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Optical Tunable Filter

OTF-920

Operation Manual

santec

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About This Manual

This manual explains the operation and safety features of the OTF-920 Optical Tunable Filter. To ensure the safe operation of the instrument, and to prevent the risk of personal injury and/or damage to the equipment we recommend that you read the manual fully before commencing installation and operation. In particular Chapter 6 outlines the precautions necessary to ensure safe operation. The following safety symbols are used throughout the manual and on the equipment to indicate safety related information.



This indicates a dangerous procedure that could result in serious injury or death if not performed properly.



This indicates a hazardous procedure or danger that might result in injury or that could damage the equipment if proper precautions are not taken.



This mark is used on the equipment as a warning of danger.

Packing Materials

The original packing materials are required to ensure the safe long term storage and safe transportation of this equipment. It is recommended that all packing materials are kept for these purposes.

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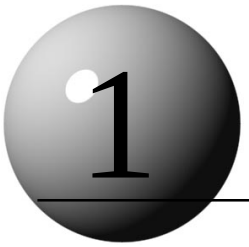
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Introduction



The OTF-920 has been designed to achieve exceptional optical performance whilst maintaining flexibility and ease of use. It incorporates a multi-layer dielectric filter that has been carefully fabricated to ensure high optical quality and long term stability. In addition, the filter uses Santec's unique linear sliding tuning technology which enables a wide tuning range to be achieved, whilst the optical properties such as bandwidth, insertion loss, and polarization dependent loss (PDL) are all wavelength independent.

The OTF-920 is particularly unique in that it has two optical sliders. This allows for flexibility in configuration and operation. Each slider provides a 40nm tuning range and can be configured with either a filter element or a variable attenuator. A combination of the two sliders can thus provide: continuous tuning over a full 80nm, 40nm tuning but with two separate bandwidths, or simultaneous control of wavelength and power using a combination of filter element and attenuator in the sliders.

The OTF-920 boasts a very flexible peak search function that enables it to be used when even multiple signals are present. This feature, combined with the GPIB and RS-232C interfaces, enable the filter to be used in a wide range of applications. The OTF-920 is easy to use, but to obtain the most from your unit we recommend that you read this manual fully and become familiar with its contents prior to operation. We hope that you will be satisfied with your purchase.

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Specifications

Item	Unit	Value		
		Min.	Typ.	Max.
Filter Type	-	Linear Sliding Interference Filter		
Filter in Slider 1		12-S-2: C-band, 12 Type, Single Cavity, Double Stage		
Filter in Slider 2		12-S-2: L-band, 12 Type, Single Cavity, Double Stage		
Wavelength Range	nm	1530		1610
Insertion Loss	dB		2.5	3.0
Bandwidth at -3dB	nm	0.9	1.0	1.1
Bandwidth at -20dB	nm	-	4.5	-
PDL	dB	-	0.1	0.2
PMD	ps	-	-	0.1
Return Loss	dB	45	50	-
Max. Optical Input Power	dBm	-	-	20
Operating Temperature	˚C	20	-	30
Fiber Type	-	SMF		
Connector Type		FC/SPC (FC/APC, SC/SPC, SC/APC options)		
Communication Interface	-	GPIB, RS-232C		
Size	mm	210 x 80 x 300		
Weight	kg	4		
Supply Voltage	V	100 / 110 / 230 / 240		
Maximum Power	W	40		

A wide range of filter types and a 0-20dB attenuator are available. The above table shows an example specification using a nominal 1.2nm bandwidth (12 type), single cavity, double stage filter in both sliders. Please see the serial number label on the rear panel for details of the filter type and options installed on each unit.

The following items should be supplied with your OTF-920 unit:

1. 2 power switch keys
2. Power supply cable
3. Operation manual
4. Test report

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3 Features

3.1. Wavelength Range

The OTF-920 contains two sliders in which the optical filter elements, or variable attenuator elements, are mounted. The OTF-920 can thus be supplied in a variety of configurations. Please note that it is not usually possible to change the configuration after manufacture. Each slider has a tuning range of 40nm for a tunable filter and 20dB for the variable attenuator. The sliders are automatically controlled to provide seemless wavelength tuning, or simultaneous wavelength tuning and power control. The following combinations are possible:

- Identical filter profiles on each slider providing 80nm tuning range, e.g. 1530 - 1610nm.
- Different filter profiles on each slider, each with 40nm tuning range.
- One tunable filter and one attenuator providing both wavelength selection and power control.

3.2. Peak Search Function

The Peak Search function provides automatic searching and selection of the wavelength with the greatest optical power. The function operates by sweeping the filter through a specified wavelength range whilst continuously monitoring the optical power. On completion of the search the filter automatically moves to the wavelength with greatest optical power. The Peak Search Function has two modes. In the standard mode the OTF-920 sweeps through the specified wavelength range in 0.001nm steps. A peak is thus selected with high accuracy, and by selecting a suitable scan range the function can even be used to select a single wavelength from a comb of signals. In addition, a Rapid Mode can also be programmed. In Rapid Mode an initial course wavelength sweep is performed at 1nm intervals and this is followed by a fine wavelength sweep in 0.001nm steps over a range of ±1nm from the detected peak. The Rapid Mode thus enables a rapid scan over a broad wavelength range to be achieved whilst maintaining the high resolution and accuracy.

3.3. Optical Power Monitor

Optical power monitoring is realized by tapping the optical signal using a coupler behind the filter element and monitoring this using a photodetector. Compensation for the wavelength sensitivity of the photodetector is carried out automatically.

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3.4. Optical Power Control

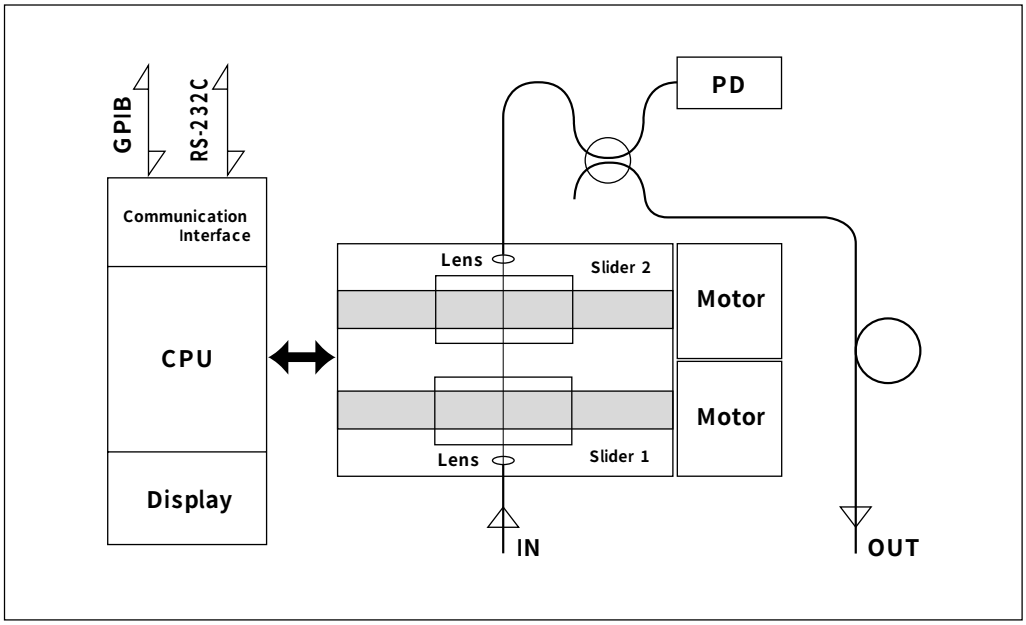
The output optical power can be controlled using the variable attenuator (if fitted). The unit contains two independent sliders; a variable attenuator can be mounted onto one of the sliders. The attenuation can be controlled either manually or automatically. The automatic control uses an integral closed feedback loop, using the signal from the photodetector, and provides automatic power control of the output signal.

