conditions

Asynchronous, full duplex

Transmission speed (Baud rate): Select from 2400 bps to 19.2 kbps

Data length: 8 bits

Stop bit: 1 bit

Parity: None

X control: None

■ 7-2-2. Setting the Transmission Speed, and the Delimiter

1. Press Menu (F4 key) → Next (F4 key) → RS-232 (F2 key) soft keys from the main screen. The RS-232 setting screen appears.

   Speed: Set the transmission speed.

   Select one from 2400, 4800, or 9600 bps, or 19.2 kbps. The default is 9600 bps.

   Delimiter: Select the delimiter of the command from “CR”, “LF” or “CR+LF”.

   At receiving time, the reception of commands is completed and analysis begins after the delimiter is recognized. At sending time, the delimiter is added to the end of the response string and then sent.

2. Go back with the Back or Home key after setting.

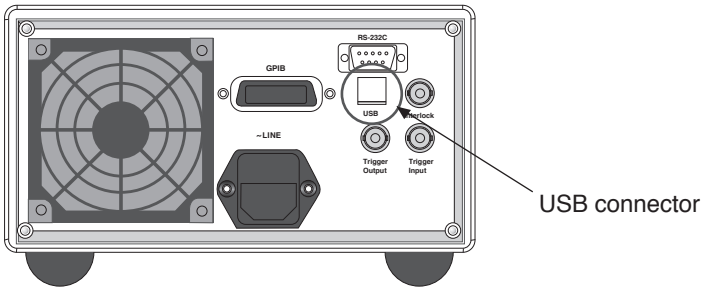
■ 7-2-3. Command

Only Command set 2 can be used. Refer to “7-4-2. TSL-550 Specific Command List (Command set 2)”

7-3 USB

■ 7-3-1. Connection

Connect the B-type connector cable to the USB connector on the rear panel.



■ 7-3-2. Communication Conditions and System Requirements

USB 2.0 compatible

Transfer speed: 1 MBps (with D2XX driver)

Transfer speed: 300 KBps (with VCP driver)

Transfer FIFO size

Sending FIFO：384 bytes

Receiving FIFO: 128 bytes

Setting the Delimiter: The delimiter of the command is “CR”.
At receiving time, the reception of commands is completed and analysis begins after the delimiter is recognized. At sending time, the delimiter is added to the end of the response string and then sent.

CAUTION

The USB controller of this products are available to work with the following operating systems.and it can not guarantee with other operating systems.

- Windows 98
- Windows ME
- Windows 2000
- Windows XP
- Windows XP x64
- Windows Vista
- Windows Vista x64
- Windows 7
- Windows 7 x64

■ 7-3-3. Installing a USB Driver Software

To enable USB communication, USB driver software must be installed.

Even though some pop-up messages will be displayed when USB cable is connected the device and PC, please click cancel or close message.

1. Open “Device Manager” (Figure 7-3-3-1) and open “TSL-550” under “Other devices.” Right-click on “TSL-550” and click on “Update Driver Software...”.

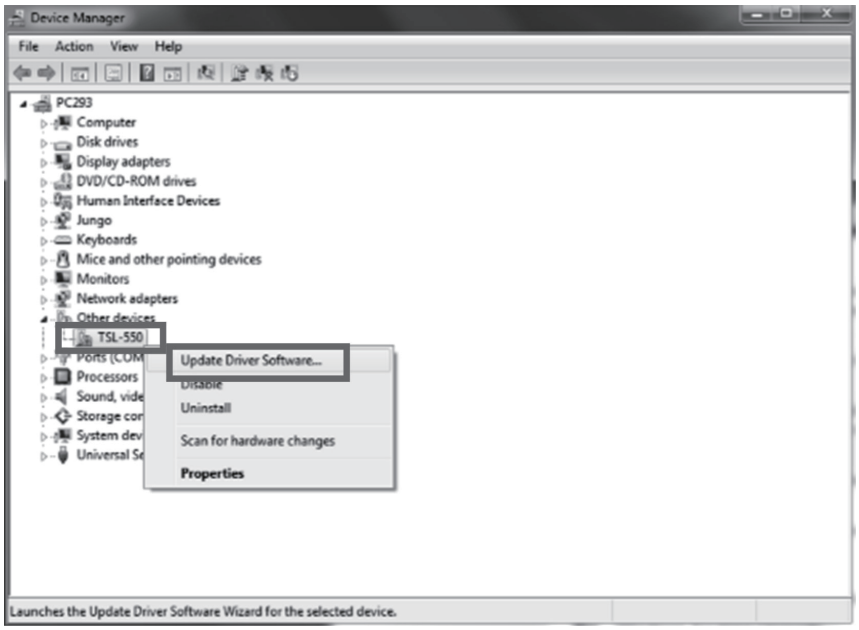


Figure7-3-3-1. Device manager

2. Click on “Browse my computer for driver software” when message window (Figure 7-3-3-2) appears.

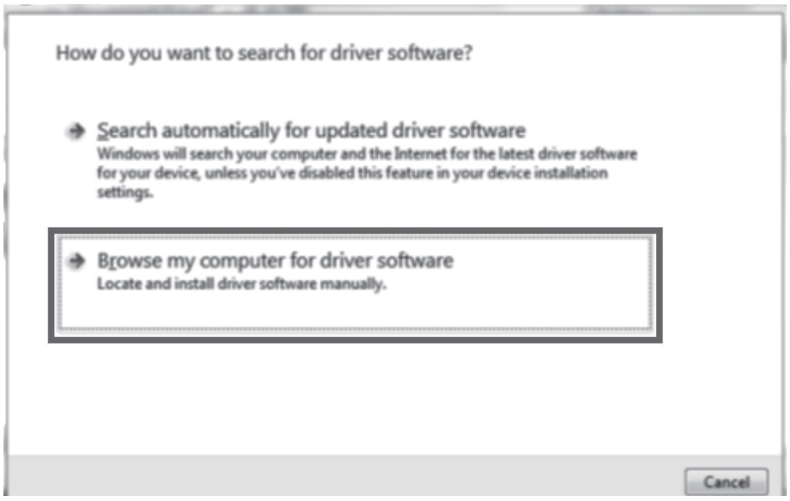


Figure7-3-3-2. Update driver software

3. On message window (Figure 7-3-3-3), click on “Browse” button to select the driver software location under Removable disk included in package.
(e.g. D:\Common\USB Driver on Figure 7-3-3-3)



Figure7-3-3-3. Search for driver software location

4. Installation will automatically start. Message window Figure 7-3-3-4 will appear.



Figure7-3-3-4. Installation in progress

5. If a Windows Security message in Figure 7-3-3-5 appears, please click on “Install this driver software anyway” to proceed.

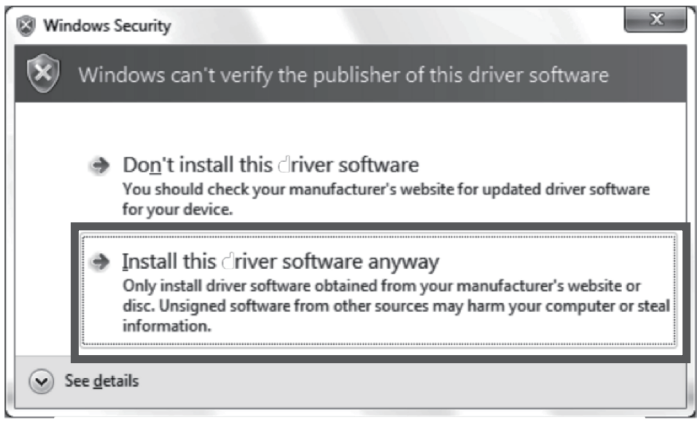


Figure7-3-3-5. Security warning

6. Installation is completed successfully when Figure 7-3-3-6 appears. Click on “Close” to exit the installation.

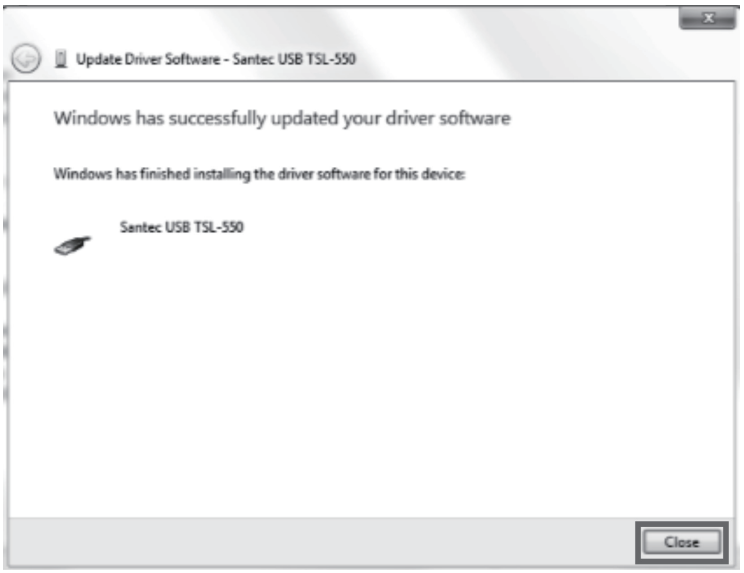


Figure7-3-3-6. Installation complete

■ 7-3-4. Installing a VCP Driver Software

To enable VCP communication, VCP driver software must be installed.

1. After installed USB driver software by 7-3-3, open “Device Manager” (Figure 7-3-4-1), and open “Santec USB TSL-550” under “Universal Serial Bus Controllers”. Right-click on “Santec USB TSL-550” and click on “Properties”.

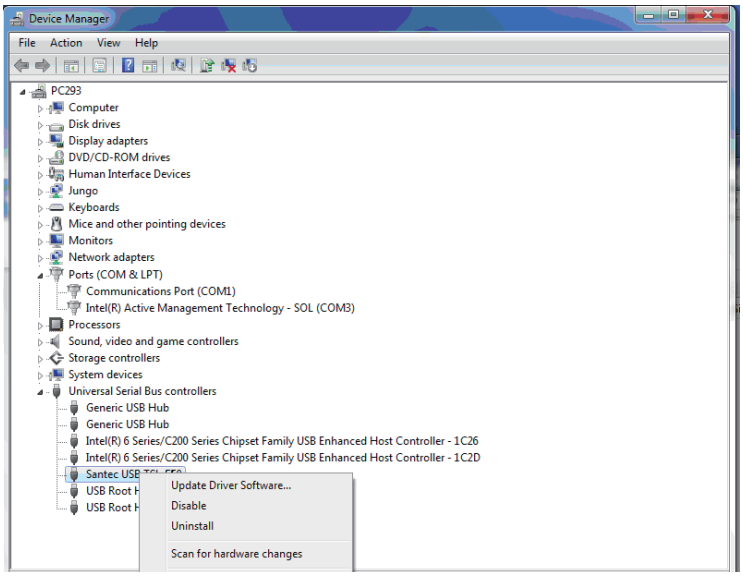


Figure7-3-4-1. Device Manager

2. Check “Load VCP” in “Advanced” tab.

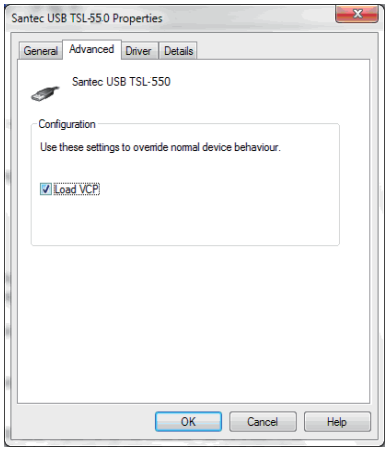


Figure7-3-4-2. Santec USB TSL-550 Properties

3. Disconnect USB cable from PC, and reconnect to PC.

Open “Device Manager” (Figure 7-3-4-3) and open “USB Serial Port” under “Other Devices”. Right-click on “USB Serial Port” and click on “Properties”.