3.5. Wavelength Offset

The OTF-920 is calibrated in the factory and should not usually require adjustment. The wavelength calibration feature enables a user to recalibrate the unit should this become necessary. An adjustment of up to ±1.0nm is possible. If the device requires an adjustment greater than this there may be a more serious problem and we recommend that you contact Santec's technical support division.

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4 Principle of Operation



The OTF-920 uses Santec's unique linear sliding tuning technology. This ensures that the optical properties of the filter, including bandwidth, insertion loss and polarization dependent loss (PDL) are all wavelength independent. The filter element is fabricated with a wavelength gradient along its length. Wavelength tuning is achieved by linearly sliding the filter element in the optical beam. This tuning method ensures that the optical beam always passes perpendicularly through the filter element and eliminates the changes in optical properties that would otherwise occur.

The OTF-920 contains two independent optical sliders. The figure above shows a schematic diagram of this design. A tunable filter element, with a tuning range of 40nm, or a variable attenuator element, with 20dB attenuation, can be mounted on each slider. Using tunable filters on both sliders a tuning range of 80nm can thus achieved. The sliders are automatically controlled to provide seemless wavelength tuning or simultaneous wavelength tuning and power control.

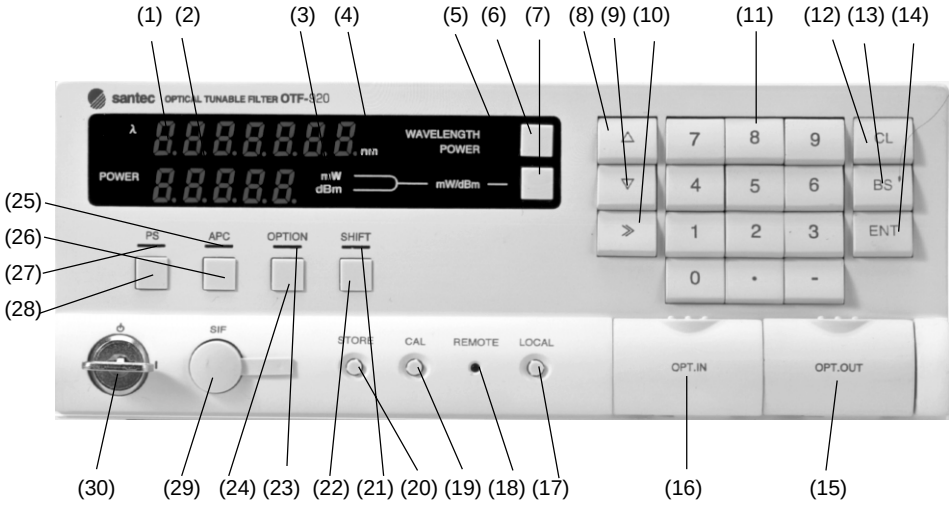
A small portion of the output light is tapped and monitored by a photodetector. This enables accurate power monitoring, and when the Automatic Power Control (APC) mode is activated the signal is processed by the CPU to provide automatic power control of the output signal.

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5 Panel Descriptions

5-1. Front Panel



(1) Wavelength Display Panel

Displays the current wavelength setting in nm

(2) Optical Power Display Panel

Displays the optical output power. The measurement unit can be set to either mW or dBm and is toggled by pressing the mW/dBm selector key (7). The power is calibrated according to the wavelength setting shown in the Wavelength Display Panel (1). (Note: When the attenuator option is fitted and the unit is operated in APC mode, the display will show the target value for automatic power control when the PS key (28) is pressed

(3) Optical Power Unit Indicator

Indicates unit of optical output power (mW or dBm).

(4) Wavelength Unit Indicator

Indicates units of displayed wavelength (nm).

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(5)(6) Attenuation / Wavelength Selector Key and Indicator LED (Option)

Toggles the Wavelength Display (1) between display of attenuation and wavelength. This is used only when the attenuator option is fitted. The indicator LED shows which parameter has been selected.

(7) Optical Power Unit Selector Key

Toggles the optical power measurement unit between mW and dBm.

(8)(9) Up / Down Arrow Key

Increments / decrements value of selected digit by one unit.

(10) Cursor Key

Allows digit selection when using Up / Down Arrow Keys to set value.

(11) Numeric Keypad

Allows direct input of parameters in setting modes.

(12) Clear Key (CL)

Clears values when setting.

(13) Backspace Key (BS)

Moves cursor back one space when entering parameter using numeric keypad.

(14) Enter Key (ENT)

Registers the value entered via either Up / Down Arrow Keys or Numeric Keypad.

(15) Optical Output Connector

The optical output connector is located behind a safety cover. The cover pulls down for use.

(16) Optical Input Connector

The optical input connector is located behind a safety cover. The cover pulls down for use.

(17) GPIB Local Key / GPIB Address Change Key (LOCAL)

a. Pressing this key when GPIB remote operation is active returns control to the front panel.

b. Pressing this key after pressing the SHIFT Key (22) enables the GPIB address and delimiter to be changed. The GPIB address is first displayed in the Optical Power Display Panel (2) and can be changed using the Up / Down Arrow Keys (8)(9). Pressing the GPIB Local Key a second time displays the GPIB delimiter which can be similarly changed using the Up / Down Arrow Keys. Pressing the GPIB Local Key a third time returns control to normal operation.

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(18) GPIB Remote LED

Indicates GPIB remote operation is active. When active the front panel keys become inoperative. To return control to the front panel press the GPIB Local Key (17).

(19) Calibration Key (CAL)

Allows an offset to be applied to the wavelength value displayed. Also used in conjunction with the Shift Key to remove a slider from the optical beam.

(20) Store Key

Stores the wavelength offset data to internal flash memory. This setting is then retained even when power to the OTF-920 is switched off.

(21)(22) Shift Key with Indicator LED

Enables alternative operation of other key functions. The indicator LED lights when the Shift Key is pressed and remains lit until a valid function key is pressed or until the Shift Key is pressed a second time. Pressing the Shift Key a second time cancels its operation. Valid key combinations are:

a. Shift + Local: Allows GPIB Address and Delimiter to be set.

b. Shift + PS: Sets wavelength scan range for Peak Search function.

c. Shift + APC: Sets optical power range for APC control (option).

(23)(24) Option Key with Indicator LED

Enables optional features, such as independent slider control, of the OTF-920 to be operated. The indicator LED lights when the Option Key is pressed and remains lit until a valid function key is pressed or until the Option Key is pressed a second time. Pressing the Option Key a second time cancels its operation.

(25)(26) Automatic Power Control (APC) Key with Indicator LED (Option)

Turns APC control on and off. This function is only available when the attenuator option is fitted. The indicator LED lights when APC control is active. Pressing this key after pressing the SHIFT Key (22) enables the control range of the APC function to be set.

(27)(28) Peal Search (PS) Key with Indicator LED

1. Activates peak search function. Pressing this key during the search cancels the operation. The LED indicates when peak search mode is active.
2. Pressing the key after pressing the SHIFT key enables the wavelength range used for the peak search to be set.