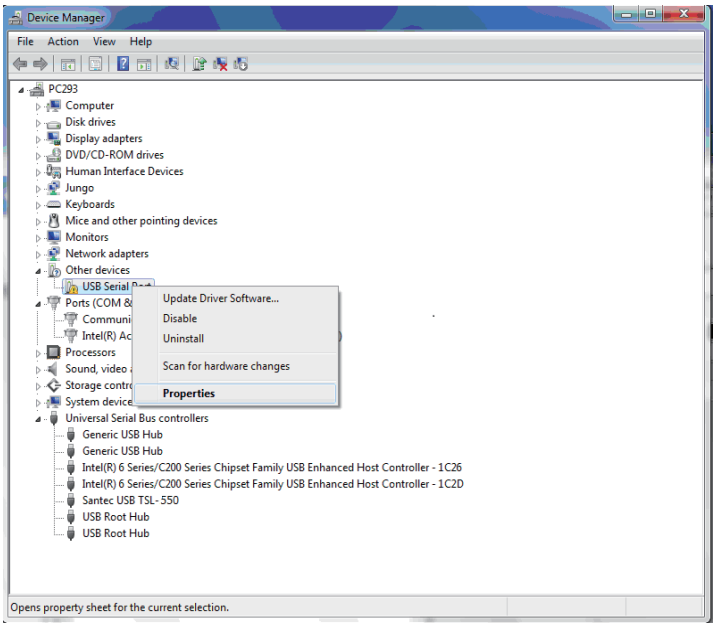


Figure7-3-4-3 Device Manager

4. Click “Update Driver…” in “Driver” tab.

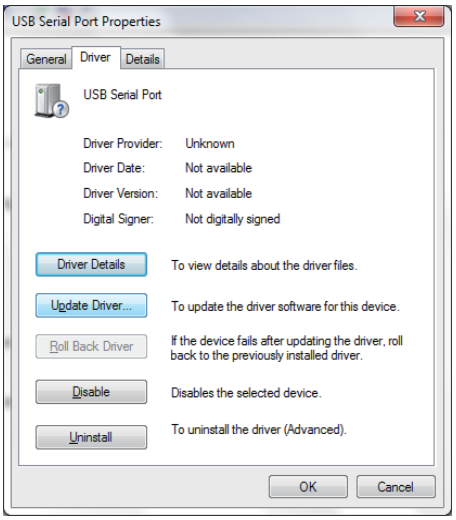


Figure7-3-4-4 USB Serial Port Properties

5. Click on “Browse my computer for driver software” when message window (Figure 7-3-4-5) appears.

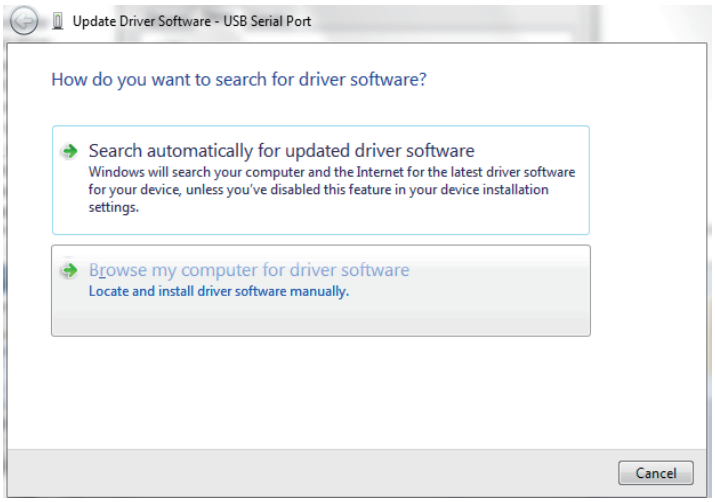


Figure7-3-4-5. Update Driver Software

6. On Message window (Figure 7-3-4-6), click on “Browse” button to select the driver software location under Removable disk included in package.
(e.g. D:\Common\USB Driver on Figure 7-3-4-6)

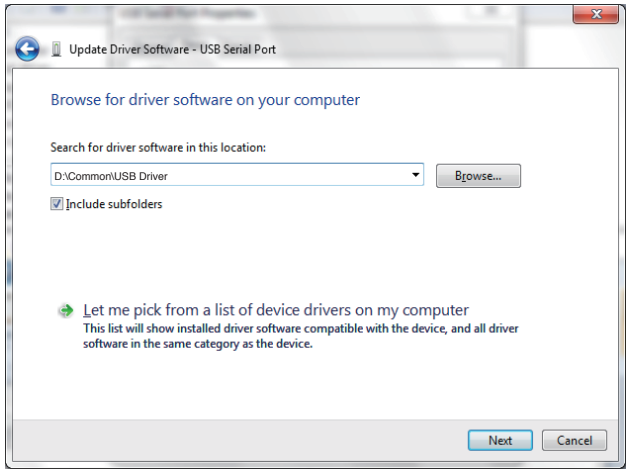


Figure7-3-4-6.Search for driver software location

7. Installation will automatically start. Message window Figure 7-3-4-7 will appear.

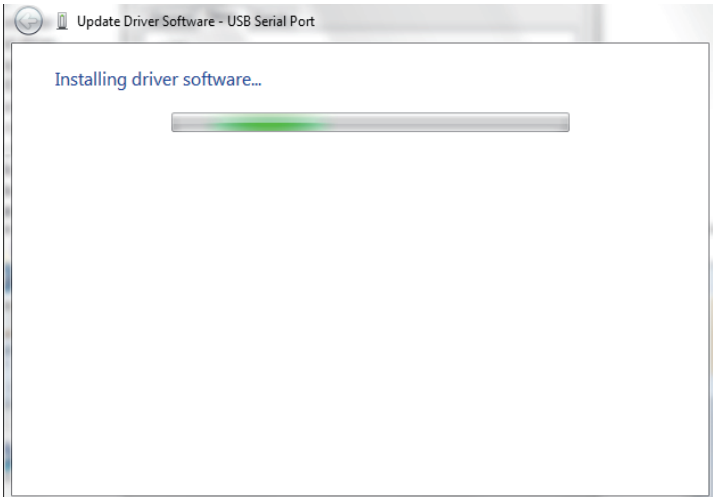


Figure7-3-4-7. Installation in progress

8. Installation is completed successfully when Figure 7-3-4-8 appears. Click on “Close” to Exit the installation.

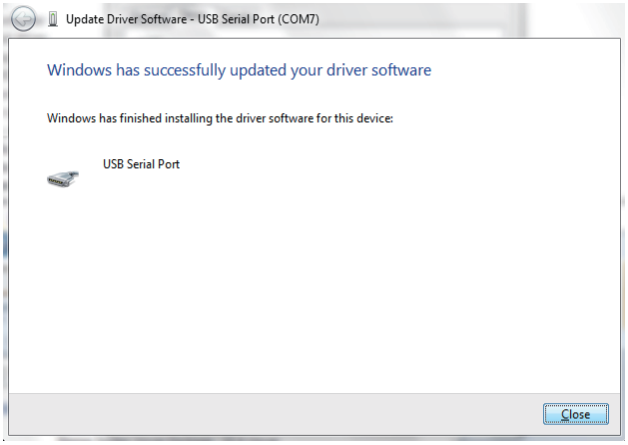


Figure7-3-4-8. Installation complete

9. Open “Device Manager” (Figure 7-3-4-9), to check added information of serial port number on “Ports (COM & LPT). (E.g. USB Serial Port (COM7))

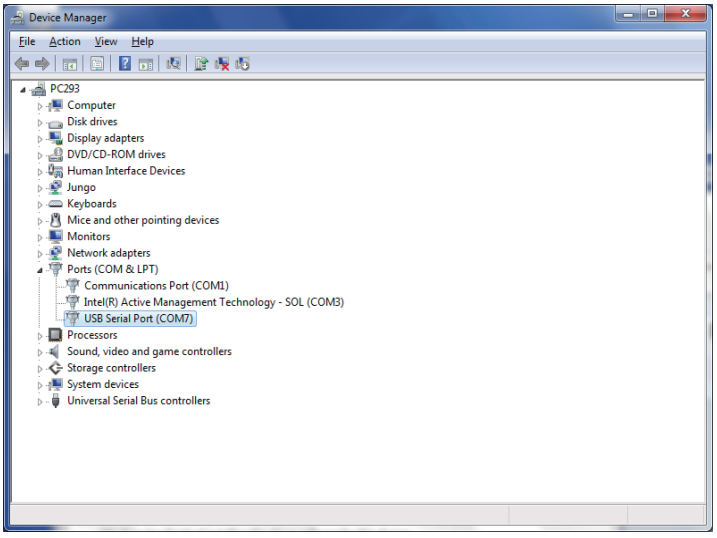


Figure7-3-4-9. Device Manager

■ 7-3-5. Command

Only Command set 2 can be used. Refer to “7-4-2. TSL-550 Specific Command List (Command set 2)”.

7-4 Command Reference

Two kinds of command sets are provided for the TSL-550. Select one of them in advance and use the commands in that category. Commands in one command set cannot be used with commands in the other command set simultaneously.

Command set 1

This command set complies with IEEE-488.2, and is available only in GPIB communication. Set the command setting for GPIB to “SCPI” to make the command set available.

Command set 2

Santec’s original existing command set.

・In GPIB communication, set the command setting to “Santec” to make the command set available.

・Use this command set for USB or RS-232C communication.

■ 7-4-1. Command set 1 (Complies with IEEE-488.2)

1. Common Command List

Available for IEEE-488.2 common commands in the following list.

Common Commands (Command set 1 Group)

Command	Description	Page
*IDN?	Identification Query Returns strings that identify the device.	7-20
*RST	Reset (Aborts the standby command.)	7-20
*TST?	Initiates an instrument self-test and returns the results.	7-20
*OPC?	Queries the completion of operation.	7-21
*CLS	Status Clear (Clears STBR and SESR.)	7-21
*ESE	Sets Standard Event Enable Register. (The result of SESR and SEER is set to ESB.)	7-21
*ESE?	Reads out the value of the Standard Event Enable Register.	7-21
*ESR?	Reads out the value of the Standard Event Status Register.	7-21
*SRE	Sets Service Request Enable. (Selects enable or disable SRQ.)	7-22
*SRE?	Reads out the value of the Service Request Enable Register.	7-22
*STB?	Reads out the value of the Status Byte Register.	7-22

2. TSL-550 Status system

When Command set 1 is selected, the following status systems with four registers are provided.

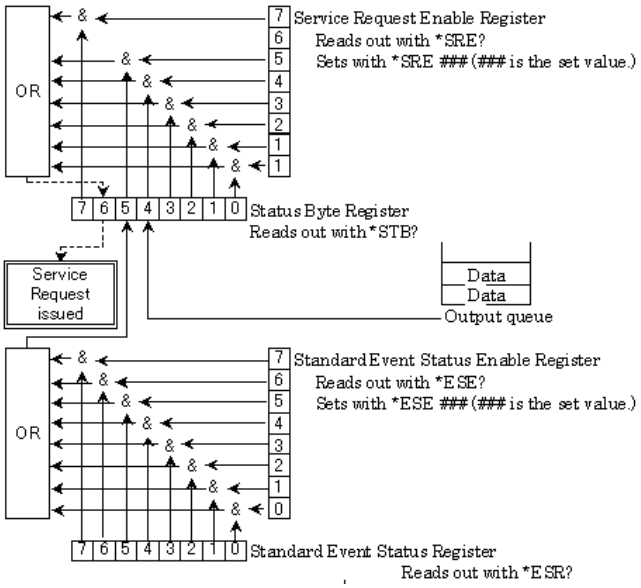
(1) Status Byte Register (STBR)

(2) Service Request Enable Register (SRER)

(3) Standard Event Status Register (SESR)

(4) Standard Event Enable Register (SEER)

1) Status System Structure Overview



* Output queue is cleared when a new command is input into the input queue.

2) Status Byte Register (STBR)

The status is read out by serial poll, or *STB? command.

7	6	5	4	3	2	1	0
Not used	RQS	ESB	MAV	Not used	Not used	Not used	Not used

RQS (Request Service Bit):
RQS is set when a Service Request is issued.
ESB (Event Status Bit):
ESB is set when any of the bits of the Standard Event Status Register (SESR) is set.
MAV (Message Available Bit):
MAV is set when output data is prepared.

3) Service Request Enable Register (SRER)
An 8-bit register to set Enable/Disable of each bit of the Status Byte Register. If a bit of the SRER is set to 1, the corresponding bit of the STBR is set to Enable.

4) Standard Event Status Register (SESR)
An 8-bit register to indicate the standard status of the device.

7	6	5	4	3	2	1	0
PON	Not used	CME	EXE	DDE	QYE	Not used	OPC

PON (Power ON):
Bit is set when power is turned on.
CME (Command Error):
CME is set when a command has a syntax error or is misspelled.
EXE (Execution Error):
EXE is set when a command is not available for the device, or a command cannot be executed in the current device condition.
DDE (Device Definition Error):
Not used
QYE (Query Error):
QYE is set when an attempt is made to read data from the output queue while the output queue is empty.
OPC (Operation Completion):
OPC is set when all pending operations are completed.

5) Standard Event Enable Register (SEER)
SEER is an 8-bit register to set Enable/Disable of each bit of the SESR. If a bit of the SEER is set to 1, the corresponding bit of the SESR is set to Enable.

3. IEEE-488.2 common commands - Detailed description

1) *IDN? Identification Query

Syntax	*IDN?
Description	A query to identify the device; places strings of device information such as the name, firmware, and version in the output queue.
Parameter	None
Response	SANTEC,TSL-550,########,****.**** # field = serial number of the device in 8 digits. * field = firmware version as 4 digits + .(period) + 4 digits.
Example	*IDN? → SANTEC,TSL-550,06020001,0001.0000

2) *RST Device Reset

Syntax	*RST
Description	Aborts standby operation. Clears the following items. ・Command input queue ・Error queue
Parameter	None
Response	None

3) *TST? Self-test Query

Syntax	*TST?
Description	Initiates an instrument self-test and places the results in the output queue. It performs internal calibration of laser and/or diagnostic. Initializes motors, checks output power, LD current, and LD temperature. It takes a couple of minutes.
Response	This should return “0” for success, non-zero return values for error conditions. Return value is a combination of the following numbers. 0: No error 1: LD temperature is out of range (at LD OFF) 2: LD temperature is out of range (at LD ON) 4: Wavelength monitor temperature is out of range 8: LD injection current is overload 16: Power monitor is malfunction

4) *OPC? Operation Complete Query

Syntax	*OPC?
Description	Places 1 in the output queue when all operation processing has completed.
Response	0: (In operation) 1: (Operation completed)

5) *CLS Clear Status

Syntax	*CLS
Description	Clears all event registers and queues and reflects the summary in the Status Byte Register. Clears the following items. ・Status Byte Register ・Standard Event Status Register ・Error Queue
Parameter	None
Response	None

6) *ESE Standard Event Enable Register Setting

Syntax	*ESE<wsp><value>
Description	Sets the Standard Event Enable Register (SEER).
Parameter	Setting value from 0 to 255
Response	None

7) *ESE? Standard Event Enable Register Query

Syntax	*ESE?
Description	Places the value of the Standard Event Enable Register (SEER) in the output queue.
Parameter	None
Response	Integer from 0 to 255

8) *ESR? Standard Event Status Register Query

Syntax	*ESR?
Description	Places the value of the Standard Event Status Register (SESR) in the output queue. Register is cleared after being read.
Parameter	None
Response	Integer from 0 to 255

9) *SRE Service Request Enable Register Setting

Syntax	*SRE<wsp><value>
Description	Sets the Service Request Enable Register (SRER).
Parameter	Setting value from 0 to 255
Response	None

10) *SRE? Service Request Enable Register Query

Syntax	*SRE?
Description	Places the value of the Service Request Enable Register (SRER) in the output queue.
Parameter	None
Response	Integer from 0 to 63, or 128 to 191. (Values are missing since Bit 6 is always 0.)

11) *STB? Status Byte Register Query

Syntax	*STB?
Description	Places the value of the Status Byte Register (STBR) in the output queue.
Parameter	None
Response	Integer from 0 to 255 When read out by a serial poll, the value returned is the sum of 64 and the value of the Status Byte Register (since Bit 6 is set in the serial poll).

4. TSL-550 Specific command overview

An overview of the specific commands available in Command set 1 is shown in the following table.

TSL-550 Specific Command List (Command set 1 Group)

Command	Description	Page
:SPECial:REBoot	Resets the device.	7-26
:SYSTem:ERRor?	Reads out the error issued.	7-26
:SYSTem:VERSion?	Reads out the version of the firmware.	7-26
:SYSTem:COMMunicate:GPIB:ADDRess	Sets the GPIB address.	7-26
:SYSTem:COMMunicate:GPIB:ADDRess?	Reads out the GPIB address.	7-26
:SYSTem:COMMunicate:GPIB:DELimiter	Sets the command delimiter for GPIB communication.	7-27
:SYSTem:COMMunicate:GPIB:DELimiter?	Reads out the command delimiter for GPIB communication.	7-27
:SYSTem:COMMunicate:SERial:SPEed	Sets the speed of serial communication.	7-27
:SYSTem:COMMunicate:SERial:SPEed?	Reads out the speed of serial communication.	7-28
:SYSTem:COMMunicate:SERial:DELimiter	Sets the command delimiter for serial communication.	7-28
:SYSTem:COMMunicate:SERial:DELimiter?	Reads out the command delimiter for serial communication	7-28
:SYSTem:Lock?	Check for Interlock and system lock (option)	7-29
:TRIGger:INPut:EXTernal	Sets Enable/Disable of the external trigger signal input.	7-29
:TRIGger:INPut:EXTernal?	Reads out the setting of the external trigger signal input.	7-29
:TRIGger:INPut:STANdby	Puts the device in trigger signal input standby mode.	7-29
:TRIGger:INPut:STANdby?	Reads out the trigger signal input standby mode.	7-30
:TRIGger:OUTPut	Sets the timing of the trigger signal output.	7-30
:TRIGger:OUTPut?	Reads out the timing setting of the trigger signal output.	7-30
:TRIGger:OUTPut:STEP[:WIDTh]	Sets the interval of the trigger signal output.	7-30
:TRIGger:OUTPut:STEP[:WIDTh]?	Reads out the interval of the trigger signal output.	7-31
[:SOURce]:COHCtrl	Turns ON/OFF the coherence control.	7-31
[:SOURce]:COHCtrl?	Reads out the state of the coherence control.	7-31
[:SOURce]:POWer:STATe	Sets ON/OFF the LD.	7-31
[:SOURce]:POWer:STATe?	Reads out the ON/OFF status of the LD.	7-32
[:SOURce]:POWer:ATTenuation	Sets the attenuator value.	7-32
[:SOURce]:POWer:ATTenuation?	Reads out the attenuator value.	7-32
[:SOURce]:POWer:ATTenuation:AUTo	Switches to Auto/Manual for the power control.	7-32
[:SOURce]:POWer:ATTenuation:AUTo?	Reads out the setting of the power control.	7-33

Command	Description	Page
[:SOURce]:POWer:SHUTter	Sets Open/Close status of the internal shutter.	7-33
[:SOURce]:POWer:SHUTter?	Reads out the status of the internal shutter.	7-33
[:SOURce]:POWer:UNIT	Changes the unit of the power setting and display.	7-33
[:SOURce]:POWer:UNIT?	Reads out the unit of the power setting and display.	7-33
[:SOURce]:POWer[:LEVel]	Sets the optical output power.	7-34
[:SOURce]:POWer[:LEVel]?	Reads out the setting value of the optical output power.	7-34
[:SOURce]:POWer[:LEVel]:MINimum?	Reads out the minimum available power.	7-34
[:SOURce]:POWer[:LEVel]:MAXimum?	Reads the maximum available power.	7-34
[:SOURce]:POWer:ACTual[:LEVel]?	Reads out the setting value of the optical output power.	7-35
[:SOURce]:POWer:CORRection:PROFile	Revises the compensate power data of sweeps in auto power mode.	7-35
[:SOURce]:WAVelength:UNIT	Sets the unit of the wavelength indication.	7-35
[:SOURce]:WAVelength:UNIT?	Reads out the unit setting of the wavelength indication.	7-36
[:SOURce]:WAVelength	Sets the output wavelength.	7-36
[:SOURce]:WAVelength?	Reads out the setting value of the wavelength.	7-36
[:SOURce]:WAVelength:MINimum?	Reads out the minimum acceptable wavelength.	7-36
[:SOURce]:WAVelength:MAXimum?	Reads out the maximum acceptable wavelength.	7-36
[:SOURce]:WAVelength:FINe	Sets the fine-tuning	7-37
[:SOURce]:WAVelength:FINe?	Reads out the setting value of the fine-tuning.	7-37
[:SOURce]:WAVelength:FINe:DISable	Disables the fine-tuning.	7-37
[:SOURce][:WAVelength]:FREQuency	Sets the output wavelength in optical frequency.	7-37
[:SOURce][:WAVelength]:FREQuency?	Reads out the output wavelength in optical frequency.	7-38
[:SOURce][:WAVelength]:FREQuency: MINimum?	Reads out the minimum acceptable frequency.	7-38
[:SOURce][:WAVelength]:FREQuency: MAXimum?	Reads out the maximum acceptable frequency.	7-38
[:SOURce]:WAVelength:SWEep:CYCLes	Sets the number of wavelength sweeps.	7-38
[:SOURce]:WAVelength:SWEep:CYCLes?	Reads out the setting of the number of wavelength sweeps.	7-38
[:SOURce]:WAVelength:SWEep:COUNt? LD is on state and power control is Auto	Reads out the current number of completed sweeps.	7-38

Command	Description	Page
[:SOURce]:WAVelength:SWEep:DELay	Sets the wait time between each sweep in continuous sweep operation.	7-39
[:SOURce]:WAVelength:SWEep:DELay?	Reads out the wait time between each sweep in continuous sweep operation.	7-39
[:SOURce]:WAVelength:SWEep:DWELl	Sets the amount of time spent during each step in step sweep operation.	7-39
[:SOURce]:WAVelength:SWEep:DWELl?	Reads out the amount of time spent during each step in step sweep operation.	7-40
[:SOURce]:WAVelength:SWEep:MODe	Sets the sweep operation mode.	7-40
[:SOURce]:WAVelength:SWEep:MODe?	Reads out the sweep operation mode.	7-40
[:SOURce]:WAVelength:SWEep:SPEed	Sets the speed for continuous sweep.	7-40
[:SOURce]:WAVelength:SWEep:SPEed?	Reads out the speed of continuous sweep.	7-41
[:SOURce]:WAVelength:SWEep:STARt	Sets the sweep start wavelength.	7-41
[:SOURce]:WAVelength:SWEep:STARt?	Reads out the sweep start wavelength.	7-41
[:SOURce]:WAVelength:SWEep:STOP	Sets the sweep end wavelength.	7-41
[:SOURce]:WAVelength:SWEep:STOP?	Reads out the sweep end wavelength.	7-42
[:SOURce]:WAVelength:SWEep:STEP[:WIDTh]	Sets the step interval (wavelength) of step sweeps.	7-42
[:SOURce]:WAVelength:SWEep:STEP[:WIDTh]?	Reads out the step interval (wavelength) of step sweeps.	7-42
[:SOURce][:WAVelength]:FREQuency:SWEep:STARt	Sets the sweep start frequency.	7-42
[:SOURce][:WAVelength]:FREQuency:SWEep:STARt?	Reads out the sweep start frequency.	7-43
[:SOURce][:WAVelength]:FREQuency:SWEep:STOP	Sets the sweep end frequency.	7-43
[:SOURce][:WAVelength]:FREQuency:SWEep:STOP?	Reads out the sweep end frequency.	7-43
[:SOURce][:WAVelength]:FREQuency:SWEep:STEP[:WIDTh]	Sets the step interval (frequency) of step sweeps.	7-43
[:SOURce][:WAVelength]:FREQuency:SWEep:STEP[:WIDTh]?	Reads out the step interval (frequency) of step sweeps.	7-44
[:SOURce]:WAVelength:SWEep[:STATe]	Sets the sweep mode state.	7-44
[:SOURce]:WAVelength:SWEep[:STATe]?	Reads out the current sweep mode state.	7-44
[:SOURce]:WAVelength:SWEep[:STATe]:REPeat	Executes a continuous sweep.	7-45
[:SOURce]:WAVelength:SWEep:SOFTtrigger	Issues a soft trigger.	7-45
[:SOURce]:READout:POINts?	Reads the number of data points recorded by wavelength logging.	7-45
[:SOURce]:READout:DATa?	Reads all the data recorded by wavelength logging. The data is comprised of a header (ASCII characters) and wavelength data array (4-byte binary).	7-45
[:SOURce]:AM:STATe	Enables and disables amplitude modulation of the laser output.	7-46
[:SOURce]:AM:STATe?	Reads out status of amplitude modulation of the laser output.	7-46

5. TSL-550 specific command detailed description
Specific commands in Command set 1 are described in detail as follows.

1) System related commands

:SPECial:REBoot

Syntax	:SPECial:REBoot
Description	Resets the device.
Parameter	None
Response	None
Example	:SPEC:REB

:SYSTem:ERRor?

Syntax	:SYSTem:ERRor?
Description	Reads out the error issued.
Parameter	None
Response	Error Number (Refer to “6. Command Error” below.)
Example	:SYST:ERR? Error numbers and error messages are returned.

:SYSTem:VERSion?

Syntax	:SYSTem:VERSion?
Description	Reads out the version of the firmware.
Parameter	None
Response	The format is (4 digits) + (period) + (4 digits) ****.****
Example	:SYST:VERS? → 0001.0000

:SYSTem:COMMunicate:GPIB:ADDRess

Syntax	:SYSTem:COMMunicate:GPIB:ADDRess <wsp><value>
Description	Sets the GPIB address.
Parameter	Integer from 1 to 30
Response	None
Example	:SYST:COMM:GPIB:ADDR 10 Sets the GPIB address to “10”.

:SYSTem:COMMunicate:GPIB:ADDRess?

Syntax	:SYSTem:COMMunicate:GPIB:ADDRess?
Description	Reads out the GPIB address.

Parameter	None
Response	Integer from 1 to 30
Example	:SYST:COMM:GPIB:ADDR? → 10 Indicates that the GPIB address is “10”.

:SYSTem:COMMunicate:GPIB:DELimiter

Syntax	:SYSTem:COMMunicate:GPIB:DELimiter<wsp> <value>
Description	Sets the command delimiter for GPIB communication. EOI is always sent.
Parameter	0：CR 1：LF 2：CR+LF 3：None
Response	None
Example	:SYST:COMM:GPIB:DEL 1 Sets the GPIB command delimiter to “LF”.

:SYSTem:COMMunicate:GPIB:DELimiter?

Syntax	:SYSTem: COMMunicate: GPIB:DELimiter?
Description	Reads out the command delimiter for GPIB communication.
Parameter	None
Response	0：CR 1：LF 2：CR+LF 3 : None
Example	: SYST:COMM:GPIB:DEL? → 1 Indicates that the GPIB delimiter is ”LF”.

:SYSTem:COMMunicate:SERial:SPEed

Syntax	:SYSTem:COMMunicate:SERial:SPEed<wsp> <value>
Description	Sets the speed of serial communication.
Parameter	0：2400 bps 1：4800 bps 2：9600 bps 3：19200 bps
Response	None
Example	: SYST:COMM:SER:SPE 2 Sets the serial communication speed to “9600 bps”.