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(29) Serial Interface (SIF) Connector

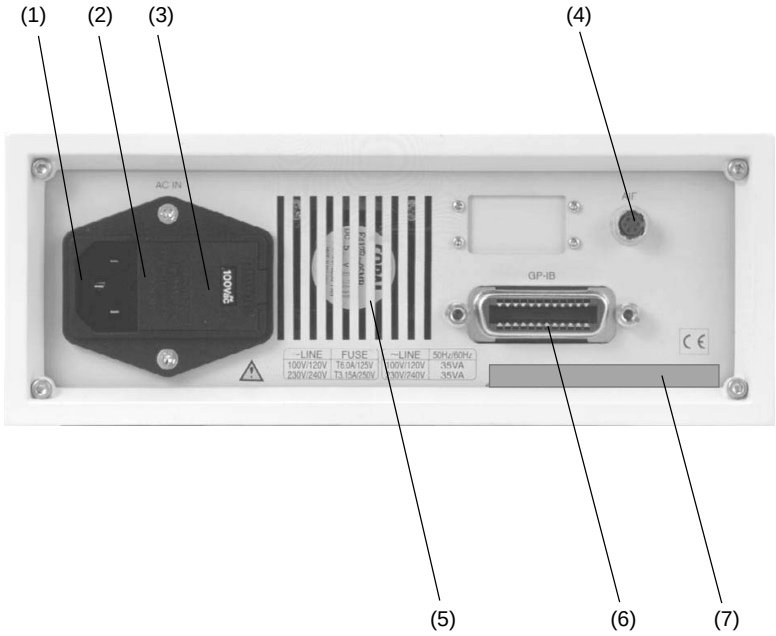
Used for RS-232C communication.

(30) Power On / Off Key Switch

Operated using the power switch key, this is used to switch the unit on and off.

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5.2. Rear Panel



(1) Mains Connector Socket

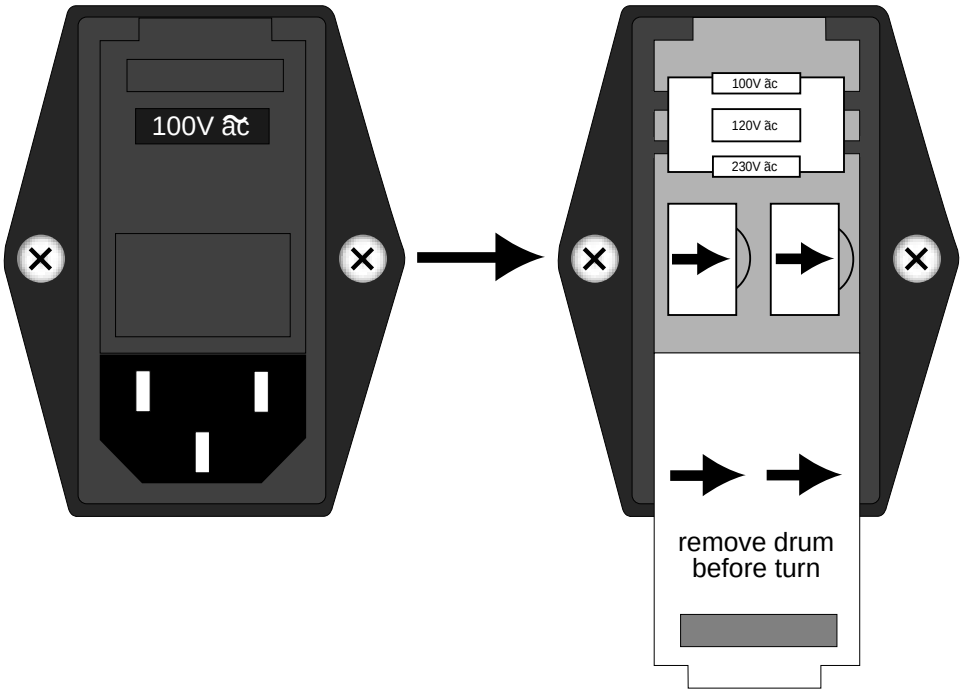
(2) Fuse Housing

(3) Mains Voltage Indicator

The supply voltage is selected by removing the fuse housing cover, and rotating the mains voltage indicator so that the correct voltage, corresponding to the mains supply voltage, is shown in the window when the fuse housing cover is replaced. Ensure that the housing cover is tightly closed before reconnecting the mains cord.

(4) Analogue Interface (AIF) Connector (not used)

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(5) Slit

Slit for heat dissipation. It is important to leave at least 5 cm of space behind the OTF-920 unit to ensure proper ventilation and cooling.

(6) GPIB Connector

(7) Serial Number Label

Indicates model number, serial number and options installed on each unit.

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6 Safety Information

6.1. Mains Voltage

Please ensure the voltage indicated on the rear panel of the instrument corresponds with the mains voltage supply. Applying an incorrect mains voltage will damage the equipment. See Section 5.2 for details of how to change the voltage setting and Section 10.4 for details of changing the fuse. Ensure that the rating of the fuse corresponds to the mains voltage selected; details are given in Section 10.4.

The unit is provided with a three pin cord. To ensure the safe operation of the instrument please make sure that this is connected to a grounded power outlet.

6.2. Installation

To ensure the safe operation of the instrument it should not be installed:

- In a position where the air from the cooling fan cannot flow freely. Allow at least 5cm behind the unit for this purpose.
- Where there are high levels of vibration.
- Where it would come into contact with water.
- In very humid or dusty locations.
- Where there are strong electric or magnetic fields.
- In direct sunlight.
- Where there are extremes of temperature.

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6.3. Safe Operation

The unit should not be operated in any of the following circumstances:

- If water or other liquid is spilt on the unit.
- When the unit is cleaned or moved.
- If damage is found to the mains cord.

In the event that these occur while the unit is being used the Power On / Off Key Switch should be turned off immediately, and the mains power turned off at the outlet.

Also, please note that if the unit is moved from a cool location to a warm location there is a possibility that condensation may form on the inside of the instrument. In these circumstances allow sufficient time for the instrument to dry thoroughly before connecting the mains power.



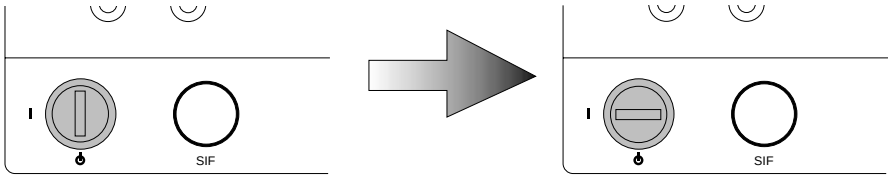
There is a danger of serious injury or death from electric shock if the instrument is used without the correct connection to ground.

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7 Operation Procedures

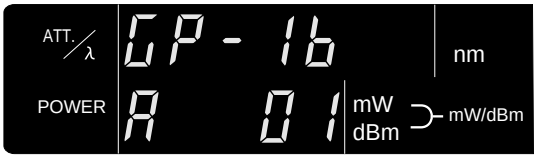
7.1. Power On / Off

The power cord socket is located on the unit's rear panel. Check that the voltage displayed in the window of the socket corresponds to the local mains voltage and plug the power cord into the socket. If the correct voltage is not displayed see Section 5.2 and select the appropriate voltage. Connecting an incorrect voltage will cause damage to the unit.



The main 'Power On' switch is a key switch located on the front panel. Insert the key and rotate clockwise 90 degrees to switch the unit on. The key can only be inserted or removed when it is in the vertical 'Off' position. The unit will perform a short initialization and check procedure lasting about one minute. The display will sequence through the following patterns.





This display indicates the currently set GPIB address. In this example the address is 01.

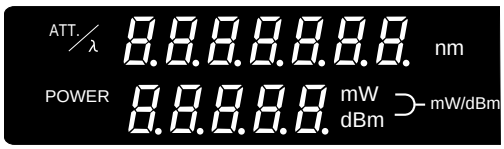


This display indicates the currently set GPIB delimiter. In this example the delimiter is CR+LF.

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This display indicates the currently set GPIB delimiter. In this example the delimiter is CR.



The RS-232C delimiter can be changed by pressing and holding the CL or BS keys when the power is turned on. Once set, the delimiter setting is retained even when power to the unit is turned off. The action of each key when pressed at 'Power On' is indicated below.

CL Key	Sets RS-232C delimiter to CR.
BS Key	Sets RS-232C delimiter to LF.
CL + BS Key	Sets RS-232C delimiter to CR+LF (keys pressed together).

The OTF-920 unit is turned off using the main 'Power On / Off' switch located on the front panel. Rotate the key anti-clockwise 90 degrees to switch the unit off. The key can only be removed when the unit is switched off and in the vertical 'Off' position.

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7.2. Optical Fiber Connection

Open the cover of the optical input connector and connect the optical fiber to the connector. Repeat the operation with the optical output connector.



Before connecting an optical fiber, always clean the end face of the connector. In addition, we recommend that the socket is also periodically cleaned (see Section 10.3). If dirt is present on either the end face of the connector or the socket the insertion loss will be increased. In addition, when high optical powers are used there is the possibility that the connectors may be damaged by scorching.

Before connecting the input light, check that the optical power does not exceed the maximum specified level for the OTF-920. The maximum level is +20dBm. If the optical input exceeds this limit, there is a risk of damage to the OTF-920's internal optical elements.

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7.3. Setting Parameters

A numeric value can be entered using either the Numeric Keypad or the Up / Down Arrow Keys. The following descriptions outline the general operation of each.

7.3.1. Setting using the Numeric Keypad

The numeric keypad provides direct numeric entry for parameters such as wavelength and attenuation. The numeric value shown on the display is only saved to the OTF-920's memory when the enter (ENT) key is pressed. After checking the numeric value displayed is the intended value to be set, always remember to press the ENT key. If the ENT key is pressed before all digits have been entered the remaining digits will be entered as zeros.

The CL key will clear the current display during numeric keypad entry. This is particular useful when an entry error has been made and allows re-entry of all digits.

The BS key will move the cursor position back one digit. This is particularly useful when an entry error has been made and allows re-entry of a single digit.

The Up / Down Arrow Keys and other function keys will become inactive when setting values using the Numeric Keypad.

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7.3.2 Setting using the Up / Down Arrow Keys

The Up / Down Arrow and Cursor Select Keys provide an alternative method for numeric entry of parameters such as wavelength and attenuation. The Up / Down Arrow Keys are used to increment / decrement an individual digit and the Cursor Key is used to step through and select the digit to be set.

Setting mode is activated by pressing either of the Up / Down Arrow Keys or the Cursor Select Key. When setting mode is activated the active digit will flash. The Up / Down Arrow keys are then used to increment / decrement the active digit as required, and the Cursor Key is used to step through individual digits.

When all digits have been set the numeric value shown on the display is saved to the OTF-920's memory by pressing the enter (ENT) key. After checking the numeric value displayed is the intended value to be set, always remember to press the ENT key. When setting some parameters the display will continue to flash for a few seconds indicating that the setting mode is still active, and the flashing digit can be changed if required. The numeric value will, however, have been saved when the ENT key was pressed.

The CL and BS Keys, Numeric Keypad and other function keys will become inactive when setting values using the Up / Down Arrow Keys.

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7.4. Wavelength Tuning / Setting

1. Check that the indicator light adjacent to the Wavelength / Power Selection Key is lit and indicating wavelength. If the indicator light is not indicating wavelength press the Wavelength / Power Selection Key to toggle from the Power setting.

2. Enter the required wavelength value using either the Numerical Keypad or the Up / Down Arrow keys. When using the numerical keypad the first number entered must be a one (1). This is the 1000's unit for the wavelength in nanometers (nm). The value entered must be within the tuning range of the device and has three decimal places. If a wavelength outside the specified range is entered the OTF-920 will be set at either the minimum or maximum achievable value. To cancel the input press the Wavelength / Power Selector Key and the display will return to its currently set value.

3. Press the enter (ENT) key to save the displayed value to memory and initiate a change in the wavelength setting.

7.5. Independent Slider Control (Option)

The OTF-920 contains two sliders in which optical filters can be mounted. When both sliders contain filters which operate over the same wavelength range it is useful to be able to control each slider independently and also to add a wavelength offset between the two sliders. When the OTF-920 is first switched on both sliders move simultaneously when the wavelength is tuned. The sliders can be selected to be either 'active' or 'fixed' by pressing the Shift Key followed by the Option Key according to the procedure below.

1. Press the Shift Key followed by the Option Key. The unit will enter the Slider Selection Mode and the display will show one of the following:

SL 1 2	Slider 1 Active, Slider 2 Active
SL 1	Slider 1 Active, Slider 2 Fixed
SL 2	Slider 1 Fixed, Slider 2 Active
SL	Slider 1 Fixed, Slider 2 Fixed

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2. Press the numeric keys 1 or 2 to toggle the respective sliders between 'Active' and Fixed'.

3. When either Slider 1 or Slider 2 has been selected as 'Active' and the other slider is 'Fixed' pressing the Option Key a second time allows the 'Active' slider to be moved by an offset amount. The display will show d 00.000 as the offset amount. Enter the required offset value using the Numerical Keypad. Pressing ENT will set the offset for the selected 'Active' slider. To cancel this operation without entering a value press the Attenuation / Wavelength Selector Key.

It is also possible to completely remove either one or both sliders from the path of the optical beam. The procedure is described below.

1. Press the Shift Key followed by the CAL Key. The display will show one of the following:

SO 1 2	Slider 1 Removed, Slider 2 Removed
SO 1	Slider 1 Removed, Slider 2 Active
SO 2	Slider 1 Active, Slider 2 Removed
SO	Slider 1 Active, Slider 2 Active

2. Press the numeric keys 1 or 2 to toggle the respective sliders between 'Removed' and 'Active'.
3. Press the CAL Key to register the selection and remove or activate the sliders. To cancel the operation without changing the slider selection press the Attenuation / Wavelength Selector Key.

7.6. Peak Search

The Peak Search function operates by scanning through a range of wavelengths and measuring the power at every point. The filter then automatically sets itself to the wavelength with maximum optical power. The Peak Search uses the currently set wavelength as the center wavelength for the scan, and allows the scan range to be set. This method allows the peak of a signal to be selected even from a comb of wavelengths such as that might be found in a DWDM system, and by minimizing the scan range allows rapid setting and signal optimization. The default scan range is ±1.0nm. The Peak Search function has two modes. In the standard mode the OTF-920 steps in increments of 0.001nm and monitors the power at each wavelength. In

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Rapid Mode the OTF-920 initially scans the wavelength range in 1nm steps and finds the wavelength with the maximum optical power. It then scans in 0.001nm steps over a range of ±1nm about this peak. The Rapid Mode thus enables a rapid scan over a wide wavelength range, whilst maintaining high accuracy of the acutual peak position, to be achieved. The Rapid Mode can only be activated throught the GPIB or RS-232C communication interfaces.

7.6.1 Setting Scan Range

1. Press the Shift Key. The LED immediately above the Shift Key will light indicating the Shift function is active.

2. While the Shift function is active, press the Peak Search (PS) Key. The LED immediately above the PS Key will light. The Wavelength Display Panel will now show the letter 'S' indicating 'shorter scan range' on the left hand side. The currently set shorter scan range will be displayed on the right hand side.

3. Enter the required value for the shorter scan range using either the Numeric Keypad or the Up / Down Arrow Keys. When using the Numeric Keypad the first digit entered is the 100's unit for the wavelength in nm. To set, for example, a shorter scan range of 5nm enter 005.000. Remember to press the enter (ENT) key to register the value. The Shift function will remain active.