:SYSTem:COMMunicate:SERial:SPEed?

Syntax	:SYSTem:COMMunicate:SERial:SPEed?
Description	Reads out the speed of serial communication.
Parameter	None
Response	0：2400 bps 1：4800 bps 2：9600 bps 3：19200 bps
Example	:SYST:COMM: SER:SPE? → 2 Indicates that the serial communication speed is ”9600 bps”.

:SYSTem:COMMunicate:SERial:DELimiter

Syntax	: SYSTem:COMMunicate:SERial:DELimiter<wsp><value>
Description	Sets the command delimiter for serial communication.
Parameter	0：CR 1：LF 2：CR+LF
Response	None
Example	:SYST:COMM:SER:DEL 1 Sets the command delimiter for serial communication to “LF”.

: SYSTem: COMMunicate: SERial: DELimiter?

Syntax	: SYSTem:COMMunicate:SERial:DELimiter?
Description	Reads out the command delimiter for serial communication.
Parameter	None
Response	0：CR 1：LF 2：CR+LF
Example	: SYST:COMM:SER:DEL? → 1 Indicates that the serial communication delimiter is ”LF”.

:SYSTem:LOCK?

Syntax	:SYSTem:LOCK?
Description	Reads out interlock and system lock status.
Parameter	None
Response	0：Unlocked 1：System locked (Password is required) 2：Interlock is on 3：Interlock and system lock on
Example	: SYST:LOCK?

2) Input /Output related command

:TRIGger:INPut:EXTernal

Syntax	:TRIGger:INPut:EXTernal<wsp><value>
Description	Sets Enable/Disable of the external trigger signal input.
Parameter	0：Disable 1：Enable
Response	None
Example	:TRIG:INP:EXT 1 Enables the external trigger signal input.

:TRIGger:INPut:EXTernal?

Syntax	:TRIGger:INPut:EXTernal?
Description	Reads out the setting of the external trigger signal input.
Parameter	None
Response	0：Disable 1：Enable
Example	:TRIG:INP:EXT? → 1 Indicates that the external trigger is enabled.

:TRIGger:INPut:STANdby

Syntax	:TRIGger:INPut:STANdby<wsp><value>
Description	Puts the device in trigger signal input standby mode.
Parameter	0: Normal operation mode 1: Trigger standby mode
Response	None
Example	: TRIG:INP:STAN 1 Puts the device in trigger standby mode.

:TRIGger:INPut:STANdby?

Syntax	:TRIGger:INPut:STANdby?
Description	Reads out the trigger signal input standby mode.
Parameter	None
Response	0: Normal operation mode 1: Trigger standby mode
Example	:TRIG:INP: STAN? → 1 Indicates that the device is in trigger standby mode.

:TRIGger:OUTPut

Syntax	:TRIGger:OUTPut <wsp> <value>
Description	Sets the timing of the trigger signal output.
Parameter	0：None 1：Stop 2：Start 3：Step
Response	None
Example	:TRIG: OUTP 1 Sets the timing of the trigger signal output to be at sweep completion.

:TRIGger:OUTPut?

Syntax	:TRIGger: OUTPut?
Description	Reads out the timing setting of the trigger signal output.
Parameter	None
Response	0：None 1：Stop 2：Start 3：Step
Example	:TRIG:OUTP? → 2 Indicates that the timing of the trigger signal output is at sweep start.

:TRIGger:OUTPut:STEP[:WIDTh]

Syntax	:TRIGger:OUTPut:STEP[:WIDTh]<wsp><value>
Description	Sets the interval of the trigger signal output.
Parameter	Range：0.0001 ～ 160 （nm） Step：0.0001（nm）

Response	None
Example	:TRIG:OUTP:STEP 1
	Sets the interval of the trigger signal output.

:TRIGger:OUTPut:STEP[:WIDTh]?

Syntax	:TRIGger:OUTPut:STEP[:WIDTh]?
Description	Reads out the interval of the trigger signal output.
Parameter	None
Response	Range：0.0001 ～ 160（nm）
	Step：0.0001（nm）
Example	:TRIG:OUTP:STEP?
	→ 10.000
	Indicates that the trigger signal output interval is 10 nm.

3）Optical output characteristic related commands

[:SOURce]:COHCtrl

Syntax	[:SOURce]:COHCtrl<wsp><value>
Description	Turns ON/OFF the coherence control.
	Coherence control cannot be changed to ON, when modulation setting is “Ext.”.
Parameter	0: Coherence Control OFF
	1: Coherence Control ON
Response	None
Example	:COHC 1
	Turns the coherence control ON.

[:SOURce]:COHCtrl?

Syntax	[:SOURce]:COHCtrl?
Description	Reads out the state of the coherence control.
Parameter	None
Response	0: Coherence Control OFF
	1: Coherence Control ON
Example	:COHC?
	→ 1
	Indicates that the coherence control is ON.

[:SOURce]:POWer:STATe

Syntax	[:SOURce]:POWer:STATe<wsp><value>
Description	Sets ON/OFF the LD.
Parameter	0: LD OFF
	1: LD ON

Response	None
Example	: POW :STAT 1
	Turns the LD ON.

[:SOURce]:POWer:STATe?

Syntax	[:SOURce]:POWer:STATe?
Description	Reads out the ON/OFF status of the LD.
Parameter	None
Response	0: LD ON
	1: LD OFF
Example	: POW:STAT?
	→ 1
	Indicates that the LD is ON.

[:SOURce]:POWer:ATTenuation

Syntax	[:SOURce] : POWer : ATTenuation <wsp><value>
Description	Sets the attenuator value.
Parameter	Range：0 ～ 30 (dB)
	Step：0.01 (dB)
Response	None
Example	:POW:ATT 10
	Sets the attenuator value to 10 dB.

[:SOURce]:POWer:ATTenuation?

Syntax	[:SOURce]:POWer:ATTenuation?
Description	Reads out the attenuator value.
Parameter	None
Response	Range：0 ～ 30 (dB)
	Step：0.01 （dB）
Example	: POW : ATT?
	→10.000
	Indicates that the attenuator value is 10 dB.

[:SOURce]:POWer:ATTenuation:AUTo

Syntax	[:SOURce]:POWer:ATTenuation:AUTo<wsp><value>
Description	Switches to Auto/Manual for the power control.
Parameter	0：Manual
	1：Auto
Response	None
Example	:POW:ATT:AUT 1
	Sets the power control to Auto.

[:SOURce]:POWer:ATTenuation:AUTo?

Syntax	[:SOURce]:POWer:ATTenuation:AUTo?
Description	Reads out the setting of the power control.
Parameter	None
Response	0：Manual 1：Auto
Example	:POW:ATT:AUT?

[:SOURce]:POWer:SHUTter

Syntax	[:SOURce]:POWer:SHUTter<wsp><value>
Description	Sets Open/Close status of the internal shutter.
Parameter	0：Shutter Open 1: Shutter Close
Response	None
Example	:POW:SHUT 1 Closes the internal shutter.

[:SOURce]:POWer:SHUTter?

Syntax	[:SOURce]:POWer:SHUTter?
Description	Reads out the status of the internal shutter.
Parameter	None
Response	0：Shutter Open 1：Shutter Close
Example	:POW:SHUT? → 1 Indicates that the internal shutter is closed.

[:SOURce]:POWer:UNIT

Syntax	[:SOURce]:POWer:UNIT<wsp><value>
Description	Changes the unit of the power setting and display.
Parameter	0：dBm 1：mW
Response	None
Example	:POW:UNIT 1 Sets the power setting and display unit to “mW”.

[:SOURce]:POWer:UNIT?

Syntax	[:SOURce]:POWer:UNIT?
Description	Reads out the unit of the power setting and display.
Parameter	None
Response	0：dBm 1：mW

Example :POW:UNIT?
→ 1
Indicates that the power setting and display unit is set to “mW”.

[:SOURce]:POWer[:LEVel]

Syntax [:SOURce]:POWer[:LEVel] <wsp> <value>
Description Sets the optical output power.
Parameter Range: 30dB up to peak power
Typical value
-17 ~ +13dBm (0.02 ~ 20mW)
The available range of output power depends on the product characteristics.
Step: 0.01dBm (0.01mW)
Set the unit with the [:SOURce]:POWer:UNIT command in advance.
Response None
Example :POW 5
Sets the power to 5 dBm or 5 mW depending on the value set for the unit.

[:SOURce]:POWer[:LEVel]?

Syntax [:SOURce]:POWer[:LEVel][:MINimuml:MAXimum]?
Description Reads out the setting value of the optical output power.
Parameter None Reads out the currently set wavelength.
MINimum: Reads out the minimum available output power.
MAXimum: Reads out the maximum available output power.
Response Range: 30dB up to peak power
Typical value
-17 ~ +13dBm (0.02 ~ 20mW)
The available range of output power depends on the product characteristics.
Step: 0.01dBm (0.01mW)
The unit is previously set with the [:SOURce]:POWer:UNIT command.
Example :POW?
→ 10.000
Indicates that the optical output power is either 10 dBm or 10 mW depending on the value set for the unit.

[:SOURce]:POWer:ACTual[:LEVel]?

Syntax	[:SOURce]:POWer:ACTual[:LEVel]?
Description	Reads out the monitored value of the optical output power. The monitored value is the value actually measured by the self-contained power monitor.
Parameter	None
Response	Range: 30dB up to peak power Typical value -17 ~ +13dBm (0.02 ~ 20mW) The available range of output power depends on the product characteristics. Step: 0.01dBm (0.01mW) The unit is previously set with the [:SOURce]:POWer:UNIT command.
Example	: POW : ACT? → 9.600 The output power is 9.6 dBm or 9.6 mW depending on the value set for the unit.

[:SOURce]:POWer:CORRection:PROFile

Syntax	[:SOURce]:POWer:CORRection:PROFile
Description	Revises the compensate power data of sweeps in auto power mode. Recommend executing this command when "Over LD"or "Low Pwr" is displayed.
Parameter	None
Response	None
Example	:POW:CORR:PROF

[:SOURce]:WAVelength:UNIT

Syntax	[:SOURce]: WAVelength: UNIT<wsp><value>
Description	Sets the unit of the wavelength indication (Wavelength, Frequency). Separate commands exist for setting frequency and wavelength.
Parameter	0：nm 1：THz
Response	None
Example	:WAV:UNIT 1 Sets the wavelength unit t THz.

[:SOURce]:WAVelength:UNIT?

Syntax	[:SOURce]:WAVelength:UNIT?
Description	Reads out the unit setting of the wavelength indication.
Parameter	None
Response	0：nm 1：THz
Example	:WAV:UNIT? → 1 Indicates that the wavelength unit is THz.

[:SOURce]:WAVelength

Syntax	[:SOURce]:WAVelength<wsp><value>
Description	Sets the output wavelength.
Parameter	Range：Range: Minimum setting wavelength to Maximum (nm) Step：0.0001 (nm)
Response	None
Example	:WAV 1550 Sets the output wavelength to 1550nm.

[:SOURce]:WAVelength?

Syntax	[:SOURce]:WAVelength[:MINimuml:MAXimum]?
Description	Reads out the setting value of the wavelength.
Parameter	None: Reads out the currently set wavelength. MINimum: Reads out the minimum acceptable wavelength. MAXimum: Reads out the maximum acceptable wavelength.
Response	Range：Minimum acceptable wavelength to Maximum acceptable wavelength (nm) Step：0.0001 (nm)
Example	:WAV? → 1550.000 Indicates that the currently set wavelength is 1550 nm.

[:SOURce]:WAVelength:FINe

Syntax	[:SOURce]:WAVelength:FINe <wsp><value>
Description	Sets the fine-tuning.
Parameter	Range：-100.00 ～ +100.00 (Unit: None) Step：0.01 (Unit: None)
Response	None
Example	:WAV:FIN 50 Sets the fine-tuning to50.

[:SOURce]:WAVelength:FINe?

Syntax	[:SOURce]:WAVelength:FINe?
Description	Reads out the setting value of the fine-tuning.
Parameter	None
Response	Range：-100.00 ～ +100.00 (Unit: None) Step：0.01 (Unit: None)
Example	:WAV:FIN? → 100.00 Indicates that the setting value of the fine-tuning is 100.

[:SOURce]:WAVelength:FINe:DISable

Syntax	[:SOURce]:WAVelength:FINe:DISable
Description	Disables the fine-tuning.
Parameter	None
Response	None
Example	:WAV:FIN:DIS

[:SOURce][:WAVelength]:FREQuency

Syntax	[:SOURce][:WAVelength]:FREQuency<wsp><value>
Description	Sets the output wavelength in optical frequency. The unit is THz. When the unit is returned to wavelength (nm), execute the [:SOURce]:WAVelength:UNIT 0 command.
Parameter	Range：Minimum frequency to Maximum frequency (THz) Step：0.00001(THz)
Response	None
Example	:FREQ 190.0000 Sets the output wavelength to 190 THz.

[:SOURce][:WAVelength]:FREQuency?