4. To continue the setting procedure press the Peak Search (PS) Key twice. The LED immediately above the PS Key will light again and the Wavelength Display Panel will now show the letter 'L' indicating 'longer scan range' on the left hand side. The currently set longer scan range is indicated on the right hand side. If you do not want to change the longer scan range press the Shift Key to cancel the shift function and return to normal operation.

5. Enter the required value for the longer scan range using either the Numeric Keypad or the Up / Down Arrow. Again, when using the Numeric Keypad the first digit entered is the 100's unit for the wavelength in nm. To set, for example, a 'longer' scan range of 5nm enter 005.000. Remember to press the enter (ENT) key to register the value.

6. Press the Shift Key to cancel the Shift function. The LED immediately above the Shift Key will then go off.

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7.6.2 Performing a Scan

1. The Peak Search uses the currently set wavelength as the center wavelength for its search. It is therefore necessary to first set the center wavelength for the scan as detailed in section 7.4.

2. The Peak Search is initiated by simply pressing the Peak Search (PS) key. To cancel the Peak Search press the PS key a second time.

7.7. Optical Power Control (Option)

The Optical Power Control funtion is only available on OTF-920 units supplied with an attenuator mounted in one of the sliders. There are two methods to control the optical output power. The first is referred to as Automatic Power Control (APC) and requires setting the target output power value and the APC Control Range as detailed below. This method will automatically adjust the value of the attenuation to maintain a constant optical output power. The second method is setting the attenuation value directly.

7.7.1 Automatic Power Control (APC)

The Automatic Power Control (APC) operates by monitoring the intensity of the light immediately before the output connector and continuously adjusting the attenuator in steps of 0.01dB to maintain constant output power, at the target value within the limits set by the APC Control Range. When APC is active it is not possible to set the attenuation manually.

APC is activated by pressing the APC Key; when active the LED above the key is lit. When APC mode is active, the setting of the optical output power can be made as indicated below. Note: when APC is switched on the target value automatically becomes the current output power.

1. Check that the LED immediately above the APC Key is lit. If the LED is not lit press the APC Key to activate the APC function.

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2. Check that the Wavelength / Power Indicator LED is indicating Power. If not, press the Wavelength Power Selector Key to toggle from the Wavelength setting.

3. Enter the required value using either the Numeric Keypad or the Up / Down Arrow keys. The value can be entered in either mW or dBm as indicated in the Power Display Panel. The value entered must be in the range –40dBm to 20dBm and has two decimal places. To cancel the input press the Attenuation / Wavelength Selector Key and the display will return to its currently set value.

7.7.2 APC Control Range Setting

The APC Control Range enables a target power range or width to be set for APC control. The automatic feedback will only adjust the attenuation setting when the optical output power exceeds the range specified by the APC Control Range. The power range is the peak to peak width and should be set in the range 0.1dB to 3.0dB. When the optical input power fluctuates rapidly it is recommended to increase the APC Control Range to prevent instability. When no value is entered the default value is 0.1dB.

1. Check that the Wavelength / Power Indicator LED is indicating Power. If not, press the Wavelength Power Selector Key to toggle from the Wavelength setting.

2. Press the Shift Key. The LED immediately above the Shift Key will light indicating the Shift function is active. While the Shift function is active, press the APC Key. The LED immediately above the APC Key will flash and the Shift function will deactivate (Shift LED extinguishes). The Power Display Panel will now show the APC Control Range.

3. Enter the required value for the control range using the Numeric Keypad. The value should be entered in dB and is indicated in the Power Display Panel. The value entered must be in the range 0.1dB to 3.0dB and has two decimal places. To cancel the input press the Attenuation / Wavelength Selector Key and the display will return to its currently set value. It is not possible to set the APC Control Range using the Up / Down Arrow keys.

4. Press the enter (ENT) key to save the displayed value to memory and set the APC Control Range.

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7.7.3 Attenuation Setting

The optical output power can also be adjusted by setting the attenuation directly according to the procedure below. Note that when the APC control is switched off, to enable manual attenuation setting, the attenuator will remain at its current value to ensure the output power does not suddenly change.

1. Check that the Wavelength / Power Indicator LED is indicating Power. If not, press the Wavelength Power Selector Key to toggle from the Wavelength setting. The current setting for the attenuator will be displayed in the Power Display Panel.

2. Enter the required value in units of dB using either the Numeric Keypad or the Up / Down Arrow keys. The value entered must be in the range 0 to 20dB and has three decimal places. To cancel the input press the Attenuation / Wavelength Selector Key and the display will return to its currently set value.

3. Press the enter (ENT) key to save the displayed value to memory and set the Attenuation.

7.8. Changing Display Units

The Power Display Panel can display the optical power in either mW or dBm. The display is toggled by pressing the mW / dBm Selector Key.

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7.9. Wavelength Offset (Calibration)

The OTF-920 is calibrated during manufacture and should not normally require re-calibration. It is useful, however, to have the ability to apply an offset to the wavelength setting; for example, to compensate for the difference between a wavelength in air or in vacuum, or to match the OTF-920 calibration to that of other instruments in the same system. A Wavelength Offset function, which provides up to 1.0nm adjustment, is provided for this purpose.

1. Press the CAL Key. The Wavelength Display Panel changes to indicate the currently set wavelength and the Optical Power Display Panel changes to show 'CAL'.

2. Enter the value of the new wavelength for this position of the filter using either the Numerical Keypad or the Up / Down Arrow keys. To cancel the input press the Wavelength / Power Selector Key and the display will return to its currently set value.

3. Press the enter (ENT) key to save the displayed value, set the Wavelength Offset and return to normal operating mode. If a wavelength has been entered such that the Wavelength Offset is greater than 1.0nm from the factory setting the ENT key will not have an effect. In this case press the CL or BS keys to clear the input and reenter the wavelength, or press the Wavelength / Power Selector Key to cancel the operation. The data will be stored until the power to the OTF-920 is turned off, or the unit is reset. To permanently store the offset follow the procedure given in Section 7.10 below.

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7.10. Storing Wavelength Offset & Parameter Settings

Data set using the Wavelength Offset described in Section 7.10 above is only saved in RAM and is not stored when the power to the OTF-920 is turned off, or when the unit is reset. To permanently store the offset data to memory follow the procedure below. This procedure stores the following parameters: Wavelength Offset, APC target power (option) and APC Control Range (option).

1. Press the Store Key. The message 'STORE' will be displayed in the Wavelength Display Panel. The Optical Power Display Panel will display 'ALL'.

2. Press the enter (ENT) key to store the parameters to memory. To cancel the input without storing the settings press the Store key a second time.

7.11. Resetting Factory Defaults

The OTF-920 can be returned to its default factory settings by pressing and holding the Store Key when power to the unit is turned on and the unit is initialized. Any offset applied to the wavelength setting will thus be removed.

1. Press and hold the Store Key and turn on power to the OTF-920 using the Power On Key. The Wavelength Display Panel will display "INITIAL".

2. When the unit has initialized, pressing the Store Key will reset all parameters to their factory defaults.

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8 Communication Interfaces

The OTF-920 supports both GPIB and RS-232C communication protocols. This enables remote operation of the device, and integration in automated test and measurement systems. Although the two protocols are fundamentally different the core control commands are the same.

8-1. GPIB Control

A standard GPIB delta connector is used. Connections should be made using IEEE-488 compatible cables.

The GPIB protocol requires each device connected to the data bus to have a unique address. The OTF-920 allows addresses to be set in the range 00 to 30. The factory default setting is 01.

To enter the GPIB Address Setting Mode or to check the address that has been set press the SHIFT key followed by the Local key. The current GPIB Address will be displayed. To exit the Address Setting Mode without changing the address press the Local key twice in succession. To change the GPIB Address type in the required value using the number keypad. The address is saved by pressing the Local key twice in succession.

When GPIB remote control is active the 'Remote LED' on the front panel will be lit. Control is returned to the front panel by pressing the Local key on the front panel. The GPIB Local Lockout command (LLO) can be issued to prevent operation of the front panel Local key. In Visual Basic this command is issued using the 'Call SendLLO(0)' code. When the Local Lockout command has been issued control can only be returned to the front panel using the GPIB Interface Clear command (IFC). In Visual Basic this is issued as 'Call SendIFC(0)' where '0' is the GPIB interface number.



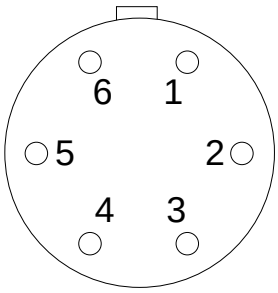
Please ensure the power to the unit is turned off before connecting or disconnecting either the GPIB or RS-232C interfaces.

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8.2. RS-232C Control

The OTF-920 provides support for RS-232C communication through the SIF connector on the front panel. The RTDX (transmit) terminal of the OTF-920 should be connected to the receive terminal of the external device (e.g. computer). The RRDX (receive) terminal of the OTF-920 should be connected to the transmit terminal of the external device. Please ensure that the handshake line on the external device is closed. The terminals for the SIF interface (Hirose Electric HR10-7P-6S) are listed below:

1	N/C	Not used (Do not connect)
2	N/C	Not used (Do not connect)
3	GND	Ground
4	N/C	Not used (Do not connect)
5	RTDX	RS-232C Transmit
6	RRDX	RS-232C Receive



Viewed from front of OTF-920

The following table lists the communication conditions that should be set to enable communication through the RS-232C interface of the OTF-920.

Communication Method	Full Duplex
Baud rate	9600 bps
Data Length	8 bit
Stop Bit	1 bit
Parity	None
Flow Control	None

The delimiter for RS-232C communication is set in the factory as CR (carriage return). This can be changed when power to the OTF-920 is initially switched on. For an explanation of this procedure please see Section 7.1 Power On.

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8.3. Control Commands

The table below lists the control commands specific to the OTF-920 which can be implemented using either the GPIB or RS-232C protocols. A command consists of two letters and may be written in either upper or lower case. As appropriate, the commands can be issued with or without a numerical suffix. A delimiter must be attached to the end of each command to ensure correct execution and termination of each command line. The delimiter required for GPIB operation is CR+LF. The delimiter required for RS-232C operation can be CR, LF or CR+LF. This delimiter is set in the factory to CR and this can be changed during the 'Power On' procedure; for details see Section 7.1 Power On.

In both GPIB and RS-232C protocols when a command is issued that cannot be interpreted the OTF-920 outputs "NR" to the next data request. This output stops when a valid command is received. In RS-232C communication "echo-back" is used to verify correct communications.

Command	Description	Format
WA	Sets output variable to indicate wavelength.	WA
	Sets wavelength to a specific value (nm).	WA xxxx.xxx
CW	Sets output variable to indicate current wavelength offset.	CW
	Sets wavelength offset to a specific value (nm).	CW xxxx.xx
WS	Sets output variable to shorter scan range for PS function.	WS
	Sets shorter scan range to a specific value (nm).	WS xxx.xx
WL	Sets output variable to longer scan range for PS function.	WL
	Sets longer scan range to a specific value (nm).	WL xxx.xx
PS	Executes peak search function.	PS
PO	Sets peak search function to rapid mode.	PO
PF	Cancels rapid mode of peak search function.	PF
OP*1	Sets output variable to indicate optical power (dBm).	OP
	Used with APC control, sets optical power (dBm).	OP xx.xx
LP*1	Sets output variable to indicate optical power (mW).	LP
	Used with APC control, sets optical power (mW).	LP xxx.xx
AT*1	Sets output variable to indicate attenuation (dB).	AT
	Sets value of attenuation (dB).	AT xx.xxx

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AW*1	Sets output variable to indicate optical power control range.	AW
	Sets value of optical power control range.	AW x.x
AO*1	Switches APC (automatic power control) function ON.	AO
AF *1	Switches APC (automatic power control) function OFF.	AF
SE *3	Sets slider to be active. Slider number entered as suffix, 1 or 2.	SE x
SD *3	Sets slider to be fixed. Slider number entered as suffix, 1 or 2.	SD x
SF *3	Removes slider from beam. Slider number entered as a suffix, 1 or 2.	SF x
SO *3	Returns slider from removed state. Slider number entered as a suffix, 1 or 2.	SO x
DO*3	Sets value of offset between sliders (nm).	DO xx.xxx
RE	Initiates reset of OTF-920 unit.	RE
SU*2	Sets output variable to indicate status.	SU
SS*2*3	Sets output variable to suplimentary status.	SS
DI *2	Receive data command for RS-232C communication only. The value of the output variable that has been set is received after this command is issued.	DI

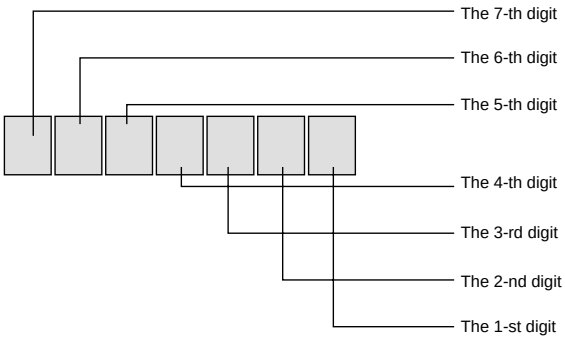
*1 This command is only available when the unit has an attenuator fitted on one of the sliders.

*2 This command does not support "echo-back" in RS-232C communication.

*3 This command is only valid when the unit is configured with both sliders operating over the same wavelength range.

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Status Command



Standard Configuration

The SU command is provided to enable the current operation status of the OTF-920 to be probed. The command returns a seven digit number. The interpretation of the seven digit number is detailed below:

1-st digit	0	– Both sliders are stationary.
	1	– Wavelength is set at given wavelength, but slider 1 is moving.
	2	– Wavelength is set at given wavelength, but slider 2 is moving.
	3	– Wavelength is being tuning.
	4	– Slider is removed from beam, or is moving to set a wavelength offset.
	5	– Slider 2 is set at given wavelength, slider 1 is being removed frombeam.
	6	– Slider 1 is set at given wavelength, slider 2 is being removed from beam.
	7	– Wavelength is being tuned, whilst other slider is removed from beam.
2-nd digit	0	– Peak search function is not active
	1	– Peak search function is active.
	2	– Peak search function is set to rapid mode.
	3	– Rapid peak search function is in rapid mode and active.
3-rd digit	0	– Normal operation.
	1	– Indicates out of control range when operated in APC mode.
4-th digit	0	– Normal operation.
5-th digit	0	– Normal operation.
6-th digit	0	– Normal operation.
	1	– Attenuator is under automatic control (APC Mode on).
7-th digit	0	– Normal operation.

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Supplimentary Status Command

When the OTF-920 is configured with both sliders operating over the same wavelength range the SS (supplimentary status) command can be used to probe the current operation of each slider. The value returned by the SS command has the following meaning.