Syntax	[:SOURce][:WAVelength]:FREQuency [:MINimuml:MAXimum]?
Description	Reads out the output wavelength in optical frequency.
Parameter	None: Reads out the currently set frequency. MINimum: Reads out the minimum acceptable frequency. MAXimum: Reads out the maximum acceptable frequency.
Response	Range: Minimum frequency to Maximum frequency：(THz) Step：0.00001 (THz)
Example	:FREQ:MIN? Returns the minimum acceptable frequency.

[:SOURce]:WAVelength:SWEep:CYCLes

Syntax	[:SOURce]:WAVelength:SWEep:CYCLes <wsp><value>
Description	Sets the number of wavelength sweeps.
Parameter	Range：0 ～ 999 Step：1
Response	None
Example	:WAV:SWE:CYCL 100 Sets the number of sweeps to100.

[:SOURce]:WAVelength:SWEep:CYCLes?

Syntax	[:SOURce]:WAVelength:SWEep:CYCLes?
Description	Reads out the setting of the number of wavelength sweeps.
Parameter	None
Response	Range：0 ～ 999 Step：1
Example	:WAV:SWE:CYCL? → 100 Indicates that the number of sweeps is set to 100.

[:SOURce]:WAVelength:SWEep:COUNt?

Syntax	[:SOURce]:WAVelength:SWEep:COUNt?
Description	Reads out the current number of completed sweeps.
Parameter	None

Response	Range：0 ～ 999 Step：1
Example	:WAV:SWE:COUN? → 100 Indicates that 100 sweeps have completed.

[:SOURce]:WAVelength:SWEep:DELay

Syntax	[:SOURce]:WAVelength:SWEep:DELay <wsp><value>
Description	Sets the wait time between each sweep in continuous sweep operation.
Parameter	Range：0 ～ 999.9 (s) Step：0.1 (s)
Response	None
Example	:WAV:SWE:DEL 1 Sets the wait time to 1 second.

[:SOURce]:WAVelength:SWEep:DELay?

Syntax	[:SOURce]:WAVelength:SWEep:DELay?
Description	Reads out the wait time between each sweep in continuous sweep operation.
Parameter	None
Response	Range：0 ～ 999.9 (s) Step：0.1 (s)
Example	: WAV:SWE:DEL? → 1.0 Indicates that the wait time is set to 1 second.

[:SOURce]:WAVelength:SWEep:DWELl

Syntax	[:SOURce]:WAVelength:SWEep:DWELl <wsp><value>
Description	Sets the amount of time spent during each step in step sweep operation. The wait time between each sweep is also set to the same value. This wait time does not include the time required for wavelength conversion.
Parameter	Range：0 ～ 999.9 (s) Step：0.1 (s)
Response	None
Example	:WAV:SWE:DWEL 1 Sets the wait time of each step to 1 second.

[:SOURce]:WAVelength:SWEep:DWELl?

Syntax	[:SOURce]:WAVelength:SWEep:DWELl?
Description	Reads out the amount of time spent during each step in step sweep operation.
Parameter	None
Response	Range：0 ～ 999.9 (s) Step：0.1 (s)
Example	:WAV:SWE:DWEL? → 3.0 Indicates that the wait time is set to 3 seconds.

[:SOURce]:WAVelength:SWEep:MODe

Syntax	[:SOURce]:WAVelength:SWEep:MODe <wsp><value>
Description	Sets the sweep operation mode.
Parameter	0: Step operation, One-way 1: Continuous operation, One-way 2: Step operation, Two-way 3: Continuous operation, Two-way
Response	None
Example	:WAV:SWE:MOD 1 Sets the sweep mode to Continuous operation, One-way mode.

[:SOURce]:WAVelength:SWEep:MODe?

Syntax	[:SOURce]:WAVelength:SWEep:MODe?
Description	Reads out the sweep operation mode.
Parameter	None
Response	0: Step operation, One-way 1: Continuous operation, One-way 2: Step operation, Two-way 3: Continuous operation, Two-way
Example	:WAV:SWE:MOD? → 1 Indicates that the sweep mode is set to Continuous operation, One-way.

[:SOURce]:WAVelength:SWEep:SPEed

Syntax	[:SOURce]:WAVelength:SWEep:SPEed <wsp><value>
Description	Sets the speed for continuous sweep.
Parameter	Range：1.0 ～ 100 (nm/s) Step：0.1 (nm/s)
Response	None

Example :WAV:SWE:SPE 100
Sets the sweep speed to 100 nm/s.

[:SOURce]:WAVelength:SWEep:SPEed?

Syntax [:SOURce]:WAVelength:SWEep:SPEed?
Description Reads out the speed of continuous sweep.
Parameter None
Response Range：1.0 ～ 100 (nm/s)
Step：0.1 (nm/s)
Example :WAV:SWE:SPE?
→ 100.000
Indicates that the sweep speed is set to 100 nm/s.

[:SOURce]:WAVelength:SWEep:STARt

Syntax [:SOURce]:WAVelength:SWEep:STARt<wsp><value>
Description Sets the sweep start wavelength.
Parameter Range: Wavelength range (nm)
Step：0.0001 (nm)
Response None
Example :WAV:SWE:STAR 1500
Sets the sweep start wavelength to 1500 nm.

[:SOURce]:WAVelength:SWEep:STARt?

Syntax [:SOURce]:WAVelength:SWEep: STARt?
Description Reads out the sweep start wavelength.
Parameter None
Response Range: Wavelength range (nm)
Step：0.0001 (nm)
Example :WAV:SWE:STAR?
→ 1500.000
Indicates that the sweep start wavelength is set to 1500 nm.

[:SOURce]:WAVelength:SWEep:STOP

Syntax [:SOURce]:WAVelength:SWEep:STOP<wsp><value>
Description Sets the sweep end wavelength.
Parameter Range: Wavelength range (nm)
Step：0.0001 (nm)
Response None
Example :WAV:SWE:STOP 1620
Sets the sweep end wavelength to 1620 nm.

[:SOURce]:WAVelength:SWEep:STOP?

Syntax	[:SOURce]:WAVelength:SWEep:STOP ?
Description	Reads out the sweep end wavelength.
Parameter	None
Response	Range: Wavelength range (nm) Step：0.0001 (nm)
Example	:WAV:SWE:STOP? → 1620.000 Indicates that the sweep end wavelength is 1620 nm.

[:SOURce]:WAVelength:SWEep:STEP[:WIDTh]

Syntax	[:SOURce]: WAVelength:SWEep:STEP [:WIDTh] <wsp> <value>
Description	Sets the step interval (wavelength) of step sweeps.
Parameter	Range：0.0001 ～ 160 (nm) Step：0.0001 (nm)
Response	None
Example	:WAV:SWE:STEP 0.1 Sets the step interval to 0.1 nm.

[:SOURce]:WAVelength:SWEep:STEP[:WIDTh]?

Syntax	[:SOURce]:WAVelength:SWEep:STEP[:WIDTh]?
Description	Reads out the step interval (wavelength) of step sweeps.
Parameter	None
Response	Range：0.0001 ～ 160 (nm) Step：0.0001 (nm)
Example	:WAV:SWE:STEP? → 0.100 Indicates that the step interval is 0.1 nm.

[:SOURce][:WAVelength]:FREQuency:SWEep:STARt

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep:STARt <wsp><value>
Description	Sets the sweep start frequency.
Parameter	Range: Frequency tuning range (THz) Step：0.00001 (THz)
Response	None
Example	:FREQ:SWE:STAR 185.0570 Sets the sweep start frequency to 185.0570 THz.

[:SOURce][:WAVelength]:FREQuency:SWEep:STARt?

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep:STARt?
Description	Reads out the sweep start frequency.
Parameter	None
Response	Range: Frequency tuning range (THz) Step：0.00001 (THz)
Example	:FREQ:SWE:STAR? → 185.0570 Indicates that the sweep start frequency is 185.0570 THz.

[:SOURce][:WAVelength]:FREQuency:SWEep:STOP

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep:STOP<wsp><value>
Description	Sets the sweep end frequency.
Parameter	Range: Frequency tuning range (THz) Step：0.00001 (THz)
Response	None
Example	:FREQ:SWE:STOP 199.8616 Sets the sweep end frequency to 199.8616 THz.

[:SOURce][:WAVelength]:FREQuency:SWEep:STOP?

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep:STOP?
Description	Reads out the sweep end frequency.
Parameter	None
Response	Range: Frequency tuning range (THz) Step：0.00001 (THz)
Example	: FREQ:SWE:STOP? → 199.8616 Indicates that the sweep end frequency is 199.8616 THz.

[:SOURce][:WAVelength]:FREQuency:SWEep:STEP[:WIDTh]

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep:STEP[:WIDTh]<wsp><value>
Description	Sets the step interval (frequency) of step sweeps.
Parameter	Range：0.00002 ～ 19.76219 (THz) Step：0.00001 (THz)
Response	None
Example	:FREQ:SWE:STEP 0.01 Sets the step interval (frequency) to 0.01 THz.

[:SOURce][:WAVelength]:FREQuency:SWEep:STEP[:WIDTh]?

Syntax	[:SOURce][:WAVelength]:FREQuency:SWEep :STEP[:WIDTh]?
Description	Reads out the step interval (frequency) of step sweeps.
Parameter	None
Response	Range：0.00002 ～ 19.76219 (THz) Step：0.00001 (THz)
Example	:FREQ:SWE:STEP? → 0.010 Indicates that the step interval (frequency) is 0.01 THz.

[:SOURce]:WAVelength:SWEep[:STATe]

Syntax	[:SOURce]:WAVelength:SWEep[:STATe]<wsp><value>
Description	Sets the sweep mode state.
Parameter	0: Stop. Stops the sweep. Available during sweep operation, and pause. 1: Start. Executes a sweep one time. Available in sweep stop state. Repeating operations are executed with other commands. 2: Pause. Pauses the sweep. Available only during sweep operation. 3: Resume. Resumes a sweep from the pause state. Available only during pause.
Response	None
Example	:WAV:SWE 1 Starts a sweep.

[:SOURce]:WAVelength:SWEep[:STATe]?

Syntax	[:SOURce]:WAVelength:SWEep[:STATe]?
Description	Reads out the current sweep mode state.
Parameter	None
Response	0: Stop 1: Operation 2: Pause 3: Trigger standby 4: Returning to START wavelength * When state is “4”, sweep “STOP” and “PAUSE” command are not accepted.
Example	:WAV:SWE? → 1 Indicates that a sweep is in operation.

[:SOURce]:WAVelength:SWEep[:STATe]:REPeat

Syntax	[:SOURce]:WAVelength:SWEep[:STATe]:REPeat
Description	Executes multiple sweeps.
Parameter	None
Response	None
Example	:WAV:SWE:REP Executes multiple sweeps.

[:SOURce]:WAVelength:SWEep:SOFTtrigger

Syntax	[:SOURce]:WAVelength:SWEep:SOFTtrigger
Description	Issues a soft trigger. Executes sweep from trigger standby mode.
Parameter	None
Response	None
Example	: WAV:SWE:SOFT Issues a soft trigger.

[:SOURce]:READout:POINts?

Syntax	[:SOURce]:READout:POINts?
Description	Reads the number of data points recorded by wavelength logging.
Parameter	None
Response	0 ～ 65535 (Returned with a 5-digit integer)

[:SOURce]:READout:DATa?

Syntax	[:SOURce]:READout:DATa?
Description	Reads all the data recorded by wavelength logging. The data is comprised of a header (ASCII characters) and wavelength data array (4-byte binary).
Parameter	None
Response	Ex.: #42000□□□□□□□□ ..... The “4” after the “#” indicates the number of digits following “4”. The following four digits, “2000”, indicate the amount of recorded data in byte units. In this example, there are 2000 bytes of data (500 points). The data is saved in integer format in 0.1 pm units. Binary data is transmitted in Intel byte order.

[:SOURce]:AM:STATe

Syntax	[:SOURce]:AM:STATe<wsp><value>
Description	Enables and disables amplitude modulation of the laser output.External modulation setting cannot be changed to enable, when coherence control is On.
Parameter	0: Disable 1: Enable
Response	None
Example	:AM:STAT 1 Enables the amplitude modulation of the laser output.

[:SOURce]:AM:STATe?

Syntax	[:SOURce]:AM:STATe?
Description	Reads out status of amplitude modulation of the laser output.
Parameter	None
Response	0:Disable 1:Enable
Example	:AM:STAT? →1 Indicates that the amplitude modulation is enabled.

6. Command error

Errors issued in Command set 1 are stored as error messages in the error queue and can be read out with the ":SYSTem:ERRor?" command. The list is as shown below.

Command Error List (Command set 1 Group)

Code	Error message
0	No error
-102	Syntax error
-103	Invalid separator
-108	Parameter not allowed
-109	Missing parameter
-113	Undefined header
-148	Character data not allowed
-200	Execution error
-222	Data out of range
-410	Query INTERRUPTED

■ 7-4-2. TSL-550 Specific Command set List (Command set 2)

This Command set maintains compatibility with existing Santec products, though does not satisfy the requirements specified in IEEE-488.2. Only Command set 2 is available at control when using USB or RS-232C.

1. TSL-550 Specific command overview (Command set 2)
An overview of the specific commands available in Command set 2 is shown in the following table.