1-st digit	0	– Slider 1 is stationary.
	1	– Slider 1 is moving.
2-nd digit	0	– Slider 1 is fixed (see SL command Section 7.5).
	1	– Slider 1 is active (see SL command Section 7.5).
3-rd digit	1	– Slider 1 is removed (see SO command Section 7.5).
	3	– Slider 1 is moving to removed state (see SO command Section 7.5).
	4	– Slider 1 is moving from removed state (see SO command Section 7.5).
4-th digit	0	– Slider 2 is stationary.
	1	– Slider 2 is moving.
5-th digit	0	– Slider 2 is fixed (see SL command Section 7.5).
	1	– Slider 2 is active (see SL command Section 7.5).
6-th digit	1	– Slider 2 is removed (see SO command Section 7.5).
	3	– Slider 2 is moving to removed state (see SO command Section 7.5).
	4	– Slider 2 is moving from removed state (see SO command Section 7.5).
7-th digit	0	– Normal operation.

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9 Example Programs

9.1. GPIB Program

The following program provides an example of the use of the Control Commands for GPIB communication. The program is written in Visual Basic and has an input function to set the wavelength and an output function to read the Optical Power.

```
'Set Wavelength Routine                          'Subroutine description
Private Sub Wavelength_Set()                     'Sets routine name to
                                                  Wavelength_Set

'Define Variables                                'Comment
Dim ans As String * 30                           'Dimensions ans array as
                                                  String of length 30
Dim otf920 As Integer                            'Dimensions otf920 as
                                                  integer
Dim otf920a As Integer                           'Dimensions otf920a as
                                                  integer for error checking

'Initialise Device                               'Comment
Call SendIFC(0)                                  'Initialise GPIB interface
Call ibdev(0, 1, 0, T10s, 0, 0, otf920)          'Open and initialise device
Call ibln(otf920, 1, 0, otf920a)                 'Check for device presence
                                                  (error checking)
gpib_dl$ = Chr$(13) + Chr$(10)                   'Set Cr/Lf as delimitter

'Set Wavelength Subroutine                       'Comment
ans = InputBox("Required Wavelength (nm)")       'Ask user for required
                                                  wavelength value
Call ibwrt(otf920, "WA" + ans + gpib_dl$)        'Set wavelength to value
                                                  defined by user input

End Sub                                          'End subroutine
```


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```
'READ POWER (dBm) ROUTINE                    'Subroutine description
Private Sub Power_Read_dBm()                 'Sets routine name to
                                             Power_Read_dBm

'Define Variables                            'Comment
Dim Status_dBm As String * 30                'Dimensions and array as
                                             String of length 30
Dim otf920 As Integer                        'Dimensions otf920 as
                                             integer
Dim otf920a As Integer                       'Dimensions otf920a as
                                              integer for error checking

'Initialise Device                           'Comment
Call SendIFC(0)                              'Initialise GPIB interface
Call ibdev(0, 1, 0, T10s, 0, 0, otf920)      'Open and initialise device
Call ibln(otf920, 1, 0, otf920a)             'Check for device presence
                                             (error checking)
gpib_dl$ = Chr$(13) + Chr$(10)               'Set Cr/Lf as delimitter

'Read Power                                  'Comment
Call ibwrt(otf920, "OP" + gpib_dl$)          'Set output variable to
                                             output power in dBm
Call ibrd(otf920, Status_dBm)                'Read set output variable
MsgBox ("Power = " & Str(Status_dBm))        'Output read data to screen

End Sub                                      'End subroutine
```


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9.2. RS-232C Program

The following program provides an example of the use of the Control Commands for RS-232C communication. The program is written in Visual Basic and has an input function to set the wavelength and an output function to read the optical power. The communications port in this example is Com1 and requires the ActiveX MSComm component to be included in the program.

```
'Set Wavelength Routine                          'Subroutine description
Private Sub Wavelength_Set()                     'Sets routine name to
                                                  Wavelength_Set

'Define Variables                                'Comment
Dim ans As String * 30                           'Dimensions ans array as
                                                  string of length 30

'Set Wavelength Subroutine                       'Comment
ans = InputBox("Required Wavelength (nm)")       'Ask user for required
                                                  wavelength value
Form1.MSComm1.PortOpen = True                    'Open Port MSComm1 in Form1
                                                  of program
Form1.MSComm1.Output = "WA" + ans + Chr$(&HD)    'Send value of wavelength to
                                                  Com port with CR delimiter.
Form1.MSComm1.PortOpen = False                   'Close Port MSComm1 in Form1

End Sub                                          'End Subroutine

'READ POWER (dBm) ROUTINE                        'Subroutine description
Private Sub Power_Read_dBm()                     'Sets routine name to
                                                  Power_Read_dBm

'Define Variables                                'Comment
Dim ans As String * 30                           'Dimensions ans array as
                                                  String of length 30

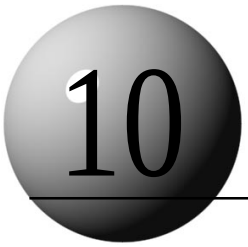
'Read Power Subroutine                           'Comment
Form1.MSComm1.PortOpen = True                    'Open port MSComm1 of Form1
Form1.MSComm1.Output = "OP" + Chr$(&HD)          'Set output variable to output
                                                  power in dBm (CR delimiter)
```


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```
Form1.MSComm1.Output = “DI” + Chr$(&HD)          ‘Send receive data command
                                                  for RS-232 (echo back)
For I = 1 To 1000000                              ‘Delay to wait for echo back
Next I
ans = Form1.MSComm1.Input                         ‘Read data from MSComm1 port
MsgBox (“Power = “ & ans)                         ‘Output read data to screen
Form1.MSComm1.PortOpen = False                    ‘Close communication port

End Sub                                           ‘End subroutine
```


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10 Care and Maintenance

10.1. Care

The OTF-920 is a precision optical instrument and as such requires reasonable care to be taken with its handling, operation and storage. In particular:

- Do not drop or expose the unit to shock as this may cause misalignment of the optics,
- Do not expose the unit to direct sunlight or to extremes of temperature or humidity,
- Avoid letting dust, water, oil or other dirt into the unit and do not operate the unit within such an environment.
- Do not apply a voltage exceeding that indicated in the specifications.

10.2. Maintenance

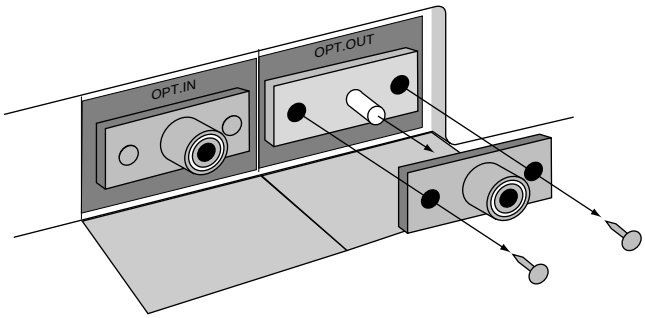
Occasional cleaning of the exterior surfaces of the unit may be required. Please do not use chemical cleaning agents. In particular, avoid chemicals that contain benzene, toluene, xylene, acetone or similar solvents. A dry or slightly damp cloth is recommended.

It is also recommended that the optical connector is cleaned periodically with a cotton pad dipped in alcohol.

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10.3. Cleaning the Optical Connectors

It is important to ensure the optical connectors of the OTF-920 remain clean. Any dirt that accumulates will cause increased loss and when high optical powers are used may lead to connector damage. Periodic cleaning of the optical connectors is recommended. This is achieved by removing the connector adapters as indicated in the cleaning procedure below.



1. Remove the two screws holding each of the connector adapters as shown in the diagram above.

2. Pull each of the connector adapters forward to remove them from the OTF-920 unit.

3. Carefully clean the surface of the protruding optical connectors using a soft lint free cloth moistened with alcohol. Do not press unnecessarily on the end of the connector as this will cause it to become detached from its socket.