Specific Command List (Command set 2 Group)

Command	Description	Page
*IDN?	Identification Query. Returns strings that identify the device.	7-49
LO	Sets ON the LD.	7-49
LF	Sets OFF the LD.	7-49
WA	Sets / reads out the output wavelength.	7-49
FQ	Sets / reads out the output wavelength in optical frequency.	7-49
FT	Sets / reads out the fine-tuning.	7-50
FTF	Stops Fine-tuning mode	7-50
OP	Sets / reads out the optical output power in dBm.	7-50
LP	Sets / reads out the optical output power in mW.	7-51
AF	Switches to Auto for the power control.	7-51
AO	Switches to Manual for the power control.	7-51
AT	Sets / reads out the attenuator value.	7-51
SC	Sets Close status of the internal shutter.	7-51
SO	Sets Open/ status of the internal shutter.	7-52
PR	Revises the compensate power data of sweeps in auto power mode.	7-52
SS	Sets / reads out the sweep start wavelength.	7-52
FS	Sets / reads out the sweep start frequency.	7-52
SE	Sets / reads out the sweep end wavelength.	7-53
FF	Sets / reads out the sweep end frequency.	7-53
SA	Sets / reads out the wait time between each sweep in continuous sweep operation.	7-53
SB	Sets / reads out the amount of time spent during each step in step sweep operation.	7-54
SZ	Sets / reads out the number of wavelength sweeps.	7-54
SN	Sets / reads out the speed for continuous sweep.	7-54
WW	Sets / reads out the step interval (wavelength) of step sweeps.	7-55

Command	Description	Page
WF	Sets / reads out the step interval (frequency) of step sweeps.	7-55
SM	Sets the sweep operation mode.	7-55
SG	Execute a sweep.	7-56
SP	Pause the sweep.	7-56
SQ	Stop the sweep.	7-56
SR	Resume the sweep from pause state.	7-57
ST	Issues a soft trigger.	7-57
SX	Reads out the current number of completed sweeps.	7-57
SK	Reads out the current sweep condition	7-57
TRE	Sets Enable of the external trigger signal input.	7-58
TRD	Sets Disable of the external trigger signal input.	7-58
TM	Sets the timing of the trigger signal output.	7-58
TW	Sets / reads out the interval of the trigger signal output.	7-58
CO	Turns ON the coherence control.	7-58
CF	Turns OFF the coherence control.	7-58
GA	Sets / reads out the GPIB address.	7-59
GD	Sets / reads out the command delimiter for GPIB communication.	7-59
BL	Sets / reads out the speed of serial communication.	7-59
SD	Sets / reads out the command delimiter for serial communication.	7-59
SU	Reads out the status.	7-60
TN	Reads the number of data points recorded by wavelength logging.	7-61
TD	Reads the data recorded by wavelength logging one data record at a time. The data is returned in ASCII characters.	7-61
TA	Reads all the data recorded by wavelength logging. The data is in 4-byte binary format (Intel byte order).	7-61
HFE	Turns the status of external modulation bandwidth broader.	7-62
HFD	Turns the status of external modulation bandwidth narrower.	7-62
WAS	Registers a wavelength data to the memory area.	7-62
WAM	Recalls the wavelength data from the memory area.	7-62
WAR	Reads out wavelength data registered in the memory.	7-62

2. TSL-550 specific command detailed description

Specific commands in Command set 2 are described in detail as follows.

***IDN?** Syntax *IDN?
Description A query to identify the device; places strings of device information such as the name, firmware, and version in the output queue.
Parameter None
Response SANTEC,TSL-550,########,****.****
field = serial number of the device in 8 digits.
* field = firmware version as 4 digits + .(period) + 4 digits.
Example *IDN?
→ SANTEC,TSL-550,06020001,0001.0000

LO Syntax LO
Description Sets ON the LD.
Parameter None
Response None

LF Syntax LF
Description Sets OFF the LD.
Parameter None
Response None

WA Syntax WA<value>
Description Sets the output wavelength. When parameter is not specified, reads out the wavelength currently set.
Parameter Range: Minimum setting wavelength to Maximum (nm)
Step: 0.0001(nm)
Response Currently set value. A value is returned both on setting and on reading.
Example Sets output wavelength to 60.123nm.
WA1560.123
Reads out the currently set value
WA
→ 1560.000
Indicates that the currently set wavelength is 1560nm.

FQ Syntax FQ<value>
Description Sets the output frequency. A set unit is THz.
When parameter is not specified, reads out the frequency currently set.
Parameter Range: Minimum setting frequency to Maximum (THz)
Step: 0.00001 (THz)

	Response	Currently set value. A value is returned both on setting and on reading.
	Example	Sets output frequency to 192.0000THz. FQ192.0000 Reads out the currently set value FQ → 192.0000 Indicates that the currently set frequency is 192.0000THz.
FT	Syntax	FT<value>
	Description	Sets the Fine-Tuning value. When parameter is not specified, reads out the value currently set.
	Parameter	Range: -100 ~+ 100 Step: 0.01
	Response	Currently set value. A value is returned both on setting and on reading.
	Example	Sets the Fine-Tuning value to –50. FT-50 Reads out the currently set value FT → 0100.00 Indicates that the currently set value is 100.
FTF	Syntax	FTF
	Description	Stops Fine-tuning mode, and starts closed-loop wavelength controlling.
	Paramete	None
	Response	None
OP	Syntax	OP<value>
	Description	Sets the optical output power in dBm. When parameter is not specified, reads out the actual power value.
	Parameter	Range: -17 ~ + 13 dBm (typical) Step: 0.01(dB)
	Response	Currently set value. A value is returned both on setting and on reading.
	Example	Sets the optical output power to +3dBm. OP3 Reads out the actual power value. OP → 002.995 Indicates that the actual power value is 2.995dBm.

LP

Syntax: LP<value>

Description: Sets the optical output power in mW.
When parameter is not specified, reads out the actual power value.

Parameter: Range: 0.02 ~ 20mW (typical)
Step: 0.01(mW)

Response: Currently set value. A value is returned both on setting and on reading.

Example:
Sets the optical output power to 10mW.
LP10
Reads out the actual power value.
LP
→ 010.005
Indicates that the actual power value is 10.005mW.

AF

Syntax: AF

Description: Sets the power control to Auto.

Parameter: None

Response: None

AO

Syntax: AO

Description: Sets the power control to Manual.

Parameter: None

Response: None

AT

Syntax: AT<value>

Description: Sets the internal attenuator value.
When parameter is not specified, reads out the value currently set.

Parameter: Range: 0 ~ 30(dB)
Step: 0.01(dB)

Response: Currently set value. A value is returned both on setting and on reading.

Example:
Sets the internal attenuator value to 3dB.
AT3
Reads out the currently set value
AT
→ 010.000
Indicates that the currently set attenuator value is 10dB.

SC

Syntax: SC

Description: Sets CLOSE status of the internal shutter.

Parameter: None

Response: None

SO

Syntax SO
Description Sets OPEN status of the internal shutter.
Parameter None
Response None

PR

Syntax PR
Description Revises the compensate power data of sweeps in auto power mode.
Recommend executing this command when "Over LD"or"Low Pwr"
is displayed.
Parameter None
Response None

SS

Syntax SS<value>
Description Sets the sweep start wavelength. When parameter is not specified, reads out the currently set value
Parameter Range: Minimum setting wavelength to Maximum (nm)
Step: 0.0001(nm)
Response Currently set value. A value is returned both on setting and on reading.
Example Sets the sweep start wavelength to 1510nm.

SS1510

Reads out the currently set value.

SS
→ 1560.000
Indicates that the currently set start wavelength is 1560nm.

FS

Syntax FS<value>
Description Sets the sweep start frequency. When parameter is not specified, reads out the currently set value
Parameter Range: Minimum setting frequency to Maximum (THz)
Step: 0.00001 (THz)
Response Currently set value. A value is returned both on setting and on reading.
Example Sets the sweep start frequency to 199.8616THz.

FS199.8616

Reads out the currently set value.

FS
→ 199.8616
Indicates that the currently set start frequency is 199.8616THz.

SE

Syntax: SE<value>

Description: Sets the sweep stop wavelength. When parameter is not specified, reads out the currently set value.

Parameter: Range: Minimum setting wavelength to Maximum (nm)
Step: 0.0001(nm)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the sweep stop wavelength to 1630nm.

```
SE1630
```

Reads out the currently set value.

```
SE
→ 1560.000
```

Indicates that the currently set stop wavelength is 1560nm.

FF

Syntax: FF<value>

Description: Sets the sweep stop frequency. When parameter is not specified, reads out the currently set value.

Parameter: Range: Minimum setting frequency to Maximum (THz)
Step: 0.00001 (THz)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the sweep stop frequency to 199.8616THz.

```
FF199.8616
```

Reads out the currently set value.

```
FF
→ 199.8616
```

Indicates that the currently set stop frequency is 199.8616THz.

SA

Syntax: SA<value>

Description: Sets the wait time between each sweep in continuous sweep operation. When parameter is not specified, reads out the currently set value.

Parameter: Range: 0 ~ 999.9 (s)
Step: 0.1 (s)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the wait time between each sweep to 1 second.

```
SA1
```

Reads out the currently set value.

```
SA
→ 0000.50
```

Indicates that the currently set wait time is 0.5 second.

SB

Syntax: SB<value>

Description: Sets the amount of time spent during each step in step sweep operation. The wait time between each sweep is also set to the same value. This wait time does not include the time required for wavelength conversion. When parameter is not specified, reads out the currently set value.

Parameter: Range: 0 ~ 999.9 (s)
Step: 0.1 (s)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the wait time of each step to 1 second.

```
SB1
```

Reads out the currently set value.

```
SB
→ 0000.50
```

Indicates that the currently set wait time of each step is 0.5 second.

SZ

Syntax: SZ<value>

Description: Sets the number of wavelength sweeps. When parameter is not specified, reads out the currently set value.

Parameter: Range: 0 ~999
Step: 1

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the number of sweeps to 100.

```
SZ100
```

Reads out the currently set value.

```
SZ
→ 000100
```

Indicates that the number of sweeps is set to 100.

SN

Syntax: SN<value>

Description: Sets the speed for continuous sweep. When parameter is not specified, reads out the currently set value.

Parameter: Range: 1.0 ~ 100 (nm/s)
Step: 0.1 (nm/s)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the speed for continuous sweep to 100nm/s.

```
SN100
```

Reads out the currently set value.

```
SN
→ 100.000
```

Indicates that the sweep speed is set to 100 nm/s.

WW

Syntax: WW<value>

Description: Sets the step interval (wavelength) of step sweeps.
When parameter is not specified, reads out the currently set value.

Parameter: Range: 0.0001 ~ 160 (nm)
Step: 0.0001 (nm)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the step interval to 1 nm.

```
WW1
```

Reads out the currently set value.

```
WW
→ 010.000
```

Indicates that the step interval is 10nm.

WF

Syntax: WF<value>

Description: Sets the step interval (frequency) of step sweeps. When parameter is not specified, reads out the currently set value.

Parameter: Range: 0.00002 ~ 19.76219 (THz)
Step: 0.00001 (THz)

Response: Currently set value. A value is returned both on setting and on reading.

Example: Sets the step interval (frequency) to 0.1 THz.

```
WF0.1
```

Reads out the currently set value.

```
WF
→ 00.1000
```

Indicates that the step interval (frequency) is 0.1THz.

SM

Syntax: SM<value>

Description: Sets the sweep operation mode. When parameter is not specified, reads out the currently set value.

Parameter:
1: Continuous operation, One-way
2: Continuous operation, Two-way
3: Step operation, One-way
4: Step operation, Two-way
5: Step operation, One-way (constant frequency interval)
6: Step operation, Two-way (constant frequency interval)
7: Continuous operation, One-way. Operation is started by trigger signal.
8: Continuous operation, Two-way. Operation is started by trigger signal.
9: Step operation, One-way. Operation is started by trigger signal.
10: Step operation, Two-way. Operation is started by trigger signal.
11: Step operation, One-way (constant frequency interval). Operation is started by trigger signal.
12: Step operation, Two-way (constant frequency interval). Operation is started by trigger signal.

Response Currently set value. A value is returned both on setting and on reading.
Example Sets the sweep mode to Continuous One-way operation.

SM1

Reads out the currently set value.

SM
→ 00009
Indicates that Step one-way operation is started by trigger signal.

SG Syntax SG
Description Executes sweeps or puts the device in trigger signal input standby.
When sweep mode is SM1 to 6, executes sweeps of number that specified by SZ.
When sweep mode is SM7 to 12, puts the device in trigger signal input standby.
Parameter None: Executes multiple sweeps.
1: Executes a sweep once.
Response None
Example Execute a sweep.

SG1

SP Syntax SP
Description Pauses the sweep.
When a fast sweep speed is set, pause will not function.
Parameter None
Response None
Example Pauses the sweep.

SP

SQ Syntax SQ
Description Stops the sweep.
In continuous operation mode, the sweep is continued to the stop wavelength, and stop. Send pause command “SP” and then send “SQ” to stop a sweep before reaching the end wavelength.
Parameter None
Response None
Example Stops the sweep.

SQ

SR Syntax SR
Description Resumes a sweep from the pause state.

Parameter None
Response None
Example Resumes a sweep.
SR

ST Syntax ST
Description Issues a soft ware trigger. This command is used as institute of an external trigger. Set the sweep mode from SM 7 to 12, and trigger standby before operation.
Parameter None
Response None
Example Starts a sweep.
ST

SX Syntax SX
Description Reads out the current number of completed sweeps.
Parameter None
Response current number
Example SX
→ 000100
Indicates that the number of completed sweeps is 100.

SK Syntax SK
Description Reads out the current sweep condition.
Parameter None
Response 0: Stop
1: Executing
2: Pause
3: Awaiting Trigger
4: Setting to sweep start wavelength
*When in state “4”, sweep stop/pause commands are not accepted.
Example SK
→ 1
Indicates that a sweep is in operation.

TRE Syntax TRE
Description Sets Enable of the external trigger signal input.
Parameter None
Response None

TRD Syntax TRD
Description Sets Disable of the external trigger signal input.
Parameter None
Response None

TM Syntax TM<value>
Description Sets the timing of the trigger signal output. When parameter is not specified, reads out the currently set value.
Parameter 0:None
1:Stop
2:Start
3:Step
Response Currently set value
Example Sets the timing to Stop.
TM1

TW Syntax TW<value>
Description Sets the interval of the trigger signal output. When parameter is not specified, reads out the currently set value.
Parameter Range: 0.0001 ~ 160 (nm)
Step: 0.0001 (nm)
Response Currently set value. A value is returned both on setting and on reading.
Example Sets the interval of the trigger signal output to 1nm.
TW1

CO Syntax CO
Description Turns On the coherence control. Coherence control cannot be changed to ON. when modulation setting is “Ext.”.
Parameter None
Response None

CF Syntax CF
Description Turns OFF the coherence control.
Parameter None
Response None

GA

Syntax GA<value>
Description Sets GPIB address. When parameter is not specified, reads out the currently set value.
Parameter Range: 1 ~ 30
Step: 1
Response Currently set value
Example Sets GPIB address to 20.
GA20

GD

Syntax GD<value>
Description Sets the command delimiter for GPIB communication. When parameter is not specified, reads out the currently set value.
Parameter 0:CR
1:LF
2:CR+LF
3:No delimiter, EOI is sent.
Response Currently set value
Example Sets the command delimiter to CR+LF.
GD2

BL

Syntax BL<value>
Description Sets the speed of serial communication (Baud rate). When parameter is not specified, reads out the currently set value.
Parameter 0:2400bps
1:4800bps
2:9600bps
3:19200bps
Response Currently set value
Example Sets baud rate to 19200bps.
BL3

SD

Syntax SD<value>
Description Sets the command delimiter for serial communication. When parameter is not specified, reads out the currently set value.
Parameter 0:CR
1:LF
2:CR+LF
Response Currently set value
Example Sets the command delimiter to CR+LF.
SD2

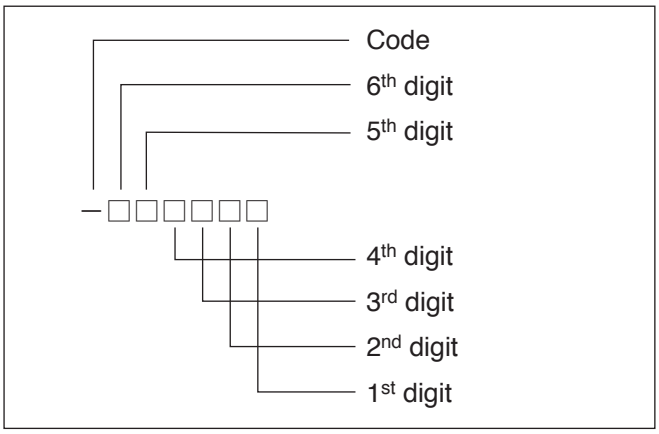
SU

Syntax SU

Description Reads out the status.

Parameter None

Response Status. Status is shown by the first sign and the numerical value of six digits. The state that each digit shows is as follows.



Code [-/none] indicates LD status. 0:OFF, 1:ON
6th digit [0 / 1] indicates coherence control. 0:OFF, 1:ON
5th digit [0 / 1] indicates Fine-tuning. 0:OFF, 1:ON
4th digit [0 - 5] indicates control mode of output power, attenuator, and power monitor range. For detail refer to the table below.
3rd digit [0 / 1] indicates LD temperature error.
0:No error, 1:Error occurred.
2nd digit [0 / 1] indicates LD current limit error.
0:No error, 1:Error occurred.
1st digit [0 - 7] indicates operation status.
0:Operation is completed.
1:Wavelength is tuning.
2:LD current is setting (LD is on state and power control is Auto).
3:Wavelength is tuning and LD current is setting .
4:Attenuator is setting.
5:wavelength is setting and attenuator is setting.
6:LD current is setting and attenuator is setting.
7:Wavelength is tuning ,LD current is setting and attenuator is setting.

Example Reads status.

SU

→ -000005 LD is ON ,wavelength tuning is operating and attenuator tuning is operating.

Detail description of the 4th digit

Value	Power control	Attenuator control	Power monitor range control
0	Auto	Hold	Auto
1	Manual	Hold (Manual)	Auto
2	Auto	Auto	Auto
4	Auto	Hold	Hold
5	Manual	Hold (Manual)	Hold

TN

Syntax: TN
Description: Reads the number of data points recorded by wavelength logging.
Parameter: None
Response: 00000 ~ 65535 (The numerical value of five digits)
Example:
TN
→ 01000
Indicates that recorded data points are 1000.

TD

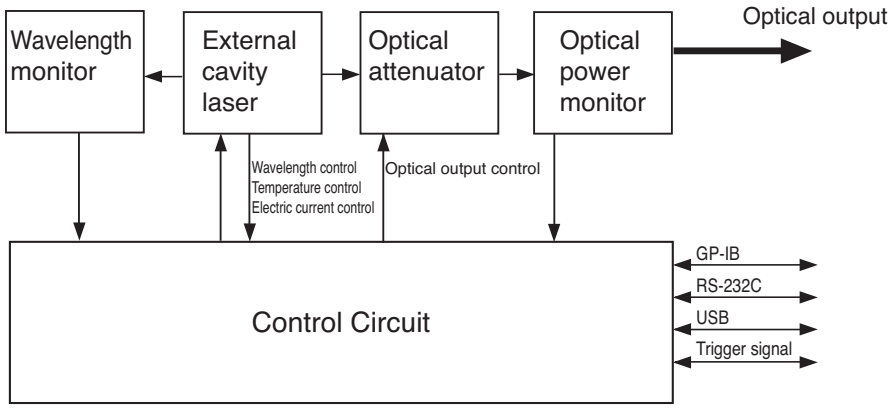
Syntax: TD
Description: Reads the data recorded by wavelength logging one data record at a time. The data is returned in ASCII characters.
The reading point moves to the next data after reading one data.
Parameter: None
Response: Wavelength data in nm.
Example:
TD
→ 1555.000 (ASCII characters)
Recorded data at this point is 1555nm.

TA

Syntax: TA
Description: Reads out all data recorded by wavelength logging at a time. A data is in 4-byte binary, and transmitted in Big endians. Data format is integer number in 0.1 pm units.
Parameter: None
Response: Binary data array
Example:
TA
→ 00E6686000E68F7000E6B680 (in Hexadecimal number)
It includes three 4-byte data and they are transformed to 15100000 15110000 15120000 in decimal numbers.

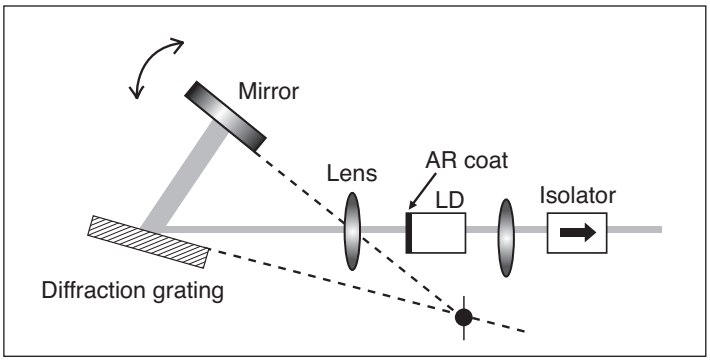
HFE	Syntax	HFE
	Description	Turns the status of external modulation bandwidth broader. This command is necessary when LF modulation is used. External modulation setting cannot be changed to enable, when coherence control is ON.
	Parameter	None
	Response	None
HFD	Syntax	HFD
	Description	Turns the status of external modulation bandwidth narrower. It is effective for reduction of the spectral linewidth.
	Parameter	None
	Response	None
WAS	Syntax	WAS <value>
	Description	Registers a wavelength data to the memory area. Wavelength that is registered is currently set wavelength.
	Parameter	Memory number
	Response	None
WAM	Syntax	WAM<value>
	Description	Recalls the wavelength data from the memory area. Wavelength is set to the recalled value.
	Parameter	Memory number
	Response	None
WAR	Syntax	WAR<value>
	Description	Reads out wavelength data registered in the memory.
	Parameter	Memory number
	Response	Registered wavelength in nm.

8 Operating Principles



TSL-550 block diagram

This device consists of an external cavity laser, optical attenuator, optical power monitor, Wavelength monitor and an electronic control circuit. As shown in Fig.2, the external cavity laser consists of a laser diode (LD), diffraction grating and a mirror. By changing the angle of the mirror, the lasing wavelength can be tuned. By optimally configuring these components a lasing cavity structure is created and while tuning the wavelength, mode-hop is reduced to virtually zero.



Principle of external cavity laser

In order to ensure a constantly stable oscillation state, the LD is maintained at a uniform temperature. Feed back signals from the optical power monitor to the optical attenuator and a regulated electrical current for the LD, controls and stabilizes the optical output power (during Auto mode).



Specifications

9-1 Specifications

■ Optical Specifications

Wavelength range: 1260 to 1360nm and 1500 to 1630nm

Category	Parameter		Unit	Performance	
				TypeA	TypeC
Wavelength Characteristics	Wavelength Tuning Range		nm	1260 to 1360 / 1500 to 1630	
	Wavelength Setting Resolution		pm	0.1	
	Absolute Wavelength Accuracy *1, *2		pm	±15	±3
	Absolute Wavelength Accuracy (operating temperature) *1		pm	±20	±5
	Wavelength Repeatability (typ.) *1		pm	±5	±1
	Wavelength Stability (typ.) *3		pm	≤ ±5	≤ ±1
	Sweep Speed		nm/sec	1 to 100	
Optical power Characteristics	Output Power	Peak (typ.)	dBm	≥ 13	
		Full Tuning Range	dBm	≥ 10	
	Power Repeatability *1, *4		dB	±0.01	
	Power Stability *3, *4		dB	±0.01	
	Power Flatness vs. Wavelength *1, *4		dB	±0.2	
	Relative Intensity Noise (RIN) (typ.) *7		dB/Hz	-145 (1 MHz to 3 GHz)	
Spectrum	Linewidth (typ.)	Coherence Ctrl. Off	kHz	200	
		Coherence Ctrl. On	MHz	40	
	SMSR (typ.)		dB	≥ 45	
	Signal to Total Source Spontaneous Emission Ratio *5		dB	≥ 70	
	Signal to Source Spontaneous Emission Ratio *6		dB/nm	≥ 80 (≥ 90 dB/0.1 nm)	

* All specifications are quoted after 1 hour warm-up period. Specifications apply for wavelengths not equal to any water absorption line.
*1: At static condition or "Step" sweep mode. *2: At 25± 1 °C. *3: For period of 1 hour. Within ± 0.5 °C. *4: At "Auto" power mode.
*5: Ratio of signal power to total spontaneous emission power within ±15nm of the signal wavelength (typical value).
*6: Ratio of signal power to maximum spontaneous emission power in a 1 nm band within a ±3 nm band around the signal wavelength (typical value).
*7: At maximum output power.

Wavelength range: 1355 to 1485nm and 1480 to 1630nm

Category	Parameter		Unit	Performance	
				TypeA	TypeC
Wavelength Characteristics	Wavelength Tuning Range		nm	1355 to 1485 / 1480 to 1630	
	Wavelength Setting Resolution		pm	0.1	
	Absolute Wavelength Accuracy *1, *2		pm	±15	±3
	Absolute Wavelength Accuracy (operating temperature) *1		pm	±20	±5
	Wavelength Repeatability (typ.) *1		pm	±5	±1
	Wavelength Stability (typ.) *3		pm	≤ ±5	≤ ±1
	Sweep Speed		nm/sec	1 to 100	
Optical power Characteristics	Output Power	Peak (typ.)	dBm	≥ 13	
		≥ 10dBm Range	dBm	≥ 10 (1380 to 1485 nm) @1355 to 1485 nm model ≥ 10 (1500 to 1630 nm) @1480 to 1630 nm model	
		Full Tuning Range	dBm	≥ 7	
	Power Repeatability *1, *4		dB	±0.01	
	Power Stability *3, *4		dB	±0.01	
	Power Flatness vs. Wavelength *1, *4		dB	±0.2	
	Relative Intensity Noise (RIN) (typ.) *7		dB/Hz	-145 (1 MHz to 3 GHz)	
Spectrum	Linewidth (typ.)	Coherence Ctrl. Off	kHz	200	
		Coherence Ctrl. On	MHz	40	
	SMSR (typ.)		dB	≥ 45	
	Signal to Total Source Spontaneous Emission Ratio *5		dB	≥ 70	
	Signal to Source Spontaneous Emission Ratio *6		dB/nm	≥ 80 (≥ 90 dB/0.1 nm)	

* All specifications are quoted after 1 hour warm-up period. Specifications apply for wavelengths not equal to any water absorption line.
*1: At static condition or "Step" sweep mode. *2: At 25± 1 °C. *3: For period of 1 hour. Within ± 0.5 °C. *4: At "Auto" power mode.
*5: Ratio of signal power to total spontaneous emission power within ±15 nm of the signal wavelength (typical value).
*6: Ratio of signal power to maximum spontaneous emission power in a 1 nm band within a ±3 nm band around the signal wavelength (typical value).
*7: At maximum output power.