4. Carefully replace the connector adapters by sliding them over the protruding optical connectors and tighten with the two fixing screws. The alignment notch in the connector adapter should be positioned at the top of the connector.

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10.4. Changing the Fuse

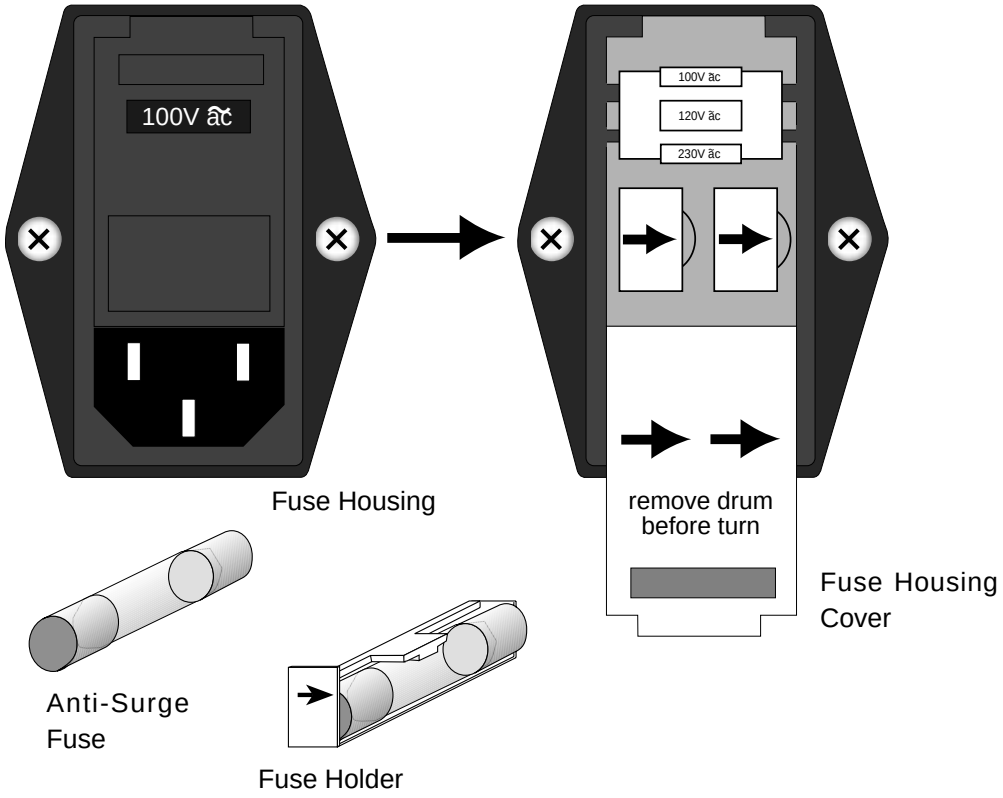
If the fuse blows it is important to determine the cause and repair the fault before replacement. The fuse rating is determined by the supply voltage as indicated below. Failure to use a fuse of the correct rating may result in damage to the equipment. An anti-surge type fuse is required.

Main Voltage	Fuse Rating
100V-120V	3A/125V
230V-240V	1.6A/250V

To change the fuse first remove the mains cord from the back of the instrument and open the cover of the fuse housing using a small screwdriver. Note the direction of the arrows on the end of each fuse holder. The fuse holders can then be removed by pulling from the housing.

When replacing the fuse holders into the housing, ensure that the direction of the arrows on the end of the fuse holder corresponds with the marking on the housing cover. Also, ensure that the housing cover is firmly closed before reconnecting the mains cord.

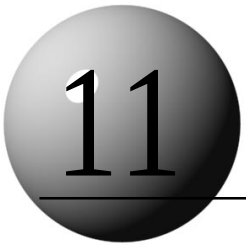
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CAUTION

Before changing the fuse, always disconnect the power cord from the power outlet.

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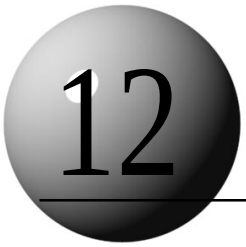
Troubleshooting

Problem	Possible Cause	Remedy
Unable to switch on.	Power cable is unplugged.	Make sure the cable is plugged in.
	Fuse blown.	Open the fuse holder cover on the rear panel and check the supply voltage and fuse.
	No fuse.	
	Wrong supply voltage.	
Unable to change wavelength setting.	ENT has not been pressed.	Press ENT key after entering values.
	Unit is in power setting mode.	Press the Wavelength / Power selector key to change to wavelength setting mode.
	Setting is out of the tuning range.	Check the specification of unit.
	Unit is in calibration mode.	Exit calibration mode.
Unable to change attenuation setting.	Attenuator option not fitted.	Check the specification of unit.
	Unit is in wavelength setting mode.	Press the Wavelength / Power selector key to change to power setting mode.
	Setting is out of the tuning range.	Check the specification.
	Unit is in calibration mode.	Exit calibration mode.
	ENT has not been pressed.	Press ENT key after entering values.
	Unit is in APC mode.	Press APC key to cancel APC mode.
Unable to use front panel.	In GPIB remote mode.	If the GPIB remote LED is lit, press local key to release the GPIB remote mode. Note this function will not work if the Front Panel lockout command has been issued via GPIB.
No light output.	Wavelength of input light is different from wavelength setting of filter.	Set wavelength or use peak search to scan for wavelength peak.
	Attenuation is set too high.	Reduce the attenuation setting or set the unit to APC mode with appropriate setting.
GPIB Communication is not possible.	GPIB address is not set correctly.	Press Shift +Local to check GPIB address and set if necessary.
	Delimiter setting is incorrect.	Check the delimiter setting.
	Cable is not connected properly.	Check the connection of the cable.
RS-232C Communication is not possible.	Communication protocol is incorrect.	Check the communication protocol.
	Delimiter setting is incorrect.	Check the delimiter setting.
	Cable is not connected properly.	Check the connection of the cable.
	Cable is not wired correctly.	Check the pin assignment of the cable.

If after checking the above, the unit is still not operating correctly please contact Santec's technical support division.

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12 Warranty

This product is warranted by Santec Corporation of Japan against defect in material or workmanship for a period of one year from the date of delivery. In the event that a defect occurs during the warranty period, Santec Corporation of Japan will repair this product within a reasonable period of time after notification, free of parts and labor charges, provided that (a) the defective unit is returned to Santec Corporation of Japan, if required, or a specified Santec repair facility; (b) all shipping/customs costs to Japan are paid by the owner of the defective product; (c) the defective unit has not been damaged by power failures or power surges, fire, water, pest or rodent infestation, an act of war, or any other act of nature; and (d) the user has followed the instructions in the operation manual.

Any unauthorized modification, repair, or attempt to repair will render this warranty VOID. Santec will not be responsible for the product when the seals have been broken or damaged.

This warranty is effective only for the original purchaser of this product and is NOT transferable.

All other expressed warranties are disclaimed and all implied warranties for this product, including the warranties of merchantability and fitness for a particular purpose, are limited in duration to a period of one year from the date of delivery. In no event shall Santec Corporation of Japan nor any subsidiary of Santec nor any distributor of Santec's products be liable to the customer for any damages, including lost profits, or other incidental or consequential damages arising out of the use or inability to use this product.

All requests for repair or service under this warranty must be made as soon as possible after the defect has been noticed and must be directed to the original seller of the product, whether a distributor of Santec's products, a subsidiary of Santec Corporation, or Santec Corporation of Japan.

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