■ Optical Specifications

Wavelength range: 1560 to 1680nm

Category	Parameter		Unit	Performance	
				TypeA	TypeC
Wavelength Characteristics	Wavelength Tuning Range		nm	1560 to 1680	
	Wavelength Setting Resolution		pm	0.1	
	Absolute Wavelength Accuracy *1, *2		pm	±15	±3
	Absolute Wavelength Accuracy (operating temperature) *1		pm	±20	±5
	Wavelength Repeatability *1		pm	±5	±1
	Wavelength Stability (typ.) *3		pm	≤±5	≤±1
	Sweep Speed		nm/sec	1 to 100	
Optical power Characteristics	Output Power *8	Peak (typ.)	dBm	≥ 13	
		Full Tuning Range	dBm	≥ 10	
	Power Repeatability *1, *4		dB	±0.01	
	Power Stability *3, *4		dB	±0.01	
	Power Flatness vs. Wavelength *1, *4		dB	±0.2	
	Relative Intensity Noise (RIN) (typ.) *7		dB/Hz	-145 (1 MHz to 3 GHz)	
Spectrum	Linewidth (typ.)	Coherence Ctrl. Off	kHz	200	
		Coherence Ctrl. On	MHz	40	
	SMSR (typ.)		dB	≥ 45	
	Signal to Total Source Spontaneous Emission Ratio *5		dB	≥ 35	
	Signal to Source Spontaneous Emission Ratio *6		dB/nm	≥ 45 (≥ 55 dB/0.1 nm)	

* All specifications are quoted after 1 hour warm-up period. Specifications apply for wavelengths not equal to any water absorption line.
*1: At static condition or "Step" sweep mode. *2: At 25± 1 ºC. *3: For period of 1 hour. Within ± 0.5 ºC. *4: At "Auto" power mode.
*5: Ratio of signal power to total spontaneous emission power within ±15 nm of the signal wavelength (typical value).
*6: Ratio of signal power to maximum spontaneous emission power in a 1 nm band within a ±3 nm band around the signal wavelength (typical value).
*7: At maximum output power. *8: Warrant range is 1560 to 1650 nm

■ General specifications

Interface	Optical Output Connector	-	FC or SC, SPC or APC
	Optical Fiber	-	SMF or PMF *1
	Communication	-	GP-IB (IEEE 488.2), USB, RS-232C
	Power Monitor	V	0 to 3
Modulation	LF Modulation	kHz	DC to 400 (Input level -2 to 0V, Modulation depth >50%/V (typ.))
	RF Modulation (option)	MHz	2 to 100 (Input level 5Vp-p, Modulation depth >10% (typ.))
Environmental Conditions and others	Operating Temperature	ºC	15 to 35
	Operating Humidity	%	< 80 (non-condensing)
	Power Supply	-	AC 100-240 V±10%, 50/60 Hz
	Power Consumption	VA	100
	Dimensions (W) x (D) x (H)	mm	210x440x110
	Weight	kg	6.5

*1: In case of PMF, polarization axis in alignment with connector key. Polarization extinction ratio is 17 dB (typical value).

9-2 Regulations conformity

This product conforms the following standards.

- EMC: EN 61326-1:2013
  EN55011:2009 + A1:2010 (Class A, Group 1)
  EN61000-4-2:2009
  EN61000-4-3:2006 + A1:2008 + A2:2010
  EN61000-4-4:2012
  EN61000-4-5:2014 + A1:2017
  EN61000-4-6:2014
  EN61000-4-8:2010
  EN61000-4-11:2004 + A1:2017

  FCC 47 CFR Part15 Subpart B Class A (ANSI C63.4:2014)
  ICES-003 Issue 6 Class A (ANZI C63.4:2014)

- Safety: IEC 61010-1: 2010 + AMD1:2016
  IEC 60825-1: 2014(3rd Edition)

- RoHS: EN 50581:2012

10 Maintenance

10-1 Daily Maintenance

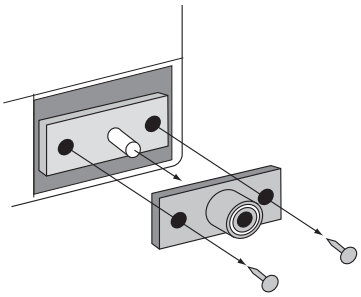
Turn off the power and pull out the power cord before cleaning, and use a soft dry cloth to gently dust the instrument. Do not use chemicals (acetone, alcohol, cleaning fluid, etc), as they may cause damage to the coating. Do not vigorously rub the display, as damage may result.

10 -2 Cleaning the Optical Connector

Connection of the optical fiber with dust and dirt on the end of the optical connector of TSL-550 cause loss of optical output, therefore, clean the connector periodically. The optical adapter arranged at the optical connector may be pulled out by removing fixation screws, therefore, remove it and clean the end of the optical connector.



This product uses a semiconductor laser. Laser beam may cause visual injury if it gets in eye. Before cleaning of the optical connector, be sure to turn the power off (Refer to 5-7), and make sure there is no optical output power.



■ Procedures

1) Remove the 2 screws that fix the optical adapter with a philips screwdriver.
2) Pull out the optical adapter. To facilitate removal, attach a connector cap to the optical adapter, and pinch and pull out the connector cap.
3) Clean the end of the optical connector with alcohol.
4) After cleaning, insert the optical adapter into the optical connector and fix it with 2 screws.

NOTE

After cleaning, insert the optical adapter into the optical connector and fix it securely with 2 screws. If the optical adapter is not attached correctly, optical output power loss will result.

10 - 3 Replacing Fuses

Use two surge resistant type fuses. T1.6A/250V(100~240V). Fuses are in the fuse box above the power inlet on the rear panel. Pull out the fuse box, and replace with new fuses.

10 -4 Inspection/Calibration

TSL-550 is warranted for a period of one year. Inspection and calibration on a regular basis (once every 12 months) is recommended.Please contact our Sales Department concerning requests for instrument inspection/calibration or consultation on other matters.

10 -5 Long-term Storage

■ Before storing the instrument:

1) Make sure the power is shut down completely. (Refer to 5-7 Turning off the unit)
2) Wipe off dust, fingerprints, dirt, stains, etc, from the instrument.
3) Use the packing materials that were originally used to package the instrument.
4) Avoid storing the instrument in the following types of places.
   - Locations that receive direct sunlight
   - Locations subject to high temperature or high humidity
   - Locations where there's a large amount of dirt, dust, salt content, or corrosive gas
   - Locations subject to vibration
   - Locations where the instrument can be affected by noise from an electric or magnetic field,

CAUTION

Damage of the device may be caused by the vibration under transportation if the power supply is not shut down properly. Make sure the power is shut down completely. (Refer to 5-7)

Since this instrument is precision measuring equipment, please avoid vibration as much as possible, and maintain the storage conditions previously specified.

11 Re-packing and Shipping

Special attention for re-packing and shipping is required when you ship the instrument for repair or to a remote location.

11-1 Re-packing

Please make sure that the original shipping box is used during the shipment, according to the following instructions. If the original shipping box is misplaced or damaged, please contact our customer service department. We can arrange for the shipping box to be sent to you.
Alternately, when the original shipping box is not available, send the instrument with a sturdy, robust shipping box and at least 10cm packing material between the instrument and the shipping box. The entire 10cm space on every side of the instrument should be filled with a cushioning material.

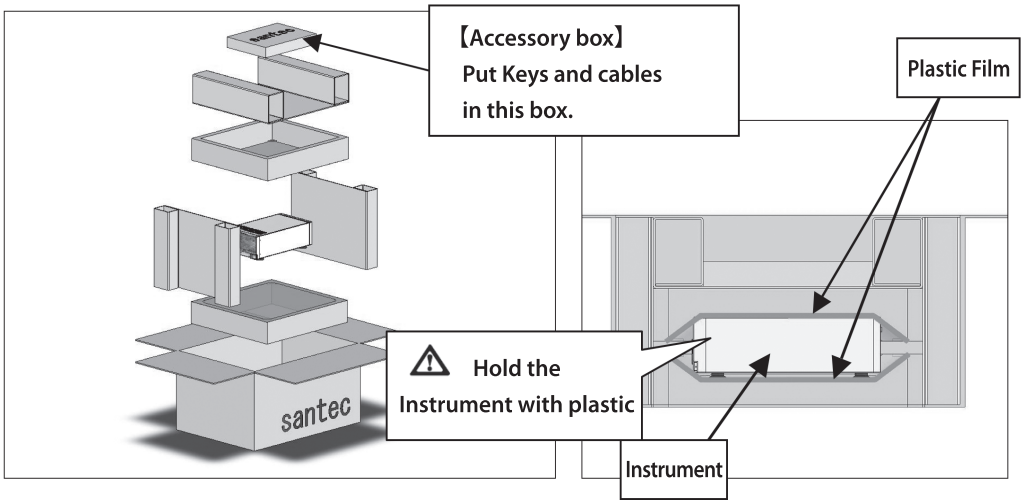
CAUTION

The packing materials we used are designed to protect the instrument from the shock or vibration during the shipment. If the instrument is shipped without packing materials or improperly packed, the instrument might not be able to maintain performance. Any instrument damage that occurred when the instrument shipped without the original shipping box or without proper packing, will not be applicable for warranty repair, even at the guaranteed term.

Damage of the device may be caused by the vibration under transportation if the power supply is not shut down properly. Make sure the power is shut down completely. (Refer to 5-7)

11-2 Packing Instruction

1 Please pack the instrument as shown below.



< Side Angle >

Absorb the shock during the shipment by holding the instrument with fi lms that works as a cushion from the top and the bottom

2 Close the box while applying the pressure.

3 Secure the box by shipping tape or band after closing the box.

11-3 Shipping

Treat the box carefully, and avoid shock or vibration as much as possible. Maintain the box in an upright position and label “THIS SIDE UP” as much as possible.



Troubleshooting

Fault condition	Cause	Action
No power	Cord is unconnected.	Connect cord properly.
	No fuse or fuse is blown out	Open the fuse box lid and replace fuse.
The unit is not turn off.	Some electrical faults occur.	Keep pressing the Power ON/OFF key at least 10 seconds.
No light output	LD drive key is not turned on.	Press LD button to turn LD ON. (see section 5-2)
	Target output power is not set or too low.	Set target out put power (see section 5-4).
	surface of connector is dirty	Clean the surface of connector. (see section 10-2)
	Internal shutter is closed.	Open the shutter. (see section 6-11)
	Interlock circuit is open.	Short the interlock circuit.
Optical output power adjustment is not possible	Power control is manual.	Switch to Auto control. (see section 6-3)
	Power setting mode is not selected.	Select the power setting mode. (see section 5-4)
Optical output power is too low	Attenuator setting is not proper.	Set the attenuator properly. (see section 6-3)
	surface of connector is dirty.	Clean the surface of connector. (see section 10-2)
"TempErr" is displayed on the screen while LD is illuminated.	The ambient temperature may have exceeded the operating temperature range.	"Turn off LD output immediately. If the ambient illuminated. temperature is not within the operating temperature range, turn LD output back on after the ambient temperature returns to within the operating temperature range. Please contact our office if "TempErr" continues to be displayed.
"WL.Err" status is displayed,	The closed-loop wavelength control using the built-in wavelength monitor is not working properly.	Please restart the product and turn on the LD. If "WL.Err" is still displayed, please contact us.
"TempErr" is displayed while LD output is OFF.	LD output was turned off automatically because the LD temperature continued to rise due to abnormal LD temperature control. The ambient temperature may have exceeded the operating temperature range.	Set the ambient temperature to within the operating temperature range and then turn on LD output. Please contact our office if "TempErr" continues to be displayed.
GP-IB communication is not possible	GP-IB address is not set correctly.	Set GPIB address correctly. (see section 7-1-2)
	Delimiter setting is incorrect.	Check the delimiter setting. (see section 7-1-2)
	Cable is not connected properly.	Check the connection of the cable. (see section 7-1-2)

WARNING!

In the event of any trouble with this product, turn the unit off in accordance with the procedures to shut off the power described in this operation manual, disconnect the power source cord, record the product name and serial number described on the name plate of the product, and then contact our dealer at your place or directly contact us at Santec Photonics Laboratories. Our telephone number and facsimile number are shown below. However, we are not responsible for any trouble arising from your own repair or modification on this product.

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